VELALAR

COLLEGE OF ENGINEERING AND TECHNOLOGY

(Autonomous)

(Approved by AICTE, New Delhi and Affiliated to Anna University, Chennai)

(Accredited by NAAC with 'A+' Grade)

DEPARTMENT OF MEDICAL ELECTRONICS

Regulations R2018

CHOICE BASED CREDIT SYSTEM

Curriculum & Syllabi
(for the students admitted in AY 2021)

B.E. MEDICAL ELECTRONICS

VELALAR COLLEGE OF ENGINEERING AND TECHNOLOGY
(Autonomous)
(Accredited by NAAC with 'A+' Grade & NBA)

B.E. MEDICAL ELECTRONICS (MD)

Summary of credits for the Curriculum
Regulations R2018

S.No	Course Category	Credits as per semester								Credits		AICTE %
		I	II	III	IV	V	VI	VII	VIII	Total	Percentage	
1	HS	3	3					6		12	7%	12
2	BS	11	8	4	4					27	17%	25
3	ES	8	8	4	7	4				31	19%	24
4	PC			12	11	8	11	6		48	31%	48
5	PE					6	6	6		18	11%	18
6	OE					3	3	3		9	6%	18
7	EC						3		12	15	9%	15
8	MC	✓	✓	✓	✓	✓	✓	✓	-			
9	VC	✓										
10	OC, SC, AC	✓										
Total Credits/Sem		22	19	20	22	21	23	21	12	160		

HS - Humanities and Social Science
BS - Basic Science
ES - Engineering Science
PC - Professional Core
PE - Professional Elective
OE - Open Elective
EC - Employability Enhancement Course (Project, Seminar, Internship, etc.)
MC - Mandatory Course
VC - Value added course (If three or more credits earned, then one elective course may be exempted)
OC - Online Course (If six or more credits earned, then two elective courses may be exempted)
SC - Self Study course
AC - Audit Course

	VELALAR COLLEGE OF ENGINEERING AND TECHNOLOGY (Autonomous)	CURRICULUM UG R - 2018 Ver- 4

Department	Medical Electronics (MD)
Programme	B.E. – Medical Electronics

INCORPORATING RELATIVE GRADING SYSTEM

SEMESTER 1

Sl. No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
THEORY														
1	HS	21	EN	T	1	1	Communicative English - I	3	0	0	3	40	60	100
2	BS	21	MA	T	1	1	Engineering Mathematics - I	3	1	0	4	40	60	100
3	BS	21	PH	T	1	1	Engineering Physics	3	0	0	3	40	60	100
4	BS	21	CY	T	1	1	Engineering Chemistry	3	0	0	3	40	60	100
5	ES	21	EC	T	1	1	Semiconductor Devices	3	0	0	3	40	60	100
6	ES	21	ME	C	1	1	Engineering Graphics	2	0	4	4	40	60	100
PRACTICALS														
7	BS	21	PH	L	1	1	Physics and Chemistry Laboratory - I	0	0	3	1	60	40	100
8	ES	21	ME	L	1	1	Workshop Practices Laboratory	0	0	3	1	100	0	100
MANDATORY														
9	MC	21	MC	L	1	1	Universal Human Values-I	1	0	1	0	100	0	100
							Total credits	**22**						

SEMESTER 2

Sl. No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
THEORY														
1	HS	21	EN	T	2	1	Communicative English - II	3	0	0	3	40	60	100
2	BS	21	MA	T	2	1	Engineering Mathematics - II	3	1	0	4	40	60	100
3	BS	21	BM	T	2	3	Medical Physics	3	0	0	3	40	60	100
4	ES	21	CS	T	1	3	Python Programming	3	0	0	3	40	60	100
5	ES	21	EC	T	2	1	Basic Electrical Engineering	3	0	0	3	40	60	100
PRACTICALS														
6	BS	21	PH	L	2	1	Physics and Chemistry Laboratory - II	0	0	3	1	60	40	100
7	ES	21	CS	L	1	3	Python Programming Laboratory	0	0	3	1	60	40	100
8	ES	21	EC	L	2	1	Circuits and Devices Laboratory	0	0	3	1	60	40	100
MANDATORY														
9	MC	21	MC	T	0	2	Environmental Science and Engineering	2	0	0	0	100	0	100
							Total credits	19						

Semester							3							
Sl. No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
THEORY														
1	BS	21	MA	T	3	1	Transforms and Partial Differential Equations	3	1	0	4	40	60	100
2	PC	21	MD	T	3	1	Life Sciences	3	0	0	3	40	60	100
3	PC	21	MD	T	3	2	Sensors and Measurements	3	0	0	3	40	60	100
4	PC	21	MD	C	3	1	Analog Electronics	3	0	2	4	50	50	100
5	ES	21	EC	T	3	1	Signals and Systems	3	1	0	4	40	60	100
PRACTICALS														
6	PC	21	MD	L	3	1	Life Sciences Laboratory	0	0	3	1	60	40	100
7	PC	21	MD	L	3	2	Sensors and Measurements Laboratory	0	0	3	1	60	40	100
MANDATORY														
8	MC	21	MC	L	0	3	Essential English for Professionals	0	0	2	0	100	0	100
							Total credits	**20**						

Semester							4							
Sl. No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
THEORY														
1	BS	21	MA	T	4	1	Probability and Random Processes	3	1	0	4	40	60	100
2	ES	21	IT	T	4	3	Data Structures using Object Oriented Programming	3	0	0	3	40	60	100
3	PC	21	MD	T	4	1	Linear and Digital Integrated Circuits	3	0	0	3	40	60	100
4	PC	21	MD	T	4	2	BioControl System Engineering	3	1	0	4	40	60	100
5	PC	21	MD	T	4	3	Medical Equipment - I	3	0	0	3	40	60	100
6	ES	21	EC	T	4	6	Analog and Digital Communication	3	0	0	3	40	60	100
PRACTICALS														
7	ES	21	IT	L	4	2	Data Structures using Object Oriented Programming Laboratory	0	0	3	1	60	40	100
8	PC	21	MD	L	4	1	Linear and Digital Integrated Circuits Laboratory	0	0	3	1	60	40	100
MANDATORY														
9	MC	21	MC	L	0	4	Professional Communication	0	0	2	0	100	0	100
							Total credits	**22**						

SEMESTER 5															
Sl. No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
THEORY														
1	PC	21	MD	C	5	1	BioSignal Processing	3	0	2	4	50	50	100
2	ES	21	MD	T	5	1	Microprocessor and Embedded Controllers	3	0	0	3	40	60	100
3	PC	21	MD	T	5	2	Medical Equipment - II	3	0	0	3	40	60	100
5	PE						Professional Elective - I	3	0	0	3	40	60	100
6	PE						Professional Elective - II	3	0	0	3	40	60	100
7	OE						Open Elective - I	3	0	0	3	40	60	100
PRACTICALS														
8	ES	21	MD	L	5	1	Bio Medical Instrumentation Laboratory	0	0	3	1	60	40	100
10	PC	21	MD	L	5	2	Microprocessor and Embedded Controllers Laboratory	0	0	3	1	60	40	100
MANDATORY														
11	MC	21	MC	T	0	5	Aptitude and Logical Reasoning	2	0	0	0	100	0	100
12	MC	21	MC	L	0	9	Communication Skills Laboratory	0	0	2	0	100	0	100
Total credits								21						

SEMESTER 6														
Sl. No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
THEORY														
1	PC	21	MD	T	6	1	Medical Image Processing	3	0	0	3	40	60	100
2	PC	21	MD	T	6	2	Rehabilitation Engineering	3	0	0	3	40	60	100
3	PC	21	MD	T	6	3	Hospital Engineering and Management	3	0	0	3	40	60	100
4	PE						Professional Elective - III	3	0	0	3	40	60	100
5	PE						Professional Elective - IV	3	0	0	3	40	60	100
6	OE						Open Elective - II	3	0	0	3	40	60	100
PRACTICALS														
7	PC	21	MD	L	6	1	Diagnostic and Therapeutic Equipment Laboratory	0	0	3	1	60	40	100
8	PC	21	MD	L	6	2	Medical Image Processing Laboratory	0	0	3	1	60	40	100
9	EC	21	MD	L	6	3	Mini Project	0	0	6	3	40	60	100
MANDATORY														
10	MC	21	MC	T	0	7	Arithmetic and Analytical Ability	2	0	0	0	100	0	100
Total credits								23						

SEMESTER 7														
Sl. No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
THEORY														
1	HS	21	IT	T	7	1	Economics and Management for Engineers	3	0	0	3	40	60	100
2	PC	21	MD	T	7	1	Medical Expert Systems	3	0	0	3	40	60	100
3	PE						Professional Elective - V	3	0	0	3	40	60	100
4	PE						Professional Elective - VI	3	0	0	3	40	60	100
5	OE						Open Elective - III	3	0	0	3	40	60	100
6	HS	21	HS	T	1	2	Human Values and Professional Ethics	3	0	0	3	40	60	100
PRACTICALS														
7	PC	21	MD	L	7	1	Expert System Laboratory	0	0	3	1	60	40	100
8	PC	21	MD	L	7	2	Hospital Training	0	0	4	2	60	40	100
MANDATORY														
9	MC	21	MC	T	0	8	Indian Constitution and Traditional Knowledge	2	0	0	0	100	0	100
Total credits								21						

Semester	8

Sl. No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
THEORY														
1	EC	21	MD	L	8	1	Internship	-	-	-	2	100	0	100
2	EC	21	MD	L	8	2	Project Work	0	0	20	10	40	60	100
Total credits								12						
Total Programme Credits								160						

PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL 1	VERTICAL 2	VERTICAL 3	VERTICAL 4	VERTICAL 5	VERTICAL 6
Healthcare 4.0	**Medical System Design**	**Innovation and Product Development**	**Healthcare Management**	**Signal and Image Processing**	**ICT for Healthcare**
Haptics	Radiological Equipment	Foundation Skills in Integrated Product Development	Hospital Planning and Management	Speech and Audio Signal Processing	Medical Informatics
Medical Optics and Photonics	Medical Device Design	Patient Safety Standards and Ethics	Health Management Information Systems	Computer Vision	Wearable Devices
Rapid Prototyping	BioMEMS	Medical Device Regulations	Medical Waste Management	Medical Imaging Systems	Telehealth Technology
Ergonomics for Healthcare	Assistive Devices	Electrical Safety and Quality Assurance	Medical Ethics And Standards	Advanced Digital Signal Processing	IoT in Healthcare
AI in Healthcare	ICU and OT Equipment	Medical Innovation and Entrepreneurship	Forensic Science in Healthcare	Brain Computer Interface and Applications	Cloud Computing for Healthcare
Robotics and Automation in Healthcare	Analytical Instrumentation	Intellectual Property Rights	Biostatistics	Biometric Systems	Augmented Reality and Virtual Reality in Healthcare
Physiological Modeling	Medical Equipment Maintenance and Troubleshooting	Medical Device Packaging	Digital Healthcare Technologies	Pattern Recognition and Neural Networks	Cyber Security for Medical Systems

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI. The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Honours) or Minor degree also**.**

PROFESSIONAL ELECTIVES															
Sl. No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
Vertical I Healthcare 4.0														
1	PE	21	MD	E	0	1	Haptics	3	0	0	3	40	60	100
2	PE	21	MD	E	0	2	Medical Optics and Photonics	3	0	0	3	40	60	100
3	PE	21	MD	E	0	3	Rapid Prototyping	3	0	0	3	40	60	100
4	PE	21	MD	E	0	4	Ergonomics for Healthcare	3	0	0	3	40	60	100
5	PE	21	MD	E	0	5	AI in Healthcare	3	0	0	3	40	60	100
6	PE	21	MD	E	0	6	Robotics and Automation in Healthcare	3	0	0	3	40	60	100
7	PE	21	MD	E	0	7	Physiological Modeling Systems	3	0	0	3	40	60	100
Vertical II Medical Device and Development														
1	PE	21	MD	E	0	8	Radiological Equipment	3	0	0	3	40	60	100
2	PE	21	MD	E	0	9	Medical Device Design	3	0	0	3	40	60	100
3	PE	21	MD	E	1	0	BioMEMS	3	0	0	3	40	60	100
4	PE	21	MD	E	1	1	Assistive Devices	3	0	0	3	40	60	100
5	PE	21	MD	E	1	2	ICU and OT Equipment	3	0	0	3	40	60	100
6	PE	21	MD	E	1	3	Analytical Instrumentation	3	0	0	3	40	60	100
7	PE	21	MD	E	1	4	Medical Equipment Maintenance and Troubleshooting	3	0	0	3	40	60	100
Vertical III Innovation and Product Development														
1	PE	21	MD	E	1	5	Foundation Skills in integrated product Development	3	0	0	3	40	60	100
2	PE	21	MD	E	1	6	Patient safety, Standards and Ethics	3	0	0	3	40	60	100
3	PE	21	MD	E	1	7	Medical Device Regulations	3	0	0	3	40	60	100
4	PE	21	MD	E	1	8	Electrical Safety and Quality Assurance	3	0	0	3	40	60	100
5	PE	21	MD	E	1	9	Medical Innovation And Entrepreneurship	3	0	0	3	40	60	100
6	PE	21	MD	E	2	0	Intellectual Property Rights	3	0	0	3	40	60	100
7	PE	21	MD	E	2	1	Medical Device Packaging	3	0	0	3	40	60	100
Vertical IV Healthcare Management														
1	PE	21	MD	E	2	2	Hospital Planning and Management	3	0	0	3	40	60	100
2	PE	21	MD	E	2	3	Health Management Information Systems	3	0	0	3	40	60	100
3	PE	21	MD	E	2	4	Medical Waste Management	3	0	0	3	40	60	100

4	PE	21	MD	E	2	5	Medical Ethics And Standards	3	0	0	3	40	60	100
5	PE	21	MD	E	2	6	Forensic Science in healthcare	3	0	0	3	40	60	100
6	PE	21	MD	E	2	7	Biostatistics	3	0	0	3	40	60	100
7	PE	21	MD	E	2	8	Digital Healthcare Technologies	3	0	0	3	40	60	100
Vertical V Signal and Image Processing														
1	PE	21	MD	E	2	9	Speech and Audio signal Processing	3	0	0	3	40	60	100
2	PE	21	MD	E	3	0	Computer Vision	3	0	0	3	40	60	100
3	PE	21	MD	E	3	1	Medical Imaging System	3	0	0	3	40	60	100
4	PE	21	MD	E	3	2	Advanced Digital Signal Processing	3	0	0	3	40	60	100
5	PE	21	MD	E	3	3	Brain Computer Interface and Applications	3	0	0	3	40	60	100
6	PE	21	MD	E	3	4	Biometric Systems	3	0	0	3	40	60	100
7	PE	21	MD	E	3	5	Pattern Recognition and Neural Networks	3	0	0	3	40	60	100
Verticals VI ICT for Healthcare														
1	PE	21	MD	E	3	6	Medical Informatics	3	0	0	3	40	60	100
2	PE	21	MD	E	3	7	Wearable Devices	3	0	0	3	40	60	100
3	PE	21	MD	E	3	8	Telehealth Technology	3	0	0	3	40	60	100
4	PE	21	MD	E	3	9	IoT in Healthcare	3	0	0	3	40	60	100
5	PE	21	MD	E	4	0	Cloud Computing for Healthcare	3	0	0	3	40	60	100
6	PE	21	MD	E	4	1	Augmented Reality and Virtual Reality in Healthcare	3	0	0	3	40	60	100
7	PE	21	MD	E	4	2	Cyber Security for Medical Systems	3	0	0	3	40	60	100

VERTICALS FOR MINOR DEGREE-
(In addition to all the verticals of other programmes)

Vertical I Fintech and Block Chain	Vertical II Entrepreneurship	Vertical III Public Administration	Vertical IV Business Data Analytics	Vertical V Environmental and Sustainability	Vertical VI Artificial Intelligence
Financial Management	Foundations of Entrepreneurship	Principles of Public Administration	Statistics for Management	Sustainable infrastructure Development	Introduction to Data Science
Fundamentals of Investment	Team Building & Leadership Management for Business	Constitution of India	Data mining for Business Intelligence	Sustainable Agriculture and Environmental Management	Principles of Artificial Intelligence
Banking, Financial Services and Insurance	Creativity & Innovation in Entrepreneurship	Public Personnel Administration	Human Resource Analytics	Sustainable Bio Materials	Data Warehou sing and data mining
Introduction to Blockchain and its Applications	Principles of Marketing Management For Business	Administrative Theories	Digital Marketing and Social Network Analytics	Materials for Energy Sustainability	Machine Learning Techniques
Fintech Personal Finance and Payments	Human Resource Management for Entrepreneurs	Indian Administrative System	Supply Chain Analytics	Green Technology	Expert Systems
Introduction to Fintech	Financing New Business Ventures	Public Policy Administration	Financial Analytics	Environmental Quality Monitoring and Analysis	Cognitive Science
-	-	-	-	Integrated Energy Planning for Sustainable Development	Gamifi cation
-	-	-	-	Energy Efficiency for Sustainable Development	-

VERTICALS FOR MINOR DEGREE											
S. No	**Course Code**	**Course Title**	**Category**	**Periods / Week**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CA**	**SE**	**Tot.**
VERTICAL I FINTECH AND BLOCK CHAIN										
1	21ITM11	Financial Management	PE	3	0	0	3	40	60	100
2	21ITM12	Fundamentals of Investment	PE	3	0	0	3	40	60	100
3	21ITM13	Banking, Financial Services and Insurance	PE	3	0	0	3	40	60	100
4	21ITM14	Introduction to Blockchain and its Applications	PE	3	0	0	3	40	60	100
5	21ITM15	Fintech Personal Finance and Payments	PE	3	0	0	3	40	60	100
6	21ITM16	Introduction to Fintech	PE	3	0	0	3	40	60	100
VERTICAL II ENTREPRENEURSHIP										
1	21MEM21	Foundations of Entrepreneurship	PE	3	0	0	3	40	60	100
2	21MEM22	Team Building & Leadership Management for Business	PE	3	0	0	3	40	60	100
3	21MEM23	Creativity & Innovation in Entrepreneurship	PE	3	0	0	3	40	60	100
4	21MEM24	Principles of Marketing Management For Business	PE	3	0	0	3	40	60	100
5	21MEM25	Human Resource Management for Entrepreneurs	PE	3	0	0	3	40	60	100
6	21MEM26	Financing New Business Ventures	PE	3	0	0	3	40	60	100
VERTICAL III PUBLIC ADMINISTRATION										
1	21ECM31	Principles of Public Administration	PE	3	0	0	3	40	60	100
2	21ECM32	Constitution of India	PE	3	0	0	3	40	60	100
3	21ECM33	Public Personnel Administration	PE	3	0	0	3	40	60	100
4	21ECM34	Administrative Theories	PE	3	0	0	3	40	60	100
5	21ECM35	Indian Administrative System	PE	3	0	0	3	40	60	100
6	21ECM36	Public Policy Administration	PE	3	0	0	3	40	60	100
VERTICAL IV BUSINESS DATA ANALYTICS										
1	22CSM41	Statistics for Management	PE	3	0	0	3	40	60	100
2	22CSM42	Data mining for Business Intelligence	PE	3	0	0	3	40	60	100
3	22CSM43	Human Resource Analytics	PE	3	0	0	3	40	60	100
4	22CSM44	Digital Marketing and Social Network Analytics	PE	3	0	0	3	40	60	100
5	22CSM45	Supply Chain Analytics	PE	3	0	0	3	40	60	100
6	22CSM46	Financial Analytics	PE	3	0	0	3	40	60	100

VERTICAL V ENVIRONMENTAL AND SUSTAINABILITY										
1	21CEM51	Sustainable infrastructure Development	PE	3	0	0	3	40	60	100
2	21CEM52	Sustainable Agriculture and Environmental Management	PE	3	0	0	3	40	60	100
3	21CEM53	Sustainable Bio Materials	PE	3	0	0	3	40	60	100
4	21CEM54	Materials for Energy Sustainability	PE	3	0	0	3	40	60	100
5	21CEM55	Green Technology	PE	3	0	0	3	40	60	100
6	21CEM56	Environmental Quality Monitoring and Analysis	PE	3	0	0	3	40	60	100
7	21CEM57	Integrated Energy Planning for Sustainable Development	PE	3	0	0	3	40	60	100
8	21CEM58	Energy Efficiency for Sustainable Development	PE	3	0	0	3	40	60	100
VERTICAL VI ARTIFICIAL INTELLIGENCE										
1	22CSM61	Introduction to Data Science	PE	3	0	0	3	40	60	100
2	22CSM62	Principles of Artificial Intelligence	PE	3	0	0	3	40	60	100
3	22CSM63	Data Ware housing and Data Mining	PE	3	0	0	3	40	60	100
4	22CSM64	Machine Learning Techniques	PE	3	0	0	3	40	60	100
5	22CSM65	Expert Systems	PE	3	0	0	3	40	60	100
6	22CSM66	Cognitive Science	PE	3	0	0	3	40	60	100
7	22CSM67	Gamification	PE	3	0	0	3	40	60	100

OPEN ELECTIVES (Offered to other Departments)														
Sl. No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
1	OE	21	MD	O	0	1	Introduction To Medical Electronics	3	0	0	3	40	60	100
2	OE	21	MD	O	0	2	Hospital Waste Management	3	0	0	3	40	60	100
3	OE	21	MD	O	0	3	Hospital Information System	3	0	0	3	40	60	100
4	OE	21	MD	O	0	4	IoT Applications in Healthcare	3	0	0	3	40	60	100

OPEN ELECTIVES
(Offered by other Departments to B.E.Medical Electronics Programme)

OPEN ELECTIVES (Offered by Department of Biomedical Engineering)														
Sl. No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
1	OE	21	BM	O	0	1	Biotelemetry	3	0	0	3	40	60	100
2	OE	21	BM	O	0	2	Biometric systems and their applications	3	0	0	3	40	60	100
3	OE	21	BM	O	0	3	Biology for Engineers	3	0	0	3	40	60	100
4	OE	21	BM	O	0	4	Healthcare Management Systems	3	0	0	3	40	60	100
5	OE	21	BM	O	0	5	Medical Robotics	3	0	0	3	40	60	100
6	OE	21	BM	O	0	5	Rapid Prototyping	3	0	0	3	40	60	100

OPEN ELECTIVES (Offered by Department of Civil Engineering)														
Sl. No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
1	OE	21	CE	O	0	1	Civil and Infrastructure Engineering	3	0	0	3	40	60	100
2	OE	21	CE	O	0	2	Environmental Pollution and waste management	3	0	0	3	40	60	100
3	OE	21	CE	O	0	3	Disaster Management and Mitigation	3	0	0	3	40	60	100
4	OE	21	CE	O	0	4	Building Services	3	0	0	3	40	60	100

OPEN ELECTIVES (Offered by Department of Computer Science Engineering)														
Sl. No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
1	OE	21	CS	O	0	1	Cyber security	3	0	0	3	40	60	100

2	OE	21	CS	O	0	2	Web designing	3	0	0	3	40	60	100
3	OE	21	CS	O	0	3	Knowledge management	3	0	0	3	40	60	100
4	OE	21	CS	O	0	4	Green computing	3	0	0	3	40	60	100
5*	OE	21	CS	O	0	5	Principles of Artificial Intelligence	3	0	0	3	40	60	100

OPEN ELECTIVES
(Offered by Department of Electronics and Communication Engineering)

