RATHINAM TECHNICAL CAMPUS (AUTONOMOUS)

Curriculum and Syllabi

B.E. BIOMEDICAL ENGINEERING

SEMESTERS I to VIII

Regulations 2022

Programme: B.E. BIOMEDICAL ENGINEERING

2022 Regulations

(2022 Batch onwards)

Curriculum for Semesters I to VIII

SEMESTER I

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Cum Practical Courses									
1.	22HS101	English for Communication	3	0	2	5	4	60 / 40	HS
2.	22PH101	Engineering Physics	3	0	2	5	4	60 / 40	BS
3.	22CS101	Problem Solving Techniques I	3	0	2	5	4	60 / 40	ES
4.	22ES101	Innovation and Design Thinking	1	0	2	3	2	0 / 100	ES
5.	22EE101	Circuit Theory	3	0	2	5	4	60 / 40	PC
Theory Courses									
6.	22MA101	Matrices and Calculus	3	1	0	4	4	60 / 40	BS
7.	22AC101	Heritage of Tamil	1	0	0	1	1	0 / 100	AC
8.	22EEC101	Aptitude and Soft Skills	1	0	0	1	1	0 / 100	EEC
Mandatory Course									
9.		Student Induction Programme							MC

SEMESTER II

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Cum Practical Courses									
1.	22CH101	Engineering Chemistry	3	0	2	5	4	60 / 40	BS
2.	22CS201	Problem Solving Techniques II	3	0	2	5	4	60 / 40	ES

Theory Courses									
3.	22MA201	Numerical Methods	3	1	0	4	4	60 / 40	BS
4.	22AC201	Tamils and Technology	1	0	0	1	1	0 / 100	AC
5.	22EEC201	Aptitude and Soft Skills II	1	0	0	1	1	0 / 100	EEC
6.	22EC201	Electron Devices	3	0	0	3	3	60 / 40	ES
7.	22EC202	Electrical Technology	3	0	0	3	3	60 / 40	PC
8.	22HS203	Universal Human Values	2	0	0	2	2	0 / 100	HS
Practical Course									
9.	22ES201	Engineering Practice Laboratory	0	0	4	4	2	40 / 60	ES

SEMESTER III

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Cum Practical Courses									
1.	22BM301	Physio Anatomy	3	0	2	5	4	60 / 40	PC
2.	22CS301	Data Structures	3	0	2	5	4	60 / 40	ES
Theory Courses									
3.	22MA301	Transforms and Partial Differential Equation	3	1	0	4	4	60 / 40	BS
4.	22BM302	Digital Electronics	3	0	0	3	3	60 / 40	ES
5.	22BM303	Pathology and Medical Microbiology	3	0	0	3	3	60 / 40	PC
Practical Course									
6.	22EEC301	Industrial Training / Internship – I	0	0	0	2 Weeks	1	0/100	EEC

SEMESTER IV

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Cum Practical Courses									
1.	22CS403	Database Management Systems	3	0	2	5	4	60 / 40	ES
2.	22EC401	Linear Integrated Circuits	3	0	2	5	4	60 / 40	PC
Theory Courses									
3.	22MA303	Probability and Statistics	3	1	0	4	4	60 / 40	BS
4.	22BM401	Microprocessors and Microcontroller	3	0	0	3	3	60 / 40	PC
5.	22BM402	Bio-control Systems	3	0	0	3	3	60 / 40	PC
6.	22BM403	Biomedical Signal Processing	3	0	0	3	3	60 / 40	PC
Mandatory Course									
7.	22MC401	Indian Constitution					-	0 / 100	MC

SEMESTER V

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Cum Practical Course									
1.	22BM501	Digital Fabrication, Simulation Techniques and Tools	3	0	2	5	4	60 / 40	ES
Theory Course									
2.	22BM502	Biomedical Instrumentation	3	0	0	3	3	60 / 40	PC

Elective Courses									
3.		Professional Elective - I					3	60 / 40	PE
4.		Professional Elective - II					3	60 / 40	PE
5.		Open Elective - I					3	60 / 40	OE
Practical Course									
6.	22BM503	Biomedical Instrumentation Laboratory	0	0	4	4	2	40 / 60	PC
7.	22EEC501	Industrial Training / Internship - II	0	0	0	2 Weeks	1	0 / 100	EEC
8.	22EEC504	Mobile Web Application and Dashboard Development For Biomedical Applications	0	0	2	2	1	0 / 100	EEC

SEMESTER VI

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Cum Practical Course									
1.	22BM601	Medical Image Processing	3	0	2	5	4	60 / 40	PC
Theory Course									
2.	22BM602	Diagnostic and Therapeutic Equipments	3	0	0	3	3	60 / 40	PC
Elective Courses									
3.		Professional Elective - III					3	60 / 40	PE
4.		Open Elective - II					3	60 / 40	OE
5.		Open Elective - III					3	60 / 40	OE
Practical Course									
6.	22BM603	Diagnostic and	0	0	4	4	2	40 / 60	PC

		Therapeutic Equipments Laboratory							
7.	22BM604	FEA-Tool-Ansys workbench	0	0	2	2	1	0 / 100	EEC
8.	22BM605	Virtual Instrumentation Laboratory	0	0	4	4	2	40 / 60	PC
Mandatory Course									
9.	22MC602	Environmental Science					-	0 / 100	MC

SEMESTER VII

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Courses									
1.	22BM701	AR, VR and XR in Biomedical Applications	3	0	0	3	3	60 / 40	PC
2.	22BM702	Pattern Recognition and Neural Networks	3	0	0	3	3	60 / 40	PC
3.	22BM703	Biomedical Entrepreneurship	3	0	0	3	3	60 / 40	HS
Elective Courses									
4.		Professional Elective - IV					3	60 / 40	PE
5.		Open Elective - IV					3	60 / 40	OE
Practical Course									
6.	22EEC701	Project Work – Phase I	0	0	4	4	2	0/100	EEC
7.	22BM704	Clinical immersion and rotation	0	0	6	6	3	40 / 60	PC

SEMESTER VIII

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
Theory Courses									
1.	22MG802	Project Management and Finance	3	0	0	3	3	60 / 40	HS
Elective Course									
2.		Professional Elective - V					3	60 / 40	PE
Practical Course									
3.	22EEC801	Project Work – Phase II	0	0	20	20	10	60/40	EEC

Total Credits: 165

Programme: B.E. BIOMEDICAL ENGINEERING

2022 Regulations

(2022 Batch onwards)

SUMMARY

S.No	SUBJECT AREA	CREDITS AS PER SEMESTER								CREDITS TOTAL
		I	II	III	IV	V	VI	VII	VIII	
1	HS	4	2					3	3	12
2	BS	8	8	4	4					24
3	ES	6	9	7	4	4				30
4	PC	4	3	7	13	5	11	9		52
5	PE					6	3	3	3	15
6	OE					3	6	3		12
7	EEC	1	1	1		2	1	2	10	18
8	AC	1	1							2
	Total	24	24	19	21	20	21	20	16	165
9	MC (Non Credit)	~			~		~			

HUMANITIES AND SOCIAL SCIENCES (HS)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22HS101	English for Communication	3	0	2	5	4	60 / 40	HS
2.	22HS203	Universal Human Values	2	0	0	2	2	0 / 100	HS
3.	22BM703	Biomedical Entrepreneurship	3	0	0	3	3	60 / 40	HS
4.	22MG802	Project Management and Finance	3	0	0	3	3	60 / 40	HS

BASIC SCIENCES (BS)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PH101	Engineering Physics	3	0	2	5	4	60 / 40	BS
2.	22MA101	Matrices and Calculus	3	1	0	4	4	60 / 40	BS
3.	22CH101	Engineering Chemistry	3	0	2	5	4	60 / 40	BS
4.	22MA201	Numerical Methods	3	1	0	4	4	60 / 40	BS
5.	22MA301	Transforms and Partial Differential Equation	3	1	0	4	4	60 / 40	BS
6.	22MA303	Probability and Statistics	3	1	0	4	4	60 / 40	BS

ENGINEERING SCIENCES (ES)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22CS101	Problem Solving	3	0	2	5	4	60 / 40	ES

		Techniques I							
2.	22ES101	Innovation and Design Thinking	1	0	2	3	2	0 / 100	ES
3.	22CS201	Problem Solving Techniques II	3	0	2	5	4	60 / 40	ES
4.	22EC201	Electron Devices	3	0	0	3	3	60 / 40	ES
5.	22ES201	Engineering Practice Laboratory	0	0	4	4	2	40 / 60	ES
6.	22CS301	Data Structures	3	0	2	5	4	60 / 40	ES
7.	22BM302	Digital Electronics	3	0	0	3	3	60 / 40	ES
8.	22CS403	Database Management Systems	3	0	2	5	4	60 / 40	ES
9.	22BM501	Digital Fabrication, Simulation Techniques and Tools	3	0	2	5	4	60 / 40	ES

PROFESSIONAL CORE (PC)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22EE101	Circuit Theory	3	0	2	5	4	60 / 40	PC
2.	22EC202	Electrical Technology	3	0	0	3	3	60 / 40	PC
3.	22BM301	Physio Anatomy	3	0	2	5	4	60 / 40	PC
4.	22BM303	Pathology and Medical Microbiology	3	0	0	3	3	60 / 40	PC
5.	22EC401	Linear Integrated Circuits	3	0	2	5	4	60 / 40	PC
6.	22BM401	Microprocessors and Microcontroller	3	0	0	3	3	60 / 40	PC
7.	22BM402	Bio-control Systems	3	0	0	3	3	60 / 40	PC

8.	22BM403	Biomedical Signal Processing	3	0	0	3	3	60 / 40	PC
9.	22BM502	Biomedical Instrumentation	3	0	0	3	3	60 / 40	PC
10.	22BM503	Biomedical Instrumentation Laboratory	0	0	4	4	2	40 / 60	PC
11.	22BM601	Medical Image Processing	3	0	2	5	4	60 / 40	PC
12.	22BM602	Diagnostic and Therapeutic Equipments	3	0	0	3	3	60 / 40	PC
13.	22BM603	Diagnostic and Therapeutic Equipments Laboratory	0	0	4	4	2	40 / 60	PC
14.	22BM605	Virtual Instrumentation Laboratory	0	0	4	4	2	40 / 60	PC
15.	22BM701	AR, VR and XR in Biomedical Applications	3	0	0	3	3	60 / 40	PC
16.	22BM702	Pattern Recognition and Neural Networks	3	0	0	3	3	60 / 40	PC
17.	22BM704	Clinical immersion and rotation	0	0	6	6	3	40 / 60	PC

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22EEC101	Aptitude and Soft Skills	1	0	0	1	1	0 / 100	EEC
2.	22EEC201	Aptitude and Soft Skills II	1	0	0	1	1	0 / 100	EEC
3.	22EEC301	Industrial	0	0	0	2 Weeks	1	0/100	EEC

		Training / Internship – I							
4.	22EEC501	Industrial Training / Internship - II	0	0	0	2 Weeks	1	0 / 100	EEC
5.	22EEC504	Mobile Web Application and Dashboard Development For Biomedical Applications	0	0	2	2	1	0 / 100	EEC
6.	22BM604	FEA-Tool- Ansys workbench	0	0	2	2	1	0 / 100	EEC
7.	22EEC701	Project Work – Phase I	0	0	4	4	2	0/100	EEC
8.	22EEC801	Project Work – Phase II	0	0	20	20	10	60/40	EEC

AUDIT COURSES (AC)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22AC101	Heritage of Tamil	1	0	0	1	1	0 / 100	AC
2.	22AC201	Tamils and Technology	1	0	0	1	1	0 / 100	AC

NON CREDIT MANDATORY COURSES (NCMC)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.		Student Induction Programme							MC
2.	22MC401	Indian Constitution					-	0/100	MC
3.	22MC602	Environmental Science					-	0/100	MC

Programme: B.E. BIOMEDICAL ENGINEERING

2022 Regulations

(2022 Batch onwards)

Professional Electives

Professional Elective I

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBM01	Tissue Engineering and Artificial Organs	3	0	0	3	3	60/40	PE
2.	22PBM02	Medical Wearable Systems	3	0	0	3	3	60/40	PE
3.	22PBM03	Medical Nanotechnology	3	0	0	3	3	60/40	PE
4.	22PBM04	BioMEMS	3	0	0	3	3	60/40	PE
5.	22PBM05	Biochemistry	3	0	0	3	3	60/40	PE
6.	22PBM06	Biometric Systems	3	0	0	3	3	60/40	PE
7.	22PBM07	Molecular Diagnostics & Genetic Engineering	3	0	0	3	3	60/40	PE
8.	22PBM08	Neuromechanics	3	0	0	3	3	60/40	PE

Professional Elective II

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBM09	Biomechanics	2	0	2	4	3	60/40	PE
2.	22PBM10	Bio Informatics and Drug Design	3	0	0	3	3	60/40	PE
3.	22PBM11	Computational Foundation for Natural Intelligence	3	0	0	3	3	60/40	PE
4.	22PBM12	Radiological Equipments	3	0	0	3	3	60/40	PE

5.	22PBM13	Neural Engineering	3	0	0	3	3	60/40	PE
6.	22PBM14	Medical Waste Management	3	0	0	3	3	60/40	PE
7.	22PBM15	Critical Care and Operation Theatre Equipment	3	0	0	3	3	60/40	PE

Professional Elective III

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBM16	Movement Science and Rehabilitation Engineering	3	0	0	3	3	60/40	PE
2.	22PBM17	Biometrics	3	0	0	3	3	60/40	PE
3.	22PBM18	Biofluids and Dynamics	3	0	0	3	3	60/40	PE
4.	22PBM19	Advancements in Healthcare Technology	3	0	0	3	3	60/40	PE
5.	22PBM20	Physiological modelling of biosystems	3	0	0	3	3	60/40	PE
6.	22PBM21	Bio robotics	3	0	0	3	3	60/40	PE
7.	22PBM22	Medical Regulatory Affairs and Standards	3	0	0	3	3	60/40	PE
8.	22PBM23	Biomaterials	3	0	0	3	3	60/40	PE

Professional Elective IV

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBM24	Ultrasound in Medicine	3	0	0	3	3	60/40	PE
2.	22PBM25	Computational Neuroscience	3	0	0	3	3	60/40	PE

3.	22PBM26	Speech and Language Processing	3	0	0	3	3	60/40	PE
4.	22PBM27	Principles of Tissue Engineering	3	0	0	3	3	60/40	PE
5.	22PBM28	Clinical trials and design of experiments	3	0	0	3	3	60/40	PE
6.	22PBM29	Forensic Science in Medicine	3	0	0	3	3	60/40	PE
7.	22PBM30	Occupational Safety and Public Health Safety Engineering	3	0	0	3	3	60/40	PE
8.	22PBM31	Biocompatibility and microbiological Activity	3	0	0	3	3	60/40	PE

Professional Elective V

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBM32	Intellectual Property Rights	3	0	0	3	3	60/40	PE
2.	22PBM33	Bio photonics	3	0	0	3	3	60/40	PE
3.	22PBM34	Product Ergonomics and Design	3	0	0	3	3	60/40	PE
4.	22PBM35	Biomedical Optics	3	0	0	3	3	60/40	PE
5.	22PBM36	Cardiovascular engineering	3	0	0	3	3	60/40	PE
6.	22PBM37	Bio microfluidics	3	0	0	3	3	60/40	PE
7.	22PBM38	Cognitive neuroscience	3	0	0	3	3	60/40	PE

Programme: B.E. BIOMEDICAL ENGINEERING

2022 Regulations

(2022 Batch onwards)

Open Electives

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22OBM01	Analytical Instruments	3	0	0	3	3	60 / 40	OE
2.	22OBM02	Batteries Management System	3	0	0	3	3	60 / 40	OE
3.	22OBM03	Bioinspired Soft Computing	3	0	0	3	3	60 / 40	OE
4.	22OHS02	Biophysics	3	0	0	3	3	60 / 40	OE
5.	22OBT01	Biostatistics	3	0	0	3	3	60 / 40	OE
6.	22OCS02	Brain Computer Interface	3	0	0	3	3	60 / 40	OE
7.	22OBM05	Clinical Genomics and Proteomics	3	0	0	3	3	60 / 40	OE
8.	22OCS03	Cloud Computing	3	0	0	3	3	60 / 40	OE
9.	22OBM06	Company Specific Assessments for Employability	3	0	0	3	3	60 / 40	OE
10.	22OEC01	Consumer electronics	3	0	0	3	3	60 / 40	OE
11.	22OAG04	Disaster Management	3	0	0	3	3	60 / 40	OE
12.	22OEC06	Electrical Safety and Quality Assurance	3	0	0	3	3	60 / 40	OE
13.	22OEC07	Electromagnetic Interference and Compatibility	3	0	0	3	3	60 / 40	OE
14.	22OEC08	Embedded Systems and C	3	0	0	3	3	60 / 40	OE
15.	22OME09	Engineering	3	0	0	3	3	60 / 40	OE

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
		Graphics and Drawing							
16.	22OEC11	Foundation Skills in Integrated Product Development	3	0	0	3	3	60 / 40	OE
17.	22OBM08	Fundamentals of Nanoscience	3	0	0	3	3	60 / 40	OE
18.	22OCS16	Game Design and Development	3	0	0	3	3	60 / 40	OE
19.	22OBM09	Holistic Nutrition	3	0	0	3	3	60 / 40	OE
20.	22OBM11	Hospital Waste Management	3	0	0	3	3	60 / 40	OE
21.	22OHS03	Human Rights	3	0	0	3	3	60 / 40	OE
22.	22OBT04	Industrial Biotechnology	3	0	0	3	3	60 / 40	OE
23.	22OBM12	Introduction of cell biology	3	0	0	3	3	60 / 40	OE
24.	22OCS22	Introduction to HTML and website development	3	0	0	3	3	60 / 40	OE
25.	22OCS23	Introduction to JAVA	3	0	0	3	3	60 / 40	OE
26.	22OEC12	Introduction to MEMS and NEMS	3	0	0	3	3	60 / 40	OE
27.	22OME17	Introduction to robotics	3	0	0	3	3	60 / 40	OE
28.	22OBM13	Lab on Chip	3	0	0	3	3	60 / 40	OE
29.	22OME20	Mechanical behavior of Materials	3	0	0	3	3	60 / 40	OE
30.	22OBM14	Medical Coding and Transcription	3	0	0	3	3	60 / 40	OE
31.	22OBM15	Medical device	3	0	0	3	3	60 / 40	OE

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
		service and care							
32.	22OEC18	Nanomaterials and its Applications	3	0	0	3	3	60 / 40	OE
33.	22OBM17	Professional Ethics	3	0	0	3	3	60 / 40	OE
34.	22OBM18	Publication writing and plagiarism knowledge	3	0	0	3	3	60 / 40	OE
35.	22OBM19	Research methodology	3	0	0	3	3	60 / 40	OE
36.	22OBM20	Reverse Engineering and Industry	3	0	0	3	3	60 / 40	OE
37.	22OEC22	Signal and image analysis using Matlab	3	0	0	3	3	60 / 40	OE
38.	22OME34	Total Quality Management	3	0	0	3	3	60 / 40	OE
39.	22OEC24	Virtual Instrumentation using LabVIEW	3	0	0	3	3	60 / 40	OE
40.	22OEC25	VLSI system design	3	0	0	3	3	60 / 40	OE

Programme: B.E. BIOMEDICAL ENGINEERING

2022 Regulations

(2022 Batch onwards)

Verticals

Vertical I : Bio Engineering

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBM23	Biomaterials	3	0	0	3	3	60/40	PE
2.	22PBM39	Artificial Organs and Implants	3	0	0	3	3	60/40	PE
3.	22PBM40	Biomedical Optics and Photonics	2	0	2	4	3	60/40	PE
4.	22PBM13	Neural Engineering	3	0	0	3	3	60/40	PE
5.	22PBM27	Principles of Tissue Engineering	3	0	0	3	3	60/40	PE
6.	22PBM41	Genetic Engineering	3	0	0	3	3	60/40	PE

Vertical II : Medical Device Innovation and Development

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBM42	Foundation Skills in Integrated Product Development	3	0	0	3	3	60/40	PE
2.	22PBM43	Medical Device Design	3	0	0	3	3	60/40	PE
3.	22PBM44	Patient safety, Standards and Ethics	3	0	0	3	3	60/40	PE
4.	22PBM45	Medical Device Regulations	3	0	0	3	3	60/40	PE
5.	22PBM46	Medical	3	0	0	3	3	60/40	PE

		Innovation and Entrepreneurship							
6.	22PBM47	Rapid Prototyping	3	0	0	3	3	60/40	PE

Vertical III : Management (Healthcare)

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBM48	Clinical Engineering	3	0	0	3	3	60/40	PE
2.	22PBM49	Hospital Planning and Management	3	0	0	3	3	60/40	PE
3.	22PBM14	Medical Waste Management	3	0	0	3	3	60/40	PE
4.	22PBM50	Economics and Management for Engineers	3	0	0	3	3	60/40	PE
5.	22PBM51	Biostatistics	2	0	2	4	3	60/40	PE
6.	22PBM52	Forensic Science in Healthcare	3	0	0	3	3	60/40	PE

Vertical IV : Mechanics

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBM09	Biomechanics	2	0	2	4	3	60/40	PE
2.	22PBM53	Rehabilitation Engineering	3	0	0	3	3	60/40	PE
3.	22PBM54	Physiological Modelling	3	0	0	3	3	60/40	PE
4.	22PBM55	Assistive Technology	3	0	0	3	3	60/40	PE
5.	22PBM56	Ergonomics	3	0	0	3	3	60/40	PE
6.	22PBM57	Haptics	3	0	0	3	3	60/40	PE

Vertical V : Signal and Image Processing

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBM58	Bio Signal Processing	3	0	0	3	3	60/40	PE
2.	22PCS43	Computer Vision	2	0	2	4	3	60/40	PE
3.	22PBM59	Speech and Audio Signal Processing	3	0	0	3	3	60/40	PE
4.	22PBM60	Medical Imaging Systems	3	0	0	3	3	60/40	PE
5.	22PBM61	Brain Computer Interface and Applications	3	0	0	3	3	60/40	PE
6.	22PBM17	Biometrics	3	0	0	3	3	60/40	PE

Vertical VI : Communication

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBM62	Communication Systems	3	0	0	3	3	60/40	PE
2.	22PBM63	Wearable Devices	3	0	0	3	3	60/40	PE
3.	22PBM64	Body Area Networks	3	0	0	3	3	60/40	PE
4.	22PBM65	Virtual Reality and Augmented Reality in Healthcare	3	0	0	3	3	60/40	PE
5.	22PBM66	Telehealth Technology	2	0	2	4	3	60/40	PE
6.	22PBM67	Medical Informatics	3	0	0	3	3	60/40	PE

Vertical VII : Advanced Healthcare Devices

S. No	Course Code	Course	L	T	P	Total Contact Periods/Week	Credits	External / Internal	Category
1.	22PBM68	Bio MEMS	3	0	0	3	3	60/40	PE
2.	22PBM69	Critical Care Equipment	3	0	0	3	3	60/40	PE
3.	22PBM70	Human Assist Devices	3	0	0	3	3	60/40	PE
4.	22PBM19	Advancements in Healthcare Technology	3	0	0	3	3	60/40	PE
5.	22PBM71	Robotics in Medicine	3	0	0	3	3	60/40	PE
6.	22PBM72	Therapeutic Equipment	3	0	0	3	3	60/40	PE

22HS101	ENGLISH FOR COMMUNICATION	L	T	P	C
		3	0	2	4

Pre-requisite Nil

Course Objectives:

1. To improve the communicative competence of learners.
2. To help learners use language effectively in academic /work contexts.
3. To build on students' English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
4. To develop learners' ability to read and write complex texts, summaries, articles, blogs, definitions, essays and user manuals.
5. To use language efficiently in expressing their opinions via various media.

Course Content:

UNIT I INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 15

Listening - for general information-specific details- conversation: Introduction to classmates - Audio / video (formal & informal); Telephone conversation; Listening to voicemail & messages;

Listening and filling a form.

Speaking - Self Introduction; Introducing a friend; Conversation - politeness strategies; Telephone conversation; Leave a voicemail; Leave a message with another person; asking for information to fill details in a form.

Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails.

Writing - Writing emails / letters introducing oneself.

Grammar - Present Tense (simple and progressive); Question types: Wh / Yes or No / and Tags.

Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).

UNIT II NARRATION AND SUMMATION 15

Listening - Listening to podcast, anecdotes / stories / event narration; documentaries and interviews with celebrities.

Speaking - Narrating personal experiences / events; Interviewing a celebrity; Reporting / and summarising of documentaries / podcasts/ interviews.

Reading - Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel & technical blogs.

Writing - Guided writing-- Paragraph writing Short Report on an event (field trip etc.)

Grammar - Past tense (simple); Subject-Verb Agreement; and Prepositions.

Vocabulary - Word forms (prefixes& suffixes); Synonyms and Antonyms. Phrasal verbs.

UNIT III DESCRIPTION OF A PROCESS / PRODUCT 15

Listening - Listen to a product and process descriptions; a classroom lecture; and advertisements about a product.

Speaking - Picture description; Giving instruction to use the product; Presenting a product; and Summarising a lecture.

Reading - Reading advertisements, gadget reviews; user manuals.

Writing - Writing definitions; instructions; and Product /Process description.

Grammar - Imperatives; Adjectives; Degrees of comparison; Present & Past Perfect Tenses.

Vocabulary - Compound Nouns, Homonyms; and Homophones, discourse markers(connectives & sequence words)

UNIT IV CLASSIFICATION ND RECOMMENDATIONS 12

Listening - Listening to TED Talks; Scientific lectures; and educational videos.

Speaking - Small Talk; Mini presentations and making recommendations.

Reading - Newspaper articles; Journal reports-and Non Verbal Communication (tables, pie charts etc.,)

Writing - Note-making / Note-taking (*Study skills to be taught, not tested); Writing recommendations; Transferring information from nonverbal (chart, graph etc., to verbal mode)

Grammar - Articles; Pronouns - Possessive & Relative pronouns.

Vocabulary - Collocations; Fixed / Semi fixed expressions.

UNIT V EXPRESSION 15

Listening - Listening to debates/ discussions; different viewpoints on an issue; and panel discussions.

Speaking - group discussions, Debates, and Expressing opinions through Simulations & Role-play.
Reading - Reading editorials; and Opinion Blogs;

Writing - Essay Writing (Descriptive or narrative).

Grammar - Future Tenses, Punctuation; Negation (Statements & Questions); and Simple, Compound & Complex Sentences.

Vocabulary - Cause & Effect Expressions – Content vs Function words.

TOTAL LECTURE CUM PRACTICALPERIODS 75Periods

Expected Course Outcome:

1. To listen and comprehend complex academic texts.
2. To read and infer the denotative and connotative meanings of technical texts.
3. To write definitions, descriptions, narrations and essays on various topics.
4. To speak fluently and accurately in formal and informal communicative contexts.

5. To express their opinions effectively in both oral and written medium of communication.

Text Book(s):

1. English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition).
2. English for Science & Technology Cambridge University Press, 2021. Authored by Dr.VeenaSelvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

Reference Books:

1. Technical Communication – Principles And Practices, Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2. A Course Book On Technical English By Lakshminarayanan, Scitech Publications (India) Pvt. Ltd.
3. English For Technical Communication (With CD) By AyshaViswamohan, Mcgraw Hill Education, ISBN: 0070264244.
4. Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.
5. Learning to Communicate – Dr. V. Chellammal, Allied Publishing House, New Delhi,2003.

22PH101	**ENGINEERING PHYSICS**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

Pre-requisite Nil

Course Objectives:

1. To make the students effectively achieve an understanding of mechanics and properties of matter.
2. To enable the students to gain knowledge of electromagnetic waves.
3. To introduce the basics of solid-state physics.
4. Equipping the students to successfully understand the importance of optics and Laser.
5. To motivate the students towards the applications of quantum mechanics.
6. To learn problem solving skills related to physics principles and interpretation of experimental data.
7. To determine error in experimental measurements and techniques used to minimize such error.

Course Content:

UNIT I MECHANICS AND PROPERTIES OF MATTER 9

*Mechanics:*Center of mass (CM) – CM of continuous bodies – motion of the CM – kinetic energy of the system of particles. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy-moment of inertia and its theorem- gyroscope - torsional pendulum.

*Elasticity:*Elastic modules – Poisson’s ratio – relation between them – determination of Young’s modulus by uniform and non-uniform bending- I section girders.

UNIT II ELECTROMAGNETIC WAVES **9**

Maxwell's equations (Basics) - Charged particles in uniform and constant electric field – Charged particles in an alternating electric field- polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium vacuum interface for normal incidence.

UNIT III SOLID STATE PHYSICS **9**

Elements of crystallography; diffraction methods for structure determination; bonding in solids; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids: nearly free electron and tight binding models; metals, semiconductors and insulators; conductivity, mobility and effective mass; optical, dielectric and magnetic properties of solids; elements of superconductivity: Type-I and Type II superconductors, Meissner effect, London equation.

UNIT IV OPTICS & LASER **9**

Classification of optical materials – carrier generation and recombination processes - insulators and semiconductors (concepts only) - photo current in a P-N diode – solar cell - LED– Laser diodes – Optical data storage techniques.

Laser (Basics)– Einstein's coefficient- Types of Laser- He- Ne Laser - CO_2 laser, Nd-YAG laser, semiconductor laser – MASER Introduction - Holography: Principle and construction -Reconstruction of Holography.

UNIT V QUANTUM MECHANICS & NANODEVICES **9**

Compton effect - The Schrodinger equation (Time dependent and time independent forms)- particle in an infinite potential well: 1D,2D and 3D Boxes.

NanoDevices: Introduction - quantum confinement – quantum structures: quantum wells, wires and dots – – band gap of nanomaterials. Tunneling – Single electron phenomena: Coulomb blockade - resonant-tunneling diode – single electron transistor – quantum cellular automata - Quantum system for information processing.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

1. Understand the importance of mechanics and properties of matter
2. Express their knowledge in electromagnetic waves.
3. Demonstrate a strong foundational knowledge in solid state physics.
4. Gain the knowledge in optics and Laser.
5. Understand the importance of quantum physics and Nanodevices.
6. Understand the functioning of various physics laboratory equipment.
7. Use graphical models to analyze laboratory data.
8. Use mathematical models as a medium for quantitative reasoning and describing physical reality.

Text Book(s):

1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017.
2. Brijlal and N. Subramaniam "Properties of Matter", Eurasia Publishing House Limited, 1993.
3. E.M.Purcell and D.J.Morin, Electricity and Magnetism, Cambridge Univ. Press.
4. Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGrawHill (Indian Edition), 2017.

5. Parag K. Lala, Quantum Computing: A Beginner's Introduction, McGraw-Hill Education (Indian Edition), 2020.

Reference Books:

1. R.Wolfson. Essential University Physics. Volume 1 & 2. Pearson Education (Indian Edition), 2009.
2. Paul A. Tipler, Physics – Volume 1 & 2, CBS, (Indian Edition), 2004.
3. K.Thyagarajan and A.Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications, (Indian Edition), 2019.
4. D.Halliday, R.Resnick and J.Walker. Principles of Physics, Wiley (Indian Edition), 2015.
5. G.W. Hanson, Fundamentals of Nanoelectronics, Pearson Education (Indian Edition) 2009.

Web Links:

1. https://bayanbox.ir/view/7764531208313247331/Kleppner-D.-Kolenkow-R.J.-Introduction-to-Mechanics-2014.pdf
2. https://physicaeducator.files.wordpress.com/2017/11/electricity_and_magnetism-by-purcell-3ed-ed.pdf
3. https://safehandsakola.org/downloads/Physics/Concepts%20of%20Modern%20Physics%20-Arthur%20Beiser.pdf
4. https://web.pdx.edu/~pmoeck/books/Tipler_Llewellyn.pdf
5. https://farside.ph.utexas.edu/teaching/qmech/qmech.pdf
6. https://web.pdx.edu/~pmoeck/phy381/workbook%20nanoscience.pdf

List of Experiments:

1.	Exchange the values of two variables	**3**
2.	Circulate the values of n variables, distance between two points.	**3**
3.	Square root, gcd, Exponentiation.	**3**
4.	Linear search, binary search.	**3**
5.	Simple sorting, histogram, Students marks statement.	**3**
6.	Retail bill preparation.	**3**
7.	Word count, copy file.	**3**
8.	Voter’s age validation, Marks range validation (0-100).	**3**
9.	Mini Project – 1	**3**
10.	Mini Project –2	**3**

TOTAL PRACTICAL PERIODS 30Periods

TOTAL LECTURE CUM PRACTICAL PERIODS 75Periods

22CS101	PROBLEM SOLVING TECHNIQUES I	L	T	P	C
		3	0	2	4

Pre-requisite Nil

Course Objectives:

1. To understand the basics of algorithmic problem solving.
2. To learn to solve problems using Python conditionals and loops.
3. To define Python functions and use function calls to solve problems.
4. To use Python data structures - lists, tuples, dictionaries to represent complex data.
5. To do input/output with files in Python.

Course Content:

UNIT I COMPUTATIONAL THINKING AND PROBLEM SOLVING 9

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion).

UNIT II DATA TYPES, EXPRESSIONS, STATEMENTS 9

Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string , and list; variables, expressions, statements, tuple assignment, precedence of operators, comments;

UNIT III CONTROL FLOW, FUNCTIONS, STRINGS 9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays.

UNIT IV LISTS, TUPLES, DICTIONARIES 9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension;

UNIT V FILES, MODULES, PACKAGES 9

Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages;

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

1. Develop algorithmic solutions to simple computational problems.
2. Develop and execute simple Python programs.
3. Write simple Python programs using conditionals and loops for solving problems.
4. Decompose a Python program into functions.
5. Represent compound data using Python lists, tuples, dictionaries etc.
6. Read and write data from/to files in Python programs.

Text Book(s):

1. Allen B. Downey, “Think Python: How to Think like a Computer Scientist”, 2nd Edition, O’Reilly Publishers, 2016.
2. Karl Beecher, “Computational Thinking: A Beginner's Guide to Problem Solving and Programming”, 1st Edition, BCS Learning & Development Limited, 2017.

Reference Books:

1. Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.
2. G Venkatesh and MadhavanMukund, “Computational Thinking: A Primer for Programmers and Data Scientists”, 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data”, Third Edition, MIT Press, 2021
4. Eric Matthes, “Python Crash Course, A Hands - on Project Based Introduction to Programming”, 2nd Edition, No Starch Press, 2019.
5. Martin C. Brown, “Python: The Complete Reference”, 4th Edition, Mc-Graw Hill, 2018.

Web Links:

1. https://www.python.org/

22ES101 INNOVATION AND DESIGN THINKING

L	T	P	C
1	0	2	2

Pre-requisite Nil

Course Objectives:

1. To explain the concept of design thinking for product and service development
2. To explain the fundamental concept of innovation and design thinking
3. To discuss the methods of implementing design thinking in the real world.

Course Content:

UNIT I PROCESS OF DESIGN **3**

Understanding Design thinking - Shared model in team-based design – Theory and practice in Design thinking – Explore presentation signers across globe – MVP or Prototyping.

UNIT II TOOLS OF DESIGN THINKING **3**

Real-Time design interaction captures and analysis – Enabling efficient collaboration in digital space – Empathy for design – Collaboration in distributed Design.

UNIT III DESIGN THINKING IN IT **3**

Design Thinking to Business Process modelling, Finding pain points.

UNIT IV DT FOR STRATEGIC INNOVATIONS **3**

Growth – Story telling representation – Strategic Foresight - Change – Sense Making - experience design - Standardization – Humanization - Creative Culture.

UNIT V DESIGN THINKING WORKSHOP **3**

Design Thinking Workshop Empathize, Design, Ideate, Prototype and Test.

TOTAL LECTURE CUM PRACTICAL PERIODS 15 Periods

Expected Course Outcome:

1. To immerse students into the world of innovation as a systematic process of tackling relevant business and/or social problems.
2. To provide a social and thinking space for the recognition of innovation challenges and the design of creative.
3. To expose the student with state of the art perspectives, ideas, concepts, and solutions related to the design and execution of innovation driven projects using design thinking principles.

4. To develop an advance innovation and growth mindset form of problem identification and reframing, foresight, hindsight and insight generation.

Text Book(s):

1. John.R.Karsnitz, Stephen O’Brien and John P. Hutchinson, “Engineering Design”,Cengage learning (International edition) Second Edition, 2013.
2. Roger Martin, "The Design of Business: Why Design Thinking is the Next Competitive Advantage", Harvard Business Press, 2009.
3. Hasso Plattner, Christoph Meinel and Larry Leifer (eds), "Design Thinking: Understand – Improve – Apply", Springer, 2011.
4. Idris Mootee, "Design Thinking for Strategic Innovation: What They Can't Teach You at Business or Design School", John Wiley & Sons 2013.

Reference Books:

1. Yousef Haik and Tamer M. Shahin, “Engineering Design Process”, Cengage Learning, Second Edition, 2011.
2. Book - Solving Problems with Design Thinking - Ten Stories of What Works (Columbia Business School Publishing) Hardcover – 20 Sep 2013 by Jeanne Liedtka (Author), Andrew King (Author), Kevin Bennett (Author).

22EE101	**CIRCUIT THEORY**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

Pre-requisite Nil

Course Objectives:

1. To understand DC and AC circuits.
2. To learn network theorems and two port networks for circuit analysis.
3. To explore the transient and resonance response of different electrical circuit.

Course Content:

UNIT I BASIC CIRCUITS ANALYSIS 15

Ohm’s Law – Kirchhoff’s laws - Resistors & Capacitors in series and parallel circuits - voltageand current division, dependent and independent sources-source transformation – star delta conversion-Mesh current and nodevoltagemethod of analysis forD.C Circuits.

UNIT II NETWORK THEOREMS FOR DC CIRCUITS 15

Thevenin’s and Norton Theorem – Superposition Theorem – Maximum power transfer theorem – Reciprocity Theorem - Millman’s Theorem.

UNIT III AC CIRCUITS 15

Representationofsinusoidalwaveforms,peakandrmsvalues,phasorrepresentation,realpower, reactive power, apparent power, power factor.Analysis of single-phase AC circuits consisting of R, L, C, RL, RC, RLC combinations (Series and Parallel), Mesh and Nodal analysis for AC circuits-Three phase balanced circuits– voltage, current, power relations in star and delta connections.

UNIT IV RESONANCE AND COUPLED CIRCUITS 15

Seriesandparallelresonance–frequencyresponse–QualityfactorandBandwidth–Inductance - Self and mutual inductance – Coefficient of coupling – Tuned circuits – Single tuned circuits –Double Tuned Circuits.

UNIT V TRANSIENT RESPONSE FOR DC CIRCUITS 15

Transient response of RL, RC and RLC Circuits using Laplace transform for DC input– Characterization of two port networks in terms of Z, Y and H parameters, An introduction to Network Topology, Trees and General Nodal analysis, Links and Loop analysis.

TOTAL LECTURE PERIODS 75 Periods

Expected Course Outcome:

1. Comprehend and design DC circuits.
2. Apply circuit theorems in real time.
3. Derive the sinusoidal steady-state (single-phase and three-phase) response of AC Circuits.
4. Analyse the Resonance response of electrical circuits.
5. Analyse the Transient response of electrical circuits.

Text Book(s):

1. William H. HaytJr, Jack E. Kemmerly and Steven M. Durbin, “Engineering Circuits Analysis”, McGraw Hill publishers, 9thedition, New Delhi, 2020.
2. Joseph A. Edminister, Mahmood Nahvi, “Electric circuits”, Schaum’s series, McGraw-Hill, , 2019.

Reference Books:

1. Chakrabarti A, “Circuits Theory” (Analysis and synthesis), Dhanpat Rai& Sons, New Delhi, 2020.
2. Charles K. Alexander, Mathew N.O. Sadiku, “Fundamentals of Electric Circuits”, Second Edition, McGraw Hill, 2019.
3. Sudhakar A and Shyam Mohan SP, “Circuits and Networks Analysis and Synthesis”, McGraw Hill, 2015.

Web Links:

1. http://vlab.co.in/
2. http://electrical4u.com
3. http://network_analysis_(electrical_circuits)#Two_port_parameters

22MA101	MATRICES AND CALCULUS	L	T	P	C
		3	1	0	4

Pre-requisite Nil

Course Objectives:

1. To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
2. To familiarize the students with differential calculus.
3. To familiarize the student with functions of several variables. This is needed in many branches of engineering.
4. To make the students understand various techniques of integration.
5. To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

Course Content:

UNIT I MATRICES 12

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley – Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms – Applications: Stretching of an elastic membrane.

UNIT II DIFFERENTIAL CALCULUS 12

Representation of functions – Limit of a function – Continuity – Derivatives – Differentiation rules (sum, product, quotient, chain rules) – Implicit differentiation – Logarithmic differentiation – Applications: Maxima and Minima of functions of one variable.

UNIT III FUNCTIONS OF SEVERAL VARIABLES 12

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Applications: Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.

UNIT IV INTEGRAL CALCULUS 12

Definite and Indefinite integrals – Substitution rule – Techniques of Integration: Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction– Improper integrals – Applications: Hydrostatic force and pressure, moments and centres of mass.

UNIT V MULTIPLE INTEGRALS **12**

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals – Applications: Moments and centres of mass, moment of inertia.

TOTAL LECTURE CUM TUTORIAL PERIODS 60 Periods

Expected Course Outcome:

1. At the end of the course the students will be able to Use the matrix algebra methods for solving practical problems.
2. Apply differential calculus tools in solving various application problems.
3. Able to use differential calculus ideas on several variable functions.
4. Apply different methods of integration in solving practical problems.
5. Apply multiple integral ideas in solving areas, volumes and other practical problems.

Text Book(s):

1. Kreyszig. E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Grewal. B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition, 2018.
3. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 8th Edition, New Delhi, 2015.

Reference Books:

1. Anton. H, Bivens. I and Davis. S, "Calculus", Wiley, 10th Edition, 2016.
2. Bali. N., Goyal. M. and Watkins. C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
3. Jain. R.K. and Iyengar. S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 5th Edition, 2016.
4. Narayanan. S. and Manicavachagom Pillai. T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
6. Srimantha Pal and Bhunia. S.C, "Engineering Mathematics" Oxford University Press, 2015.
7. Thomas. G. B., Hass. J, and Weir. M.D, "Thomas Calculus", 14th Edition, Pearson India, 2018.

Web Links:

1. https://www.pdfdrive.com/higher-engineering-mathematics-d18621876.html
2. https://www.pdfdrive.com/advanced-engineering-mathematics-d166759888.html
3. https://theswissbay.ch/pdf/Gentoomen%20Library/Maths/Calculus/Calculus%20-%20Early%20Transcendentals%206e.pdf

தமிழர்மரபு

L T P C

1 0 0 1

அலகு I மொழி மற்றும் இலக்கியம்: 3
இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச்சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மை கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தொடக்கம் – பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன் மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

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

அலகு III நாட்டுப்புற கலைகள் மற்றும் வீர விளையாட்டுக்கள்: 3
தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவை கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுக்கள்.

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

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

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

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

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

22EEC101	APTITUDE AND SOFT SKILLS	L	T	P	C
		1	0	0	1

Pre-requisite Nil

Course Objectives:

1. To enhance students' cognitive prowess and mental potential.
2. To improve students' mental aptitude relevant to their academic choices, vocational preferences, job profiles and their ability to succeed.
3. To measure a range of skills such as language comprehension, logical thinking and numerical ability.
4. To get familiar with the method of solving aptitude and multi-choice questions.

Course Content:

UNIT I FUNDAMENTALS OF APTITUDE **2**

English diagnostic test - EDT - Logical Reasoning-Puzzles - Factors influencing positive mind set-Importance of self-confidence and self-esteem.

UNIT II SPEAKING SKILLS **3**

Effective communication – Barriers & Strategies – Day to Day conversation -Improving responding capacity – Extempore speech practice – Speech assessment. Arithmetic aptitude – Simplification.

UNIT III READING SKILLS **2**

Reading Op-Ed columns and commentary – skimming and scamming methods -speed reading. Logical Reasoning-verbal analogies.

UNIT IV GREETINGS **2**

Greetings and expressions- expressing gratitude and apologies -expressions of courtesy. Arithmetic aptitude – Percentages.

UNIT V ETIQUETTE **3**

Etiquette- Respect, Consideration& Honesty-oral presentation-role of audio/video visual aids. Logical Reasoning – Non-verbal - Arithmetic aptitude – Introduction to numbers.

TOTAL LECTURE PERIODS 12Periods

Expected Course Outcome:

1. Students will be able to understand what he is good at and what they can be good at.
2. The vast scope and dynamics of aptitude classes ensured a streamlined process for the students to make career choices, academic pursuits, and professional growth.
3. The soft skills classes make the students scalable and standardized and help the students to outperform a large number of applicants in the market.
4. The soft skills classes help students to identify their leadership styles and work effectively as a team.

Text Book(s):

1. English for Job Seekers (Language and Soft Skills for the Aspiring) by GeethaRajeevan, C.L.N. Prakash) Cambridge University Press pvt,Ltd.
2. New International Business English by Leo Jones and Richard Alexander. Cambridge University Press pvt,Ltd.
3. Quantitative Aptitude for Competitive Examinations by R S Aggarwal, S. CHAND Publishers.
4. A Modern Approach To Logical Reasoning by R S Aggarwal, S. CHAND Publishers.

Reference Books:

1. A New Approach to REASONING Verbal & Non-Verbal Paperback – 1 January 2014 by B.S. Sijwalii & InduSijwali.
2. How to prepare for quantitative aptitude for the CAT 6th edition by Arunsharma published on May, 2014 by Mcgraw Hill Education publishers.
3. Magical Book on Quicker Maths by M Tyra and K Kundan.
4. Shortcuts in Reasoning (Verbal, Non-Verbal, Analytical & Critical) for Competitive Exams 3rd Edition by Disha Experts.
5. Everyday Etiquette: How to Navigate 101 Common and Uncommon Social Situations. Published by St. Martin's Griffin; First edition.

		L	T	P	C
22CH101	**ENGINEERING CHEMISTRY**	**3**	**0**	**2**	**4**

Course Objectives:

1. To inculcate sound understanding of water softening methods and desalination techniques.
2. To make the students conversant with basics of polymer chemistry.
3. Todevelopanunderstandingofthebasicconceptsofphaseruleanditsapplicationstosingle and two component systems.
4. To facilitate the understanding of different types of fuels, their preparation, properties.
5. To familiarize the students with the operating principles, working processes and applications of energy Conversion and storage devices.
6. Toinducethestudentstofamiliarizewithelectroanalyticaltechniquessuchas, potentiometer and conductometry in the determination of impurities in aqueous solutions.

Course Content:

UNITI WATER TECHNOLOGY 9

Hardnessofwater-types-disadvantagesofusinghardwaterinindustries–estimationoftotal, Permanent and temporary hardness of water by EDTA method -Boiler troubles (scale and sludge)-Boiler feed water treatment – external conditioning - demineralization process -desalination by reverse osmosis–portable water treatment-break point of chlorination.

UNITII POLYMER AND COMPOSITES 9

Polymer: types–addition and condensation polymerization–mechanism of free radical Addition polymerization–copolymers–plastics: classification–thermoplastics and thermosetting plastics, preparation, properties and uses of commercial plastics–PVC, Bakelite. **Composites**: definition, types of composites–polymer rmatrix composites(PMC)–fibre reinforced plastics (FRP) -applications.

UNIT III ALLOYS AND PHASE RULE 9

Alloys: Properties of alloys-significance of alloying, functions and effect of alloying elements-Nichrome and stainless steel (18/8)–heat treatment of steel. **Phaserule**: definition of terms with examples, one component system-water system–reduced phase rule–two component systems– lead-silver system–Pattinson process,Cu-Nisystem.

UNIT IV ENERGY SOURCES AND STORAGE DEVICES 9

Nuclear fission–control led nuclear fission–nuclear fusion –nuclear chain reactions–nuclear energy – light water nuclear power plant – breeder reactor – solar energy conversion – solar cells–wind energy.

Batteries, fuelcells and supercapacitors: Types of batteries–primary battery(drycell) secondary battery (lead acid battery, lithium-ion-battery) fuel cells – H_2-O_2fuel cell- supercapacitors.

UNITV FUELS AND COMBUSTION 9

Fuels: Classification of fuels–coal–proximate and ultimate analysis–carbonization manufacture of metallurgical coke(Otto Hoffmann method)–petroleum–refining–manufacture of synthetic petrol (Bergius process) – knocking – octane number – diesel oil –cetane number – compressed natural gas (CNG) – liquefied petroleum gases (LPG) –power alcohol and biodiesel.

Combustion of fuels: Calorific values – calculations – theoretical air requirement – ignition temperature – spontaneous ignition temperature– flue gas analysis (chromatography and gas sensors).

TOTAL LECTURE PERIODS 45Periods

Expected Course Outcome:

1. To analyse the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.
2. Discuss the types of polymer formation and composites.
3. To apply the knowledge of phase rule and alloys for material selection requirements.
4. To recommend suitable fuels for engineering processes and applications.
5. To recognize different forms of energy resources and apply them for suitable applications in energy sectors.
6. To quantitatively analyse the impurities in solution by electro-analytical techniques.

TextBook(s):

1. P.C.JainandMonicaJain,“EngineeringChemistry”,17thEdition,DhanpatRaiPublishingCompany (P)Ltd,NewDelhi,2018.
2. SivasankarB.,“EngineeringChemistry”,TataMcGraw-HillPublishingCompanyLtd,NewDelhi,2008.
3. 3.S.S.Dara,“ATextbookofEngineeringChemistry”,S.ChandPublishing,12thEdition,2018.

Reference Books:

1. O.G.Palanna,“EngineeringChemistry”McGrawHillEducation(India)PrivateLimited,2ndEdition,2017.
2. FriedrichEmich,“EngineeringChemistry”,ScientificInternationalPVT,LTD,NewDelhi,2014.
3. ShikhaAgarwal,“EngineeringChemistry-FundamentalsandApplications”,CambridgeUniversityPress,Delhi,SecondEdition,2019.
4. O.V.Roussak and H.D.Gesser, Applied Chemistry-A Text Book for Engineers and Technologists, Springer Science Business Media, NewYork,2 nd Edition, 2013.

List of Experiments:

1.	Determination of total, temporary & permanent hardness of water by EDTA method.	**3**
2.	Determination of chloride content of water sample by Argentometric method.	**3**
3.	Estimation of copper content of the given solution by Iodometry.	**3**
4.	Determination of alkalinity in water sample.	**3**
5.	Determination of DO content of water sample by Winkler’s Method.	**3**
6.	Estimation of Phase change in a solid.	**3**
7.	Determination of molecular weight of polyvinylalcohol using Ostwald viscometer.	**3**
8.	Determine strength of given hydrochloricacid using pH meter.	**3**
9.	Determine strength of acids in a mixture of acids using conductivitymeter.	**3**
10.	Determine iron content of the given solution using potentiometer.	**3**

TOTAL PRACTICAL PERIODS 30 Periods

TOTAL LECTURE CUM PRACTICAL PERIODS 75 Periods

22CS201	PROBLEM SOLVING TECHNIQES - II	L	T	P	C
		3	0	2	4

Pre-requisite Nil

Course Objectives:
1. To understand the constructs of C Language.
2. To develop C Programs using basic programming constructs
3. To develop C programs using arrays and strings
4. To develop modular applications in C using functions
5. To develop applications in C using pointers and structures
6. To do input/output and file handling in C

Course Content:

UNIT I BASICS OF C PROGRAMMING 9

Introduction to programming paradigms, Applications of C Language - Structure of C program, C programming: Data Types ,Constants, Enumeration Constants, Keywords ,Operators: Precedence and Associativity - Expressions - Input/output statements, Assignment statements – Decision making statements - Switch statement – Looping statements – Preprocessor directives - Compilation process.

UNIT II ARRAYS AND STRINGS 9

Introduction to Arrays: Declaration, Initialization, One dimensional array, Two dimensional arrays, String operations: length, compare, concatenate, copy Selection sort, linear and binary search.

UNIT III FUNCTIONS AND POINTERS 9

Modular programming, Function prototype, function definition, function call, Built-in functions (string functions, math functions) Recursion, Binary Search using recursive functions, Pointers ,Pointer operators, Pointer arithmetic – Arrays and pointers – Array of pointers – Parameter passing: Pass by value, Pass by reference.

UNIT IV STRUCTURES AND UNION 9

Structure - Nested structures – Pointer and Structures – Array of structures – Self referential structures – Dynamic memory allocation - Singly linked list – typedef – Union – Storage classes and Visibility.

UNIT V FILE PROCESSING 9

Files – Types of file processing: Sequential access, Random access – Sequential access file - Random access file - Command line arguments.

TOTAL LECTURE PERIODS 45 PERIODS

Expected Course Outcome: On completion of the course, the student is expected to
1. Demonstrate knowledge on C Programming constructs
2. Develop simple applications in C using basic constructs
3. Design and implement applications using arrays and strings
4. Develop and implement modular applications in C using functions.
5. Develop applications in C using structures and pointers.
6. Design applications using sequential and random access file processing.

Text Book(s):

1. ReemaThareja, “Programming in C”, Oxford University Press, Second Edition, 2016.
2. Kernighan, B.W and Ritchie,D.M, “The C Programming language”, Second Edition, Pearson Education, 2015.

Reference Books:

1. Paul Deitel and Harvey Deitel, “C How to Program with an Introduction to C++”, Eighth
2. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.
3. Byron S. Gottfried, “Schaum’s Outline of Theory and Problems of Programming with C”, McGraw-Hill Education, 1996.

List of Experiments:

1.	Write a C program to calculate and display the area of a rectangle using the input values entered by the user.	**3**
2.	Write a C program to sort an array of integers using selection sort technique.	**3**
3.	Write a C program to concatenate two strings entered by the user and display the resultant string.	**3**
4.	Write a C program to find the factorial of a number using recursion.	**3**
5.	Write a C program to swap two numbers using call by value and call by reference.	**3**
6.	Write a C program to create a structure named student with the fields roll no, name, and marks in three subjects. Initialize the structure with the values entered by the user and display the details.	**3**
7.	Write a C program to read data from a text file and display it on the screen.	**3**
8.	Write a C program to implement a singly linked list and display its elements	**3**
9.	Write a C program to open a binary file, write data to it, and read data from it.	**2**
10.	Write a C program to implement a stack using an array and perform push, pop, and display operations.	**2**

TOTAL PRACTICAL PERIODS 30 Periods

TOTAL LECTURE CUM PRACTICAL PERIODS 75 Periods

List of Equipments: (for batch of 30 students)

1.	Standalone Computer	30 nos
2.	TURBO C	

22MA201	NUMERICAL METHODS	L	T	P	C
		3	1	0	4

Pre-requisite Nil

Course Objectives:

1. To introduce the basic concepts of solving algebraic and transcendental equations.
2. To introduce the numerical techniques of interpolation in various intervals in real life situations.
3. To acquaint the student with understanding of numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines?
4. To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.
5. To understand the knowledge of various techniques and methods of solving various types of partial differential equations.