Sl. No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
1	OE	21	EC	O	0	1	Automotive Electronics	3	0	0	3	40	60	100
2	OE	21	EC	O	0	2	SCILAB for Engineers	3	0	0	3	40	60	100
3	OE	21	EC	O	0	3	Satellite Applications	3	0	0	3	40	60	100
4	OE	21	EC	O	0	4	Consumer Electronics	3	0	0	3	40	60	100
5	OE	21	EC	O	0	5	Principles of Communication Engineering	3	0	0	3	40	60	100
6	OE	21	EC	O	0	6	Microcontroller based Sytsem Design	3	0	0	3	40	60	100

OPEN ELECTIVES
(Offered by Department of Electrical and ElectronicsEngineering)

Sl. No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
1	OE	21	EE	O	0	1	PLC and SCADA	3	0	0	3	40	60	100
2	OE	21	EE	O	0	2	Renewable Energy Sources	3	0	0	3	40	60	100
3	OE	21	EE	O	0	3	Embedded Real Time System	3	0	0	3	40	60	100
4	OE	21	EE	O	0	4	Energy Auditing and Conservation	3	0	0	3	40	60	100
5	OE	21	EE	O	0	5	Electric Vehicles	3	0	0	3	40	60	100

OPEN ELECTIVES
(Offered by Department of Mechanical Engineering)

Sl. No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
1	OE	21	ME	O	0	1	Foundations of Entrepreneurship	3	0	0	3	40	60	100
2	OE	21	ME	O	0	2	Team Building and Leadership Management for Business	3	0	0	3	40	60	100
3	OE	21	ME	O	0	3	Creativity and Innovation in Entrepreneurship	3	0	0	3	40	60	100
4	OE	21	ME	O	0	4	Principles of Marketing Management for Business	3	0	0	3	40	60	100
5	OE	21	ME	O	0	5	Human Resource Management for Entrepreneurs	3	0	0	3	40	60	100
6	OE	21	ME	O	0	6	Financing New Business Ventures	3	0	0	3	40	60	100

OPEN ELECTIVES
(Offered by Department of Information Technology)

Sl. No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
1	OE	21	IT	O	0	1	Basics of Java Programming	3	0	0	3	40	60	100
2	OE	21	IT	O	0	2	Ethical Hacking	3	0	0	3	40	60	100

3	OE	21	IT	O	0	3	E-Commerce and Applications	3	0	0	3	40	60	100
4	OE	21	IT	O	0	4	Basics of Android Application Development	3	0	0	3	40	60	100
5*	OE	21	IT	O	0	5	Principles of Data Science	3	0	0	3	40	60	100

OPEN ELECTIVES
(Offered by Department of Science & Humanities)

Sl. No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
1*	OE	21	GE	O	0	1	National Cadet Corps Studies-I	3	0	0	3	40	60	100
2*	OE	21	GE	O	0	2	National Cadet Corps Studies-II	3	0	0	3	40	60	100

*Added in 6th BoS(From the AY 2021-22 onwards)

VALUE ADDED COURSES
(Offered by Department of Medical Electronics)

Sl. No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
1	VC	21	MD	V	0	1	Clinical Pathology and Microbiology	0	0	2	1	100	0	100
2	VC	21	MD	V	0	2	Calibration and Testing of Medical Devices.	0	0	2	1	100	0	100
3	VC	21	MD	V	0	3	PCB design using Altium Designer/OrCAD/EAGLE.	0	0	2	1	100	0	100
4	VC	21	MD	V	0	4	Modelling,Simulation and Analysis of Biological Systems using LabVIEW	0	0	2	1	100	0	100
5	VC	21	MD	V	0	5	Arduino Programming for Health Care Applications.	0	0	2	1	100	0	100
6	VC	21	MD	V	0	6	Machine Learning using Matlab/Python.	0	0	2	1	100	0	100
7	VC	21	MD	V	0	7	Biomedical Equipment Repair and Maintenance.	0	0	2	1	100	0	100
8	VC	21	MD	V	0	8	Development of Assistive Devices for Disabled persons.	0	0	2	1	100	0	100
9	VC	21	MD	V	0	9	Development of Health care Apps.	0	0	2	1	100	0	100
10	VC	21	MD	V	1	0	Designing of Medical Devices using Autodesk Fusion 360.	0	0	2	1	100	0	100

21ENT11 **COMMUNICATIVE ENGLISH-I** **L T P C**
3 0 0 3

Preamble:
Communicative English is a life skill necessary for all students of Engineering and Technology. The course Communicative English-I aims at developing Communication Skills in English essential for the learner to handle English language for a variety of everyday purposes through acquisition of basic grammar and vocabulary along with necessary listening, speaking, reading and writing skills.

Course Outcomes: Upon completion of the course, students will be able to :
1. Use a wide range of vocabulary in oral and written communication.
2. Use correct grammatical structures in speaking and writing.
3. Write clear and coherent informal Passages.
4. Follow different kinds of spoken excerpts and distinguish relevant from irrelevant information, grasp proper sentence pattern and vocabulary through reading
5. Give short informal presentations and participate in classroom discussions

UNIT 1 VOCABULARY **6**
Synonyms and Antonyms- Single Word Substitutes - Use of Abbreviations andAcronyms-Homonyms and Homophones-Business Vocabulary - Commonly Confused Words- Collocation - British and American Vocabulary- Word formation

UNIT 2 GRAMMAR **9**
Comparative Adjectives - Modals -Phrasal Verbs -Tenses – Connectives-Impersonal Passive Voice -Types of Questions -Mechanics of Writing (Editing) -Direct and Indirect Speech- Numerical Adjectives - Gerunds and Infinitives-Expressions of Purpose- Conditional Sentences- Same Word Used as Different Parts of Speech –SubjectVerb Agreement

UNIT 3 INFORMAL WRITING **5**
Letter Writing - Informal Letters - Dialogue Writing -Informal Dialogues – Essay Writing-Informal Essays
Movie/Book Reviews

UNIT 4 LANGUAGE ENHANCEMENT THROUGH LISTENING & READING **9**
Listening Comprehension -Listening for General Ideas- Listening to You Tube Documentaries - Listening for Specific Information- Listening for Details-Listening for Vocabulary-BBC Learn English Videos -Reading Comprehension-Understanding General and Specific Information -Sign Post Words-Jumbled Sentences - Finding Topic Sentences and Supporting Arguments - Reading for Vocabulary-Reading News Papers

UNIT 5 LANGUAGE ENHANCEMENT THROUGH SPEAKING **16**
Introduction to IPA-Syllable, Stress, Intonation, etc., -Conversation Starters- Describing Places, People, Things and Pictures -Self Introduction - Narrating Personal Experiences and Incidents-Informal Group Discussions

TOTAL: 45 PERIODS

TEXT BOOKS:
1. Sanjay KumarandPushp Lata, "Communication Skills" 2nd Edition, Oxford University Press, New Delhi,2017
2. Raman, Meenakshi and Sangeetha Sharma, "Technical Communication: English Skills for Engineers", 1st Edition, Oxford University Press, New Delhi. 2008.

REFERENCES:
1. Department of English, Anna University, "Mindscapes: English for Technologists and Engineers", 1st Edition, Orient Black Swan, Chennai. 2012
2. Dhanavel, S.P, "English and Communication Skills for Students of Science and Engineering", 1st Edition, Orient Black Swan, Chennai. 2011
3. Rizvi, Ashraf. M, "Effective Technical Communication", 2st Edition, Tata McGraw-Hill, New Delhi,2021.

e- RESOURCES:
1. http://www.usingenglish.com
2. https://www.khanacademy.org/humanities/grammar

21MAT11 **ENGINEERING MATHEMATICS I** **L T P C**
3 1 0 4

Preamble:

The course aims at achieving conceptual understanding of topics such as Matrix Algebra and Calculus. The syllabus is designed to provide the skills for modeling engineering problems and understand the role of single variable and multivariables in the discipline of engineering and computer science.

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

1. Evaluate Eigen values, eigenvectors and diagonalization of symmetric matrices.
2. Use limit definition, understand differentiation and integration methods.
3. Compute curvature, centre of curvature, evolute and envelope of curves.
4. Express functions of two variables in Taylor's series and compute Jacobians, maximum and minimum values.
5. Apply multiple integrals to determine area in cartesian and polar coordinates and volume in cartesian co ordinates.

UNIT 1 MATRICES **9+3**

Characteristic equation – Eigen values and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors – Statement and application of Cayley Hamilton Theorem – Orthogonal transformation of a symmetric matrix to diagonal form – Reduction of quadratic form to canonical form by orthogonal transformation.

UNIT 2 CALCULUS **9+3**

Representation of functions – Mathematical Models – New Functions from Old Functions – Graphing Calculators and Computers – The Limit of a Function – Calculating Limits Using the Limit Laws – Continuity – Exponential Growth and Decay – Hyperbolic Functions – Areas and Distances – The Definite Integral – The Fundamental Theorem of Calculus – Improper Integrals.

UNIT 3 GEOMETRICAL APPLICATIONS OF DIFFERENTIAL CALCULUS **9+3**

Curvature – Radius, Centre and Circle of curvature in Cartesian and Parametric form - Evolute – Envelope of family of curves with one and two parameters – Evolute as the envelope of normals – Properties of Evolute and Envelope.

UNIT 4 FUNCTIONS OF SEVERAL VARIABLES **9+3**

Partial derivatives – Total derivative – Differentiation of implicit functions – Jacobian- Properties – Taylor's series expansion for functions of two variables – constrained Maxima and Minima – Lagrange's multipliers with single constraint.

UNIT 5 MULTIPLE INTEGRALS **9+3**

Double integrals in Cartesian and Polar co ordinates- Change of order of Integration – Change of variables from Cartesian to Polar co ordinates – Area as a double integral in Cartesian and Polar form – Volume as a triple integral in Cartesian co ordinates

TOTAL : 60 PERIODS

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics" 43rd Edition, Khanna Publishers, New Delhi, 2014.
2. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Edition, New Delhi, 2015. [Sections 1.1, 1.2, 1.3, 1.4, 2.2, 2.3, 2.5, 3.8, 3.11, 5.1, 5.2, 5.3 and 7.8].

REFERENCES:

1. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, 26th Reprint, New Delhi, 2016
2. Kreyszig Erwin, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
3. N.P.Bali,Manish Goyal, "Engineering Mathematics",Lakshmi Publications(PVT) Ltd,4 th edition,2014

e-RESOURCES:

1. http://nptel.ac.in/courses/111105035/"Advanced Engineering Mathematics", Prof. Pratima Panigrahi, Indian Institute of Technology, Kharagpur
2. http://nptel.ac.in/courses/122104017/ " Mathematics-I", Prof. S.K. Ray, Indian Institute of Technology,Kanpur

21PHT11 **ENGINEERING PHYSICS** **L T P C**
3 0 0 3

Preamble:
Ultrasonics forms the basis of Sonar and in the field of medicine for both diagnostics and therapeutic applications. Mechanical properties of Engineering materials are explored for industrial applications such as construction of bridges and railway wagons. Particle and wave nature of quantum particles form the basis of quantum computers .The virtues of lasers are explored in applications such as holography, computers ,space satellites and medicines.

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

1 Demonstrate the knowledge of wave optics in propagation of light waves in optical fibers in communications system.
2 Explain the production of Ultrasonics and its NDT techniques in scanning methods, medical applications.
3 Describe the Elastic property of solid materials and thermal conductivity of solids in industrial applications.
4 Explore the dual nature of light waves with quantum theory on Black body radiation and Schrodinger's wave equations.
5 Demonstrate the knowledge on Nd-YAG, CO_2, Semiconductor lasers in industrial applications of welding, heat treatment, cutting, medical treatment and holography.

UNIT 1 WAVES AND OPTICS **9**

Classification of waves-wave equation-(qualitative)-Typical and General wave equation-qualitative analysis of phase and group velocities of waves-Differential equation of simple harmonic motion-Forced oscillations –analysis and classification of damped oscillations through differential equations-coherent sources and incoherent sources.
Superposition principle of Waves- Illustrations-Principle and propagation of light in optical fibers-numerical aperture and acceptance angle-Types of optical fibers (material, refractive index, mode-Application of optical fibers.

UNIT 2 ULTRASONICS **9**

Introduction – Production techniques– Magnetostriction effect– Piezoelectric effect - Piezoelectric generator- detection of ultrasonic waves - properties – cavitations - velocity measurement – acoustic grating - Industrial applications – drilling, welding, soldering and cleaning – SONAR - non destructive testing – pulse echo system, through transmission and reflection modes - A,B and C scan - medical applications - sonograms.

UNIT 3 MECHANICAL AND THERMAL PROPERTIES **9**

Elasticity – Stress-strain diagram and its uses – factors affecting elastic modulus and tensile strength. Torsional stress and deformations – twisting couple – torsion pendulum: theory and experiment – bending of beams. Bending moment – cantilever, Young's Modulus by Uniform and non-uniform bending: theory and experiment – I-shaped girders.
Modes of heat transfer -thermal conductivity- Specific heat-Newton's law of cooling - Forbe's and Lee's disc method: theory and experiment– thermal insulation – applications: heat exchangers, refrigerators, ovens and solar water heaters

UNIT 4 MODERN PHYSICS **9**

Wave- particle duality, de-Broglie matter waves, Davisson-Germer experiment, Heisenberg uncertainty principle and its applications, Black body radiation – Planck's theory (derivation) – deduction of Wien's displacement law and Rayleigh – Jeans' law from Planck's theory — Matter waves – concept of operator-Eigen value and Eigen function- Physical significance of wave function -Schrodinger's time independent wave equation — Particle in a one dimensional box ,qualitative explanation on wave equation and energy value in three dimensional box.

UNIT 5 LASER **9**

Introduction – principle of spontaneous emission and stimulated emission, population inversion, pumping. Einstein's coefficients - derivation. Types of lasers- Nd-YAG-CO_2, Semiconductor lasers (homojunction & heterojunction) – Industrial applications - lasers in welding, heat treatment, cutting- medical applications- holography-construction and reconstruction-Safety classes of laser.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Gaur R.K. and Gupta S.L., "Engineering Physics", 8th Edition, Dhanpat Rai publishers, 2009.
2. Mani Naidu S., "Engineering Physics", 2nd Edition, Pearson Publishing, 2011.

REFERENCES

1. Serway and Jewett, "Physics for Scientists and Engineers with Modern Physics", 9th Edition, Thomson Brooks Cole, 2013
2. Young H.D., Freedman R.A. and Ford A.L., "Sears and Zemansky's University Physics with Modern Physics", 13th Edition, Pearson India, 2013.
3. Tipler P.A. and Mosca G.P., "Physics for Scientists and Engineers with Modern Physics", 6th Edition, W.H.Freeman, 2007.

e- RESOURCES:

1. http://nptel.ac.in/courses/115101003 , "Atomic and Molecular Physics" – Dr. T. Kundu, IIT Bombay.
2. https://www.khanacademy.org/science/physics/quantum-physics

Preamble:

The study of water technology enables engineers to acquire skills to make the simple design calculation of drinking water as well as industrial water treatment. Electrochemistry and corrosion explain the fundamentals, corrosion prevention, identification and implementation for solving electrochemical and corrosion problems. The study of energy storage devices exposes some of the most commonly used energy storage technologies.Instrumental methods and analysis describe basic concepts and promote to solve real analytical problems. Studies of Nanochemistry span many areas as assemblies significant new structures like nanowire, nanotube and lab-in-chip devices.

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

1. Evaluate the process to purify hard water using ion-exchange, zeolite and reverse osmosis methods.
2. Compare and contrast corrosion control methods and analyze the performance of alkaline, lead acid and fuel cells.
3. Analyze the metal ion concentration for solid and liquid samples with the aid of flame photometry, colorimetry, UV and IR spectroscopy.
4. Categorize different types of polymers to select injection or compression fabrication method.
5. Analyze the synthesis of nanoparticles using top down and bottom up process.

UNIT 1 WATER TECHNOLOGY 9

Hardness – types, estimation by EDTA method, Boiler troubles – scale, sludge, priming, foaming, caustic embrittlement and boiler corrosion, Internal conditioning - carbonate, phosphate and calgon conditioning, External conditioning – zeolite and demineralisation process, Desalination – reverse osmosis method.

UNIT 2 ELECROCHEMISTRY AND CORROSION 9

Electrochemistry –cell terminology, EMF series. Corrosion – chemical (corrosion by O_2, H_2 and liquid-metal) and electrochemical corrosion (H_2 evolution and absorption of O_2), Corrosion control – sacrificial anode, Impressed current method and electroless plating.

Application of electrochemistry-primary battery (alkaline battery), secondary battery (lead acid battery) and fuel cell (H_2-O_2 fuel cell)

UNIT 3 INSTRUMENTAL METHODS AND ANALYSIS 9

Basic principles – Beer-lamberts law, instrumentation with block diagram and applications of calorimetry (estimation of Fe^{2+}), UV-Visible spectroscopy, infrared spectroscopy and flame photometry (estimation of sodium).

UNIT 4 HIGH POLYMERS 9

Polymers – classification (based on molecular forces-thermoplastics and thermosetting plastics), polymerisation – types, mechanism (Free radical only),Compounding and fabrication – compression, injection, Composites-definition, types, polymer matrix composites-FRP only.

Real time applications of thermoplastics (PVC, Teflon), thermosetting plastics (nylon, epoxy resin)

UNIT 5 NANOCHEMISTRY 9

Basics – distinction between molecules, nanoparticles and bulk materials, Nanoparticles – nano cluster, nano rod, nanotube (CNT) and nanowire, Synthesis – top down process (laser ablation and electro-deposition),bottom up process (thermolysis – hydrothermal, solvothermal), Nanoparticles –properties and applications.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. P.C Jain and Monika Jain, "Engineering Chemistry", 16th edition,DanpatRai publishing company (P) Ltd, New Delhi, 2015
2. N. Krishnamurthy, P. Vallinayagam and D. Madhavan, "Engineering Chemistry", 3rd edition. PHI Learning PVT., LTD, New Delhi, 2014.

REFERENCES:

1. S.S.Dara, "A Text book of Engineering Chemistry", 12th Edition, S.Chand & Company Ltd., New Delhi, 2010.
2. "Engineering chemistry", 2nd edition, Wiley India private Ltd. New Delhi, 2014.
3. V.R.Gowariker, N.V.Viswanathan and Jayadevsreedhar, "Polymer Science" 2nd edition, New age International publishers, New Delhi, 2015.

e- RESOURCES:

1. http://nptel.ac.in/courses/113104061/ ,"Environmental Degradation of Materials" - Dr.KallolMondal Department of Metallurgy and Material Science, IIT Kanpur
2. http://nptel.ac.in/courses/113105028/ , "Science and Technology of Polymers"- Prof.B.Adhikari, Department of Metallurgical & Materials Engineering,IITKharagpur

21ECT11	SEMICONDUCTOR DEVICES	L T P C 3 0 0 3

Preamble:
The invention of solid state diodes and transistors have revolutionized the world. All the developments in the applications of electronics started with these. The fundamental components spawned into a range of signal and power devices. An ECE engineer has to understand these devices which the building blocks of the circuits and systems are.

Course Outcomes: Upon completion of the course, students will be able to:
1. Describe the characteristics of PN junction diodes.
2. Discuss the characteristics of BJT
3. Demonstrate the knowledge of FETs
4. Discuss the characteristics and applications of special diodes
5. Explain the characteristics of power devices and operation of rectifier circuits.

UNIT 1 PN JUNCTION DIODE **9**
Construction, Theory and operation of PN junction diode – VI Characteristics – current equation – Diode resistances and capacitances – Ratings – Applications - Zener diode and its characteristics – voltage regulation using zener diodes..

UNIT 2 BJT TRANSISTOR **9**
Principle of operation of PNP and NPN transistors – study of CE, CB and CC configurations and comparison of their characteristics.

UNIT 3 FET AND MOSFET **9**
Construction, Operation, Characteristics and Application of JFET - JFET Parameters -JFET as VVR.
Construction, Operation, Characteristics and Application of MOSFETs - EMOSFET and DMOSFET.

UNIT 4 SPECIAL PURPOSEDIODES **9**
Construction, Operation, Characteristics and Application of Tunnel diode, Varactor diode, LED, Laser diode, Photodiode, Gunn diode, Schottky Diode.

UNIT 5 POWER DEVICES AND DIODE APPLICATIONS **9**
Construction, Operation, Characteristics and Application of SCR, DIAC, TRIAC- IGBT. Operation and Analysis of Rectifiers: Half-Wave and Full-Wave (both centre-tapped and bridge types) Rectifiers with capacitor filters.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Robert L. Boylestad and Louis Nasheresky, "Electronic Devices and Circuit Theory", 10th Edition, Pearson Education / PHI, 2008.
2. Salivahanan S. &SureshkumarN. , "Electronic Devices and Circuits", McGraw Hill, Third Edition, Fifth Reprint, 2014

REFERENCES:

1. Monograms prepared by Faculty of ECE dept.
2. V.K.Mehta, Principles of Electronics, S.Chand& Co., 2011.
3. J. Millman , C CHalkias&SatyabrataJit, "Electronic Devices & Circuits", Tata McGraw Hill, 3rd Edition, 2010.

e. RESOURCES :
1. http://nptel.ac.in/courses/117101106/1, Analog Circuits,Prof. A N Chandorkar, IIT Bombay.
2. http://nptel.ac.in/courses/117103063/,Basic Electronics,Prof. Sunil Khijwania,IIT Guwahati..

Preamble:

The knowledge of Engineering graphics is essential for the Engineering graduates in proposing new product designs through drawings and interpreting data from existing drawings. Engineering Design inculcates into an Engineer the creativity and knowledge on various aspects to be considered while designing and realizing the functional products and processes. This course deals with Engineering curves, orthographic and pictorial projections, sectional views and development of surfaces.

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

1. Draw the various conic sections and Engineering curves.
2. Sketch the orthographic views from given pictorial views and projections of lines.
3. Draw the projections of planes and solids kept in various positions.
4. Sketch sectioned views of solids and development of surfaces.
5. Draw the isometric and perspective projections of simple solids.

UNIT 1 INTRODUCTION AND PLANE CURVES 12

Importance of graphics in Engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lines, lettering and dimensioning-Basic geometrical constructions. (PRACTICE ONLY AND NOT FOR EXAMINATIONS).

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 2 PROJECTION OF POINTS, LINES AND FREE HAND SKETCHING 12

Orthographic projection- principles-Principal planes-First angle projection- Projection of points in four quadrants - End point 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.

Visualization concepts- Free hand sketching – Conversion of Isometric view to orthographic views.

UNIT 3 PROJECTION OF PLANE SURFACES AND SOLIDS 12

Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

Projection of simple solids- Cube, prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane and parallel to the other by rotating object method.

UNIT 4 SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES 12

Sectioning of above solids in simple vertical position when cut by a cutting plane which is inclined to one of the reference planes and perpendicular to the other – Obtaining true shape of section.

Development of lateral surfaces of simple and truncated solids in simple vertical position – Cube, prisms, pyramids, cylinder and cone.

UNIT 5 ISOMETRIC AND PERSPECTIVE PROJECTIONS 12

Principles of isometric projection – Isometric scale –Isometric projections of simple solids - Prisms, pyramids, cylinder and cone- Combination of two solid objects in simple vertical position.

Perspective projection of simple solids-Cube, prisms, pyramids, cylinder and cone, by visual ray method when axis is either parallel or perpendicular to ground plane.

TOTAL : 60 PERIODS

TEXT BOOKS:

1 Venugopal K and Prabhu Raja V., "Engineering Graphics", New Age International (P) Ltd, 13th Edition, 2015.
2 Jeyapoovan T. , "Engineering Graphics with AUTOCAD", Vikas Publishing House Pvt., Ltd., 7th Edition, 2015.

REFERENCES:

1 Bhatt N.D., Panchal, V.M. and Ingle P.R., "Engineering Drawing", Charotar Publishing House Pvt. Ltd., 53rd Edition, 2014.
2 Parthasarathy N.S. and Vela Murali, "Engineering Drawing", Oxford University Press, 1st Edition, Second Impression 2015.
3 Luzzader W..J. and Duff J.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.

e- RESOURCES:

1. http://nptel.ac.in/courses/105104148, "Engineering Graphics" - Dr. Nihar Ranjan Patra , IIT Kanpur
2. http://cfd.annauniv.edu/webcontent.htm, "Engineering Graphics" - Dr. Velamurali

21PHL11	PHYSICS AND CHEMISTRY LABORATORY -I	L T P C 0 0 3 1

Preamble: In the present course related to the lab, understanding of physics concepts applied in optics, thermal and properties of matter has been developed. The necessary practical skills in the determination of water quality parameters and strength of acid has been explored.

Course Outcomes:

1. Experiment and determine the physical characteristics of given solid materials.
2. Experiment and determine the velocity of ultrasonic waves through water medium.
3. Experiment and determine the optical property of light sources.
4. Experiment and estimate hydroxyl, carbonate and bicarbonate alkalinity using HCl in water sample.
5. Experiment and determine the amount of total, temporary, permanent hardness of water using EDTA by complexometric titration.
6. Experiment and determine the amount of iron content present in the given sample using potentiometer, spectrophotometer and strength of acid using conductivity meter.

PHYSICS LABORATORY – I

(Any Five Experiments)

LIST OF EXPERIMENTS

1. (a) Determination of Wavelength, and particle size using Laser
   (b) Determination of acceptance angle in an optical fiber.
2. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer.
3. Determination of wavelength of mercury spectrum – spectrometer grating
4. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
5. Determination of Young's modulus by Non uniform bending method
6. Determination of Planck's constant by photocell method

CHEMISTRY LABORATORY – I

LIST OF EXPERIMENTS

1. Determination of alkalinity in water sample.
2. Determination of total, temporary and permanent hardness of water by EDTA method.
3. Determination of iron content of the water sample using spectrophotometer (1,10-phenanthroline /thiocyanate method).
4. Determination of iron content of the given solution using a potentiometer.
5. Determination of strength of acid using conductivity meter.

TOTAL : 30 PERIODS

- **Laboratory classes on alternate weeks for Physics and Chemistry.**

Preamble:

Workshop practices give hands-on training practice to Engineering students. This course includes carpentry, plumbing, welding, sheet metal forming and welding exercises. Also, this course will inculcate in the students the habit of selecting right tools, planning the job and its execution.

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

1. Fabricate various joints by carpentry and to prepare plumbing line assemblies.
2. Fabricate various joints through arc welding and gas welding processes.
3. Perform metal forming and basic machining operations.
4. Construct various types of domestic wiring and measure the various electrical parameters.
5. Develop and test circuits with active elements and verify truth table of logic gates.

GROUP A

CIVIL **9**

Plumbing Works:

- Study of plumbing tools, pipeline joints, its location, functions and safety aspects.

1. a. Distribution of water from sump to overhead tank and return to home tap with bye pass connection.
   b. Distribution of water in mixed pipes.

Carpentry using Power Tools only:

- Study of the carpentry tools, joints and processes in roofs, doors, windows and furniture and safety precautions.

Hands-on-exercise:

1. Tee Lap joint
2. Dove tail joint

MECHANICAL **15**

Welding:

1. Arc welding - Lap joint
2. Arc welding - Tee joint

Basic Machining:

3. Simple Turning and Facing
4. Drilling and Tapping

Sheet Metal Work- Forming & Bending:

5. Model making - Tray / Funnel

Study Experiments:

(a) Study of centrifugal pump
(b) Study of air conditioner

Demonstration:

- Gas welding practice

GROUP B

ELECTRICAL **12**

1. Residential house wiring using switches, fuse, indicator and lamps.
2. Fluorescent lamp wiring.
3. Stair case wiring.
4. Reading of voltage, current, power, energy and other parameters with 1 phase digital energy meter.
5. Measurement of earth resistance.

ELECTRONICS **9**

1. Identification and Study of Electronic components and equipments – Resistors, capacitors, inductors, colour coding and measurement.
2. Measurement of AC signal parameters (peak-peak, RMS value, period, frequency) using CRO.
3. Verification of the truth tables of logic gates: AND, OR, XOR and NOT.
4. Construction of Half Wave and Full Wave Rectifiers and study their output waveforms.
5. Soldering practice – Using general purpose PCB.

TOTAL : 45 PERIODS

REFERENCES: Manual prepared by the faculty of Mechanical Engineering Department, VCET.

e- RESOURCES: http://vlabs.iitkgp.ernet.in/be/#

21MCL11 **UNIVERSAL HUMAN VALUES – I** **L T P C**
1 0 1 0

Preamble:

Universal Human Values is a life skill necessary for all to develop physical health and factors for strengthening life force. This course aims to expose the students in the areas of mediation and impart the knowledge on social virtues and morals.

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

1. Demonstrate the knowledge on physical health
2. Discuss the factors for strengthening life force
3. Classify mind waves and explain the benefits of meditation
4. Explain individual and social virtues
5. Identify and explain the importance of morals.

UNIT 1 Physical Health **6**

SKY – Introduction – Education as a means for youth empowerment – Greatness of Education – Yoga for Youth Empowerment – Simplified Physical Exercises: Explanation – Hand, Leg, Breathing and Eye exercises – Kapalabathi, Makarasanam, Massaging, Acupressure and Relaxation practices –Yogasanas- Explanation – Benefits.

UNIT 2 Strengthening Life Forces **6**

Reasons for Diseases: Natural Reasons (Hereditary, Planetary Position, Natural Calamities and Climatic changes) – Artificial Reasons (Food, Thought, Deed). Philosophy of Kayakalpa: Physical Body –Life Force – Biomagnetism – Mind. Maintaining Youthfulness – Postponing Aging – Transformation of Food into seven Body constituents.

UNIT 3 Wellness of Mind **6**

Classification of Mind Waves – Beta, Alpha, Theeta, Delta – Agna Meditation – Benefits. Shanthi Mediation – Benefits. Thuriya Meditation – Benefits. Blessing and its Benefits: Auto Suggestion – Blessing the family and others – Blessings the World – Divine Protection.

UNIT 4 Virtues **6**

Individual Virtues: Self Control – Self Confidence – Speaking Truth – Contentment – Humility – Mind Control. Tolerance – Adjustment – Sacrifice – Forgiveness. Cleanliness (Body, Dress, Surrounding)-External, Mental, Inner Cleanliness. **Societal Virtues :** Ahimsa – Services, Patriotism – Equality, Respecting the parents and elders – Caring for them – Respecting Teachers. Punctuality – Time Management.

UNIT 5 Morals **6**

Importance of introspection: I and Mine (Ego, Possessiveness), Six Temperaments: Greed – Anger – Miserliness – Immoral Sexual Passion – Inferior Superior complex – Vengeance. Maneuvering the Six Temperaments: Contentment – Tolerance – Charity – Chastity – Parity – Forgiveness. Five important Benefits of Meditation: Perspicacity – Magnanimity – Adaptability – Receptivity – Creativity. (Enhancing memory) (Effective Examination Preparation)

TOTAL : 30 PERIODS

TEXT BOOKS:

1. "Yoga for Youth Empowerment" compiled by Vethathiri Maharishi Institute for Spiritual and Institutional Education, Aliyar, Pollachi, 1st Edition 2016.
2. "Yoga for Human Excellence", compiled by Vethathiri Maharishi Institute for Spiritual and Institutional Education, Aliyar, Pollachi 1st Edition 2009.

e-RESOURCE:

1. www.online.vethathiri.edu.in "online in (Virtual) Programme on Yoga and Human Excellence".

Preamble:
Communicative English is a life skill necessary for all students of Engineering and Technology. The course Communicative English-II aims at developing Communication Skills in English essential for expressing the ideas through speaking and writing in different social, academic and professional contexts.

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

1. Start, maintain and close a conversation in a variety of contexts including formal/informal and telephonic conversation.
2. Use structurally correct expressions and conversations.
3. Speak fluently using phrasal verbs and Idiomatic Expressions by recognizing and rectifying own pronunciation and intonation problems.
4. Speak fluently using a wide range of vocabulary.
5. Communicate effectively by using business correspondence structures.

UNIT 1 EFFECTIVE SPEAKING -BASIC LANGUAGE CHUNKS 10

Conversational Starters – Closing a Conversation - Greeting and Leave Taking - Introducing Oneself - Introducing Others - Making Request - Offering Help - Expressing Gratitude -Extending Invitation - – Conveying Wishes – Encouraging Words -Seeking Permission – Granting Permission-Making Complaints - Seeking Apology - Making Interruption - Expressing Possibility- Expressing Agreement and Disagreement - Expressing Hesitation -Asking for Directions and Giving Directions - Giving Instructions- Questions and Expressions with Time – Checking for Understanding -Showing Interest -Expressing Likes and Dislikes

UNIT 2 EFFECTIVE SPEAKING –ADVANCED LANGUAGE CHUNKS 10

Expressing Personal Opinion - Expressing Feelings - Accepting Responsibility - Giving Clarifications - Tag Questions - Giving Comments – Giving Advice – Making Suggestions- –Making Comparisons – Analyzing Problems- Exploring Options – Making Classifications and Elaborations - Speaking Hypothetically-- Discussing Plans-Making Negotiations-Making Presentations-Telephone Etiquette - Telephone Conversation

UNIT 3 EFFECTIVE SPEAKING - PHRASAL VERBS AND IDIOMATIC EXPRESSIONS 3

Most useful Phrasal Verbs related to Self-Introduction-Idiomatic Expressions related to Person, Time and Action

UNIT 4 EFFECTIVE SPEAKING – VOCABULARY ENRICHMENT 10

Talking about Abilities – Travel – Shopping – Climate -Commuting – Distance – Food – Occupation – Parties and Festivals – Daily Routine – Clothing – Hobbies – Favorites- Family – Buying and Selling- Schedules and Plans

NIT 5 BUSINESS WRITING 12

Writing Instructions - Recommendations - Checklist - Tour Itinerary -Writing Slogans - E- mail Writing - Single Line Definitions - Process Description – SMS - Transcoding Graphics - Bar Chart, Flow Chart, Pie Chart and Tables - Business Letters - Calling for Quotations, Placing Orders, Letter of Complaint, Letter of Clarification - Agenda and Meeting Minutes - Cover Letter with Résumé - Report Writing - Accident Report, Industrial Visit Report, Survey Report and Feasibility Report- Summary Writing.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Sanjay KumarandPushp Lata, “Communication Skills” 2nd Edition, Oxford University Press, New Delhi.2017.
2. J.K.Gangal, “A Practical Course in Spoken English” 1st Edition PH1 Learning Private Limited, Delhi,2014.

REFERENCES:

1. Dr K Elango, Dr. Veena Selvam, Dr. Sujatha Priyadarshini, “Resonance English for Engineers and Technologists”.Cambridge University Press, 1st Edition, Foundation Books,New Delhi, 2013.
2. Dr.MahendraSarawat, “Speak English Fluently” UpkarPrakashan Publishers, 1st Edition,Agra,2010.
3. S.Sumant,Joyce Pereira, “Technical English”,Vijay Nicole imprints Private Limited,1st EditionChennai,2017.

e-RESOURCES:

1. https://www.fluentu.com/Blog/english/english-small-talk/
2. http://www.britishcouncil.com

21MAT21 **ENGINEERING MATHEMATICS – II** **L T P C**

(Common to ALL B.E/B.TECH programmes in Second Semester) **3 1 0 4**

Preamble:

Vector calculus is a form of mathematics that is focused on the integration of vector fields. An Engineer should know the Transformations of the Integrals, as Transformation of Line Integral to surface and then to volume integrals. Complex Integration approach is very useful to evaluate many improper integrals of a real variable. Laplace transform method is a powerful method for solving linear ODEs and corresponding initial value problems as well as systems of ODEs arising in Engineering. The knowledge of transformations is to create a new domain in which it is easier to handle the problem that is being investigated.

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

1. Compute gradient, directional derivative by vector differentiation and determine line integrals, surface integrals and volume integrals by vector integration.
2. Construct analytic functions and transforms the analytic functions from one domain to another using conformal mapping.
3. Classify the singularities, find Laurent's series for analytic functions and compute complex integrals using Cauchy's integral theorem and Cauchy's Residue theorem.
4. Solve linear higher order differential equations with constant and variable coefficients
5. Solve linear second order ordinary differential equations with constant coefficients using the properties of Laplace Transforms.

UNIT 1 VECTOR CALCULUS **9+3**

Vector Differentiation: Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector integration: Line, Surface and Volume Integrals -Green's theorem in a plane, Gauss Divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving squares, rectangles, cubes and rectangular parallelepipeds.

UNIT 2 ANALYTIC FUNCTIONS **9+3**

Functions of a complex variable – Analytic functions: Necessary conditions – Cauchy-Riemann equations and sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function – Harmonic conjugate – Construction of analytic functions by Milne's method – Conformal mapping: $w = z+k$, kz, $1/z$ and bilinear transformation.

UNIT 3 COMPLEX INTEGRATION **9+3**

Statement and applications of Cauchy's integral theorem and Cauchy's integral formula (excluding proof) – Taylor's and Laurent's series expansions – Singularities – Residues – Cauchy's residue theorem(excluding proof) – Application of residue theorem to evaluate real definite integrals as contour integrals around unit circle and semi-circle (excluding poles on the real axis).

UNIT 4 ORDINARY DIFFERENTIAL EQUATIONS **9+3**

Linear higher order differential equations with constant coefficients – Method of variation of Parameters – Cauchy's and Legendre's linear differential equations – Simultaneous first order linear differential equations with constant coefficients.

UNIT 5 LAPLACE TRANSFORMS **9+3**

Laplace transform: Sufficient conditions – Transform of elementary functions – Basic Properties – Transforms of derivatives and integrals of functions — Transform of periodic functions

Inverse Laplace transform: Standard results – Statement of Convolution theorem and its applications – Initial and final value theorems – Solution of linear second order ODE with constant coefficients using Laplace transformation techniques.

TOTAL : 60 PERIODS

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics'', Khanna Publishers, 43rd Edition, New Delhi, 2014.
2. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, 26th Reprint, New Delhi, 2016

REFERENCES:

1. Kreyszig Erwin, "Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Veerarajan T., "Engineering Mathematics (I Year)", 3 rd Edition, Tata McGraw Hill Publishing Company, New Delhi, 2012.
3. P.Kandasamy, K.Thilagavathy, K.Gunavathy, "Higher Engineering Mathematics", S.Chand & Company Limited, Chennai,2016.

e-RESOURCES:

1. http://nptel.ac.in/courses/122107036/ "**Mathematics-II", Prof. Tanuja Srivastava, Department of Mathematics, Indian Institute of Technology, Roorkee.**
2. http://nptel.ac.in/courses/122107037/ "**Mathematics – III", Prof. Dr. P. N. Agrawal , Indian Institute of Technology, Roorkee**

Preamble:

Medical Physics is an applied branch of Physics concerned with the application of the radiation concepts and methods of Physics in Medical science. This course accentuates the principle, effects and clinical applications of ionizing, non-ionizing and electromagnetic radiation. This also enunciates the fundamentals of acoustic waves and their interaction with human tissues.

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

1. **Interpret** the properties of electromagnetic radiations and its effect on human.
2. **Describe** the principles and production of radioactive nuclides.
3. **Explain** the interaction of radiation with matter.
4. **Identify and explain** the radiation quantities and its effects
5. **Demonstrate** the knowledge on the properties of sound and its application in medicine.

UNIT 1 LOW ENERGY ELECTROMAGNETIC SPECTRUM AND ITS MEDICAL APPLICATION **9**

Physics of light, Intensity of light, limits of vision and color vision an overview, Non-ionizing Electromagnetic Radiation: Overview of non-ionizing radiation effects-Tissue as a leaky dielectric-Low Frequency Effects- Higher frequency effects., Thermography– Application

UNIT 2 PRINCIPLES OF RADIOACTIVE NUCLIDES **9**

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

UNIT 3 INTERACTION OF RADIATION WITH MATTER LIPIDS **9**

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

UNIT 4 RADIATION DOSE AND ITS EFFECTS **9**

Dose and Exposure measurements – Units (SI), Inverse square law, Maximum permissible exposure, relationship between the dosimetric quantities, Radiation biology – effects of radiation, concept of LD 50, Stochastic and Non-stochastic effects, Radiation Syndrome.

UNIT 5 PRINCIPLES AND APPLICATIONS OF SOUND IN MEDICINE **9**

Physics of sound, Normal sound levels, ultrasound fundamentals, Generation of ultrasound (Ultrasound Transducer), Interaction of Ultrasound with matter- Cavitations, Reflection, Transmission, Scanning methods, Artifacts, Ultrasound- Doppler effect, Clinical Applications

TOTAL : 45 PERIODS

TEXT BOOKS:

1. B.H. Brown, R.H. Smallwood, D.C. Barber, P.V. Lawford, D.R. Hose, ―Medical Physics and Biomedical Engineering‖, Institute of physics publishing, Bristol and Philadelphia, 1999. (Unit 1,4,5)
2. Gopal B. Saha ―Physics and Radiobiology of Nuclear Medicine‖ Third edition Springer, 2006. (Unit 2,3,4)

REFERENCES:

1. 1. W.J. Meredith and J.B. Massey ―Fundamental Physics of Radiology‖ Varghese Publishing house. 1992.
2. 2. Steve Webb, The Physics of Medical Imaging, Taylor & Francis, Newyork, 2010
3. 3.R.S. Khandpur, ―Handbook of Biomedical Instrumentation‖, Tata McGraw-Hill, New Delhi, 2003.

e-RESOURCES:

1. http://www.nptel.ac.in/courses/115102017/ , "Nuclear science and Engineering", Dr. Santanu Gosh, Department of Physics, IIT, Delhi.
2. http://www.uthgsbsmedphys.org/GS02-0093/ ," Introduction to Medical Physics I‖", Dr George Starkschall, The University of Texas at Houston.

21CST13 **PYTHON PROGRAMMING** **L T P C**

(Common to BE / B.Tech. -BM, CS, EC, EE, MD, IT Programmes) **3 0 0 3**

Preamble

Python is easy to use, powerful, and versatile, making it a great choice for beginners and experts alike. Python's readability makes it a great first programming language — it allows you to think like a programmer and not waste time understanding the mysterious syntax that other programming languages can require. The syntax in Python helps the programmers to do coding in fewer steps**.** Python is widely used in bigger organizations because of its multiple programming paradigm*s.*

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

1. Develop algorithms, flowcharts and write Python programs using decision control statements for solving given problems.
2. Apply list, set for solving a given problem using functions in python.
3. Develop modules and packages for solving problems using tuple and dictionary data structures in python.
4. Write python program using string handling features and object-oriented programming concepts
5. Identify the essential concepts involved in the design of a database and accessing, manipulating data in the file usingSQL.

UNIT 1 COMPUTING & PYTHON PROGRAMMING 12

Introduction to digital computer - Problem Solving Strategies: Problem Analysis – Algorithms – Flowcharts – Examples of algorithms and flowcharts- Introduction to Python: Python Overview – Comments – Python Identifiers –Reserved Keywords – Variables – Standard Data Types – Operators – Statement and Expressions –Control Statements – Iteration – While statements - Input from keyboard.

UNIT 2 FUNCTIONS, LIST AND SET 9

Introduction – Built-in functions – Composition of functions – User defined functions – Parameters and Arguments – Function calls – The return statement – Recursive functions – The anonymous functions. Lists-creating lists, traversing a list, Deleting elements from list, cloning list, list operations, list methods. Sets-creating sets, set operations.

UNIT 3 TUPLES, DICTIONARY, MODULES AND PACKAGES 6

Tuples- creating tuples, accessing values, tuple assignment, tuple as return values, operations on tuples, built-in tuple functions. Dictionary-creating, accessing, updating, Deleting elements from dictionary, operations and methods. Modules – Packages in Python – Standard library modules.

UNIT 4 STRINGS AND OOP Concepts 9

Strings: String Operations – Compound Data type – len function –String Slices – Strings are immutable – String Traversal – Escape Characters – String formatting operator – String formatting functions. Classes and objects: Overview of OOP – Class definition – creating objects – objects as arguments – objects as return values- Built-in class attributes – inheritance – method overriding – data encapsulation – data hiding.

UNIT 5 FILES AND BASIC DATABASE OPERATIONS 9

File: Types of files – opening, closing, reading and writing files. Purpose of database system - Data model - Creating DB-making table - Adding Data - Querying DB - Database in the real world - Using SQL in Databases - Sorting – Getting unique item - updating records - Deleting records.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. E Balagurusamy,“ Problem Solving and Python Programming”, McGraw Hill Education, 2018
2. Katie Cunningham, “Teach yourself python”, Pearson Education,2014

REFERENCES:

1. Reema Thareja, “Python Programming using Problem Solving Approach”, Oxford University Press, 2017.
2. Allen B. Downey, “Think Python: How to Think Like a Computer Scientist”, 2nd edition, Updated for Python 3, Shroff/O‘Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
3. Guido van Rossum and Fred L.Drake Jr, “An Introduction to Python – Revised and updated for Python 3.2”, Network theory ltd., 2011.
4. John V Guttag, “Introduction to Computation and Programming Using Python”, Revised and expanded Edition, MIT Press , 2013.
5. Robert Sedgewick, Kevin Wayne, Robert Dondero, “Introduction to Programming in Python: An Inter-disciplinary Approach”, Pearson India Education Services Pvt. Ltd., 2016.

e- RESOURCES:

1. https://swayam.gov.in/course/4178-spoken-tutorial-python-english, “Introduction to Python”, Prof. Prabhu Ramachandran, IIT Bombay.
2. https://onlinecourses.nptel.ac.in/noc18_cs21, “Programming, Data Structures and Algorithms Using Python”, Prof.Madhavan Mukund, IIT-Bombay.

Preamble :

Electrical networks, systems and devices are the basic building blocks for today's most complex electrical and electronic systems. It is essential to understand these fundamentals to gain knowledge on solving circuits using network theorems and to obtain the transient responses of AC and DC circuits. As an electronics engineer has to work with many electrical systems, it is relevant the know the functional aspect of machines, wiring and other devices. This course is an introduction to all of them.

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

1. Identify and explain the different laws and theorems of electrical circuits.
2. Solve for network parameters using various circuit theorems
3. Demonstrate the knowledge on transient responses, resonance and coupled circuits.
4. Illustrate the construction and operation of motors and transformers.
5. Demonstrate the knowledge of the practices of wiring and operation of appliances.

UNIT 1 BASIC CIRCUIT ANALYSIS 9

Ohm's Law – Kirchhoff's laws – Network Elements- R,L,C-Elements in series and parallel –Mesh and nodal method of analysis for DC and AC circuits – voltage and current sources- Dependent and independent sources-series and parallel connection of independent sources.

UNIT 2 NETWORK THEOREMS FOR DC CIRCUITS 9

Network reduction: voltage and current division rule, source transformation – star -delta conversion. Thevenin's and Norton's Theorems – Superposition Theorem – Maximum power transfer theorem – Reciprocity Theorem-Duality in circuits.

UNIT 3 AC CIRCUITS 9

AC passing through pure R, L and C.Frequency response – Series and parallel resonances – Quality factor and Bandwidth - Self and mutual inductances – Dot Convention - Coefficient of coupling-series and parallel connection of coupled coils– Transient response of RL, RC and RLC Circuits using Laplace transform for DC inputs.