Course Content:

UNIT I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 9+3

Solution of algebraic and transcendental equations - Fixed point iteration method– Newton Raphson method - Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a matrix by Power method and Jacobi's method for symmetric matrices.

UNIT II INTERPOLATION AND APPROXIMATION 9+3

Interpolation with unequal intervals - Lagrange's interpolation – Newton's divided difference interpolation – Cubic Splines - Interpolation with equal intervals - Newton's forward and backward difference formulae.

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 9+3

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 rule – Romberg's Method - Two point and three-point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules.

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 9+3

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

UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS **9+3**

Finite difference methods for solving second order two - point linear boundary value problems - One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method.

TOTAL LECTURE PERIODS 60 Periods

Expected Course Outcome:

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

1. Understand the basic concepts and techniques of solving algebraic and transcendental equations.
2. Appreciate the numerical techniques of interpolation and error approximations in various intervals in real life situations.
3. Apply the numerical techniques of differentiation and integration for engineering problems.
4. Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
5. Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

Text Book(s):

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

Reference Books:

1. Brian Bradie, "A Friendly Introduction to Numerical Analysis", Pearson Education, Asia, New Delhi, 2007.
2. Gerald. C. F. and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia,6th Edition, New Delhi, 2006.
3. Mathews, J.H. "Numerical Methods for Mathematics, Science and Engineering", 2nd Edition, Prentice Hall, 1992.
4. Sankara Rao. K., "Numerical Methods for Scientists and Engineers", Prentice Hall of India Pvt. Ltd, 3rd Edition, New Delhi, 2007.
5. Sastry, S.S, "Introductory Methods of Numerical Analysis", PHI Learning Pvt. Ltd, 5thEdition, 2015.

22AC201	TAMILS AND TECHNOLOGY	L	T	P	C
		1	0	0	1

Pre-requisite Nil

Course Content:

UNIT I WEAVING AND CERAMIC TECHNOLOGY 3

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

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3

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

UNIT III MANUFACTURING TECHNOLOGY 3

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

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3

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

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

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

TOTAL LECTURE PERIODS 15 Periods

Text cum Reference Books:

1. □□□□□□□□□□□□ – □□□□□□□□□□□□□□□□□□ – □□.□□. □□□□□□ (□□□□□□□□□: □□□).

2. □□□□□□□□□□□□□ – □□□□□□□□□. □□□□□□□□ . (□□□□□□□□□□□□□□□).

3. □□□□□ – □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□ (□□□□□□□□□□□□□□□□□□□□□□□□)

4. □□□□□□□ – □□□□□□□□□□□□□□□□□□. (□□□□□□□□□□□□□□□□□□□□□□□)

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

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

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

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

9. Keeladi - 'Sangam City C ivilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (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.

22EEC201	**APTITUDE AND SOFT-SKILLS II**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**1**

Pre-requisite Nil

Course Objectives:

1. To enhance Cognitive Abilities Improving critical thinking, problem-solving and decision-making skills to achieve better academic and professional outcomes.
2. Boosting Soft Skills and Developing interpersonal, communication and time-management skills to excel in personal and professional relationships.
3. Enhancing verbal and written communication skills to promote effective collaboration and build relationships.
4. Developing self-awareness, empathy, and social skills to navigate complex interpersonal situations and increase team morale.

Course Content:

UNIT I APTITUDE **3**

Personality Assessment - SWOT analysis - Adaptability and Flexibility - Team building activity - Numerical Reasoning - calculations, identify patterns, and problem solving.

UNIT II SPEAKING SKILLS **3**

Core Components of Effective Communication - Non-Verbal Communication - active listening and written communication - Business English - Communication enhancement activities - Abstract Reasoning - shapes, symbols, or images - Visual Reasoning.

UNIT III READING SKILLS **3**

Vocabulary Building – Comprehension – Fluency - Critical Reading - Reading for Information - Group problem-solving activities -Critical thinking and analysis -Creative problem solving - Decision making and evaluation -Deductive reasoning and connectives - Logical puzzles and games.

UNIT IV FLOW STATE **3**

S.M.A.R.T Goal Setting - Developing action plans - Overcoming Obstacles - Review and Reflection - Habit Building -Identifying Habits - Maintaining Habits -Habit Stacking Arithmetic aptitude - Number system.

UNIT V EMOTIONAL QUOTIENT **3**

Emotional Intelligence - Empathy and interpersonal skills - Self-awareness and self-regulation - Motivation and drive - Social awareness and relationship management - Quantitative aptitude - Equations - Word problems.

TOTAL LECTURE PERIODS **15 Periods**

Expected Course Outcome:

1. Increased efficiency, productivity and performance in academic and professional settings.
2. Enhanced communication, collaboration and teamwork among students.
3. Increased ability to identify, analyze and solve complex problems in personal and professional settings.
4. Improved self-awareness, emotional intelligence and interpersonal skills leading to better personal and professional relationships.

Text Book(s):

1. Quantitative Aptitude for Competitive Examinations - 2022/edition-S Chand Publishing-Paperback_Edition-2022.
2. Fast Track Objective Arithmetic by Rajesh Verma, January 2018 edition.
3. How to Talk to Anyone: 92 Little Tricks for Big Success in Relationships, Publisher: Harper Element; New edition.
4. Emotional Intelligence by Daniel Goleman, Bloomsbury Publishing India Private Limited; new edition, January 1995.

Reference Books:

1. How to Prepare for Quantitative Aptitude for CAT by Arun Sharma, McGraw Hill Education; Eighth edition.
2. The Pearson Guide to Quantitative Aptitude for Competitive Examinations by Dinesh Khattar
3. Crucial Conversations by Al Switzler, Joseph Grenny, and Ron McMillan, Brilliance Audio; Abridged, Updated edition, August 2013.
4. Nonviolent Communication by Marshall B. Rosenberg, Puddle Dancer Press; 3rd edition, September 2015.

		L	T	P	C
22EC201	**ELECTRON DEVICES**	**3**	**0**	**0**	**3**

Course Objectives:

To acquaint the students with the construction, theory and operation of the basic electronic devices such as PN junction diode, Bipolar and Field effect Transistors, Power control devices, LED, LCD and other Opto-electronic devices

Course Content:

UNIT I SEMICONDUCTOR DIODE 9

PN junction diode, Current equations, Energy Band diagram, Diffusion and drift current densities, forward and reverse bias characteristics, Transition and Diffusion Capacitances, Switching Characteristics, Breakdown in PN Junction Diodes.

UNIT II BIPOLAR JUNCTION TRANSISTORS 9

NPN -PNP -Operations-Early effect-Current equations – Input and Output characteristics of CE, CB, CC - Hybrid -π model - h-parameter model, Ebers Moll Model- Gummel Poon-model, Multi Emitter Transistor.

UNIT III FIELD EFFECT TRANSISTORS 9

JFETs – Drain and Transfer characteristics,-Current equations-Pinch off voltage and its significance-MOSFET- Characteristics- Threshold voltage -Channel length modulation, DMOSFET, E-MOSFET-Characteristics – Comparison of MOSFET with JFET.

UNIT IV SPECIAL SEMICONDUCTOR DEVICES 9

Metal-Semiconductor Junction- MESFET, FINFET, PINFET, CNTFET, DUAL GATE MOSFET, Schottky barrier diode-Zener diode-Varactor diode –Tunnel diode- Gallium Arsenide device, LASER diode, LDR.

UNIT V POWER DEVICES AND DISPLAY DEVICES 9

UJT, SCR, Diac, Triac, Power BJT- Power MOSFET- DMOS-VMOS. LED, LCD, Photo transistor, Opto Coupler, Solar cell, CCD.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Describe the principle and characteristics of semiconductor diode.
2. Analyze various transistor configurations.
3. Understand the Construction and Operation of Field Effect Transistors.
4. Describe the principle of operation and characteristics of special Semiconductor diodes.
5. Discuss the operation of various semiconductor photo devices and power electronic devices.

Text Book(s):

1. Donald A Neaman, "Semiconductor Physics and Devices", Fourth Edition, Tata Mc GrawHill Inc. 2012.
2. Salivahanan. S, Suresh Kumar. N, Vallavaraj.A, "Electronic Devices and circuits", Third Edition, Tata McGraw- Hill, 2008.

Reference Books:

1. Robert Boylestad and Louis Nashelsky, "Electron Devices and Circuit Theory" Pearson Prentice Hall, 10th edition, July 2008.
2. R.S.Sedha, " A Text Book of Applied Electronics" S.Chand Publications, 2006.

22EC202	ELECTRICAL TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

Course Content:

UNIT I MAGNETIC CIRCUITS AND CORE LOSSES 9

Different laws for calculating magnetic field - Biot-Savart law- Ampere's circuital law-Application of Ampere's circuital law in magnetic circuit-Reluctance permanence & B-H Characteristics Different zones of B-H characteristic - Analysis of Series magnetic circuit-Analysis of Series-parallel magnetic circuit.

UNIT II TRANSFORMER 9

Single phase transformer-Operation of practical transformer under no-load and on-load with phasor diagrams-Open circuit and Short circuit tests-calculation of equivalent circuit parameters and predetermination of efficiency-commercial and all-day efficiency-Voltage regulation and its significance-Three-phase Transformers-Constructional features of three-phase transformers.

UNIT III DC MACHINES 9

Construction-working of DC Generator-EMF Equation-types and characteristics of DC generator-Principle of DC motor-Torque Equation of Motor-types of DC Motors-Torque speed characteristic and speed control of DC motor.

UNIT IV THREE PHASE INDUCTION MOTOR 9

construction details of cage and wound rotor machines-production of a rotating magnetic field - principle of operation - rotor Emf and rotor frequency - rotor reactance -rotor current and pf at standstill and during operation-Rotor power input-rotor copper loss and mechanical power developed and their inter relation-torque equation-deduction from torque equation - expressions for maximum torque and starting torque - torque slip characteristic.

UNIT V MEASURING INSTRUMENTS 9

Electronic voltmeter- precision rectifiers-true r.m.s voltmeter-basics of digital measurements-A/D and D/A converters, programmable gain amplifier- auto-ranging; comparators and function generators- elements of digital multimeter- clamp-on meter; solid state energy meter, frequency, phase angle and time period measurement. Cathode Ray Oscilloscope, Digital Storage Oscilloscope. Sample and Hold circuits, Data Acquisition System. Time and Frequency measurement- Oscilloscopes.

TOTAL LECTURE PERIODS 45 Periods

Text Book(s):

1. Electric Machines , D. P. Kothari, I. J. Nagrath, McGraw Hill 5th edition, 2017.
2. J. B. Gupta , Rajeev Manglik, Rohit Manglik(2015), Theory & Performance of Electrical Machines, 14th edition, S. K. Kataria& Sons, New Delhi.

Reference Books:

1. Electrical Machines, V.K Mehta , Rohit Mehta 2014,S.Chand Publishers.
2. Electrical And Electronic Measurements, Banerjee, Gopal Krishna 2016,PHI Learning Pvt. Ltd.

22HS203	UNIVERSAL HUMAN VALUES	L	T	P	C
		2	0	0	2

Pre-requisite Nil

Course Objectives:

The Course prepares second semester engineering and Technology students to:

1. Understand the importance of "VALUES" and "SKILLS" working together to ensure long-term happiness and prosperity.
2. Developing a holistic view on life, careers, happiness, and prosperity based on an accurate understanding of human reality and the rest of existence.
3. Attention to realistic ramifications of such a holistic view in terms of moral behaviour, reliable and gratifying human relationship with nature, and ethical human conduct.

Course Content:

UNIT I COURSE INTRODUCTION – AND VALUE EDUCATION 6

Introduction to human virtues, recognizing the need, fundamental guidelines, Content and Process on Value Education. Self-exploration-Wealth vs Prosperity, Understanding Needs of Self and Body.

UNIT II KNOWING HUMAN HAPPINESS AND MY HAPPINESS 6

Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health.

UNIT III FAMILY AND SOCIETY HARMONY AND HUMAN RELATIONSHIP 6

The basic unit of human interaction,"trust"-the core value of Relations, "respect" understood as correct evaluation, different emotions, justice in relationships, harmony in society, a vision of Undivided Society (Akhand Samaj), Universal Order (Sarvabhaum Vyawastha)- from family to world family! - Practice Exercises and Case Studies will be taken up in Practice Sessions.

UNIT IV WHOLE EXISTENCE AS CO-EXISTENCE AND CONCORD OF NATURE 6

Concord in nature, link, self monitoring, understanding of mutual fulfillment in the four orders of nature, recognizing existence as coexistence on all levels, holistic awareness of happiness inexistence.

UNIT V HOLISTIC UNDERSTANDING OF HAPPINESS OF UNIVERSAL HUMAN VALUES 6

Inference of the above holistic understanding of happiness of universal human values. Accepting human values naturally. Finality of ethical human behaviour. A Humanistic Constitution and a Humanistic World Order. Ability in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical, Strategies for Transition.

TOTAL LECTURE PERIODS 30 Periods

Expected Course Outcome:

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

1. The big picture of life
2. Socially Responsible Behavior
3. Environmentally friendly work
4. Ethical Human Behaviour
5. Have the ability and skills to maintain good health and hygiene
6. Recognize and pursue excellence(merit)and appreciate everyone

Reference Books:

1.Vivekananda - Romain Rolland (English).

2.Gandhi - Romain Rolland (English).

3.Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991 15. Donella H.
4.Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome's report, Universe Books.

5.A Nagraj, 1998, Jeevan Vidya Ek Parichay, Divya Path Sansthan, Amarkanta k.

Reference Links:

1.https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw

2.https://fdp-si.aicte-india.org/8dayUHV_download.php

3. https://www.youtube.com/watch?v=8ovkLRYXIjE

4.https://www.youtube.com/watch?v=OgdNx0X923I

5.https://www.youtube.com/watch?v=nGRcbRpvGoU

6.https://www.youtube.com/watch?v=sDxGXOgYEKM

22ES201	**ENGINEERING PRACTICES LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

Pre-requisite
GROUP A (CIVIL &MECHANICAL)
List of Experiments: (Civil Engineering)

PLUMBING WORK

1 Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
2 Preparing plumbing line sketches.
3 Laying pipe connection to the suction side of a pump
4 Laying pipe connection to the delivery side of a pump.
5 Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances

WOODWORK:

1 Sawing
2 Planing and
3 Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.
4 Studying joints in doorpanels and wooden furniture
5 Studying common industrial trusses using models.

WELDINGWORK:

1 Welding of Butt Joints, LapJoints, and TeeJoints using arcwelding.
2 Practicing gas welding.

BASICMACHININGWORK:

1 (simple)Turning.
2 (simple)Drilling.
3 (simple)Tapping.

ASSEMBLYWORK:

1 Assembling a centrifugal pump.
2 Assembling a household mixer.
3 Assembling an airconditioner.

SHEETMETALWORK:

1 Making of a square tray

FOUNDRYWORK:

1 Demonstrating basic foundry operations.

GROUP B (ELECTRICAL AND ELECTRONICS)

ELECTRICALENGINEERINGPRACTICES

1 Introduction to switches, fuses, indicators and lamps-Basic switch
2 Staircase wiring
3 Fluorescent Lamp wiring with introduction to CFL and LED types.
4 Energy meter wiring and related calculations/calibration
5 Study of Iron Box wiring and assembly
6 Study of Fan Regulator(Resistor type and Electronic type using Diac/Triac/quadrac)
7 Study of emergency lamp wiring/Water heater

ELECTRONICENGINEERINGPRACTICES

SOLDERINGWORK:

1 Soldering simple electronic circuits and checking continuity.

ELECTRONICASSEMBLYANDTESTINGWORK:

1 Assembling and testing electronic components on a small PCB.

ELECTRONICEQUIPMENTSTUDY:

1 Study an elements of smartphone.
2 Assembly and dismantle of LEDTV.
3 Assembly and dismantle of computer/laptop

TOTAL PRACTICAL PERIODS 30 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.
2. Wire various electrical joints in common household electrical wire work.
3. Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical assembly of common household equipments; Make a tray out of metal sheet using sheet metal work.
4. Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

Reference Books:

1. S Gowri& T Jeyapoovan, Engineering Practices Lab Manual, Vikas Publishing-2021.

List of Equipment:(For A Batch of 30 Students)
1.CIVIL ENGINEERING

1.	Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings.	15 Sets.
2.	Carpentry vice (fitted to work bench)	15 Nos.
3.	Standard woodworking tools	15 Sets.
4.	Models of industrial trusses, door joints, furniture joints	5 Each.
5.	Rotary Hammer	2 Nos.
6.	Demolition Hammer	2 Nos.
7.	Circular Saw	2 Nos.
8.	Planer	2 Nos.
9.	Hand Drilling Machine	2 Nos.
10.	Jigsaw	2 Nos.

2.MECHANICAL

1.	Arc welding transformer with cables and holders	5 Nos.
2.	Welding booth with exhaust facility	5 Nos.
3.	Welding accessories like welding shield, chipping hammer, wire brush, etc.	5 Sets.
4.	Oxygen and acetylene gas cylinders, blow pipe and other welding outfit.	2 Nos.
5.	Centre lathe	2 Nos.
6.	Hearth furnace, anvil and smithy tools	2 Sets.
7.	Moulding table, foundry tools	2 Sets.
8.	Power Tool: Angle Grinder	2 Nos
9.	Study-purpose items: centrifugal pump, air-conditioner	One each

3.ELECTRICAL

1.	Assorted electrical components for house wiring	15 Sets.
2.	Electrical measuring instruments	10 Sets.
3.	Study purpose items: Iron box, fan and regulator, emergency lamp	1 Each.
4.	Megger (250V/500V)	1 No.
5.	Range Finder	2 Nos.
6.	Digital Live-wire detector	2 Nos.

4.ELECTRONICS

1.	Soldering guns	10 Nos.
2.	Assorted electronic components for making circuits	50 Nos.
3.	Small PCBs	10 Nos.
4.	Multimeters	10 Nos.
5.	Study purpose items: Telephone, FM radio, low-voltage power supply	1 Each.

22BM301	PHYSIO ANATOMY	L	T	P	C
		3	0	2	4

Pre-requisite Engineering Physics, Biology

Course Objectives:

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

Course Content:

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

Cell – Cell Structure and organelles - Functions of each component in the cell. Cell membrane -transport across membrane - Action potential (Nernst, Goldman equation), Homeostasis. Tissue: Types, functions.

UNIT II SKELETAL AND MUSCULAR SYSTEM **9**

Skeletal: Types of Bone and function – Physiology of Bone formation – Division of Skeleton –Types of joints and function – Types of cartilage and function. –Types of muscles – Structure and Properties of Skeletal Muscle- Changes during muscle contraction- Neuromuscular junction.

UNIT III CARDIOVASCULAR AND RESPIRATORY SYSTEM **9**

Cardiovascular System: Structure – Conduction System of heart – Cardiac Cycle – Cardiac output. Blood: Composition – Functions - Haemostasis – Blood groups and typing. Blood Vessels – Structure and types - Blood pressure - Respiratory system: Parts of respiratory system – Respiratory physiology – Lung volumes and capacities – Gaseous exchange.

UNIT IV DIGESTIVE AND EXCRETORY SYSTEMS 9

Structure and functions of gastrointestinal system - secretory functions of the alimentary tract - digestion and absorption in the gastrointestinal tract - structure of nephron - mechanism of urine formation - skin and sweat gland - temperature regulation.

UNIT V NERVOUS AND SENSORY SYSTEM 9

Structure and function of nervous tissue – Brain and spinal cord – Functions of CNS – Nerve conduction and synapse – Reflex action – Somatic and Autonomic Nervous system. Physiology of Vision, Hearing, Integumentary, Olfactory systems. Taste buds.

TOTAL LECTURE PERIODS 45 PERIODS

Expected Course Outcome: On completion of the course, the student is expected to

1. Students would be able to explain basic structure and functions of cell
2. Students would be learnt about anatomy and physiology of various systems of human body
3. Students would be able to explain interconnect of various systems

Text Book(s):

1. Prabhjot Kaur. Text Book of Anatomy and Physiology. Lotus Publishers. 2014
2. Elaine.N. Marieb , Essential of Human Anatomy and Physiology, Eight Edition, Pearson Education, New Delhi, 2007

Reference Books:

1. Frederic H. Martini, Judi L. Nath, Edwin F. Bartholomew, Fundamentals of Anatomy and Physiology. Pearson Publishers, 2014
2. Gillian Pocock, Christopher D. Richards, The human Body – An introduction for Biomedical and Health Sciences, Oxford University Press, USA, 2013
3. William F.Ganong, Review of Medical Physiology, 22nd Edition, Mc Graw Hill, New Delhi, 2010
4. Eldra Pearl Solomon, Introduction to Human Anatomy and Physiology, W.B. Saunders Company, 2015
5. Guyton and Hall, Medical Physiology, 13th Edition, Elsevier Saunders, 2015

List of Experiments:

1.	Collection of Blood Samples	**3**
2.	Identification of Blood groups (Forward and Reverse)	**3**
3.	Bleeding and Clotting time	**3**
4.	Estimation of Hemoglobin	**3**
5.	Total RBC Count	**3**
6.	Total WBC Count	**3**
7.	Differential count of Blood cells	**3**
8.	Estimation of ESR	**3**
9.	PCV, MCH, MCV, MCHC	**2**

10.	Hearing test – Tuning fork	**2**
11.	Visual Activity – Snellens Chart and Jaegers Chart	**2**

TOTAL PRACTICAL PERIODS 30 Periods

TOTAL LECTURE CUM PRACTICAL PERIODS 75 Periods

List of Equipments: (for batch of 30 students)

1.	Microscope	2 no
2.	Centrifuge Normal	1 no
3.	Wintrobe's tube	2 no
4.	PCV tube	2 no
5.	Neubaur's Chamber	2 no
6.	Heparinized Syringe	1 box
7.	Haemoglobinometer	1 no
8.	Blood grouping kit	1 no
9.	Capillary tubes	1 box
10.	Ophthalmoscope	1 no
11.	Tuning fork	(256Hz to 512Hz) 5 Nos.
12.	Microslides	2 packets
13.	Lancet	5 boxes

22CS301	DATASTRUCTURES	L	T	P	C
		3	0	2	4

Pre-requisite Nil

Course Objectives:

1. To understand the concepts of ADTs.
2. To Learn linear datastructures–lists, stacks, and queues.
3. To understand non-linear datastructures –trees and graphs.
4. To understand sorting, searching and hashing algorithms.
5. To apply Tree and Graph structures

Course Content:

UNIT I LISTS 9

Abstract Data Types (ADTs) – List ADT – Array-based implementation – Linked list implementation –Singlylinkedlists–Circularlylinkedlists–Doubly-linkedlists–Applicationsoflists–PolynomialADT RadixSort–Multilists

UNIT II STACKS AND QUEUES 9

Stack ADT – Operations – Applications – Balancing Symbols – Evaluating arithmetic expressions- In fix to Postfix conversion – Function Calls – Queue ADT – Operations – Circular Queue – DeQueue – Applications of Queues

UNIT III TREES **9**

Tree ADT – Tree Traversals - Binary Tree ADT – Expression trees – Binary Search Tree ADT – AVLTrees –Priority Queue(Heaps)–Binary Heap.

UNIT IV MULTIWAY SEARCH TREES AND GRAPHS **9**

B-Tree –B+ Tree – Graph Definition – Representation of Graphs – Types of Graph - Breadth-first traversal –Depth-first traversal –– Bi-connectivity – Euler circuits –Topological Sort –Dijkstra's algorithm– Minimum Spanning Tree–Prim's algorithm–Kruskal's algorithm.

UNIT V SEARCHING,SORTING AND HASHING TECHNIQUES **9**

Searching–LinearSearch–BinarySearch.Sorting–Bubblesort–Selectionsort–Insertionsort –Shell sort –. Merge Sort – Hashing –Hash Functions – Separate Chaining – Open Addressing –Rehashing– Extendible Hashing

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Define linear and non-linear datastructures.
2. Implement linear and non–linear data structure operations.
3. Use appropriate linear/non–linear datastructure operations for solving a given problem.
4. Apply appropriate graph algorithms for graph applications.
5. Analyze the various searching and sorting algorithms

Text Book(s):

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd Edition, Pearson Education, 2005.
2. Kamthane, Introduction to DataStructures in C, 1st Edition, Pearson Education, 2007

Reference Books:

1. Langsam,Augenstein and Tanenbaum, Data Structures Using C and C++, 2nd Edition, Pearson Education, 2015.
2. Thomas H.Cormen, Charles E. Leiserson, Ronald L. Rivest ,Clifford Stein, Introduction to Algorithms", Fourth Edition, Mcgraw Hill/MITPress,2022.
3. Alfred V.Aho, Jeffrey D.Ullman, John E.Hopcroft, Data Structures and Algorithms,1st edition, Pearson,2002.
4. Kruse, Data Structures and Program Design in C,2nd Edition, Pearson Education, 2006

List of Experiments:

1.	Array implementation of Stack, Queue and Circular Queue ADTs	**3**
2.	Implementation of Singly Linked List	**3**
3.	Linked list implementation of Stack and Linear Queue ADTs	**3**
4.	Implementation of Polynomial Manipulation using Linked list	**3**
5.	Implementation of Evaluating Post fix Expressions, In fix to Post fix conversion	**3**
6.	Implementation of Binary Search Trees	**3**
7.	Implementation of AVL Trees	**3**

8.	Implementation of Heaps using Priority Queues	**3**
9.	Implementation of Dijkstra’s Algorithm	**3**
10.	Implementation of Open Addressing(Linear Probing and Quadratic Probing)	**3**

TOTAL PRACTICAL PERIODS 30 Periods

TOTAL LECTURE CUM PRACTICAL PERIODS 75 Periods

List of Equipment: (for batch of 30 students)

1. Systems with Linux Operating System with gnu compiler 30 nos

22MA301	**TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Pre-requisite Nil

Course Objectives:

1. To introduce the basic concepts of PDE for solving standard partial differential equations.
2. To introduce Fourier series analysis this is central to many applications in engineering apart from its use in solving boundary value problems.
3. To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
4. To acquaint the student with Fourier transform techniques used in wide variety of situations.
5. To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

Course Content:

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 9+3

Formation of partial differential equations— Solutions of standard types of first order partial differential equations – Lagrange’s linear equation — Linear partial differential equations of second and higher order with constant coefficients of homogeneous type.

UNIT II FOURIER SERIES 9+3

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

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9+3

Classification of PDE – Method of separation of variables – Solutions of one-dimensional wave equation – One dimensional equation of heat conduction.

UNIT IV FOURIER TRANSFORMS 9+3

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

UNIT V Z - TRANSFORMS AND DIFFERENCE EQUATIONS 9+3

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

TOTAL LECTURE PERIODS 60 Periods

Expected Course Outcome:

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

1. Understand how to solve the given standard partial differential equations.
2. Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
3. Appreciate the physical significance of Fourier series techniques in solving one heat flow problems and one-dimensional wave equations.
4. Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.
5. Use the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.

Text Book(s):

1. Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint, 2012.

2. Grewal. B.S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publishers, Delhi, 2012.

3. Narayanan.S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students" Vol. II & III, S.Viswanathan Publishers Pvt. Ltd.1998.

Reference Books:

1. Bali.N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 7th Edition, Laxmi Publications Pvt Ltd, 2007.

2. Ramana.B.V., “Higher Engineering Mathematics”, Tata Mc Graw Hill Publishing Company Limited, NewDelhi, 2008.

3. Glyn James, “Advanced Modern Engineering Mathematics”, 3rd Edition, Pearson Education, 2007.

4. Erwin Kreyszig, “Advanced Engineering Mathematics”, 8th Edition, Wiley India, 2007.

5. Ray Wylie. C and Barrett.L.C, “Advanced Engineering Mathematics” Tata Mc Graw Hill Education Pvt Ltd, Sixth Edition, New Delhi, 2012.

6. Datta.K.B., “Mathematical Methods of Science and Engineering”, Cengage Learning India Pvt Ltd, Delhi, 2013.

22BM302	DIGITAL ELECTRONICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To present the Digital fundamentals, Boolean algebra and its applications in digital systems.
2. To familiarize with the design of various combinational digital circuits using logic gates.
3. To introduce the analysis and design procedures for synchronous and asynchronous sequential circuits.
4. To explain the various semiconductor memories and related technology.
5. To introduce the electronic circuits involved in the making of logic gates.

Course Content:

UNIT I DIGITAL FUNDAMENTALS 9

Number Systems — Decimal, Binary, Octal, Hexadecimal, 1?s and 2?s complements, Codes — Binary, BCD, Excess 3, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Minterms and Maxterms, Karnaugh map Minimization and Quine-McCluskey method of minimization.

UNIT II COMBINATIONAL CIRCUIT DESIGN 9

Design of Half and Full Adders, Half and Full Subtractors, Binary Parallel Adder — Carry look ahead Adder, BCD Adder, Multiplexer, Demultiplexer, Magnitude Comparator, Decoder, Encoder, Priority Encoder.

UNIT III SYNCHRONOUS SEQUENTIAL CIRCUITS 9

Flip flops — SR, JK, T, D, Master/Slave FF — operation and excitation tables, Triggering of FF, Analysis and design of clocked sequential circuits — Design — Moore/Mealy models, state minimization, state assignment, circuit implementation — Design of Counters- Ripple Counters, Ring Counters, Shift registers, Universal Shift Register.

UNIT IV ASYNCHRONOUS SEQUENTIAL CIRCUITS 9

Stable and Unstable states, output specifications, cycles and races, state reduction, race free assignments, Hazards, Essential Hazards, Pulse mode sequential circuits, Design of Hazard free circuits.

UNIT V MEMORY DEVICES AND DIGITAL INTEGRATED CIRCUITS 9

Basic memory structure — ROM -PROM — EPROM — EEPROM –EAPROM, RAM — Static and dynamic RAM — Programmable Logic Devices — Programmable Logic Array (PLA) — Programmable Array Logic (PAL) — Field Programmable Gate Arrays (FPGA) — Implementation of combinational logic circuits using PLA, PAL. Digital integrated circuits: Logic levels, propagation delay, power dissipation, fan-out and fan-in, noise margin, logic families and their characteristics-RTL, TTL, ECL, CMOS

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. M. Morris Mano and Michael D. Ciletti, Digital Design, 5th Edition, Pearson, 2014.

Reference Books:

1. Charles H.Roth. Fundamentals of Logic Design, 6th Edition, Thomson Learning, 2013.
2. Thomas L. Floyd, Digital Fundamentals, 10th Edition, Pearson Education Inc, 2011
3. S.Salivahanan and S.ArivazhaganDigital Electronics, Ist Edition, Vikas Publishing House pvt Ltd, 2012.
4. Anil K.Maini Digital Electronics, Wiley, 2014.
5. A.Anand Kumar Fundamentals of Digital Circuits, 4th Edition, PHI Learning Private Limited, 2016.
6. Soumitra Kumar Mandal Digital Electronics, McGraw Hill Education Private Limited, 2016.

22BM303	PATHOLOGY AND MEDICAL MICROBIOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. Gain knowledge on the structural and functional aspects of living organisms.
2. Know the etiology and remedy in treating the pathological diseases.
3. Empower the importance of public health.

UNIT I CELL DEGENERATION, REPAIR AND NEOPLASIA 9

Cell injury and Necrosis, Apoptosis, Intracellular accumulations, Pathological calcification, cellular adaptations of growth and differentiation, Inflammation and Repair including fracture healing, Neoplasia, Classification, Benign and Malignant tumours, carcinogenesis, spread of tumours. Autopsy and biopsy.

UNIT II FLUID AND HEMODYNAMIC DERRANGEMENTS 9

Edema, normal hemostasis, thrombosis, disseminated intravascular coagulation, embolism, infarction, shock. Hematological disorders-Bleeding disorders, Leukaemias, Lymphomas.

UNIT III MICROSCOPES 9

Morphological features and structural organization of bacteria, growth curve, identification of bacteria

, culture media and its types , culture techniques and observation of culture.

UNIT IV MICROBIAL CULTURES 9

Stable and Unstable states, output specifications, cycles and races, state reduction, race free assignments, Hazards, Essential Hazards, Pulse mode sequential circuits, Design of Hazard free circuits.

UNIT V IMMUNOLOGY 9

Natural and artificial immunity, opsonization, phagocytosis, inflammation, Immune deficiency syndrome, antibodies and its types, antigen and antibody reactions, immunological techniques: immune diffusion, immuno electrophoresis, RIA and ELISA, monoclonal antibodies. Disease caused by bacteria, fungi, protozoal, virus and helminthes.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Ramzi S Cotran, Vinay Kumar & Stanley L Robbins, "Pathologic Basis of Diseases", 7th edition, WB Saunders Co. 2005 (Units I & II).

2. Prescott, Harley and Klein, "Microbiology", 5th edition, McGraw Hill, 2002 (Units III,IV & V).

Reference Books:

1. Underwood JCE: General and Systematic Pathology Churchill Livingstone, 3rd edition, 2000.
2. Ananthanarayanan & Panicker, "Microbiology" Orient black swan, 2005.
3. Dubey RC and Maheswari DK. "A Text Book of Microbiology" Chand & Company Ltd, 2007

22EEC301	INDUSTRIAL TRAINING /INTERNSHIP - I	L	T	P	C
		0	0	2	1

Pre-requisite Industry Domain,
Networking &
Communication Skills

COURSE OBJECTIVES: To enable students to
Get connected with industry/ laboratory/research institute

TOTAL WEEKS 2 Weeks

Expected Course Outcome: On completion of the course, the student is expected to

1. System-level design processes, verification and validation techniques, manufacturing and production processes in the firm or research facilities in the laboratory/research institute.
2. Analysis of industrial / research problems and their solutions.

22CS403	DATABASE MANAGEMENT SYSTEMS	L	T	P	C
		3	0	2	4

Pre-requisite Nil

Course Objectives:

1. To learn the fundamentals of data models and to represent a database system using ER diagrams.

2. To study SQL and relational database design.

3. To understand the internal storage structures using different file and indexing techniques which will help in physical DB design.

4. To understand the fundamental concepts of transaction processing- concurrency control techniques and recovery procedures.

5. To have an introductory knowledge about the Storage and Query processing Techniques

Course Content:

UNIT I RELATIONAL DATABASES 9

Purpose of Database System – Views of data – Data Models – Database System Architecture – Introduction to relational databases–RelationalModel–Keys–RelationalAlgebra–SQLfundamentals–AdvancedSQLfeatures–EmbeddedSQL–DynamicSQL.

UNIT II DATABASE DESIGN 9

Entity-Relationship model – E-R Diagrams – Enhanced-ER Model – ER-to-Relational Mapping – FunctionalDependencies–Non-lossDecomposition–First,Second,ThirdNormalForms,Dependency Preservation – Boyce/Codd Normal Form – Multi-valued Dependencies and Fourth Normal Form–Join Dependencies and Fifth Normal Form.

UNIT III TRANSACTIONS **9**

Transaction Concepts – ACID Properties – Schedules – Serializability – Concurrency Control –Need for Concurrency –Locking Protocols – Two Phase Locking –Deadlock –Transaction Recovery -SavePoints–IsolationLevels–SQLFacilitiesforConcurrency and Recovery

UNIT IV IMPLEMENTATIONTECHNIQUES **9**

RAID – File Organization – Organization of Records in Files – Indexing and Hashing –Ordered Indices – B+ tree Index Files – B tree Index Files – Static Hashing – Dynamic Hashing – Query Processing Overview – Algorithms for SELECT and JOIN operations – Query optimization using Heuristics and Cost Estimation

UNIT V ADVANCED TOPICS **9**

Distributed Databases: Architecture, Data Storage, Transaction Processing–Mongo DB–DDL,DLL,DML–Object-based Databases: Object Database Concepts, Object-Relational features, ODMG Object Model, ODL,OQL - XML Databases: XML Hierarchical Model, DTD, XML Schema, XQuery – Information Retrieval: IR Concepts, Retrieval Models, Queries in IR systems.

TOTAL LECTURE PERIODS **45 Periods**

Expected Course Outcome: On completion of the course, the student is expected to

1. Classify the modern and futuristic database applications based on size and complexity
2. Map ER model to Relational model to perform database design effectively
3. Write queries using normalization criteria and optimize queries
4. Compare and contrast various indexing strategies in different database systems
5. Appraise how advanced databases differ from traditional databases

Text Book(s):

1. AbrahamSilberschatz,HenryF.Korth,S.Sudharshan,“DatabaseSystemConcepts”,SixthEdition,Tata McGraw Hill,2011.
2. Ramez Elmasri, Shamkant B.Navathe, “Fundamentals of Database Systems”,Sixth Edition,Pearson Education,2011.

Reference Books:

1. C.J.Date, A.Kannan, S.Swamynathan, “An Introduction to Database Systems”,Eighth Edition, Pearson Education, 2006.
2. Raghu Ramakrishnan, Database Management Systems, Fourth Edition, McGraw Hill College Publications, 2015.
3. G.K.Gupta,"DatabaseManagementSystems”,TataMcGrawHill,2011

List of Experiments:

1.	Data Definition Commands, Data Manipulation Commands for inserting, deleting, updating and retrieving Tables and Transaction Control statements	**3**
2.	Database Querying–Simple queries, Nested queries, Subqueries and Joins.	**3**
3.	Views, Sequences, Synonyms.	**3**
4.	Database Programming: Implicit and Explicit Cursors.	**3**
5.	Procedures and Functions	**3**
6.	Triggers	**3**
7.	Exception Handling	**3**
8.	Database Designusing ER modeling, normalization and Implementation for any application.	**3**
9.	Database Connectivity with Front End Tools.	**3**
10.	Case Study using real life database applications.	**3**
	TOTAL PRACTICAL PERIODS	**30 Periods**
	TOTAL LECTURE CUM PRACTICAL PERIODS	**75 Periods**

List of Equipment: (for batch of 30 students)

1.	Systems with MySql	30nos
2.	Visual Studio	30nos
3.	Server	-

22EC401 **LINEAR INTEGRATED CIRCUITS**

L	T	P	C
3	0	2	4

Course Objectives:

1. To study the basic concepts of OPAMP.
2. To impart knowledge on various applications of OPAMP.
3. To know the working of comparators and waveform generators.
4. To impart the design concepts of ADC and DAC
5. To study the working of PLL and voltage regulators

Course Content:

UNIT I BASICS OF OPERATIONAL AMPLIFIERS 9

Basic information about op-amps, Ideal Operational Amplifier -General operational amplifier stages DC and AC performance characteristics, slew Rate , Open and closed loop configurations.

UNIT II APPLICATIONS OF OPERATIONAL AMPLIFIERS 9

Sign Changer, Scale Changer, Phase Shift Circuits, Voltage Follower, V-to-1 and I-to-V converters, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator, Precisionrectifier, clipper and clamper, Low-pass, high-pass and band-pass Butterworth filters.

UNIT III COMPARATORS AND WAVEFORM GENERATORS 9

Comparators, Schmitt trigger, Sine-wave generators, Multivibrators, IC 555, Frequency toVoltage and Voltage to Frequency converters

UNIT IV ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS 9

D/A converter-specifications-weighted resistor type, R-2R Ladder type, Voltage Mode and Current-Mode –R-2RLadder types swatches for D/A converters, A/D Converters specifications-Flash type-Successive Approximation type-Single Slope type-Dual Slope Type.

UNIT V PLL and VOLTAGE REGULATORS 9

Operation of the basic PLL, Voltage controlled oscillator, Application of PLL for AMdetection, FM detection, IC Voltage regulators-Three terminal fixed and adjustable voltage.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. To understand the characteristics of opamp.
2. To understand the various applications of opamp.
3. To understand the various wave generating and shaping circuits.
4. To apply ADC and DAC for various applications.
5. To understand the concept of PLL. and voltage regulators.

Text Book(s):

1. D.Roy Choudhry, Shail Jain, "Linear Integrated Circuits", Wiley Easter, New Delhi, 2014.
2. Ramakant A. Gayakwad, "OP-AMP and Linear ICs, 4th Edition, Pearson Education 2015.

Reference Books:

1. Salivahanan & V.S. Kanchana Bhaskaran, "Linear Integrated Circuits", 2nd edition McGraw Hill, 2014.
2. Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", 3rd Edition, Tat McGraw-Hill, 2007.
3. Robert F.Coughlin, Frederick F.Driscoll, "Operational Amplifiers and Linear Integrated Circuits", Sixth Edition, PHI, 2001.
4. B S Sonde, "System design using Integrated Clots, 2nd Edition, New Age Pub, 2001.

List of Experiments:

1.	Design and test the following experiments Inverting and Non Inverting Amplifiers Using IC 741	**3**
2.	Active Low Pass, High pass filters using IC 741	**3**
3.	Astable Multivibrator and Monostable Multivibrator using IC 741	**3**
4.	Clippers and Clampers using IC741	**3**
5.	Integrator and Differentiator circuits using Op-Amp	**3**
6.	RC Phase shift oscillator and Wien Bridge Oscillator	**3**
7.	Hartley Oscillator and Colpitts Oscillator	**3**

SIMULATION USING SPICE

8.	Integrator and Differentiator using SPICE.	**3**
9.	Astable Multivibrator and Monostable Multivibrator with NE555 Timer	**3**
10.	RC Phase shift oscillator and Wien Bridge Oscillator with op-amp using SPICE.	**3**

TOTAL PRACTICAL PERIODS 30 Periods
TOTAL LECTURE CUM PRACTICAL PERIODS 75 Periods

List of Equipments: (for batch of 30 students)

1.	Dual power supply/ single mode power supply	15 nos
2.	CRO (30MHz) , Signal Generator /Function Generators (3 MHz)	15 nos
3.	Bread Boards	15 nos
4.	Multimeter	15 nos
5.	IC741, LM 555, NE555, LM311	25 Each

22MA303	**PROBABILITY AND STATISTICS**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Pre-requisite Nil

Course Objectives:

1. This course aims at providing the required skill to apply the statistical tools in engineering problems.
2. To introduce the basic concepts of probability and random variables.
3. To introduce the basic concepts of two-dimensional random variables.
4. To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems?
5. To introduce the basic concepts of classifications of design of experiments which plays very important roles in the field of agriculture and statistical quality control?

Course Content:

UNIT I PROBABILITY AND RANDOM VARIABLES 9+3

Probability – Axioms of probability – Conditional probability – Baye‘s theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

UNIT II TWO - DIMENSIONAL RANDOM VARIABLES 9+3

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III TESTING OF HYPOTHESIS 9+3

Sampling distributions - Estimation of parameters - Statistical hypothesis - Large sample tests based on Normal distribution for single mean and difference of means -Tests based on t, Chi-square and F distributions for mean, variance and proportion - Contingency table (test for independent) - Goodness of fit.

UNIT IV DESIGN OF EXPERIMENTS 9+3

One way and Two-way classifications - Completely randomized design – Randomized block design – Latin square design.

UNIT V STATISTICAL QUALITY CONTROL 9+3

Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling.

TOTAL LECTURE PERIODS 60 Periods

Expected Course Outcome:

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

1. Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon.
2. Understand the basic concepts of one- and two-dimensional random variables and apply in engineering applications.
3. Apply the concept of testing of hypothesis for small and large samples in real life problems.
4. Apply the basic concepts of classifications of design of experiments in the field of agriculture and statistical quality control.
5. Have the notion of sampling distributions and statistical techniques used in engineering and management problems.

Text Book(s):

1. Johnson, R.A., Miller, I and Freund J., "Miller and Freund‗s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.

Reference Books:

1. Devore. J.L., "Probability and Statistics for Engineering and the Sciences‖, Cengage Learning, New Delhi, 8th Edition, 2014.

2. Papoulis, A. and Unnikrishnapillai, S., "Probability, Random Variables and Stochastic Processes", McGraw Hill Education India, 4th Edition, New Delhi, 2010.

3. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier, 2004.

4. Spiegel. M.R., Schiller. J. and Srinivasan, R.A., "Schaum‗s Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004.

5. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 8th Edition, 2007.

22BM401	MICROPROCESSORS AND MICROCONTROLLER	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the Architecture of 8086 microprocessor.
2. To learn the design aspects of I/O and Memory Interfacing circuits.
3. To interface microprocessors with supporting chips.
4. To study the Architecture of 8051 microcontroller.
5. To design a microcontroller based system

Course Content:

UNIT I THE 8086 MICROPROCESSOR **9**

Introduction to 8086 – Microprocessor architecture – Addressing modes - Instruction set andassembler directives – Assembly language programming – Modular Programming - Linkingand Relocation - Stacks - Procedures – Macros – Interrupts and interrupt service routines – Byte and String Manipulation.

UNIT II 8086 SYSTEM BUS STRUCTURE **9**

8086 signals – Basic configurations – System bus timing –System design using 8086 – I/O programming – Introduction to Multiprogramming – System Bus Structure – Multiprocessorconfigurations – Coprocessor, Closely coupled and loosely Coupled configurations – Introduction to advanced processors.

UNIT III I/O INTERFACING **9**

Memory Interfacing and I/O interfacing - Parallel communication interface – Serial communication interface – D/A and A/D Interface - Timer – Keyboard /display controller – Interrupt controller – DMA controller – Programming and applications Case studies: TrafficLight control, LED display , LCD display, Keyboard display interface and Alarm Controller.

UNIT IV MICROCONTROLLER **9**

Architecture of 8051 – Special Function Registers(SFRs) - I/O Pins Ports and Circuits – Instruction set - Addressing modes - Assembly language programming.

UNIT V INTERFACING MICROCONTROLLER 9

Programming 8051 Timers - Serial Port Programming - Interrupts Programming – LCD & Keyboard Interfacing - ADC, DAC & Sensor Interfacing - External Memory Interface- Stepper Motor and Waveform generation - Comparison of Microprocessor, Microcontroller, PIC and ARM processors

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Understand and execute programs based on 8086 microprocessor.
2. Design Memory Interfacing circuits.
3. Design and interface I/O circuits.
4. Design and implement 8051 microcontroller based systems.

Text Book(s):

1. Yu-Cheng Liu, Glenn A.Gibson, “Microcomputer Systems: The 8086 / 8088 Family - Architecture, Programming and Design”, Second Edition, Prentice Hall of India, 2007.
2. Mohamed Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, “The 8051 Microcontroller and Embedded Systems: Using Assembly and C”, Second Edition, Pearsoneducation, 2011.

Reference Books:

1. Doughlas V.Hall, “Microprocessors and Interfacing, Programming and Hardware”,TMH,2012
2. A.K.Ray,K.M.Bhurchandi, "Advanced Microprocessors and Peripherals" 3rd edition, Tata McGrawHill, 2012

22BM402 BIO-CONTROL SYSTEMS	L	T	P	C
	3	0	0	3

Course Objectives:

1.To understand the concept behind feedback and continuum in various systems and subsystems.

2.To analyse the systems in time and frequency domain and to understand the concept of stability

3.To apply mathematical modelling principles in understanding the various fundamental biological systems

4.To analyse biological system models using MATLAB

Course Content:

UNIT I INTRODUCTION **9**

Open and Closed loop Systems, Mathematical Modeling of systems, Block diagram and signal flow graph representation of systems - reduction of block diagram and signal flow graph, Introduction to Physiological control systems- Illustration, Linear models of physiological systems, Difference between engineering and physiological control systems.

UNIT II TIME RESPONSE ANALYSIS **9**

Step and impulse responses of first order and second order systems - time domain specifications of first and second order systems - steady state error constants.

UNIT III STABILITY **9**

Definition of stability, Routh- Hurwitz criteria of stability, Root locus technique - construction of root locus and study of stability.

UNIT IV FREQUENCY RESPONSE ANALYSIS **9**

Frequency domain specifications - Polar plots - Bode plots - Nyquist plot - Nyquist stability criterion, closed loop stability - Constant M and N circles - Nichol‘s chart.

UNIT V BIOLOGICAL CONTROL SYSTEM ANALYSIS **9**

Simple models of muscle stretch reflex action - steady state analysis of muscle stretch reflex action, transient response analysis of neuromuscular reflex model action, frequency response of circulatory control model, Stability analysis of Pupillary light reflex.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. I.J. Nagarath and M. Gopal, Control Systems Engineering, New Age International Publishers, 1st September, 2018.

2. Michael C K Khoo, Physiological Control Systems, IEEE Press, Prentice Hall India, 2005.

Reference Books:

1. Salivahanan S. Rengaraj R. and Venkatakrishnan G. R., Control Systems Engineering, Pearson Education India, 2015.

2. Benjamin C. Kuo, Automatic Control Systems, Prentice Hall of India, 1995.

3. Ogata, Katsuhiko and Yanjuan Yang, Modern control engineering, Vol 4, Prentice-Hall, 2002.

22BM403	**BIOMEDICAL SIGNAL PROCESSING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. To Make Students Understand the Sources, Types & Characteristics of Different Noises and Artifacts Present in Biomedical Signals.
2. To Make Students Able to Design Time Domain and Frequency Domain Filters for Noise and Artifact Removal from Biomedical signals.
3. To Make Students Able to Understand and Apply Various Methods for Analyzing Biomedical Signal Characteristics.
4. To Motivate Students to Explore Alternative Techniques of Analyzing Biomedical Signals in Time and Frequency Domain.

Course Content:

UNIT I INTRODUCTION TO BIOMEDICAL SIGNALS 12

Action Potential and Its Generation, Origin and Waveform Characteristics of Basic Biomedical Signals Like: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Phonocardiogram (PCG), Electroneurogram (ENG), Event-Related Potentials (ERPS), Electrogastrogram (EGG), Objectives of Biomedical Signal Analysis, Difficulties in Biomedical Signal Analysis, Computer-Aided Diagnosis.

UNIT II REMOVAL OF NOISE AND ARTIFACTS FROM BIOMEDICAL SIGNAL 9

Random and Structured Noise, Physiological Interference, Stationary and Nonstationary Processes, Noises and Artifacts Present in ECG, Time and Frequency Domain Filtering.

UNIT III EEG SIGNAL PROCESSING AND EVENT DETECTION IN BIOMEDICAL SIGNALS 12

EEG Signal and Its Characteristics, EEG Analysis, Linear Prediction Theory, Autoregressive Method, Sleep EEG, Application of Adaptive Filter for Noise Cancellation in ECG and EEG Signals; Detection of P, Q, R, S and T Waves in ECG, EEG Rhythms, Waves and Transients, Detection of Waves and Transients, Correlation Analysis Ad Coherence Analysis of EEG Channels.

UNIT IV ANALYSIS OF NONSTATIONARY SIGNALS 12

Frequency domain specifications - Polar plots - Bode plots - Nyquist plot - Nyquist stability criterion, closed loop stability - Constant M and N circles - Nichol‘s chart.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Rangayyan, R.M., 2015. Biomedical signal analysis (Vol. 33). John Wiley & Sons.

2. Reddy, D.C., 2005. Biomedical signal processing: principles and techniques. McGraw-Hill

Reference Books:

1. Tompkins, W.J., 1993. Biomedical digital signal processing. Editorial Prentice Hall.

2. Sörnmo, L. and Laguna, P., 2005. Bioelectrical signal processing in cardiac and neurological

3. applications (Vol. 8). Academic Press.

22MC401	INDIAN CONSTITUTION	L	T	P	C
		-	-	-	-

Course Objectives:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional.
3. Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
4. To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution

Course Content:

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties

UNIT IV ORGANS OF GOVERNANCE

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions

UNIT V LOCAL ADMINISTRATION

District's Administration head: Role and Importance, •Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

30 Periods

TOTAL LECTURE PERIODS

Expected Course Outcome:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

Reference Books:

1. The Constitution of India,1950(Bare Act),Government Publication.

2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.

3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.

4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

22BM501	DIGITAL FABRICATION SIMULATION TECHNIQUES AND TOOLS	L	T	P	C
		3	0	2	4

Pre-requisite Digital Fabrication Simulation Techniques And Tools

Course Objectives:

1. To give exposure to various digital production tools to build artefacts as part of creative design process.
2. To give knowledge about utilizing prototyping and modelling as a design medium that supports the full spectrum of digital design as a paperless process.
3. 3**.** To give knowledge about fabrication process in Digital Architecture as a way to bring software models into reality.

Course Content:

UNIT I MATERIALS AND PROPERTIES 9

Plastics & Composites- Polymers, Thermoplastics, Honeycomb materials .Wood and Fibrous Materials Case Studies and Application, Laminated wood products, Veneers, Steam bent members. Metals and Ceramics Case Studies and Applications - Steel, Aluminium, Alloys Ceramic Hybrids, Production and Fabrication Standards.

UNIT II ADDITIVE FABRICATION PROCESSES 9

Additive Fabrication Processes Case Studies Fused Deposition Processes Injection Molding, Roto Molding Casting Technologies 3D Printing (SLA, SLS, FDM)

UNIT III SUBTRACTIVE FABRICATION PROCESSES 9

Subtractive Fabrication Processes Case Studies Laser Cutting [vaporization cutting and industrial manufacturing] Water Jet Processes CNC 3, 5, & 7 Axis Milling, Cutting, Planing, Drilling.

UNIT IV TRANSFORMATIVE FABRICATION & MASS PRODUCTION MANUFACTURING PROCESSES 9

Transformative Fabrication Processes Case Studies- Methods of Factory, Based production

UNIT V EXPERIMENTAL FABRICATION PROCESSES 9

Experimental Fabrication Processes Case Studies, Biological Growth Formation, Crystal Structure Formation , Explosion Forming, Muscle Wire and Self Assembling Structures

TOTAL LECTURE PERIODS 45 PERIODS

Expected Course Outcome: On completion of the course, the student is expected to

1. Design preamplifiers and amplifiers for various bio signal recordings.
2. Measure various non-electrical parameters using suitable sensors/transducers

3. Design PCB layout for any bio amplifier.

Text Book(s):

1. Operational Amplifiers and Linear IC‘s‖, David A. Bell, 2nd edition, PHI/Pearson, 2004. ISBN 978-81-203-2359-9.

2. Linear Integrated Circuits‖, D. Roy Choudhury and Shail B. Jain, 4thedition, Reprint 2006, New Age International ISBN 978-81-224-3098-1.