UNIT 4 DC MACHINES, TRANSFORMERS AND INDUCTION MOTORS 9

Construction and Principle of operation of DC Machines – EMF equation of DC Generator –shunt generator– DC motor- speed and torque characteristics of DC series and shunt motors- back emf- Applications of series and shunt motors. 1 phase and 3 phase AC systems(for sine wave)- phasor notation- Single phase transformer- types: step down, step up, Auto and isolation transformers-Construction and principle of operation of 1 phase squirrel cage induction motors- Construction and operation of Stepper and BLDC Motors.

UNIT 5 ELECTRICAL WIRING AND APPLIANCES 9

Domestic wiring: Components of Distribution Board -Typical domestic distribution - stair case wiring – types of wires and their rating -Earthing- Fuse ratings –MCB-ELCB- Online UPS- rating of UPS and battery. Fluorescent and LED Lamps – Qualitative approach of Electrical appliances - Ceiling fan,Mixie- Compressor, centrifugal and submersible pumps.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Sudhakar A and Shyammohan SP, "Circuits and Networks", McGraw Hill, 5th edn. 2015.
2. V.N.Mittle&AravindMittal,"Basic Electrical Engineering",2nd Edition, Tata McGraw Hill,2006.

REFERENCES:

1. Monograms prepared by the Faculty of ECE Dept.
2. William H. Hayt Jr, Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuits Analysis", Tata McGraw Hill publishers, 6th edition, New Delhi, 2003.
3. Vincent Del Toro, "Electrical Engineering Fundamentals", 2nd Edition, Pearson Edn,2017.(3rd Reprint).

e. RESOURCES :

1. http://www.nptel.ac.in/courses/108108076/1, Basic Electrical technology, Dr. L. Umanand, IISc, Bangalore
2. http://nptel.ac.in/courses/108105053/, Electrical Engineering, Prof. G.D. Roy, Prof. N.K. De & Prof. T.K. Bhattacharya ,IITKharagpur.

21PHL21	PHYSICS AND CHEMISTRY LABORATORY II	L T P C 0 0 3 1

Preamble :

The understanding of characteristics of solids and liquids and properties of semiconducting materials has been explored. The practical skills in the instrumental methods for quantitative estimation of metal ions content has been the main focus.

Course Outcomes:

1. Experiment and determine the physical characteristics of given solid material.
2. Experiment and determine the Energy band gap of the given semiconducting materials.
3. Experiment and determine the physical characteristics of given liquid.
4. Experiment and estimate dissolved oxygen content using alkali iodide solution by Winkler's method, amount of copper content using EDTA by complexometric titration.
5. Experiment and test chloride content present in the waste water by titrating against silver nitrate using Mohr's method.
6. Experiment and determine the concentration of metals and ions present in the wastewater with the aid of flame photometer and pH meter.

PHYSICS LABORATORY II
(Any Five Experiments)

LIST OF EXPERIMENTS

1. Determination of Young's modulus by uniform bending method.
2. Determination of band gap of a semiconductor.
3. Determination of coefficient of viscosity of a liquid – Poiseuille's method.
4. Determination of thickness of a thin wire – Air wedge method.
5. Determination of rigidity modulus – Torsion pendulum.
6. Determination of Hysteresis of a ferromagnetic material –Deflection magnetometer

CHEMISTRY LABORATORY II

LIST OF EXPERIMENTS

1. Determination of Dissolved Oxygen content of waste water sample by Winkler's method.
2. Determination of chloride content of wastewater sample by Argentometric method.
3. Determination of acid strength in waste water using pH meter.
4. Estimation of dissolved metal ions present in wastewater using flame photometer.
5. Estimation of dissolved metal ions(copper) present in wastewater byEDTA method.

TOTAL : 30 PERIODS

- **Laboratory classes on alternate weeks for Physics and Chemistry.**

Preamble:
Python is a dynamic and powerful programming language that focuses on code readability. The Python language has diversified application in the software development companies such as in gaming, web frameworks and applications, language development, prototyping, graphic design applications, etc. This provides the language a higher plethora over other programming languages used in the industry.

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

1. Create documents, presentation slides and perform data manipulations using Libre Office packages. Design flowcharts using Raptor.
2. Develop programs using expressions and Control statements in Python.
3. Apply suitable data structure in Python for a real-world problem.
4. Develop programs using functions, OOP concepts, modules and packages for a given problem.
5. Create and manipulate files and database connectivity using Python.

LIST OF EXPERIMENTS

1. Creating document, presentation slides and performing mathematical calculations using Libre Office packages.
2. Design flowchart using Raptor for the following problems:
   - Solving problems using algorithm and flowchart.
   - To find if a given year is a leap year or not. Any year which is divisible by 4 and not by 100 are leap years. Otherwise, any year which is divisible by 400 is also a leap year.
   - To find the sum of numbers divisible by 4. The flowchart must allow the user to accept a number and add it to the sum if it is divisible by 4. It should continue accepting numbers as long as the user wants to provide an input and should display the final sum.
3. Write a python programs for solving the problems:
   - All decision control statements.
   - An organization has decided to provide salary hike to its employees based on their job level. Employees can be in job levels 3, 4 or 5. In case of invalid job level, consider hike percentage to be 0. Given the current salary and job level, write a python program to find and display the new salary for 10 employees in the organization. Hike percentage based on job levels are given below:

Job level	Hike Percentage
3	15
4	7
5	5

4. Write a python program to find the list of 'n' prime numbers using functions.
5. Write a python program to implement list, set, tuple and dictionary.
6. Write a python program by defining a user defined module **leap**. Import the module and find whether a given year is leap year or not.
7. Write a python program to perform the arithmetic operations using packages.
8. Write a python Program to implement string handling functions.
9. Write a python program to implement object-oriented concepts.
10. Write a python program to implement database connectivity.

SOFTWARE

- Python 3 interpreter / open source IDE
- Raptor Tool
- Libre Office Packages

TOTAL: 45 PERIODS

21ECL21	CIRCUITS AND DEVICES LABORATORY	L T P C 0 0 3 1

Preamble:
The goals are to supplement the theory courses 21ECT11 and 21ECT21 to assist the students in obtaining a better understanding of the operation of electronic circuits and devices and to provide experience in analyzing network theorems.

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

1. Verify Kirchoff's laws and network theorems.
2. Construct RL and RC circuits and study their properties.
3. Experiment and determine the characteristics of PN and Zener diodes.
4. Determine the characteristics of BJT and FET.
5. Experiment and test different application circuits using diodes.

LIST OF EXPERIMENTS

1. Verification of KVL and KCL
2. Verification of Thevenin's and Norton's Theorems.
3. Verification of superposition Theorem.
4. Verification of Maximum power transfer and reciprocity theorems.
5. Frequency response of RLC series and parallel resonance circuits.
6. Characteristics of PN and Zener diode.
7. Characteristics of CE, CB configurations.
8. Characteristics of JFET.
9. Half wave and Full wave rectifier with capacitor filter.
10. Voltage regulation using zener diode.
11. Study of characteristics of photo diodes
12. Study of characteristics of SCR

TOTAL PERIODS: 45

21MCT02 **ENVIRONMENTAL SCIENCE AND ENGINEERING** **L T P C**
2 0 0 0

Preamble:

The study of biodiversity reflects the extent of the interest of a nation in its natural resources and heritage, which is considered as a crucial portion of the national wealth. Since India is one of the twelve mega-diversity center of the earth, much emphasis should be put on understanding, preserving and utilizing the biodiversity of our biotic resources. Environmental protection is an important issue for society today as scientific research provides evidence of increasing global warming, ozone depletion and higher levels of pollution. Engineers should learn how to design, develop and evaluate structures, equipment and systems to provide practical solutions to problems caused by pollution, exploitation of natural resources and population explosion.

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

1. Compare and contrast structure and function of forest and marine ecosystem to conserve biodiversity
2. Analyze the sources, effects, control measures of air and water, solid waste management to maintain green environment.
3. Describe overexploitation of forest, overutilization of water and environmental impacts related to food resources to preserve environment.
4. Explain human health, environment and disaster management through information technology.
5. Discuss air and water act to solve environmental issues of climatic change.

UNIT 1 ECOSYSTEM AND BIODIVERSITY MANAGEMENT ***6***

Importance of environmental studies-Ecosystem-Definition, Characteristics, structure and functions of Forest and Ocean ecosystem.Biodiversity-Definition, Significance, Values of biodiversity, Threats to biodiversity-Habitat loss and poaching, Biodiversity conservation-In-situ (Biosphere and National park), Ex-situ (Gene bank and Seed bank)

UNIT 2 ENVIRONMENTAL POLLUTION **6**

Pollution- Definition causes and effects of Air and Water. Control strategies-Air pollution- (Catalytic converter,Cyclone separator). Water pollution-waste water treatment (Primary, Secondary and Tertiary Treatment). Solid waste-Source and generation of solid waste, Methods of disposal- Sanitary land fill, Incineration and composting.

UNIT 3 NATURAL RESOURCES ***6***

Forest Resources: Functions of forest, deforestation-causes, consequences and steps to prevent deforestation.
Water Resources: over-exploitation of surface and ground water, benefits and problems of dams on forests and tribal people. Food Resources: Environmental impacts related to food resources –Effects of modern agriculture (fertilizer and pesticide problems),water logging and salinity.

UNIT 4 ROLE OF IT AND DISASTER MANAGEMENT ***6***

Role of IT in environment-Remote Sensing and GIS application,Global positioning system, Environmental data base. Role of IT in human health – EHR, Medical Transcription, Endoscopy, Automated dispensing machine (ADM), Teleconference, Picture achieving and Communication System (PACS) method.Disaster management-Cause, effects and mitigation of Flood, Cyclone, Earthquake, Tsunami

UNIT 5 SOCIAL ISSUES AND ENVIRONMENTAL LEGISLATION ***6***

Social Issues: Climate change- Global warming, Ozone layer depletion ,Water conservation-Rain water harvesting (Roof top method). Legislation- Function of State and Central pollution control Board (Air and Water).

TOTAL : 30PERIODS

TEXT BOOKS:

1. Dr.Arun Luiz T, 'Environmental Science and Engineering', 1st edition (2017), VK publications.
2. P. Yugananth&Dr. R. Kumaravelan,'Environmental Science and Engineering', 2nd edition, reprint (2017),Scitech Publication (India) Pvt. Ltd., Chennai.

REFERENCES:

1. Benny Joseph, 'Environmental Science and Engineering', 3rd reprint (2015), McGraw Hill Education (India) Pvt.Ltd.,New Delhi.
2. Gilbert M.Masters, 'Introduction to 'Environmental Engineering and Science', 2nd edition (2004), Prentice Hall of India Pvt. Ltd.

e-RESOURCES:

1. https://nptel.ac.in/courses/105104099/4 "Types and forms of Air Pollutants" – Prof. Mukesh Sharma,Department of Civil Engineering, IIT Kanpur.
2. https://nptel.ac.in/courses/105104183/8 -"Introduction to natural hazards(Flood and Tsunami)- Prof.Javed Malik, Department of Civil Engineering,IIT Kanpur

21MAT31 **TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS** **L T P C**
(Common to B.E./B.Tech- BM, CE,EC, EE, MDE,ME Programmes) **3 1 0 4**

Preamble:

The phenomena of heat conduction, wave and signal propagation in media are described by Partial Differential equations (PDE) or Difference equations. For analyzing such phenomena, knowledge of mathematical techniques for solving PDE and Difference equations are needed for engineering students. This course aims to provide sufficient knowledge to engineering students in the specific mathematical techniques such as Fourier series, Fourier transform, Z-transform andPDE.

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

1. Compute the trigonometric form of the Fourier series for periodic waveforms satisfying the Dirichlet's conditions and using them to evaluate infinite series.
2. Compute the solution for the standard forms of linear partial differential equations of first order and solve homogeneous partial differential equations of first and second order with constant coefficients.
3. Compute the analytical solution for the given physical model for the specified initial and boundary conditions in one dimensional and two-dimensional distributions.
4. Compute the Fourier transform of elementary non-periodic waveforms using Fourier Transform properties.
5. Solve the difference equations of first and second order using Z-transform techniques.

UNIT 1 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 2 PARTIAL DIFFERENTIAL EQUATIONS **9+3**

Formation of partial differential equations – Singular Integrals – Solutions of standard types of first order partial differential equations: $F(p, q) = 0$, $F(z, p, q) = 0$, $F(x, p) = G(y, q)$ and $z = px + qy + F(p, q)$ –Lagrange's linear equation – Linear partial differential equations of second and higher order with constant coefficients of homogeneous type.

UNIT 3 APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS **9+3**

One dimensional wave equation – Transverse vibrations of a string – One dimensional equation of heat conduction – Steady state temperature distribution in a rod – Two-dimensional steady state temperature distributions in a plate.

UNIT 4 FOURIER TRANSFORMS **9+3**

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

UNIT 5 Z TRANSFORMS AND DIFFERENCE EQUATIONS **9+3**

Z-transforms - Elementary properties – Inverse Z-transform (using Partial Fraction and Residues) – Convolution theorem - Formation of difference equations – Solution of difference equations using Z-transform.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Bali.N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 7th Edition, University Press India (P) Ltd, Hyderabad (2015).
2. Grewal, B.S, "Higher Engineering Mathematics", 43rd Edition, Khanna publishers, Delhi (2016).

REFERENCES:

1. Ramana.B.V., "Higher Engineering Mathematics", First edition, Tata Mc-GrawHill Publishing Company limited, New Delhi, 2016.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", Tenth edition, Wiley Dream Tech India (P) Ltd. 2016.
3. Babu Ram, "Engineering Mathematics", Second edition, Vol.2 , Dorling Kindersley India (P) Ltd,Licenses of Pearson Education in South Asia, 2012.

e-RESOURCES:

1. http://nptel.ac.in/courses/111105035/27 , "Advanced Engineering Mathematics", Prof. Jitendra Kumar, Department of Mathematics, Indian Institute of Technology, Kharagpur.
2. http://nptel.ac.in/courses/111106046, "Fourier Series", Prof.R.Radha, and Prof S. Thangavelu,Department of Mathematics, Indian Institute of Technology Madras, Chennai.

21MDT31 **LIFE SCIENCES** **L T P C**

3 0 0 3

Preamble:

The Course enables the students towards to recognize the structure, classification, properties and functions of all systems in the human body and biomolecules.

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

1. Interpret the basic structure and function of cell.
2. Assess about the anatomy and physiology of respiratory and cardiovascular system.
3. Illustrate the structure and function of urinary and special sensory system.
4. Generalize the interconnect of various system and Gastrointestinal system.
5. Infer the properties of carbohydrates and the mechanism of metabolic pathways.

UNIT 1 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 2 RESPIRATORY AND CARDIOVASCULAR SYSTEM 9

Respiratory System: Components of respiratory system – Respiratory Mechanism. Types of Respiration - Oxygen and carbon dioxide transport- Acid base regulation–Types of muscles – Structure and Properties of Skeletal Muscle- Changes during muscle contraction- Neuromuscular junction Structure of heart –Blood vessels - Properties of Cardiac muscle – Conducting system of heart – Cardiac cycle – Heart sound – ECG - Volume and pressure changes and regulation of heart rate –Coronary Circulation.

UNIT 3 URINARY AND SENSORY SYSTEM 9

Urinary system: Structure of Kidney and Nephron. Mechanism of Urine formation and acid base Regulation – Micturition reflex –. Special senses: Eye and Ear.

UNIT 4 NERVOUS SYSTEM AND GASTERO INTESTINAL SYSTEM 9

Structure of a Neuron – Types of Neuron. Synapses and types. Conduction of action potential in Neuron. Brain – Divisions of brain lobes - Cortical localizations and functions. Autonomic nervous system and its functions. Introduction to digestive system-Mouth and salivary glands-Stomach-pancreas-liver and Gall bladder-Small, large intestines.

UNIT 5 BIOMOLECULES AND METABOLISM 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. Metabolic pathways: synthesis and degradation of fatty acid (beta oxidation), hormonal regulation of fatty acid metabolism and ketogenesis.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. K. Sembulingam, Prema Sembulingam, “Essentials of Medical Physiology” Jaypee Brothers Medical Publishers (P) Ltd New Delhi, Seventh Edition ,2016
2. U. Satyanarayana, “Biochemistry”, Books and Allied (p) Ltd, Kolkata, Revised Reprint, 2007.

REFERENCES:

1. Hall, John E, “Textbook of Medical Physiology”, Philadelphia, PA: Elsevier, Thirteenth edition, 2016.
2. Victor W. Rodwell, David Bender, Kathleen M. Botham, Peter J. Kennelly, P. Anthony Weil, “Harper’s Illustrated Biochemistry”, Thirty first Edition, McGraw-Hill Professional, 2018
3. Sarada Subramanyam, MadhavanKutty. K and Singh. H.D, “Text Book of Human Physiology”– Chand. S, & Company, Fifth Edition, 2014.

e. RESOURCES :

1. http://nptel.ac.in/courses/107103004/7, “Human physical dimension concern”, Prof.Mainak Das, IIT Kandpur.
2. http://nptel.ac.in/courses/122103039/14, “Nervous System”, Prof.MainakDas, IIT Kandpur.
3. https://nptel.ac.in/courses/102105034/17, “Biochemistry”, Prof. Swagatagupta, IIT Kandpur.

21MDT32 **SENSORS AND MEASUREMENTS** **L T P C**
3 0 0 3

Preamble:

The Course enables the students to assess the measuring instruments and the methods of measurement.

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

1. Analyze the purpose and methods of measurements and classification of transducer.
2. Identify the type of transducers and explain their need in biomedical applications.
3. Assess the principles of signal conditioning and signal analyzer.
4. Explicate the photoelectric and piezoelectric transducers.
5. Infer the knowledge on different display and recording devices for various applications.

UNIT 1 MEASUREMENT SYSTEM AND BASICS OF TRANSDUCER 9

Measurements: Significance of measurements – Methods of measurements, Instrumentation – classification of instruments – Functions of instruments and measurement systems – applications of measurement systems, Elements of a generalized measurement systems, Static characteristics – accuracy - precision – linearity– hysteresis – threshold – Dead time and Dead zone, Dynamic characteristics-Dynamic response-Dynamic analysis of measurement systems , Errors in measurement, calibration, standards and their classification, Classification of transducers.

UNIT 2 MEASUREMENT OF NON-ELECTRICAL QUANTITIES 9

Strain gauges: gauge factor-Types of strain gauges- Biomedical applications-strain gauge as displacement and pressure transducers, transducer: capacitive: capacitance measuring circuits -biomedical applications, Inductive: LVDT-Biomedical applications, Passive types: Thermoresistors- thermistor - biomedical applications, Active type: Thermocouple - biomedical applications, Hall effect Transducers.

UNIT 3 SIGNAL CONDITIONING & SIGNAL ANALYSER 9

AC and DC Bridges –wheat stone bridge – Kelvin –kelvin double bridge, Maxwell – Hay – Schering, Anderson's, Signal analyzer: Wave- Spectrum- Harmonic Distortion analyzer.

UNIT 4 OPTICAL AND PIEZO ELECTRIC SENSORS 9

Photo emissive tubes- Photo Multiplier Phototube (PMT)-scintillation counter-photovoltaic and junction diodes-Photo conductive cells-phototransistor- comparison of photoelectric transducers-Spectro photometric applications of photo electric transducers, Piezoelectric transducers- modes of operation of piezoelectric crystals- uses of piezoelectric materials and transducers, biomedical applications as ultrasound transducers.

UNIT 5 DISPLAY, RECORDING SYSTEM AND SENSOR TECHNOLOGY 9

Digital voltmeter, Multi meter, CRO and DSO, Graphic recorders-strip chart, X-Y recorder, Magnetic tape recorder, photographic recorder, inkjet recorder, Thermal array recorder, Development in Sensor Technology-Smart Sensors, Biosensors

TOTAL: 45 PERIODS

TEXT BOOKS:

1. L.A Geddas and L.E.Baker, "Principles of Applied Biomedical Instrumentation", John Wiley and Sons, Third Edition, Reprint, 2008.
2. Sawhney A.K, "A course in electrical and electronic measurements and instrumentation", Dhanpat Rai & Co (P) Ltd, Reprint, 2015.

REFERENCES:

1. Albert D Helfrick, William D Cooper, "Modern Electronic Instrumentation and Measurement techniques", PHI Learning Private Limited, Pearson Education India, 2015.
2. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Pearson India, 2nd Edition, 2015.

e. RESOURCES :

1. http://nptel.ac.in/courses/112103174/3, Sensors and Transducers by Prof. Alok Barua Department of Electrical Engineering, IIT – Kharagpur.
2. http://nptel.ac.in/courses/108105064/1, Classification of Instruments by Prof. Alok Barua Department of Electrical Engineering, IIT – Kharagpur.
3. http://www.nptelvideos.in/2012/11/industrial-instrumentation.html, Piezoelectric sensors by Prof. Alok Barua, Department of Electrical Engineering, IIT – Kharagpur.

21MDC31 **ANALOG ELECTRONICS** **L T P C**
3 0 2 4

Preamble:

The course introduces the biasing of BJTs, FETs and MOSFETs in constructing amplifiers. It also details the structure and properties of feedback for analyzing amplifiers and oscillators. Additionally, the course exposes the analysis and design of wave shaping and multivibrator circuits.

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

1. Design transistor amplifier circuits with Fixed, Collector to Base, Voltage divider biasing techniques.
2. Evaluate Class A, B, AB, C amplifiers for a given load with respect to its efficiency.
3. Analyze feedback amplifiers and identify suitable amplifier for a given application using gain, input- output resistance and bandwidth.
4. Analyze the performance and characteristics of RC and LC oscillator circuits.
5. Design wave shaping and multivibrator circuits using active and passive components for a givenApplication.

UNIT 1 BIASING OF BJT AND FET **9**

Bias Stability – Need for biasing – quiescent point – DC load line and AC load line – Thermal runaway. Stability factors, Different types of biasing circuits – Fixed bias – Collector to base bias – Voltage divider bias. Biasing the FET, Biasing the MOSFET.

UNIT 2 AMPLIFIERS **9**

Differential amplifier – transfer characteristics - Class A amplifiers: Direct coupled, transformer coupled efficiency – Class B amplifier: push-pull amplifier – complementary symmetry amplifier – efficiency –Cross over distortion.

UNIT 3 FEEDBACK AMPLIFIERS **9**

General Feedback Structure, Determining the Loop Gain, Properties of negative feedback, Basic FeedbackTopologies. Method of identifying feedback topology and feedback factor – Voltage Series Feedback – Current Series Feedback – Current Shunt Feedback – Voltage Shunt Feedback.

UNIT 4 OSCILLATORS **9**

Classification, Barkhausen Criterion, General form of an LC Oscillator, Hartley, Colpitts. RC Oscillators –Phase Shift – Wien bridge. Frequency range of RC and LC Oscillators, Crystal Oscillators – Quartz Crystal Construction, Miller and Pierce Crystal oscillators, frequency stability of oscillator.

UNIT 5 WAVE SHAPING AND MULTIVIBRATOR CIRCUITS **9**

RC & RL Integrator and Differentiator circuits – Storage, delay and calculation of transistor switching times – Speed– up capacitor, Diode clippers, Clampers. Collector coupled Astable multivibrator and Monostable multivibrator, Bistable multivibrator, Schmitt trigger circuit – UJT sawtooth waveform generator.