Reference Books:

1. Bob Shiel, Ruairi Glynn, Fabricate: Making Digital Architecture, Toronto: Riverside Architectural Press, 2011
2. Emergent Design Group, Morphogenetic Design Strategies AD, 2004
3. Farshid Moussavi, Daniel Lopez, Garrick Ambrose, Ben Fortunato, Ryan R. Ludwig and Ahmadreza Schricker, The Function of Form
4. Rivka Oxman and Robert Oxman, The New Structuralism: Design, Engineering and Architectural Technologies
5. Michael Weinstock, Michael Hensel, Achim Menges (eds.), Emergence: Morphogenetic Design Strategies, AD, Vol 74, No. 3, May/June 2004

List of Experiments:

1.	Introduction to CADD	**2**
2.	Introduction to modeling software Pro-E	**2**
3.	2D Drafting of Plummer block bearing	**2**
4.	2D Drafting of Non-return valves	**2**
5.	2D Drafting of Safety Valve	**2**
6.	3D Assembly of Flange Coupling	**2**
7.	3D Assembly of Universal Coupling	**2**
8.	3D Assembly of Oldham’s Coupling	**2**
9.	3D Assembly of Knuckle joint	**2**
10.	3D Assembly of Socket and Spigot joint	**2**
11.	3D Assembly of Gi band Cotter joint	**2**
12.	3D Assembly of Connecting rod	**2**
13.	3D Assembly of Piston	**2**
14.	3D Assembly of Stuffing box	**2**
15.	3D Assembly of Crosshead	**2**

TOTAL PRACTICAL PERIODS 30 Periods

TOTAL LECTURE CUM PRACTICAL PERIODS 75 Periods

List of Equipments: (for batch of 30 students)

S.I. No	Name of the Equipment	Qty
1.	Intel Octa core i9 processor	6GHz, 16GBRam, 600s8D HD-50
2.	Windows11	50S7DA cad License
3.	Creo 9.0	50S7DA cad License
4.	Solid Works2023	50S7DA cad License
5.	Auto desk Inventor 2023.1.1	50S7DA cad License
6.	Auto CAD 2023	50S7DA cad License
7.	Intel Octa core i9 processor	50S7DA cad License
8.	Windows11	50S7DA cad License

22BM502 BIOMEDICAL INSTRUMENTATION

L	T	P	C
3	0	0	3

Course Objectives:

1. To Illustrate origin of bio potentials and its propagations
2. To understand the different types of electrodes and its placement for various recordings
3. To design bio amplifier for various physiological recordings
4. To learn the different measurement techniques for non-physiological parameters.
5. To Summarize different biochemical measurements.

Course Content:

UNIT I BIOPOTENTIAL ELECTRODES 9

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

UNIT II BIOPOTENTIAL MEASUREMENTS 9

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 EGG.

UNIT III SIGNAL CONDITIONING CIRCUITS 9

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 .

UNIT IV MEASUREMENT OF NON-ELECTRICAL PARAMETERS **9**

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

UNIT V BIOCHEMICAL MEASUREMENT AND BIOSENSORS **9**

Biochemical sensors - pH, pO2 and pCO2, Ion selective Field effect Transistor (ISFET),Immunologically sensitive FET (IMFET), Blood glucose sensors, Blood gas analyzers -colorimeter, Sodium Potassium Analyser, spectrophotometer, blood cell counter, auto analyzer(simplified schematic description) – Bio Sensors – Principles – amperometric and voltometric techniques.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Leslie Cromwell, ―Biomedical Instrumentation and measurement‖, 2nd edition, Prentice hall of India, New Delhi, 2015.

Reference Books:

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

2. Joseph J. Carr and John M. Brown, ―Introduction to Biomedical Equipment Technology‖, Pearson Education, 2004.

3. Myer Kutz, ―Standard Handbook of Biomedical Engineering and Design‖, McGraw Hill Publisher, 2003.

4. Khandpur R.S, ―Handbook of Biomedical Instrumentation‖, 3rd edition, Tata McGraw-Hill New Delhi, 2014

22BM503	BIOMEDICAL INSTRUMENTATION LABORATORY	L	T	P	C
		0	0	2	1

Pre-requisite Biomedical Instrumentation Theory

List of Experiments:

1.	Design of pre amplifiers to acquire bio signals along with impedance matching circuit using suitable IC's	**3**
2.	Design of ECG Amplifiers with appropriate filter to remove power line	**2**
3.	Design of EMG amplifier	**2**
4.	Design a suitable circuit to detect QRS complex and measure heart rate	**2**
5.	Design of frontal EEG amplifier	**2**
6.	Design of EOG amplifier to detect eye blink	**2**
7.	Design a right leg driven ECG amplifier.	**2**
8.	Design and study the characteristics of optical Isolation amplifier	**2**
9.	Design a Multiplexer and Demultiplexer for any two biosignals.	**2**
10.	Measurement of pulse-rate using Photo transducer.	**2**
11.	Measurement of pH and conductivity.	**2**
12.	Measurement of blood pressure using sphygmomanometer.	**2**
13.	Measurement and recording of peripheral blood flow	**2**
14.	Design a PCB layout for any bio amplifier using suitable software tool.	**3**

TOTAL PRACTICAL PERIODS 30 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Design preamplifiers and amplifiers for various bio signal recordings.
2. Measure various non-electrical parameters using suitable sensors/transducers
3. Design PCB layout for any bio amplifier.

List of Equipments: (for batch of 30 students)

1.	pH meter and conductivity meter	1
2.	Photo transducer for pulse measurement	1
3.	Sphygmomanometer and Stethoscope	1
4.	Blood flow measurement system	1
5.	Multi-parameter (ECG, EMG, EEG) Simulator	2
6.	Function generator, DSO, Regulated Power supplies, Bread boards	8
7.	IC LM 324, AD 620, INA series (126,128 etc.), 555 Timer	20
8.	Opto Isolator IC: MCT2E	1

9. Software tool for PCB design 1

Reference Books:

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

22EEC501	INDUSTRIAL TRAINING /INTERNSHIP - II	L	T	P	C
		0	0	2	1

Pre-requisite Industry Domain, Networking & Communication Skills

COURSE OBJECTIVES: To enable students to

1. Get connected with industry/ laboratory/research institute
2. Get practical knowledge on production process in the industry and develop skills to solve related problems
3. Develop skills to carry out research in the research institutes/laboratories

The students individually undergo training in reputed firms/ research institutes / laboratories for the specified duration. After the completion of training, a detailed report should be submitted within ten days from the commencement of next semester. The students will be evaluated as per the Regulations.

TOTAL WEEKS 2 Weeks

Expected Course Outcome: On completion of the course, the student is expected to

1. System-level design processes, verification and validation techniques, manufacturing and production processes in the firm or research facilities in the laboratory/research institute
2. Analysis of industrial / research problems and their solutions
3. Documentation of system specifications, design methodologies, process parameters, testing parameters and results.
4. Preparing of technical report and presentation.

22EEC504	MOBILE WEB APPLICATION AND DASHBOARD DEVELOPMENT FOR BIOMEDICAL APPLICATIONS	L	T	P	C
		0	0	2	1

Pre-requisite JAVA, Android Studio

List of Experiments:

1.	Develop an application that uses GUI components, Font and Colors	**3**
2.	Develop an application that uses Layout Managers and event listeners.	**3**
3.	Develop a native calculator application.	**3**
4.	Write an application that draws basic graphical primitives on the screen.	**3**
5.	Develop an application that makes use of database.	**3**
6.	Develop an application that makes use of RSS Feed.	**3**
7.	Implement an application that implements Multi-threading	**3**
8.	Develop a native application that uses GPS location information.	**3**
9.	Implement an application that writes data to the SD card.	**2**
10.	Implement an application that creates an alert upon receiving a message.	**2**
11.	Write a mobile application that creates alarm clock	**2**

TOTAL PRACTICAL PERIODS 30 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Develop Mobile Applications Using GUI and Layouts.
2. Develop Mobile Applications Using Event Listener.
3. Develop Mobile Applications Using Databases.
4. Develop Mobile Applications Using RSS Feed, Internal/External Storage, SMS,Multi threading and GPS.
5. Analyze and discover own mobile app for simple needs.

List of Equipments: (for batch of 30 students)

Software :

C / C++ / Java or equivalent compiler GnuPG, Snort, N-Stalker or Equivalent

Hardware:

Standalone desktops - 30 Nos. (or) Server supporting 30 terminals or more.

Reference Books:

1. Build Your Own Security Lab, Michael Gregg, Wiley India

		L	T	P	C
22BM601	**MEDICAL IMAGE PROCESSING**	**3**	**0**	**2**	**4**

Pre-requisite Biomedical Signal Processing

Course Objectives:

1. Learn the fundamental concepts of medical Image Processing techniques.
2. Understand the concepts of various image intensity transformation and filtering operations.
3. Be familiar in the techniques of segmentation and restoration of medical images.
4. Gain knowledge in medical image registration and visualization.
5. Be familiar with the application of medical image analysis.

Course Content:

UNIT I FUNDAMENTALS OF MEDICAL IMAGE PROCESSING TRANSFORMS 9

Overview of Image Processing system and human Visual system- Image representation – pixel and voxels, Gray scale and color models- Medical image file formats- DICOM, ANALYZE 7.5,NIFTI and INTERFILE- Discrete sampling model and Quantization- Relationship between the pixels, Arithmetic and logical operations- Image quality and Signal to Noise ratio- Image Transforms- 2D DFT, DCT, KLT. Interpret the basics of image models, Digitization of images and the transformations of medical images using Matlab.

UNIT II ENHANCEMENT TECHNIQUES 9

Gray level transformation- Log transformation, Power law transformation, Piecewise linear transformation. Histogram processing- Histogram equalization, Histogram Matching. Spatial domain Filtering-Smoothing filters, sharpening filters. Frequency domain filtering- Smoothing filters, Sharpening filters- Homomorphic filtering -Medical image enhancement using Hybrid filters Performance measures for enhancement techniques. Experiment with various filtering techniques for noise reduction and enhancement in medical images using Matlab.

UNIT III SEGMENTATION AND RESTORATION TECHNIQUES 9

ROI definition -Detection of discontinuities–Edge linking and boundary detection – Region based segmentation- Morphological processing, Active contour models. Image Restoration- Noise models– Restoration in the presence of Noise – spatial filtering, Periodic noise reduction by frequency domain filtering- linear position- Invariant degradation- Estimation of degradation function, Inverse filter, Weiner filtering. Analyze the segmentation techniques to extract the region of interest and restoration of degraded images using Matlab.

UNIT IV REGISTRATION AND VISUALISATION 9

Registration–Rigid body transformation, principal axes registration, and feature based. Visualisation- Orthogonal and perspective projection in medicine, Surface based rendering, Volume visualization in medical image. Explain the significance of registration of various imaging modalities and appraise the concepts of image visualization in healthcare using Matlab.

UNIT V APPLICATIONS OF MEDICAL IMAGE ANALYSIS 9

Medical Image compression- DCT and Wavelet transform based image compression, Preprocessing of medical images -Retinal images, Ultrasound –liver, kidney, Mammogram. Segmentation of ROI -blood vessels, lesions, tumour, lung nodules, feature extraction- shape and 95 texture, Computer aided diagnosis system – performance measures (confusion matrix, ROC, AUC).

TOTAL LECTURE PERIODS 45 PERIODS

Expected Course Outcome: On completion of the course, the student is expected to

1. Perform enhancing operations on the image using spatial filters and frequency domain filters.
2. Uses transforms and analyze the characteristics of the image.
3. Perform segmentation operations in the images.
4. Estimate the efficiency of the compression technique on the images.
5. Apply image processing technique to solve real health care problems.

Text Book(s):

1. Rafael C. Gonzalez and Richard E. Woods, Digital Image Processing, Pearson Education,3rd edition, 2016.

2. Isaac N. Bankman, Handbook of Medical Image Processing and Analysis, 2nd Edition,Elsevier, 2009.

3. Wolfgang Birkfellner, Applied medical Image Processing: A Basic course, CRC Press, 2011

Reference Books:

1. Atam P.Dhawan, Medical Image Analysis, Wiley-Interscience Publication, NJ, USA 2003

2. Rangaraj M. "Rangayyan, Biomedical Image Analysis", 1st Edition, CRC Press, Published December 30, 2004.

3. Joseph V.Hajnal, Derek L.G.Hill, David J Hawkes, "Medical image registration", Biomedical Engineering series, CRC press,2001

4. Milan Sonka, Image Processing, Analysis And Machine Vision, Brookes/Cole, Vikas Publishing

House, 2nd edition, 1999.

List of Experiments:

1.	Image sampling and quantization	**2**
2.	Analysis of spatial and intensity resolution of images.	**2**
3.	Intensity transformation of images.	**2**
4.	DFT analysis of images	**2**
5.	Transforms (Walsh, Hadamard, DCT, Haar)	**2**
6.	Histogram Processing and Basic Thresholding functions	**2**
7.	Image Enhancement-Spatial filtering	**2**
8.	Image Enhancement- Filtering in frequency domain	**2**
9.	Image segmentation – Edge detection, line detection and point detection.	**2**
10.	Basic Morphological operations.	**2**
11.	Region based Segmentation	**2**
12.	Segmentation using watershed transformation	**1**
13.	Analysis of images with different color models.	**1**
14.	Study of DICOM standards	**1**
15.	Image compression techniques	**1**
16.	Image restoration	**1**
17.	A mini project based on medical image processing	**3**

TOTAL PRACTICAL PERIODS 30 Periods

TOTAL LECTURE CUM PRACTICAL PERIODS 75 Periods

List of Equipments: (for batch of 30 students)

Software:

MATLAB 2021

Hardware:

Standalone desktops - 30 Nos. (or) Server supporting 30 terminals or more.

Reference Books:

1. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins,' Digital Image Processing using MATLAB', Pearson Education, Inc., 2004.

22BM602 DIAGNOSTIC AND THERAPEUTIC EQUIPMENT

L	T	P	C
3	0	2	4

Course Objectives:

1. Understand the devices for measurement of parameters related to cardiology.
2. Illustrate the recording and measurement of EEG
3. Demonstrate EMG recording unit and its uses.
4. Explain diagnostic and therapeutic devices related to respiratory parameters.
5. Understand the various sensory measurements that hold clinical importance.

Course Content:

UNIT I CARDIAC EQUIPMENT 9

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 NEUROLOGICAL EQUIPMENT 9

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

UNIT III MUSCULAR AND BIOMECHANICAL MEASUREMENTS 9

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 RESPIRATORY MEASUREMENT SYSTEM 9

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 SENSORY MEASUREMENT 9

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.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

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. REFERENCES: 1. Myer Kutz, “Standard Handbook of Biomedical Engineering & Design”, McGraw Hill, 2003. 2. L.A Geddes and L.E.Baker, “Principles of Applied Biomedical Instrumentation”, 3rd Edition, 2008.

3. Leslie Cromwell, “Biomedical Instrumentation and Measurement”, Pearson Education, New Delhi, 2007.

Reference Books:

1.Antony Y.K.Chan,”Biomedical Device Technology, Principles and design”, Charles Thomas Publisher Ltd, Illinois, USA, 2008.

2. B H Brown, R H Smallwood, D C Barber, P V Lawford and D R Hose, “Medical Physics and Biomedical Engineering”, 2nd Edition, IOP Publishers. 2001.

22BM603	DIAGNOSTIC AND THERAPEUTIC EQUIPMENTS LABORATORY	L	T	P	C
		0	0	2	1

Pre-requisite Diagnostic and Therapeutic Equipments Theory

List of Experiments:

1.	Measurement of visually and auditory evoked potential.	**2**
2.	Galvanic skin resistance (GSR) measurement.	**2**
3.	Measurement of output intensity from shortwave and ultrasonic diathermy	**2**
4.	Measurement of various physiological signals using biotelemetry	**2**
5.	Electrical safety measurements.	**2**
6.	Measurement of various physiological signals using biotelemetry.	**2**
7.	Measurement of stimulation current waveforms used in medical	**2**
8.	Analyze the working of ESU–cutting and coagulation modes.	**2**
9.	Recording of Audiogram.	**2**
10.	Study the working of Defibrillator and pacemakers.	**2**
11.	Study of ECG, EEG and EMG electrodes.	**2**
12.	Study of ventilators and Ultrasound Scanners	**2**
13.	Study of speech signals using speech signal trainer kit	**2**

14. Measurement of Oxygen Saturation and Heart Rate using Pulse-oximeter. **2**
15. Study of heart lung machine model. **2**

TOTAL PRACTICAL PERIODS 30 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Measure the different bioelectrical signals.
2. Record the various physiological signals using telemetry.
3. Demonstrate various diagnostic and therapeutic techniques.
4. Examine the electrical safety measurements.
5. Analyze the different bio signals using suitable tools.

List of Equipments: (for batch of 30 students)

Sl. No.	Description of Equipment	Required
1.	EEG Machine with Visually and Auditory evoked potential setup	1 No.
2.	GSR setup	1 No.
3.	Multi-output power supply (+15v, -15v, +30V variable, +5V, 2A)	2 Nos.
4.	Short wave Diathermy	1 No
5.	Ultrasonic diathermy	1 No
6.	Multiparameter biotelemetry system	1 No.
7.	Electrical Safety Analyser	1 No.
8.	ECG Simulator	1 No.
9.	Medical stimulator	1 No.
10.	Surgical diathermy with analyzer	1 No.
11.	Audiometer	1No.
12.	Pacemaker and Defibrillator	1 No
13.	Hemodialysis model and Heart lung Model	1 No
14.	Ventilator	1 No.
15.	Ultrasound Scanner	1 No.

Online Resources :
http://bmsp-coep.vlabs.ac.in/List%20of%20experiments.html?domain=Biotechnology

Reference Books:

1. L.A Geddes and L.E.Baker, “Principles of Applied Biomedical Instrumentation”, 3rd Edition, 2008.
2. Khandpur. R.S.,“Handbook of Biomedical Instrumentation”. Second Edition. Tata McGrawHill Pub. Co.,Ltd. 2003.

3. Antony Y.K.Chan,"Biomedical Device Technology, Principles and design", Charles Thomas Publisher Ltd, Illinois, USA, 2008.
4. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Pearson Education, New Delhi, 2007.

22BM604	FEA – TOOL- ANSYS WORKBENCH	L	T	P	C
		0	0	2	1

Pre-requisite Engineering Physics, Biomechanics, Mechanical Behavior of Material

List of Experiments:

A. SIMULATION

1.	MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables	**2**
2.	Use of Matlab to solve simple problems in vibration	**2**
3.	Mechanism Simulation using Multi body Dynamic software	**2**

B. ANALYSIS

4.	Force and Stress analysis using link elements in Trusses, cables etc.	**2**
5.	Stress and deflection analysis in beams with different support conditions.	**2**
6.	Stress analysis of flat plates and simple shells.	**2**
7.	Stress analysis of axi–symmetric components.	**3**
8.	Thermal stress and heat transfer analysis of plates.	**3**
9.	Thermal stress analysis of cylindrical shells.	**3**
10.	Vibration analysis of spring-mass systems.	**3**
11.	Model analysis of Beams.	**3**
12.	Harmonic, transient and spectrum analysis of simple systems.	**3**

TOTAL PRACTICAL PERIODS 30 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Simulate the working principle of air conditioning system, hydraulic and

pneumatic cylinder and cam follower mechanisms using MATLAB.

2. Analyze the stresses and strains induced in plates, brackets and beams and heat transfer problems.
3. Calculate the natural frequency and mode shape analysis of 2D components and beams.

Reference Books:

1 ANSYS Workbench 14.0, for engineers and designers
2 ANSYS Lab manual , Anna University, 2012

List of Equipments: (for batch of 30 students)

1.	Computer Work Station	15 no
2.	Color Desk Jet Printer	01 no
3.	C/MATLAB 2021	05 licenses

		L	T	P	C
22BM605	**VIRTUAL INSTRUMENTATION LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

Pre-requisite Basic knowledge of LABVIEW,
Biomedcal Instrumentation

List of Experiments:

1.	Basic Arithmetic Operations	**3**
2.	Boolean Operations	**3**
3.	Sum Of ‘n’ Numbers Using ‘For’ Loop	**3**
4.	Factorial Of A Give Number Using For Loop	**3**
5.	Sum Of ‘N’ Natural Numbers Using While Loop	**3**
6.	Factorial Of A Give Number Using While Loop	**3**
7.	Sorting Even Numbers Using While Loop In An Array	**3**
8.	Array Maximum And Minimum	**3**
9.	Bundle And Unbundle Cluster	**4**
10.	Flat And Stacked Sequence	**4**
11.	Application Using Formula Node	**4**

12.	Median Filter	**4**
13.	Discrete Cosine Transform	**4**
14.	Convolution Of Two Signals	**4**
15.	Windowing Technique	**4**
16.	Instrumentation Of An Amplifier To Acquire An ECG Signal	**4**
17.	Acquire, Analyze And Present An EEG Using Virtual Instrumentation	**4**

TOTAL PRACTICAL PERIODS 60 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Familiar with Virtual Instrumentation.
2. Understand the logical and arithmetic operation using lab view.
3. Understand the concepts Arrays, loops, stack structures bundle functions.
4. Design the automation application like home automation, robotic based applications.
5. Analyze circuit performance with signal source from Labview

Reference Books:

1. Johnson, G., LabVIEW Graphical Programming, McGraw Hill (2006).
2. Sokoloft, L., Basic Concepts of LabVIEW 4, Prentice Hall Inc. (2004).
3. Wells, L.K. and Travis, J., LabVIEW for Everyone, Prentice Hall Inc. (1996).

List of Equipments: (for batch of 30 students)

1.	Computer Work Station	15 no
2.	Color Desk Jet Printer	01 no
3.	NI Lab VIEW (2015 LV- 64bitWin Eng)	05 licenses

22MC602 ENVIRONMENTAL SCIENCE

L	T	P	C
-	-	-	-

Course Objectives:

1. To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation.
2. To impart knowledge on the causes, effects and control or prevention measures of environmental pollution and natural disasters.
3. To facilitate the understanding of global and Indian scenario of renewable and nonrenewable resources, causes of their degradation and measures to preserve them.
4. To familiarize the concept of sustainable development goals and appreciate the interdependence of economic and social aspects of sustainability, recognize and analyze climate changes, concept of carbon credit and the challenges of environmental management.
5. To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles and analyze the role of sustainable urbanization

Course Content:

UNIT I ENVIRONMENT, ECOSYSTEMS & BIODIVERSITY 6

Definition, scope and importance of environment – need for public awareness.Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

UNIT II ENVIRONMENTAL POLLUTION 6

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts.

UNIT III RENEWABLE SOURCES OF ENERGY 6

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

UNIT IV SUSTAINABILITY AND MANAGEMENT 6

Development , GDP ,Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study

UNIT V SUSTAINABILITY PRACTICES 6

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

TOTAL LECTURE PERIODS 30 Periods

Text Books:

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

Reference Books:

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

22BM701 AR, VR and XR in Biomedical Applications

L	T	P	C
3	**0**	**0**	**3**

Course Objectives:

1. 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
2. To understand virtual reality, augmented reality and using them to build Biomedical engineering applications
3. To know the intricacies of these platform to develop PDA applications with better optimality

Course Content:

UNIT I INTRODUCTION 9

The three I's of virtual reality-commercial VR technology and the five classic components of a VR system - Input Devices: (Trackers, Navigation, and Gesture Interfaces): Three-dimensional position trackers, navigation and manipulation-interfaces and gesture interfaces-Output Devices: Graphics displays-sound displays & haptic feedback.

UNIT II VR DEVELOPMENT PROCESS 9

Geometric modeling - kinematics modeling- physical modeling - behaviour modeling - model Management.

UNIT III CONTENT CREATION CONSIDERATIONS FOR VR 9

Methodology and terminology-user performance studies-VR health and safety issues-Usability of virtual reality system- cyber sickness -side effects of exposures to virtual reality environment

UNIT IV VR ON THE WEB & VR ON THE MOBILE 9

JS-pros and cons-building blocks (WebVR, WebGL, Three.js, device orientation events)-frameworks (A-frame, React VR)-Google VR for Android-Scripts, mobile device configuration, building to android-cameras and interaction-teleporting-spatial audio-Assessing human parameters-device development and drivers-Design Haptics

UNIT V APPLICATIONS 9

Medical applications-military applications-robotics applications- Advanced Real time Tracking- other applications- games, movies, simulations, therapy

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. C. Burdea& Philippe Coiffet, “Virtual Reality Technology”, Second Edition, Gregory, John Wiley & Sons, Inc.,2008
2. Jason Jerald. 2015. The VR Book: Human-Centred Design for Virtual Reality. Association for Computing Machinery and Morgan & Claypool, New York, NY, USA.

Reference Books:

1. 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

2. Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability),Steve Aukstakalnis, Addison-Wesley Professional; 1 edition, 2016.

3. The Fourth Transformation: How Augmented Reality & Artificial Intelligence Will Change Everything, Robert Scoble& Shel Israel, Patrick Brewster Press; 1 edition, 2016.

4. Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile, Tony Parisi, O’Reilly Media; 1 edition, 2015.

22BM702	**PATTERN RECOGNITION AND NEURAL NETWORKS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. To study the fundamentals of pattern recognition and its application.

2. To learn algorithms suitable for pattern classification.

3. To understand applications of pattern recognition and classification in image processing and computer vision.

Course Content:

UNIT I SUPERVISED LEARNING 9

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

UNIT II UNSUPERVISED LEARNING AND CLUSTERING ANALYSIS 9

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

UNIT III INTRODUCTION TO NEURAL NETWORK 9

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

UNIT IV BACK PROPAGATION NETWORK AND ASSOCIATIVE MEMORY 9

Back propagation network, generalized delta rule, Bidirectional Associative memory, Hopfield Network

UNIT V NEURAL NETWORKS BASED ON COMPETITION 9

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

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Duda R.O, Hart P.G, "Pattern Classification and scene analysis'', Wiley Edition, 2000.

2. Earl Gose, Richard Johnsonbaugh Steve Jost, "Pattern Recognition and Image Analysis", Prentice Hall of India Pvt Ltd., New Delhi,1999.

3. Freeman J. A., and Skapura B.M, "Neural networks, algorithms, applications and programming techniques", Addison- Wesley,2003.

Reference Books:

1. Hagan, Demuth and Beale, "Neural Network Design'', Vikas Publishing House Pvt Ltd., New Delhi, 2002.

2. Robert Schalkoff, "Pattern recognition, Statistical, Structural and neural approaches", John Wiley and Sons (Asia) Pvt Ltd., Singapore, 2005. 3. Laurene Fausett, "Fundamentals of Neural Networks- Architectures, Algorithms and Application", Prentice Hall, 1994.

		L	T	P	C
22BM703	**BIOMEDICAL ENTREPRENEURSHIP**	**3**	**0**	**0**	**3**

Course Objectives:

1.To learn fundamentals of entrepreneurship

2.To apply the methods of entrepreneurship in medical field

3.To evaluate the medical devices and market trends

Course Content:

UNIT I SCOPE FOR BIOMEDICAL ENGINEERING ENTREPRENEURSHIP 9

Fundamentals and models, Advancements in biomedical field, Supporting societies and professional activities. Impact of innovation in medical devices. Case study.

UNIT II VENTURE **9**

Assessing the venture, Establish venture invention, market research, presenting the business plan, case study.

UNIT III REGULATIONS **9**

Certification, ISI, CE, UL, NABL and FDA regulations, ISO:13485, ISO:14791, risk management, Environmental regulation. Case study on risk management. Case study.

UNIT IV IDENTIFYING THE GRANTS **9**

Identify and organize support for product development, funding agencies, collaborative initiatives, and angel investors. Medical product manufacturing, marketing, leadership, quality management.

UNIT V ENVIRONMENTAL AWARENESS **9**

Environmental regulations, safety, safe disposal, preventing pollution, preventing health hazards.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Duda R.O, Hart P.G, "Pattern Classification and scene analysis'', Wiley Edition, 2000.

2. Earl Gose, Richard Johnsonbaugh Steve Jost, "Pattern Recognition and Image Analysis", Prentice Hall of India Pvt Ltd., New Delhi,1999.

3. Freeman J. A., and Skapura B.M, "Neural networks, algorithms, applications and programming techniques", Addison- Wesley,2003.

Reference Books:

1. Hagan, Demuth and Beale, "Neural Network Design'', Vikas Publishing House Pvt Ltd., New Delhi, 2002.

2. Robert Schalkoff, "Pattern recognition, Statistical, Structural and neural approaches", John Wiley and Sons (Asia) Pvt Ltd., Singapore, 2005. 3. Laurene Fausett, "Fundamentals of

Neural Networks- Architectures, Algorithms and Application”, Prentice Hall, 1994.

22EEC701	PROJECT WORK – PHASE I	L	T	P	C
		0	0	4	2

Pre-requisite Biomedical Engineering Subjects

COURSE OBJECTIVES: To enable students to

1. To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
2. To train the students in preparing project reports and to face reviews and viva-voce examination.
3. To develop the methodology to solve the identified problem.

The student individually works on a specific topic approved by the head of the division under the guidance of a faculty member who is familiar in this area of interest. The student can select any topic which is relevant to the area of construction engineering and management. The topic may be theoretical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be 20 evaluated through a viva-voce examination by a panel of examiners including one external examiner.

TOTAL WEEKS 4 Weeks

Expected Course Outcome: On completion of the course, the student is expected to

At the end of the course the students will have a clear idea of his/her area of work and they are in a position to carry out the remaining phase II work in a systematic way.

22BM704 **CLINICAL IMMERSION AND ROTATION**

L	T	P	C
0	0	0	2

Pre-requisite Hospital Management Theory, Knowledge about Biomedical Equipments.

COURSE OBJECTIVES: To enable students to

1. Observe medical professionals at work in the wards and the roles of Allied Health Professionals;
2. Provide access to healthcare Professionals to get a better understanding of their work;
3. Demonstrate patient-care in a hospital setting.

ASSESSMENT:

1. Students need to complete training in any leading Multi-speciality hospital for a period of 15 days. They need to prepare an extensive report and submit to their respective course in-charges during the session.
2. 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.

S.I. No	**Departments For Visit**
1.	Cardiology
2.	ENT
3.	Ophthalmology
4.	Orthopaedic 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. Paediatric/Neonatal
19. Dental
20. Oncology
21. PAC's
22. Medical Records / Telemetry

TOTAL WEEKS 6 Weeks

Expected Course Outcome: On completion of the course, the student is expected to

1. Advocate a patient-centred approach in healthcare
2. Communicate with other health professionals in a respectful and responsible manner
3. Recognize the importance of inter-professional collaboration in healthcare.
4. Propose a patient-centred inter-professional health improvement plan based upon the patient's perceived needs
5. Use the knowledge of one's own role and those of other professions to address the healthcare needs of populations and patients served.

22MG802 PROJECTMANAGEMENT AND FINANCE

L	T	P	C
3	0	0	3

Course Objectives:

1. To understand what are the objectives of project management.
2. To outline the principles followed in carrying out a project.
3. To demonstrate knowledge and understanding of engineering and management principles.
4. To function effectively as an individual, and as a member or leader in diverse teams.
5. To understand the concepts of finance and accounts carried out in project management.

Course Content:

UNIT I PROJECT MANAGEMENT,PROJECT SELECTION AND PROJECT **9**

Objectives of project management –Types of Projects – Project Management Life Cycle – Project Selection – Feasibility study – Estimation of Project Cost – Cost of Capital – Network analysis Techniques – PERT – CPM.

UNIT II PROJECT IMPLIMENTATION,MONITORING AND CONTROL **9**

Project representation and preliminary manipulations – Basic Scheduling concepts – Resourceleveling – Resource allocation – Setting a base line – Project management information system –Importance of contracts in projects – Team work in Project Management – Formation of Effectiveterms.

UNIT III PROJECT EVALUATION,AUDITING AND OTHER RELATED TOPICS IN PROJECT MANAGEMENT **9**

Project Evaluation – Project auditing – Phase of project audit – Project closure reports, computers,e-markets in Project Management.

UNIT IV FINANCE AND ACCOUNTING **9**

Source of finance – Term Loans – Capital Structure – Financial Institution Accounting Principles –Preparation and Interpretation of balance sheets and profit and loss statements - Fixed Assets –Current assets – Depreciation methods – Break even analysis.

UNIT V WORKING CAPITAL MANAGEMENT AND CAPITAL BUDGETING **9**

Current assets management – Estimation of working capital requirements – Capital budgeting –Capital budgeting methods – Pack back method – Present value method – Accounting rate ofreturn methods.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Paneer Selvam, R., and Senthilkumar, P., “Project Management”, PHI, 2011.
2. James C.Van Horne, “Fundamentals of Financial Management”, Person Education 2004.

Reference Books:

1. Khanna, R.B., “Project Management”, PHI 2011
2. Prasanna Chandra, “Financial Management”, Tata McGraw-Hill,2008.

22EEC801	**PROJECT WORK – PHASE II**	**L**	**T**	**P**	**C**
		0	**0**	**20**	**10**

Pre-requisite Biomedical Engineering Subjects

COURSE OBJECTIVES: To enable students to

1. To develop skills to analyze and discuss the test results, and make conclusions.
2. To solve the identified problem based on the formulated methodology.

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

TOTAL WEEKS 20 Weeks

Expected Course Outcome: On completion of the course, the student is expected to

Be in a position to take up any challenging practical problems in the field of Biomedical engineering and management and find better solutions to it.

22PBM01	TISSUE ENGINEERING AND ARTIFICIAL ORGANS	L	T	P	C
		3	0	0	3

Course Objectives:

1. Learn and understand the Concepts, Classification and Properties, and Structural variations in biomaterials.
2. Understand the testing of implants and cell-interfacing materials.
3. Know the applications of biomaterials in Artificial Organs and their development.

UNIT I ORGAN REPLACEMENT **9**

Evolution of organ replacement technology. Organ replacement outlook, Biology of transplantation of tissue products matching. Types of tissue grafts, design considerations, evaluation process.

UNIT II ARTIFICIAL ORGANS **9**

Artificial heart valves, Heart valve prosthesis - mechanical and tissue valves, Cardiac pace makers, Pacemaker Implantation, Artificial Lung, Artificial skin, Artificial pancreas, Artificial kidney, Dialysis - The Nephron and Mass Transfer, Dialysis Procedure and the Dialysis System, Dialyzer Cartridge Reuse.

UNIT III TRANSPLANTS **9**

Transplants types, immunological considerations, blood transfusions. Individual organs - Kidney, liver, heart, lung, bone, skin, and pancreas. Regeneration and ethical considerations.

UNIT IV TISSUEENGINEERING **9**

Tissue engineering - Basic principles and considerations, Bioreactor - design and applications, Biomaterials - Protein surface interaction, Protein adsorption, Engineering Biomaterials for Tissue Engineering - 10 to 100micron size scale.

UNIT V STEM CELLS 9

The Biology of Stem cells - Embryonic stem cells, adult stem cells, aging of stem cells, The importance of Stromal cells, Tissue engineering of Bone marrow.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Markolf H.Niemz,“Laser-Tissue Interaction Fundamentals and Applications”, Springer, 2007

2. Abraham Katzir, “Lasers and Optical Fibers in Medicine”, Academic press Inc.

Reference Books:

1. L Hench J. Jones, “Biomaterials, Artificial Organs and Tissue Engineering”, Woodhead Publishing, 2005.

2. Michael Lysaght and Thomas Webster, “Biomaterials for artificial Organs”, Woohead Publishing series in biomaterials, 2010.

3. Sujata V. Bhatt, “Biomaterials” Second Edition, Narosa Publishing House,2005.

4. Rajendran V. and Marikani A., Materials Science, Tata McGraw Hill Pub. Company Ltd., New Delhi, 2004.

22PBM02 MEDICAL WEARABLE SYSTEMS

L	T	P	C
3	0	0	3

Course Objectives:

1. Study about sensors and its application in wearable systems.

2. Learn about applications of wearable systems.

UNIT I SENSORS **9**

Need for wearable systems, Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor, GSR, Radiant thermal sensor, Wearable motion sensors, CMOS –Based Biosensors, E-Textiles, Bio compatibility.

UNIT II SIGNAL PROCESSING **9**

Wearability issues -physical shape and placement of sensor, Technical challenges – sensor design, signal acquisition, Constraint on sampling frequency for reduced energy consumption, light weight signal processing, Rejection of irrelevant information, Datamining.

UNIT III ENERGY HARVESTING FOR WEARABLE DEVICES **9**

Solar cell, Vibration based Thermal based Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.

UNIT IV WIRELESS HEALTH SYSTEMS **9**

Need for wireless monitoring, Definition of Body area network and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication techniques.

UNIT V APPLICATIONS OF WEARABLE SYSTEMS **9**

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Multi parameter monitoring, Neural recording, Gait analysis, Sports Medicine, Smart Fabrics.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Annalisa Bonfiglio, Danilo De Rossi ,"Wearable Monitoring Systems",

Springer,2011.

2. Sandeep K.S. Gupta, Tridib Mukherjee, Krishna Kumar Venkata Subramanian, "Body Area Networks Safety, Security, and Sustainability," Cambridge University Press,2013.

Reference Books:

1. Hang,Yuan-Ting, "wearable medical sensors andsystems",Springer-2013

2. Mehmet R. Yuce, Jamil Y. Khan,"Wireless Body Area Networks Technology, Implementation and Applications " , Pan Stanford Publishing Pvt. Ltd, Singapore,2012.

3. Guang-Zhong Yang(Ed.), "Body Sensor Networks, "Springer,2006.

4. Andreas Lymberis, Danilo de Rossi ,'Wearable eHealth systems for Personalised Health Management - State of the art and future challenges ' IOS press, The Netherlands,2004

22PBM03	MEDICAL NANOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To introduce the relevance of this course to the existing technology through.
2. demonstrations, case studies, simulations, contributions of scientist, national/international.
3. policies with a futuristic vision along with socio-economic impact and issues.
4. To know the sensor and signal processing requirement of wearable systems.
5. To understand the communication and security aspects.
6. To know the level of energy involvement in wearable systems.

Course Content:

UNIT I **NANOSTRUCTURES** **9**

Preparation, properties and characterization - Self-assembling nanostructure - vesicular and micellar polymerization-nanofilms - Metal Nanoparticles- lipid nanoparticles- nanoemulsion - Molecular nanomaterials: dendrimers, etc.,

UNIT II **NANOTECHNOLOGY IN BIOMEDICAL INDUSTRY** **9**

Reconstructive Intervention and Surgery- Nanomaterials in bone substitutes and dentistry – Implants and Prosthesis -in vivo imaging- genetic defects and other disease states — Nanorobotics in Surgery –Nanocarriers: sustained, controlled, targeted drug delivery systems.

UNIT III **NANOTECHNOLOGY IN CANCER THERAPY** **9**

Cancer Cell Targeting and Detection- Polymeric Nanoparticles for cancer treatment – mechanism of drug delivery to tumors -advantages and limitations - Multifunctional Agents - Cancer Imaging – Magnetic Resonance Imaging- Cancer Immunotherapy.

UNIT IV **NANOTECHNOLOGY IN COSMETICS** **9**

Polymers in cosmetics: Film Formers – Thickeners – Hair Colouring – Conditioning Polymers: conditioning, Cleansing – Silicons – Emulsions – Stimuli Responsive Polymeric Systems - Formulation of Nano Gels, Shampoos, Hair-conditioners -Micellar self-assembly Sun-screen dispersions for UV protection – Color cosmetics.

UNIT V **NANOTOXICITY** **9**

Nano Toxicology- introduction, dose relationship- Hazard Classification-Risk assessment and management - factors affecting nano toxicity- Dermal Effects of Nanomaterials, Pulmonary, Neuro and Cardiovascular effects of Nanoparticles - Gene–Cellular and molecular Interactions of Nanomaterials.

TOTAL LECTURE PERIODS **45 Periods**

Text Books:

1.Springer Handbook of Nanotechnology- Ed. by B. Bhushan, Springer-Verlag 2004

2.Nanobiotechnology: Concepts, Applications and Perspectives,. CM.Niemeyer C A. Mirkin, (Eds) , Wiley, 2004

3.Nanotechnology: Health and Environmental Risks, Jo Anne Shatkin, Second Edition, CRC Press, 2013

4.Sarah E. Morgan, Kathleen O. Havelka, Robert Y. Lochhead "Cosmetic Nanotechnology: Polymers and Colloids in Cosmetics", American Chemical Society, 2006.

Reference Books:

1.Nanotechnology in Biology and Medicine: Methods, Devices and Applications, Tuan VoDinh, CRC Press, 2007

2.The Chemistry of Nanomaterials: Synthesis, Properties and Applications, C.N.R. Rao, A. Muller, A. K. Cheetham (Eds), Wiley-VCH Verlag 2004

3.Nanotechnology: Environmental Health and safety, Risks, Regulation and Management, Matthew Hull and Diana Bowman, Elsevier, 2010.

22PBM04	BIOMEMS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To learn various MEMS fabrication techniques.
2. To understand different types of sensors and actuators and their principles of operation at the micro scale level.
3. To know the applications of MEMS in different fields of medicine.

UNIT I MEMS MATERIALS AND FABRICATION **9**

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

UNIT II MECHANICAL AND THERMAL - SENSORS AND ACTUATORS 9

Mechanics for MEMs design- static bending of thin plates, mechanical vibration, thermos mechanics, fracture and thin film mechanics. Mechanical sensors and actuators – beam and cantilever – microplates, strain, pressure and flow measurements, Thermal sensors and actuatorsactuator based on thermal expansion, thermal couples, thermal resistor, Shape memory alloysInertia sensor, flow sensor.

UNIT III ELECTROSTATIC, PIEZOELECTRIC SENSORS AND ACTUATORS 9

Parallel plate capacitor, pull in effect, Electrostatic sensors and actuators- Inertia sensor, Pressuresensor, flow sensor, tactile sensor, comb drive. Properties of piezoelectric materials, Piezoelectric sensor and actuator – inchworm motor, inertia sensor, flow sensor.

UNIT IV MICROFLUIDIC SYSTEMS 9

Fluid dynamics, continuity equation, momentum equation, equation of motion, laminar flow in circular conduits, fluid flow in microconduits, in submicrometer and nanoscale. Microscale fluid, expression for liquid flow in a channel. Fluid actuation methods- electro wetting, thermocapillary effect, electro osmosis, dielectrophoresis. Microfluid dispenser, microneedle, micro pumpscontinuous flow system, micromixers.

UNIT V APPLICATIONS OF BIOMEMS 9

CAD for MEMs, Drug delivery, micro total analysis systems (MicroTAS) detection and measurement methods, microsystem approaches to polymerase chain reaction (PCR),DNA sensor, MEMS based drug delivery, electronic nose. Introduction to 3D printing.

TOTAL LECTURE PERIODS **45 Periods**

Text Books:

1. Chang Liu, " Foundations of MEMS", Pearson Education International, New Jersey, USA, 2nd Edition, 2011.

2. Tai Ran Hsu , "MEMS and Microsystems design and manufacture", Tata McGraw Hill Publishing Company, New Delhi, 2002

Reference Books:

1. Wanjun Wang, Stephen A.Soper, "BioMEMS: Technologies and applications", CRC Press, New York, 2007

2. Marc J. Madou, "Fundamentals of Microfabrication: the science of miniaturization'', CRC Press, 2002.

3. Nadim Maluf, Kirt Williams, "An Introduction to Microelectro mechanical Systems Engineering", Second Edition, Artech House Inc, MA, 2004.

4. Nitaigour Premchand Mahalik, "MEMS", Tata McGraw Hill Publishing Company, New Delhi, 2007.

22PBM05	BIO CHEMISTRY	L	T	P	C
		3	0	0	3

Course Objectives:

The student should be:

1. Introduced to Biochemistry
2. Familiarized with the Classification, structure and properties of carbohydrates, Lipids, Protein and Enzyme.

UNIT I INTRODUCTION TO BIOCHEMISTRY 6

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.

UNIT II **CARBOHYDRATES** **9**

Classification of carbohydrates - mono, di, oligo and polysaccharides. Isomerism, racemisation and mutarotation .Structure, physical and chemical properties of carbohydrates. Metabolic pathways and bioenergetics – Glycolysis, glycogenesis, glycogenolysis and its hormonal regulation. TCA cycle and electron transport chain. Oxidative phosphorylation

UNIT III **LIPIDS** **12**

Classification of lipids- simple, compound and derived lipids. Nomenclature of fatty acid, physical and chemical properties of fat. Saponification number, Reichert- Meissl number and iodine number.Metabolic pathways: synthesis and degradation of fatty acid (beta oxidation), hormonal regulation of fatty acid metabolism, ketogenesis, structural architecture and significance of biological membrane.

UNIT IV **NUCLEIC ACID & PROTEIN** **9**

Structure of purines and pyrimidines, nucleoside , nucleotide , DNA act as a genetic material , chargoffs rule. Watson and crick model of DNA. Structure of RNA and its type. Classification, structure and properties of proteins, structural organization of proteins, classification and properties of aminoacids.Separation of protein: gel filtration, electrophoresis and ultracentrifugation.

UNIT V **ENZYME AND ITS KINETICS** **9**

Classification of enzymes, apoenzyme, coenzyme, holoenzyme and cofactors. Kinetics of enzymes - Michaelis-Menten equation. Factors affecting enzymatic activity: temperature, pH, substrate concentration and enzyme concentration. Inhibitors of enzyme action: Competitive, non- competitive, irreversible. Enzyme: Mode of action, allosteric and covalent regulation. Clinical significance of enzymes. Measurement of enzyme activity and interpretation of units.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. David.W.Martin, Peter.A.Mayes , Victor. W.Rodwell, "Harper‟s Review of Biochemistry", LANGE Medical Publications, 1981.

2. Keith Wilson & John Walker, "Practical Biochemistry - Principles & Techniques",Oxford University Press, 2009.

Reference Books:

1. Trevor palmer, "Understanding Enzymes", Ellis Horwood Ltd. 1991.

2. Pamela.C.Champe & Richard.A.Harvey, "Lippincott Biochemistry Lippincott‟s Illustrated Reviews", Raven publishers,1994.

22PBM06	BIOMETRIC SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the basics of Biometrics and its functionalities
2. To learn the role of biometric in the organization
3. To expose the concept of IRIS and sensors
4. To expose the context of Biometric Applications
5. To learn to develop applications with biometric security

Course Content:

UNIT I INTRODUCTION 9

Person Recognition – Biometric systems –Biometric functionalities: verification, identification – Biometric systems errors - The design cycle of biometric systems – Applications of Biometric systems – Security and privacy issues.

UNIT II **FINGER PRINT AND FACIAL RECOGNITION** **9**

FINGERPRINT : Introduction – Friction ridge pattern- finger print acquisition :sensing techniques ,image quality –Feature Extraction –matching –indexing. FACE RECOGNITION: Introduction –Image acquisition: 2D sensors ,3D sensors- Face detection- Feature extraction -matching.

UNIT III **IRIS AND OTHER TRAITS** **9**

Design of IRIS recognition system-IRIS segmentation- normalization –encoding and matchingIRIS quality –performance evaluation –other traits- ear detection –ear recognition –gait feature extraction and matching challenges-hand geometry –soft biometrics.

UNIT IV **BEHAVIORAL BIOMETRICS** **9**

Introduction –Features- classification of behavioral biometrics –properties of behavioral biometrics – signature –keystroke dynamics –voice- merits –demerits –applications- error sources-types –open issues –future trends.

UNIT V **APPLICATIONS AND TRENDS** **9**

Application areas: surveillance applications- personal applications –design and deployment -user system interaction-operational processes – architecture –application development –design validation disaster recovery plan-maintenance-privacy concerns.

TOTAL LECTURE PERIODS **45 Periods**

Text Books:

1. James wayman, Anil k. Jain ,Arun A.Ross ,Karthik Nandakumar, ―Introduction to Biometrics‖, Springer, 2011
2. John Vacca "Biometrics Technologies and Verification Systems" Elsevier 2007
3. James Wayman, Anil Jain, David MAltoni,DasioMaio(Eds) "Biometrics Systems Technology" ,Design and Performance Evalution. Springer 2005

Reference Books:

1. Khalid saeed with Marcin Adamski, Tapalina Bhattasali, Mohammed K. Nammous, Piotr panasiuk, mariusz Rybnik and soharab H.Sgaikh, ―New Directions in Behavioral Biometrics‖, CRC Press 2017
2. Paul Reid "Biometrics For Network Security "Person Education 2004
3. Shimon K.Modi , ―Biometrics in Identity Management :concepts to applications‖, Artech House 2011

22PBM07 MOLECULAR DIAGNOSTICS AND GENETIC ENGINEERING

L	T	P	C
3	0	0	3

Course Objectives:

1. Familiarize students with the cell and molecular biology of both Prokaryotes and Eukaryotes.
2. Acquire basic fundamental knowledge and explore skills in molecular biology and become aware of the complexity and harmony of the cells.
3. To discuss the gene cloning methods and the tools and techniques involved in gene cloning and genome analysis and genomics.
4. To explain the heterologous expression of cloned genes in different hosts.

Course Content:

UNIT I DNA STRUCTURE AND FUNCTION 9

Structure and Properties of Nucleic Acids, Nucleosome assembly, DNA replication in prokaryotes, DNA replication in eukaryotes, DNA Repair Mechanisms, Homologous Recombination, Site specific recombination.

UNIT II DNA TRANSCRIPTION-AN OVERVIEW 9

Transcription in prokaryotes, Transcription in eukaryotes, Post-Transcriptional Modifications, RNA editing, Regulation of Transcription in Prokaryotes, Regulation of Transcription in Eukaryotes, Protein synthesis in prokaryotes, Protein synthesis in eukaryotes.

UNIT III NUCLEOSOME REMODELING AND EPIGENETICS 9

Nucleosome remodeling, DNA methylation and gene regulation, Mechanisms of Gene Silencing: RNA interference- RISC-mediated silencing, mechanisms of RNA interference, Role of heterochromatin in gene silencing, Epigenetic Regulation.

UNIT IV DNA CLONING-AN OVERVIEW 9

DNA manipulative enzymes, Principles of Gene Cloning, Desirable properties of vectors, Prokaryotic and Eukaryotic Expression Systems (Constitutive & Inducible): Plasmid Vectors, Phage Vectors, Cosmids, Phagemids, Artificial chromosomes, Lentiviral Vectors, Adenoviral Vectors, Plant Vectors, Insect Vectors.

UNIT V PCR-PRINCIPLES AND APPLICATIONS 9

Polymerase Chain Reaction, Quantitative Real Time PCR, Gel Electrophoresis, Blotting Techniques: Southern, Western & Northern, Construction of Genomic and cDNA Libraries, Applications of DNA microarray, DNA Sequencing: sanger's method, shotgun and clone contig approach, next generation sequencing.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Friefelder, David. “Molecular Biology.” Narosa Publications, 1999

2. Weaver, Robert F. “Molecular Biology” IInd Edition, Tata McGraw-Hill, 2003.

3. Old RW, Primrose SB, “Principles Of Gene Manipulation, An Introduction To Genetic Engineering “, Blackwell Science Publications, 1993.

4. Principles of Genome Analysis and Genomics by S.B.Primrose and R.M.Twyman, 3rd Ed. (Blackwell Publishing)

Reference Books:

1. Tropp, Burton E. “Molecular Biology: Genes to Proteins”. IIIrd Edition.

Jones and Bartlett, 2008.

2. Glick , B.R. and J.J. Pasternak. “Molecular Biotechnology: Principles and Applications of Recombinant DNA” 4th Edition. ASM, 2010.

3. Ansubel FM, Brent R, Kingston RE, Moore DD, “Current Protocols In Molecular Biology“Greene Publishing Associates, NY, 1988.

4. Berger Sl, Kimmer AR, “Methods In Enzymology”, Vol 152, Academic Pres

22PBM08	NEUROMECHANICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To introduce the neural system responsible for generation of human movements.
2. To introduce neural control of movements (principles and theories) Briefly introduce topics of motor disorders and rehabilitation approaches.

Course Content:

UNIT I FEATURES OF MOVEMENT PRODUCTION SYSTEM 9

Muscles, Neurons, Neuronal pathways, Sensory receptors, Reflexes and its kinds, Spinal control mechanisms.

UNIT II MAJOR BRAIN STRUCTURES RESPONSIBLE FOR MOVEMENT GENERATION 9

Motor Cortex (including a discussion of premotor and supplementary motor areas), Basal Ganglia, Cerebellum, Descending and ascending pathways.

UNIT III CONTROL THEORY APPROACHES TO MOTOR CONTROL 9

Force control, generalized motor programs, muscle activation control, Merton's servo hypothesis, optimal control (including Posture based movement control)

UNIT IV PHYSICAL APPROACHES TO MOTOR CONTROL AND COORDINATION OF HUMAN MOVEMENTS 9

Mass-Spring models, Threshold control, Equilibrium point hypothesis, Referent configurations Approaches to studying coordination: Optimization, Dynamical systems approach, Synergies, Action-Perception interactions and coupling.

UNIT V EXEMPLARY BEHAVIORS 9

Prehension, postural control, locomotion, Kinesthesia. Changing and Evolving behaviors- Changes to movement control due to fatigue and aging. Motor disorders (introduction only): Spinal cord injury and Spasticity, Cortical disorders (Examples: Stroke, Cerebral Palsy), Disorders of Basal Ganglia (Examples: Parkinson's disease, Huntington's disease), Cerebellar disorders (Ataxia, Tremor, Timing issues, problems with error correction). Approaches to rehabilitation (Example: Deep Brain Stimulation in Parkinson's patients)

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Neurophysiological basis of movement (2 ed), Mark Latash, Human Kinetics, 2008.

2. Fundamentals of Motor control Mark Latash, Academic Press (Elsevier) (2012).

Reference Books:

1. Progress in Motor Control: A Multidisciplinary Perspective (Advances in Experimental Medicine and Biology) (No. 5), Dagmar Sternad (ed), Springer (2007).

2. Neuroscience (5 ed), Dale Purves et al, Sinauer Associates (2011).

3. Human Motor Control (2 ed), David Rosenbaum, Academic Press (Elsevier) (2009).

4. Principles of neural science (5 ed), Eric Kandel, James Schwartz et al (2012).

22PBM09	BIOMECHANICS	L	T	P	C
		3	0	0	3

Course Objectives:

The student should be made to:

1. Explain the principles of mechanics.
2. Discuss the mechanics of physiological systems.
3. Explain the mechanics of joints.
4. Illustrate the mathematical models used in the analysis of biomechanical systems

Course Content:

UNIT I INTRODUCTION TO MECHANICS 9

Intrinsic fluid properties – Density, Viscosity, Compressibility and Surface Tension, Viscometers – Capillary, Coaxial cylinder and cone and plate, Rheological properties of blood, Pressure-flow relationship for Non-Newtonian Fluids, Fluid mechanics in straight tube – Steady Laminar flow, Turbulent flow, Flow development, Viscous and Turbulent Sheer Stress, Effect of pulsatility, Boundary Layer Separation, Structure of blood vessels, Material properties and modeling of Blood vessels, Heart –Cardiac muscle characterisation, Native heart valves – Mechanical properties and valve dynamics, Prosthetic heart valve fluid dynamics.

UNIT II BIOFLUID MECHANICS 9

Motor Cortex (including a discussion of premotor and supplementary motor areas), Basal Ganglia, Cerebellum, Descending and ascending pathways.

UNIT III MUSCULOSKELETAL MECHANICS 9

Constitutive equation of viscoelasticity – Maxwell &Voight models, anisotropy, Hard Tissues – Structure, blood circulation, elasticity and strength, viscoelastic properties, functional adaptation, Soft Tissues – Structure, functions, material properties and modeling of Soft Tissues – Cartilage, Tendons and Ligaments Skeletal Muscle – Muscle action, Hill's models, mathematical modeling, Bone fracture mechanics, Implants for bone fractures.

UNIT IV BIOMECHANICS OF JOINTS 9

Skeletal joints, forces and stresses in human joints, Analysis of rigid bodies in equilibrium, Free body diagrams, Structure of joints, Types of joints, Biomechanical analysis of elbow, shoulder, spinal column, hip, knee and ankle, Lubrication of synovial joints, Gait analysis, Motion analysis using video.

UNIT V MODELING AND ERGONOMICS 9

Introduction to Finite Element Analysis, finite element analysis of lumbar spine; Ergonomics – Musculoskeletal disorders, Ergonomic principles contributing to good workplace design, Design of a Computer work station, Whole body vibrations, Hand transmitted vibrations.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Y.C. Fung, "Bio-Mechanics- Mechanical Properties of Tissues", Springer-Verlag, 1998.

2. Subrata Pal, "Textbook of Biomechanics", Viva Books Private Limited, 2009.

Reference Books:

1. Krishna B. Chandran, Ajit P. Yoganathan and Stanley E. Rittgers, "Biofluid Mechanics: The Human Circulation", Taylor and Francis, 2007.

2. Sheraz S. Malik and Shahbaz S. Malik, "Orthopaedic Biomechanics Made Easy", Cambridge University Press, 2015.

3. Jay D. Humphrey, Sherry De Lange, "An Introduction to Biomechanics: Solids and Fluids, Analysis and Design", Springer Science Business Media, 2004.

4. Shrawan Kumar, "Biomechanics in Ergonomics", Second Edition, CRC Press 2007.

5. Neil J. Mansfeild, "Human Response to Vibration", CRC Press, 2005.

6. Carl J. Payton, "Biomechanical Evaluation of movement in sports and Exercise", 2008.

22PBM10	BIO INFORMATICS AND DRUG DESIGN	L	T	P	C
		3	0	0	3

Course Objectives:

1. To improve the programming skills of the student.
2. To let the students know the recent evolution in biological science.
3. To understand how drugs function at the molecular level.
4. To understand the relationships between physico-chemical properties of drugs and their biological activities.
5. To know how drugs interact with receptors of different kinds.

Course Content:

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

Introduction to Operating systems, Linux commands, File transfer protocols ftp and telnet, Introduction to Bioinformatics and Computational Biology, Biological sequences, Biological databases, Genome specific databases, Data file formats, Data life cycle, Database management system models, Basics of Structured Query Language (SQL).

UNIT II **SEQUENCE ALIGNMENT** **9**

Sequence Analysis, Pair wise alignment, Dynamic programming algorithms for computing edit distance, string similarity, shotgun DNA sequencing, end space free alignment. Multiple sequence alignment, Algorithms for Multiple sequence alignment, Generating motifs and profiles, Local and Global alignment, Needleman and Wunsch algorithm, Smith Waterman algorithm, BLAST, PSIBLAST and PHIBLAST algorithms.

UNIT III **PHYLOGENETIC METHODS** **9**

Introduction to phylogenetics, Distance based trees UPGMA trees, Molecular clock theory, Ultrametric trees, Parsimonious trees, Neighbour joining trees, trees based on morphological traits, Bootstrapping. Protein Secondary structure and tertiary structure prediction methods, Homology modeling, abinitio approaches, Threading, Critical Assessment of Structure Prediction, Structural genomics.

UNIT IV **PROTEIN STRUCTURE ANALYSIS** **9**

Machine learning techniques: Artificial Neural Networks in protein secondary structure prediction, Hidden Markov Models for gene finding, Decision trees, Support Vector Machines. Introduction to Systems Biology and Synthetic Biology, Microarray analysis, DNA computing,Bioinformatics approaches for drug discovery, Applications of informatics techniques in genomics and proteomics: Assembling the genome, STS content mapping for clone contigs, Functional annotation, Peptide mass fingerprinting.

UNIT V **DRUG DESIGN** **9**

General approach to discovery of new drugs - lead discovery – lead modification – physiochemical principles of drug action – drug stereo chemistry –drug action - 3D database search – computer aided drug design – docking - molecular modeling in drug design – structure based drug design – pharmacophores - QSAR.

TOTAL LECTURE PERIODS **45 Periods**

Text Books:

1. Introduction to Bioinformatics by Arthur K. Lesk , Oxford University Press.

2. Algorithms on Strings, Trees and Sequences by Dan Gusfield, Cambridge University Press.

3. Biological Sequence Analysis Probabilistic Models of proteins and nucleic acids by R.Durbin, S.Eddy, A.Krogh, G.Mitchison.

4. Bioinformatics Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press.

5. Beginning Perl for Bioinformatics: An introduction to Perl for Biologists by James Tindall, O’Reilley Media

Reference Books:

1. Bioinformatics The Machine Learning Approach by Pierre Baldi and Soren Brunak.

2. T K Attwood, D J parry-Smith, Introduction to Bioinformatics, Pearson Education, 1st Edition, 11th Reprint 2005.

22PBM11 COMPUTATIONAL FOUNDATION FOR NATURAL INTELLIGENCE

L	T	P	C
3	0	0	3

Course Objectives:

1. To provide a strong foundation on fundamental concepts in Computational
2. Intelligence. To enable Problem-solving through various searching techniques.
3. To apply these techniques in applications which involve perception, reasoning and
4. learning. To apply Computational Intelligence techniques for information retrieval

To apply Computational Intelligence techniques primarily for machine learning.

Course Content:

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

Introduction to Artificial Intelligence-Search-Heuristic Search-A* algorithm-Game PlayingAlpha-Beta Pruning-Expert systems-Inference-Rules-Forward Chaining and Backward Chaining- Genetic Algorithms.

UNIT II **KNOWLEDGE REPRESENTATION AND REASONING** **9**

Proposition Logic - First Order Predicate Logic – Unification – Forward Chaining - Backward Chaining - Resolution – Knowledge Representation - Ontological Engineering - Categories and Objects – Events - Mental Events and Mental Objects – Reasoning Systems for Categories - Reasoning with Default

Information - Prolog Programming.

UNIT III **UNCERTAINTY** **9**

Non monotonic reasoning-Fuzzy Logic-Fuzzy rules-fuzzy inference-Temporal Logic Temporal Reasoning-Neural Networks-Neuro-fuzzy Inference.

UNIT IV **LEARNING** **9**

Probability basics - Bayes Rule and its Applications - Bayesian Networks – Exact and Approximate Inference in Bayesian Networks - Hidden Markov Models - Forms of Learning - Supervised Learning - Learning Decision Trees – Regression and Classification with Linear Models - Artificial Neural Networks – Nonparametric Models - Support Vector Machines - Statistical Learning - Learning with Complete Data - Learning with Hidden Variables- The EM Algorithm Reinforcement Learning.

UNIT V **INTELLIGENCE ANDAPPLICATIONS** **9**

Natural language processing-Morphological Analysis-Syntax analysis-Semantic AnalysisAIl applications – Language Models - Information Retrieval – Information Extraction – Machine Translation – Machine Learning - Symbol-Based – Machine Learning: Connectionist – Machine Learning.

TOTAL LECTURE PERIODS **45 Periods**

Text Books:

1. Stuart Russell, Peter Norvig, ―Artificial Intelligence: A Modern Approach‖, Third Edition, Pearson Education / Prentice Hall of India, 2010.

2. Elaine Rich and Kevin Knight, ―Artificial Intelligence‖, Third Edition, Tata McGrawHill, 2010.

Reference Books:

1. Patrick H. Winston. "Artificial Intelligence", Third edition, Pearson Edition, 2006.

2. Dan W.Patterson, ―Introduction to Artificial Intelligence and Expert Systems‖, PHI, 2006.

3. Nils J. Nilsson, ―Artificial Intelligence: A new Synthesis‖, Harcourt Asia Pvt. Ltd., 2000.

22PBM12	RADIOLOGICAL EQUIPMENTS	L	T	P	C
		3	0	0	3

Course Objectives:

The student should be made:

1. To understand the generation of X-ray and its uses in imaging
2. To describe the principle of Computed Tomography.
3. To know the techniques used for visualizing various sections of the body.
4. To learn the principles of different radio diagnostic equipment in Imaging
5. To discuss the radiation therapy techniques and radiation safety.

Course Content:

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

Nature of X-rays- X-Ray absorption – Tissue contrast. X- Ray Equipment (Block Diagram) – X-Ray Tube, the collimator, Bucky Grid, power supply, Cathode and filament currents, Focusing cup, Thermionic emission, Electromagnetic 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 temp due to over exposure, x-ray tube rating charts.X-ray Image Intensifier tubes – Fluoroscopy – Digital Fluoroscopy. Angiography, Cine Angiography, Digital subtraction Angiography. Mammography and Dental x-ray unit.

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

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 projection and iterative method. Spiral CT, 3D Imaging and its application.

UNIT III MAGNETIC RESONANCE IMAGING 9

Fundamentals of magnetic resonance- Interaction of Nuclei with static magnetic field and Radio frequency wave- rotation and precession – Induction of magnetic resonance signals – bulk magnetization – Relaxation processes T1 and T2. Block Diagram approach of MRI systemsystem 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 NUCLEAR MEDICINE TECHNIQUES 9

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

UNIT V RADIATION THERAPY AND RADIATION SAFETY 9

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

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Steve Webb, “The Physics of Medical Imaging”, Adam Hilger, Philadelpia, 1988 (Units I, II, III & IV).

2. R.Hendee and Russell Ritenour “Medical Imaging Physics”, Fourth Edition William, WileyLiss, 2002.

Reference Books:

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.Ragunathan, “Magnetic Resonance Imaging and Spectroscopy in Medicine Concepts and Techniques”,Paperback – Import, 2007.

		L	T	P	C
22PBM13	**NEURAL ENGINEERING**	**3**	**0**	**0**	**3**

Course Objectives:

The student should be made:

1. To discuss the physiological concepts of nerve impulse generation and Electromyography
2. To discuss about EEG and its various applications
3. To Explore Evoked potentials and its importance in medicine
4. To introduce various techniques to study central and peripheral nerve function
5. To discuss the electrophysiological evaluation in special situations.

Course Content:

UNIT I NERVE EXCITABILITY AND ELECTROMYOGRAPHY 8

Nerve Excitability: Functional insights derived from axonal structures, Nerve excitability findings in Neurologic diseases: Chemotherapy induced neurotoxicity, Porphyric Neuropathy, Inflammatory Neuropathy and its Treatment, Spinal Cord Injury; Nerve conduction studies, Microneurography and its potential clinical applications.Clinical Electromyography (EMG), Quantitative EMG,Neuromuscular Ultrasound as a compliment to the electrodiagnostic evaluation, Electrophysiologic study of Disorders of Neuromuscular Junction:, H-Reflex and F-Reflex, Blink reflex and other cranial nerve reflexes, Electrophysiological evaluation of movement disorders, Evaluation of autonomic nervous system.

UNIT II **ELECTROENCEPHALOGRAPHY** **10**

Electroencephalography (EEG): General Principles and Clinical Applications, Neonatal and Paediatric EEG, EEG Artefacts and Benign Variants, Video EEG monitoring for epilepsy, Invasive Clinical Neurophysiology in Epilepsy and movement disorders, Topographic mapping, Frequency analysis and other quantitative techniques in EEG, Intraoperative EEG monitoring during carotid endarterectomy and cardiac surgery, Magnetoencephalography.

UNIT III **EVOKED POTENTIALS** **9**

Evoked Potentials and Related Techniques: Visual Evoked potentials (VEPs), Electroretinography and other diagnostic approaches to the Visual System, VEPs in infants and children, Brainstem Auditory Evoked Potentials (AEPs), Brainstem AEPs in infants and children, Somatosensory evoked potentials, Diagnostic and therapeutic role of Magnetic stimulation in neurology.

UNIT IV **FUNCTIONAL NEUROIMAGING AND COGNITION** **9**

Historical and physiological perspective, Functional neuroimaging methods: PET and fMRI, Network analyses, Functional neuroimaging of: Attention, Visual recognition, Semantic memory, Language, Episodic memory, Working memory, Cognitive aging, Neuro-psychologically impaired patients

UNIT V **ELECTROPHYSIOLOGICAL EVALUATION IN SPECIAL SITUATIONS** **9**

Electrophysiological evaluation of sacral function: Bladder, bowel and sexual function, Vestibular laboratory testing, Polysomnographic evaluation of sleep disorders, Electrophysiologic evaluation of: brain death, patients in the intensive care unit, patients with suspected neurotoxic disorders.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Michael J. Aminoff, et. al., “Aminoff’selectrodiagnosis in Clinical Neurology”, Sixth Edition, Elsevier Saunders, 2012.

2. Kim E. Baretteet. al., “Ganong’s review of Medical Physiology”, 23rd Edition, McGraw Hill Medical, 2010.

Reference Books:

1. Eric R. Kandelet. al., “Principles of Neural Science” ,McGraw-Hill, New York, 2012.

2. R. Cooper, et. al, “Techniques in Clinical Neurophysiology: A Practical Manual , Elsevier, Amsterdam, The Netherlands, 2005.

3. Holodny, Andrei I., et al, “Functional neuroimaging: a clinical approach”. Informa Health Care, 2008.

22PBM14	MEDICAL WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives:

The student should be made to:

1. Understand the hazardous materials used in hospital and its impact on health
2. Understand various waste disposal procedures and management.

Course Content:

UNIT I HEALTHCARE HAZARD CONTROL AND UNDERSTANDING ACCIDENTS 9

Healthcare Hazard Control : Introduction, Hazard Control, Hazard Control

Management, Hazard Control Responsibilities, Addressing Behaviors, Hazard Control Practice, Understanding Hazards, Hazard Analysis, Hazard Control and Correction, Personal Protective Equipment, Hazard Control Committees, Hazard Control Evaluation, Hazards, System Safety, Ergonomics. Understanding Accidents: Accident Causation Theories, Human Factors, Accident Deviation Models, Accident Reporting, Accident Investigations, Accident Analysis, Organizational Functions That Support Accident Prevention, Workers' Compensation, Orientation, Education, and Training

UNIT II BIOMEDICAL WASTE MANAGEMENT 9

Biomedical Waste Management : Types of wastes, major and minor sources of biomedical waste, Categories and classification of biomedical waste, hazard of biomedical waste, need for disposal of biomedical waste, waste minimization, waste segregation and labeling, waste handling, collection, storage and transportation, treatment and disposal

UNIT III HAZARDOUS MATERIALS 9

Hazardous Materials : Hazardous Substance Safety, OSHA Hazard Communication Standard, DOT Hazardous Material Regulations, Healthcare Hazardous Materials, Medical Gas Systems, Hazardous Waste Operations and Emergency Response Standard, Respiratory Protection.

UNIT IV FACILITY SAFETY 9

Facility Safety : Introduction, Facility Guidelines Institute, Administrative Area Safety, Slip, Trip, and Fall Prevention, Safety Signs, Colors, and Marking Requirements, Scaffolding, Fall Protection, Tool Safety, Machine Guarding, Compressed Air Safety, Electrical Safety, Control of Hazardous Energy, Permit Confined Spaces, OSHA Hearing Conservation Standard, Heating, Ventilating, and Air-Conditioning Systems, Assessing IAQ, Landscape and Grounds Maintenance, Fleet and Vehicle Safety.

UNIT V INFECTION CONTROL, PREVENTION AND PATIENT SAFETY 9

Healthcare Immunizations, Centers for Disease Control and Prevention, Disinfectants, Sterilants, and Antiseptics, OSHA Bloodborne Pathogens Standard, Tuberculosis, Healthcare Opportunistic Infections, Medical Waste. Patient Safety: An Organizational Function, Errors and Adverse Events, Safety Cultures, Patient-Centered Healthcare, Quality Improvement Tools and Strategies, Healthcare-Associated Infections, Medication Safety.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Anantpreet Singh, Sukhjit Kaur, Biomedical Waste Disposal, Jaypee Brothers Medical Publishers (P) Ltd (2012)

2. Tweedy, James T., Healthcare hazard control and safety management-CRC Press_Taylor and Francis (2014).

Reference Books:

1. R.C.Goyal, "Hospital Administration and Human Resource Management", PHI – Fourth Edition, 2006

2. V.J. Landrum, "Medical Waste Management and disposal", Elsevier, 1991

22PBM15	CRITICAL CARE AND OPERATION THEATRE EQUIPMENT	L	T	P	C
		3	0	0	3

Course Objectives:

The student should be made to:

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

Course Content:

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

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 **CRITICAL CARE EQUIPMENT** **9**

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

UNIT III **OPERATION THEATRE EQUIPMENT** **9**

Craniotomy, Electrosurgical Machines (ESU), electrosurgical analyzers, surgical aspirator,, Instruments for operation. Anesthesia Machine, Humidification, Sterilization aspects, Boyles apparatus. Endoscopy – Laparoscopy - Cryogenic Equipment - Anesthesia gas, Anesthesia gas monitor, - surgical microscope.

UNIT IV **CENTRALISED SYSTEMS** **9**

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

UNIT V **PATIENT SAFETY** **9**

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 LECTURE PERIODS **45 Periods**

Text Books:

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.

Reference Books:

1. L.A Geddes and L.E.Baker, “Principles of Applied Biomedical Instrumentation”, 3rd Edition, 2008.

2. Antony Y.K.Chan,”Biomedical Device Technology, Principles and design”, Charles Thomas Publisher Ltd, Illinois, USA, 2008.

3. Leslie Cromwell, “Biomedical Instrumentation and Measurement”, Pearson Education, New Delhi, 2007

22PBM16	MOVEMENT SCIENCE AND REHABILITATION ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

The student should be made to:

1. To develop an understanding of the various rehabilitation aid principle and its working.
2. To give various information about rehabilitation medicine and Advocacy.

Course Content:

UNIT I PROSTHETIC AND ORTHOTIC DEVICES 9

Hand and arm replacement, different types of models for externally powered limb prosthetics, Lower limb, Upper limb orthotics, and material for prosthetic and orthotic devices, mobility aids.

UNIT II **AUDITORY AND SPEECH ASSIST DEVICES** **9**

Types of deafness, hearing aids, application of DSP in hearing aids, Cochlear implants, Voice synthesizer, speech trainer.

UNIT III **VISUAL AIDS** **9**

Ultra sonic and laser canes, Intra ocular lens, Braille Reader, Tactile devices for visually challenged, Text voice converter, screen readers.

UNIT IV **MOVEMENT STIMULATOR** **9**

Introduction to virtual reality, Virtual reality based rehabilitation, Hand motor recovery systems with Phantom haptics, Robotics and Virtual Reality Applications in Mobility Rehabilitation.

UNIT V **REHABILITATION MEDICINE AND ADVOCACY** **9**

Legal aspect available in choosing the device and provision available in education, job and in day-to-day life, Physiological aspects of Function recovery, Psychological aspects of Rehabilitation therapy,

TOTAL LECTURE PERIODS **45 Periods**

Text Books:

1. Rory A Cooper, An Introduction to Rehabilitation Engineering, CRC press,2006
2. Joseph D.Bronzino,The Biomedical Engineering Handbook,Third Edition: Three Volume Set,CRC Press,2006
3. Levine.S.N.Editor, Advances in Bio Medical Engineering and Medical Physics, Inter University Publication, New York 1968.
4. .

Reference Books:

1. Albert M.Cook and Webster J.G, Therapeutic Medical devices, Prentice Hall Inc., NewJersy, 1982.

2. Reswick.J, What is Rehabilitation Engineering, Annual review of Rehabilitation-volume2, Springer-Verlag, New York 1982

22PBM17	BIOMETRICS	L	T	P	C
		3	0	0	3

Course Objectives:

To Study about:

1. 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.
2. To understand the general principles of design of biometric systems and the underlying trade-offs.
3. To study the technologies of fingerprint, iris, face and speech recognition.
4. To study of evaluation of biometrics systems.

Course Content:

UNIT I INTRODUCTION TO BIOMETRICS 9

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

UNIT II FINGERPRINT TECHNOLOGY 9

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

UNIT III FACE RECOGNITION AND HAND GEOMETRY 9

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

UNIT IV IRIS RECOGNITION 9

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

UNIT V VOICE SCAN AND MULTIMODAL BIOMETRICS 9

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

TOTAL LECTURE PERIODS 45 Periods

Text Books:

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. S.Y. Kung, S.H. Lin, M.W., “Biometric Authentication: A Machine Learning Approach”, Prentice Hall, 2004.

Reference Books:

1. Nalini K Ratha, Ruud Bolle, "Automatic fingerprint recognition system'', Springer, 2003.

2. L C Jain, I Hayashi, S B Lee, U Halici, "Intelligent Biometric Techniques in Fingerprint and Face Recognition", CRC Press, 1st Edition, 1999.

3. John Chirillo, Scott Blaul, "Implementing Biometric Security", John Wiley & Sons, 2003.

22PBM18	**BIOFLUIDS AND DYNAMICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

The student should be made

1. To understand the basics of fluid mechanics,
2. To analyze cellular, ocular, cardiovascular and respiratory fluid mechanics
3. To learn mathematical modelling of fluid biological systems.

Course Content:

UNIT I **BIOFLUID MECHANICS** **8**

Intrinsic fluid properties - Density, Viscosity, Compressibility, Surface tension, Hydrostatics Fluid characteristics and viscosity – Displacement and velocity, Sheer stress and viscosity Bernoulli equation, Introduction to pipe flow – Reynolds number, Poiseuille's law, Flow Rate, Womersley number, Constitutive equations – Newtonian fluid, Non-Newtonian viscous fluid, Diameter, velocity and pressure of blood flow relationship, Resistance against flow, Viscoelasticity – Viscoelastic models, Response to Harmonic variation, Use of viscoelastic models, Bio-Viscoelastic fluids – Protoplasm, Mucus, Saliva, Synovial fluids.

UNIT II CELLULAR AND OCCULAR MECHANICS 8

Cellular Biomechanics – Eukaryotic cell architecture, Cytoskeleton, Cell-matrix interactions, Mechanical property measurement – Atomic Force microscopy, Optical Trapping, Magnetic bead microrheometry, Micropipette aspiration, Models of cellular biomechanical behavior, Computational model of a chondrocyte in its matrix, Mechanotransduction, Techniques for mechanical stimulation of the cells, Tissue cell mechanobiology – Endothelial, smooth muscle cells, Chondrocytes, Osteoblasts, Ocular Biomechanics – Occular anatomy, Biomechanics of Glaucoma, Ocular blood flow.

UNIT IV BLOOD RHEOLOGY AND BLOOD VESSEL MECHANICS 10

Viscometry, Elements of Blood, Blood characteristics – Viscosity of blood, Einstein's equation, Biomechanics of red cell membrane, Apparent and relative viscosity, Blood viscosity variation,Casson‟s equation, Rheology of Blood In Micro vessels – Fahraeus-Lindquist effect and its inversion, Anatomy and physiology of blood vessels, Arterial wall as membrane – Uniaxial loading, Biaxial loading, Torsion, Hemodynamics of Large arteries – Ventricular outflow and the aorta, Pressure-flow relations and Vascular Impedance, Wave propagation and reflection.

UNIT IV CARDIO RESPIRATORY MECHANICS AND SPACE MEDICINE 9

Cardiac cycle – Pressure volume diagrams, Changes in contractility, Ventricular performance, Congestive heart failure, Pulsality index, Physics of valvular diseases, Prosthetic heart valves and replacements, Respiratory System – Alveolar ventilation-lung volumes and capacities, Mechanics of breathing, Work of breathing – Lung compliance, Airway resistance, Gas exchange and transport, Oxygen dissociation curve, Lung surfactant, Pulmonary pathologies, Space Medicine – Hypoxia, Physiology of decompressive sickness, Human response to acceleration, Thermal Stress.

UNIT V COMPUTATIONAL FLUID DYNAMICS 10

Computational fluid dynamics – CFD Code, Problem solving with CFD, Conservation Laws of Fluid Motion and Boundary Conditions, Turbulence and its modelling, The Finite Volume Method for Diffusion Problems and Convection-Diffusion Problems, Solution Algorithms for Pressure-Velocity Coupling in steady flows, Solution of Discretized Equations, The Finite Volume Method for Unsteady flows, Implementation of Boundary Conditions Application – Multiphysics computational models for cardiac flow and virtual cardiography.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Krishnan B. Chandran, Ajit P. Yoganathan, Stanley E. Rittgers, “Biofluid Mechanics- The human circulation”, CRC Taylor and Francis, 2007.

2. Y.C Fung, “Biomechanics- Mechanical properties of living tissues”, 2nd Edition, SpringerVerlag, 1993.

3. Jeffery R. Davis et. Al., “Fundamentals of Aerospace Medicine”, Wolter Kluwer Health, Lippincott Williams and Wilkins, 2008

Reference Books:

1. Jung HeeSeo, Vijay Vedula, Theodore Abraham and Rajat Mittal, “Multiphysics computational models for cardiac flow and virtual cardiography”, Int. J. Numer. Meth. Biomed. Engng. (2013) Published online in Wiley Online Library

2. Lee Waite, Jerry Fine, “Applied Biofluid Mechanics”, McGraw Hill, 2007

3. John K-J Li, “Dynamics of Vascular System”, World Scientific, 2004

4. C. Ross Ethier, Craig A Simmons, “Introduction to Biomechanics- From Cells to Organisms”, Cambridge Texts in Biomedical Engineering, 2007

5. H K Versteeg, W Malalasekera, “An Introduction to Computational Fluid Dynamics The Finite Volume Method”, Longman Scientific and Technical, 1995.

22PBM19	ADVANCEMENTS IN HEALTHCARE TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

The student should be made to:

1. Understand the needs for wearable devices and the technology
2. Learn the concepts in digital health care and digital hospitals
3. Apply the tools in design, testing and developing digital health care equipment

Course Content:

UNIT I DIGITAL HEALTH **9**

Digital Health: Requirements and best practices, Laws and regulations in Digital health, Ethical issues, barriers and strategies for innovation.

UNIT II DIGITAL RADIOLOGY **9**

Digital radiology for digital hospital, picture archiving and communication, system integration, digital history of radiology, medical image archives, storage and networks.

UNIT III E-HEALTH **9**

E-Health: Health care networking, medical reporting using speech recognition, physiological tests and functional diagnosis with digital methods, tele-consultation in medicine and radiology.

UNIT IV M-HEALTH CARE AND WEARABLE DEVICES **9**

Introduction to mobile healthcare devices-economy-average length of stay in hospital, outpatient care, health care costs, mobile phones, 4G, smart devices, wearable devices, Uptake of e-health and m-health technologies. Standards, system Design and case study.

UNIT V **MODALITY AND STANDARDS FOR INTER-OPERABILITY** **9**

Multimodality registration in daily clinical practice. Mobile healthcare. Selection and Implementation in e-Health project, design of medical equipment based on user needs. Security and privacy in digital health care. Case study.

TOTAL LECTURE PERIODS **45 Periods**

Text Books:

1. Christoph Thuemmler, Chunxue Bai, "Health 4.0: How Virtualization and Big Data are

Revolutionizing Healthcare", Springer, 1st ed. 2017

2. Wlater Hruby, "Digital revolution in radiology – Bridging the future of health care, second edition, Springer, New York. 2006

3. Samuel A. Fricker, Christoph Thümmler , Anastasius Gavras, "Requirements Engineering For Digital Health", Springer, 2015.

Reference Books:

1. Rick Krohn (Editor), David Metcalf, Patricia Salber, "Health-e Everything: Wearables and The Internet of Things for Health, ebook. 2013.

2. Khandpur,R.S,"Handbook of Biomedical Instrumentation ",Second Edition. Tata Mc Graw Hill Pub. Co., Ltd. 2003

3. John, G. Webster. Medical Instrumentation: Application and Design. Second Edition. Wiley Publisher, New Delhi. 2013.

22PBM20	PHYSIOLOGICAL MODELLING OF BIOSYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the application of Physiological models and Vital organs.
2. To understand methods and techniques for analysis and synthesis of dynamic models
3. To model dynamically varying physiological system
4. To develop differential equations to describe the dynamic models
5. To simulate and visualize, dynamic responses of physiological models using software.

Course Content:

UNIT I **SYSTEM CONCEPT** **9**

Introduction to Physiological control systems, Purpose of physiological modeling and signal analysis, Illustration- example of a physiological control system. Difference between engineering and physiological control systems. System variables and properties- Resistance – both static and dynamic, Compliance and combination of resistance and compliance. Resistance and compliance models - respiratory system, aortic segments, lumped model of physiological thermal system, and step response of resistance-compliance system – dye dilution study of circulation

UNIT II **SYSTEM ANALYSIS** **9**

Review of transfer function, transfer function of coupled system. Impedance based transfer function - flexible tube feeding a single port compliant model, development of a lung model. Periodic signals: sinusoidal analysis of second order system, analysis of respiratory system based on sinusoidal excitation, pendelluft.

UNIT III **TRANSIENTAND FEEDBACK** **9**

Review of transient and stability analysis. Homeostasis, representation, finger tracking. Characterization of Physiological Feedback systems- Hypophysis adrenal systems. Nonlinear systems and linearization - transfer function analysis of pupillary control system as a closed loop and method of opening the closed loop, pupillary hippus.

UNIT IV MODELING OF CARDIOPULMONARY SYSTEM 9

Model of cardiac output regulation - Starling‘s law, Physical Significance of under damped responses of post systolic operations in aortic arch, model of circadian rhythms, chemical regulation of ventilation, Cheyne-Stoke breathing, biot breathing.

UNIT V OTHER PHYSIOLOGICAL MODELS AND SIMULATION 9

Steady state analysis of regulation of glucose, Hodgin-Huxley model, Thermal system – model and simulation, modeling of eye movement- types of eye movement, saccade model, model of occulomotor control. Introduction to digital control system.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. William B.Blesser, “A System Approach to Biomedicine”, McGraw Hill Book Co., New York, 1969.

2. Micheal C.K.Khoo ,“Physiological Control System Analysis, Simulation and Estimation”, Prentice Hall of India , New Delhi ,2001.

Reference Books:

1. Manfreo Clynes and John H.Milsum, “Biomedical Engineering System”, McGraw Hilland Co., New York ,1970.

2. Richard Skalak and ShuChien, “Hand Book of Biomedical Engineering” , McGraw Hilland Co., New York, 1987.

3. Douglas S.Rigg, “Control Theory and Physiological Feedback Mechanism”, The Wilkliam and Wilkins Co. Baltimore, 1970.

4. Joseph D,Bronzino, “’The Biomedical Engineering Handbook’’, CRC

Press,3rd Edition, 2006.

5. ChristofKoch, “”Biophysics of Computation”, Oxford University Press, 2004.

6. F.C. Hoppensteadt and C.S.Peskin, "Modeling and Simulation in Medicine and the Life Sciences" Springer, 2nd Edition, 2002.

22PBM21	BIO ROBOTICS	L	T	P	C
		3	0	0	3

Course Objectives:

The objective of this course is to enable the student to:

1. Basics of robots,
2. programming and applications in robots

Course Content:

UNIT I **BASICS OF ROBOTICS** **9**

Robot-Basic concepts, Need, Law, History, Anatomy, specifications. Robot configurations-cartesian, cylinder, polar and articulate. Robot wrist mechanism, Precision and accuracy of robot.

UNIT II **ROBOT ELEMENTS** **9**

End effectors-Classification, Types of Mechanical actuation, Gripper design, Robot drive system Types, Position and velocity feedback devices-Robot joints and links-Types, Motion interpolation.

UNIT III **ROBOT KINEMATICS AND CONTROL** **10**

Robot kinematics – Basics of direct and inverse kinematics, Robot trajectories, 2D and 3D Transformation-Scaling, Rotation, Translation Homogeneous transformation. Control of robot manipulators – Point to point, Continuous Path Control, Robot programming

UNIT IV ROBOT SENSORS 9

Sensors in robot – Touch sensors-Tactile sensor – Proximity and range sensors. Force sensor-Light sensors, Pressure sensors, Introduction to Machine Vision and Artificial Intelligence.

UNIT V FUZZY CONTROL AND APPLICATIONS IN MEDICINE 8

Fuzzy control - Crisp vs Fuzzy, Sets, Inference rules, Defuzzification, Simulation, Applications in Biomedical Engineering, Applications in rehabilitation, Nanobots in medicine, Clinical diagnosis and Surgery – Cardiac and abdominal procedures with teleoperated robots, Orthopedic surgery with cooperative robots Case studies

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. S. B. Niku, Introduction to Robotics, Analysis, Control, Applications, Pearson Education, 2020

2. Robert Schilling, Fundamentals of Robotics-Analysis and control, Prentice Hall of India, 2003.

3. Fu Gonzales and Lee, Robotics, McGraw Hill, 1987.

4. J Craig, Introduction to Robotics, Pearson Education, 2005.

Reference Books:

1. Mikell P. Groover, Mitchell Weiss, Roger N Nagel, Nicholas G Odrey, “Industrial Robotics Technology, Programming and Applications”, Tata – McGraw Hill Pub. Co., 2008.
2. Deb.S.R and Sankha Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill Publishing Company Limited, 2010.
3. Klafter.R.D, Chmielewski.T.A, and Noggin’s., “Robot Engineering: An Integrated Approach”’, Prentice Hall of India Pvt. Ltd., 1994.
4. Fu.K.S, Gonzalez.R.C&Lee.C.S.G, “Robotics control, sensing, vision and

intelligence”, Tata- McGraw Hill Pub. Co., 2008.
5. Bijay K. Ghosh, Ning Xi, T.J. Tarn, Control in Robotics and Automation Sensor – Based integration, Academic Press, 1999.
6. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, Robotic engineering – An Integrated Approach, Prentice Hall Inc, Englewoods Cliffs, NJ, USA, 1989.

22PBM22	MEDICAL REGULATORY AFFAIRS AND STANDARDS	L	T	P	C
		3	0	0	3

Course Objectives:

The objective of this course is to enable the student to

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

Course Content:

UNIT I MEDICAL DEVICE REGULATIONS 9

History of medical device regulation, regulatory affairs professional’s roles, required competencies, medical device classification: scope, definitions, main classifications, Risk based classification, practical examples, labeling of medical devices: definition, elements, risk management, clinical evaluation and labeling, language level and intended users. differentiating medical devices IVDs and combination products from that of pharmaceuticals.

UNIT II ISO STANDARDS 9

ISO 13485:2016: Requirements for regulatory purposes: Quality Management Systems, certification process. ISO 14971: Application of Risk management to medical Devices.

UNIT III **IEC, REGULATORY SYSTEMS IN USA & EU** **9**

IEC international standards and conformity assessment for medical devices, Good submission process, medical device regulatory system in the USA and European Union.

UNIT IV **INDIAN REGULATORY SYSTEM** **9**

India: Medical device regulatory system: market environment, functions undertaken by DGGI, central government, FDA and state governments, guidance documents, details of key regulators, IMDRF and CDSCO, regulatory overview in India, product registration on conformity assessment, quality system regulation, technical material and labeling requirements, commercial aspects, upcoming regulation changes.

UNIT V **CLINICAL TRIALS AND DIGITAL REGULATIONS** **9**

Regulatory strategy and competitive advantage, Preclinical and Clinical Trial Design for Medical Devices in India; FDA approved devices, post-market surveillance/vigilance, Digital health regulations: Connected care, intelligent design control, reducing design time and cost with in-silico clinical trials

TOTAL LECTURE PERIODS **45 Periods**

Text Books:

1. Medical Regulatory Affairs: An International Handbook for Medical Devices and Healthcare Products, 3rd Edition, Taylor & Francis Group, 2021

Reference Books:

1. Reliable Design of Medical Devices, Second Edition by Richard Fries, CRC Press, 2006

2. Medical Device Quality Assurance and Regulatory Compliance by Richard C

Fries, CRC Press, 1998.

3. Product Safety in the European Union by GaborCzitan, Attila Gutassy, Ralf Wilde, TUV Rheinland Akademia, 2008.

22PBM23	BIOMATERIALS	L	T	P	C
		3	0	0	3

Course Objectives:

The student should be made to:

1. Learn characteristics and classification of Biomaterials
2. Understand different metals, ceramics and its nanomaterial's characteristics as biomaterials
3. Learn polymeric materials and its combinations that could be used as a tissue replacement implants
4. Get familiarized with the concepts of Nano Science and Technology
5. Understand the concept of biocompatibility and the methods for biomaterials testing

Course Content:

UNIT I INTRODUCTION TO BIO-MATERIALS 9

Definition and classification of bio-materials, mechanical properties, visco elasticity, biomaterial performance, body response to implants, wound healing, blood compatibility, Nano scale phenomena.

UNIT II METALLIC AND CERAMIC MATERIALS 9

Metallic implants - Stainless steels, co-based alloys, Ti-based alloys, shape memory alloy, nanostructured metallic implants, degradation and corrosion, ceramic implant – bio inert, biodegradable or bioresorbable, bioactive ceramics, nanostructured bio ceramics.

UNIT III POLYMERIC IMPLANT MATERIALS 9

Polymerization, factors influencing the properties of polymers, polymers as biomaterials, biodegradable polymers, Bio polymers: Collagen, Elastin and chitin. Medical Textiles, Materials for ophthalmology: contact lens, intraocular lens. Membranes for plasma separation and Blood oxygenation, electro spinning: a new approach.

UNIT IV TISSUE REPLACEMENT IMPLANTS 9

Small intestinal sub mucosa and other decullarized matrix biomaterials for tissue repair: Extra cellular Matrix. Softtissue replacements, sutures, surgical tapes, adhesive, Percutaneous and skin implants, maxillofacial augmentation, Vascular grafts, hard tissue replacement Implants, joint replacements, tissue scaffolding and engineering using Nano biomaterials.

UNIT V TESTING OF BIOMATERIALS 9

Biocompatibility, blood compatibility and tissue compatibility tests, Toxicity tests, sensitization, carcinogenicity, mutagenicity and special tests, Invitro and Invivo testing; Sterilisation of implants and devices: ETO, gamma radiation, autoclaving. Effects of sterilization.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Sujata V. Bhatt, "Biomaterials", Second Edition, Narosa Publishing House, 2005.

2. Sreeram Ramakrishna, MuruganRamalingam, T. S. Sampath Kumar, and Winston O. Soboyejo, "Biomaterials: A Nano Approach", CRC Press, 2010.

Reference Books:

1. Myer Kutz, "Standard Handbook of Biomedical Engineering & Design", McGraw Hill, 2003

2. John Enderle, Joseph D. Bronzino, Susan M.Blanchard, "Introduction to Biomedical Engineering", Elsevier, 2005.

3. Park J.B., "Biomaterials Science and Engineering", Plenum Press, 1984.

4. A.C Anand, J F Kennedy, M.Miraftab, S.Rajendran,"Woodhead Medical

Textiles and Biomaterials for Healthcare”, Publishing Limited 2006.

5. D F Williams, “Materials Science and Technology: Volume 14, Medical and Dental Materials: A comprehensive Treatment Volume”, VCH Publishers 1992.

6. Monika Saini, Yashpal Singh, Pooja Arora, Vipin Arora, and KratiJain. “Implant biomaterials: A comprehensive review”, World Journal of Clinical Cases, 2015.

22PBM24	ULTRASOUND IN MEDICINE	L	T	P	C
		3	0	0	3

Course Objectives:

1. To teach the principles of ultrasonic’s and its interaction with tissue.
2. Students will be able to know about the scanning techniques and real time scanners
3. principles and application of these principles in health care settings & gain knowledge
4.
   about the various applications of ultrasound in medicine.

Course Content:

UNIT I PRINCIPLES OF ULTRASONICS 9

Introduction, Piezo Electric Devices, The Fields of ‘simple’, CW excited sources, The Pulsed Acoustic field, Effects of human body on Beam Propagation, Beam formation by transducer arrays, Magnitudes of Acoustic Field variables, Displacement detectors Thermal mechanisms, Cavitation, Radiation Pressure.

UNIT II TISSUE-ULTRASOUND INTERACTION 9

Introduction, Absorption in biological tissues, Tissue-Ultrasound interaction cross sections, Theory of mechanisms for the absorption of ultrasonic longitudinal waves, Measurement of attenuation and Absorption Coefficients in tissues, Acoustic properties reflecting different levels of tissue organization, Molecular aspects of soft tissue mechanics, Structural contribution to bulk and shear acoustic properties of tissues. Relevance to tissue characterization, Ultrasound quantitation and tissue characterization

UNIT III SCANNING TECHNIQUES 9

Ultrasound transducers, Construction of ultrasonic probe, Measurement of ultrasonic energy, pulse echo imaging, Pulse echo equation, Transducer motion, Transmit steering and focusing, Beam forming and Dynamic focusing, Transmitter, Receiver, Positional information, Scan converterAnalog, Digital. Image display, Image position, Transducer output, signal processing, adjustment of controls. Scanning Techniques- Acoustic windows, Scanning motion, Transducer Selection, Scan Indexing. Basic Image Interpretation-Contour, Internal Echo pattern, Attenuation, Classification, Artifacts.

UNIT IV REAL TIME ULTRASONIC SCANNERS 9

Different modes of display-A mode, B mode, M mode, B-scan System, The Principles of Ultrasound Motion Detection, Techniques for Measuring Target Velocity, Phase Fluctuation (Doppler Methods), Envelope Fluctuation Methods, Phase Tracking Methods, Envelope Tracking Techniques, Ultrasound Imaging Systems, Considerations Specific To Color Flow Imaging, Angle Independent Velocity Motion Imaging, Tissue Elasticity & Echo Strain Imaging, Performance Criteria, Use of Contrast Media, Real Time Echo, 2-D and 3-D Scanners, Color Doppler.

UNIT V ULTRASONIC APPLICATIONS 9

Ultrasonic diagnosis in Abdomen, Breast, Thyroid, Heart, Chest, Eye, Kidney, Skull, Pregnant and Non Pregnant uterus, 3-Dimensional Ultrasonic Imaging of The Fetus, Advantages And Limitations of 3-Dimensional Ultrasound.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Shirley Blackwell Cusick, Farman and Vicary, A User’s Guide to Diagnostic Ultrasound; Pitman Medical Publishing Co Ltd; Kent, England. (1978).

2. C.R.Hill, Jeff C.Bamber, Gail Haa, Physical Principles of medical Ultrasonics; John Wiley & Sons Ltd; 2nd Edition, 2004.

Reference Books:

1. W.N.McDicken, Churchill Livingstone, Diagnostic Ultrasonics – Principles and use instruments – New York, 3rd Edition, 1991.

2. Khandpur R.S Hand Book of Biomedical Instrumentation – Tata Mc Graw Hill publication , New Delhi 2nd edition 2003

22PBM25	COMPUTATIONAL NEUROSCIENCE	L	T	P	C
		3	0	0	3

Course Objectives:

1. To know the general organization of brain and physiological and cognitive processes.
2. To apply the molecular, cellular, and cognitive bases of learning and memory.

Course Content:

UNIT I NEUROANATOMY 9

What are central and peripheral nervous systems; Structure and function of neurons; types of neurons; Synapses; Glial cells; myelination; Blood Brain barrier; Neuronal differentiation; Characterization of neuronal cells; Meninges and Cerebrospinal fluid; Spinal Cord.

UNIT II NEUROPHYSIOLOGY 9

Using current clamp techniques, the electroresponsive behavior of cells are studied by generating a frequency(f)-vs-current(I) plot. This experiment deals with the f-I curve.

UNIT III SINGLE NEURON MODELING 9

Ion flux in membranes, Nernst Planck Equation, Ion-Channels, Excitable membranes, Spiking, Hodgkin Huxley models, Integrate and Fire Neurons

UNIT IV NEURAL ENCODING AND DECODING 9

Spike train statistics, Receptive fields, Linear and Nonlinear models of Receptive fields, Applications of Information Theory in neural coding and decoding

UNIT V PLASTICITY: ADAPTATION AND LEARNING 9

Synapses: structure and function, plasticity, Spike Timing Dependent Plasticity (STDP), Learning rules, Supervised and Unsupervised Learning, Classical conditioning, Reinforcement Learning

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Mathews G.G. Neurobiology, 2nd edition, Blackwell Science, UK, 2000.
2. Gordon M. Shepherd G.M, and Shepherd Neurobiology, 3rd Edition Oxford University Press, USA, 1994
3. Theoretical Neuroscience - Computational and Mathematical Modeling of Neural Systems by Peter Dayan and L.F. Abbott
4. C.R.Hill, Jeff C.Bamber, Gail Haa, Physical Principles of medical Ultrasonics; John Wiley & Sons Ltd; 2nd Edition, 2004.

Online Reference:

1. https://courses.cit.cornell.edu/bionb330/Class%20Notes%20PartIV.pdf (Unit III)
2. https://courses.cit.cornell.edu/bionb330/Class_notes_PARTIII.pdf(Unit III)

Reference Books:

1. Mason P., Medical Neurobiology, Oxford University Press, 2011.

22PBM26	SPEECH AND LANGUAGE PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce speech production and related parameters of speech
- To show the computation and use of techniques such as short time Fourier transform,
- linear predictive coefficients and other coefficients in the analysis of speech
- To understand different speech modeling procedures such as Markov and their
- implementation issues
- To introduce speech recognition and synthesis techniques

Course Content:

UNIT I BASIC CONCEPTS 10

Speech Fundamentals: Articulatory Phonetics – Production and Classification of Speech Sounds; Acoustic Phonetics – Acoustics of speech production; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods.

UNIT II SPEECH ANALYSIS 10

Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures – mathematical and perceptual – Log–Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization – Dynamic Time Warping, Multiple Time – Alignment Paths.

UNIT III SPEECH MODELING 8

Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues.

UNIT IV SPEECH RECOGNITION 8

Large Vocabulary Continuous Speech Recognition: Architecture of large vocabulary continuous speech recognition system – acoustics and language models – n-grams, context dependent subword units; Applications and present status.

UNIT V SPEECH SYNTHESIS 9

Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, sub-word units for TTS, intelligibility and naturalness – role of prosody, Applications and present status.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1.Lawrence Rabinerand Biing-Hwang Juang, "Fundamentals of Speech Recognition" Pearson Education, 2003.

2. Daniel Jurafsky and James H Martin, "Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Pearson Education, 3rd Edition, 2018.

Reference Books:

1. Frederick Jelinek, "Statistical Methods of Speech Recognition", MIT Press, Reprint 2001

2. Steven W. Smith, "The Scientist and Engineer‘s Guide to Digital Signal Processing", California Technical Publishing, 1997.

3. Thomas F Quatieri, "Discrete-Time Speech Signal Processing Principles and Practice", Pearson Education, 2004.

4. Claudio Becchetti and LucioPrinaRicotti, "Speech Recognition", John Wiley and Sons, 1999.

5. Ben Gold and Nelson Morgan, "Speech and Audio Signal Processing and

Perception of Speech and Music", Wiley- India Edition, 2006 Edition.

6. Melanie Mitchell, An Introduction to Genetic Algorithms: Prentice Hall of India, New Delhi 1998..

7. Simon Haykins, Neural Networks, Prentice Hall international lnc, 1999.

8. James A Freeman and David M. Skapura, Neural Networks, Addison - Wesley, India 1999.

22PBM27 PRINCIPLES OF TISSUE ENGINEERING

L	T	P	C
3	0	0	3

Course Objectives:

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

Course Content:

UNIT I BASICS OF TISSUE ENGINEERING 9

Introduction to Tissue Engineering - Objectives of Tissue Engineering - Basic definitions - Structure and organization of Tissues – Development of Tissue – Tissue exchange and diffusion of simple metabolites – Tissue Equivalent - Wound Healing Process - Biocompatibility and toxicity assessment.

UNIT II FUNDAMENTALS OF CELL MECHANISMS 9

Cell adhesion, Cell migration and Cell aggregation – Cell growth and Cell cycle. Cellular Interactions: Cell – Cell and Cell – Matrix. Control of Cell migration in Tissue Engineering –Cell delivery and Recirculation – Cell Culture in vitro – 3D culture in Tissue Engineering - In vitro Organogenesis - Cell transplantation.

UNIT III BIOMATERIALS IN TISSUE ENGINEERING 9

Definition – Biological vs Nonbiological materials – Extra Cellular Matrix – Collagen, Chitin & Degradable and Nondegradable materials – Polymer, Ceramics and Metals – Cell interaction with different materials –- Scaffolds - Control releaser agents in Tissue Engineering – Cell interaction with suspension and gels – Tissue response to implants.

UNIT IV STEM CELLS IN TISSUE ENGINEERING 9

Introduction of Stem cells – Hemopoetic Stem cells - Embryonic Stem cells - Adult stem cells – Cancer Stem cells – Cord Blood cells – Induced Pluripotent Stem cells - Stem cell identification - Surface markers & FACS analysis – Differentiation, Dedifferentiation and Immortalization – Application of stem cells in tissue Engineering..

UNIT V TISSUE ENGINEERING APPLICATIONS 9

Synthetic components – Artificial organs – Joints and dental prostheses - Connective Tissue Engineering – Cardiovascular Tissue Engineering – Neural Tissue Engineering - Cell and Drug Delivery systems.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. W. Mark Saltzman Tissue Engineering – Engineering principles for design of replacement organs and tissue –- Oxford University Press inc New York, 2004.
2. Gray E Wnek, Gray L Browlin – Encyclopaedia of Biomaterials and Biomedical Engineering – Marcel Dekker Inc New York, 2004.
3.

Reference Books:

1. 1. Fr R.Lanza, J.Gearhart et.al,(Eds), Essential of Stem cell Biology, Elsevier Academic Press, 2006.
2. Sujata V.Bhatt, Biomaterials (2nd Edition), Narosa Publishing House, 2005.

22PBM28	CLINICAL TRIALS AND DESIGN OF EXPERIMENTS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To highlight the epidemiologic methods, study design, protocol preparation
2. To gain knowledge in the basic bio-statistical techniques involved in clinical research.
3. To describe the principles involved in ethical, legal and regulatory issues in clinical trials.

Course Content:

UNIT I ROLE OF CLINICAL TRIALS IN NEW DRUG DEVELOPMENT 9

Drug Discovery, regulatory guidance and governance, pharmaceutical manufacturing, nonclinical research, clinical trials, post-marketing surveillance, ethical conduct during clinical trials.

UNIT II FUNDAMENTALS OF TRIAL DESIGN 9

Randomised clinical trials, uncontrolled trials. Protocol development, endpoints, patient selection, source and control of bias, randomization, blinding, sample size and power.

UNIT III ALTERNATE TRIAL DESIGNS 9

Crossover design, factorial design, equivalence trials, bioequivalence trials, non-inferiority trials, cluster randomized trials, multi-center trials.

UNIT IV BASICS OF STATISTICAL ANALYSIS 9

Types of data and normal distribution, significance tests and confidence intervals, comparison of means, comparison of proportions, analysis of survival data, subgroup analysis, regression analysis, missing data.

UNIT V **REPORTING OF TRIALS** **9**

Overview of reporting, trial profile, presenting baseline data, use of tables, figures, critical appraisal of report, meta-analysis.

TOTAL LECTURE PERIODS **45 Periods**

Text Books:

1. Fundamentals of Clinical Trials, Lawrence M. Friedman, Springer Science & Business

Media, 2010.

2. Textbook of Clinical Trials, David Machin, Simon Day, Sylvan Green, John Wiley & Sons, 2007.

3. Krishnaiah K, and Shahabudeen P, “Applied Design of Experiments and Taguchi Methods”, PHI, India, 2011.

Reference Books:

1. Clinical trials, A practical guide to design, analysis and reporting. Duolao Wang and

AmeetBakhai. Remedica. 2006.

2. Introduction to statistics in pharmaceutical clinical trials. T.A. Durham and J Rick Turner. Pharmaceutical Press.

3. Douglas C. Montgomery, “Design and Analysis of Experiments”, John Wiley & sons, 2005

4. Phillip J. Ross, “Taguchi Techniques for Quality Engineering”, Tata McGraw-Hill, India, 2005.

22PBM29 FORENSIC SCIENCE IN MEDICINE

L	T	P	C
3	0	0	3

Course Objectives:

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

1. The Blood stain identification
2. Methodology of collecting & interpreting data for fingerprint application
3. Types of professionals involved in evaluating a crime scene and the collection of evidence
4. Forensic microscope and Anthropology
5. History of the forensic sciences and its place in popular culture

Course Content:

UNIT I **FORENSIC SCIENCE AND ITS HISTORY** **9**

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

UNIT II **LEGAL CONSIDERATIONS AT THE CRIME SCENE** **9**

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

UNIT III **SKELETAL DETERMINATION** **9**

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

Forensic Anthropology.

UNIT IV DNA PHENOTYPING AND RNA PROFILING 9

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

UNIT V AUTOMATED FINGERPRINT IDENTIFICATION SYSTEMS (AFIS) 9

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

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Sharma, B.R. (1974) Forensic Science in Criminal Investigation and Trials, Central Law Agency, Allahabad, 1974
2. .James, S.H and Nordby, J.J. (2003) Forensic Science: An introduction to scientific and investigative techniques CRC Press.
3. Nanda, B.B. and Tewari, R.K. (2001) Forensic Science in India: A vision for the twenty first century Select Publisher, New Delhi.

Reference Books:

1. Saferstein : Criminalistics (1976) Prentice Hall Inc., USA.

2. Deforest, Gansellen & Lee : Introduction to Criminalistics.

3. Sharma, B.R. (1974) Forensic Science in Criminal Investigation and Trials, Central Law Agency, Allahabad, 1974

22PBM30	OCCUPATIONAL SAFETY AND PUBLIC HEALTH SAFETY ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

1. Anticipate, recognize, evaluate and control hazardous conditions and practices affecting people, property and the environment
2. Communicate and interact effectively with technical and non-technical audiences
3. Integrate ethical, social, current, and global issues and responsibilities in their practice as a professional in the field.
4. Work individually or on a team to critically analyze, interpret, and provide leadership to address and manage problems in occupational safety and health

Course Content:

UNIT I OCCUPATIONAL HAZARD AND CONTROL PRINCIPLES 9

Safety, History and development, National Safety Policy. Occupational safety and Health Act (OSHA), Occupational Health and Safety administration-Laws governing OSHA and right to know. Accident-causation, investigation, investigation plan, Methods of acquiring accident facts, Supervisory role in accident investigation.

UNIT II ERGONOMICS AT WORK PLACE 9

Ergonomics at Work Place: Ergonomics Task analysis, Preventing Ergonomic Hazards, Work space Envelops, Visual Ergonomics, Ergonomic Standards, Ergonomic Programs. Hazard cognition and Analysis, Human Error Analysis-Fault Tree Analysis-Emergency Response-Decision for action-purpose and considerations.

UNIT III FIRE PREVENTION AND PROTECTION 9

Fire Triangle, Fire Development and its severity, Effect of Enclosures, early detection of Fire, Classification of fire and Fire Extinguishers. Electrical Safety, Product

Safety:Technical Requirements of Product safety.