List of Experiments:

1. Differential Amplifier - CMRR measurement.
2. Frequency response of Class A power amplifiers.
3. RC Phase shift oscillator
4. Clippers and Clampers.
5. RC Integrator and Differentiator circuits.

TOTAL (L: 45+P: 15): 60 PERIODS

TEXT BOOKS:

1. Salivahanan S. & Sureshkumar N. “Electronic Devices and Circuits”, McGraw Hill Education, ThirdEdition, Fifth Reprint, 2014.
2. Adel S. Sedra and Kenneth C. Smith, “Microelectronic Circuits”; Sixth Edition, Oxford University Press, 2011.

REFERENCES:

1. Robert L. Boylestad and Louis Nashelsky, “Electronic Devices and Circuit Theory”, 10th Edition, Pearson EducatioPHI, 2009.
2. J. Millman , C C Halkias & Satyabrata Jit, “Electronic Devices & Circuits”, Tata McGraw Hill, 4thEdition, 2015.
3. David A. Bell, “Electronic Devices and Circuits”, Fifth Edition, Oxford University Press, 2008.

e -RESOURCES :

1. http://nptel.ac.in/courses/117103063/2, “Basic Electronics”, Dr.Chitralekha Mahanta, IIT, Guwahati.
2. http://nptel.ac.in/courses/117101106/1, “Analog Circuits” Prof.A.N.Chandorkar, IIT Bombay.

21ECT31 **SIGNALS AND SYSTEMS** **L T P C**

(Common to B.E- BM,EC,MD Programmes) **3 1 0 4**

Preamble :

Signals and systems concerns with analysis and synthesis of deterministic signals and their interaction with LTI systems. The analysis of Signals and its concepts play a vital role in signal processing, image and video processing and digital/analog communications. In order to understand the analysis of signals in the frequency domain it is essential to learn Fourier analysis, Laplace and Z transforms. The discrete time version of a signal is needed to make a filtering and further processing of a signal.

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

1. Verify the linearity, stability, causality and time invariance properties of CT and DT systems.
2. Compute the frequency spectrum of the periodic CT signals using Fourier series and aperiodic CT signals using Fourier & Laplace transforms.
3. Realize the Direct Form I & II structures of the given LTI-CT systems and compute the impulse response.
4. Determine the frequency response of the given DT sequences using Z transform and DTFT.
5. Develop the Direct Form I & II structures of the given LTI-DT systems and determine the impulse response.

UNIT 1 CLASSIFICATION OF SIGNALS AND SYSTEMS 9+3

Continuous time signals - Discrete time signals – Impulse, Step, Ramp, Parabolic, Sinusoidal, Exponential, Pulse – Operations on Signals – Classification of CT and DT signals: Deterministic & Random signals, Periodic & Aperiodic signals, Energy & Power signals, Causal & Non-causal, Even & Odd signals – CT systems and DT systems – Classification of systems: Static & Dynamic, Linear & nonlinear, Time-variant & Time-invariant, Causal & non-causal, Stable & unstable.

UNIT 2 ANALYSIS OF CONTINUOUS TIME SIGNALS 9+3

Fourier series (Trigonometric and Exponential) – Spectrum of Continuous Time (CT) signals – Properties of Laplace Transform – Fourier and Laplace Transforms in CT signal analysis.

UNIT 3 LINEAR TIME INVARIANT- CONTINUOUS TIME SYSTEMS 9+3

Differential Equations – Impulse response – Block diagram representation – Realization using Direct form I, Direct form II – Convolution integrals – Fourier and Laplace transforms in analysis of CT systems - Introduction to SCILAB – CT Signal Modeling using Scilab.

UNIT 4 ANALYSIS OF DISCRETE TIME SIGNALS 9+3

Sampling theorem – DTFT and Inverse DTFT – Z and Inverse Z Transform – Properties of Z Transform – DT Signal Analysis using Scilab.

UNIT 5 LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS 9+3

Difference equations – Impulse response – Block diagram representation – Realization using Direct form I, Direct form II – Convolution sum – DTFT and Z Transform analysis of Recursive & Non-Recursive systems - System Analysis using Scilab.

TOTAL(L:45+T:15)= 60 PERIODS

TEXT BOOKS:

1. Allan V.Oppenheim, S.Wilsky and S.H.Nawab, “Signals and Systems”, Pearson Education, India, Second Edition, reprint,2015.
2. P.Ramesh Babu and R.Anandanatarajan, “Signals and Systems”, Scitech Publication, 2014.

REFERENCES:

1. B. P. Lathi , “Principles of Linear Systems and Signals”, Second Edition, Oxford, 2009.
2. M.J.Roberts, “Signals and Systems Analysis using Transform methods and MATLAB”, Mc Graw Hill, 2nd Edition,2010.
3. A.Nagoorkani, “Signals and Systems”, Mc Graw Hill, Second Edition, 2010.

e. RESOURCES :

1. http://www.nptel.in/courses/117101055, “Signals and systems”, Prof.V.M.Gadre, IIT Bombay.
2. http://www.nptel.in/courses/117104074, “Signals and systems”, Prof.K.S.Venkatesh, IIT Kanpur.
3. http://www.scilab.org.

21MDL31	LIFE SCIENCES LABORATORY	L T P C 0 0 3 1

Preamble: The Course enables the students to provide practice to learn fundamental approaches for experimentally investigating biochemical and physiological problems.

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

1. Experiment and Identify the chemical and microscopic components of biological samples under different physiological conditions.
2. Experiment and quantify the abnormal constituents in biological samples and interpret common result patterns related to different pathological conditions.
3. Perform physiological tests that examine the function of various components of a body system.
4. Experiment by using the laboratory microscope.
5. Experiment and identify the bacteria in the biological sample

LIST OF EXPERIMENTS

1. General tests for carbohydrates, proteins and lipids.
2. Estimation of blood glucose.
3. Estimation of creatinine
4. Estimation of urea
5. ESR , PCV, MCH , MCV ,MCHC , total count of RBCs and hemoglobin
6. Weber's and Rinnee's test for auditory conduction.
7. Ishihara chart for colour blindness and Snellen's chart for myopia and hyperopia –by letters reading and ophthalmoscope to view retina
8. Study of parts of compound microscope
9. Identification of microorganism by Simple staining
10. Identification of microorganism by Gram staining

TOTAL:45 PERIODS

21MDL32	SENSORS AND MEASUREMENTS LABORATORY	L T P C 0 0 3 1

Preamble: The Course enables the students to study the various characteristics of transducers, signal conditioning circuits and their biomedical applications.

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

1. Experiment to verify the characteristics of transducer.
2. Analyze the various transducers in biomedical applications
3. Design the bridge circuits to find out unknown resistor, inductor and capacitor values.
4. Analyze the working of X-Y recorders
5. Design the measurement system for various biomedical applications

LIST OF EXPERIMENTS

1. Characteristics of strain gauges.
2. Measurement of Force or Weight by Load Cell
3. Displacement measurement using LVDT.
4. Characteristics of temperature sensors
5. Measurement of skin temperature – contact and non-contact method
6. Characteristics of Light Sensors- Light Dependent Resistor, Photodiode and Photo Transistor
7. Measurement of SpO2
8. Bridge Circuits for Measurement of Resistance, capacitance and inductance
9. Measurement of respiration rate
10. Study the characteristics of X-Y Recorder.

TOTAL:45 PERIODS

21MCL03 **ESSENTIAL ENGLISH FOR PROFESSIONALS** **L T P C**

(Common to All Branches in Third Semester) **0 0 2 0**

Preamble:

Communicative English is a life skill necessary for all students of Engineering and Technology. The course Essential English for Professionals aims at enabling the learners to communicate effectively and appropriately in professional contexts by exposing them to LSRW tasks.

COURSE OUTCOMES : After the completion of this course, students will be able to

1. Analyze the given listening material and answer the questions correctly employing listening techniques.
2. Analyze the given reading material and answer the questions correctly employing reading techniques.
3. Write within the stipulated time syntactically and semantically correct sentences to present ideas in the form of paragraphs and letters.
4. Give well structured effective time sensitive presentations extemporaneously or after careful preparation.
5. Identify within the stipulated time syntactically and semantically correct sentences for a variety of language exercises.

UNIT 1 LISTENING **6**

Listening to Casual Conversation and TED Talks

UNIT 2 READING **8**

Poem – Robert Frost – Road not Taken Essays - Bacon's Essays

UNIT 3 WRITING **6**

Letter Writing – Letters Seeking Permission and Letters Seeking Apology and Letters Requesting Certificates and Paragraph Writing

UNIT 4 PRESENTATION **7**

Watching Presentations - Presentation Techniques - JAM and Three Minute Presentation

UNIT 5 VERBAL ABILITY **3**

Verbal Analogy - Cloze Test- Idioms and Phrases- Sentence Completion – Concord – Common Errors

TOTAL : 30 PERIODS

REFERENCES:

1. Rizvi, Ashraf. M, "Effective Technical Communication", 2st Edition, Tata McGraw-Hill, New Delhi,2018.
2. Raman, Meenakshi and Sangeetha Sharma, "Technical Communication: English Skills for Engineers", 1st Edition, Oxford University Press, New Delhi. 2008.

e-RESOURCES:

1. https://agendaweb.org/listening/audio-books-mp3.html
2. https://www.ndtv.com/world-news
3. https://www.naukri.com/blog/self-introduction-for-interview/
4. http://learnenglishteens.britishcouncil.org/skills/reading
5. https://www.bbc.com/bitesize/guides/zphc9j6/revision/1

21MAT41 **PROBABILITY AND RANDOM PROCESSES** **L T P C**

(Common to B.E. BM, EC,MD Programmes) **3 1 0 4**

Preamble:

Probability theory is used extensively in the design of modern communication systems in order to understand the behavior of noise in the system. It is concerned with the study of one dimensional random variables. The concept of random process deals with time varying function and plays a vital role in modeling physical phenomenon. The language of signal coding is primarily that of random processes and linear systems. The response of an LTI system to random signals plays an important role in signal analysis.

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

1. Compute moments and moment generating functions of one dimensional random variables and solve the problems involving discrete and continuous distributions.
2. Measure the degree of relationship between the two dimensional random variables using correlation and regression.
3. Classify the first and second order stationary processes and solve the problems involving Markovand Poisson processes.
4. Solve problems involving correlation and spectral densities of random processes.
5. Analyze the response of random inputs to linear time invariant systems

UNIT 1 ONE DIMENSIONAL RANDOM VARIABLES 9+3

Discrete and continuous random variables – Moments – Moment generating functions – Distributions: Discrete distributions – Binomial, Poisson – Continuous distributions –Uniform, Exponential and Normal distributions.

UNIT 2 TWO DIMENSIONAL RANDOM VARIABLES 9+3

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

UNIT 3 RANDOM PROCESSES 9+3

Classification – Stationary process – First order , Second order Stationary Process , SSS Process , WSS Process – Markov Process – Poisson Process

UNIT 4 CORRELATION AND SPECTRAL DENSITIES 9+3

Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties (Excluding Proof)

UNIT 5 LINEAR SYSTEMS WITH RANDOM INPUTS 9+3

Linear time invariant system – System transfer function – Linear systems with random inputs – Autocorrelation and Cross correlation functions of input and output.

TOTAL : 60 PERIODS

TEXT BOOKS:

1. Ibe.O.C., “Fundamentals of Applied Probability and Random Processes", Elsevier, 2nd Edition 2014.
2. Hwei Hsu, " Probability, Random Variables and Random Processes", Tata Mc Graw Hill Edition, New Delhi, 3rd Edition 2014

REFERENCES:

1. Veerarajan T., “Probability Statistics and Random Processes with Queueing theory and Queueing Networks”, 4th Edition, Tata McGraw Hill Edition, New Delhi, 2015.
2. Stark. H., and Woods. J.W., "Probability and Random Processes with Applications to Signal Processing", 3rd Edition, Pearson Education, Asia, 2002.
3. Peebles. P.Z., "Probability, Random Variables and Random Signal Principles", Tata McGraw Hill, 4th Edition, New Delhi, 2002

e-RESOURCES:

1. http://nptel.ac.in/courses/117105085/7, “Probability and Random Variables”,Prof. M. Chakraborty, Department of Electronics and Electrical Communication Engineering, Indian Institute of Technology, Kharagpur.
2. http://nptel.ac.in/courses/111102014/, “Stochastic Processes”, Prof. Dr. S. Dharmaraja, Department of Mathematics, Indian Institute of Technology, Delhi.

21ITT43	DATA STRUCTURES USING OBJECT ORIENTED PROGRAMMING	L T P C 3 0 0 3

(Common to B.E. EE & MD Programmes)

Preamble

This course provides the data structures and object oriented programming concepts for the students to develop software in C++ Programming Language. It also demonstrates the C++ techniques and different data structures with associated algorithms by implementing the solutions to real world problems.

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

3. Create array Abstract Data Type for a given list of elements using C++.
4. Develop linked list Abstract Data Type for a given list of elements using C++.
5. Create switch box routing for the given problem statement using stack Abstract Data Type and Create Queue Abstract Data Type for the given problem statement using array.
6. Construct tree and graph Abstract Data Type for the given list of data by ensuring tree properties and analyze the tree and graph traversal for the constructed tree and graph Abstract Data Type.
7. Evaluate the searching and sorting algorithms for a given integer elements using linear search, binary search, bubble sort, Insertion sort and selection sort algorithms.

UNIT 1 INTRODUCTION TO C++ **9**

Introduction to C++ programming – Functions in C++ - Classes and objects - Defining member functions – ADTs and C++ classes - Array ADT – Array implementation in C++.

UNIT 2 LINKED LIST ADT **9**

Linked list ADT - Definition - Singly Linked List - Doubly Linked List – Circular Linked List - Applications of Linked List.

UNIT 3 STACK AND QUEUE ADT **9**

Stack ADT-Array Implementation- Application of Stacks: Infix to postfix conversion – Evaluation of Postfix Expression - Case Study: Switch Box routing using Stack ADT - Queue ADT – Array Implementation.

UNIT 4 TREES AND GRAPHS **9**

Trees: Binary Tree-Binary Tree Traversal-Binary Search Tree, Graphs: Definitions- Graph Traversal - Shortest path algorithm – Dijkstra's Algorithm - Case Study: Wire length optimization in electrical circuit.

UNIT 5 SORTING AND SEARCHING **9**

Sorting Algorithms: Bubble Sort, Selection Sort, Insertion Sort, Searching Algorithms: Linear Search, Binary Search.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. E. Balagurusamy, "Object Oriented Programming with C++", Tata McGraw Hill Company Ltd., 7th Edition, 2017.
2. Yashavant Kanetkar, "Data Structures through C++", 2nd Edition, BPB Publications,2012.

REFERENCES:

1. Sartaj Sahni, "Data Structures, Algorithms and Applications in C++", 2nd Edition, Universities Press (India) Private Limited,2011.
2. Bhushan Trivedi, "Programming with ANSI C++, A Step-By-Step approach", Oxford University Press, 2010.
3. Bjarne Stroustrup, "The C++ Programming Language", 4th Edition, Addison Wesley, 2013.

e-RESOURCES:

1. http://nptel.ac.in/courses/106105151, "Programming in C++", Prof Pratha Pratim Das, Department of computer science, IIT – Kharagpur.
2. https://nptel.ac.in/courses/106102064/, "Introduction to Data Structures and Algorithms", Prof Naveen Garg, IIT – Delhi.

21MDT41 LINEAR AND DIGITAL INTEGRATED CIRCUITS L T P C
3 0 0 3

Preamble:

This course introduces the basic building blocks of the integrated circuits along with fundamental concepts in digital logic systems and linear integrated circuits. It also provides knowledge in code conversion, Boolean simplification using karnaugh map and designing of simple IC based circuits.

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

1. Design a linear and non-linear circuits using op amp.
2. Design a first order and second order active filters and signal generators using op-amp.
3. Design application circuits using 555 Timer, 565 PLL, 0808DAC, 0809ADC
4. Simplify the given Boolean expression using karnaugh map and implement using universal logic gates.
5. Design a modulo N counter using state diagrams.

UNIT 1 OPERATIONAL AMPLIFIERS 9

The characteristics of Ideal Operation, Slew rate, Offset voltage, Bias current, CMRR, Bandwidth, Equivalent circuit of an op-amp, Virtual ground concept, Linear application of op-amp - inverting andnon- inverting amplifiers, summing, subtracting, averaging amplifiers, Voltage to current converter, current to voltage converter, Differential amplifiers, Differentiator and Integrator. Non Linear applications- Comparator, Schmitt triggers, Precision Diode Half wave and Full wave rectifiers, Peak detector.

UNIT 2 ACTIVE FILTERS AND SIGNAL GENERATORS 9

Active Filters (First and Second order)- Low pass , High pass, Band pass ,Band reject filters (Notch Filters).Oscillators – RC phase shift and Wein-Bridge. Waveform generators – Square , Triangular and Sawtooth.

UNIT 3 TIMER, PLL, A/D AND D/A CONVERTERS 9

555 Timer -internal diagram and its applications- monostable multivibrator, astable multivibrator, Phase Locked Loop(565)- block diagram approach and its applications- Frequency multiplication, Frequency translation, Voltage to frequency and Frequency to voltage converters, Binary weighted DAC and R-2R DAC - 0808DAC, Successive approximation ADC - 0809ADC.

UNIT 4 NUMBER SYSTEMS AND LOGIC GATES 9

Decimal, Binary, Octal and Hexadecimal Numbers-Conversion between these number systems – r"s Complements and (r-1)"s complements-subtraction using complements-Encoding numbers and characters using Binary digits –Binary coded Decimal- Gray code- Binary to Gray code conversion –ASCII Code. The Karnaugh Map – Half adder and Full adder- Multiplexers and Demultiplexers – Decoders and Encoders.

UNIT 5 REGISTERS AND COUNTERS 9

Flip Flops-RS ,D,T,JK Flip Flops- Characteristics equations, exciting tables, JK Master Slave Flip Flop, Universal shift register, Design of modulo – N counters, counter design using state diagram.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. M. Morris Mano and Michael D. Ciletti, "Digital design" Fifth Edition Pearson Education, New Delhi, 2013.
2. Ramakant A. Gayakwad , "Op-AMP and Linear Ics", fourth Edition, Prince Hall, 2016.

REFERENCES:

1. S.Salivahanan and S. Arivazhagan ,"Digital Circuits and Design" fourth edition, vikas publishing house pvt ltd,2012
2. Charles H. Roth Jr, "Fundamentals of Logic Design", Seventh Edition, Jaico Publishing House, Mumbai, 2014.
3. Robert B.Northrop, "Analysis and Application of Analog Electronic Circuits to BiomedicalInstrumentation", CRC Press, 2004.

e-RESOURCES:

1. http://nptel..iitm.ac.in/courses/117106086, "Digital Circuits and Systems-video", Prof.S.Srinivasan, IIT -Madras.
2. http://www.satishkashyap.com/2012/02/digital-electronic-circuits-by-shouri.html,"Digital Electronics", Dr.Shouri Chatterjee, IIT- Delhi.
3. http://nptel.ac.in/courses/117103063/26, "Ideal op-amp and its applications" Dr. Chitralekha Mahanta Department of Electrical and Communication Engineering Indian Institute of Technology, Guwahati.

21MDT42 **BIOCONTROL SYSTEM ENGINEERING** **L T P C**

3 1 0 4

Preamble:

The Course enables the students to impart the concept and different mathematical techniques applied in analyzing any given system in time domain, frequency domain and stability and to develop the knowledge of modeling of physiological control system.

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

1. Identify the different types of control systems, and interpret the system concepts and different mathematical techniques for analyzing the given system.
2. Analyze the time domain of the system using different mathematical techniques.
3. Apply various techniques for analyzing the stability of the system.
4. Analyze the frequency domain of the system using different graphical plots.
5. Use the knowledge of control system modeling to design and evaluate the models of physiological control system.

UNIT 1 MODELING OF SYSTEMS 9+3

Terminology and basic structure of control system, examples of a control system, transfer functions, modeling of electrical systems, translational and rotational mechanical systems, and electromechanical systems, block diagram and signal flow graph representation of systems, conversion of block diagram to signal flow graph, reduction of block diagram and signal flow graph.

UNIT 2 TIME RESPONSE ANALYSIS 9+3

Test input signals, Step and impulse responses of first order and second order systems, determination of time domain specifications of first and second order systems from its output responses, definition of steady state error constants and its computations.

UNIT 3 STABILITY ANALYSIS 9+3

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

UNIT 4 FREQUENCY RESPONSE ANALYSIS 9+3

Frequency response, definition of gain margin and phase margin, determination of gain margin and phase margin using Bode plot, Polar plot, determination of closed loop response using M and N circles, Nichol's chart to compute response frequency and bandwidth.

UNIT 5 PHYSIOLOGICAL CONTROL SYSTEM 9+3

Example of physiological control system, difference between engineering and physiological control systems, generalized system properties, models with combination of system elements, linear models of physiological systems- respiratory mechanics - Model of cardiac output- Thermal Regulation, introduction to simulation.

TOTAL (L:45+T:15): 60 PERIODS

TEXT BOOKS:

1. M. Gopal "Control Systems Principles and Design", Tata McGraw Hill, Fourth Edition 2012.
2. Michael C K Khoo, "Physiological Control Systems", IEEE Press, John Wiley & Sons, 2018.

REFERENCES:

1. Farid Golnaraghi, Benjamin C. Kuo, "Automatic Control Systems", John Wiley & Sons, 2009.
2. John Enderle Susan Blanchard, Joseph Bronzino "Introduction to Biomedical Engineering", Third edition, Academic Press, 2012.
3. Richard C. Dorf, Robert H. Bishop, "Modern control systems", Pearson Education, Twelfth Edition,2013.

e. RESOURCES :

1. https://nptel.ac.in/courses/107106081/ , 'Control Systems', Prof. C.S. Shankar Ram, IIT Madras.
2. http://nptel.ac.in/courses/108103007/, 'Advanced Control Systems', Prof. Somanath Majhi, IIT, Guwahati.
3. https://www.edx.org/course/system-dynamics-health-sciences-witsx-hsd101x#!, "System dynamics for Health Sciences", David Rubin Adjunct Professor, Biomedical Engineering University of the Witwatersrand.

21MDT43 **MEDICAL EQUIPMENT - I** **L T P C**
3 0 0 3

Preamble:

The Course enables the students to describe the working of Diagnostic and Therapeutic Engineering Equipment.

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

1. Differentiate different biopotentials electrode for measuring electrical physiological measurements.
2. Design the bio amplifiers for various physiological recordings
3. Describe the working & recording setup of basic cardiac equipment.
4. Understanding the devices for measurement related to cardiology.
5. Explain various for non-electrical physiological measurements.

UNIT 1 BIO POTENTIAL ELECTRODES AND BIO AMPLIFIER 9

Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode–skin interface, half- cell potential, polarization electrode – nonpolarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier, Impedance matching circuit, isolation amplifiers.

UNIT 2 CARDIAC MEASUREMENTS 9

Electrocardiograph, Right leg driven ECG amplifier, Normal and Abnormal Waves, Heart rate monitor, Holter Monitor, Phonocardiography, Plethysmography. Cardiac Pacemaker- Internal and External Pacemaker– Batteries, AC and DC Defibrillator- Internal and External.

UNIT 3 NEUROLOGICAL MEASUREMENTS 9

EEG -10-20 electrode system- Montage- Multi-channel EEG recording system, sleep patterns, Evoked Potential- EMG - unipolar and bipolar mode- Electro occulograph (EOG), Electro retinography (ERG), Audiometer-Pure tone, Speech. Galvanic skin resistance (GSR) - Bio feedback instrumentation.

UNIT 4 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 5 PATIENT MONITORING, TELEMETRY AND PATIENT SAFETY 9

Patient monitoring systems, ICU/CCU Equipment's, Infusion pumps, bed side monitors, Central consoling controls-Telemetry- Portable and Land line- Macro shock – Micro shock hazards – Patient's electrical environment – Isolated Power system – Conductive surfaces – Electrical safety codes and standards – Basic Approaches to Protection against shock, Protection equipment design, Electrical safety analyzer – Testing the Electric system.

TOTAL :45 PERIODS

TEXT BOOKS:

1. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, Fourth Edition 2015.
2. Khandpur R.S, "Handbook of Biomedical Instrumentation", McGraw-Hill Education, Third Edition 2014.
3. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004.

REFERENCES:

1. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Pearson India, Second Edition 2015.
2. Myer Kutz, "Standard Handbook of Biomedical Engineering and Design", McGraw Hill Publisher, 2003.

e-RESOURCES:

1. https://www.youtube.com/watch?v=XEv4K1gHUEo, "Recording a 12 lead ECG", Nick smith, Central Manchester University hospitals.
2. https://www.youtube.com/watch?v=2Cs4CJBaTN4, "Introduction to Biopotentials", Sarwar K, University of Texas.

21ECT46 **ANALOG AND DIGITAL COMMUNICATION** **L T P C**
3 0 0 3

Preamble :

This course aims at designing Analog and Digital communication systems that are used for the transmission of information. A detailed quantitative framework for analog and digital transmission techniques is addressed.

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

1. Evaluate the AM, FM and PM systems with respect to performance and signal to noise ratio.
2. Compare the performance of various shift keying techniques used in digital communication systems
3. Analyze the characteristics of PAM, PTM and PCM modulation techniques and evaluate natural and flat top sampling techniques in digital pulse modulation
4. Compare and contrast of Huffman and Shannon-Fano coding techniques for coding efficiency of lossless data compression
5. Summarize the basic physical and technical settings of mobile communication systems and illustrate the orbital parameters of a satellite.

UNIT 1 ANALOG COMMUNICATION **9**

Introduction to **Communication Systems**: Modulation – Types – Need for Modulation. Theory of Amplitude Modulation – Evolution and Description of SSB Techniques – Theory of Frequency and Phase Modulation – Comparison of various Analog Communication System (AM – FM – PM).

UNIT 2 DIGITAL COMMUNICATION **9**

Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK) –Phase Shift Keying (PSK) – BPSK – QPSK – 8 PSK– Quadrature Amplitude Modulation (QAM) – 8 QAM– Comparison of various Digital Communication System (ASK – FSK – PSK – QAM).

UNIT 3 DATA AND PULSE COMMUNICATION **9**

Data Communication: Standards Organizations for Data Communication – Data Communication Circuits– Error Detection and Correction Techniques – Data communication Hardware

Pulse Communication: Pulse Amplitude Modulation (PAM) – Pulse Time Modulation (PTM) – Pulse code Modulation (PCM) – Comparison of various Pulse Communication System (PAM – PTM – PCM

UNIT 4 SOURCE AND ERROR CONTROL CODING **9**

Entropy, Source encoding theorem, Shannon fano coding, Huffman coding, mutual information, channel capacity, channel coding theorem, Error Control Coding, linear block codes, cyclic codes

UNIT 5 MULTI-USER RADIO COMMUNICATION **9**

Global System for Mobile Communications (GSM) – Cellular Concept and Frequency Reuse – Channel Assignment and Hand off – Satellite Communication: Kepler's Law – satellite orbit – Geostationary Satellite – Satellite link modes – Bluetooth – Wi Fi.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Wayne Tomasi, "Electronic Communication Systems", 5th Edition, Pearson Education, 2008.
2. Wayne Tomasi, "Advanced Electronic Communication Systems", 6th Ed, Pearson Education, 2009.

REFERENCES:

1. Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons, 2004
2. Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd Edition, Pearson Education, 2007.
3. H.Taub, D L Schilling and G Saha, "Principles of Communication", 3rd Edition, Pearson Education, 2007.

e. RESOURCES :

1. http://nptel.ac.in/courses/ 117101051 /, "Quantization , PCM and Delta Modulation", Prof. Bikash Kumar Dey, IIT, Bombay.
2. http://nptel.ac.in/courses/ 117101051 /, "Source Coding (Part - 1)", Prof. Bikash Kumar Dey, IIT, Bombay.
3. http://nptel.ac.in/courses/ 117101051 /, "Introduction to Digital Communication)", Prof. Bikash Kumar Dey, III, Bombay.

21ITL42	DATA STRUCTURES USING OBJECT ORIENTED PROGRAMMING LABORATORY	L T P C 0 0 3 1

(Common to B.E.- EE & MD Programmes in Fourth Semester)

Preamble

This Laboratory course will enable students to identify, formulate and solve real world engineering problems that require usage of data structure algorithms in C++. The course serves as a foundation laboratory for improving the problem solving skills of students

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

1. Develop and test C++ program to implement a list, stack and queue ADT for a given set of elements.
2. Develop a C++ programto implement inorder, preorder and postorder traversal techniques for a given binary tree using recursive functions.
3. Construct a binary search tree to perform insertion, deletion, and search operations for the given list of data.
4. Develop a C++ program to find shortest wire length between two components using Dijkstra's algorithm for a given circuit.
5. Implement and test C++ programto perform bubble sort and binarysearch for a given set of elements.

LIST OF EXPERIMENTS

1. Develop and test C++ program to implement an array ADT using classes, objects and member functions.
2. Develop a C++ program to implement insert, search and display operations in a singly linked list for a given list of integer data.
3. Design a C++ program to implement the stack operations (PUSH, POP, DISPLAY) using array concept for a given list of integer data.
4. Code a C++ program to implement Queue ADT using array for the followingoperations i.) Enqueue ii.) Dequeue iii.) Display
5. Construct a C++ program to evaluate the postfix expression using stack.
6. Develop a C++ program for traversing a binary tree in preorder, inorder and postorder using recursive function.
7. Create a Binary Search Tree to implement the insert, search and delete operations usingrecursive function.
8. Develop a C++ program to find shortest wire length between two components using Dijkstra's algorithm for a given circuit.
9. Implement and test a C++ program to sort the given list of numbers using bubble sort.
10. Develop and test a C++ Program to check whether the given number is in the list using binary search.

SOFTWARE

- Code Blocks - GCC Compiler

21MDL41	LINEAR AND DIGITAL INTEGRATED CIRCUITS LABORATORY	L T P C 0 0 3 1

Preamble:

This course is to provide practice in designing of combinational and sequential logic circuits. It also gives design experience in analog circuits in implementing amplifiers, active filters, waveform generators, comparator, multivibrators.

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

1. Design and Test inverting, non-inverting amplifier, integrator, differentiator, active filters, comparator and peak detector Circuits using IC741.
2. Design and test multivibrator circuits using IC 555.
3. Experiment and Test Analog to Digital & Digital to Analog Converter ICs
4. Design and Test adder, decoder, encoder, multiplexer, demultiplexer using logic gates.
5. Design and Test Sequential Circuits using flip flops.

LIST OF EXPERIMENTS

1. Inverting, Non-inverting amplifier, Integrator and Differentiator using IC741.
2. Second order low pass and high pass active filters using IC741.
3. Comparator, Peak detector using IC 741.
4. Wein Bridge Oscillator.
5. Multivibrator using IC 555 Timer.
6. Analog to Digital converter using 0809ADC and Digital to Analog converter using 0808DAC.
7. Half adder and Full adder.
8. Encoder and Decoder, Multiplexer and Demultiplexer using logic gates.
9. Universal shift register using flip flops.
10. Design of Mod-N counter.

TOTAL:45 PERIODS

21MCL04	PROFESSIONAL COMMUNICATION (Common to All Branches in Fourth Semester)	L T P C 0 0 2 0

Preamble:
Communicative English is a life skill necessary for all students of Engineering and Technology. The course Professional Communication aims at enabling the learners to communicate effectively and appropriately in professional contexts by exposing them to LSRW tasks.

Course Outcomes – After the completion of this course, students will be able to

1. Analyze the given listening material and answer the questions correctly , employing listening techniques.
2. Take part effectively in group discussions , conforming to professional norms
3. Analyze the given reading material and answer the questions correctly , employing reading techniques
4. Write within the stipulated time ,syntactically and semantically correct sentences to present ideas in the form of an essay.
5. Identify within the stipulated time syntactically and semantically correct sentences for a variety of language exercises

UNIT 1 LISTENING **6**

Listening to News Bulletins and Documentaries

UNIT 2 GROUP DISCUSSION **8**

Watching Group Discussion videos – Do's and Don'ts of GD – Mock GD

UNIT 3 READING **6**

Letters to Editor Column - Reading News Articles - Biographies of Famous Personalities

UNIT 4 WRITING **6**

IELTS Essay Writing

UNIT 5 VERBAL ABILITY **4**

Verbal analogy - Cloze Test- Idioms and Phrases- Sentence Completion -Error Spotting

TOTAL : 30 PERIODS

REFERENCES:

1. Raman, Meenakshi and Sangeetha Sharma, "Technical Communication: English Skills for Engineers", 1st Edition, Oxford University Press, New Delhi. 2008.
2. Rizvi, Ashraf. M, "Effective Technical Communication", 2st Edition, Tata McGraw-Hill, New Delhi,2018

e-RESOURCES:

1. http://www.slideshare.net/rohitjsh/presentation-on-group-discussion
2.https://www.bbc.com/bitesize/guides/zphc9j6/revision/1
3.https://www.fresherslive.com/online-test/verbal-ability-test/questions-and-answers

21MDC51 **BIOSIGNAL PROCESSING** **L T P C**
3 0 2 4

Preamble:
This course provides an introduction to the basic concepts of signal processing methods and to acquire knowledge of analysis of bio signal systems using various transformation techniques. It provides students to realize about different filter structure and also to develop algorithm for signal processing.

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

1. Discuss the different types of biomedical signals and identify their spectral components.
2. Apply established engineering methods to analyses neurological signals.
3. Identify physiological interference and artifacts affecting ECG Signals
4. Explain the adaptive filtering method on biomedical signals and noise cancellation performance.
5. Analyze non stationary biomedical signals through advanced techniques.

UNIT 1 INTRODUCTION TO BIOMEDICAL SIGNALS 9

Nature of Biomedical Signals –Example of Biomedical Signals: Action Potential–Electroneurogram (ENG) – Electromyogram(EMG) – Electro Cardiogram (ECG) – Electroencephalogram (EEG)– Electrogastrogram (EGG) – Phonocardiogram (PCG) – CP and Speech Signals–Objectives of Biomedical Signal Analysis – Difficulties in Biomedical Signal Analysis.

UNIT 2 NEUROLOGICAL SIGNAL PROCESSING 9

Electroencephalogram Signal and its characteristics – EEG analysis –Parametric Model –Phenomenological Model –Linear prediction theory – Spectral error measure –EEG Segmentation.

UNIT 3 CARDIOLOGICAL SIGNAL PROCESSING 9

Basic Electrocardiography –ECG Data acquisition –ECG Parameters and their Estimation: ECG QRS Detection Techniques –Template QRS Detection Technique –Differentiation based QRS Detection Technique–Arrhythmia Analysis Monitoring–Long term continuous ECG recording.

UNIT 4 ADAPTIVE FILTERING AND NOISE CANCELLATION 9

Principle of an adaptive filter– Steepest Descent Algorithm – The Widrow-Hoff Least Mean Square (LMS) Adaptive Algorithm – LMS Algorithm for the Scalar (One weight) Case–Adaptive Noise Cancelling: Adaptive noise canceller–Cancellation of 60Hz interference in electrocardiography – Cancellation of the electrocardiographic signal from the electrical activity of the chest muscles.

UNIT 5 ANALYSIS OF NONSTATIONARY SIGNALS 9

Illustration of the problems with case studies – Heart Sound and murmurs– EEG rhythms and waves –Articular cartilage damage and knee joint vibrations – Time variant systems – Characterization of non stationary signals and dynamic systems– Use of Adaptive filters for segmentation – Monitoring the RLS filter– Applications.

List of Experiments:

1. Generation of Elementary sequences.
2. Analysis of EEG signal.
3. Analysis of ECG signal.
4. Processing of Bio signals using adaptive filters.
5. Analysis of Non stationary Signals

TOTAL (L:45+P:15)=60 PERIODS

TEXT BOOKS:

1. Reddy D C, “Biomedical Signal Processing –Principles and Techniques”, The McGraw Hill Publishing Company Limited, New Delhi, Reprint 2011.
2. Rangaraj M Rangayyan, “Biomedical Signal Analysis A Case Study Approach” John Wiley, 2016.

REFERENCES:

1. Willis Tompkins, “Biomedical Digital Signal Processing”, Prentice Hall of India Publications 1995.
2. Bruce E N, “Biomedical Signal Processing and Signal Modelling”, Wiley India Private Limited, New Delhi, 2006.

e-RESOURCES :

1. https://ocw.mit.edu/courses/health-sciences-and-technology/hst-582j-biomedical-signal-and-image-processing-spring-2007/“Biomedical Signal and Image Processing”, Dr.Julie Greenberg, Massachusetts Institute of Technology.
2. http://bmsp-coep.vlabs.ac.in/#, “Biomedical and Signal Processing Laboratory”, College of Engineering, Pune.

21MDT51	MICROPROCESSOR AND EMBEDDED CONTROLLERS	L T P C 3 0 0 3

Preamble:

The purpose of this course is to provide students to gain knowledge about the architecture, instruction set, interrupts, interfacing, and programming of 8086 microprocessor and 8051 microcontroller. This course develops skills of students to program, design and implement smart system applications using Arduino.

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

1. Analyze the activities performed in T-States of fetch, read and write cycle in the minimum and maximum mode of 8086 microprocessor.
2. Develop assembly programs for the given problems using 8086 instruction set and design circuits to interface 8255PPI with 8086 microprocessor system.
3. Illustrate the architecture and memory organization of 8051 microcontroller.
4. Design circuits to interface ADC, DAC, relays, optoisolators, DC motor and stepper motor with 8051 microcontroller system.
5. Develop programs on Arduino platform for real world problems.

UNIT 1 8086 MICROPROCESSOR ARCHITECTURE ***9***

Introduction to microprocessor – 8086 Architecture – Memory segmentation – Memory banking – Pin diagram – Minimum mode configuration – Maximum mode configuration

UNIT 2 8086 PROGRAMMING AND INTERFACING ***9***

Addressing modes – Instruction set – Assembler directives – Assembly language programming – Interrupts – 8255 Programmable Peripheral Interface – Interfacing of 8255 with 8086

UNIT 3 8051 MICROCONTROLLER ARCHITECTURE ***9***

8051 Architecture – Memory organization – Special Function Registers – Addressing modes – Instruction set – Timers/Counters – Serial port – I/O ports

UNIT 4 8051 INTERRUPTS AND INTERFACING ***9***

Interrupts – Keyboard and LCD interfacing – ADC and DAC interfacing – Interfacing with temperature sensors – Relays and optoisolators interfacing – DC motor and stepper motor interfacing

UNIT 5 ARDUINO MICROCONTROLLER ***9***

Arduino platform – Arduino IDE – Arduino types – Arduino Uno – Arduino programming: structure of Arduino C, variables, making decisions, functions – Digital I/O – Analog I/O – Hardware libraries – LCD – Stepper motor – Servo motor

TOTAL : 45 PERIODS

TEXT BOOKS:

1. A. K. Ray and K. M. Bhurchandi, "Advanced Microprocessors and Peripherals", McGraw Hill Education, 3rd Edition 2013.
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin McKinlay, "The 8051 Microcontroller and Embedded Systems Using Assembly and C", Pearson, 2nd Edition, 2013.
3. Brain Evans "Beginning Arduino programming', Apress, 2011.

REFERENCES:

1. Yu-Cheng Liu, Glenn A. Gibson, "Microcomputer Systems: The 8086/8088 Family Architecture, Programming and Design", Pearson, 2nd Edition, 2015.
2. John Uffenbeck: "8086/8088 family: "Design, Programming and Interfacing", Prentice Hall, 2nd Edition, 1998.
3. Kenneth J. Ayala, "8051 Microcontroller: Architecture, Programming and Applications", Cenage Learning, 3rd Edition, 2007.

e-RESOURCES :

1. https://swayam.gov.in/nd1_noc20_ee42/, "Microprocessors and Microcontrollers", Prof. Santanu Chattopadhyay, Department of Computer Science and Engineering, Indian Institute of Technology, Kharagpur.
2. https://swayam.gov.in/nd1_noc20_ee11/, "Microprocessors and Interfacing", Prof. Shaik Rafi Ahamed, Department of Computer Science and Engineering, Indian Institute of Technology, Guwahati.
3. https://onlinecourses.swayam2.ac.in/aic20_sp04/, "Arduino", Prof. Kannan Moudgalya, Department of Chemical Engineering, Indian Institute of Technology Bombay.

21MDT52 **MEDICAL EQUIPMENT-II** **L T P C**
3 0 0 3

Preamble:
The Course enables the students to gain their knowledge level in ICU equipment and operation theatre equipment.

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

1. Acquire knowledge about measuring parameters related to respiratory system and respiratory devices.
2. Understand the physics underlying in the working of electrotherapy equipment, Lithotripsy and FES.
3. Depict the importance of optical equipment and biotelemetry in diagnostic area.
4. Illustrate the application of assist device in critical care unit.
5. Gain knowledge on Surgical Diathermy machines and their safety aspects, Anesthesia machine and the different controls.

UNIT 1 RESPIRATORY EQUIPMENT **9**

Pulmonary function test– spirometry– TLC graph– Principles of constant pressure and constant volume ventilators– Basic principles of electromechanical– Pneumatic and electronic ventilators– Nebulizer.

UNIT 2 ELECTROTHERAPY EQUIPMENT **9**

Electrotherapy– Electrodes– Stimulators for Nerve and Muscle– Stimulator for pain relief– Interferential current therapy– Functional ElectricalStimulation– High frequency heat therapy– Short wave diathermy– Microwave diathermy– Ultrasonic therapy– Lithotripsy.

UNIT 3 OPTICAL EQUIPMENT AND BIOTELEMETRY **9**

Various types of Endoscopes– Fiber optic– Fluid optic– Integral Camera. Electron Microscope– Transmission andReflection. Biotelemetry: Single channel, Multichannel telemetry systems.

UNIT 4 ICU EQUIPMENT **9**

Infusion pumps– Hemodialysis Machine– Different types of Dialyzers– Performance analysis– Membranes– Heart Lung Machine– Types of oxygenators– peristaltic pumps– Incubators.

UNIT 5 OPERATION THEATRE EQUIPMENT **9**

Suction apparatus– Principle of surgical diathermy– Electrosurgical techniques– Operation Theatre table & surgical lighting– Anesthesia machine– Gas supply system and delivery system– Vapor delivery system– Cryosurgery.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, 5 hEdition 2020.
2. Khandpur R.S, "Handbook of Biomedical Instrumentation", McGraw-Hill Education, 3 rdEdition 2014.

REFERENCES:

1. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Pearson India, 2 ndEdition 2015.
2. Myer Kutz, "Standard Handbook of Biomedical Engineering and Design", McGraw Hill Publisher, 2003.
3. Andrew G. Webb , "Principles of Biomedical Instrumentation ",Cambridge University Press , 1 st Edition, 2018.

e-RESOURCES :

1. https://www.researchgate.net/journal/08998205_Biomedical_Instrumentation_Technology
2. http://www.omicsonline.org/scholarly/biomedical-instrumentation-journals-articles-ppts-list.php

21MDL51	BIOMEDICAL INSTRUMENTATION LABORATORY	L T P C 0 0 3 1

Preamble:

The Course enables the students to acquire the knowledge about measurement of various physiological parameters and to understand the fundamental principle and working of the biomedical instruments.

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

1. Acquire signals to record the performance of physiological activity using electrodes.
2. Create a scenario and analyze the performance and features of ECG,EEG,EMG electrodes using biomedical instruments.
3. Establish a hearing module setup using audiometer to analyze the hearing impairment levels and standards.
4. Check the safety of any medical equipment to provide the quality assurance using safety analyzers.
5. Analyze the biomedical signal parameters using simulation tools.

LIST OF EXPERIMENTS

1. Recording of ECG signal and Analysis
2. Recording of EMG signal
3. Recording of EEG signal
4. Measurement and Recording of Peripheral Blood Flow using blood flow meter
5. Measurement of Pulse rate and Analysis
6. Real Time biomedical signal acquisition and processing using LabVIEW
7. Measurement of pH and Conductivity
8. Recording of Audiogram
9. Measurement of Galvanic Skin Resistance(GSR)
10. Design of preamplifier to acquire bio signals.

TOTAL:45 PERIODS

Preamble:
This laboratory course helps the students to develop their knowledge and programming skills on 8086 microprocessor, 8051 microcontroller and Arduino microcontroller. It provides hands-on experience to arithmetic and logic operations, data transfer, interface I/O devices, perform A/D and D/A conversions and interrupt handling.

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

1. Develop and test assembly language programs for 8086 microprocessor using trainer kits with assembler.
2. Develop and test assembly language programs for 8051 microcontroller using trainer kits with assembler and simulator.
3. Experiment & test the interfacing of ADC & DAC with 8051.
4. Experiment & test the interfacing of stepper motor, DC motor, keyboard and LCD with 8051.
5. Experiment & test LCD, servo motor and stepper motor interfacing with Arduino.

LIST OF EXPERIMENTS

8086 ASSEMBLY LANGUAGE PROGRAMMING USING ASSEMBLER

1. Arithmetic, logic operations, palindrome and factorial.
2. Sorting, searching, string manipulations and block data transfer.

8051 ASSEMBLY LANGUAGE PROGRAMMING USING ASSEMBLER AND SIMULATOR.

3. Arithmetic, logic operations and code conversion.
4. Block data transfer between internal and external memory including overlapping blocks.
5. Interrupts handling.
6. 8051 programming using simulators.

INTERFACING EXPERIMENTS WITH 8051

7. ADC and DAC interface.
8. Stepper motor and DC motor interface.
9. Keyboard and LCD display interface.

INTERFACING EXPERIMENTS WITH ARDUINO

10. LCD, servo motor and stepper motor interface.

TOTAL:45 PERIODS

21MCT05	APTITUDE AND LOGICAL REASONING (Common to All Branches in Fifth Semester)	L T P C 2 0 0 0

Preamble:

Aptitude tests are used to determine an individual's ability/potential to succeed in a certain task, with no prior knowledge or training and are frequently used as part of a pre-employment assessment. Aptitude tests are a proven tool used to identify those who are best equipped to carry out any given role.

A **logical reasoning test** is a form of testing that is widely used by corporate employers to help assess candidates during their recruitment process.

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

1. Solve the given equation using appropriate simplification methods.
2. Apply aptitude method of ratio and proportion to solve the given scenario.
3. Calculate time, speed, distance by applying suitable aptitude method for the given problem statement.
4. Calculate percentage and profit & loss for the given problem statement.
5. Compute simple interest, compound interest and predict relationship for the given problem/scenario.