UNIT IV HEALTH CONSIDERATIONS AT WORK PLACE 9

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

UNIT V OCCUPATIONAL HEALTH AND SAFETY CONSIDERATIONS 9

Water and wastewater treatment plants, Handling of chemical and safety measures in water and wastewater treatment plants and labs, Construction material manufacturing industries like cement plants, RMC Plants, precast plants and construction sites. Policies, roles and responsibilities of workers, managers and supervisors.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Goetsch D. L.,(1999), Occupational Safety and Health for Technologists, Engineers and Managers, Prentice Hall.
2. HeinrichH.W.,(2007),Industrial Accident Prevention A Scientific Approach, McGraw-Hill Book Company
3. R.K. Jain and Prof. Sunil S. Rao Industrial Safety, Health and Environment Management Systems KHANNA PUBLISHER
4. L. M. Deshmukh Industrial Safety Management: Hazard Identification and Risk Control McGraw-Hill Education
5. National Safety Council and Associate (Data) Publishers Pvt. Ltd., (1991)
6. Industrial Safety and Pollution Control Handbook.

Reference Books:

1.CollingD.A.,(1990),“IndustrialSafetyManagementandTechnology”,PrenticeHall,New Delhi.

2. Della D.E., and Giustina, (1996), “Safety and Environmental Management”, Van Nostrand Reinhold International Thomson Publishing Inc.

22PBM31	BIOCOMPATILITY AND MICROBIOLOGICAL ACTIVITY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To learn and understand the principles of biocompatibility.
2. To introduce students to the properties of Biomaterials and Biomaterials Science.
3. To solve the problems in microbial infection and their control.

Course Content:

UNIT I FUNDAMENTALS OF BIOMATERIALS SCIENCE 9

Fundamentals of Biomaterials science Concept of biocompatibility. Classes of biomaterials used in medicine, basic properties, medical requirements and clinical significance. Desinfection and sterilization of biomaterials.

UNIT II PHYSICO-CHEMICAL PROPERTIES OF BIOMATERIALS 9

Mechanical (elasticity, yield stress, ductility, toughness, strength, fatigue, hardness, wear resistance), tribological (friction, wear, lubricity), morphology and texture, physical (electrical, optical, magnetic, thermical), chemical and biological properties.

UNIT III STRUCTURAL VARIATIONS IN BIOMATERIAL 9

Definition, classification and properties of bio-materials, Surface, bulk, mechanical and biological. Types of biomaterials; Biological response to biomaterials; Crystal structure of metals; Crystal structure of ceramics; Carbon based materials; General structure of polymers; Synthesis of polymers. Bending properties; Time dependent properties – creep properties of polymers; Influence of porosity and the degradation of mechanical properties; Introduction to fatigue.

UNIT IV BIOCOMPATIBILITY 9

Biocompatibility–Toxicology, Biocompatibility, Mechanical and Performance Requirements, Regulation. Biomaterials associated infection. Cytocompatibility evaluation laboratory, Tissue compatibility evaluation laboratory, Hemocompatibility evaluation laboratory, Sterility evaluation laboratory, Histopathology evaluation laboratory, Physiochemical evaluation laboratory.

UNIT V IMPLANTATION 9

In vitro assays for inflammatory response due to biomaterial implantation; Fibrous encapsulation of healing process; Ideal features of soft tissue implants; Metallic Implant materials, Polymeric Implant materials, Tissue replacement materials-soft, hard and blood interfacing materials.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. John B.Park Joseph D. Bronzino, “Biomaterials - Principles and Applications” CRC Press, 4th edition, 2003.

2. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons. An Introduction to Materials in Medicine. Academic Press. USA, 2006.

Reference Books:

1. L Hench J. Jones, “Biomaterials, Artificial Organs and Tissue Engineering”, Woodhead Publishing, 2005.

2. Michael Lysaght and Thomas Webster, “Biomaterials for artificial Organs”, Woohead Publishing series in biomaterials, 2010

3. Sujata V. Bhatt, “Biomaterials” Second Edition, Narosa Publishing House,2005.

4. Rajendran V. and Marikani A., Materials Science, Tata McGraw Hill Pub. Company Ltd., New Delhi, 2004.

22PBM32 INTELLECTUAL PROPERTY RIGHTS

L	T	P	C
3	0	0	3

Course Objectives:

1. To give an idea about IPR, registration and its enforcement.

Course Content:

UNIT I INTRODUCTION 9

Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – the way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

UNIT II REGISTRATION OF IPRs 10

Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad

UNIT III AGREEMENTS AND LEGISLATIONS 10

International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

UNIT IV DIGITAL PRODUCTS AND LAW 9

Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.

UNIT V	ENFORCEMENT OF IPRs	7

Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012

2. S. V. Satakar, "Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi, 2002.

Reference Books:

1. Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets", Cengage Learning, Third Edition, 2012.

2. Prabuddha Ganguli,"Intellectual Property Rights: Unleashing the Knowledge Economy", McGraw Hill Education, 2011.

3. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.

22PBM33	BIO PHOTONICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. The objective of this course is to learn about the emerging field of biophotonics which deals with the application of optics based technologies for life science applications such as biosensing, imaging, cell manipulation and so on.

Course Content:

UNIT I **INTRODUCTORY OPTICS** **9**

Geometric, Wave, EM and Quantum Picture of Light. Concept of phase, polarization and coherence. Diffraction and Interference.

UNIT II **LIGHT- MATTER INTERACTIONS** **9**

Energy level picture of materials. Photons, Photoelectric effect, Interaction of photons with materials. Phosphorescence and fluorescence. Stimulated emission of photons. Principle of laser action. Laser types and applications (CW, Pulsed, Ultra- fast, Solid state, Gas, Dye …). Spectroscopy: Types and applications (UV-Vis, Infrared, Raman, FTIR …).

UNIT III **OPTICAL IMAGING I** **9**

Basic imaging theory, concept of diffraction limit. Optical microscope. Methods for contrast-generation (Dark-field, Phase contrast, DIC, Polarization). Fluorescence microscopy. Fluorescence techniques (FRET, FLIM, FRAP, FCS…). Nanoparticle fluorescence. 3D sectioning: Confocal and multi-photon imaging. Advanced Topics - Nanoparticle fluorescence - Super-resolution techniques (STED, STEM, STORM, PALM …) - Super-resolution image reconstruction methods.

UNIT IV **OPTICAL IMAGING II** **9**

Biomedical (Physiological Imaging). Light Scattering phenomena. Tomographic techniques: OCT. Image reconstruction techniques.

UNIT V **APPLICATIONS** **9**

Optical biosensors. Optical manipulation of biological materials. Optical tweezers. Laser dissection and surgery. Neural excitation.

TOTAL LECTURE PERIODS **45 Periods**

Text Books:

1. Bahaa Saleh and Malvin Teich, Fundamentals of Photonics, Wiley & Sons (1991).

Reference Books:

1. Paras N. Prasad, Introduction to Biophotonics, Wiley & Sons (2003).

22PBM34	PRODUCT ERGONOMICS AND DESIGN	L	T	P	C
		3	0	0	3

Course Objectives:

1. To get exposed to principles of visual capabilities.
2. To learn the mechanics of muscle physiology and significance of rest cycle.
3. To learn spatial compatibility and the relation between control orders and control response.
4. To know about the measurements and proportions of the human body.
5. To be familiar with the mathematical models, analysis and design of biomedical devices using case studies.

Course Content:

UNIT I VISUAL AND AUDITORY ERGONOMICS 9

Process of seeing – visual capabilities – factors affecting visual acuity and contrast sensitivity – human factor aspects of hard copy text and computer screen text, factors in selecting graphic representations symbols, qualitative visual display – process of hearing – principles of auditory display. Measures for monitoring control & mitigation.

UNIT II MUSCLE PHYSIOLOGY 9

Muscle physiology – muscle metabolism – respiratory response – joint motion study – measure of physiological in-efficiency and energy consumption – work rest cycles – aspects of manual and posture study, material handling (MMH) Bio-mechanical recommended limits of MMH.

UNIT III CONTROLS AND DISPLAYS 9

Spatial compatibility and physical arrangement of displays and controls - Design of displays and controls – movement capability – rotary controls and rotor displays movement of displays orientation of the operator and movement relationships control orders and control responses – human limitations in tracking task

UNIT IV ANTHROPOMETRY 9

Anthropometry – anthropometric design principles – Physical work load and energy expenditure - work space envelope – factors in design of work space surfaces – principles of seat design – principles of control panel. ergonomic implications. Organization classification of human errors theories of accident causation-reducing accidents by altering behavior.

UNIT V CASE STUDIES 9

Optical biosensors. Optical manipulation of biological materials. Optical Case Study 1: computer design, control panel design of an electronic instrument, computer key board, hand drill etc. Case Study 2: Biomedical Application, Design optimization of Medical Equipment.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Pascale Carayon, “Handbook of Human Factors and Engineering”, Second Edition, CRC Press, 2011

2. Martin Helander, “Guide to Human Factors and Ergonomics”, Second Edition, CRC Press,2005

3. Benjamin W.Niebel, “Motion and Time Study”, Richard, D. Irwin Inc., Seventh Edition, 2002

Reference Books:

1. Shrawan Kumar, Biomechanics in Ergonomics, Second Edition, CRC

Press2007.

2. George Kanawaty, “Introduction to work study”, ILO, 3rd edition, Oxford & IBH publishing, 2001

3. Stephen Pheasant, Christine M. Haslegrave, Bodyspace: Anthropometry, Ergonomics and the Design of Work, CRC Press, 2005. \

22PBM35	BIOMEDICAL OPTICS	L	T	P	C
		3	0	0	3

Course Objectives:

To Study about:

1. The optical properties of the tissues and the interactions of light with tissues.
2. The instrumentation and components in Medical Optics.
3. The Medical Lasers and their applications
4. The optical diagnostic applications
5. The emerging optical diagnostic and therapeutic techniques

Course Content:

UNIT I OPTICAL PROPERTIES OF THE TISSUES **9**

Fundamental Properties of light - Refraction, Reflection, Laws (Snell’s law and Fresnel law) Scattering, Absorption, Light transport inside the tissue, Tissue properties, Laser Characteristics as applied to medicine and biology, Laser tissue Interactions – Photo chemical, Photo thermal and Photo mechanical interactions, Fluorescence, Speckles, Photo ablative processes.

UNIT II INSTRUMENTATION IN PHOTONICS **9**

Instrumentation for absorption, Scattering and emission measurements, Excitation light sources – high pressure arc lamps, LEDs, Lasers, Optical filters – Prism and Monochromators, Polarizers, Optical detectors – Single Channel and Multichannel detectors, Time resolved and phase resolved detection methods, Optical fibers – Total Internal Reflection.

UNIT III SURGICAL THERAPEUTIC APPLICATIONS OF LASERS **9**

Lasers in ophthalmology, Dermatology, Dentistry, Urology, Otolaryngology, Tissue welding and Soldering.

UNIT IV NON THERMAL DIAGNOSTIC APPLICATIONS **9**

Optical coherence tomography, Elastography, Laser Induced Fluorescence (LIF)- Imaging, FLIM Raman Spectroscopy and Imaging, FLIM – Holographic and Speckle applications of lasers in biology and medicine.

UNIT V DIAGNOSTIC AND THERAPEUTIC TECHNIQUES **9**

Near field imaging of biological structures, In vitro clinical diagnostics, Phototherapy, Photodynamic therapy (PDT) - Principles and mechanisms - Oncological and non-oncological applications of PDT - Biostimulation effect – applications - Laser Safety Procedures.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Tuan Vo Dirh, "Biomedical Photonics – Handbook", CRC Press, Bocaraton, 2014.

2. Paras N. Prasad, "Introduction to Biophotonics", A. John Wiley and Sons, Inc. Publications, 2003

Reference Books:

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

2. G.David Baxter "Therapeutic Lasers – Theory and practice", Churchill

Livingstone publications Edition- 2001.

3. Leon Goldman, M.D., & R.James Rockwell, Jr., “Lasers in Medicine”, Gordon and Breach, Science Publishers Inc., 1975.

22PBM36 CARDIOVASCULAR ENGINEERING

L	T	P	C
3	0	0	3

Course Objectives:

1. To provide an introduction to biomedical engineering, showcasing the scope of engineering techniques and concepts that are used within healthcare, illustrating each with examples related to the cardiovascular system.

Course Content:

UNIT I ANTI FAILURE AGENTS 9

Diuretics-furosemide, torsamide, thiazide diuretics, metolazone, spironolactone, combination diuretics,Angiotensin convertying enzyme (ACE) inhibitors ARB (Angiotensin Receptor Blocker) – Valsartan Cosartan Telmisartan – captopril Enalapril, ramipril, lisinopril, ACE inhibitors for diabetics and hypertensive renal disease,Digitalis and acute ionotropes – digoxin, odoubutamine, dopamine, adrenaline, noradrenaline, isoprenaline,Beta Blockers – Carvidilol, Bisoprolol, metaprolol.

UNIT II ANTI THROMBOTIC AGENTS 9

Platelet inhibitors: aspirin, clopidogrel, Prasugrel, ticagrelor , Anticoagulants: heparin, low molecular weight heparin, warfarin fondaparinux_ Fibrinolytics: streptokinase, urokinase Tenectaplase reteplase,Glycoprotein 2b3a antagonists: abciximab, tirofiban, eptifibatide.

UNIT III ANTI-ARRHYTHMIC AGENTS 9

Amiodarone, adenosine, verapamil, ivabradine, diltiazem, lidocaine, mexiletine, Phenytoin, flecainide, bretylium, atropine, Isoprenaline.

UNIT IV **ANTI-HYPERTENSIVE DRUGS** **9**

Diuretics, beta-blockers, ACE inhibitors, calcium antagonists, direct Vasodilators, centrally acting and peripherally acting vasodilators. Angiotensin Receptor Blocker – Valsartan Losartan Telmisartan olmesartan,

UNIT V **ANAPHYLAXIS, DRUG REACTIONS, DRUG INTERACTION PROTAMINE** **9**

Narcotics: morphine, pethidine, fentanyl-Sedatives: diazepam, midazolam - Steroids: hydrocortisone, oprednisolone, Antihistamines: diphenhydramine - Antibiotics: pecicillins, cephalosporins, -Antacids and proton pump inhibitors - Anaesthetic agents: local general - Anaphylaxis, Drug reactions, Drug interaction (Basics).

TOTAL LECTURE PERIODS **45 Periods**

Text Books:

1. Satish Gupta Short text book of Medical Laboratory for technician J.P. Bros, New Delhi – 1998
2. Ramanic Sood, Laboratory Technology (Methods and interpretation) 4th Ed. J.P. Bros, New Delhi –1996.

Reference Books:

1. Sachdev K.N. Clinical Pathology and Bacteriology 8th Ed, J.P. Bros, 26 New Delhi-1991.
2. K.D. Tripathi, Essentials of Medical Pharmacology, V. Edition, M/s. Jaypee Brothers, Post Box, 7193, G-16, EMCA House, 23/23, Bansari Road, Daryaganj, New Delhi.

22PBM37	BIO MICROFLUIDS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To identify, and understand microfluidic principles in the context of the medical industry and current research problems.
2. To understand Electro kinetics and Microfabrication techniques.

Course Content:

UNIT I INTRODUCTION **9**

Origin, Definition, Benefits, Challenges, Commercial activities, Physics of miniaturization, Scaling laws.

UNIT II MICRO-SCALE FLUID MECHANICS **9**

Intermolecular forces, States of matter, Continuum assumption, Governing equations, Constitutive relations. Gas and liquid flows, Boundary conditions, Slip theory, Transition to turbulence, Low Re flows, Entrance effects. Exact solutions, Couette flow, Poiseuille flow, Stokes drag on a sphere, Time-dependent flows, Two-phase flows, Thermal transfer in microchannels. Hydraulic resistance and Circuit analysis, Straight channel of different cross-sections, Channels in series and parallel.

UNIT III ELECTROKINETICS **9**

Electrohydrodynamics fundamentals. Electro-osmosis, Debye layer, Thin EDL limit, Ideal electro- osmotic flow, Ideal EOF with back pressure, Cascade electro- osmotic micropump, EOF of power-law fluids. Electrophoresis of particles, Electrophoretic mobility, Electrophoretic velocity dependence on particle size. Dielectrophoresis, Induced polarization and DEP , Point dipole in a dielectric fluid, DEP force on a dielectric sphere, DEP particle trapping, AC DEP force on a dielectric sphere. Electro-capillary effects, Continuous electro-wetting, Direct electro-wetting, Electro-wetting on dielectric.

UNIT IV MICROFABRICATION TECHNIQUES 9

Materials, Clean room, Silicon crystallography, Miller indices. Oxidation, photolithography- mask, spin coating, exposure and development, Etching, Bulk and Surface micromachining, Wafer bonding. Polymer microfabrication, PMMA/COC/PDMS substrates, micromolding, hot embossing, fluidic interconnections.

UNIT V MICROFLUIDICS COMPONENTS 9

Micropumps, Check-valve pumps, Valve-less pumps, Peristaltic pumps, Rotary pumps, Centrifugal pumps, Ultrasonic pump, EHD pump, MHD pumps. Microvalves, Pneumatic valves, Thermopneumatic valves, Thermomechanical valves, Piezoelectric valves, Electrostatic valves, Electromagnetic valves, Capillary force valves. Microflow sensors, Differential pressure flow sensors, Drag force flow sensors, Lift force flow sensors, Coriolis flow sensors, Thermal flow sensors. Micromixers, Physics of mixing, Pe-Re diagram of micromixers, Parallel lamination, Sequential lamination, Taylor-Aris dispersion. Droplet generators, Kinetics of a droplet, Dynamics of a droplet, In-channel dispensers, T-junction and Cross-junction, Droplet formation, breakup and transport. Microparticle separator, principles of separation and sorting of microparticles, design and applications. Microreactors, Design considerations, Liquid-phase reactors, PCR, Design consideration for PCR reactors.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1.Nguyen, N. T., Werely, S. T., Fundamentals and applications of Microfluidics, Artech house Inc., 2002. Bruus, H., Theoretical Microfluidics, Oxford University Press Inc., 2008.

2.Madou, M. J., Fundamentals of Microfabrication, CRC press, 2002.

Reference Books:

1.Tabeling, P., Introduction to microfluidics, Oxford University Press Inc., 2005.

2.Kirby, B.J., Micro- and Nanoscale Fluid Mechanics: Transport in Microfluidic Devices, Cambridge University Press, 2010.

3.Colin, S., Microfluidics, John Wiley & Sons, 2009.

22PBM38	COGNITIVE NEUROSCIENCE	L	T	P	C
		3	0	0	3

Course Objectives:

To enable the students

1. To know the general organization of brain and physiological and cognitive processes.
2. To apply the molecular, cellular, and cognitive bases of learning and memory.

Course Content:

UNIT I **NEUROANATOMY** **9**

Classification of central and peripheral nervous systems; Structure and function of neurons; types of neurons; cranial nerves, spinal nerves, glial cells; myelination; Brief anatomy of Brain and Spinal cord Blood Brain barrier; Meninges and Cerebrospinal fluid; Spinal Cord.

UNIT II **NEUROPHYSIOLOGY** **9**

Resting and action potentials; Mechanism of action potential conduction; Voltage dependent channels; nodes of Ranvier; Chemical and electrical synaptic transmission; information representation and coding by neurons.

UNIT III **NEUROPHARMACOLOGY** **9**

Overview of drug mechanism of action and classification – parasympathetic and sympathetic drugs, neuroleptics, thymoleptics, analeptics, drugs used in Alzheimers and Parkinson disease, drug addiction

UNIT IV INTRODUCTION TO COGNITIVE SCIENCE 9

The Cognitive view –Some Fundamental Concepts – Computers in Cognitive Science – Applied Cognitive Science – The Interdisciplinary Nature of Cognitive Science – Artificial Intelligence: Knowledge representation -The Nature of Artificial Intelligence - Knowledge Representation – Artificial Intelligence: Search, Control, and Learning.

UNIT V BEHAVIOUR AND COGNITIVE SCIENCE 9

Basic mechanisms associated with motivation; behavioural studies – interpersonal interaction models, Transactional Analysis, neurology of memory; disorders associated with the nervous system.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Ross and Wilson Anatomy and Physiology in Health and Illness:, 11th edition, Anne Waugh 2010
2. Principles of Neural Science, Fifth Edition by Eric R. Kandel (Editor), James H. Schwartz (Editor), Thomas M. Jessell (Editor), Steven A. Siegelbaum (Editor), A. J. Hudspeth 2012
3. Neuroscience by Dale Purves, George J. Augustine, David Fitzpatrick, William C. Hall, Anthony-Samuel LaMantia, Leonard E. White 6 edition (October 12, 2017)
4. Lippincott Illustrated Reviews: Pharmacology 6th edition, Karen Whalen 2014

Reference Books:

1. Neuroscience: Exploring the Brain 4th Edition, by Mark F. Bear, Barry W. Connors, Michael A. Paradiso Wolters Kluwer Health; 4 edition 2015
2. Mathews G.G. Neurobiology:molecules, cells and systems/Gary G. Mathews 2nd edition, Blackwell Science, UK, 2000.
3. The Brain That Changes Itself: Stories of Personal Triumph from the Frontiers of Brain Science, Norman Doidge Penguin USA 2007

4. For detailed syllabus of all the other subjects of Industrial Technology 7th Sem, visit Industrial Biotech 7th Sem subject syllabuses for 2019 regulation.

22OBM01	ANALYTICAL INSTRUMENTS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide various techniques and methods of analysis which occur in the various regions of the spectrum. These are the powerful tools used in clinical and research laboratories.
2. To give unique methods of separation of closely similar materials, the most powerful being gas chromatography.
3. To study important methods of analysis of industrial gases. Awareness and control of pollution in the environment is of vital importance.

UNIT I COLORIMETRY AND SPECTROPHOTOMETRY 9

Special methods of analysis – Beer-Lambert law – Colorimeters – UV-Vis spectrophotometers – Single and double beam instruments – Sources and detectors – IRspectrophotometers – Types – Attenuated total reflectance flame photometers – Atomic absorption spectrophotometers – Sources and detectors – FTIR spectrophotometers – Flame emission photometers.

UNIT II CHROMATOGRAPHY 9

Different techniques – Gas chromatography – Detectors – Liquid chromatographs – Applications – High-pressure liquid chromatographs – Applications.

UNIT III INDUSTRIAL GAS ANALYZERS AND POLLUTION MONITORING INSTRUMENTS 9

Types of gas analyzers – Oxygen, NO2 and H2S types, IR analyzers, thermal conductivity analyzers, analysis based on ionization of gases. Air pollution due to carbon monoxide, hydrocarbons, nitrogen oxides, sulphur dioxide estimation - Dust and smoke measurements.

UNIT IV pH METERS AND DISSOLVED COMPONENT ANALYZERS 9

Principle of pH measurement, glass electrodes, hydrogen electrodes, reference electrodes, selective ion electrodes, ammonia electrodes, biosensors, dissolved oxygen analyzer – Sodium analyzer – Silicon analyzer.

UNIT V RADIO CHEMICAL AND MAGNETIC RESONANCE TECHNIQUES 9

Nuclear radiations – Detectors – GM counter – Proportional counter – Solid state detectors – Gamma cameras – X-ray spectroscopy – Detectors – Diffractometers – Absorption meters – Detectors. NMR – Basic principles – NMR spectrometer - Applications. Mass spectrometers – Different types – Applications.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. R.S. Khandpur, 'Handbook of Analytical Instruments', Tata McGraw Hill publishing Co. Ltd., 2003.
2. H.H.Willard, L.L.Merritt, J.A.Dean, F.A.Settle, 'Instrumental methods of analysis', CBS publishing & distribution, 1995.

Reference Books:

1. Robert D. Braun, 'Introduction to Instrumental Analysis', McGraw Hill, Singapore, 1987.
2. G.W.Ewing, 'Instrumental Methods of Analysis', McGraw Hill, 1992.
3. DA Skoog and D.M.West, 'Principles of Instrumental Analysis', Holt, Saunders Publishing, 1985.
4. C.K. Mann, T.J Vickers & W.H. Gullick, 'Instrumental Analysis', Harper and Row publishers, 1974.

22OBM02	BATTERIES AND MANAGEMENT SYSTEM	L	T	P	C
		3	0	0	3

Course Objectives:

The objective of this course is to make the students to understand the working andcharacteristics of different types of batteries and their management

Course Content:

UNIT I ADVANCED BATTERIES 9

Li-ion Batteries-different formats, chemistry, safe operating area, efficiency, aging. Characteristics SOC,DOD, SOH. Balancing-Passive Balancing Vs Active Balancing. Other Batteries-NCM and NCA Batteries. NCR18650B specifications.

UNIT II BATTERY PACK 9

Battery Pack- design, sizing, calculations, flow chart, real and simulation Model. Peak power – definition, testing methods-relationships with Power, Temperature and ohmic Internal

Resistance. Cloud based and Local Smart charging.

UNIT III BATTERY MODELLING 9

Battery Modelling Methods-Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons- Rint model, Thevenin model, PNGV model. State space Models Introduction. Battery Modelling software/simulation frameworks.

UNIT IV BATTERY STATE ESTIMATION 9

SOC Estimation- Definition, importance, single cell Vs series batteries SOC. Estimation Methods Load voltage, Electromotive force, AC impedance, Ah counting, Neural networks, Neuro-fuzzy forecast method, Kalman filter. Estimation Algorithms.

UNIT V BMS ARCHITECTURE AND REAL TIME COMPONENTS 9

Battery Management System- need, operation, classification. BMS ASIC-bq76PL536A-Q1 Battery Monitor IC- CC2662R-Q1 Wireless BMS MCU. Communication Modules- CAN Open-Flex Ray-287 CANedge1 package. ARBIN Battery Tester. BMS Development with Modeling software and Model Based Design.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Jiuchun Jiang and Caiping Zhang, "Fundamentals and applications of Lithium-Ion batteries in Electric Drive Vehicles'', Wiley, 2015.
2. Davide Andrea ,"Battery Management Systems for Large Lithium-Ion Battery Packs"ARTECH House, 2010.

Reference Books:

1. Developing Battery Management Systems with Simulink and Model-Based Design- whitepaper

2. Panasonic NCR18650B- Data Sheet

3. bq76PL536A-Q1- IC Data Sheet

4. CC2662R-Q1- IC Data Sheet

22OBM03 BIOINSPIRED SOFT COMPUTING

	L	T	P	C
	3	**0**	**0**	**3**

Course Objectives:

1. To Learn bio-inspired theorem and algorithms
2. To Understand random walk and simulated annealing
3. To Learn genetic algorithm and differential evolution
4. To Learn swarm optimization and ant colony for feature selection
5. To understand bio-inspired application in image processing

Course Content:

UNIT I INTRODUCTION 9

Introduction to algorithm - Newton ' s method - optimization algorithm - No-Free-Lunch Theorems - Nature-Inspired Mataheuristics -Analysis of Algorithms -Nature Inspires Algorithms -Parameter tuning and parameter control.

UNIT II RANDOM WALK AND ANEALING 9

Random variables - Isotropic random walks - Levy distribution and flights - Markov chains - step sizes and search efficiency - Modality and intermittent search strategy - importance of randomization- Eagle strategy-Annealing and Boltzmann Distribution - parameters -SA algorithm - Stochastic Tunneling.

UNIT III GENETIC ALOGORITHMS AND DIFFERENTIAL EVOLUTION 9

Introduction to genetic algorithms and - role of genetic operators - choice of parameters - GA varients - schema theorem - convergence analysis - introduction to differential evolution - varients - choice of parameters - convergence analysis - implementation.

UNIT IV SWARM OPTIMIZATION AND FIREFLY ALGORITHM 9

Swarm intelligence - PSO algorithm - accelerated PSO - implementation - convergence analysis - binary PSO - The Firefly algorithm - algorithm analysis - implementation - varients-Ant colony optimization toward feature selection.

UNIT V APPLICATION IN IMAGE PROCESSING 9

Bio-Inspired Computation and its Applications in Image Processing: An Overview - Fine-Tuning Enhanced Probabilistic Neural Networks Using Meta-heuristic-driven Optimization - Fine-Tuning Deep Belief Networks using Cuckoo Search - Improved Weighted Thresholded Histogram Equalization Algorithm for Digital Image Contrast Enhancement Using Bat Algorithm - Ground Glass Opacity Nodules Detection and Segmentation using Snake Model -

Mobile Object Tracking Using Cuckoo Search

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Eiben, A.E., Smith, James E, "Introduction to Evolutionary Computing", Springer 2015.
2. Helio J.C. Barbosa, "Ant Colony Optimization - Techniques and Applications", Intech 2013

Reference Books:

1. Xin-She Yang ,Jaao Paulo papa, "Bio-Inspired Computing and Applications in Image Processing", Elsevier 2016
2. Xin-She Yang, "Nature Ispired Optimization Algorithm, Elsevier First Edition 2014
3. Yang ,Cui, XIao, Gandomi, Karamanoglu ,"Swarm Intelligence and Bio-Inspired Computing", Elsevier First Edition 2013

22OHS02	BIOPHYSICS	L	T	P	C
		3	0	0	3

Pre-requisite Nil

Course Objectives:

To enable the students

1. To gain structural knowledge of biological systems.
2. To understand transport and dynamic properties of biological systems.

Course Content:

UNIT I MOLECULAR STRUCTURE OF BIOLOGICAL SYSTEMS 9

Intramolecular bonds – covalent – ionic and hydrogen bonds – biological structures –general features – water structure – hydration – interfacial phenomena and membranes – self-assembly and molecular structure of membranes.

UNIT II CONFORMATION OF NUCLEIC ACIDS 9

Primary structure – the bases – sugars and the phosphodiester bonds- double helical structure – the a b and z forms – properties of circular DNA – topology – polymorphism and flexibility of DNA – structure of ribonucleic acids – hydration of nucleic acids.

UNIT III CONFORMATION OF PROTEINS 9

Conformation of the peptide bond – secondary structures – Ramachandran plots – use of potential functions – tertiary structure – folding – hydration of proteins – hydropathy index.

UNIT IV CELLULAR PERMEABILITY AND ION – TRANSPORT 9

Ionic conductivity – transport across ion channels – mechanism - ion pumps- proton transfer – nerve conduction – techniques of studying ion transport and models.

UNIT V ENERGETICS & DYNAMICS OF BIOLOGICAL SYSTEMS 9

Concepts in thermodynamics – force and motion – entropy and stability – analyses of fluxes – diffusion potential – basic properties of fluids and biomaterials – laminar and turbulent flows.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

1. To analyze the various forces responsible for biological molecular structure.
2. To be familiar with different levels of conformation in biomolecules.
3. To gain the knowledge of cellular permeability and ion transport.
4. To understand the dynamics of biological systems.

Text Book(s):

1. Biophysics ; R. Glaser, Springer Verlag , 2000.
2. Biophysics: Molecules In Motion ; R. Duane. Academic Press , 1999.

Reference Books:

1. Cantror, Charles R. and Paul R. Schimmel "Biophysical Chemistry" . 1-3 Vols. W.H.Freeman& Co.,1980.

22BT403	BIOSTATISTICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. This course is designed to provide a solid foundation on topics in statistics that can be useful for the biotechnologists to conduct research on different types of data arising in public health and clinical studies.
2. It is framed to address the issues in biotechnology using the concepts on probability, regression, sampling, estimation theory, testing of hypothesis and design an analysis of experiments.

UNIT I RANDOM VARIABLE AND PROBABILITY DISTRIBUTION 9

Discrete random variable – Probability mass function – Properties – Continuous random variable – Probability density function – Properties – Moments : Mean and variance with properties – Special distributions : Binomial, Poisson, Geometric, Uniform, Exponential, Gamma, Weibull and Normal – Properties - Simple Problems..

UNIT II SAMPLING DISTRIBUTION AND ESTIMATION THEORY 9

Random sampling – Sample mean and variance – Standard error – Simple problems – Estimator: Unbiasedness – Maximum likelihood estimation – Method of moments – Curve fitting by the method of least squares : Fitting curves of the form y ax b, y ax 2 bx c, y abx and y ax b - Multiple regression lines.

UNIT III TESTING OF HYPOTHESIS 9

Sampling distributions – Type I and Type II errors – Tests based on Normal, t,2 and F distributions for testing of mean, difference between two means, proportion, difference between two proportions, variance, ratio of two variances Independence of attributes (r x c contingency table) - Goodness of fit.

UNIT IV NON-PARAMETRIC STATISTICS 9

One sample sign test–Sign test for paired samples – Signed rank test – Ranksumtest : The U-test – Rank-sum test : The H-test – Test based on runs.

UNIT V DESIGN OF EXPERIMENTS 9

Completely random design–Randomized complete block design – Analysis of variance: One - way and Two - way classifications – Latin square design - 22 factorial design.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome:

Upon completion of the course, students will be able to

1. Basic probability axioms and rules and the moments of discrete and continuous random variables.
2. Distributions and their properties, Least squares, correlation, regression, consistency, efficiency and unbiasedness of estimators, method of maximum likelihood estimation and Central Limit Theorem.
3. Sampling and use statistical tests in testing hypotheses on data.
4. List the guidelines for designing experiments, recognize the key historical figures in Design of Experiments, conduct statistical tests and analyze the results.
5. Analyze the experiments by applying suitable non-parametric tests
6. The students should have the ability to use the appropriate and relevant, fundamental and applied mathematical and statistical knowledge, methodologies and modern computational tools.

Text Books:

1. Mathematics and Biostatistcs, Second Edition, 2007-2008, G. K. Jani, Atul Prakashan

2. Pharmaceutical Statistics: Practical and Clinical Applications, Fourth Edition, 2004, Sanford Bolton

Reference Books:

1. . Devore, J.L., “Probability and Statistics for Engineering and Sciences”, 8th Edition,
2. Cengage Learning Pvt. Ltd., New Delhi, 2014.2. Freund, J.E., “Mathematical Statistics”, 5th Edition, Prentice Hall of India, 2001.
3. Gupta, S.C. and Kapoor, V. K, “Fundamentals of Mathematical Statistics”, Sultan Chand and Sons, 14th Edition, 2016.
4. Johnson, R.A and Gupta C. B., “Miller and Freund’s Probability and Statistics for Engineers”, Pearson Education Int., Asia, 8th Edition, 2011.
5. Libschutz, S. “Probability and Statistics”, 4th Edition, McGraw Hill, New Delhi, 2010.
6. Miller, I. and Miller, “Mathematical Statistics”, 7th Edition, Pearson Education Inc. (10th impression), 2012.

22OCS02 **BRAIN COMPUTER INTERFACE**

L	T	P	C
3	0	0	3

Course Objectives:

1. Brain-computer interfaces (BCIs) allow their users to communicate or control external devices using brain signals rather than the brains normal output pathways of peripheral nerves and muscles.
2. Efforts have recently begun to provide laboratory-validated BCI systems to severely disabled individuals for real-world applications.
3. BCI review the BCI- relevant signals from the human brain, and describe the functional components of BCIs.
4. We will also review current clinical applications of BCI technology, and identify potential users and potential applications.
5. Finally, we will discuss current limitations of BCI technology, impediments to its widespread clinical use, and expectations for the future.

Course Content:

UNIT I BCI AN INTRODUCTION **9**

Introduction - Brain structure and function, Brain Computer Interface Types - Synchronous and Asynchronous -Invasive BCI -Partially Invasive BCI - Non Invasive BCI, Structure of BCI System, BCI Monitoring Hardware, EEG, ECoG, MEG, fMRI.

UNIT II BRAIN ACTIVATION **9**

Brain activation patterns - Spikes, Oscillatory potential and ERD, slow cortical potentials, Movement related potentials-Mu rhythms, motor imagery, Stimulus related potentials - Visual Evoked Potentials – P300 and Auditory Evoked Potentials, Potentials related to cognitive tasks.

UNIT III FEATURE EXTRACTION METHODS **9**

Data Processing – Spike sorting, Frequency domain analysis, Wavelet analysis, Time domain analysis, Spatial filtering -Principal Component Analysis (PCA), Independent Component Analysis (ICA), Artifacts reduction, Feature Extraction - Phase synchronization and coherence.

UNIT IV MACHINE LEARNING METHODS FOR BCI **9**

Classification techniques –Binary classification, Ensemble classification, Multiclass Classification, Evaluation of classification performance, Regression - Linear, Polynomial, RBF’s, Perceptron’s, Multilayer neural networks, Support vector machine, Graph theoretical functional connectivity analysis

UNIT V APPLICATIONS OF BCI **9**

Case Studies - Invasive BCIs: decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, Cursor and robotic control using multi electrode array implant, Cortical control of muscles via functional electrical stimulation. Noninvasive BCIs: P300 Mind Speller, Visual cognitive BCI, Emotion detection, Ethics of Brain, Computer Interfacing

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Comprehend and appreciate the significance and role of this course in the present contemporary world
2. Differentiate various concept of BCI.
3. Allocate functions appropriately to the human and to the machine.
4. Select appropriate for feature extraction methods.
5. Design a system using machine learning algorithms for translation.

Text Books:

1. Book(s):. Rajesh.P.N.Rao, “Brain-Computer Interfacing: An Introduction”, Cambridge University Press, First edition, 2013.

2. Jonathan Wolpaw, Elizabeth Winter Wolpaw, ―Brain Computer Interfaces: Principles and practice‖, Oxford University Press, USA, Edition 1, January 2012.

Reference Books:

1. Ella Hassianien, A &Azar.A.T (Editors), “Brain-Computer Interfaces Current Trends and Applications”, Springer, 2015.

2. Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human Computer Interaction", Springer, 2010

3. Ali Bashashati, Mehrdad Fatourechi, Rabab K Ward, Gary E Birch,” A survey of signal Processing algorithms in brain–computer interfaces based on electrical brain signals” Journal of Neural Engineering, Vol.4, 2007, PP.32-57.

22OBM05 CLINICAL GENOMICS AND PROTEOMICS

	L	T	P	C
	3	**0**	**0**	**3**

Course Objectives:

1. To acquaint the student with genome organization,
2. To study gene identification, expression and applications of genomics analysis.
3. To learn about proteomics, analysis and its applications

UNIT I INTRODUCTION TO GENOMICS AND PROTEOMICS 9

Introduction – Organization and structure of genomes, Genome size, Sequence complexity, Introns and Exons, Genome structure in viruses and prokaryotes, Isolation of Chromosomes, chromosome micro dissection, Retrofitting. Introduction to Proteomics – The Proteome, Mining proteomes, Bridging Genomics and Proteomics. Proteomics and the new biology.

UNIT II GENE IDENTIFICATION AND EXPRESSION 9

Genome annotation, traditional routes of gene identification, detecting open-reading Frames, software programs for finding genes, Identifying the function of a new gene, gene ontology, overview of comparative genomics, Protein structural genomics, determining gene function by sequence comparison and through conserved protein structure Global expression profiling – Introduction, traditional approaches to expression profiling, Analysis of RNA expression, applications of genome analysis and genomics.

UNIT III ANALYSIS OF PROTEOMES I 9

Analysis of proteomes - Two-dimensional polyacrylamide gel electrophoresis, Sample Preparation, Solubilization, Reduction, Resolution, Reproducibility of 2-DEDetecting proteins in polyacrylamide gels, Image analysis of 2-DE gels.

UNIT IV ANALYSIS OF PROTEOMES II 9

Analysis of Proteomes II: Mass spectrometry based methods for protein identification- De novo sequencing using mass spectrometric data- Correlative mass spectrometric based identification strategies, 2-DE gel electrophoresis coupled with mass spectrometry, Micro array techniques- Types of micorarrays, Designing a microarray experiment, Microarray Technology in Treating Disease

UNIT V APPLICATIONS OF GENOMICS AND PROTEOMICS ANALYSIS 9

Analysis of Genomes – Human, Mouse, Plasmodium falsiparum, Saccharomyces cerevisiae, Mycobacterium tuberculosis. Application of proteome analysis- drug development and toxicology, Pharmaceutical Applications, Proteomics in drug Discovery in human, phage antibodies as tools, Glycobiology and Proteomics in plant genetics and breeding.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. S. B. Primrose and R.M. Twyman - Principles of Genome Analysis and Genomics, 7 th Edition, Blackwell Publishing, 2006.
2. S. Sahai - Genomics and Proteomics, Functional and Computational Aspects, Plenum Publication, 1999.

Reference Books:

1. Andrezej K Konopka and James C. Crabbe, Compact Hand Book - Computational Biology, Marcel Dekker, USA, 2004.
2. Pennington & Dunn - Proteomics from Protein Sequence to Function, 1st edition, Academic Press, San Diego, 199

22CS601	CLOUD COMPUTING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the concept of cloud computing.
2. To appreciate the evolution of cloud from the existing technologies.
3. To have knowledge on the various issues in cloud computing.
4. To be familiar with the lead players in cloud.
5. To appreciate the emergence of cloud as the next generation computing paradigm.

Course Content:

UNIT I INTRODUCTION 9

Introduction to Cloud Computing – Definition of Cloud – Evolution of Cloud Computing – Underlying Principles of Parallel and Distributed Computing – Cloud Characteristics – Elasticity in Cloud – On-demand Provisioning

UNIT II CLOUD ENABLING TECHNOLOGIES 9

Service Oriented Architecture – REST and Systems of Systems – Web Services – Publish-Subscribe Model – Basics of Virtualization – Types of Virtualization – Implementation Levels of Virtualization – Virtualization Structures – Tools and Mechanisms – Virtualization of CPU – Memory – I/O Devices –Virtualization Support and Disaster Recovery.

UNIT III CLOUD ARCHITECTURE, SERVICES AND STORAGE 9

Layered Cloud Architecture Design – NIST Cloud Computing Reference Architecture – Public, Private and Hybrid Clouds - laaS – PaaS – SaaS – Architectural Design Challenges – Cloud Storage – Storage-as-a-Service – Advantages of Cloud Storage – Cloud Storage Providers – S3.

UNIT IV RESOURCE MANAGEMENT AND SECURITY IN CLOUD 9

Inter Cloud Resource Management – Resource Provisioning and Resource Provisioning Methods – Global Exchange of Cloud Resources – Security Overview – Cloud Security Challenges – Software-as-a-Service Security – Security Governance – Virtual Machine Security – IAM – Security Standards

UNIT V CLOUD TECHNOLOGIES AND ADVANCEMENTS 9

Hadoop – MapReduce – Virtual Box -- Google App Engine – Programming Environment for Google App Engine –– Open Stack – Federation in the Cloud – Four Levels of Federation – Federated Services and Applications – Future of Federation

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.

2. Rittinghouse, John W., and James F. Ransome, “Cloud Computing: Implementation, Management and Security”, CRC Press, 2017

Reference Books:

1. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, “Mastering Cloud Computing”, Tata Mcgraw Hill, 2013.

2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing - A Practical Approach”, Tata Mcgraw Hill, 2009.

3. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice)", O'Reilly, 2009.

22OBM06	**COMPANY SPECIFIC ASSESSMENTS FOR EMPLOYABILITY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. Emphasize and Enhance Speaking Skills
2. Increase Ability to Express Views & Opinions
3. Develop and Enhance Employability Skills
4. Induce Entrepreneurship and Plan for the Future
5. Expose & Induce Life Skills for Effective Managerial Ability

UNIT I COMPANY SPECIFIC TIER 1 TEST PATTERN 9

Tier 1 Company Assessment patterns for employability (Quantitative techniques and logical ability Section) – Sample sets of Tier 1 Company questions – Cognitive learning technique introduction.

UNIT II COMPANY SPECIFIC TIER 2 TEST PATTERN 9

Tier 2 Company Assessment patterns for employability (Quantitative techniques and logical ability Section) – Sample sets of Tier 2 Company questions – Cognitive learning technique

UNIT III VERBAL ABILITY 9

Application of Verbal Ability concepts in Question Types such as Sentence Errors, Sentenc Correction and Sentence Completion –High Frequency words – Spellings – Idioms – Phrasal Verbs -Application of strategies in Analogies – Synonyms – Antonyms – Order of Words – Odd Word Out, Reading Comprehension passages – keyword search strategies

UNIT IV COMPANY SPECIFIC TIER 1 VERBAL ABILITY PATTERN 9

Tier 1 Company Assessment patterns for employability (Verbal section)- Company specific mock tests for Verbal Ability section.

UNIT V COMPANY SPECIFIC TIER 2 VERBAL ABILITY PATTERN 9

Tier 2 Company Assessment patterns for employability (Verbal section) - Company specific mock tests for Verbal Ability section

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. R.S. Aggarwal - 2017 "A Modern Approach to Logical Reasoning".
2. R.S. Aggarwal - 2017 "A Modern Approach to Verbal & Non-Verbal Reasoning"
3. R.S. Aggarwal -2017 "Quantitative Aptitude for Competitive Examinations"
4. Arun Sharma and Meenakshi Upadhyay - How to Prepare for Verbal Ability and Reading Comprehension for the CAT

Reference Books:

1. "Ten Soft Skills You Need to Advance Your Career(Andre Keys Book 9)" by Lisa Smith.
2. Developing Communications Skills,Krishna Mohan, MacMillan Publishers, 2nd Edition.

22OEC02	CONSUMER ELECTRONICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To study the basics of audio and video technology.
2. To understand the electronic gadgets and telecommunication systems.
3. To learn the working concepts of consumer appliances.

UNIT I AUDIO SYSTEM COMPONENTS 9

Introduction to wave motion -Interference and superposition of waves- Beats, Resonance, Echos characteristics of microphones- types of microphone- wireless microphones-types of headphones- Types of loudspeakers- Multispeaker systems-Acoustic Insulation and acoustic design. Stereo systems and multiway systems..

UNIT II AUDIO PROCESSING 9

Audio Filters, Types of AGC -Loudspeaker Impedance matching- Pre-emphasis and De-emphasis noise reduction- Optical recording and reproduction- stereophony, Quadraphony Stereo controls- Active tone control, filtering, bass and treble control-Integrated Stereo amplifier- Equalizers- Codecs -LPC, Sub-band Coding, CELP. MPEG-1, MPEG-2, MPEG-4 and Dolby Digital.

UNIT III VIDEO STANDARDS AND SYSTEMS 9

Elements of a TV system, scanning process- resolution, interlacing, composite signal- Types of TV camera-compatibility between monochrome and colour TV - TV standards- NTSC, PAL, SECAM, CCIR-B.

UNIT IV COMMUNICATION AND CONSUMER GADGETS 9

Radio system- VHF and UHF- Types of mobile phones-Facsimile machine- electronic calculators-digital clocks- Automobile computers- Antilocking Breaking Systems, Electronically Controlled Suspension, Safety Belt System, Navigation System- Microwave Ovens. Dish washers and TV Remote.

UNIT V CONSUMER APPLICATIONS 9

Washing Machines- electronic controller, fuzzy logic, Hardware and Software development Air Conditioners- Components, Remote Controls, Bar Coders- Bar codes, scanner and decoder- Set Top Box-Types, firmware development, Interactive program guides. Video on demand.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Illustrate different Microphones and Loudspeakers used in real time applications.
2. Analyse different techniques involved in audio processing.
3. Analyse the different television standards.
4. Design the different consumer appliances.
5. Analyze the evolution and development of Modern Consumer Gadgets and

Technology.

Text Books

1. C.A. Schuler and W.L. Mc Namee, Modern Industrial Electronics, McGraw Hill, 2002.

Reference Books:

1. S.P.Bali, Consumer Electronics, Pearson Education, 2005. Department of ECE, Bannari Amman Inst. of Tech. | Regulation 2011|Revision 2013 Approved in 9th Academic Council Meeting.
2. D.J. Shanefield, Industrial Electronics for Engineers, Chemists and Technicians, Jaico Publishing House, 2007.

22OAG04	**DISASTER MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. To provide students an exposure to disasters, their significance and types.
2. To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction
3. To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
4. To enhance awareness of institutional processes in the country and
5. To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

Course Content:

UNIT I INTRODUCTION TO DISASTERS 9

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters –Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don᾽s during various types of Disasters

UNIT II APPROACHES TO DISASTER RISK REDUCTION (DRR) 9

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake- holders- Institutional Processess and Framework at State and Central Level- State Disaster Management Authority(SDMA) – Early Warning System – Advisories from Appropriate Agencies.

UNIT III INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT 9

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT IV DISASTER RISK MANAGEMENT IN INDIA 9

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment

UNIT V DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELDWORKS 9

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Singhal J.P. “Disaster Management”,Laxmi Publications, 2010. ISBN-10:

9380386427 ISBN-13: 978-9380386423

2. Tushar Bhattacharya, “Disaster Science and Management”, McGraw Hill India Education Pvt. Ltd., 2012. ISBN-10: 1259007367, ISBN-13: 978-1259007361]

3. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011

4. Kapur Anu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, New Delhi, 2010.

Reference Books:

1. Govt. of India: Disaster Management Act, Government of India,NewDelhi,2005

2. Government of India, National Disaster Management Policy,2009.

22OEC07	ELECTRICAL SAFETY & QUALITY ASSURANCE	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide electrical protection and maintenance in working environment and ensure that electrical safety.

Course Content:

UNIT I ELECTRICAL HAZARDS 9

Review of Electrical concept, Electrostatic – Electro magnetism – Electrical Hazards – Energy leakage – Clearance and insulation– Current surges – Electrical causes of fire and explosion –Human interface with electricity – Human resistance to electricity.

UNIT II STANDARDS AND REQUIREMENTS 9

National electrical Safety code - Standards and statutory requirements – Indian electricity acts and rules – statutory requirements from Electrical inspectorate. Hazardous area classification and classification of electrical equipments for hazardous areas (IS, NFPA, API and OSHA standards)

UNIT III ELECTRICAL PROTECTION & MAINTENANCE 9

Selection of Environment, Protection and Interlock – Discharge rods and earthing device – Safety in the use of portable tools - Preventive maintenance. First aid-cardio pulmonary resuscitation(CPR),

UNIT IV STANDARDIZATION OF QUALITY MEDICAL CARE IN HOSPITALS 9

Define Quality- Need for Standardization& Quality Management, QM in Health Care Organization-Quality assurance methods, QA in (Medical Imaging & Nuclear medicine) Diagnostic services – Classification of equipment.

UNIT V REGULATORY REQUIREMENT FOR HEALTH CARE 9

CE and FDA regulations, Accreditation for hospitals - JCI, NABH and NABL, Other regulatoryCodes.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. B.M.Sakharkar, Principles of Hospital administration and Planning, JAYPEE Brothers, Medical Publishers (P) Ltd. 24
2. K.Shridhara Bhat, Quality Management, Himalaya Publishing House Cesar A. Cacere & Albert Zana, The Practice of Clinical Engg. Academic press, New York, 1977

Reference Books:

3. Webster J.G and Albert M.Cook, Clinical Engg, Principles & Practices, Prentice Hall Inc., Engle wood Cliffs, New Jersy, 1979.
4. Karen Parsley, Karen Parsley Philomena Corrigan" Quality improvement in Healthcare, 2nd edition, Nelson Thrones Pub, 2002.
5. Sharon Myers "Patient Safety & Hospital Accreditation - A Model for Ensuring Success" Springer Publishers 2012 7. Joseph F Dyro "Clinical Engineering Handbook" Elsevier Publishers, 2004.

22OEC08	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To gain broad conceptual understanding of the various aspects of electromagnetic (EM) interference and compatibility
2. To develop a theoretical understanding of electromagnetic shielding effectiveness
3. To understand ways of mitigating EMI by using shielding, grounding and filtering

4. To understand the need for standards and to appreciate measurement methods
5. To understand how EMI impacts wireless and broadband technologies

UNIT I	**INTRODUCTION & SOURCES OF EM INTERFERENCE**	**9**

Introduction - Classification of sources - Natural sources - Man-made sources - Survey of the electromagnetic environment.

UNIT II	**EM SHIELDING**	**9**

Introduction - Shielding effectiveness - Far-field sources - Near-field sources - Low-frequency, magnetic field shielding - Effects of apertures

UNIT III	**INTERFERENCE CONTROL TECHNIQUES**	**9**

Equipment screening - Cable screening - grounding - Power-line filters - Isolation – Balancing- Signal-line filters - Nonlinear protective devices.

UNIT IV	**EMC STANDARDS, MEASUREMENTS AND TESTING**	**9**

Need for standards - The international framework - Human exposure limits to EM fields - EMC measurement techniques - Measurement tools - Test environments.

UNIT V	**EMC CONSIDERATIONS IN WIRELESS AND BROADBAND TECHNOLOGIES**	**9**

Efficient use of frequency spectrum - EMC, interoperability and coexistence - Specifications and alliances - Transmission of high-frequency signals over telephone and power networks – EMC and digital subscriber lines - EMC and power line telecommunications..

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Demonstrate knowledge of the various sources of electromagnetic interference
2. Display an understanding of the effect of how electromagnetic fields couple through apertures, and solve simple problems based on that understanding
3. Explain the EMI mitigation techniques of shielding and grounding
4. Explain the need for standards and EMC measurement methods
5. Discuss the impact of EMC on wireless and broadband technologies

Text Books:

1. Christopoulos C, Principles and Techniques of Electromagnetic Compatibility, CRC Press, Second Edition, Indian Edition, 2013.
2. Paul C R, Introduction to Electromagnetic Compatibility, Wiley India, Second Edition,2008.

Reference Books:

1. Kodali V P, Engineering Electromagnetic Compatibility, Wiley India, Second Edition,2010.
2. Henry W Ott, Electromagnetic Compatibility Engineering, John Wiley & Sons Inc,
3. Newyork,2009.
4. Scott Bennett W, Control and Measurement of Unintentional Electromagnetic
5. Radiation, John Wiley& Sons Inc., Wiley Interscience Series, 1997.

22OEC09	EMBEDDED SYSTEMS AND C	L	T	P	C
		3	0	0	3

Course Objectives:

1. Understand the concepts of embedded system design and analysis.
2. Learn the architecture and programming of ARM processor.
3. Be exposed to the basic concepts of embedded programming.
4. Learn the real time operating systems.

UNIT I INTRODUCTION TO EMBEDDED SYSTEM DESIGN 9

Complex systems and micro processors– Embedded system design process –Design example: Model train controller- Design methodologies- Design flows - Requirement Analysis – Specifications-System analysis and architecture design – Quality Assurance techniques -

Designing with computing platforms – consumer electronics architecture – platform-level performance analysis.

UNIT II ARM PROCESSOR AND PERIPHERALS 9

ARM Architecture Versions – ARM Architecture – Instruction Set – Stacks and Subroutines Features of the LPC 214X Family – Peripherals – The Timer Unit – Pulse Width Modulation Unit – UART – Block Diagram of ARM9 and ARM Cortex M3 MCU.

UNIT III EMBEDDED PROGRAMMING 9

Components for embedded programs- Models of programs- Assembly, linking and loading – compilation techniques- Program level performance analysis – Software performance optimization – Program level energy and power analysis and optimization – Analysis and optimization of program size- Program validation and testing.