UNIT 1 **6**

Number System, Simple Equation, Sequence and Series

UNIT 2 **6**

Ratio and Proportion, Problems on Ages, Partnership

UNIT 3 **6**

Time and Distance, Problems on Trains, Boats and Streams

UNIT 4 **6**

Percentage, Profit and Loss, Directions Sense

UNIT 5 **6**

Simple Interest and Compound Interest, Blood Relations

TOTAL : 30 PERIODS

REFERENCES:

1 Dr.R.S.Aggarwal, "Quantitative Aptitude for Competitive Examination", S.Chand Publications, 2017

2 Dr.R.S.Aggarwal, "A Modern Approach to Verbal & Non-Verbal Reasoning", S.Chand Publications, 2018

21MCL09 **COMMUNICATION SKILLS LABORATORY** **L T P C**
(Common to All Branches in Fifth /Sixth Semester) **0 0 2 0**

Preamble:

Communication Skill is a life skill necessary for all students of Engineering and Technology. The course Communicative Skills Laboratory aims at developing effective oral and written communication to facilitate their success in competitive examinations, and recruitment screening thereby ensuring professional success and progress.

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

1. Respond quickly and correctly to questions from different types of scripts , exhibiting good comprehension and analyzing skills
2. Participate effectively in formal group discussions and prepare professional e mails , persuasive and expository paragraphs to establish and meet organizational needs and goals.
3. Fare well in IELTS and other English language assessment segments of competitive examinations within the stipulated time.
4. Write effective résumés,and face interviews with communicative competence and confidence, with a good knowledge of career skills .
5. Select appropriate vocabulary and idiomatic expressions , identify errors in syntax , arrange sentences to make meaningful paragraphs,without any aid.

UNIT 1 RECEPTIVE SKILLS 6

LISTENING & READING – Developing Listening & Reading Skills - Comprehension and Analysis –Listening & Reading for Main Idea - Specific Information - Sequence-Vocabulary - Cultural Interest-Attitude and Opinion-Functional language.

UNIT 2 PRODUCTIVE SKILLS 8

SPEAKING - Group Discussion skills – Structure- Types- Techniques - Keywords -Vital qualities -Tips to improve performance. **WRITING -** Emails and Paragraph Writing - Expository and Persuasive

UNIT 3 ENGLISH FOR NATIONAL AND INTERNATIONAL EXAMINATIONS 4

Orientation to International English Language Testing System (IELTS), Public Service Commission Exams (TNPSC,UPSC)

UNIT 4 CAREER SKILLS 6

Different types of Interview formats - Answering Questions – FAQ's - Mock Interviews - Body Language - Preparation of Résumé and Job Application Letter - Team Work - Managing Time - Managing Stress - Negotiation Skills - Networking Professionally - Social Protocols – Upskilling

UNIT 5 VERBAL ABILITY 6

Synonyms and Antonyms - Verbal Analogy - Cloze Test- Idioms and Phrases - Sentence Completion - Jumbled Sentences - Error Spotting - Theme Detection - Sentence Arrangement

TOTAL : 30 PERIODS

RECOMMENDED SOFTWARE: Globerena

REFERENCES:

1 Rizvi M.Ashraf 'Effective Technical Communication' MC Graw Hill Education, New Delhi,2005.
2 Koneru Aruna 'Professional Communication' MC Graw Hill Education ,Chennai, 2008.
3 Upadhyay Meenakshi & Arun Sharma 'Comprehension Interpersonal & Communication Skills for General Studies Civil Services Preliminary Examination' MC Graw Hill Education, New Delhi,2012.

WEB SOURCES:

1 http://www.slideshare.net/rohitjsh/presentation-on-group-discussion
2 https://www.teachingenglish.org.uk/article/email-writing
3 https://www.naukri.com/blog/frequently-asked-hr-interview-questions-and-answers/
4 http://www.oxforddictionaries.com/words/writing-job-applications
5 https://www.freshers live.com/online-test/verbal-ability-test/questions-and-answers

21MDT61 **MEDICAL IMAGE PROCESSING** **L T P C**

3 0 0 3

Preamble:

Medical image processing provides an introduction to the basic concepts of image processing methods and to acquire knowledge of processing of digital and medical images using various transformation techniques. It provides students to realize about different filters and to develop algorithms for image processing.In order to understand the analysis of entire image in frequency domain it is essential to learn the various image transforms.Also, it is necessary to learn the concepts of image enhancement, segmentation and compression.

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

1. Infer the digital image using sampling and quantization techniques.
2. Analyze the enhanced image by spatial domain and frequency domain methods.
3. Analyse and restore the enhanced images using inverse and weiner filtering.
4. Contrast the given image discontinuities by point, line and edge detection and segment the given image by thresholding and represent the boundary of images using chain codes and polygonal approximation.
5. Illustrate the compression techniques for the images using Huffma coding,Run Length coding ,Predictive coding and Transform coding.

UNIT 1 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 image fundamentals - RGB, 2Dtransforms - DFT, DCT.

UNIT 2 IMAGE ENHANCEMENT **9**

Spatial Domain: Gray level transformations – Histogram processing – Histogram equalisation to Mammographic images.Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering, Frequency Domain: Introduction to Fourier Transform– Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussianfilters, Homomorphic filtering approach to X-ray images.

UNIT 3 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 – Medical Image Restoration-Inverse Filtering – Wiener filtering.

UNIT 4 IMAGE SEGMENTATION AND REPRESENTATION **9**

Detection of discontinuities-Point,Line and Edge detection-Gradient operators-Edge linking via Hough transform – Thresholding - Region based segmentation – Region growing – Region splitting and merging . Boundary representation-chain codes-polygonal approximation-Breast Tissue detection-Analysis of Tissue structure.

UNIT 5 IMAGE COMPRESSION AND RECOGNITION **9**

Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEG standard, MPEG. Texture - Patterns and Pattern classes - Recognition based on matching. Content Based Medical Image Retrieval.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Rafael C. Gonzalez, Richard E. Woods, “Digital Image Processing”, Pearson, 4thEdition, 2017.
2. Anil K. Jain, “Fundamentals of Digital Image Processing”, Pearson, 4 th Edition, 2002.

REFERENCES:

1. Kenneth R. Castleman, “Digital Image Processing”, Pearson, 2nd Edition,2006.
2. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, “Digital Image Processing using MATLAB”, Pearson Education, Inc., 2nd Edition, 2011.
3. Wolfgang Birkfellner , “Applied Medical Image Processing: A Basic Course ”, Taylor & Francis , 2nd Edition, 2016.

e-RESOURCES :

1. NPTEL Video https://nptel.ac.in/courses/117105079/ “Introduction to Digital Image Processing”,Prof.Prabir Kumar Biswas,IIT Kharagpur.
2. NPTEL Video https://www.digimat.in/nptel/courses/video/108105091/L01.html“ Introduction to Medical Image Analysis”, Prof.Debdoot Sheet, IIT Kharagpur.

21MDT62 **REHABILITATION ENGINEERING** **L T P C**
3 0 0 3

Preamble:
This course aims to develop an understanding of the various rehabilitation aids so as to enable the student to design and apply them with confidence, to help the challenged people

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

1. Understand the key terminologies used by the rehabilitation team.
2. Identify the use of the orthopedic prosthetics and orthotics in rehabilitation.
3. Interpret the ETA, wheel chair technology and methods to provide as a mobily assist to challenged people.
4. Illustrate the various assist devices for different disabilities of the body
5. Suggest augumented , substitute assistive devices for visually impaired persons.

UNIT 1 INTRODUCTION TO REHABILITATION **9**

Definition– Concept ofRehabilitation:TypesofPhysicalImpairments,PrinciplesofAssistiveTechnology Assessment, Principles of Rehabilitation Engineering- Key Engineering Principles– Key Ergonomic Principles– Engineering Concepts in Sensory & Motorrehabilitation.

UNIT 2 ORTHOTICS & PROSTHETICS IN REHABILITATION **9**

Types of orthosis-FO,AFO,KAFO,HKAFO and prosthesis ,Partial Foot Prostheses- Foot-ankle assembly– Trans femoral Prostheses– Prosthetic Hand– Advance and automated prosthetics and orthosis– Externallypowered and Controlled orthotics & prosthetics – FES system– Restoration of Hand function– Restoration of standing and walking.

UNIT 3 MOBILITY AIDS **9**

Electronic Travel Appliances (ETA) : Path Sounder, Laser Cane, Ultrasonic Torch, Sonic Guide, Light Probes, Nottingham Obstacle Sensors, Electro cortical Prosthesis, Polarized Ultrasonic Travel aids.Materials used for wheel chairs– Type of Wheel Chairs– design of wheel Chair– Walking frames– Parallel bars– Rollators– Quadripods– Tripods & walking sticks– Crutches.

UNIT 4 AUDITORY AND SPEECH ASSIST DEVICES **9**

Types of deafness– hearing aids– application of DSP in hearing aids– Cochlear implants– Voice synthesizer– speech trainer.

UNIT 5 SENSORY AUGMENTATION AND SUBSTITUTIONS **9**

Classification of Visual Impairments– Prevention and cure of visual impairments– Visual Augmentation– Tactile vision substitution– auditory substitution and augmentation– tactile auditory substitution– Assistive devices for the visual impaired.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Joseph D.Bronzino, "The Biomedical Engineering Handbook", 3 rdEdition: Three Volume Set,CRC Press,2006.
2. Raymond V. Smith, "Rehabilitation Engineering", CRC press, Reprint 2018.

REFERENCES:

1. Xingdong Zhang, David Williams, "Definitions of Biomaterials for the Twenty-First Century", Elsevier, 2019.
2. Joseph Webster, Douglas Murphy, "Atlas of Orthoses and Assistive Devices", Elsevier, 5 th Edition, 2017.
3. RoryACooper,"AnIntroductiontoRehabilitationEngineering",Taylor& Francis,CRCpress,2006.

e-RESOURCES :

1. https://swayam.gov.in/nd2_aic19_ge01/preview, "Development of Assistive technology for persons with Disabilities", Indumathi Rao, C B R Network.
2. https://www.resna.org/Resources/Research-Guidelines "RESNA's Guidelines and Priorities for Assistive Technology and Rehabilitation Research".

21MDT63 HOSPITAL ENGINEERING AND MANAGEMENT **L T P C**

3 0 0 3

Preamble:

The Course enables the students to explore various information management systems and relative supportive services.

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

1. llustrate the overall structure and planning in hospital to meet the requirements of accreditation.
2. dentify the importance of Human resource management to recruit,select, train and evaluate the performance of a healthcare professional.
3. nterpret the market research considerations and utilities in the evolving healthcare market environment.
4. mplement different modules of computerised system in hospital to support clinical activity.
5. Develop knowledge into the procedures used in quality control and assurance activities to be ollowed in hospitals.

UNIT 1 OVERVIEW OF HOSPITAL ADMINISTRATION 9

Planning the Hospitals – Guiding principles in planning hospital facilities and services –Preliminary survey – Financial planning – Equipment Planning – Purchase of capital equipment – Organizational structure - Management Structure – Organizational Charts

UNIT 2 HUMAN RESOURCE MANAGEMENT IN HOSPITAL 9

Principles of HRM – Functions of HRM – Profile of HRD Manager – Tools of HRD –Human Resource Inventory – Manpower Planning. Recruitment, Selection, Training Guidelines –Methods of Training – Evaluation of Training – Leadership grooming and Training, Promotion
– Transfer, Communication – nature, scope, barriers, styles and modes of communication.

UNIT 3 MEDICAL AND SUPPORTIVE SERVICES 9

Outpatient services – Clinical Laboratory services – Surgical Department – Hospital Information System - General Nursing units – Intensive care units - Medical Records - Pharmacy – Central Sterile Supply Department (CSSD) - Materials Management - Hospital linen and Laundry services – house keeping

UNIT 4 HOSPITAL SERVICE MANAGEMENT 9

Engineering department - maintenance management- clinical engineering – electrical system- air conditioning system- water supply and sanitary system – centralized medical gas system- communication system- solid waste management and transportation.

UNIT 5 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 – Environment Management Systems. NABH, JCI, NABL. Security – Loss Prevention – Fire Safety – Alarm System – Safety Rules. Hazard and Safety in a hospital Setup.

TOTAL :45PERIODS

TEXT BOOKS:

1. R.C.Goyal, "Hospital Administration and Human Resource Management", PHI –4 thEdition, 2006.
2. G.D.Kunders, ―Hospitals – Facilities Planning and Management – TMH, New Delhi 5 th Reprint 2007.

REFERENCES:

1. Cesar A.Caceres and Albert Zara, "The Practice of Clinical Engineering", Academic Press, New York, 1977.
2. Norman Metzger, "Handbook of Health Care Human Resources Management" , 2ndEdition , Aspen Publication Inc. Rockville, Maryland, USA, 1990.
3. B.M. Sakharkar, "Principles of hospital administration and planning", Jaypee Brothers Medical Publishers Pvt Limited, 2nd edition, 2009.

e-RESOURCES:

1. NPTEL Videoshttps://nptel.ac.in/courses/110/104/110104095/ "Economics of health and health care",Dr. Angan Sengupta, IIT Kanpur.
2. NPTEL Videos https://nptel.ac.in/courses/127/106/127106136/ "Regulatory requirements for medical devices and IVDs in India", Dr. Sucheta Banerjee Kurundkar, IIT Madras.

21MDL61 DIAGNOSTIC AND THERAPEUTIC EQUIPMENT LABORATORY

L	T	P	C
0	0	3	1

Preamble:

The Course enables the students to acquire the knowledge about measurement of various physiological parameters and to understand the fundamental principle and working of the biomedical instruments

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

1. Elucidate various diagnostic and therapeutic techniques
2. Describe the features patient monitoring system and telemetry
3. Experiment and Determine the flow rate for safer and micro administration of doses.
4. Assess different non-electrical parameters using various methodologies
5. Analyse the respiration trajectories for various phases using inhalation and exhalation mechanisms.

LIST OF EXPERIMENTS

1. Study of Shortwave Diathermy.
2. Recording of various physiological parameters using patient monitoring system .
3. Study of Ultrasonic Diathermy.
4. Simulation of ECG- detection of QRS complex and Heart rate using MATLAB.
5. Measurement of Flow rate using Syringe pump and Infusion pump.
6. Perform an Experiment to convert fibrillated rhythmic ECG to normal form using defibrillator.
7. Measurement of Heart rate using biotelemetry.
8. Analyze the working of ESU – Cutting and Coagulation modes.
9. Study of Pacemaker .
10. Measurement of Respiratory rate using spirometer.

TOTAL:45 PERIODS

21MDL62	MEDICAL IMAGE PROCESSING LABORATORY	L T P C 0 0 3 1

Preamble:

The Course enables the students to familiarize with the principles of processing medical signal and images to extract diagnostic information from them.

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

1. Determine the performance ratio of sampling, quantization, convolution of ECG,EEG,PCG biomedical signals.
2. Implement time frequency analysis and data reduction techniques to biomedical signals.
3. Develop and implement algorithms for image enhancement and restoration .
4. Analyze the enhanced image by spatial domain and frequency domain methods.
5. Develop programs for image segmentation and classification of retinal images to diagnose retinal disorders.

LIST OF EXPERIMENTS

1. Image arithmetic operations
    a. Addition
    b. Subtraction
    c. Multiplication
    d. Division of 2 images.
2. Medical Image Enhancement techniques
    a. Histogram
    b. Segmentation
    c. Edge Detection
    d. Classification
    e. Enhancement
    f.Restoration..
3. Medical Image Segmentation- Edge detection, line detection and boundary detection.
4. Basic Morphological Operations.
5. Texture analysis with statistical properties.
6. Image classification / recognition of Medical Images
7. Medical image analysis using Python
8. Image Enhancement using Python
9. Feature Detection using Python
10. Processing of Retinal Images.

TOTAL:45 PERIODS

21MDL63	MINI PROJECT	L T P C 0 0 6 3

Preamble:

The Course enables the students to estimate the ability of the student in transforming the theoretical knowledge studied so far into a working model of a Biomedical/ Electronics/ Mechatronic/ Instrumentation system.

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

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

21MCT07 **ARITHMETIC AND ANALYTICAL ABILITY** **L T P C**

(Common to All Branches in Sixth Semester) **2 0 0 0**

Preamble:

Arithmetic And Analytical Ability evaluates the talent and potential to perform a certain task, with no prior knowledge and/or training. This course deals with sort of problems on dynamic thinking, numeric capacity and spatial question. This course is further used for prediction of future success both in educational and vocational careers and aptitude skills help the students in the proper choice of courses and careers.

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

1. Compute time, work, capacity and identify the pattern by analyzing the given problem/scenario
2. Analyze the given problem involving mixture, averages, seating arrangement and apply the suitable method to get the appropriate result.
3. Interpret the given chart and determine the solution.
4. Identify and apply the appropriate permutation, Combination, probability technique to determine the solution.
5. Infer the solution for the given scenario involving syllogisms, clocks, calendar using suitable techniques.

UNIT 1 **6**

Time and Work, Pipes and Cisterns, Symbol Series

UNIT 2 **6**

Alligation or Mixture, Averages, Seating Arrangements

UNIT 3 **6**

Data Interpretation-Table Charts, Bar Charts, Pie Charts, Line Charts

UNIT 4 **6**

Permutation and Combination, Probability

UNIT 5 **6**

Syllogisms, Clocks, Calendar

TOTAL : 30 PERIODS

REFERENCES:

1 Dr.R.S.Aggarwal, “Quantitative Aptitude for Competitive Examination”, S.Chand Publications, 2017

2 Dr.R.S.Aggarwal, “A Modern Approach to Verbal & Non-Verbal Reasoning”, S.Chand Publications, 2018

21ITT71 ECONOMICS AND MANAGEMENT FOR ENGINEERS L T P C
3 0 0 3

Preamble:
The main aim of this course is to understand the concepts of Economics with respect to the demand and supply analysis. This course makes the students to analyze the theory of production and the analysis of the cost parameter by using the Elasticity. This course will enable the students to manage and plan the situation with the help of the available strategies to support the decision making process.

Course Outcomes: Upon completion of the course, students will be able 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.

UNIT 1 INTRODUCTION TO ECONOMICS 9

Introduction toEconomics – 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 2 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 3 THEORY OF PRODUCTION AND ANALYSIS OF COST 9

Meaning of Production – Production concepts – Production Function – Laws of Production – Cost Concepts - Short-Run CostOutput Relations – Long Run Cost output relations – Economics of Scale.

UNIT 4 INTRODUCTION TO MANAGEMENT 9

Management: An Overview – Management Defined – Managerial skills – Managerial roles – Management responsibilities – Management functions. Evolution of Management: Classical approaches to Management – Contemporary Management Perspectives.

UNIT 5 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 : 45 PERIODS

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.

REFERENCES:

1. RanbirSingh,“ Principles of Engineering Economics and Management”, S .K.Kataria& Sons, New Delhi, 2013.
2. Manish Varshney and VidhanBanerjee,“Engineeringand Managerial Economics”,First Edition, CBS Publishers and Distributors Pvt. Ltd., 2015.

e-RESOURCES:

1. http://nptel.ac.in/courses/110101005/, Prof.Trupti Mishra, S.J.M. School of Management, IIT Mumbai, Managerial Economics.
2. https://nptel.ac.in/courses/122106031/slides/3_1s.pdf, Dr.M.Thenmozhi, Professor, IIT Madras.

		L T P C
21MDT71	**MEDICAL EXPERT SYSTEMS**	**3 0 0 3**

Preamble:

The course will focus strongly on expert systems, but will provide scope for the examination of other areas of interest important to course participants.

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

1. Compare and contrast expert system with conventional systems and human experts.
2. Illustrate the strategy to acquire and manipulate the knowledge from the knowledge base and arrive at a particular solution for a disorder.
3. Identify and represent relations,recommendations,directives,strategy and heuristics to solve a problem using rule based approach.
4. Identify and explain neuro fuzzy systems for classification and prediction in diagnosis of different types of medical disorders.
5. Summarize the knowledge based tools available for physicians to asssist computer based clinical consultation system.

UNIT 1 ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEM 9

Artificial Intelligence–Constituents of AI –Conventional Artificial Intelligence to Computational Intelligence. Expert System-Characteristics and capabilities–Components of Expert systems–Limitations and applications– Expert system development steps– Expert system technology–Development environment,tools and shells.

UNIT 2 KNOWLEDGE BASED EXPERT SYSTEM 9

Search techniques–Problem definition and solution process. Search techniques–Breadth first search–Depth First Search–Heuristic Search–Generate and Test–Best First Search. KBES- Architecture of Knowledge Based Expert System–Knowledge Base–Inference Mechanisms.

UNIT 3 RULE BASED EXPERT SYSTEMS 9

RBES–Introduction, Elements of Rule based system, Rules as knowledge representation techniques–Expert system development architecture–Basic structure of RBES–Inference chain–Examples of inference chain. Methods used for conflict resolution–Meta knowledge Metarules-Advantages and Disadvantages of RBES.

UNIT 4 FUZZY AND NEURO FUZZY INTELLIGENT SYSTEM 9

Basics of Neural Networks –Fuzzy logic– Fuzzy rules and reasoning–Fuzzy decision making.Neuro Fuzzy Inference System– Architecture–Neuro Fuzzy Modeling–Rule Based Structure Identification–Neuro Fuzzy Control– Expert Control–Back Propagation Through Time and Real Time Recurrent Learning.

UNIT 5 EXPERT SYSTEM IN HEALTHCARE 9

Medical expert systems–Knowledge tools for physicians–Development of expert system to monitor Heart Diseases–Retinal Diseases– Expert System for Diagnosis of Human Diseases.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Dan W. Patterson, “Introduction to Artificial Intelligence and Expert Systems”, Prentice Hall of India, Delhi,Reprint 2001.
2. C.S. Krishnamoorthy, S. Rajeev, “Artificial Intelligence and Expert Systems for Engineers”, CRC Press , Reprint 2018.

REFERENCES:

1. Elain Rich and Kevin Knight, “Artificial Intelligence:A Modern Approach”, Pearson Education,3 rd Edition 2015.
2. Swetapadma, Aleena, Sarraf , “Expert System Techniques in Biomedical Science Practice ”, IGI Global ,2 nd Edition , 2018.
3. Jay Liebowitz, “The Handbook of Applied Expert Systems”, CRC Press ,1 st Edition 2019.

e-RESOURCES :

1. NPTEL Videos https://nptel.ac.in/courses/106/105/106105077/,“Introduction to Artificial Intelligence”, Prof.Sudeshna Sarkar ,Department of Computer Science & Engineering ,IIT, Kharagpur.
2. https://nptel.ac.in/courses/106/105/106105215/ “ Deep Learning”, Prof. Prabir Kumar Biswa, Department of Electronics and Elecrical Communication Engineering, IIT Kharagpur.

21MCT12 **HUMAN VALUES AND PROFESSIONAL ETHICS** **L T P C**

(Common to All Programmes)

3 0 0 3

Preamble:

Universal Human Values is a life skill necessary for all students of Engineering and Technology. The course aims to identify the values and skills, and to realize the need, basic guidelines, content and process of value education. Professional Ethics For Engineers deals with the human values, integrity and work ethics in the common world. This course is mainly concerned about the theories of ethics, which form the basis for the understanding and responsibility of the various groups encountered in Engineering.

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

1. Relate the significance of value inputs in a classroom and start applying them in their life and profession.
2. Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual.
3. Interpret the value of harmonious relationships based on the trust and respect in their life and profession.
4. Discuss the ethical issues related to Engineering.
5. Discuss Engineer's work in the context of its impact on society.

UNIT 1 INTRODUCTION TO UNIVERSAL HUMAN VALUES **9**

Understanding the need, basic guidelines, content and process for Value Education. Self Exploration– Mechanism for self exploration. Continuous Happiness and Prosperity- Basic Human Aspirations and its requirements for fulfillment of Human Aspirations understanding and living in harmony at various levels.