UNIT IV REAL TIME SYSTEMS 9

Structure of a Real Time System — Estimating program run times – Task Assignment and Scheduling – Fault Tolerance Techniques – Reliability, Evaluation – Clock Synchronisation.

UNIT V PROCESSES AND OPERATING SYSTEMS 9

Introduction – Multiple tasks and multiple processes – Multirate systems- Preemptive realtime operating systems- Priority based scheduling- Interprocess communication mechanisms – Evaluating operating system performance- power optimization strategies for processes – Example Real time operating systems-POSIX-Windows CE. – Distributed embedded systems – MPSoCs and shared memory multiprocessors. – Design Example - Audio player, Engine control unit – Video accelerator.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Describe the architecture and programming of ARM processor.
2. Outline the concepts of embedded systems.
3. Explain the basic concepts of real time operating system design.
4. Model real-time applications using embedded-system concepts.

Text Books:

1. Marilyn Wolf, “Computers as Components - Principles of Embedded Computing System Design”, Third Edition “Morgan Kaufmann Publisher (An imprint from

Elsevier), 2012.

2. Jane W.S.Liu," Real Time Systems", Pearson Education, Third Indian Reprint, 2003.

Reference Books:

1. Lyla B.Das, "Embedded Systems : An Integrated Approach" Pearson Education, 2013.
2. Jonathan W.Valvano, "Embedded Microcomputer Systems Real Time Interfacing", Third Edition Cengage Learning, 2012.
3. David. E. Simon, "An Embedded Software Primer", 1st Edition, Fifth Impression, AddisonWesley Professional, 2007.
4. K.V.K.K.Prasad, "Embedded Real-Time Systems: Concepts, Design & Programming", Dream Tech Press, 2005.

22OME09	**ENGINEERING GRAPHICS AND DRAWING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

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

1. Drawing engineering curves.
2. Drawing freehand sketch of simple objects.
3. Drawing orthographic projection of solids and section of solids.
4. Drawing development of solids
5. Drawing isometric and perspective projections of simple solids.

Course Content:

UNIT I PLANE CURVES AND FREEHAND SKETCHING 9

Basic Geometrical constructions, Curves used in engineering practices: Conics — Construction of ellipse, parabola and hyperbola by eccentricity method — Construction of cycloid — construction of involutes of square and circle — Drawing of tangents and normal to the above curves.

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE 9

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS 9

.Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes and parallel to the other by rotating object method. Visualization concepts and Free Hand sketching: Visualization principle Representation of Three Dimensional objects — Layout of views- Freehand sketching of multiple views from pictorial views of objects.Practicing three dimensional modeling of simple objects by CAD Software(Not for examination)

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 9

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other — obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids — Prisms, pyramids cylinders and cones.Practicing three dimensional modeling of simple objects by CAD Software(Not for examination).

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 9

Principles of isometric projection — isometric scale —lsometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions - Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method Practicing three dimensional modeling of isometric projection of simple objects by CAD Software.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Bhrad tt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 53 Edition, 2019.
2. Natrajan K.V., “A Text Book of Engineering Graphics”, Dhanalakshmi Publishers,

Chennai, 2018

3. Parthasarathy, N. S. and Vela Murali, “Engineering Drawing”, Oxford University Press, 2015

Reference Books:

1. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, McGraw Hill, 2 nd Edition, 2019

2. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Publications, Bangalore, 27th Edition,2017.

3. Luzzader, Warren.J. and Duff,John M., “Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.

4. Parthasarathy N. S. and Vela Murali, “Engineering Graphics”, Oxford University, Press, New Delhi, 2015

5. Shah M.B., and Rana B.C., “Engineering Drawing”, Pearson Education India, 2nd Edition, 2009

6. Venugopal K. and Prabhu Raja V., “Engineering Graphics", New Age International (P) Limited, 2008.

22OEC12	**FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. To understand the global trends and development methodologies of various types of products and services.
2. To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
3. To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification
4. To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
5. To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

Course Content:

UNIT I BASICS OF PRODUCT DEVELOPMENT 9

Global Trends Analysis and Product decision - Social Trends - Technical Trends Economical Trends - Environmental Trends - Political/Policy Trends - Introduction to Product Development Methodologies and Management - Overview of Products and Services – Types of Product Development - Overview of Product Development methodologies - Product Life Cycle – Product Development Planning and Management.

UNIT II REQUIREMENTS AND SYSTEM DESIGN 9

Requirement Engineering - Types of Requirements - Requirement Engineering – traceability Matrix and Analysis - Requirement Management - System Design & Modeling – Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.

UNIT III DESIGN AND TESTING 9

Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines,Concept Screening & Evaluation - Detailed Design - Component Design and Verification Mechanical, Electronics and Software Subsystems - High Level Design/Low Level Design of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping - Introduction to Rapid Prototyping and Rapid Manufacturing - System Integration, Testing, Certification and Documentation

UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT 9

Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - Sustenance -Maintenance and Repair – Enhancements - Product EoL – Obsolescence Management – Configuration Management - EoL Disposal

UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY 9

The Industry - Engineering Services Industry - Product Development in Industry versus Academia –The IPD Essentials - Introduction to Vertical Specific Product Development processes - Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Tradeoffs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Define, formulate, and analyze a problem
2. Solve specific problems independently or as part of a team
3. Gain knowledge of the Innovation & Product Development process in the Business Context
4. Work independently as well as in teams
5. Manage a project from start to finish

Text Book(s)

1. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011
2. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill Eleventh Edition, 2005.

Reference Books:

1. Hiriyappa B, “Corporate Strategy – Managing the Business”, Author House, 2013.
2. Peter F Drucker, “People and Performance”, Butterworth – Heinemann [Elsevier], Oxford, 2004.
3. Vinod Kumar Garg and Venkita Krishnan N K, “Enterprise Resource Planning – Concepts”, Second Edition, Prentice Hall, 2003.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013.

22OBM08	FUNDAMENTALS OF NANOSCIENCE	L	T	P	C
		3	0	0	3

Course Objectives:
To learn about basis of nanomaterial science, preparation method, types and application

Course Content:

UNIT I INTRODUCTION 8

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering- Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thinfilms- multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT II GENERAL METHODS OF PREPARATION 9

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE

UNIT III NANOMATERIALS **12**

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides-ZnO, TiO_2,MgO, ZrO_2, NiO, nanoalumina, CaO, $AgTiO_2$, Ferrites, Nanoclays- functionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications.

UNIT IV CHARACTERIZATION TECHNIQUES **9**

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation.

UNIT V APPLICATIONS **9**

NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Cay S. Horstmann and Gary Cornell, “Core Java: Volume I – Fundamentals”, Eighth Edition, Sun Microsystems Press, 2008.

Reference Books:

1. K. Arnold and J. Gosling, “The JAVA programming language”, Third edition, PearsonEducation, 2000.

2. Timothy Budd, “Understanding Object-oriented programming with Java”, UpdatedEdition, Pearson Education, 2000.

3. C. Thomas Wu, “An introduction to Object-oriented programming with Java”, FourthEdition, Tata McGraw-Hill Publishing company Ltd., 2006.

22OCS16	GAME DESIGN AND DEVELOPMENT	L	T	P	C
		3	0	0	3

Course Objectives:

1. To know the basicsof 2D and 3D graphics for game development.
2. To know the stages of game development.
3. To understand the basics of a game engine.
4. To survey the gaming development environment and too lkits.
5. To learn and develop simple games using Pygame environment

Course Content:

UNIT I 3D GRAPHICS FOR GAME DESIGN 9

Genres of Games, Basics of 2D and 3D Graphics for Game Avatar, Game Components ,2D and3D Transformations , Projections, Color Models, Illumination and Shader Models, Animation, Controller Based Animation.

UNIT II GAME DESIGN PRINCIPLES 9

Character Development, Storyboard Development for Gaming – Script Design – Script Narration, Game Balancing, Core Mechanics, Principles of Level Design–Proposals–Writing for Preproduction, Production and Post–Production.

UNIT III GAME ENGINE DESIGN 9

Rendering Concept – Software Rendering – Hardware Rendering – Spatial Sorting Algorithms, Algorithms for Game Engine– Collision Detection–Game Logic–Gam eAI– Path finding**.**

UNIT IV OVERVIEW OF GAMING PLATFORMS AND FRAMEWORKS 9

Pygame Game development – Unity – Unity Scripts –Mobile Gaming, Game Studio, Unity Single player and Multi-Player games

UNIT V GAME DEVELOPMENT USING PYGAME 9

Developing 2D and 3D interactive games using Pygame – Avatar Creation – 2D and 3D Graphics Programming – Incorporating music and sound – Asset Creations – Game Physics algorithms Development–Device Handling in Pygame–Overview of Isometric and Tile Based arcade Games–Puzzle Games

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Sanjay Madhav,"Game Programming Algorithms and Techniques: A Platform Agnostic Approach",AddisonWesley,2013.
2. Will McGugan, "Beginning Game Development with Python and Pygame:From Novice to Professional", Apress,2007

Reference Books:

1. Paul Craven," Python Arcade games",Apress Publishers,2016.

2. David H.Eberly,"3D Game Engine Design: A Practical Approach to Real Time Computer Graphics", Second Edition,CRCPress,2006.

3.Jung Hyun Han,"3D Graphics for Game Programming",Chapman and Hall/CRC, 2011

		L	T	P	C
22OBM09	**HOLISTIC NUTRITION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. The importance of teaching clients to read labels in today's world of chemicals; educating patients/clients how to easily prepare basic whole foods
2. The indications and contraindications of various eating plans such as vegan, vegetarian, keto, whole foods, etc.; discuss food as a healing tool.

Course Content:

UNIT I NUTRITION AND HEALTH 9

Introduction to the principles of nutrition; Basics of nutrition including; micronutrients (vitamins and minerals), the energy-yielding nutrients (Carbohydrates, Lipids and Proteins), metabolism, digestion, absorption and energy balance. Lipids: their functions, classification, dietary requirements, digestion & absorption, metabolism and links to the major fatal diseases, heart disease and cancer.

UNIT II AYURVEDA – MIND/BODY HEALING 9

Philosophy of Holistic Nutrition with spiritual and psychological approaches towards attaining optimal health; Principles and practical applications of Ayurveda, the oldest healing system in the world. Three forces – Vata, Pitta and Kapha, that combine in each being into a distinct constitution. Practical dietary and lifestyle recommendations for different constitutions will also be explored in real case studies.

UNIT III NUTRITION AND ENVIRONMENT 9

Based on an underlying philosophy that environments maintain and promote health and that individuals have a right to self-determination and self-knowledge, Nutrition principles which promote health and prevent disease. Safety of our food supply, naturally occurring and environmental toxins in foods, microbes and food poisoning.

UNIT IV COMPARATIVE DIETS 9

Evaluating principles of food dynamics, nutrient proportions, holistic individuality, the law of opposites, food combining, and more. Therapeutic benefits and limitations of several alternative diet approaches, including: modern diets (intermittent fasting, macrobiotics), food combining (colour-therapy/rainbow diet), high protein diets (Ketogenic, Paleo), Vegetarian approaches (plant based/vegetarian/vegan variations, fruitarian, raw food), as well as cleansing and detoxification diets (caffeine, alcohol, and nicotine detoxes, juice fasts).

UNIT V PREVENTIVE HEALTH CARE 9

Proper nutrition protection against, reverse and/or retard many ailments including: osteoporosis, diabetes, atherosclerosis and high blood pressure, arthritis, cancer, anemia, kidney disease and colon cancer. Current research developments on phytochemicals, antioxidants and nutraceuticals will be explored.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Desai, B. B., Handbook of Nutrition and Diet. Marcel Dekker, New York. 2000
2. Macrae, R., Rolonson Roles and Sadlu, M.J. 1994. Encyclopedia of Food Science & Technology & Nutrition. Vol. XI. Academic Press

Reference Books:

1. Modern Nutrition in Health & Disease by Young & Shils.
2. Food, Nutrition and Diet Therapy – by Krause and Mahan 1996, Publisher- W.B. Saunders, ISBN: 0721658350

3. Nutritive Value of Indian Foods.- by C. Gopalan, B. V. Rama Sastri, S. C. Balasubramanian Published by National Institute of Nutrition, Indian Council of Medical Research, 1989.

22OBM11	HOSPITAL WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives:

1. Understand various waste disposal procedures and management.
2. The student should be made to understand the principles, practices and areas of application in Hospital management.
3. Understand various waste disposal procedures and management.

Course Content:

UNIT I IMMUNIZATION, MEDICATION SAFETY 9

Patient-Centered Healthcare, Quality Improvement Tools and Strategies, Healthcare-Associated Infections, Medication Safety. Centers for Disease Control and Prevention, Disinfectants, Sterilants, and Antiseptics. Healthcare Opportunistic Infections, Medical Waste.

UNIT II HOSPITAL WASTE MANAGEMENT 9

Hazard of Hospital waste, need for disposal of Hospital waste, waste minimization, waste segregation and labeling, waste handling, collection, storage and transportation, treatment and disposal. Types of wastes, major and minor sources of Hospital waste, Categories and classification of Hospital waste

UNIT III CHALLENGES IN HOSPITAL MANAGEMENT 9

Current Issues in Hospital Management -Telemedicine - Hospital Waste Management, Challenges in Hospital Administration –Hospital Planning –Equipment Planning- AMC – Functional Planning, Distinction between Hospital and Industry.

UNIT IV SAFETY RULES IN HOSPITALS 9

Safety Rules. Health Insurance & Managing Health Care - Medical Audit – Hazard and Safety in a hospital Setup. Security – Loss Prevention – Fire Safety – Alarm System, Quality system – Elements, implementation of quality system, Documentation, Quality auditing, International Standards NABA, JCI, NABL, NABH. ISO 9000 – 9004 – Features of ISO 9001 – ISO 14000 – ISO 13485, Environment Management Systems.

UNIT V HAZARDOUS MATERIAL REGULATION 9

OSHA Hazard Communication Standard, DOT Hazardous Material Regulations, Hazardous Materials : Hazardous Substance Safety, Hazardous Materials, Medical Gas Systems, Hazardous Waste Operations and Emergency Response Standard, Respiratory Protection.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Anantpreet Singh, Sukhjit Kaur, Biomedical Waste Disposal, Jaypee Brothers Medical Publishers (P) Ltd (2012)
2. R.C.Goyal, “Hospital Administration and Human Resource Management”, PHI–4th Edition,2006.
3. G.D.Kunders, “Hospitals – Facilities Planning and Management”, TMH, New Delhi – 5th edition Reprint 2007.
4. Tweedy, James T., Healthcare hazard control and safety management-CRC Press_Taylor and Francis (2014).

Reference Books:

1. Norman Metzger , “Handbook of Health Care Human Resources Management”, Aspen Publication Inc. Rockville, Maryland, USA, 2nd Edition 1990.
2. Arnold D. Kalcizony & Stephen M.Shortell, “Health Care Management”, 6th Edition, 2011.
3. V.J. Landrum, “Medical Waste Management and disposal”, Elsevier, 1991

22OHS03	HUMAN RIGHTS	L	T	P	C
		3	0	0	3

Course Objectives:
To educate engineering students about different facets of human rights.

Course Content:

UNIT I HUMAN RIGHTS ORIGIN AND DEVELOPMENT 9

Human Rights – Meaning, origin and Development. Notion and classification of Rights – Natural, Moral and Legal Rights. Civil and Political Rights, Economic, Social and Cultural Rights; collective / Solidarity Rights.

UNIT II EVOLUTION AND CONCEPT 9

Evolution of the concept of Human Rights Magana carta – Geneva convention of 1864. Universal Declaration of Human Rights, 1948. Theories of Human Rights.

UNIT III THEORIES AND PERSPECTIVES 9

Theories and perspectives of UN Laws – UN Agencies to monitor and compliance.

UNIT IV HUMAN RIGHTS IN INDIA 9

Human Rights in India – Constitutional Provisions / Guarantees.

UNIT V HUMAN RIGHTS OF DISADVANTAGED PEOPLE 9

Human Rights of Disadvantaged People – Women, Children, Displaced persons and Disability persons, including Aged and HIV Infected People. Implementation of Human Rights – National and State Human Rights Commission – Judiciary – Role of NGO's, Media, Educational Institutions, Social Movements.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Dr.P.Alli, C.B.Selvalakshmi, K.Santha Sheela, T.Graceshalini, Pages: 108Edition: 2022, Technical Publications

2. Dr Mridula MIshra , Human Rights: Refugee Problem in India, Publisher : Vij Books India Private Limited; 1st edition (20 January 2011)..

Reference Books:

1. Kapoor S.K., “Human Rights under International law and Indian Laws”, Central Law Agency, Allahabad, 2014.

2. Chandra U., “Human Rights”, Allahabad Law Agency, Allahabad, 2014.

3. UpendraBaxi, The Future of Human Rights, Oxford University Press, New Delhi.

22OBT04	**INDUSTRIAL BIOTECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives: To make the students aware of the overall industrial bioprocess so as to help them to

1. Manipulate the process to the requirement of the industrial needs.
2. The course prepares the students for the bulk production of commercially important modern
3. Bioproducts, Industrial Enzymes, Products of plant and animal cell cultures

Course Content:

UNIT I INTRODUCTION TO INDUSTRIAL BIOPROCESS 9

Fermentation- Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology- A brief survey of organisms, processes, products. Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheeting – block diagrams, pictorial representation.

UNIT II PRODUCTION OF PRIMARY METABOLITES 9

Primary Metabolites- Production of commercially important primary metabolites like organic acids, amino acids and alcohols

UNIT III PRODUCTION OF SECONDARY METABOLITES 9

Secondary Metabolites- Production processes for various classes of secondary metabolites: Antibiotics, Vitamins and Steroids.

UNIT IV PRODUCTION OF ENZYMES AND OTHER BIOPRODUCTS 9

Production of Industrial Enzymes, Biopesticides, Biofertilizers, Biopreservatives, Biopolymers Biodiesel. Cheese, Beer, SCP & Mushroom culture, Bioremediation.

UNIT V PRODUCTION MODERN BIOTECHNOLOGY PRODUCTS 9

Production of recombinant proteins having therapeutic and diagnostic applications, vaccines. Bioprocess strategies in Plant Cell and Animal Cell culture.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Satyanarayana, U. "Biotechnology" Books & Allied (P) Ltd., 2005.
2. Kumar, H.D. "A Textbook on Biotechnology" IInd Edition. Affiliated East West Press Pvt.Ltd., 1998.
3. Balasubramanian, D. etal., "Concepts in Biotechnology" Universities Press Pvt. Ltd., 2004.
4. Ratledge, Colin and Bjorn Kristiansen "Basic Biotechnology" IInd Edition Cambridge University Press, 2001.
5. Dubey, R.C. "A Textbook of Biotechnology" S.Chand & Co. Ltd., 2006.

Reference Books:

1. Casida, L.E. "Industrial Microbiology", New Age International (P) Ltd, 1968.
2. Presscott, S.C. and Cecil G. Dunn, "Industrial Microbiology", Agrobios (India), 2005.
3. Cruger,Wulf and Anneliese Crueger, "Biotechnology: A Textbook of Industrial Microbiology",IInd Edition, Panima Publishing, 2000.
4. Moo-Young, Murrey, "Comprehensive Biotechnology", 4 Vols. Pergamon Press, (An Imprintof Elsevier) 2004.
5. Stanbury, P.F., A. Whitaker and S.J. Hall "Principles of Fermentation Technology", IInd Edition, Butterworth – Heinemann (an imprint of Elsevier), 1995.
6. C.F.A Bryce and EL.Mansi, Fermentation microbiology & Biotechnology, 1999.
7. K.G.Ramawat & Shaily Goyal, Comprehensive Biotechnology, 2009, S.Chand publications.

22OBM12	**INTRODUCTION TO CELL BIOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives: To make the students aware of the overall industrial bioprocess so as to help them to

1. To acquaint students with the concepts in Cell Biology.
2. To understand structure and function of the organelles of cells.
3. To learn the cell-cell interactions, transport mechanism and signaling pathways of cell.
4. To acquaint the students with basic laboratory techniques involved in cell.

Course Content:

UNIT I FEATURES OF CELL AND ITS ORGANELLES 9

Brief history of cytologyand cell theory, ProkaryotesandEukaryotes (plantcellandanimalcell), Membranes of the cell: Plasma membrane, nuclear membranes, Organelle membranes. Brief outline of organelles; Nucleus, nucleolus, ribosome, mitochondria, chloroplast, vacuole, endoplasmic reticulum, golgiapparatus, peroxisome, glyoxisome, lysosome, centriole, cilia and flagella.

UNIT II CELL CYCLE AND THEIR SOCIAL CONTEXT 9

Cell cycle and molecules that control cell cycle, Regulation of cell cycle, Microtubules, microfilaments, intermediate filaments and their binding proteins. Cell cell communication: Cell junction, Cell adhesion, Extra Cellular Matrix, Basal Lamina.

UNIT III CELL TRANSPORT AND TRAFFIC 9

Passive and active transport, permeases, osmosis, pumps and gated channels, co transport: symport, antiport. Vesicular transport: Endocytosis, Exocytosis, Protein glycosylation in eukaryotes and protein sorting. Transport in prokaryotic cells, entry of viruses and toxins in to the cell.

UNIT IV SIGNALING MOLECULES AND THEIR RECEPTORS 9

Signaling molecules: autocrine, paracrine and endocrine and its mode of action in cell signaling. Cytosolic, nuclear and membrane bound receptors: G-protein coupled receptor, protein tyrosine kinases receptor and cytokine receptors for cell signaling

UNIT V SIGNAL TRANSDUCTION 9

Signal amplification, different models of signal amplifications: role of cyclic AMP, cyclic GMP and G proteins in signal transduction, phosphorylation and regulation in signaling: serine

–threoninekinasesin signaling. Role of Inositol triphosphate(IP3)in signal transduction, calcium Ionfluxan ditsrolein cell signaling.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Geoffrey.M.CooperandRobertE.Hausman, TheCell: AMolecularApproach, FifthEdition, ASM Press and Sinauer Associates,Inc.,USA,2015.

2. BruceAlberts, AlexanderJohnson, JulianLewis and MartinRaff, Molecular Biology of the cell, fifth edition, TaylorandFrancisgroup,2012.

Reference Books:

1. De Robertis & De Robertis, Cell Biology, 4th Edition, 2010.
2. Lodish, H. and D. Baltimore, Cell Biology, W.H. Freeman publishers, 2012.
3. Gerald Karp, Cell and Molecular Biology, John Wiley and sons Inc, 2013.

22OCS22	INTRODUCTION TO HTML AND WEBSITE DEVELOPMENT	L	T	P	C
		3	0	0	3

Course Objectives:

1. To introduce students to web development and the HTML markup language.
2. To provide students with an understanding of CSS and responsive web design principles.
3. To teach students how to use web development tools and techniques to build websites.
4. To enable students to write client-side and server-side code for interactive and dynamic websites.

Course Content:

UNIT I INTRODUCTION TO WEB DEVELOPMENT AND HTML 9

History of the internet and the world wide web-HTML fundamentals-HTML syntax and structure-HTML elements and tags-Creating and formatting text-Adding images and links.

UNIT II CASCADING STYLE SHEETS (CSS) 9

. Introduction to CSS-Creating and applying styles to HTML elements-CSS syntax and selectors-Box model and positioning-Responsive web design

UNIT III WEB DEVELOPMENT TOOLS AND TECHNIQUES 9

Introduction to web development tools-Version control and collaborative coding-Debugging and troubleshooting web pages-Basic website design principles and accessibility-Responsive web design frameworks.

UNIT IV CLIENT-SIDE SCRIPTING AND JAVASCRIPT 9

Introduction to client-side scripting-JavaScript fundamentals-Document Object Model (DOM) and event handling-Form validation and manipulation-AJAX and web APIs

UNIT V SERVER-SIDE PROGRAMMING AND DATABASE INTEGRATION 9

Introduction to server-side programming-Server-side scripting with PHP-Database integration with MySQL-Managing user sessions andauthentication-Content Management Systems (CMS) and web application frameworks

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

4. Understand the basics of web development and the HTML markup language.
5. Create HTML and CSS-based websites with responsive design.
6. Use web development tools and techniques to build and manage websites.
7. Write client-side scripts with JavaScript to create interactive web pages.
8. Develop server-side code with PHP and integrate databases into web applications.

Text Books:

1. HTML and CSS: Design and Build Websites" by Jon Duckett
2. PHP and MySQL for Dynamic Web Sites: Visual QuickPro Guide" by Larry Ullman

Reference Books:

1. Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics" by Jennifer Niederst Robbins
2. Web Development and Design Foundations with HTML5" by Terry Felke-Morris

22OCS23	INTRODUCTION TO JAVA	L	T	P	C
		3	0	0	3

Course Objectives: To make the students aware of the overall industrial bioprocess so as to help them to

1. To introduce students to the Java programming language and its basic concepts.
2. To provide students with an understanding of object-oriented programming in Java.
3. To teach students how to work with Java input/output operations and data structures.
4. To enable students to write efficient and effective Java programs using advanced concepts.

Course Content:

UNIT I INTRODUCTION TO JAVA 9

Java platform and its architecture-Java Development Kit and Integrated Development Environment-Java syntax and basic constructs-Java-objects and classes-Java data types and variables-Java arrays and loops.

UNIT II OBJECT-ORIENTED PROGRAMMING IN JAVA 9

Object-oriented programming concepts-Java class inheritance-Java interfaces and abstract classes-Java encapsulation and access modifiers-Java polymorphism and method overloading-Java exception handling.

UNIT III JAVA INPUT AND OUTPUT 9

Java input/output streams-Java files and directories-Java serialization and deserialization- Java networking and socket programming-Java user interface components and events.

UNIT IV JAVA DATA STRUCTURES AND ALGORITHMS 9

Java collections framework-Java maps, lists, sets, and queues-Java iterators and comparators-Java algorithms and complexity analysis-Java recursion and backtracking.

UNIT V ADVANCED JAVA CONCEPTS 9

Java threads and concurrency-Java reflection and dynamic programming-Java annotations and metadata-Java database connectivity and SQL-Java web programming and servlets

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Understand the basics of the Java programming language.
2. Create Java programs that utilize object-oriented programming principles.
3. Develop and test Java programs using appropriate programming constructs.
4. Apply exception handling techniques to Java programs.
5. Utilize advanced Java concepts such as multithreading, networking, and database programming in Java

Text Book(s):

1. Starting Out with Java: From Control Structures through Data Structures by Tony Gaddis
2. Data Structures and Algorithms in Java" by Michael T. Goodrich and Roberto Tamassia.

Reference Books:

1. Java: The Complete Reference" by Herbert Schildt
2. Effective Java" by Joshua Bloch

22OEC14	MEMS AND NEMS	L	T	P	C
		3	0	0	3

Course Objectives

1. To introduce the concepts of micro and nano electromechanical devices
2. To know the fabrication process of Microsystems
3. To know the design concepts of micro sensors
4. To know the design concepts of micro actuators
5. To introduce the concepts of quantum mechanics and nano systems

Course Content:

UNIT I INTRODUCTION TO MEMS AND NEMS 9

Introduction to Design of MEMS and NEMS, Overview of Nano and Micro electro mechanical Systems, Applications of Micro and Nano electromechanical systems, Materials for MEMS and NEMS: Silicon, silicon compounds, polymers, metals.

UNIT II MEMS FABRICATION TECHNOLOGIES 9

Photolithography, Ion Implantation, Diffusion, Oxidation, CVD, Sputtering Etching techniques, Micromachining: Bulk Micromachining, Surface Micromachining, LIGA

UNIT III MICRO SENSORS **9**

MEMS Sensors: Design of Acoustic wave sensors, Vibratory gyroscope, Capacitive Pressure sensors, Case study: Piezoelectric energy harvester

UNIT IV MICRO ACTUATORS **9**

Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces, Case Study:RF Switch

UNIT V NANO DEVICES **9**

Atomic Structures and Quantum Mechanics, Shrodinger Equation, ZnO nanorods based NEMS device: Gas sensor.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Interpret the basics of micro/nano electromechanical systems including their applications and advantages
2. Recognize the use of materials in micro fabrication and describe the fabrication processes including surface micromachining, bulk micromachining and LIGA
3. Analyze the key performance aspects of electromechanical transducers including sensors
4. Analyze the key performance aspects actuators
5. Comprehend the theoretical foundations of quantum mechanics and Nano systems

Text Books:

1. Marc Madou, ―Fundamentals of Microfabrication, CRC press 1997.
2. Stephen D. Senturia, Micro system Design, Kluwer Academic Publishers,2001

Reference Books:

1. Tai Ran Hsu ,MEMS and Microsystems Design and Manufacture ,Tata Mcraw Hill, 2002.
2. Chang Liu, ―Foundations of MEMS, Pearson education India limited, 2006.
3. Sergey Edward Lyshevski, ―MEMS and NEMS: Systems, Devices, and Structures CRC Press,2002

		L	T	P	C
22OME17	**INTRODUCTION TO ROBOTICS**	**3**	**0**	**0**	**3**

Course Objectives

1. To understand the functions of the basic components of a Robot.
2. To study the use of various types of End of Effectors and Sensors
3. To impart knowledge in Robot Kinematics and Programming
4. To learn Robot safety issues and economics.

Course Content:

UNIT I FUNDAMENTALS OF ROBOT 9

Robot - Definition - Robot Anatomy - Co ordinate Systems, Work Envelope Types and Classification- Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load- Robot Parts and their Functions-Need for Robots-Different Applications.

UNIT II ROBOT DRIVE SYSTEMS & END EFFECTORS 9

Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

UNIT III SENSORS AND MACHINE VISION 9

Requirements of a sensor, Principles and Applications of the following types of sensors- Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors ,binary Sensors., Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors, Camera, Frame Grabber, Sensing and Digitizing Image Data- Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications- Inspection, Identification, Visual Serving and Navigation.

UNIT IV ROBOT KINEMATICS AND ROBOT PROGRAMMING 9

Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces-Manipulator Dynamics, Trajectory Generator, Manipulator Mechanism Design-Derivations and problems. Lead through Programming, Robot programming Languages-VAL Programming-Motion Commands, Sensor

Commands, End Effector commands and simple Programs.

UNIT V IMPLEMENTATION AND ROBOT ECONOMICS 9

RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. .Klafter R.D., Chmielewski T.A and Negin M., “Robotic Engineering - An Integrated Approach”, Prentice Hall, 2003.

2. Groover M.P., “Industrial Robotics -Technology Programming and Applications”, McGraw Hill, 2001.

Reference Books:

1. Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, 2008.

2. Deb S.R., “Robotics Technology and Flexible Automation” Tata McGraw Hill Book Co., 1994.

3. Koren Y., “Robotics for Engineers", Mc Graw Hill Book Co., 1992.

4. Fu.K.S.,Gonzalz R.C. and Lee C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill Book Co., 1987.

5. Janakiraman P.A., “Robotics and Image Processing”, Tata McGraw Hill, 1995.

6. Rajput R.K., “Robotics and Industrial Automation”, S.Chand and Company, 2008.

7. Surender Kumar, “Industrial Robots and Computer Integrated Manufacturing”, Oxford and IBH Publishing Co. Pvt. Ltd., 1991.

22OBM13	LAB ON CHIP	L	T	P	C
		3	0	0	3

Course Objectives

1. Describe the micro fabrication techniques for labs-on-chip devices.
2. Explain fluid flows and mass transport in micro- and nanoscale.
3. Describe the methods of analysis of macromolecules on a microchip.
4. Describe separation of cells and their analysis on a microchip.
5. Develop concepts of nucleic acid based on lab on-chip.

Course Content:

UNIT I LAB-ON-CHIP TECHNOLOGY 9

Planar process flow of a lab on chip, Fabrication materials: Silicon, silica on silicon and puresilica wafers. Photolithography, electron beam lithography, wet and dry etching techniques chemical vapor deposition, physical vapor deposition, wafer bonding. Polymer technology Soft lithography, micro-contact printing, micro molding. Deposition techniques. Deep X-ray lithography, chip-on-chip integration, - Wafer dicing and die attach, electronic interface fabrication, micro fluidic interface fabrication, optical interface fabrication, temperature control in micro fluidics.

UNIT II FLUID DYNAMICS IN MICROFLUIDIC CIRCUITS 9

Kinematic of fluid motion, the continuous fluid model, continuity equation, fluid dynamics, the momentum evolution equation, the energy evolution equation, Newtonian liquids, and flow in lab on-chip ducts: Simplified model, the liquid flow in a micro fluidic duct: Poiseuille flow. Interfaces phenomena and droplets, non-Newtonian fluids. Solutions dynamics: Diffusion - the chemical–Diffusion model, diffusion–Convection model. Electro hydrodynamics. Ions electrophoresis - Stern and Debye layers, electrophoresis, electro osmosis, electrophoresis of neutral particles, electro wetting, magneto-Hydrodynamics,magnetostatic basics, magnetophoresis, bead concentration evolution.

UNIT III MICROFLUIDIC BUILDING BLOCKS 9

Fluid flow control, Microvalve design considerations, micro valve performance comparison, fluidflow generation: Micropumps, comparison among different micropump architectures, sample preparation: Micromixers, comparison among different micromixer architectures. Filters, micro droplets in microfluidic circuits, droplet stability and breaking down, micropumps for droplet flow, thermo capillary micro pumps, electro wetting micro pumps. Surface activation for labs on chip, nanoparticle activation and functionalization, antibody and aptamer surface functionalization, stability of functionalized surfaces for labs on chip, on chip cells immobilization.

UNIT IV ELECTRONIC DETECTION 9

Detection system parameters, impedance-based cell detection and cell activity analysis, voltammetry detection, amperometry detection, alternate on-chip amperometry methods ,mechanical detection based on micro cantilevers, calorimetric detection.

UNIT V INTERPRETATION AND REPORT WRITING 9

Light detection, integrated optical circuits, lab-on-chip spectroscopy, surface plasmonresonance, lab-on-chip interferometry. Case studies - On-Chip DNA purification, On-Chip PCR amplification, On-Chip nucleic acid assays, lab-on-Chip integrating sequencing subsystems.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Eugenio Iannone, "Labs on Chip: Principles, Design and Technology", 1stEdition, CRCPress, 2014.
2. Jean Berthier and Pascal Silberzan, "Microfluidics for Biotechnology", 2ndEdition, ArtechHouse, 2009.
3. Wei-Cheng Tian and Erin Finehout, "Microfluidics for Biological Applications",1stEdition, Springer, 2009.

Reference Books:

1. Patrick Tabeling, "Introduction to Microfluidics", Reprint Edition, Oxford UniversityPress2010
2. Frank A. Gomez (Editor), "Biological Applications of Microfluidics", 1stEdition,Wiley-Interscience, 2008.

22OME20	MECHANICAL BEHAVIOR OF MATERIAL	L	T	P	C
		3	0	0	3

Course Objectives

1. The students having studied the basics of material structures and properties and strength of materials shall be introduced to dislocation theories of plasticity behaviour, various strengthening mechanisms and fracture mechanics.
2. It will expose students to failure mechanisms due to fatigue and creep as well as their testing methods.

Course Content:

UNIT I INTRODUCTION TO MECHANICAL BEHAVIOUR 9

Izod and Charpy Impacts tests, Ductile to Brittle Transition Temperature (DBTT), Factors affecting DBTT, determination of DBTT.

UNIT II STRENGTHENING MECHANISMS 9

cold working, grain size strengthening. Solid solution strengthening. martensitic strengthening, precipitation strengthening, dispersion strengthening, fibre strengthening, examples of above strengthening mechanisms from ferrous and non-ferrous systems, simple problems. Yield point phenomenon, strain aging and dynamic strain aging.

UNIT III FRACTURE AND FRACTURE MECHANICS 9

Types of fracture, basic mechanism of ductile and brittle fracture, Griffiths theory of brittle fracture, Orowans modification. Izod and Charpy Impacts tests, Ductile to Brittle Transition Temperature (DBTT), Factors affecting DBTT, determination of DBTT.

UNIT IV STRENGTHENING AND TESTING 9

Fracture mechanics-introduction, modes of fracture, stress intensity factor, strain energy release rate, fracture toughness and determination of KIC, introduction to COD, J integral.

UNIT V CREEP BEHAVIOUR AND TESTING 9

Creep curve, stages in creep curve and explanation, structural changes during creep, creep mechanisms, metallurgical factors affecting creep, high temperature alloys, stress rupture testing, creep testing machines, parametetric methods of extrapolation. Deformation Mechanism Maps according to Frost/Ashby

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Dieter, G.E., Mechanical Metallurgy, McGraw-Hill, SI Edition, 1995.
2. Davis. H. E., Troxell G.E., Hauck.G. E. W., The Testing of Engineering Materials, McGraw-Hill, 1982.

Reference Books:

1. Hayden, H. W. W. G. G. Moffatt, J. Moffatt and J. Wulff, The Structure and Properties of Materials, Vol.III, Mechanical Behavior, John Wiley and Sons, New York, 1965.
2. Honey combe R. W. K., Plastic Deformation of Materials, Edward Arnold Publishers, 1984.
3. Wulff, The Structure and Properties of Materials, Vol. III Mechanical Behavior of Materials, John Wiley and Sons, New York, USA, 1983.
4. Suryanarayana, A. V. K., Testing of Metallic Materials, Prentice Hall India, New Delhi, 1979.

22OBM14	MEDICAL CODING AND TRANSCRIPTION	L	T	P	C
		3	0	0	3

Course Objectives: To make the students aware of the overall Medical Coding and Transcription.

UNIT I INTRODUCTION TO CPT 9

Introduction to CPT, Category I to Category III, The 6 main sections of CPT,CPT Modifiers, Recognizing CPT Code

UNIT II CLINICAL DISEASE DATA CLASSIFICATION 9

The International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) is based on the World Health Organization's Ninth Revision, International Classification of Diseases (ICD-9). ICD-9-CM

UNIT III CLINICAL DATA STORAGE 9

Medical Data formats – Signal, Image and Video Formats – Medical Databases - Automation in clinical laboratories - Intelligent Laboratory Information System – PACS, Normalization techniques for Data handling - Plug-in Data Acquisition and Control Boards – Data Acquisition using Serial Interface, Representation of Data, Data modeling Techniques, Relational Hierarchical and network Approach

UNIT IV MEDICAL EXPERT SYSTEMS 9

Biometrics - GRID and Cloud Computing in Medicine, Virtual reality applications in medicine, Virtual Environment – Surgical simulation - Radiation therapy and planning – Telemedicine – virtual Hospitals - Smart Medical Homes – Personalized e-health services, Medical Expert Systems

UNIT V INTRODUCTION TO MEDICAL ETHICS 9

Definition of Medical ethics, Scope of ethics in medicine, International code of Ethics for occupational health professionals, Ethical Theories –Deontology and Utilitarianism ,Casuist theory, Virtue theory, The Right Theory. Role of ethics in Healthcare workplace – Autonomy, NonMalfeasance, Beneficence, Veracity, Justice, OSHA, Decision Model for Healthcare Dilemmas-Applications of Plus decision making model.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. R.D.Lele, “Computers in medicine progress in medical informatics”, Tata

McGraw Hill Publishing Ltd, 2005
2. Mohan Bansal, “Medical informatics”, Tata McGraw Hill Publishing Ltd, 2003
3. Domiel A Vallero , “Biomedical Ethics for Engineers”, Elsevier Pub.1st Edition, 2007

Online Reference:

1. https://www.cdc.gov/nchs/data/icd/hurricane05.pdf
2. https://www.cdc.gov/nchs/icd/icd9cm.htm
3. https://www.aapc.com/resources/medical-coding/cpt.aspx

Reference Books:

1. https://www.cms.gov/files/document/2022-hcpcs-application-summary-biannual-2-2022-non-drug-and-non-biological-items-and-services.pdf
2. Orpita Bosu and Simminder Kaur Thukral, “Bioinformatics Databases, Tools and Algorithms”, Oxford University press, 2007.
3. Yi Ping Phoebe Chen, “Bioinformatics Technologies”, Springer International Edition, New Delhi, 2007

22OBM15	MEDICAL DEVICE SERVICE AND CARE	L	T	P	C
		3	0	0	3

Course Objectives

1. Understand troubleshooting of electrical and electronic equipment.
2. Learn the troubleshooting of medical equipment.
3. Apply the tools in design, testing and developing medical equipment.

Course Content:

UNIT I TESTING OF ELECTRICAL EQUIPMENTS 9

AC, DC power supply, Grounding, shielding, Guarding, insulation testing, insulation resistance measurement, Types of Circuit Breakers, Rating – Testing of circuit breakers –Transformer testing- Earthing –Earth wires - Earthing of appliances –contactor, relay testing–CT and PT, Panel wiring- Megger-Testing equipment and instruments.

UNIT II TESTING OF ELECTRONIC COMPONENTS 9

Troubleshooting of PCB boards, Calibration of analog and digital sensor probe, Display interface, DC Power supply design, testing, Safe electrical practice, Cables and standard, Fuse.

UNIT III TESTING OF SURGICAL EQUIPMENT 9

Functions and operating procedure-Testing and maintenance of Heart lung machine, surgical lights, ventilator, patient monitor, anesthesia machine, dialyzer, surgical tools.

UNIT IV TROUBLESHOOTING OF EQUIPMENTS 9

X-ray machines, Troubleshooting of ECG recorders, incubator, baby warmer, infusion pumps, annual maintenance, contract requirements, vendor services, quality and safety standards

UNIT V LIFE CYCLE MANAGEMENT OF MEDICAL EQUIPMENT 9

Cost of the medical equipment, maintenance cost, replacement analysis, managing equipment service, decision making, extracting optimal benefit from medical equipment over its life cycle. Case study.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. B.S. Dhillon, “Medical Device Reliability and Associated Areas”, CRC Press, UK, 2000.
2. Joseph. J Carr, John M Brown, Introduction to Biomedical Equipment Technology, John Wiley& Sons, New York,4thedition, 2008.
3. Keith Willson, Keith Ison, SlavikTabakov, “Medical equipment management”, CRC Press, UK, 2014.

Reference Books:

1. Jenny Dooley,John Lehnert Virginia Evans, “Career Paths: Medical Equipment Repair”, Express Publishing, UK,2018.
2. Shakti Chatterjee, Aubert Miller, “Biomedical Instrumentation systems”, Cengage Learning Technology & Engineering, 2010.
3. David Herres, “Troubleshooting and Repairing Commercial Electrical Equipment”, McGraw Hill Professional edition, 2013.
4. R. S. Khandpur, “Troubleshooting Electronic Equipment” 1st Edition, McGraw Hill, 2007

22OEC19 NANOMATERIALS AND APPLICATIONS

L	**T**	**P**	**C**
3	**0**	**0**	**3**

Course Objectives

1. Understand basic nano particles, materials and catalysisPLC terminologies digital principles, PLC architecture and operation.
2. Develop synthesis of Nanomaterials..
3. Understand the importance of nano composites.
4. Exposures about different nano structures and characterization.

Course Content:

UNIT I INTRODUCTION 9

General definition and size effects–important nano structured materials and nano particles importance of nano materials- Size effect on thermal, electrical, electronic, mechanical, optical and magnetic properties of nanomaterials- surface area - band gap energy and applications. Photochemistry and Electrochemistry of nanomaterials –Ionic properties of nanomaterials- Nano catalysis.

UNIT II SYNTHESIS OF NANOMATERIALSMATERIALS 9

Bottom up and Top-down approach for obtaining nano materials - Precipitation methods – sol gel technique – high energy ball milling, CVD and PVD methods, gas phase condensation, magnetron sputtering and laser deposition methods – laser ablation, sputtering.

UNIT III NANO COMPOSITES 9

Definition- importance of nanocomposites- nano composite materials-classification of composites- metal/metal oxides, metal-polymer- thermoplastic based, thermoset based and elastomer based- influence of size, shape and role of interface in composites applications.

UNIT IV NANO STRUCTURES AND CHARACTERIZATION TECHNIQUES 9

Classifications of nanomaterials - Zero dimensional, one-dimensional and two-dimensional nanostructures- Kinetics in nanostructured materials- multilayer thin films and superlattice- clusters of metals, semiconductors and nanocomposites. Spectroscopic techniques, Diffraction methods, thermal analysis method, BET analysis method.

UNIT V APPLICATIONS OF NANO MATERIALS 9

Overview of nanomaterials properties and their applications, nano painting, nano coating, nanomaterials for renewable energy, Molecular Electronics and Nanoelectronics – Nanobots- Biological Applications. Emerging technologies for environmental applications- Practice of nanoparticles for environmental remediation and water treatment.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Understand the basic properties such as structural, physical, chemical properties of Nano materials and their applications.
2. Able to acquire knowledge about the different types of nano material synthesis
3. Describes about the shape, size,structure of composite nano materials and their interference
4. Understand the different characterization techniques for nanomaterials
5. Develop a deeper knowledge in the application of nanomaterials in different fields**.**

Text Books:

1. Mick Wilson, Kamali Kannangara,Geoff Smith, Michelle Simmom, Burkhard Raguse, “Nano Technology: Basic Science & Engineering Technology”, 2005, Overseas Press
2. G. Cao, “Nanostructures & Nanomaterials: Synthesis, Properties &Applications” Imperial College Press, 2004
3. William A Goddard “Handbook of Nanoscience, Engineering and Technology”, 3rd Edition, CRC Taylor and Francis group 2012..

Reference Books:

1. R.H.J.Hannink & A.J.Hill, Nanostructure Control, Wood Head Publishing Ltd.,Cambridge,2006.
2. C.N.R.Rao, A.Muller, A.K.Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications Vol. I & II, 2nd edition, 2005, Wiley VCH Verlag Gibtl & Co
3. Ivor Brodie and Julius J.Muray,’The physics of Micro/Nano – Fabrication’,Springer International Edition,2010

22OBM17	PROFESSIONAL ETHICS	L	T	P	C
		3	0	0	3

Course Objectives

1. Students will understand the importance of Values and Ethics in their Personal lives and professional careers
2. The students will learn the rights and responsibilities
3. Responsibilities of employee, team member and a global citizen.

Course Content:

UNIT I INTRODUCTION TO PROFESSIONAL ETHICS 9

Basic Concepts, Governing Ethics, Personal &Professional Ethics, Ethical Dilemmas, Life Skills, Emotional Intelligence, Thoughts of Ethics, Value Education, Dimensions of Ethics, Profession and professionalism, Professional Associations, Professional Risks, Professional Accountabilities, Professional Success, Ethics and Profession.

UNIT II BASIC THEORIES: 9

Basic Ethical Principles, Moral Developments, Deontology, Utilitarianism, Virtue Theory, Rights Theory, Casuist Theory, Moral Absolution, Moral Rationalism, Moral Pluralism, Ethical Egoism, Feminist Consequentialism, Moral Issues, Moral Dilemmas, Moral Autonomy..

UNIT III PROFESSIONAL PRACTICES IN ENGINEERING: 9

Professions and Norms of Professional Conduct, Norms of Professional Conduct vs. Profession; Responsibilities, Obligations and Moral Values in Professional Ethics, Professional codes of ethics, the limits of predictability and responsibilities of the engineering profession, Central Responsibilities of Engineers - The Centrality of Responsibilities of Professional Ethics; lessons from 1979 American AirlinesDC-10 Crash and Kansas City Hyatt Regency Walk away Collapse.

UNIT IV WORK PLACE RIGHTS & RESPONSIBILITIES 9

Ethics in changing domains of Research, Engineers and Managers; Organizational Complaint Procedure, difference of Professional Judgment within the Nuclear Regulatory Commission (NRC), the Hanford Nuclear Reservation. Ethics in changing domains of research - The US government wide definition of research misconduct, research misconduct distinguished from mistakes and errors, recent history of attention to research misconduct, the emerging emphasis on understanding and fostering responsible conduct, responsible authorship, reviewing & editing.

UNIT V GLOBAL ISSUES IN PROFESSIONAL ETHICS 9

Introduction – Current Scenario, Technology Globalization of MNCs, International Trade, World Summits, Issues, Business Ethics and Corporate Governance, Sustainable Development Ecosystem, Energy Concerns, Ozone Deflection, Pollution, Ethics in Manufacturing and Marketing, Media Ethics; War Ethics; BioEthics, Intellectual Property Rights.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Professional Ethics: R. Subramanian, Oxford University Press, 2015.
2. Ethics in Engineering Practice & Research, Caroline Whitbeck, 2e, Cambridge

Reference Books:

1. Engineering Ethics, Concepts Cases: Charles E Harris Jr., Michael S Pritchard, Michael J Rabins, 4e , Cengage learning, 2015.
2. .Business Ethics concepts & Cases: Manuel G Velasquez, 6e, PHI, 2008.

22OBM18	PUBLICATION WRITING AND PLAGIARISM KNOWLEDGE	L	T	P	C
		3	0	0	3

Course Objectives

This graduate course will address theoretical and practical issues related to scholarly writing and publishing in the 21stcentury. A broad array of genres will be addressed, including peer-reviewed articles, scholarly monographs (books), edited collections, and book reviews, although the main focus will be on peer-reviewed journal articles.

Course Content:

UNIT I ELECTRICAL HAZARDS **9**

Review of Electrical concept, Electrostatic – Electro magnetism – Electrical Hazards – Energy leakage – Clearance and insulation– Current surges – Electrical causes of fire and explosion – Human interface with electricity – Human resistance to electricity.

UNIT II STANDARDS AND REQUIREMENTS **9**

National electrical Safety code - Standards and statutory requirements – Indian electricity acts and rules – statutory requirements from Electrical inspectorate. Hazardous area classification and classification of electrical equipments for hazardous areas (IS, NFPA, API and OSHA standards).

UNIT III PUBLICATION ETHICS **9**

Publication ethics: definition, introduction and importance-Best practices/standards setting initiatives and guidelines: COPE, WAME, etc-Conflicts of interest-Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types-Violation of publication ethics, authorship and contributorship-Identification of publication misconduct, complaints and appeals-Predatory publishers and journals..

UNIT IV STANDARDIZATION OF QUALITY MEDICAL CARE IN HOSPITALS **9**

Define Quality- Need for Standardization& Quality Management, QM in Health Care

Organization-Quality assurance methods, QA in (Medical Imaging & Nuclear medicine) Diagnostic services – Classification of equipment.

UNIT V REGULATORY REQUIREMENT FOR HEALTH CARE 9

FDA regulations, Accreditation for hospitals - JCI, NABH and NABL, Regulatory Codes.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. .Neeraj Pandey and KhushdeepDharni, Intellectual Property Rights, First edition, PHI learning Pvt. Ltd., Delhi, 2014.
2. .Uma Sekaran and Roger Bougie, Research methods for Business, 5th Edition, Wiley India, New Delhi, 2012.
3. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students"", 2nd edition, Juta Academic, 2001.
4. Ramakrishna B &Anilkumar H S, Fundamentals of Intellectual Property Rights, Istedition,Notion Press, 2017.

Reference Books:

1. William G Zikmund, Barry J Babin, Jon C.Carr, Atanu Adhikari, Mitch Griffin, Business Research methods, A South Asian Perspective, 8th Edition, Cengage Learning, New Delhi, 2012.

22OBM19	RESEARCH METHODOLOGY	L	T	P	C
		3	0	0	3

Course Objectives

The main objective of this course is to introduce the basic concepts in research methodology in Social science. This course addresses the issues inherent in selecting a research problem and discuss the techniques and tools to be employed in completing a research project..

Course Content:

UNIT I RESEARCH FORMULATION AND DESIGN 9

Motivation and objectives – Research methods vs. Methodology. Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, concept of applied and basic research process, criteria of good research. Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature and research database, development of working hypothesis.

UNIT II DATA COLLECTION AND ANALYSIS 9

Accepts of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools,data analysis with statically package (Sigma STAT,SPSS for student t-test, ANOVA, etc.), hypothesis testing.

UNIT III SOFT COMPUTING 9

Computer and its role in research, Use of statistical software SPSS, GRETL etcin research. Introduction to evolutionary algorithms - Fundamentals of Genetic algorithms, Simulated Annealing, Neural Network based optimization, Optimization of fuzzy systems.

UNIT IV RESEARCH ETHICS, IPR AND SCHOLARY PUBLISHING 9

Ethics-ethical issues, ethical committees (human & animal); IPR- intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS); scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability.

UNIT V INTERPRETATION AND REPORT WRITING 9

Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, EssEss Publications. 2 volumes..

Reference Books:

1. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.

2. Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.

22OBM20	REVERSE ENGINEERING AND INDUSTRY	L	T	P	C
		3	0	0	3

Course Objectives

1. The main learning objective of this course is to prepare students for:
2. Applying the fundamental concepts and principles of reverse engineering in product design and development.
3. Applying the concept and principles material characteristics, part durability and life limitation in reverse engineering of product design and development.
4. Applying the concept and principles of material identification and process verification in reverse engineering of product design and development.
5. Analyzing the various legal aspect and applications of reverse engineering in product design and development

Course Content:

UNIT I INTRODUCTION & GEOMETRIC FORM 9

Definition – Uses – The Generic Process – Phases – Computer Aided Reverse Engineering - Surface and Solid Model Reconstruction – Dimensional Measurement –Prototyping

UNIT II MATERIAL CHARACTERISTICS AND PROCESS IDENTIFICATION 9

Alloy Structure Equivalency – Phase Formation and Identification – Mechanical Strength Hardness –Part Failure Analysis – Fatigue – Creep and Stress Rupture – Environmentally Induced Failure Material Specification - Composition Determination - Microstructure Analysis - Manufacturing Process Verification.

UNIT III DATA PROCESSING 9

Statistical Analysis – Data Analysis – Reliability and the Theory of Interference – Weibull Analysis –Data Conformity and Acceptance – Data Report – Performance Criteria – Methodology of Performance Evaluation – System Compatibility

UNIT IV 3D SCANNING AND MODELLING 9

Introduction, working principle and operations of 3D scanners: Laser, White Light, Blue Light - Applications- Software for scanning and modelling: Types- Applications- Preparation techniques for Scanning objects- Scanning and Measuring strategies - Calibration of 3D Scanner- Step by step procedure: 3D scanning - Geometric modelling – 3D inspection- Case studies.

UNIT V INDUSTRIAL APPLICATIONS 9

Reverse Engineering in the Automotive Industry; Aerospace Industry; Medical Device Industry.Case studies and Solving Industrial projects in Reverse Engineering.Legality: Patent –

Copyrights –Trade Secret – Third-Party Materials.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Robert W. Messler, Reverse Engineering: Mechanisms, Structures, Systems & Materials, 1st Edition, McGraw-Hill Education, 2014
2. Wego Wang, Reverse Engineering Technology of Reinvention, CRC Press, 2011.

Reference Books:

1. Scott J. Lawrence , Principles of Reverse Engineering, Kindle Edition, 2022
2. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and NewProduct Development, Prentice Hall, 2001
3. . Kathryn, A. Ingle, “Reverse Engineering”, McGraw-Hill, 1994.
4. Linda Wills, “Reverse Engineering”, Kluver Academic Publishers, 1996
5. Vinesh Raj and Kiran Fernandes, “Reverse Engineering: An Industrial Perspective”, SpringerVerlag London Limited 2008.

22OEC24	SIGNAL AND IMAGE ANALYSIS USING MATLAB	L	T	P	C
		3	0	0	3

Course Objectives

1. To become familiar with digital image fundamentals.
2. To get exposed to simple image enhancement techniques in Spatial and Frequency domain.
3. To learn concepts of degradation function and restoration techniques.
4. To study the image segmentation and representation techniques.
5. To become familiar with image compression and recognition methods.

Course Content:

UNIT I DIGITAL IMAGE FUNDAMENTALS 9

Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels - Color imagefundamentals - RGB, HSI models, Two-dimensional mathematical preliminaries, 2D transforms -DFT, DCT.

UNIT II IMAGE ENHANCEMENT 9

Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering–Smoothing and Sharpening Spatial Filtering, Frequency Domain: Introduction to Fourier Transform–Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement.

UNIT III IMAGE RESTORATION 9

Image Restoration - degradation model, Properties, Noise models – Mean Filters – Order Statistics –Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering –Inverse Filtering – Wiener filtering.

UNIT IV IMAGE SEGMENTATION 9

Edge detection, Edge linking via Hough transform – Thresholding - Region based segmentation –Region growing – Region splitting and merging – Morphological processing- erosion and dilation, Segmentation by morphological watersheds – basic concepts – Dam construction – Watershed segmentation algorithm.

UNIT V IMAGE COMPRESSION AND RECOGNITION 9

Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEGstandard, MPEG. Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors – Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Know and understand the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2D-transforms.
2. Operate on images using the techniques of smoothing, sharpening and enhancement.
3. Understand the restoration concepts and filtering techniques.
4. Learn the basics of segmentation, features extraction, compression and recognition methods for color models.
5. Comprehend image compression concepts.

Text Books:

1. Rafael C. Gonzalez, Richard E. Woods, ‘Digital Image Processing’, Pearson, Third Edition,2010.
2. Anil K. Jain, ‘Fundamentals of Digital Image Processing’, Pearson, 2002.

Reference Books:

1. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, 'Digital Image Processing using MATLAB', Pearson Education, Inc., 2011.
2. Kenneth R. Castleman, 'Digital Image Processing', Pearson, 2006.
3. William K. Pratt, 'Digital Image Processing', John Wiley, New York, 2002.

22OME34	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives:

1. To facilitate the understanding of Quality Management principles and process
2. To learn the fundamental concepts of Leadership and Motivation
3. To educate the tools of quality and its applications
4. To familiarize the fundamental concepts of quality improvements and measures
5. To understand the importance of quality management system and standards.

Course Content:

UNIT I INTRODUCTION **9**

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.

UNIT II TQM PRINCIPLES **9**

cold working, grain size strengthening. Solid solution strengthening. martensitic strengthening, precipitation strengthening, dispersion strengthening, fibre strengthening, examples of above strengthening mechanisms from ferrous and non-ferrous systems, simple problems. Yield point phenomenon, strain aging and dynamic strain aging.

UNIT III TQM TOOLS AND TECHNIQUES – I **9**

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

UNIT IV TQM TOOLS AND TECHNIQUES – II **9**

Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

UNIT V CREEP BEHAVIOUR AND TESTING 9

Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements—Implementation—Documentation—Internal Audits—Registration--ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001—Benefits of EMS.

TOTAL LECTURE PERIODS 45 Periods

Text Books:

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield,Mary B.Sacre,Hemant Urdhwareshe and Rashmi Urdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.

Reference Books:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8 th Edition, First Indian Edition, Cengage Learning, 2012.
2. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
3. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
4. ISO 9001-2015 standards.

22OEC27	VIRTUAL INSTRUMENTATION USING LABVIEW	L	T	P	C
		3	0	0	3

Course Objectives

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

Course Content:

UNIT I FUNDAMENTALS OF VIRTUAL INSTRUMENTATION 9

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

UNIT II GRAPHICAL PROGRAMMING ENVIRONMENT IN VI 9

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 INTERFACING DAQ SYSTEM WITH PC 9

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 SIMPLE PROGRAMMING IN VI 9

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 ANALYSIS TOOLS AND SIMPLE APPLICATIONS IN VI 9

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

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

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.

Text Books:

1. Jovitha Jerome, Virtual Instrmentation using LabVIEW, PHI, 2010.
2. Garry M. Johnson, LabVIEW Graphical Programming, Tata McGraw Hill, 1996.

Reference Books:

1. “Learning with LabView”, Robert H Bishop, Prentice Hall, 2009
2. Virtual Instrumentation using LABVIEW”, Jovitha Jerome, PHI, 2010S. Salivahanan, A. Vallavaraj and C. Gnanapriya, “Digital Signal Processing”,

McGraw-Hill Publication

3. “Virtual Instrumentation using LABVIEW”, Sanjay Gupta, Joseph John, TMH, McGraw Hill Second Edition, 2011.

22OEC28	VLSI SYSTEM DESIGN	L	T	P	C
		3	0	0	3

Course Objectives

1. Understand the fundamentals of IC technology components and their characteristics.
2. Understand combinational logic circuits and design principles.
3. Understand sequential logic circuits and clocking strategies.
4. Understand ASIC Design functioning and design.
5. Understand Memory Architecture and building blocks

Course Content:

UNIT I INTRODUCTION TO MOS TRANSISTOR 9

MOS Transistor, CMOS logic, Inverter, Pass Transistor, Transmission gate, Layout Design Rules, Gate Layouts, Stick Diagrams, Long-Channel I-V Charters tics, C-V Charters tics, Non ideal I-V Effects, DC Transfer characteristics, RC Delay Model, Elmore Delay, Linear Delay Model, Logical effort, Parasitic Delay, Delay in Logic Gate, Scaling.

UNIT II COMBINATIONAL MOS LOGIC CIRCUITS 9

Circuit Families: Static CMOS, Ratioed Circuits, Cascode Voltage Switch Logic, Dynamic Circuits, Pass Transistor Logic, Transmission Gates, Domino, Dual Rail Domino, CPL, DCVSPG, DPL, Circuit Pitfalls. Power: Dynamic Power, Static Power, Low Power Architecture.

UNIT III SEQUENTIAL CIRCUIT DESIGN 9

Static latches and Registers, Dynamic latches and Registers, Pulse Registers, Sense Amplifier Based Register, Pipelining, Schmitt Trigger, Monostable Sequential Circuits, Astable Sequential Circuits.Timing Issues : Timing Classification Of Digital System, Synchronous Design.

UNIT IV DESIGN OF ARITHMETIC BUILDING BLOCKS AND SUBSYSTEM 9

Arithmetic Building Blocks: Data Paths, Adders, Multipliers, Shifters, ALUs, power and speed tradeoffs, Case Study: Design as a tradeoff. Designing Memory and Array structures: Memory Architectures and Building Blocks, Memory Core, Memory Peripheral Circuitry.

UNIT V IMPLEMENTATION STRATEGIES AND TESTING 9

FPGA Building Block Architectures, FPGA Interconnect Routing Procedures. Design for Testability: Ad Hoc Testing, Scan Design, BIST, IDDQ Testing, Design for Manufacturability, Boundary Scan.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Realize the concepts of digital building blocks using MOS transistor.
2. Design combinational MOS circuits and power strategies.
3. Design and construct Sequential Circuits and Timing systems.
4. Design arithmetic building blocks and memory subsystems.
5. Apply and implement FPGA design flow and testing.

Text Books:

1. Neil H.E. Weste, David Money Harris "CMOS VLSI Design: A Circuits and Systems Perspective", 4th Edition, Pearson , 2017.
2. Jan M. Rabaey ,Anantha Chandrakasan, Borivoje. Nikolic, "Digital Integrated Circuits:A Design perspective", Second Edition , Pearson , 2016.

Reference Books:

1. M.J. Smith, "Application Specific Integrated Circuits", Addisson Wesley, 1997

2. Sung-Mo kang, Yusuf leblebici, Chulwoo Kim "CMOS Digital Integrated Circuits: Analysis & Design",4th edition McGraw Hill Education,2013

3. Wayne Wolf, "Modern VLSI Design: System On Chip", Pearson Education, 2007

4. R.Jacob Baker, Harry W.LI., David E.Boyee, "CMOS Circuit Design, Layout and Simulation", Prentice Hall of India 2005.

22PBM39	ARTIFICIAL ORGANS AND IMPLANTS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To have an overview of artificial organs & transplants To describe the principles of implant design with a case study
2. To explain the implant design parameters and solution in use
3. To study about various blood interfacing implants
4. To study about soft tissue replacement and hard tissue replacement

Course Content:

UNIT I ARTIFICIAL ORGANS & TRANSPLANTS 9

Introduction, outlook for organ replacements, design consideration, evaluation process, Overview, Immunological considerations, Blood transfusions, individual organs – kidney, liver, heart and lung, bone marrow, cornea.

UNIT II PRINCIPLES OF IMPLANT DESIGN 9

Principles of implant design, Clinical problems requiring implants for solution, Permanent versus absorbable devices, the missing organ and its replacement, Tissue engineering, scaffolds, cells and regulators criteria for materials selection, Case study of organ regeneration.

UNIT III IMPLANT DESIGN PARAMETERS AND ITS SOLUTION 9

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.

UNIT IV BLOOD INTERFACING IMPLANTS 9

Neural and neuromuscular implants, heart valve implants, heart and lung assist devices, artificial heart, cardiac pacemakers, artificial kidney- dialysis membrane and artificial blood.

UNIT V IMPLANTABLE MEDICAL DEVICES AND ORGANS 9

Gastrointestinal system, Dentistry, Maxillofacial and craniofacial replacement, Soft tissue repair, replacement and augmentation, recent advancement and future directions.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Gain adequate knowledge about artificial organs & transplants.
2. Get clear idea about implant design and its parameters and solution.
3. Have in-depth knowledge about blood interfacing implants
4. Explain different types of soft tissue replacement and hard tissue replacement
5. Assess compatibility and functioning of artificial organs inside the living system.

Text Books:

1. Kopff W.J, Artificial Organs, John Wiley and sons, New York, 1st edition, 1976.

Reference Books:

1. J D Bronzino, Biomedical Engineering handbook Volume II, (CRC Press / IEEE Press), 2000.
2. R S Khandpur, Handbook of Biomedical Instrumentation,Tata McGraw Hill, 2003
3. Yannas, I. V, "Tissue and Organ Regeneration in Adults", New York, NY: Springer, 2001. ISBN:9780387952147.
4. John Enderle, Joseph D.Bronzino, Susan M.Blanchard, "Introduction to Biomedical Engineering", Elsevier, 2005.

22PBM40	**BIOMEDICAL OPTICS AND PHOTONICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

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

Course Content:

UNIT I OPTICAL PROPERTIES 9

Basic principles of light - Reflection - Refraction - Absorption - Polarization - Interference - Coherence, Basic laws of light - Beer Lambert law - Snell's law, Optical properties of tissues - Absorption - Scattering - Anisotropy.

UNIT II OPTICAL INSTRUMENTATION 9

Working principle of light sources - Lasers - LEDs, Working principle of optical detectors - Photodiode - Spectrometer - CMOS and CCD cameras - Lens - Optical filters - Optical fibers.

UNIT III OPTICAL BIOSENSORS 9

Principles of Optical biosensing - Immobilization of bio-recognition elements, Types of optical biosensor - Fiber optic - Planar waveguide - Evanescent - Interferometric - Surface plasmon resonance - Advantages and disadvantages - Applications.

UNIT IV APPLICATIONS OF LASERS 9

Diagnostic - Optical coherence tomography, Fluorescence, Raman, Photoacoustic tomography, Laser induced breakdown spectroscopy (LIBS), Hyperspectral imaging. Surgical - Lasers in dentistry, Dermatology, Ophthalmology.

UNIT V LASER TISSUE INTERACTION 9

Laser tissue interactions via photochemical, Photothermal, Photomechanical techniques, Photodynamic therapy (PDT) - Oncological and non-oncological applications, Low level laser therapy (LLLT) - Biostimulation applications.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

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

Text Books:

1. Tuan Vo Dinh, "Biomedical Photonics –Handbook, CRC Press, Bocaraton, 2014.
2. Jurgen Popp, Valery V. Tuchin, Arthur Chiou and Stefen Heinemann, Handbook of Biophotonics, Vol 2: Photonics for Healthcare, John Wiley and Sons, 1st Edition, 2011.

Reference Books:

1. Markolf H. Niemz, "Laser-Tissue Interaction Fundamentals and Applications" Springer, 2007.
2. Splinter R and Hooper B. A., "An Introduction to Biomedical Optics", Taylor and Francis, 2006.
3. Mark E. Brezinski, "Optical Coherence Tomography: Principles and Applications", Academic Press, 2006.
4. Paras N. Prasad, "Introduction to Biophotonics", A. John Wiley and sons, Inc. Publications, 2003.

Lab course/Mini projects/Hospital visit - Presentations (30 hours)

Students need to visit Hospitals/Research Institutes/Industry and understand the working and applications of various Optical Techniques in the Biomedical field.

1. Lab course/Mini projects on interferometry techniques (Young's double slit, Michelson and Mach-zehnder interferometry).
2. Lab course/Mini projects on various spectroscopic techniques (absorption/transmission, scattering and emission spectroscopy).
3. Lab course/Mini projects on optical simulations and image processing – MATLAB, COMSOL, optical softwares.
4. Mini projects on Laser based Biomedical Applications
5. Hospital visit to understand the working of Optical Coherence Tomography technique
6. Hospital visit to understand the clinical applications of Lasers used in ophthalmology, dermatology, dentistry, etc.,

22PBM41	GENETIC ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To discuss the gene cloning methods and the tools and techniques involved in gene cloning and genome analysis and genomics.
2. To explain the heterologous expression of cloned genes in different hosts.

Course Content:

UNIT I BASICS OF RECOMBINANT DNA TECHNOLOGY 9

Manipulation of DNA – Restriction and Modification enzymes - Design of linkers and adaptors - Characteristics of cloning and expression vectors - Introduction of recombinant DNA in to host cells and selection methods.

UNIT II DNA LIBRARIES 9

Construction of genomic and cDNA libraries, Artificial chromosomes – Bacteria, Yeast - Chromosomal walking.

UNIT III SEQUENCING AND AMPLIFICATION OF DNA 9

Maxam Gilbert's and Sanger's methods of DNA sequencing – PCR: Inverse PCR, Nested PCR, Allele specific PCR, Hot start PCR, Colony PCR, single cell PCR, Real-time PCR/qPCR – SYBR green assay, Taqman assay, Molecular beacons. Site directed mutagenesis.

UNIT IV ORGANIZATION AND STRUCTURE OF GENOMES 9

Organization and structure of genomes - Genome sequencing methods: Conventional and shotgun genome sequencing methods, Next generation sequencing technologies - Ordering the genome sequence - Genetic maps and Physical maps, STS content based mapping, Hybridization mapping, Optical mapping.

UNIT V CURRENT STATUS OF GENOME SEQUENCING PROJECTS 9

Introduction to Functional genomics – Microarrays - Serial Analysis of Gene expression (SAGE), Subtractive hybridization, Comparative Genomics, Proteogenomics, Web resources for Genomics, Applications of genome analysis and genomics.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Would be aware of how to clone commercially important genes.
2. The students would be aware of how to produce the commercially important recombinant proteins.
3. Will be familiarized with gene and genome sequencing techniques
4. Will be aware of microarrays, Analysis of Gene expression and proteomics.
5. Acquire ability to function on multi-disciplinary teams

Text Books:

1. Old RW, Primrose SB, "Principles of Gene Manipulation, An Introduction to Genetic

Engineering”, Blackwell Science Publications, 1993.
2. Principles of Genome Analysis and Genomics by S.B.Primrose and R.M.Twyman, 3rd Ed. (Blackwell Publishing).

Reference Books:

1. Isil Aksan Kurnaz, “Techniques in Genetic Engineering”, CRC Press, 2015.
2. Oksana Ableitner, “Introduction to Molecular Biology: Working with DNA and RNA (essentials)”, Springer International, 2022.
3. Arun K. Shukla, “Proteomics in Biology”, Academic Press, 2017.

22PBM42	FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand requirement engineering and know how to collect, analyze and arrive at requirements for new product development and convert them in to design specification.
2. To understand system modeling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics.
3. To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer.
4. To understand the global trends and development methodologies of various types of products and services.
5. To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems.

Course Content:

UNIT I OVERVIEW OF PRODUCT DEVELOPMENT 9

Overview of Products and Services - Types of Product Development - Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends-Introduction to Product Development Methodologies and Management

UNIT II INTRODUCTION TO SYSTEM MODELING 9

Introduction to System Modeling Requirement Management -- - System Optimization - System Specification - Sub-System Design - Interface Design System Design & Modeling- Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis.

UNIT III INTRODUCTION TO RAPID PROTOTYPING 9

Introduction to Rapid Prototyping and Rapid Manufacturing - System Integration, Testing, Certification and Documentation Conceptualization -- Detailed Design - Component Design and Verification – Mechanical, Electronics and Software Subsystems- Industrial Design and User Interface

Design - Introduction to Concept generation Techniques – Challenges in Integration of Engineering Disciplines - Concept Screening & Evaluation - High Level Design/Low Level Design of S/W Program - Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping

UNIT IV PRODUCT TESTING STANDARDS AND CERTIFICATION 9

Product Testing Standards and Certification -- Product Documentation - Sustenance -Maintenance and Repair – Enhancements - Product EoL -Introduction to Product verification processes and stages - - Obsolescence Management – Configuration Management - EoL Disposal -Introduction to Product Validation processes and stages

UNIT V INTRODUCTION TO VERTICAL SPECIFIC PRODUCT DEVELOPMENT PROCESSES 9

Introduction to Vertical Specific Product Development processes - Manufacturing/Purchase and Assembly of Systems - The IPD Essentials - Introduction to Vertical Specific Product Development processes -Integration of Mechanical, Embedded and Software Systems The Industry - Intellectual Property Rights and Confidentiality -Engineering Services Industry - Product Development in Industry versus Academia –- – Product Development Trade-offs –- Security and Configuration Management.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Define, formulate, and analyze a problem
2. Solve specific problems independently or as part of a team
3. Gain knowledge of the Innovation & Product Development process in the Business Context
4. Work independently as well as in teams
5. Manage a project from start to finish

Text Books:

1. Hiriyappa B, “Corporate Strategy – Managing the Business”, Author House, 2013.
2. Peter F Drucker, “People and Performance”, Butterworth – Heinemann [Elsevier], Oxford, 2004.
3. Book specially prepared by NASSCOM as per the MoU.
4. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011.
5. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.

Reference Books:

1. Vinod Kumar Garg and Venkita Krishnan N K, “Enterprise Resource Planning – Concepts”, Second Edition, Prentice Hall, 2003.
2. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013

22PBM43 **MEDICAL DEVICE DESIGN**

L	T	P	C
3	0	0	3

Course Objectives: The student should be made to

1. Introduce the Medical device standards and requirements.
2. Illustrate the design procedure of medical devices.
3. Outline the quality assessment in design.
4. Describe about the design realization.
5. Understand the validation and verification of various medical devices

Course Content:

UNIT I NEEDS FINDING AND CONCEPT GENERATION 9

Strategic Focus – observation and problem identification – Need statement development. Ideation and Brainstorming – concept screening, concept selection: intellectual property basics – reimbursement basics – business models – prototyping – final concept selection. Safety and Risk Management - Tools, Documents and Deliverables.

UNIT II MEDICAL DEVICES STANDARDS AND REQUIREMENTS 9

FDA, Medical devices classification, Medical Devices Directive Process – Harmonized Standards, ISO13485, ISO 14971, IEC60601-1, IEC 62304. Reliability, Concept of failure, Product Design and Development Process.

UNIT III DESIGN ENGINEERING 9

Hardware Design, Hardware Risk Analysis, Design and Project Metrics, Design for Six Sigma, Software Design, Software Coding, Software Risk Analysis, Software Metrics.

UNIT IV TESTING AND VALIDATION 9

Basis and Types of Testing, Hardware Verification and Data Analysis, Software Verification and Data Analysis.

UNIT V DESIGN TRANSFER AND MANUFACTURING 9

Transfer to Manufacturing, Hardware Manufacturing, Software Manufacturing, Configuration Management, Intellectual Property-Copy Rights-Trademarks-Trade Secrets. Case Study.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Define the medical devices standards and requirements.
2. Summarise the concept of medical device development.
3. Recall the engineering design and project metrics.
4. Demonstrate the testing and validation of medical equipment.
5. Interpret the various design transfer and manufacturing methods.

Text Books:

1. Zenios, Makower and Yock, ―Biodesign – The process of innovating medical technologies, Cambridge University Press, 2009

2. Theodore R. Kucklick , The Medical Device R&D Handbook, Second Edition, CRC Press, 2012

3. Peter Ogrodnik,Medical Device Design Innovation from Concept to Market, Elsevier, 2013

Reference Books:

1. Richard C. Fries and Marcel Dekker AG, Handbook of Medical Device Design,2ndedition, 2005.

2. Gail Baura, Medical Device Technologies: A Systems Based Overview Using Engineering, Elsevier science, 2012.

3. Matthew Bret Weinger, Michael E. Wiklund, Daryle Jean Gardner-Bonneau‘Handbook of Human Factors in Medical Device Design‘,CRC press,2010.

4. Jagdish Chaturvedi, Inventing medical devices: A perspective from India, Create Space Independent Publishing Platform, 1st edition, 2015.

		L	T	P	C
22PBM44	**PATIENT SAFETY, STANDARDS AND ETHICS**	**3**	**0**	**0**	**3**

Course Objectives:

1. To understand the importance of patient safety against electrical hazards
2. To explain the patient safety laws and regulations
3. To understand the standards and testing of patient
4. To know the patient safety specialities in clinical
5. To know about the health care organization

Course Content:

UNIT I EFFECTS OF ELECTRICITY 9

Physiological effects of electricity - important susceptibility parameters - microshock - macroshock hazards -patients electrical environment - isolated power system - conductive surfaces

UNIT II PATIENT SAFETY LAWS AND REGULATIONS 9

Mandatory Reporting systems. Anatomy of a patient safety Law: Compliance Tips, Federal patient safety Legislation Initiatives, Medical Device Reporting, Clinical trials and Adverse-Event 110 Reporting, Patient safety Goals and standards, The Quality Assessment and performance Improvement rule.

UNIT III STANDARDS AND TESTING 9

Guidelines and safety practices to improve patient safety, Electrical safety codes and standards - IEC 60601-1 2005 standard, Basic Approaches to protection against shock, protection equipment design, Electrical safety analyser - Testing the electric system

UNIT IV PATIENT SAFETY IN MAIN CLINICAL SPECIALITIES 9

Intensive care and Anesthesiology, safety surgery save lives, Emergency department clinical risk, Obstetric safety patient, Patient safety in internal medicine, Patient safety in Radiology.

UNIT V MEDICAL ETHICS 9

Definition of Medical ethics, Scope of ethics in medicine, American medical Association code of ethics, CMA code of ethics- Fundamental Responsibilities, The Doctor and The Patient, The Doctor and The Profession, Professional Independence, The Doctor And Society, Case Studies.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Outline the importance of patient safety against electrical hazards.
2. Brief out the patient safety laws and regulations.
3. Explain the standards and testing of patient
4. Understand the concept of the patient safety specialities in clinical Setting
5. know about various health care organization

Text Books:

1. John G.Webster, “Medical Instrumentation Application and design”, 4th edition, Wiley India PvtLtd, New Delhi, 2015.
2. Liam Donaldson,Walter Ricciardi, “Textbook of patient safety and clinical Risk management”, Springer.

Reference Books:

1. Fay A. Rozovsky, James R. Woods, Jr, “ The Handbook of Patient Safety Compliance”, 2016

22PBM45	MEDICAL DEVICE REGULATIONS	L	T	P	C
		3	0	0	3

Course Objectives:

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

Course Content:

UNIT I MEDICAL DEVICE REGULATIONS 9

History of medical device regulation, regulatory affairs professional's roles, required competencies, medical device classification: scope, definitions, main classifications, Risk based classification, practical examples, labeling of medical devices: definition, elements, risk management, clinical evaluation and labeling, language level and intended users. differentiating medical devices IVDs and combination products from that of pharmaceuticals.

UNIT II ISO STANDARDS 9

ISO 13485:2016: Requirements for regulatory purposes: Quality Management Systems, certification process. ISO 14971: Application of Risk management to medical Devices.

UNIT III IEC, REGULATORY SYSTEMS IN USA & EU 9

IEC international standards and conformity assessment for medical devices, Good submission process, medical device regulatory system in the USA and European Union.

UNIT IV INDIAN REGULATORY SYSTEM 9

India: Medical device regulatory system: market environment, functions undertaken by DGGI, central government, FDA and state governments, guidance documents, details of key regulators, IMDRF and CDSCO, regulatory overview in India, product registration on conformity assessment, quality system regulation, technical material and labeling requirements, commercial aspects, upcoming regulation changes.

UNIT V CLINICAL TRIALS AND DIGITAL REGULATIONS 9

Regulatory strategy and competitive advantage, Preclinical and Clinical Trial Design for Medical Devices in India; FDA approved devices, post-market surveillance/vigilance, Digital health regulations: Connected care, intelligent design control, reducing design time and cost with in-silico clinical trials.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Define and explain the basic concepts of medical device regulations.
2. Decipher the meaning of ISO standards from a regulatory perspective.

3. Explain US-FDA, IEC and European regulations.
4. Understand Discuss regulations in India
5. Explain the regulatory aspects of clinical trials and digital alternatives

Text Books:

1. Medical Regulatory Affairs: An International Handbook for Medical Devices and Healthcare Products, 3rd Edition, Taylor & Francis Group, 2021

Reference Books:

1. Reliable Design of Medical Devices, Second Edition by Richard Fries, CRC Press, 2006
2. Medical Device Quality Assurance and Regulatory Compliance by Richard C Fries, CRC Press, 1998.
3. Product Safety in the European Union by GaborCzitan, Attila Gutassy, Ralf Wilde, TUV Rheinland Akademia, 2008.

Online Resources:

1. Regulatory requirements for medical devices including in vitro diagnostics in India (Version 2.0), IIT Madras, Prof. Arun B.Ramteke, Prof. Aseem Sahu, Prof. Malay Mitra. https://nptel.ac.in/courses/127106136

2. World Health Organization. (2003). Medical device regulations : global overview and guiding principles. World Health Organization. https://apps.who.int/iris/handle/10665/42744

3. Food And Drug Administration USA,

22PBM46	**MEDICAL INNOVATION AND ENTREPRENEURSHIP**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. To learn fundamentals of entrepreneurship
2. To apply the methods of entrepreneurship in medical field
3. To evaluate the medical devices and market trends

Course Content:

UNIT I CREATIVITY, INNOVATION AND IPR 9

The role of creativity – The innovation Process – Sources of New Ideas – Methods of Generating Ideas – Creative Problem Solving – Entrepreneurial Process. Patents – Copyright - Trademark- Geographical indications – Ethical and social responsibility and challenges.

UNIT II SCOPE FOR BIOMEDICAL ENGINEERING ENTREPRENEURSHIP 9

Definition– Characteristics and Functions of an Entrepreneur – Common myths about entrepreneurs. Fundamentals and models, Advancements in biomedical field, Supporting societies and professional activities. Impact of innovation in medical devices. Case study.

UNIT III NEW VENTURE 9

Developing an Effective Business Model: The Importance of Business Model – Starting a small-scale industry - Components of an Effective Business Model. Assessing the venture, establish venture invention, market research, presenting the business plan. Forms of Business Organization: Sole Proprietorship – Partnership – Limited liability partnership - Joint Stock Companies and Cooperatives. Case study**.**

UNIT IV FINANCING THE NEW VENTURE AND GLOBALIZATION 9

Evaluating Various options and future investments – Medical Device entrepreneurship incentives and subsidies – Determining Financial Needs – Sources of Financing: support for product development, funding agencies, collaborative initiatives, and angel investors. Impact of Globalization: Medical product manufacturing, marketing, leadership, quality management. Case studies.

UNIT V MARKETING FUNCTION 9

Industry Analysis – Competitor Analysis – Marketing Research for the New Venture – Defining the Purpose or Objectives – Gathering Data from Secondary Sources – Gathering Information from Primary Sources – Analyzing and Interpreting the Results – The Marketing Process. Case study.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Describe the role of biomedical engineers in entrepreneurship.
2. Interpret the background for biomedical engineers in entrepreneurship.
3. Acquire the skills and techniques required towards innovation.
4. Categorize the resources and funding agencies and judge the right product based on market needs
5. Explain the regulatory aspects of clinical trials and digital alternatives

Text Books:

1. Jen-Shih Lee “Biomedical Engineering Entrepreneurship”, World Scientific Publishing, USA. 2010
2. Vasant Desai, ―The Dynamics of Entrepreneurial Development and Management‖, Himalaya Publishing House, 2010.

Reference Books:

1. Brant Cooper, Patrick Vlaskovits, “The Lean Entrepreneur”, Wiley, 2nd edition, New Jersy, 2016.
2. Nathan Furr, Jeff Dyer, “The Innovator's Method: Bringing the Lean Start-up into Your Organization”, Harvard Business Press, Boston, 2014.
3. Donald F.Kuratko and Richard M. Hodgetts, “Entrepreneurship”, South-Western.
4. Gupta S.L., Arun Mittal, “Entrepreneurship Development”, International Book House, 2012.
5. Prasanna Chandra, “Projects- Planning, Analysis, Financing, Implementation and review‖, TATA McGraw Hill, 2012.
6. Sudha G. S., “Management and Entrepreneurship Development”, Indus Valley Publication, 2009.

22PBM47 RAPID PROTOTYPING

	L	T	P	C
	3	**0**	**0**	**3**

Course Objectives:

1. Learn the need and fundamentals of rapid prototyping
2. Understand the concepts of design and assembling of various parts
3. Study the process and material selection for UV and Laser based AM
4. Investigate the process of fused deposition moulding and sheet lamination
5. Explore droplet formation and beam deposition process

Course Content:

UNIT I INTRODUCTION 9

Overview –Need -Development of Additive Manufacturing Technology -Principle – AM Process Chain-Classification –Rapid Prototyping-Rapid Tooling –Rapid Manufacturing – Applications- Benefits –Case studies.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9

Design tools: Data processing -CAD model preparation –Part orientation and support structure generation –Model slicing –Tool path generation-Design for Additive Manufacturing: Concepts and objectives-AM unique capabilities –DFAM for part quality improvement-Customised design and fabrication for medical applications.

UNIT III PHOTO POLYMERIZATION AND POWDER BED FUSION PROCESSES 9

Photo polymerization: SLA-Photo curable materials –Process -Advantages and Applications. Powder Bed Fusion: SLS-Process description –powder fusion mechanism –Process Parameters – Typical Materials and Application. Electron Beam Melting.

UNIT IV EXTRUSION BASED AND SHEET LAMINATION PROCESSES 9

Extrusion Based System: FDM-Introduction –Basic Principle –Materials –Applications and Limitations –Bio extrusion. Sheet Lamination Process: LOM-Gluing or Adhesive bonding –Thermal bonding.

UNIT V PRINTING PROCESSES AND BEAM DEPOSITION PROCESSES 9

Droplet formation technologies –Continuous mode –Drop on Demand mode –Three Dimensional Printing –Advantages –Bioplotter -Beam Deposition Process: LENS-Process description –Material delivery –Process parameters –Materials –Benefits –Applications.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Demonstrate the basics of Additive manufacturing.
2. Design and assembly of various parts for the desired task.
3. Explain the process involved in laser and UV based AM.
4. Illustrate the process of fused deposition moulding and sheet lamination
5. Support design and manufacturing, case studies relevant to mass customized manufacturing, and some of the important research challenges associated with AM and its data processing tools.

Text Books:

1. Chua C.K., Leong K.F., and Lim C.S., Rapid prototyping: Principles and applications, World Scientific Publishers, Third edition, 2010.
2. Liou L.W. and Liou F.W., Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press, 2007.
3. Kamrani A.K. and Nasr E.A., Rapid Prototyping: Theory and practice, Springer, 2006

Reference Books:

1. Ian Gibson, David W.Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.
2. Tom Page Design for Additive Manufacturing, LAP Lambert Academic Publishing, 2012.
3. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.

22PBM48	**CLINICAL ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. This course will provide a basic understanding of the clinical engineering profession, qualifications, roles, activities, and expectations.
2. This course will enhance students to practice medical equipment and analyze challenges with their healthcare technology.
3. This course will engage the students to work as a team to address problems and errors in medical devices.
4. This course will help students to design better medical devices with computerized approaches.
5. This course will expose students to explore the Health Technology Management systems with medical devices and supportive services with advanced application.

Course Content:

UNIT I INTRODUCTION 9

Clinical engineering: Definition, Evolution, Role, Responsibilities, Functional status, History of clinical engineering and Technology in Health Care System, Enhancing patient safety.

UNIT II MEDICAL TECHNOLOGY MANAGEMENT PRACTICES 9

Strategic Medical Technology Planning, Scope , Clinical necessity operational support, strategic planning process – Technology assessment: Technology audit, Budget strategies, Prerequist for medical technology assessment – Management Practice for Medical Equipment - Device evaluation, Risk reduction, Asset management, ESHTA.

UNIT III ESSENTIAL HEALTH CARE TECHNOLOGY PACKAGE (EHTP) 9

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 CLINICAL ENGINEERING PROGRAM INDICATOR 9

Clinical engineering: program services, Program database – Clinical Engineering Program management, Program indicator, Managing clinical engineering performance using program indicators – Indicator management process.

UNIT V ADVANCED TECHNOLOGY FOR PATIENT SAFETY 9

Factors Contributing to Medical Errors: Heath 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 LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. State the role of clinical engineers and discuss the basic concepts of medical and healthcare technology
2. Give the program and framework to recognize the errors of medical equipment
3. State the issues or errors in patient safety and formulate patient safety package system
4. Define the problem precisely and examine the possible issues using program indicators.
5. Demonstrate computer based equipment with automated system by using CPOE method.

Text Books:

1. Ernesto Iadanza, Joseph Dyro, "Clinical Engineering Handbook", Elsevier Academic Press, 2014

Reference Books:

1. Robert Miniati, "Clinical Engineering from Devices to Systems", Academic Press, 23-Dec- 2015 - Technology & Engineering

		L	T	P	C
22PBM49	**HOSPITAL PLANNING AND MANAGEMENT**	**3**	**0**	**0**	**3**

Course Objectives:

1. 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
2. The student should be made to understand the principles, practices and areas of application in Hospital management.

Course Content:

UNIT I OVERVIEW OF HOSPITAL ADMINISTRATION 9

Distinction between Hospital and Industry, Challenges in Hospital Administration –Hospital Planning – Equipment Planning- AMC – Functional Planning - Current Issues in Hospital Management - Telemedicine - Bio-Medical Waste Management

UNIT II HUMAN RESOURCE MANAGEMENT IN HOSPITAL 9

Principles of HRM – Functions of HRM – Profile of HRD Manager – Tools of HRD –Human Resource Inventory – Manpower Planning. Different Departments of Hospital, Recruitment, Selection, Training Guidelines –Methods of Training – Evaluation of Training – Leadership grooming and Training, Promotion – Transfer.

UNIT III MARKETING RESEARCH & CONSUMER BEHAVIOUR 9

Marketing information systems - assessing information needs, developing & disseminating information - Market Research process - Other market research considerations - Consumer Markets & Consumer Buyer behaviour - Model of consumer behaviour - Types of buying decision behaviour - The buyer decision process - Model of business buyer behaviour - Major types of buying situations - global marketing in the medical sector - WTO and its implications.

UNIT IV HOSPITAL INFORMATION SYSTEMS & SUPPORTIVE SERVICES 9

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

UNIT V QUALITY AND SAFETY ASPECTS IN HOSPITAL 9

Quality system – Elements, implementation of quality system, Documentation, Quality auditing, International Standards ISO 9000 – 9004 – Features of ISO 9001 – ISO 14000 – ISO 13485, Environment Management Systems. NABA, JCI, NABL, NABH. Security – Loss Prevention – Fire Safety – Alarm System – Safety Rules. Health Insurance & Managing Health Care - Medical Audit – Hazard and Safety in a hospital Setup.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Explain the principles, practices and areas of application in Hospital Management.
2. Understand the biomedical waste disposal concept.
3. Explain the importance of supportive services.
4. Comprehend the quality aspect specified by the international standards.
5. Knowledge on Hospital safety.

Text Books:

1. R.C.Goyal, "Hospital Administration and Human Resource Management", PHI–4th Edition,2006.
2. G.D.Kunders, "Hospitals – Facilities Planning and Management", TMH, New Delhi – 5th edition Reprint 2007.
3. Cesar A.Caceres and Albert Zara, "The Practice of Clinical Engineering", Academic Press, New York,1977

Reference Books:

1. Peter Berman, "Health Sector Reform in Developing Countries", Harvard University Press, 1995.
2. Norman Metzger , "Handbook of Health Care Human Resources Management", Aspen Publication Inc. Rockville, Maryland, USA, 2nd Edition 1990.

3. Arnold D. Kalcizony & Stephen M.Shortell, “Health Care Management”, 6th Edition, 2011.
4. Blane, David, Brunner, Eric , “Health and Social organization: Towards a health policy for the 21st century”, Calrendon Press, 1994.

22PBM14	MEDICAL WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives:

1. Understand the hazardous materials used in hospital and its impact on health
2. Understand various waste disposal procedures and management.

Course Content:

UNIT I HEALTHCARE HAZARD CONTROL AND UNDERSTANDING ACCIDENTS 9

Healthcare Hazard Control : Introduction, Hazard Control, Hazard Control Management, Hazard Control Responsibilities, Addressing Behaviors, Hazard Control Practice, Understanding Hazards, Hazard Analysis, Hazard Control and Correction, Personal Protective Equipment, Hazard Control Committees, Hazard Control Evaluation, Hazards, System Safety, Ergonomics. Understanding Accidents: Accident Causation Theories, Human Factors, Accident Deviation Models, Accident Reporting, Accident Investigations, Accident Analysis, Organizational Functions That Support Accident Prevention, Workers’ Compensation, Orientation, Education, and Training.

UNIT II BIOMEDICAL WASTE MANAGEMENT 9

Biomedical Waste Management : Types of wastes, major and minor sources of biomedical waste, Categories and classification of biomedical waste, hazard of biomedical waste, need for disposal of biomedical waste, waste minimization, waste segregation and labeling, waste handling, collection, storage and transportation, treatment and disposal.

UNIT III HAZARDOUS MATERIALS 9

Hazardous Materials : Hazardous Substance Safety, OSHA Hazard Communication Standard, DOT Hazardous Material Regulations, Healthcare Hazardous Materials, Medical Gas Systems, Hazardous Waste Operations and Emergency Response Standard, Respiratory Protection.

UNIT IV FACILITY SAFETY 9

Facility Safety : Introduction, Facility Guidelines Institute, Administrative Area Safety, Slip, Trip, and Fall Prevention, Safety Signs, Colors, and Marking Requirements, Scaffolding, Fall Protection, Tool Safety, Machine Guarding, Compressed Air Safety, Electrical Safety, Control of Hazardous Energy, Permit Confined Spaces, OSHA Hearing Conservation Standard, Heating, Ventilating, and Air-Conditioning Systems, Assessing IAQ, Landscape and Grounds Maintenance, Fleet and Vehicle Safety.

UNIT V INFECTION CONTROL, PREVENTION AND PATIENT SAFETY 9

Healthcare Immunizations, Centers for Disease Control and Prevention, Disinfectants, Sterilants, and Antiseptics, OSHA Bloodborne Pathogens Standard, Tuberculosis, Healthcare Opportunistic Infections, Medical Waste. Patient Safety: An Organizational Function, Errors and Adverse Events, Safety Cultures, Patient-Centered Healthcare, Quality Improvement Tools and Strategies, Healthcare-Associated Infections, Medication Safety.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Analyze various hazards, accidents and its control.
2. Design waste disposal procedures for different biowastes.
3. Categorize different biowastes based on its properties.
4. Design different safety facility in hospitals.
5. Propose various regulations and safety norms.

Text Books:

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

Reference Books:

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

22PBM50	ECONOMICS AND MANAGEMENT FOR ENGINEERS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the concepts of Economics with respect to the demand and supply analysis.
2. To analyze the theory of production and the analysis of the cost parameter by using the Elasticity.
3. To manage and plan the situation with the help of the available strategies to support the decision making process.

Course Content:

UNIT I INTRODUCTION TO ECONOMICS 9

Introduction to Economics – Scope of Economics – Positive and Normative Science – Methodology of Economics – Economic Laws - Economy and its basic problems: Economy and its working – Kinds of economy systems – Basic problems of economy.

UNIT II DEMAND AND SUPPLY ANALYSIS 9

The Law of Demand – The Law of Supply – Elasticities of Demand and Supply: Price Elasticity of Demand - Price Elasticity and Consumption Expenditure- Cross Elasticity of Demand – Income Elasticity of Demand – The Elasticity of Price Expectations – The uses of Elasticity– Price Elasticity of Supply.

UNIT III THEORY OF PRODUCTION AND ANALYSIS OF COST 9

Meaning of Production – Production concepts – Production Function – Laws of Production – Cost Concepts - Short-Run Cost Output Relations – Long Run Cost output relations – Economics of Scale.

UNIT IV INTRODUCTION TO MANAGEMENT **9**

Management: Overview – Management Defined – Managerial skills – Managerial roles – Management responsibilities – Management functions. Evolution of Management: Classical approaches to Management – Contemporary Management Perspectives

UNIT V PLANNING **9**

Planning and Forecasting: Importance of Planning – Principles of effective Planning – Planning process – Types of Plans. Strategic Planning: Strategic Planning process – Rational decision making.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Summarize how to solve economics principles to solve economic problems in engineering discipline by satisfying the economic laws.
2. Discuss the demand and supply process for a market analysis using Price elasticity, Cross elasticity and Income elasticity.
3. Interpret short run and long run costs in the process of production for carrying out a business.
4. Apply managerial skills to make decisions and solve problems for achieving organizational objectives.
5. Express the principles of effective planning for survival and success of all organizations using standing and single use planning methods.

Text Books:

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

Reference Books:

1. Ranbir Singh, "Principles of Engineering Economics and Management", S.K.Kataria & Sons, New Delhi, 2013.
2. Manish Varshney and Vidhan Banerjee, "Engineering and Managerial Economics", First Edition, CBS Publishers and Distributors Pvt. Ltd., 2015.

22PBM51	**BIOSTATISTICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. Understand the statistical methods for the data.
2. Comprehend the fundamental of mathematical and statistical theory in the application of biomedical field.
3. Apply the regression and correlation analyze in the physiological data.
4. Understand the source of Medical data
5. Understand the Visual analytics of Healthcare data.

Course Content:

UNIT I INTRODUCTION 9

Introduction, Some basic concepts, Measurement and Measurement Scales, Simple random sample, Computers and medical data analysis, Introduction to probability, likelihood & odds, distribution variability.

UNIT II STATISTICAL PARAMETERS 9

Statistical parameters p-values, computation, level chi square test and distribution and hypothesis testing - single population proportion, difference between two population proportions, single population variance, ratio of two population variances and tests of goodness of fit, tests of independence, tests of homogeneity.

UNIT III REGRESSION AND CORRELATION ANALYSIS 9

Introduction, regression model, sample regression equation, evaluating the regression equation, using the regression equation, correlation model, correlation coefficient.

UNIT IV INTERPRETING DATA 9

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

UNIT V ANALYSIS OF VARIANCE 9

META analysis for research activities, purpose and reading of META analysis, kind of data used for META analysis, completely randomized design, randomized complete block design, repeated measures design, factorial experiment.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Define the new and existing statistical methodology for their research problem.
2. Discuss the demand and supply process for a market analysis using Price elasticity, Cross elasticity and Income elasticity.
3. Interpret short run and long run costs in the process of production for carrying out a business.
4. Apply managerial skills to make decisions and solve problems for achieving organizational objectives.
5. Express the principles of effective planning for survival and success of all organizations using standing and single use planning methods.

Text Books:

1. Wayne W. Daniel, Biostatistics-A Foundation for Analysis in the Health Sciences, John Wiley & Sons Publication, 10th Edition, 2013.
2. Peter Armotage, Geoffrey Berry and J.N.S.Mathews, Statistical methods in Medical Research, Wiley-Blackwell, 4th Edition, 2001.
3. Bernard Rosner. Fundamentals of biostatistics. Nelson Education, 8th Edition 2015 ISBN: 978-1-305-26892-0
4. Editors: Chandan K. Reddy, Charu C. Agarwal, Healthcare Data Analytics, CRC Press,

Reference Books:

1. Marcello Pagano and Kimberlee Gauvreu, Principles of Biostatistics, Chapman and Hall/CRC, 2ndEdition, 2018.
2. Ronald N Forthofer and EunSul Lee, Introduction to Biostatistics, Academic Press, 1st Edition, 2014.
3. Animesh K. Dutta, Basic Biostatistics and its Applications, New Central Book Agency, 1st Edition, 2006.

Online Resources:

1. https://nptel.ac.in/courses/106/107/106107220/
2. https://onlinecourses.nptel.ac.in/noc21_cs45/preview

22PBM52	**FORENSIC SCIENCE IN HEALTHCARE**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. The history of the forensic sciences and its place in popular culture
2. The roles of different types of professionals involved in evaluating a crime scene and the collected evidence
3. forensic microscope and Anthropology
4. The Blood stain identification
5. The methodology of collecting & interpreting data for fingerprint application.

Course Content:

UNIT I BASICS OF FORENSIC SCIENCE 9

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

UNIT II OBSERVATION AND CRIME SCENE 9

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

UNIT III FORENSIC MICROSCOPE AND ANTHROPOLOGY 9

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

UNIT IV BLOOD STAIN IDENTIFICATION 9

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

UNIT V FINGERPRINT APPLICATION 9

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

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Define the significance of forensic sciences.
2. Observe and document crime scenes**.**
3. Determine Trauma and Diseases.
4. Describe the various sources of medical data related to forensic science.
5. Demonstrate the visual analytical procedure of finger print application.

Text Books:

1. Nanda, B.B. and Tewari, R.K. (2001) Forensic Science in India: A vision for the twenty first century Select Publisher, New Delhi.
2. James, S.H and Nordby, J.J. (2003) Forensic Science: An introduction to scientific and investigative techniques CRC Press,

Reference Books:

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

22PBM53	REHABILITATION ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

The objective of this course is to enable the student to

1. Explain the need for medical aids.
2. Understand the sensory rehabilitation systems.
3. Learn the use of orthopedic prosthetics and orthotics in rehabilitation.
4. Understand virtual reality in rehabilitation
5. Have an understanding of rehabilitation medicine and advocacy.

Course Content:

UNIT I INTRODUCTION TO REHABILITATION 9

Definition - Impairments, disabilities and handicaps, Primary and secondary disabilities, Activities of daily living, Appropriate Technology, Residual function. Rehabilitation. Rehabilitation team – members and their functions. Rehabilitation care –Need for proper delivery of rehabilitation care, Community based rehabilitation and its aspects.

UNIT II ENGINEERING CONCEPTS IN SENSORY AUGMENTATION AND SUBSTITUTION 9

Sensory augmentation and substitution- Visual system: Visual augmentation, Tactual vision substitution, and Auditory vision substitution. Auditory system- Auditory augmentation, Hearing aids, cochlear implants, visual auditory substitution, tactual auditory substitution. Tactual system - Tactual augmentation, Tactual substitution.

UNIT III ORTHOPEDIC PROSTHETICS AND ORTHOTICS 9

Engineering concepts in motor rehabilitation, Artificial limbs- body powered, externally powered and controlled orthotics and prosthetics, Myoelectric hand and arm prosthetics. Functional Electrical Stimulation systems-Restoration of hand function, restoration of standing and walking, Hybrid Assistive Systems (HAS).

UNIT IV VIRTUAL REALITY 9

Introduction to virtual reality, Virtual reality based rehabilitation, Hand motor recovery systems with Phantom haptics, Robotics and Virtual Reality Applications in Mobility Rehabilitation.

UNIT V REHABILITATION MEDICINE AND ADVOCACY 9

Physiological aspects of Function recovery, Psychological aspects of Rehabilitation therapy, Legal aspect available in choosing the device and provision available in education, job and in day-to-day life.

TOTAL LECTURE PERIODS 45 Periods

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

1. Summarize the key terminologies used by the rehabilitation team.

2. Illustrate Engineering Concepts in Sensory & Motor rehabilitation.
3. Design different orthotics and prosthetics for rehabilitation applications.
4. Summarize the need of virtual reality tools for different aids.
5. Appraise the legal aspects for building rehabilitation aids for the needed people.

Text books:

1. Joseph D Bronzino, "The Biomedical Engineering Handbook". 2nd edition, CRC Press, 2000.
2. Robinson C.J, "Rehabilitation Engineering", CRC Press, 2006.

References:

1. Sashi S Kommu, "Rehabilitation Robotics", 1st edition, CRC Press, 2007.
2. Sunder, "Textbooks of Rehabilitation", Jaypee Brothers Medical Publishers Pvt. Ltd, New Delhi, 2nd Edition, Reprint 2007.
3. Horia- Nocholai Teodorecu, L.C.Jain, "Intelligent systems and technologies in rehabilitation Engineering", CRC; December 2000
4. Etienne Grandjean, Harold Oldroyd, "Fitting the task to the man", Taylor & Francis, 1988.
5. Keswick. J., "What is Rehabilitation Engineering, Annual Reviews of Rehabilitation", Springer Verlag, New York, 1982.
6. Warren E. Finn, Peter G. Lopressor, "Handbook of Neuroprosthetic Methods",CRC, 2002.
7. Roy A Cooper (Editor), Hisaichi Ohnabe (Editor), Douglas A. Hobson (Editor), "An Introduction to Rehabilitation Engineering (Series in Medical Physics and Biomedical Engineering" CRC Press, 2000

22PBM54	PHYSIOLOGICAL MODELLING	L	T	P	C
		3	0	0	3

Course Objectives: The student should be made to:

1. To explain the application of Physiological models and vital organs.
2. To Formulate the methods and techniques for analysis and synthesis of dynamic models
3. To describe the dynamic models, simulate and visualize, dynamic responses of physiological models using software.
4. To describe nonlinear models of physiological systems
5. To compute the Simulation of physiological systems

Course Content:

UNIT I INTRODUCTION TO PHYSIOLOGICAL MODELING 9

Approaches to modelling: The technique of mathematical modelling, classification of models, characteristics of models. Time invariant and time varying systems for physiological modelling. Introduction to physiology (homeostasis, cell biology) Modelling physical systems, linear models of physiological systems, the Laplace transform, Transfer functions and block diagram analysis Physiology

UNIT II MODELING OF DYNAMIC PHYSIOLOGICAL SYSTEM 9

Dynamic systems and their control, modelling and block diagrams, the pupil control systems(Human Eye), general structure of control systems, the dynamic response characteristics of the pupil control system, open &close loop systems instability, automatic aperture control..

UNIT III NONLINEAR MODELS OF PHYSIOLOGICAL SYSTEMS 9

Nonparametric Modelling-Volterra Models. Wiener Models. Efficient Volterra Kernel Estimation. Parametric Modelling - Basic Parametric Model Forms and Estimation Procedures- Volterra Kernels of Nonlinear Differential Equations. Discrete-Time Volterra Kernels of NARMAX Models.

UNIT IV COMPARTMENTENTAL PHYSIOLOGICAL MODEL 9

Modeling the body as compartments, behaviour in simple compartmental system, pharmacokinetic model, and multi compartmental system. Physiological modelling: Electrical analogy of blood vessels, model of systematic blood flow and model of coronary circulation. Mathematical modelling of the system: Thermo regulation, Thermoregulation of cold bloodedness& warm bloodedness, the anatomy of thermo regulation, lumping & partial differential equations, heat transfer examples, mathematical model of the controlled process of the body.

UNIT V SIMULATION OF PHYSIOLOGICALSYSTEMS 9

Simulation of physiological systems using Open CV / MATLAB software. Biological receptors: - Introduction, receptor characteristics, transfer function models of receptors, receptor and perceived intensity. Neuromuscular model, Renal System, Drug Delivery Model.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On successful completion of this course, the student will be able to

1. Explain the application of Physiological models
2. Describe the methods and techniques for analysis and synthesis of Linear and dynamic system
3. Develop differential equations to describe the compartmental physiological model
4. Describe Nonlinear models of physiological systems
5. Illustrate the Simulation of physiological systems

TEXT BOOKS:

1. Michel C Khoo, "Physiological Control Systems -Analysis, simulation and estimation", Prentice Hall of India, 2001.
2. Marmarelis, "Nonlinear Dynamic Modeling of Physiological Systems", Wiley-IEEE Press,2004

Reference Books:

1. Benjamin C Kuo, "Automatic control systems", Tenth Edition, McGraw-Hill Education, 2017.

2. MinruiFei, Shiwei Ma, Xin Li, Xin Sun, Li Jia and Zhou Su,"Advanced Computational Methods in Life System Modeling and Simulation", Springer,2017

3. David T Westwick, Robert E. Kearney, Identification of Nonlinear Physiological Systems, Wiley-IEEE Press, 2003.

22PBM55	ASSISTIVE TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives: The student should be made to:

1. To know the hardware requirement various assistive devices To understand the prosthetic and orthotic devices
2. To know the developments in assistive technology

Course Content:

UNIT I CARDIAC ASSIST DEVICES 9

Principle of External counter pulsation techniques, intra aortic balloon pump, Auxillary ventricle and schematic for temporary bypass of left ventricle, prosthetic heart valves..

UNIT II HEMODIALYSERS 9

Artificial kidney, Dialysis action, hemodialyser unit, membrane dialysis, portable dialyser monitoring and functional parameters.

UNIT III HEARING AIDS 10

Common tests – audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids – principles, drawbacks in the conventional unit, DSP based hearing aids.

UNIT IV PROSTHETIC AND ORTHODIC DEVICES 9

Hand and arm replacement – different types of models, externally powered limb prosthesis, feedback in orthodic system, functional electrical stimulation, sensory assist devices.

UNIT V RECENT TRENDS 8

Transcutaneous electrical nerve stimulator, bio-feedback

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: At the end of the course the student will be able to:

1. Interpret the various mechanical techniques that will help in assisting the heart functions.
2. Describe the underlying principles of hemodialyzer machine.
3. Indicate the methodologies to assess the hearing loss.

4. Evaluate the types of assistive devices for mobilization.
5. Explain about TENS and biofeedback system

TEXT BOOKS

1. Joseph D. Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press,2006
2. Marion. A. Hersh, Michael A. Johnson,Assistive Technology for visually impaired and blind,Springer Science & Business Media, 1st edition, 12-May-2010
3. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, CRC Press, 1st edition,2010.

Reference Books:

1. 1.Kenneth J. Turner Advances in Home Care Technologies: Results of the match Project, Springer, 1stedition, 2011.
2. Gerr M. Craddock Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003.
3. 3D Printing in Orthopaedic Surgery, Matthew Dipaola , Elsevier 2019 ISBN 978 -0-323- 662116
4. Cardiac Assist Devices, Daniel Goldstein (Editor), Mehmet Oz (Editor), Wiley-Blackwell April 2000 ISBN: 978-0-879-93449-1

22PBM56	ERGONOMICS	L	T	P	C
		3	0	0	3

Course Objectives: The student should be made to:

1. To get exposed to principles of visual capabilities.
2. To learn the mechanics of muscle physiology and significance of rest cycle.
3. To learn spatial compatibility and the relation between control orders and control response.
4. To know about the measurements and proportions of the human body.
5. To be familiar with the mathematical models, analysis and design of biomedical devices using case studies.

Course Content:

UNIT I VISUAL AND AUDITORY ERGONOMICS 9

Process of seeing – visual capabilities – factors affecting visual acuity and contrast sensitivity – human factor aspects of hard copy text and computer screen text, factors in selecting graphic representations symbols, qualitative visual display – process of hearing – principles of auditory display. Measures for monitoring control & mitigation.

UNIT II MUSCLE PHYSIOLOGY 9

Muscle physiology – muscle metabolism – respiratory response – joint motion study – measure of physiological in-efficiency and energy consumption – work rest cycles – aspects of manual and posture study, material handling (MMH) Bio-mechanical recommended limits of MMH.

UNIT III CONTROLS AND DISPLAYS 9

Spatial compatibility and physical arrangement of displays and controls - Design of displays and controls – movement capability – rotary controls and rotor displays movement of displays orientation of the operator and movement relationships control orders and control responses – human limitations in tracking task.

UNIT IV ANTHROPOMETRY 9

Anthropometry – anthropometric design principles – Physical work load and energy expenditure - work space envelope – factors in design of work space surfaces – principles of seat design – principles of control panel. ergonomic implications. Organization classification of human errors theories of accident causation-reducing accidents by altering behavior.

UNIT V CASE STUDIES 9

Case Study 1: computer design, control panel design of an electronic instrument, computer key board, hand drill etc. Case Study 2: Biomedical Application, Design optimization of Medical Equipment.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: At the end of the course student will be able to

1. Understand principles of ergonomics.
2. Understand the significance of posture
3. Learn about tracking tasks.
4. Learn about ergonomics and its implications to various domain
5. Perform case studies on electronic instruments and medical equipment.

TEXT BOOKS

1. Pascale Carayon, "Handbook of Human Factors and Engineering", Second Edition, CRC Press, 2011
2. Martin Helander, "Guide to Human Factors and Ergonomics", Second Edition, CRC Press,2005
3. Benjamin W.Niebel, "Motion and Time Study", Richard, D. Irwin Inc., Seventh Edition, 2002

Reference Books:

1. Shrawan Kumar, Biomechanics in Ergonomics, Second Edition, CRC Press2007.

2. George Kanawaty, “Introduction to work study”, ILO, 3rd edition, Oxford & IBH publishing, 2001
3. Stephen Pheasant, Christine M. Haslegrave, Bodyspace: Anthropometry, Ergonomics and the Design of Work, CRC Press, 2005.

22PBM57	**HAPTICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives: The objective of this course is to enable the student to

1. Expose to basic principles of Haptics and their property.
2. Give knowledge on machines in haptics.
3. Learn types of sensors and actuators.
4. Understand basic concepts of human locomotion, biomechanical analysis using Finite Element Analysis.

Course Content:

UNIT I HUMAN HAPTICS 9

Somatosensory System; Motor System, Muscle Physiology; Haptics Psychophysical experiments.

UNIT II MACHINE HAPTICS 9

Design Haptic devices; Human factors involved;

UNIT III HAPTIC SENSORS AND ACTUATORS 9

barriers in human haptics; Ergonomics

UNIT IV COMPUTATIONAL HAPTICS 9

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

UNIT V HAPTICS FOR MEDICAL APPLICATIONS 9

Applications: Telemedicine; Rehabilitation; Medical Simulations for education

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On successful completion of this course, the student will be able to

1. Explain the laws of principles of haptics for human
2. Discuss the behavior of machines in haptics
3. Analyse the suitable sensor and actuator for haptics
4. Identify suitable computation for haptics
5. Describe the finite element analysis, design the work station depending upon the haptics

TEXT BOOKS

1. Kay M.Stanney, Handbook of Virtual Environments: Design, Implementation, and Applications, Lawrence Erlbaum Associates, Publications. N. I. Durlach and A. S. Mavor, eds., Virtual Reality: Scientific and Technological Challenges, National Academy Press, Washington, D.C., 1994.
2. G.C. Burdea, Force and Touch Feedback for Virtual Reality, John Wiley & Sons, 1996
3. Kandel, Eric R., et al., eds. Principles of neural science.
4. New York: McGraw-hill, 2000

Reference Books:

1. Chang Liu, Foundations of MEMS, Pearson Education Inc., 2012.
2. Marc J. Madou, Fundamentals of Micro fabrication: the Science of miniaturization,CRC Press, 2002.
3. Nadim Maluf and Kirt Williams, An introduction to Microelectro Mechancial Systems Engineering, Second Edition, Artech House Inc, MA,2004.
4. Chang Liu, Foundations of MEMS, Pearson Education International, New Jersey,USA,2006.
5. Nitaigour Premch and Mahalik, MEMS, Tata McGraw Hill Publishing Company, New Delhi, 2007.

22PBM58	BIOSIGNAL PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To study the characteristics of different biosignals.
2. To learn linear and non linear filtering techniques to extract desired information.
3. To understand various techniques for automated classification and decision making to aid diagnosis

Course Content:

UNIT I BIOSIGNAL AND SPECTRAL CHARACTERISTICS 9

Characteristics of some dynamic biomedical signals, Noises- random, structured and physiological noises. Filters- IIR and FIR filters. Spectrum – power spectral density function, cross-spectral density and coherence function, cepstrum and homomorphic filtering. Estimation of mean of finite time signals.

UNIT II TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION 9

Time series analysis – linear prediction models, process order estimation, lattice representation, non-stationary process, fixed segmentation, adaptive segmentation, application in EEG, PCG signals, Time varying analysis of Heart-rate variability, model based ECG simulator. Spectral estimation –Blackman Tukey method, periodogram, and model based estimation. Application in Heart rate variability, PCG signals

UNIT III ADAPTIVE FILTERING AND WAVELET DETECTION 9

Filtering – LMS adaptive filter, adaptive noise canceling in ECG, improved adaptive filtering in ECG, Wavelet detection in ECG – structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets

UNIT IV BIOSIGNAL CLASSIFICATION AND RECOGNITION 9

Signal classification and recognition – Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network based classification. Application in Normal versus Ectopic ECG beats

UNIT V TIME FREQUENCY AND MULTIVARIATE ANALYSIS 9

Time frequency representation, spectrogram, Wigner distribution, Time-scale representation, scalogram, wavelet analysis – Data reduction techniques, ECG data compression, ECG characterization, Feature extraction- Wavelet packets, Multivariate component analysis-PCA,ICA.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On successful completion of this course, the student will be able to

1. Preprocess the Biosignals.
2. Analyze biosignals in time domain & to estimate the spectrum.
3. Apply wavelet detection techniques for biosignal processing.
4. Classify Biosignals using neural networks and statistical classifiers.

5. Extract the features using multivariate component analysis.

Text books:

1. Rangaraj M. Rangayyan, “Biomedical Signal Analysis-A case study approach”, Wiley, 2nd Edition, 2016.
2. Willis J. Tompkins, “Biomedical Digital Signal Processing”, Prentice Hall of India, New Delhi, 2003.
3. Arnon Cohen, “Bio-Medical Signal Processing Vol I and Vol II”, CRC Press Inc., Boca Rato, Florida, 1999

References:

1. Kayvan Najarian and Robert Splerstor, “Biomedical signals and Image processing’’, CRC – Taylor and Francis, New York, 2nd Edition, 2012.
2. K.P.Soman, K.Ramachandran, “Insight into wavelet from theory to practice”, PHI, New Delhi, 3 rd Edition, 2010.
3. D.C.Reddy, “Biomedical Signal Processing – Principles and Techniques’’, Tata McGraw-Hill Publishing Co. Ltd, 2005.
4. John L.Semmlow, “Biosignal and Biomedical Image Processing Matlab Based applications’’, Taylor& Francis Inc, 2004

22PCS43	**COMPUTER VISION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. To review image processing techniques for computer vision.
2. To understand various features and recognition techniques
3. To learn about histogram and binary vision
4. Apply three-dimensional image analysis techniques
5. Study real world applications of computer vision algorithms

Course Content:

UNIT I INTRODUCTION 9

Computer Vision ,What is Computer Vision - Low-level, Mid-level, High-level ; Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective.

UNIT II FEATURE EXTRACTION 9

Feature Extraction -Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space 69 Analysis-Image Pyramids and Gaussian derivative filters, Gabor Filters.

UNIT III COLOR IMAGES, BINARY VISION 9

Simple pinhole camera model – Sampling – Quantisation – Colour images – Noise – Smoothing – 1D and 3D histograms- Back-projection - k-means Clustering – Thresholding - Threshold Detection Methods - Variations on Thresholding - Mathematical Morphology – Connectivity..

UNIT IV 3D VISION 9

Methods for 3D vision – projection schemes – shape from shading – photometric stereo – shape from texture – shape from focus – active range finding – surface representations – point-based representation – volumetric representations – 3D object recognition – 3D reconstruction

UNIT V MOTION 9

Introduction to motion – triangulation – bundle adjustment – translational alignment – parametric motion–spline-based motion- optical flow – layered motion.

TOTAL LECTURE PERIODS 45 Periods

PRACTICAL

1. Document Image Analysis
2. Biometrics based Recognition
3.Object Recognition
4. Object Tracking
5. Medical Image Analysis
6. Content-Based Image Retrieval
7. Video Data Processing

TOTAL LECTURE PERIODS 30 Periods

Expected Course Outcome: On successful completion of this course, the student will be able to

1. Explain low level processing of image and transformation techniques applied to images.
2. Develop the feature extraction and object recognition methods
3. Apply Histogram transform for detection of geometric shapes like line, ellipse and objects.
4. llustrate 3D vision process and motion estimation techniques.
5. Apply vision techniques to real time applications

Text books:

1. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer Verlag London Limited,2011
2. Simon J. D. Prince, Computer Vision: Models, Learning, and Inference, Cambridge University Press, 2012
3. D. A. Forsyth, J. Ponce, "Computer Vision: A Modern Approach", Pearson Education, 2003

References:

1. Mark Nixon and Alberto S. Aquado, Feature Extraction & Image Processing for Computer Vision, Third Edition, Academic Press, 2012.
2. E. R. Davies, "Computer & Machine Vision", Fourth Edition, Academic Press, 2012.
3. Concise Computer Vision: An Introduction into Theory and Algorithms, by Reinhard Klette, 2014

22PBM59	SPEECH AND AUDIO SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives: The objective of this course is to enable the student to

1. Provide students with basic knowledge about speech production and hearing.
2. Understand time-frequency analysis concepts.
3. Learn fundamentals of audio coding and transform coders.
4. Understand time and frequency domain methods for speech processing.
5. Study linear predictive analysis of speech.

Course Content:

UNIT I MECHANICS OF SPEECH AND AUDIO 9

Introduction - Review of Signal Processing Theory-Speech production mechanism – Nature of Speech signal – Discrete time modelling of Speech production – Classification of Speech sounds – Phones – Phonemes – Phonetic and Phonemic alphabets – Articulatory features. Absolute Threshold of Hearing - Critical Bands- Simultaneous Masking, Masking-Asymmetry, and the Spread of Masking-Nonsimultaneous Masking - Perceptual Entropy - Basic measuring philosophy -Subjective versus objective perceptual testing - The perceptual audio quality measure (PAQM) - Cognitive effects in judging audio quality.

UNIT II TIME-FREQUENCY ANALYSIS: FILTER BANKS AND TRANSFORMS 9

Introduction -Analysis-Synthesis Framework for M-band Filter Banks- Filter Banks for Audio Coding: Design Considerations - Quadrature Mirror and Conjugate Quadrature Filters- TreeStructured QMF and CQF M-band Banks - Cosine Modulated “Pseudo QMF” M-band Banks - Cosine Modulated Perfect Reconstruction (PR) M-band Banks and the Modified Discrete Cosine Transform (MDCT) - Discrete Fourier and Discrete Cosine Transform - Pre-echo Distortion- Preecho Control Strategies.

UNIT III AUDIO CODING AND TRANSFORM CODERS 9

Lossless Audio Coding-Lossy Audio Coding- ISO-MPEG-1A,2A,2A Advanced, 4AudioCoding - Optimum Coding in the Frequency Domain - Perceptual Transform Coder -Brandenburg-Johnston Hybrid Coder - CNET Coders - Adaptive Spectral Entropy Coding -Differential Perceptual Audio Coder - DFT Noise Substitution -DCT with Vector Quantization -MDCT with Vector Quantization.

UNIT IV TIME AND FREQUENCY DOMAIN 9

Time domain parameters of Speech signal – Methods for extracting the parameters: Energy, Average Magnitude – Zero crossing Rate – Silence Discrimination using ZCR and energy Short 138 Time Fourier analysis – Formant extraction – Pitch Extraction using time and frequency domain methods HOMOMORPHIC SPEECH ANALYSIS: Cepstral analysis of Speech – Formant and Pitch Estimation – Homomorphic Vocoders.

UNIT V LINEAR PREDICTIVE ANALYSIS 9

Formulation of Linear Prediction problem in Time Domain – Basic Principle – Auto correlation method – Covariance method – Solution of LPC equations – Cholesky method – Durbin's Recursive algorithm – lattice formation and solutions – Comparison of different methods – Application of LPC parameters – Pitch detection using LPC parameters – Formant analysis – VELP – CELP.

TOTAL LECTURE PERIODS 45 Periods

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

1. Examine auditory models to design perceptual audio quality measure.
2. Design analysis-by-synthesis model for speech perception.
3. Analyze and design algorithms for speech and audio coding.
4. Analyze and design algorithms for extracting parameters from the speech signal.
5. Implement pitch detection and formant analysis in speech signals.

Text Books:

1. Rabiner. L. R and Schaffer. R. W., "Digital Processing of Speech signals", Prentice Hall, 1978
2. Andreas Spanias, Ted Painter, Venkatraman AttiWayne Tomasi, "Audio signal processing and coding", John Wiley & Sons, 2007

Reference Books:

1. Udo Zölzer , Digital Audio Signal Processing, A John Wiley& sons Ltd Publication, Second Edition, 2008.
2. Mark Kahrs, Karlheinz Brandenburg, "Applications of Digital Signal Processing to Audio And Acoustics", KLUWER ACADEMIC PUBLISHERS NEW YORK, BOSTON, DORDRECHT, LONDON, MOSCOW, 2002.
3. Blake, "Electronic Communication Systems", Thomson Delmar Publications, 2002.
4. Martin S. Roden, "Analog and Digital Communication System", Prentice Hall of India, 3rd Edition, 2002.
5. Sklar. B, "Digital Communication Fundamentals and Applications" Pearson Education, 2nd Edition, 2007.

22PBM60	MEDICAL IMAGING SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the generation of X-ray and its uses in Medical imaging
2. To describe the principle of Computed Tomography.
3. To know the techniques used for visualizing various sections of the body.
4. To learn the principles of different radio diagnostic equipment in Imaging.
5. To discuss the radiation therapy techniques and radiation safety

Course Content:

UNIT I X RAYS 9

Nature of X-rays- X-Ray absorption – Tissue contrast. X- Ray Equipment (Block Diagram) – XRay Tube, the collimator, Bucky Grid, power supply, Digital Radiography - discrete digital detectors, storage phosphor and film scanning, X-ray Image Intensifier tubes – Fluoroscopy – Digital

Fluoroscopy. Angiography, cine Angiography. Digital subtraction Angiography. Mammography.

UNIT II COMPUTED TOMOGRAPHY 9

Principles of tomography, CT Generations, X- Ray sources- collimation- X- Ray detectors – Viewing systems – spiral CT scanning – Ultra fast CT scanners. Image reconstruction techniques – back projection and iterative method.

UNIT III MAGNETIC RESONANCE IMAGING 10

Fundamentals of magnetic resonance- properties of electromagnetic waves : speed , amplitude, phase, orientation and waves in matter - Interaction of Nuclei with static magnetic field and Radio frequency wave- rotation and precession – Induction of magnetic resonance signals – bulk magnetization – Relaxation processes T1 and T2. Block Diagram approach of MRI system – system magnet (Permanent, Electromagnet and Superconductors), generations of gradient magnetic fields, Radio Frequency coils (sending and receiving), shim coils, Electronic components, fMRI.

UNIT IV NUCLEAR IMAGING 9

Radioisotopes- alpha, beta, and gamma radiations. Radio Pharmaceuticals. Radiation detectors – gas filled, ionization chambers, proportional counter, GM counter and scintillation Detectors, Gamma camera – Principle of operation, collimator, photomultiplier tube, X-Y positioning circuit, pulse height analyzer. Principles of SPECT and PET

UNIT V RADIATION THERAPY AND RADIATION SAFETY 8

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

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: At the end of the course the student will be able to:

1. Describe the working principle of the X-ray machine and its application.
2. Illustrate the principle computed tomography
3. Interpret the technique used for visualizing various sections of the body using Magnetic Resonance Imaging.
4. Demonstrate the applications of radionuclide imaging.
5. Analyze different imaging techniques and choose appropriate imaging equipment for better diagnosis and outline the methods of radiation safety.

TEXT BOOKS

1. Isaac Bankman, I. N. Bankman , Handbook Of Medical Imaging: Processing and Analysis(Biomedical Engineering),Academic Press,2000
2. Jacob Beutel (Editor), M. Sonka (Editor), Handbook of Medical Imaging, Volume 2. Medical Image Processing and Analysis , SPIE Press 2000
3. Khin Wee Lai, Dyah Ekashanti Octorina Dewi “Medical Imaging Technology”,

Springer Singapore, 2015

Reference Books:

1. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw – Hill, New Delhi, 2003.
2. Dougherty, Geoff (Ed.), “Medical Image Processing - Techniques and Applications “,Springer-Verlag New York, 2011

22PBM61	**BRAIN COMPUTER INTERFACE AND APPLICATIONS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives: The student should be made to:

1. To understand the basic concepts of brain computer interface
2. To study the various signal acquisition methods
3. To study the signal processing methods used in BCI

Course Content:

UNIT I INTRODUCTION TO BCI 9

Fundamentals of BCI – Structure of BCI system – Classification of BCI – Invasive, Non-invasive and Partially invasive BCI – EEG signal acquisition - Signal Preprocessing – Artifacts removal.

UNIT II ELECTROPHYSIOLOGICAL SOURCES 9

Sensorimotor activity – Mu rhythm, Movement Related Potentials – Slow Cortical Potentials-P300 - Visual Evoked Potential - Activity of Neural Cells - Multiple Neuromechanisms.

UNIT III FEATURE EXTRACTION METHODS 9

Time/Space Methods – Fourier Transform, PSD – Wavelets – Parametric Methods – AR,MA,ARMA models – PCA – Linear and Non-Linear Features.

UNIT IV FEATURE TRANSLATION METHODS 9

Linear Discriminant Analysis – Support Vector Machines - Regression – Vector Quantization– Gaussian Mixture Modeling – Hidden Markov Modeling – Neural Networks.

UNIT V APPLICATIONS OF BCI 9

Functional restoration using Neuroprosthesis - Functional Electrical Stimulation, Visual Feedback and control - External device control, Case study: Brain actuated control of mobile Robot:

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On successful completion of this course, the student will be able to

1. Describe BCI system and its potential applications.
2. Analyze event related potentials and sensory motor rhythms.
3. Compute features suitable for BCI.
4. Design classifier for a BCI system.
5. Implement BCI for various applications.

Text Books

1. Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, “Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction”, Springer, 2010

Reference Books:

1. R. Spehlmann, “EEG Primer”, Elsevier Biomedical Press, 1981.
2. Arnon Kohen, “Biomedical Signal Processing”, Vol I and II, CRC Press Inc, Boca Rato, Florida, 1986.
3. Bishop C.M., “Neural Networks for Pattern Recognition”, Oxford, Clarendon Press, 1995.

22PBM17	**BIOMETRIC SYSTEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives: To Study about

1. 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.
2. To understand the general principles of design of biometric systems and the underlying trade-offs.
3. To study the technologies of fingerprint, iris, face and speech recognition.
4. To study of evaluation of biometrics systems.

Course Content:

UNIT I INTRODUCTION TO BIOMETRICS 9

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

UNIT II FINGERPRINT TECHNOLOGY 9

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

UNIT III FACE RECOGNITION AND HAND GEOMETRY 9

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

UNIT IV IRIS RECOGNITION 9

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

UNIT V VOICE SCAN AND MULTIMODAL BIOMETRICS 9

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

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On successful completion of this course, the student will be able to

1. Demonstrate the principles of biometric systems.
2. Develop fingerprint recognition technique.
3. Design face recognition and hand geometry system.
4. Design iris recognition system.
5. Develop speech recognition and multimodal biometric systems.

TEXT BOOKS

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. S.Y. Kung, S.H. Lin, M.W., “Biometric Authentication: A Machine Learning Approach”, Prentice Hall, 2004

Reference Books:

1. Nalini K Ratha, Ruud Bolle, “Automatic fingerprint recognition system’’, Springer, 2003.
2. L C Jain, I Hayashi, S B Lee, U Halici, “Intelligent Biometric Techniques in Fingerprint and 143 Face Recognition”, CRC Press, 1st Edition, 1999.
3. John Chirillo, Scott Blaul, “Implementing Biometric Security”, John Wiley & Sons, 2003.

22PBM62 **COMMUNICATION SYSTEMS**

L	T	P	C
3	0	0	3

Course Objectives:

1. To study the various analog and digital modulation techniques
2. To study the principles behind various error control coding
3. To study the various digital communication techniques

Course Content:

UNIT I ANALOG MODULATION 9

Amplitude Modulation – AM, DSBSC, SSBSC, VSB – Angle modulation – PM and FM –Modulators and Demodulators

UNIT II RECEIVER CHARACTERISTICS 9

Noise sources and types – Noise figure and noise temperature – Noise in cascaded systems – Single tuned receivers – Super heterodyne receivers.

UNIT III INFORMATION THEORY 9

Measure of information – Entropy – Source coding theorem – Discrete memoryless channels – lossless, deterministic, noiseless, BEC, BSC – Mutual information – Channel capacity – Shannon-Fano coding, Huffman Coding, run length coding, LZW algorithm.

UNIT IV BANDPASS SIGNALING 9

Geometric representation of signals – Correlator and matched filter – ML detection – generation and detection, PSD, BER of coherent BPSK, BFSK, QPSK – Principles of QAM – Structure of non-coherent receivers – BFSK, DPSK

UNIT V ERROR CONTROL CODING TECHNIQUES 9

Channel coding theorem – Linear block codes – Hamming codes – Cyclic codes (CRC) – Convolutional codes – Viterbi decoding (Soft/Hard decision decoding).

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Comprehend and appreciate the significance and role of this course in the present contemporary world.
2. Apply analog modulation techniques.
3. Apply digital modulation techniques
4. Knowledge on various types of noises during transmission
5. Analyze various error control coding techniques.

Text Books:

1. B.P.Lathi, "Modern Digital and Analog Communication Systems'', Oxford University Press, 3rd Edition, 2007
2. H Taub, D L Schilling, G Saha, "Principles of Communication Systems", TMH, 3rd Edition,

2007
3. S. Haykin , “Digital Communications”, John Wiley, 2005

Reference Books:

1. H P Hsu, Schaum “Outline Series, Analog and Digital Communications”, TMH, 2006
2. B.Sklar, “Digital Communications Fundamentals and Applications”, Pearson Education, 2nd Edition, 2007.

22PBM63	WEARABLE DEVICES	L	T	P	C
		3	0	0	3

Course Objectives:

1. To know the hardware requirement of wearable systems
2. To understand the communication and security aspects in the wearable devices
3. To know the applications of wearable devices in the field of medicine

Course Content:

UNIT I INTRODUCTION TO WEARABLE SYSTEMS AND SENSORS 9

Wearable Systems- Introduction, Need for Wearable Systems, Drawbacks of Conventional Systems for Wearable Monitoring, Applications of Wearable Systems, Types of Wearable Systems, Components of wearable Systems. Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor.

UNIT II SIGNAL PROCESSING AND ENERGY HARVESTING FOR WEARABLE DEVICES 9

Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, sampling frequency for reduced energy consumption, Rejection of irrelevant information. Power Requirements- Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.

UNIT III WIRELESS HEALTH SYSTEMS 9

Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication Techniques.

UNIT IV SMART TEXTILE 9

Introduction to smart textile- Passive smart textile, active smart textile. Fabrication Techniques-Conductive Fibres, Treated Conductive Fibres, Conductive Fabrics, Conductive Inks.Case study-smart fabric for monitoring biological parameters - ECG, respiration.

UNIT V APPLICATIONS OF WEARABLE SYSTEMS 9

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, neural recording, Gait analysis, Sports Medicine.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Describe the concepts of wearable system.
2. Explain the energy harvestings in wearable device.
3. Use the concepts of BAN in health care.
4. Illustrate the concept of smart textile
5. Compare the various wearable devices in healthcare system.

Text Books:

1. Annalisa Bonfiglo and Danilo De Rossi, Wearable Monitoring Systems, Springer, 2011
2. Zhang and Yuan-Ting, Wearable Medical Sensors and Systems,Springer, 2013
3. Edward Sazonov and Micheal R Neuman, Wearable Sensors: Fundamentals, Implementation and Applications, Elsevier, 2014
4. Mehmet R. Yuce and JamilY.Khan, Wireless Body Area Networks Technology, Implementation applications,Pan Stanford Publishing Pte.Ltd, Singapore, 2012

Reference Books:

1. Sandeep K.S, Gupta, Tridib Mukherjee and Krishna Kumar Venkatasubramanian, Body Area Networks Safety, Security, and Sustainability, Cambridge University Press, 2013.
2. Guang-Zhong Yang, Body Sensor Networks, Springer, 2006.

22PBM64	**BODY AREA NETWORKS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

1. To know the hardware requirement of BAN
2. To understand the communication and security aspects in the BAN
3. To know the applications of BAN in the field of medicine

Course Content:

UNIT I INTRODUCTION 9

Definition, BAN and Healthcare, Technical Challenges- Sensor design, biocompatibility, Energy Supply, optimal node placement, number of nodes, System security and reliability, BAN Architecture – Introduction.

UNIT II HARDWARE FOR BAN 9

Processor-Low Power MCUs, Mobile Computing MCUs ,Integrated processor with radio transceiver, Memory ,Antenna-PCB antenna, Wire antenna, Ceramic antenna, External antenna, Sensor Interface, Power sources- Batteries and fuel cells for sensor nodes.

UNIT III WIRELESS COMMUNICATION AND NETWORK 9

RF communication in Body, Antenna design and testing, Propagation, Base Station-Network topology-Stand –Alone BAN, Wireless personal Area Network Technologies-IEEE 802.15.1,IEEE P802.15.13, IEEE 802.15.14, Zigbee.

UNIT IV COEXISTENCE ISSUES WITH BAN 9

Interferences – Intrinsic - Extrinsic, Effect on transmission, Counter measures- on physical layer and data link layer, Regulatory issues-Medical Device regulation in USA and Asia, Security and Self-protection-Bacterial attacks, Virus infection, Secured protocols, Self-protection.

UNIT V APPLICATIONS OF BAN 9

Monitoring patients with chronic disease, Hospital patients, Elderly patients, Cardiac arrythmias monitoring, Multi patient monitoring systems, Multichannel Neural recording, Gait analysis, Sports Medicine, Electronic pill.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Comprehend and appreciate the significance and role of this course in the present contemporary world.
2. Design a BAN for appropriate application in medicine.
3. Assess the efficiency of communication and the security parameters.
4. Understand the need for medical device regulation and regulations followed in various regions.
5. Extend the concepts of BAN for medical applications.

Text Books:

1. Sandeep K.S. Gupta,Tridib Mukherjee, Krishna Kumar Venkata Subramanian, “Body Area Networks Safety, Security, and Sustainability’’, Cambridge University Press, 2013
2. Mehmet R. Yuce, Jamil Y.Khan, “Wireless Body Area Networks Technology, Implementation, and Applications”, Pan Stanford Publishing Pte. Ltd., Singapore, 2012

Reference Books:

1. Zhang, Yuan-Ting, “Wearable Medical Sensors and Systems’’, Springer, 2013.
2. Guang-Zhong Yang(Ed.), “Body Sensor Networks’’, Springer, 2006.
3. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011.

22PBM13 VIRTUAL REALITY AND AUGMENTED REALITY IN HEALTHCARE

L	T	P	C
3	0	0	3

Course Objectives:

1. 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
2. Understand virtual reality, augmented reality and using them to build Biomedical engineering applications
3. Know the intricacies of these platform to develop PDA applications with better optimality.
4. Learn the various applications of VR.
5. Learn the possibilities of implementing target-specific VR applications on mobile.

Course Content:

UNIT I INTRODUCTION 9

The three I's of virtual reality-commercial VR technology and the five classic components of a VR system - Input Devices: (Trackers, Navigation, and Gesture Interfaces): Three-dimensional position trackers, navigation and manipulation-interfaces and gesture interfaces-Output Devices: Graphics displays-sound displays & haptic feedback.

UNIT II VR DEVELOPMENT PROCESS 9

Geometric modeling - kinematics modeling- physical modeling - behaviour modeling - model management.

UNIT III CONTENT CREATION CONSIDERATIONS 9

Methodology and terminology-user performance studies-VR health and safety issues-Usability of virtual reality system- cyber sickness -side effects of exposures to virtual reality environment

UNIT IV VR ON THE WEB & VR ON THE MOBILE 9

JS-pros and cons-building blocks (WebVR, WebGL, Three.js, device orientation events)- frameworks (A-frame, React VR)-Google VR for Android-Scripts, mobile device configuration, building to android-cameras and interaction-teleporting-spatial audio-Assessing human parameters-device development and drivers-Design Haptics

UNIT V APPLICATIONS 9

Medical applications-military applications-robotics applications- Advanced Real time Tracking-other applications- games, movies, simulations, therapy

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Analyze and Design a system or process to meet given specifications with realistic engineering constraints.
2. Identify problem statements and function as a member of an engineering design team.

3. Analyze the implications and issues pertaining to VR
4. Propose technical documents and give technical oral presentations related to design VR mini project results.
5. Develop simple and portable VR applications using appropriate software.

Text Books:

1. C. Burdea & Philippe Coiffet, "Virtual Reality Technology", Second Edition, Gregory, John Wiley & Sons, Inc.,2008

2. Jason Jerald. 2015. The VR Book: Human-Centred Design for Virtual Reality. Association for Computing Machinery and Morgan & Claypool, New York, NY, USA.

Reference Books:

1. 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

2. Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR (Usability),Steve Aukstakalnis, Addison-Wesley Professional; 1 edition, 2016.

3. The Fourth Transformation: How Augmented Reality & Artificial Intelligence Will Change Everything, Robert Scoble & Shel Israel, Patrick Brewster Press; 1 edition, 2016.

4. Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile, Tony Parisi, O'Reilly Media; 1 edition, 2015.

5. Programming 3D Applications with HTML5 and WebGL: 3D Animation and Visualization for Web Pages, Tony Parisi, O'Reilly Media; 1 edition, 2014.

6. Learning Three.js: The JavaScript 3D Library for WebGL - Second Edition, Jos Dirksen, Packt Publishing - ebooks Account; 2nd Revised ed. Edition 2015.

Online Resources:

1. http://www.vrtechnology.org/resources.html

		L	T	P	C
22PBM42	**TELEHEALTH TECHNOLOGY**	**3**	**0**	**0**	**3**

Course Objectives:

1. Learn the key principles for telemedicine and health
2. Understand telemedical technology.
3. Know telemedical standards, mobile telemedicine and it applications

Course Content:

UNIT I FUNDAMENTALS OF TELEMEDICINE 9

History of telemedicine, definition of telemedicine, tele-health, tele-care, scope, Telemedicine Systems, benefits & limitations of telemedicine.

UNIT II TYPE OF INFORMATION & COMMUNICATION INFRASTRUCTURE FOR TELEMEDICINE 9

Audio, video, still images, text and data, internet, air/ wireless communications, GSM satellite, micro wave, Mobile health and ubiquitous healthcare.

UNIT III ETHICAL AND LEGAL ASPECTS OF TELEMEDICINE 9

Confidentiality, patient rights and consent: confidentiality and the law, the patient-doctor relationship, access to medical records, consent treatment - data protection & security, jurisdictional issues.

UNIT IV PICTURE ARCHIVING AND COMMUNICATION SYSTEM 9

Introduction to radiology information system and ACS, DICOM, PACS strategic plan and needs assessment, technical Issues, PACS architecture.

UNIT V APPLICATIONS OF TELEMEDICINE 9

Teleradiology, telepathology, telecardiology, teleoncology, teledermatology, telesurgery.

TOTAL LECTURE PERIODS 45 Periods

PRACTICALS:

1. Porting sensor data on mobile devices
2. IoT for healthcare monitoring
3. Porting medical data on cloud platform
4. Cloud computing applications in health informatics
5. Study of telemedicine tools
6. Design of an application for mobile devices

TOTAL PERIODS: 30 PERIODS

Expected Course Outcome: On completion of the course, the student is expected to

1. To analyze the benefits and limitations of telemedicine.
2. To apply multimedia technologies in telemedicine.
3. To explain protocols behind encryption techniques for secure transmission of data.
4. To develop radiology based information system.
5. To apply telemedicine in various healthcare domains.

Text Books:

1. Olga Ferrer Roca, Marcelo Sosa Iudicissa, "Handbook of Telemedicine", IOS Press,

Netherland, 3. 2002
2. Khandpur R S, “TELEMEDICINE – Technology and Applications”, PHI Learning Pvt Ltd., New Delhi, 2017.
3. Norris A C, “Essentials of Telemedicine and Telecare”, John Wiley, New York, 2002

Reference Books:

1. H K Huang, “PACS and Imaging Informatics: Basic Principles and Applications” Wiley, New Jersey, 2010.
2. Khandpur R S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi, 2003
3. Keith J Dreyer, Amit Mehta, James H Thrall, “Pacs: A Guide to the Digital Revolution”, Springer, New York, 2002.
4. Garrett Grolemund, *Hands–On Programming with R*, O'Reilly , 1 edition , 2014.
5. Michael Dawson, *Python Programming for the Absolute Beginner*, Course Technology , 3rd edition ,2010
6. Magesh Jayakumar, *Arduino and Android Using Mit App Inventor*, Createspace Independent Publishing Platform , 1.0 edition ,2016

22PBM67	MEDICAL INFORMATICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To study the applications of information technology in health care management.
2. This course provides knowledge on resources, devices, and methods required to optimize the acquisition, storage, retrieval, and use of information in health and biomedicine.

Course Content:

UNIT I INTRODUCTION TO MEDICAL INFORMATICS 9

Introduction - Structure of Medical Informatics –Internet and Medicine -Security issues , Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, Health Informatics – Medical Informatics, Bioinformatics

UNIT II COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING 9

Automated clinical laboratories-Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System - Computerized ECG, EEG and EMG, Computer assisted medical imaging- nuclear medicine, ultrasound imaging, computed X-ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance.

UNIT III COMPUTERISED PATIENT RECORD 9

Introduction - History taking by computer, Dialogue with the computer, Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for patients.

UNIT IV COMPUTER ASSISTED MEDICAL DECISION-MAKING 9

Neuro computers and Artificial Neural Networks application, Expert system-General model of CMD, Computer–assisted decision support system-production rule system cognitive model, semantic networks, decisions analysis in clinical medicine-computers in the care of critically ill patients, Computer aids for the handicapped.

UNIT V RECENT TRENDS IN MEDICAL INFORMATICS 9

Virtual reality applications in medicine, Virtual endoscopy, Computer assisted surgery, Surgical simulation, Telemedicine - Tele surgery, Computer assisted patient education and health- Medical education and healthcare information, computer assisted instruction in medicine.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Explain the structure and functional capabilities of Hospital Information System
2. Describe the need of computers in medical imaging and automated clinical laboratory.
3. Articulate the functioning of information storage and retrieval in computerized patient record system.
4. Apply the suitable decision support system for automated clinical diagnosis.
5. Discuss the application of virtual reality and telehealth technology in medical industry.

Text Books:

1. Mohan Bansal, “Medical informatics”, Tata McGraw Hill Publishing Ltd, 2003.
2. R.D.Lele, “Computers in medicine progress in medical informatics”, Tata Mcgraw Hill,2005

Reference Books:

1.Kathryn J. Hannah, Marion J Ball, “Health Informatics”, 3rd Edition, Springer, 2006

22PBM68	BIO MEMS	L	T	P	C
		3	0	0	3

Course Objectives:

1. Provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices.
2. Understand various mechanical and thermal sensors and actuators and their principles of operation at the micro scale level.
3. Understand various electrostatic and piezoelectric sensors and actuators at the micro scale level.
4. Introduce micro fluidic systems.
5. Know on the applications of MEMS in different field of medicine

Course Content:

UNIT I MEMS MATERIALS AND FABRICATION 9

Semiconductor materials; photo lithography; doping; thin film growth and deposition; CVD and Ion Implantation, metallization; wet and dry etching; silicon micromachining; metal MEMS processes; submicron optical lithography; electron beam lithography; soft lithography and printing.

UNIT II MECHANICAL AND THERMAL SENSORS AND ACTUATORS 9

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, flowsensor.

UNIT III ELECTROSTATIC AND PIEZOELECTRIC SENSORS AND ACTUATOR 9

Electrostatic sensors and actuators- Inertia sensor, Pressure sensor, flow sensor, tactile sensor, and comb drive. Piezoelectric sensor and actuator – inchworm motor, inertia sensor, flow sensor.

UNIT IV MICROFLUIDIC SYSTEMS 9

Laminar flow in circular conduits, fluid flow in micro conduits, in sub micrometer and nano scale. Micro fluidic components (filters, mixers, valves, and pumps)

UNIT V APPLICATIONS OF BIOMEMS 9

CAD for MEMS,DNA sensor, MEMS based drug delivery, Biosensors- sensors for glucose, uric Acid, urea and triglyceride sensor. Introduction to the MATLAB/Simulink/ CAD tool for Modeling/simulations of bioelectronics systems.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Summarize various MEMS fabrication techniques.
2. Elucidate different types of mechanical and thermal sensors and actuators and their principles of operation at the micro Scale level.
3. Describe different types of various electrostatic and piezoelectric sensors and actuators and their principles of operation at the micro Scale level.

4. Explain micro fluidic systems
5. Illustrate MEMS in different field of medicine.

Reference Books:

1. TaiRan Hsu,MEMS and Microsystems Design and Manufacture, Tata McGrawHill Publishing Company, New Delhi, 2017.
2. WanjunWang and Stephen A.Soper, BioMEMS:Technologies and Applications, CRC Press, NewYork, 2007.
3. Chang Liu, Foundations of MEMS, Pearson Education International, New Jersey, USA, 2011.
4. Ellis Meng, Biomedical Microsystems, CRC Press, Boca Raton, FL, 2011.
5. P. Tabeling, S .Chen, Introduction to micro fluidics, Oxford University Press, 2010.
6. Alok Pandya ,Vijai Singh, Micro/Nanofluidics and Lab-on-Chip Based Emerging Technologies for Biomedical and Translational Research Applications - Part B, Academic Press, 2022

22PBM69	**CRITICAL CARE EQUIPMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objectives:

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

Course Content:

UNIT I EQUIPMENTS IN ICU 9

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

UNIT II EMERGENCY CARE EQUIPMENT 9

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

UNIT III EQUIPMENTS IN OPERATION THEATRE (OT) 9

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

UNIT IV PATIENT SAFETY 9

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

UNIT V CENTRALISED SYSTEMS 9

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

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Assess the merits of the operation theatre equipment based on its applications.
2. Design the devices for the particular application based on given specifications
3. Suggest suitable surgical instruments and operational devices.
4. Compare the various techniques for clinical diagnosis, therapy and surgery, and its recent methods.
5. Apply the knowledge acquired, in designing new monitoring devices for ICU and assist the medical personnel's during emergency situations.

Text books:

1. L.A Geddes and L.E.Baker, "Principles of Applied Biomedical Instrumentation", 3rd Edition, 2008.
2. Antony Y.K.Chan,"Biomedical Device Technology, Principles and design", Charles Thomas Publisher Ltd, Illinois, USA, 2008
3. John G. Webster, "Medical Instrumentation Application and Design", 4th edition, Wiley India PvtLtd,New Delhi, 2015
4. Khandpur. R.S.,"Handbook of Biomedical Instrumentation". Second Edition. Tata McGrawHill Pub. Co.,Ltd. 2003

References:

1. . Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson education, 2012
2. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Pearson Education, New Delhi, 2007.

22PBM70	HUMAN ASSIST DEVICES	L	T	P	C
		3	0	0	3

Course Objectives:

1. To study the role and importance of machines that takes over the functions of the heart and lungs,
2. To study various mechanical techniques that help a non-functioning heart.
3. To learn the functioning of the unit which does the clearance of urea from the blood
4. To understand the tests to assess the hearing loss and development of electronic devices to compensate for the loss.
5. To study about recent techniques used in modern clinical applications

Course Content:

UNIT I HEART LUNG MACHINE AND ARTIFICIAL HEART 9

Condition to be satisfied by the H/L System. Different types of Oxygenators, Pumps, Pulsatile and Continuous Types, Monitoring Process, Shunting, The Indication for Cardiac Transplant, Driving Mechanism, Blood Handling System, Functioning and different types of Artificial Heart, Schematic for temporary bypass of left ventricle.

UNIT II CARDIAC ASSIST DEVICES 9

Assisted through Respiration, Right and left Ventricular Bypass Pump, Auxiliary ventricle, Open Chest and Closed Chest type, Intra Aortic Balloon Pumping, Prosthetic Cardiac valves, Principle of External Counter pulsation techniques.

UNIT III ARTIFICIAL KIDNEY 9

Indication and Principle of Haemodialysis, Membrane, Dialysate, types of filter and membranes, Different types of hemodialyzers, Monitoring Systems, Wearable Artificial Kidney, Implanting Type.

UNIT IV RESPIRATORY AND HEARING AIDS 9

Ventilator and its types-Intermittent positive pressure, Breathing Apparatus Operating Sequence, Electronic IPPB unit with monitoring for all respiratory parameters. Types of Deafness, Hearing Aids, SISI, masking techniques, wearable devices for hearing correction

UNIT V RECENT TRENDS 9

Transcutaneous electrical nerve stimulator, bio-feedback, Diagnostic and point-of-care platforms.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Explain the principles and construction of artificial heart
2. Understand various mechanical techniques that improve therapeutic technology
3. Explain the functioning of the membrane or filter that cleanses the blood.
4. Describe the tests to assess the hearing loss and development of wearable devices for the same.
5. Analyze and research on electrical stimulation and biofeedback techniques in rehabilitation and physiotherapy

TEXT BOOKS:

1. Gray E Wnek, Gray L Browlin – Encyclopedia of Biomaterials and Biomedical Engineering – Marcel Dekker Inc New York 2004.
2. John. G . Webster – Bioinstrumentation - John Wiley & Sons (Asia) Pvt Ltd - 2004
3. Joseph D.Bronzino, The Biomedical Engineering Handbook, Third Edition: Three Volume Set, CRC Press, 2006

Reference Books:

1. Andreas.F. Von racum, "Hand book of bio material evaluation", Mc-Millan publishers, 1980.
2. Gray E Wnek, Gray L Browlin, "Encyclopedia of Biomaterials and Biomedical Engineering" Marcel Dekker Inc New York 2004.
3. D.S. Sunder, "Rehabilitation Medicine", 3rd Edition, Jaypee Medical Publication, 2010

22PBM19	ADVANCEMENTS IN HEALTHCARE TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. Understand the needs for wearable devices and the technology
2. Learn the concepts in digital health care and digital hospitals
3. Apply the tools in design, testing and developing digital health care equipment

Course Content:

UNIT I DIGITAL HEALTH 9

Digital Health: Requirements and best practices, Laws and regulations in Digital health, Ethical issues, barriers and strategies for innovation.

UNIT II DIGITAL RADIOLOGY 9

Digital radiology for digital hospital, picture archiving and communication, system integration, digital history of radiology, medical image archives, storage and networks.

UNIT III E-HEALTH 9

E-Health: Health care networking, medical reporting using speech recognition, physiological tests and functional diagnosis with digital methods, tele-consultation in medicine and radiology.

UNIT IV M-HEALTH CARE AND WEARABLE DEVICES 9

Introduction to mobile healthcare devices-economy-average length of stay in hospital, outpatient care, health care costs, mobile phones, 4G, smart devices, wearable devices, Uptake of e-health and m-health technologies. Standards, system Design and case study.

UNIT V MODALITY AND STANDARDS FOR INTER-OPERABILITY 9

Multimodality registration in daily clinical practice. Mobile healthcare. Selection and Implementation in e-Health project, design of medical equipment based on user needs. Security and privacy in digital health care. Case study

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Interpret the need for digital methods of handling medical records.
2. Explain the digital radiology

3. Modify the tools and methods for work flow in E-Health
4. Identify the available technology for wearable healthcare devices
5. Compare various standards for inter-operability of devices, quality and safety standards for developing healthcare systems

TEXT BOOKS

1. Christoph Thuemmler, Chunxue Bai, "Health 4.0: How Virtualization and Big Data are Revolutionizing Healthcare", Springer, 1st ed. 2017
2. Wlater Hruby, "Digital revolution in radiology – Bridging the future of health care, second edition, Springer, New York. 2006
3. Samuel A. Fricker, Christoph Thümmler , Anastasius Gavras, "Requirements Engineering For Digital Health", Springer, 2015

Reference Books:

1. Rick Krohn (Editor), David Metcalf, Patricia Salber, "Health-e Everything: Wearables and The Internet of Things for Health, ebook. 2013.
2. Khandpur,R.S,"Handbook of Biomedical Instrumentation ",Second Edition. Tata Mc Graw Hill Pub. Co., Ltd. 2003
3. John, G. Webster. Medical Instrumentation: Application and Design. Second Edition. Wiley Publisher, New Delhi. 2013.

22PBM71	ROBOTICS IN MEDICINE	L	T	P	C
		3	0	0	3

Course Objectives:

1. Get introduced to the fundamental of robotics and position analysis
2. Learn about Parallel robots, different types of motions and force analysis
3. Know the basics of trajectory planning, Motion control systems and actuators
4. Have an insight into various sensors and vision systems
5. Be acquainted to Fuzzy control and Applications of Robotics in Medicine

Course Content:

UNIT I FUNDAMENTALS AND POSITION ANALYSIS 9

Fundamentals – Classification, Advantages and disadvantages, Components, Degrees of freedom, Joints, Coordinates, Reference frames, Programming modes, Characteristics, Workspace, Languages, Collaborative robots, Position analysis – Robots as mechanisms, Conventions, Transformations, Forward and inverse kinematics, Denavit Hartenberg Representation, Degeneracy and Dextrerity, Screw based robots, Position analysis of Articulated robot Case studies

UNIT II PARALLEL ROBOTS, DIFFERENTIAL MOTIONS AND FORCE ANALYSIS 9

Parallel robots – Physical characteristics, Forward and Inverse Kinematic approaches, Planar and Spatial parallel robots, Differential relationships, The Jacobian, Large scale motions, Frame vs Robot, Differential motions and change, Hand frame, Operator, Jacobian and Inverse for Screw based and Parallel Robots, Differential operator, Lagarangian mechanics, Moments of Inertia Dynamic Equations of Multiple DOF Robots, Static force analysis, Transformation of forces and moments between coordinate frames Case studies

UNIT III TRAJECTORY PLANNING, MOTION CONTROL SYSTEMS AND ACTUATORS 10

Path and Trajectory, Joint Space and Cartesian Space Descriptions and Trajectory Planning, Cartesian, Trajectory Recording, Basics, Block diagrams, Laplace Transform, Block diagram Algebra, Transfer Functions, Characteristic equation, Steady state error, Root locus, Proportional, Integral and Derivative controllers, Compensators, Bode, Loops, Multiple IO systems, Control - State space and Digital, Nonlinear systems, Characteristics of Hydraulic, Pneumatic, Electric motors, Other actuators, Speed reduction Case studies

UNIT IV SENSORS, IMAGE PROCESSING AND ANALYSIS WITH VISION SYSTEMS 9

Sensor Characteristics, Position, Velocity, Acceleration, Force, Pressure and Torque, Micro switches, Visible and IR, Touch, Proximity, Range finders, Sniff, Vision, Transforms – Fourier, Hough, Resolution, Quantization, Sampling, Image processing, Segmentation, Region growing and splitting, Operations, Object recognition, Depth, Specialized lighting, Compression, Colour images, Heuristics, Case studies

UNIT V FUZZY CONTROL AND APPLICATIONS IN MEDICINE 8

Fuzzy control - Crisp vs Fuzzy, Sets, Inference rules, Defuzzification, Simulation, Applications in Biomedical Engineering, Applications in rehabilitation, Nanobots in medicine, Clinical diagnosis and Surgery – Cardiac and abdominal procedures with teleoperated robots, Orthopedic surgery with cooperative robotsCase studies.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Describe the fundamental of robotics and position analysis
2. Outline the functioning of parallel robots, different types of motions and force analysis.
3. Portray the basics of trajectory planning, Motion control systems and actuators.
4. Recognize and explain the use of various sensors and vision systems in robotics.
5. Employ Fuzzy control in robotics and apply it to Robotics in Medicine

TEXT BOOKS

1. S. B. Niku, Introduction to Robotics, Analysis, Control, Applications, Pearson Education, 2020
2. Robert Schilling, Fundamentals of Robotics-Analysis and control, Prentice Hall of India, 2003.
3. Fu Gonzales and Lee, Robotics, McGraw Hill, 1987.
4. J Craig, Introduction to Robotics, Pearson Education, 2005.

Reference Books:

1. Grover, Wiess, Nagel and Oderey, Industrial Robotics, McGraw Hill, 2012.
2. Klafter, Chmielewski and Negin, Robot Engineering, Prentice Hall Of India, 1989.
3. Mittal, Nagrath, Robotics and Control, Tata McGraw Hill publications, 2003.
4. Bijay K. Ghosh, Ning Xi, T.J. Tarn, Control in Robotics and Automation Sensor – Based integration, Academic Press, 1999.
5. Mikell P. Groover, Mitchell Weiss, Industrial robotics, technology, Programming and Applications, McGraw Hill International Editions, 1986.
6. Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, Robotic engineering - An Integrated Approach, Prentice Hall Inc, Englewoods Cliffs, NJ, USA, 1989.

22PBM72	THERAPEUTIC EQUIPMENT	L	T	P	C
		3	0	0	3

Course Objectives:

1. To learn the principles of cardiac assist devices.
2. To understand the need and use of extracorporeal devices, and the use of lasers in medicine.
3. To enable the students to gain knowledge on the working of therapeutic clinical equipment.

Course Content:

UNIT I CARDIAC AND RESPIRATORY THERAPY EQUIPMENT 9

Cardiac Pacemaker: Internal and External Pacemaker– Programmable pacemakers. Cardiac Defibrillators: AC and DC Defibrillator- Internal and External Defibrillators - Protection Circuit, Defibrillator analyzers. Cardiac ablation catheter. Types of Ventilators – Pressure, Volume, and Time controlled. Basic principles of electromechanical, pneumatic and electronic ventilators, Patient Cycle Ventilators, Ventilator testing. Humidifiers, Nebulizers, Inhalators. .

UNIT II BIOMECHANICAL THERAPEUTIC EQUIPMENT 9

Electro diagnosis, Therapeutic radiation, Electrotherapy, Electrodes, Stimulators for Nerve and Muscle, Functional Electrical Stimulation. Peripheral nerve stimulator, ultrasonic stimulators, Stimulators for pain and relief - Inferential Therapy Unit, TENS. GAIT Assessment and Therapy. Continuous Passive Motion unit, Cervical / Lumber Traction Machine -Traction Table

UNIT III BODY CARE EQUIPMENT 9

Skin Treatment: Ultrasonic spot remover, vacuum therapy unit, Skin tightening, Wrinkle Reduction, Facial and Rejuvenation. Laser hair therapy machine. Body Slimmer/Shaper – Deep Heat Therapy, Massager, Fitness – Treadmill, Bike.

UNIT IV DENTAL CARE EQUIPMENT 9

Dental Chair - Dental Hand pieces and Accessories: Evolution of rotary equipment, Low-speed handpiece, High-speed handpiece, Hand piece maintenance. Vacuum and Pneumatic techniques: Vacuum techniques, Oral evacuation systems, Vacuum pump, Pneumatic techniques, Dental compressor. Decontamination Unit and constant fumigation unit. Dental Radiography: Dental X-ray Machine.

UNIT V HEAT & PHOTON THERAPY EQUIPMENT 9

High frequency heat therapy, Principle, Short wave diathermy, Microwave diathermy, Ultrasonic the rapy, Lithotripsy. Therapeutic UV and IR Lamps. Basic principles of Biomedical LASERS: Applications of lasers in medicine, CO2laser, He-Ne laser, Nd-YAG and Ruby laser.

TOTAL LECTURE PERIODS 45 Periods

Expected Course Outcome: On completion of the course, the student is expected to

1. Suggest suitable therapeutic devices for ailments related to cardiology, pulmonology, neurology, etc
2. Comprehend the principles of bodycare equipment.
3. Understand the operation of dental care equipment.
4. Analyze the different types of therapies for suitable applications.
5. Appreciate the application of lasers in biomedical applications.

TEXT BOOKS

1. Khandpur. R.S.,"Handbook of Biomedical Instrumentation". Second Edition. Tata McGrawHill Pub. Co., Ltd. 2003

2. John.G.Webster. "Medical Instrumentation, Application and Design". Fourth Edition. Wiley &sons, Inc., NewYork. 2009

Reference Books:

1. Leslie Cromwell, Fred. J. Weibell & Erich. A.Pfeiffer. "Biomedical Instrumentation and Measurements". Second Edition. Prentice Hall Inc.2000.

2. John Low & Ann Reed. "Electrotherapy Explained, Principles and Practice". Second Edition. Butterworth Heinemann Ltd. 2000.

3. Joseph. J. Carr, John Michael Brown, "Introduction to Biomedical Equipment Technology", Prentice Hall and Technology, 2008.