UNIT 2 HARMONY IN ONESELF, FAMILY AND SOCIETY **9**

Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer). Understanding harmony in the Family- the basic unit of human interaction. Understanding values in human-human relationships. Trust and Respect- values of relationship. Difference between intention and competence. Difference between respect and differentiation

UNIT 3 HOLISTIC UNDERSTANDING OF HARMONY ON PROFESSIONAL ETHICS **9**

Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in Professional Ethics. Ability to utilize the professional competence for augmenting universal human order, Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems, technologies and management models.

UNIT 4 ENGINEERING ETHICS **9**

Senses of Engineering Ethics– Variety of moral issues – Types of inquiry – Moral dilemmas – Moral autonomy – Kohlberg's theory – Gilligan's theory – Consensus and controversy – Models of professional roles –Professional responsibility - Moral reasoning - Theories about right action – Self interest – Self respect – Duty ethics – Customs and religion.

UNIT 5 ENGINEERING AS SOCIAL EXPERIMENTATION **9**

Engineering as experimentation – Engineers as responsible experimenters – Role of codes- Codes of Ethics – Sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of Electronics and Telecommunication Engineers (IETE) – A balanced outlook on law - Safe exits -The Bhopal gas tragedy and Challenger case study.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Gaur R R, Sangal R, Bagaria G P, “A Foundation Course in Human Values and Professional Ethics”. 200
2. Govindarajan M, Natarajan S and Senthil Kumar V. S, “Engineering Ethics”, PHI Learning Pvt. Ltd, Ne 2017.

REFERENCES:

1. Banerjee B P, “Foundations of Ethics and Management”, Excel Books. 2005.
2. Bajpai B L, “Indian Ethos and Modern Management”, New Royal Book Co., Lucknow. Reprinted 2008.
3. Subramanian R, “Professional Ethics”, Oxford university press, 2017.

e-RESOURCES:

1. https://www.uhv.org.in/
2. https://nptel.ac.in/courses/109/106/109106117/

21MDL71	EXPERT SYSTEM LABORATORY	L T P C 0 0 3 1

Preamble:
The Course enables the students to acquaint with various computing algorithms in expert systems using software tools and understand operation of basic elements in fuzzy logic and neural network through simulation to develop algorithms to solve real life problems.

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

1. Demonstrate basic concepts fuzzy logic and neural network through simulation.
2. Develop the logic given in problem statement using algorithms in Neural network to determine performance of logical operators.
3. Implement medical fuzzy expert systems for diagnosis of human diseases using neuro fuzzy intelligent system.
4. Create a medical disorder scenario and analyse the performance of expert system using any two tools to determine the decision making rate.
5. Implement classification and prediction algorithms for diagnosis of medical disorders.

LIST OF EXPERIMENTS

1. Develop and train an Artificial Neural Network.
2. Develop and train a Perceptron network to perform logical operations using neural network toolbox.
3. Fuzzy expert deduction system- Rule Based Expert system.
4. Expert system based heart disease diagnosis system.
5. Development of logic for fuzzy relations.
6. Construct a fuzzy inference system using GUI tools for a conditional decision making process.
7. Linear regression using artificial neural networks in Python environment.
8. Image classification in Python environment.
9. Study of Matlab Neural Networks toolbox for the development of neural network based applications.
10. Study of Matlab Fuzzy Logic toolbox for the development of fuzzy logic based applications.

TOTAL:45 PERIODS

21MDL72	HOSPITAL TRAINING	L T P C 0 0 4 2

Preamble:
To develop the practical experience at place where biomedical equipment's are utilized.

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

1. Implement a patient-centred approach in healthcare
2. Communicate with other health professionals in a respectful and responsible manner
3. Demonstrate the maintanence and service of diagnostic and therapeutic equipments.
4. Propose a patient-centred inter-professional health improvement plan based upon the patient's perceived needs.
5. Demonstrate patient care in hospital setting and provide access to health care professionals to get a better understanding of their work.

LIST OF EXPERIMENTS

1. Study of Ventilator functioning.
2. Study of Ultrasound machine.
3. Study of Heart Lung Model.
4. Troubleshooting,maintenance and servicing of medical equipments.
5. Presentation on various departments and equipments in the Hospital.

Students have to undergo two weeks practical training in hospitals with the prior approval from the institution during semester holidays of that particular academic year. At the end of the training student will submit a report as per the prescribed format to the department.

TOTAL:45 PERIODS

21MCT08 INDIAN CONSTITUTION AND TRADITIONAL KNOWLEDGE L T P C
2 0 0 0

Preamble:
The course provides basic information on Indian Constitution and Indian Traditional knowledge. This is essential for all citizens and especially for engineers so that they become aware of Indian polity and governance. This also reminds the citizen about their obligation, adherence and up keeping of Constitutional rights.

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

1. Outline the evolution of Indian constitution and Federal structure
2. List and explain the functions of Centre, States and District Administrations
3. Elaborate the roles of Panchayat raj
4. Explain the powers and roles of Election Commission
5. Illustrate the Indian traditional knowledge and elucidate their recovery

UNIT 1 **6**

'Constitution' meaning of the term, Indian Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy - Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha

UNIT 2 **6**

Governor: Role and Position, CM and Council of ministers, State Secretariat: organisation, Structure and Functions District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation,

UNIT 3 **6**

Panchayatraj: Introduction, PRI: Zila Panchayat, Elected officials and their roles, CEO Zila Panchayat: Position and role, Block level: Organizational Hierarchy (Different departments),Village level: Role of Elected and Appointed officials, Importance of grass root democracy

UNIT 4 **6**

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

UNIT 5 **6**

Basic structure of Indian Knowledge System-Modern Science and Indian Knowledge –Philosophical Tradition - Indian Linguistic Tradition (Phonology, morphology, syntax and semantics) – Indian Artistic Tradition

TOTAL: 30 PERIODS

TEXT BOOKS:

1. M.Rajaram, Indian Constitution, New Age International, 2009
2. V. Sivaramakrishnan (Ed.) Cultural Heritage of India (Course Material),Bharatiya Vidya Bhavan, Mumbai. 5th Edition,2014

21MDL81	INTERNSHIP	L T P C
		- - - 2

Preamble:

This course enables off-campus experiential learning activities designed to provide students with opportunities in healthcare to make connections between the theory and practice of academic study and the practical application of that study in a professional work environment.

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

1. Identify the significance of the selected field of study and define the problem systematically.
2. Acquire practical knowledge to formulate objectives, methodology of the study.
3. Exhibit evidence of increased content knowledge gained through practical experience.
4. Apply the theoretical learning in practical situations by accomplishing the tasks assigned during the internship period. .
5. Report the findings of the study and present their views in the form of suggestions to overcome the selected problem.

GUIDELINES FOR REVIEW AND EVALUATION:

The students work on a topic approved by the head of the department under the guidance of a faculty member and shall prepare a comprehensive internship report after completing the work to the satisfaction of the organization. The progress of the intern is evaluated based on reviews. The review committee may be constituted by the Head of the Department. An intern report is required at the end of the semester.

21MDL82	PROJECT WORK	L T P C
		0 0 20 10

Preamble:

This course enables the students develop the ability to solve a real time problem as a medical electronics engineer right from its identification and literature review till the successful solution of the same. To train the students in preparing project reports and to face reviews and viva voce examination.

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

1. Identify inherent potential research areas in the field of healthcare.
2. Compare and contrast the state of art techniques and solutions for the real-time issues identified.
3. Formulate and propose a plan for creating a solution for the research plan identified.
4. Conduct the experiments as a team and interpret the results.
5. Report the documents related to their findings for detailed presentations, defend the findings and conclude with oral/written presentation.

GUIDELINES FOR REVIEW AND EVALUATION

The students in a group of 2 to 4 work on a topic approved by the head of the department under the guidance of a faculty member and shall prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL :180 PERIODS

21MDE01	HAPTICS	L	T	P	C
		3	0	0	3

Preamble

The course enables the students to understand the basic concepts of human locomotion, biomechanical analysis using Finite Element Analysis and also provide knowledge on machines in haptics.

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

CO1 Explain the laws of principles of haptics for human

CO2 Discuss the behavior of machines in haptics

CO3 Analyze the suitable sensor and actuator for haptics

CO4 Identify suitable computation for haptics

CO5 Describe the finite element analysis, design the work station depending upon the haptics

UNIT 1 HUMAN HAPTICS **9**

Somatosensory System, Motor System, Muscle Physiology; Haptic psycho physical experiments.

UNIT 2 MACHINE HAPTICS **9**

Haptic devices design, human factors involved.

UNIT 3 HAPTIC SENSORS AND ACTUATORS **9**

Barriers in human haptics, Ergonomics.

UNIT 4 COMPUTATIONAL HAPTICS **9**

Haptic rendering, Rigid bodies, Deformable bodies, Stability Rendering effects, Human performance and evaluation, Biomechanics of manipulation, Neuromuscular Models.

UNIT 5 HAPTICS FOR MEDICAL APPLICATIONS **9**

Applications- Telemedicine; Rehabilitation, Medical Simulations for education.

TOTAL : 45 PERIODS

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. Vol. 4. New York: McGraw-hill, 2000.

REFERENCES:

1. Chang Liu, Foundations of MEMS, Pearson Education Inc., 2012.
2. Nadim Maluf and Kirt Williams, An introduction to Microelectro Mechancial Systems Engineering, Second Edition, Artech House Inc, MA, 2004.
3. Nitaigour Premch and Mahalik, MEMS, Tata McGraw Hill Publishing Company, New Delhi, 2007.

e-Resources:

1. http://www.digimat.in/nptel/courses/video/109107154/L07.html
2. https://archive.nptel.ac.in/courses/121/106/121106013/

21MDE02	MEDICAL OPTICS AND PHOTONICS	L	T	P	C
		3	0	0	3

Preamble

The course enables the students to acquire knowledge on various applications of biosensors in medicine and learn the diagnostic, surgical and therapeutic applications of lasers in medicine.

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

CO1 Explain the various physical properties of light and optical properties of tissues.

CO2 Consolidate the working principles of optical components.

CO3 Discuss the various applications of biosensors in medicine.

CO4 Summarize the diagnostic and surgical applications of lasers in medicine.

CO5 Explain the laser tissue interaction and various therapeutic applications of lasers.

UNIT 1 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 2 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 3 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 4 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 5 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 : 45 Periods

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.

REFERENCES:

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.

e-Resources:

1. https://nptel.ac.in/courses/127/105/127105225/
2. https://onlinecourses.nptel.ac.in/noc21_ge13/preview

21MDE03	RAPID PROTOTYPING	L	T	P	C
		3	0	0	3

Preamble

The course makes the students to learn the need and fundamentals of rapid prototyping and understand the concepts involved in design, assembling of various parts and data processing.

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

CO1 Demonstrate the basics of Additive manufacturing.

CO2 Design and assembly of various parts for the desired task.

CO3 Explain the process involved in laser and UV based AM

CO4 Illustrate the process of fused deposition moulding and sheet lamination

CO5 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.

UNIT 1 INTRODUCTION **9**

Overview, Need and development of Additive Manufacturing Technology- Principle – AM Process Chain, Classification – Rapid Prototyping- Rapid Tooling –Rapid Manufacturing, Applications, Benefits, Case studies.

UNIT 2 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 3 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 4 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 5 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 : 45 Periods

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.

REFERENCES:

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.

e-Resources:

1. https://help.autodesk.com/view/fusion360/ENU/courses/
2. https://www.sciencedirect.com/topics/engineering/rapid-prototyping

21MDE04	ERGONOMICS FOR HEALTHCARE	L	T	P	C
		3	0	0	3

Preamble

The course enables the students to get exposed to principles of visual capabilities, learn the mechanics of muscle physiology and spatial compatibility. Also to get familiar with the mathematical models, analysis and design of biomedical devices using case studies.

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

CO1 Comprehend and appreciate the significance and role of this course in the present contemporary world.

CO2 Demonstrate knowledge of the fundamentals of optical properties of tissues.

CO3 Describe surgical applications of laser.

CO4 Describe photonics and its therapeutic applications.

CO5 Apply the concepts of laser and light to understand the laser safety procedures.

UNIT 1 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 2 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 3 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 4 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 5 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 : 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

REFERENCES:

1. Shrawan Kumar, Biomechanics in Ergonomics, Second Edition, CRC Press2007.
2. George Kanawaty, “Introduction to work study”, ILO, 3rd edition, Oxford & IBH publishing, 2001
3. Stephen Pheasant, Christine M. Haslegrave, Bodyspace: Anthropometry, Ergonomics and the Design of Work, CRC Press, 2005.

e-Resources:

1. https://onlinecourses.nptel.ac.in/noc20_de12/preview.
2. https://archive.nptel.ac.in/courses/110/105/110105162/

21MDE05	AI IN HEALTHCARE	L	T	P	C
		3	0	0	3

Preamble

The course makes the students to learn about the knowledge representation in solving AI problems and to acquire knowledge on implementing and planning Machine learning algorithms.

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

CO1 Discuss the basics of artificial intelligence and production systems
CO2 Explain various methods of knowledge representation.
CO3 Discuss about knowledge inference techniques
CO4 Illustrate the basics of machine learning and analysis of related algorithms
CO5 Illustrate the basics of expert systems and perform analysis of algorithms related to expert systems

UNIT 1 INTRODUCTION TO AL AND PRODUCTION SYSTEMS 9

Introduction to AI-Problem formulation, Problem Definition-Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics - Specialized production system- Problem solving methods – Problem graphs, Matching, Indexing and Heuristic functions -Hill Climbing-Depth first and Breath first, Constraints satisfaction – Related algorithms, Measure of performance and analysis of search algorithms.

UNIT 2 REPRESENTATION OF KNOWLEDGE 9

Game playing – Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, use of predicate calculus, Knowledge representation using other logic-Structured representation of knowledge.

UNIT 3 KNOWLEDGE INFERENCE 9

Knowledge representation -Production based system, Frame based system. Inference – Backward chaining, Forward chaining, Rule value approach, Fuzzy reasoning – Certainty factors, Bayesian Theory-Bayesian Network-Dempster – Shafer theory.

UNIT 4 PLANNING AND MACHINE LEARNING 9

Basic plan generation systems – Strips - Advanced plan generation systems – K strips – Strategic Explanations-Why, Why not and how explanations. Learning- Machine learning, adaptive Learning.

UNIT 5 EXPERT SYSTEMS 9

Expert systems – Architecture of expert systems, Roles of expert systems – Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems – MYCIN, DART, XOON, Expert systems shells.

Total : 45 Periods

TEXT BOOKS:

1. Stuart Russell and Peter Norvig, “Artificial Intelligence – A Modern Approach”, Fourth Edition, Pearson Education, 2021.
2. Ethem Alpaydin, “Introduction to Machine Learning”, MIT Press, Fourth Edition, 2020.

REFERENCES:

1. Peter Jackson, “Introduction to Expert Systems”, 3rd Edition, Pearson Education, 2007.
2. Stuart Russel and Peter Norvig “AI – A Modern Approach”, 2nd Edition, Pearson Education, 2007.
3. Deepak Khemani “Artificial Intelligence”, Tata McGraw Hill Education, 2013.

e-Resources:

1. https://onlinecourses.nptel.ac.in/noc22_cs83/preview
2. https://intellipaat.com/blog/artificial-intelligence-in-healthcare/

21MDE06	ROBOTICS AND AUTOMATION IN HEALTHCARE	L	T	P	C
		3	0	0	3

Preamble

The course makes the students to understand the basic mechanism of robotic subsystems gain knowledge on design, analysis and working principle of robotics in medical field.

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

CO1 Outline the basic concept of robotics.
CO2 Discuss about the sensors and actuators.
CO3 Explain the working principle underlying in manipulators in robotics.
CO4 Explain the working principle underlying in sensors with power source in robotics.
CO5 Discuss the applications of robotic systems in medical field.

UNIT 1 INTRODUCTION OF ROBOTICS **9**

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

UNIT 2 ACTUATORS AND GRIPPERS **9**

Pneumatic and hydraulic actuators, Stepper motor control circuits, End effectors, Various types of Grippers, Design consideration in vacuum and other methods of gripping, PD and PID feedback actuator models.

UNIT 3 MANIPULATORS & BASIC KINEMATICS **9**

Construction of Manipulators, Manipulator Dynamic and Force Control, Electronic and pneumatic manipulator, Forward Kinematic Problems, Inverse Kinematic Problems, Solutions of Inverse Kinematic problems

UNIT 4 POWER SOURCES AND SENSORS **9**

Sensors and controllers, Internal and external sensors, position, velocity and acceleration sensors, Proximity sensors, force sensors, laser range finder, variable speed arrangements, Path determination - Machinery vision, Ranging, Laser- Acoustic, Magnetic fiber optic and Tactile sensor

UNIT 5 ROBOTICS IN MEDICINE **9**

Da Vinci Surgical System, Image guided robotic systems for focal ultrasound based surgical applications, System concept for robotic Tele-surgical system for off-pump CABG surgery, Urologic applications, Cardiac surgery, Neuro-surgery, Pediatric-, and General- Surgery, Gynecologic Surgery, General Surgery and Nano robotics.

Total : 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.

REFERENCES:

1. Mittal, Nagrath, Robotics and Control, Tata McGraw Hill publications, 2003.
2. Spong and Vidhyasagar, “Robot Dynamics and Control”, John Wiley and Sons, First edition, 2015.
3. Grover, Wiess, Nagel and Oderey, Industrial Robotics, McGraw Hill, 2012.

e-Resources:

1. https://onlinecourses.nptel.ac.in/noc21_me49/preview “Robotics and Control - Theory and practice”, Prof. N. Sukavanam, Prof.M.Felix Orlando, IIT Roorkee.
2. https://link.springer.com/book/10.1007/978-3-030-79179-7

21MDE07	PHYSIOLOGICAL MODELING SYSTEMS	L	T	P	C
		3	0	0	3

Preamble

The course makes the students to describe the dynamic models and nonlinear models of physiological systems, simulate and visualize dynamic responses.

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

CO1	Explain the application of Physiological models
CO2	Describe the methods and techniques for analysis and synthesis of Linear and dynamic system
CO3	Develop differential equations to describe the compartmental physiological model
CO4	Describe Nonlinear models of physiological systems
CO5	Illustrate the Simulation of physiological systems

UNIT 1 INTRODUCTION TO PHYSIOLOGICAL MODELING 9

Approaches to modeling: The technique of mathematical modeling, classification of models, characteristics of models. Time invariant and time varying systems for physiological modeling. Introduction to physiology (homeostasis, cell biology) Modeling physical systems, linear models of physiological systems, the Laplace transform, Transfer functions and block diagram analysis Physiology.

UNIT 2 MODELING OF DYNAMIC PHYSIOLOGICAL SYSTEM 9

Dynamic systems and their control, modeling 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 3 NON LINEAR MODELS OF PHYSIOLOGICAL SYSTEMS 9

Nonparametric Modeling-Volterra Models. Wiener Models. Efficient Volterra Kernel Estimation. Parametric Modeling - Basic Parametric Model Forms and Estimation Procedures- Volterra Kernels of Nonlinear Differential Equations. Discrete-Time Volterra Kernels of NARMAX Models.

UNIT 4 COMPARTMENTENTAL PHYSIOLOGICAL MODEL 9

Modeling the body as compartments, behavior in simple compartmental system, pharmacokinetic model, and multi compartmental system. Physiological modeling: Electrical analogy of blood vessels, model of systematic blood flow and model of coronary circulation. Mathematical modeling 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 5 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 : 45 Periods

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.

REFERENCES:

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. DavidTWestwick, Robert E. Kearney, Identification of Nonlinear Physiological Systems, Wiley-IEEE Press, 2003.

e-Resources:

1. https://www.sciencedirect.com/topics/engineering/physiological-models
2. https://archive.nptel.ac.in/courses/112/107/112107214/

21MDE08	RADIOLOGICAL EQUIPMENT	L	T	P	C
		3	0	0	3

Preamble

To develop an understanding of physics principles underlying the imaging techniques and radiotherapy techniques.

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

CO1 Interpret the construction and production of X-rays in imaging systems.

CO2 Demonstrate the knowledge of concepts & principles associated with the operation of CT imaging equipment.

CO3 Differentiate relaxation process and NMR pulse sequences in magnetic resonance imaging.

CO4 Suggest an appropriate nuclear medicine systems and technique for a diagnosis environment.

CO5 Identify the need for radiation protection and various monitoring techniques used for self, staff, and patients.

UNIT 1 X-RAY EQUIPMENT 9

Nature of X-rays- Production of X-Rays– Interaction with matter– X- Ray Equipment (Block Diagram) – X-Ray Tube– the collimator– Bucky Grid– X-ray Image Intensifier tubes– Digital Radiography–Digital subtraction Angiography - Fluroscopy.

UNIT 2 COMPUTED TOMOGRAPHY 9

Principles of tomography– CT Generations – Multiscale Helical CT imaging principles- Imaging system design. Image reconstruction techniques - back projection and iterative method. Image characteristics.

UNIT 3 MAGNETIC RESONANCE IMAGING 9

Fundamentals of magnetic resonance- Basic NMR imaging system. Interaction of Nuclei with static magnetic field and Radio frequency wave- rotation and precession –Relaxation processes T1 and T2–Classification of NMR imaging methods- Discrimination based on Relaxation rates-NMR pulse sequences, Types of imaging sequences.

UNIT 4 NUCLEAR MEDICINE SYSTEMS 9

Introduction–Radioactive Emissions - alpha– beta– gamma. Radiation detectors – Ionization Chambers– Scintillation Detectors. Pulse height analyzers– Gamma Counting System– Rectilinear Scanner– GammaCamera - PET .

UNIT 5 RADIATION THERAPY AND RADIATION SAFETY 9

Radiation therapy – linear accelerator–Cardinal Principles of Radiation Protection, Radiation Detection and Measurement, Dosimeter-Radiation protection in medicine- Radiation protection principles.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. R.Hendee and Russell Ritenour “Medical Imaging Physics”, Wiley-Liss, 4th Edition 2002.
2. Faiz M. Khan, John P. Gibbons, “The Physics of Radiation Therapy”, Wolters Kulwer, Philadelphia, 5th Edition,2014.

REFERENCES:

1. Stewart C. Bushong, “Radiologic Science for Technologists”, Elsevier Mosby, 8th Edition, 2004.
2. Gopal B. Saha “Physics and Radiobiology of Nuclear Medicine” Springer, 3rd Edition, 2006.
3. Steve Webb, “The Physics of Medical Imaging”, Taylor & Francis, 2nd Edition, 2010.

e-Resources:

1. https://courses.edx.org/courses/UQx/BIOIMG101x, “Introduction to Biomedical Imaging”, Prof. Dr. GrahamGalloway, The University of Queensland.
2. http://www.imaios.com/en/e-Courses/e-MRI, “eMRI - MRI step by step”, IMAIOS SAS , France

21MDE09	MEDICAL DEVICE DESIGN	L	T	P	C
		3	0	0	3

Preamble

Medical device design provides an introduction to the basic concepts of image finding generation and to acquire knowledge of processing of digital and medical images using various transformation techniques. It provides students to realize about different analysis and to develop algorithms for image processing. In order to understand the analysis of entire image in frequency domain it is essential to learn the various image transforms. Also, it is necessary to learn the concepts of image testing, validation design transfer and manufacturing.

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

CO1 Define the medical devices standards and requirements.

CO2 Summarize the concept of medical device development.

CO3 Recall the engineering design and project metrics.

CO4 Demonstrate the testing and validation of medical equipment.

CO5 Interpret the various design transfer and manufacturing methods.

UNIT 1 NEEDS FINDING AND CONCEPT GENERATION 9

trategic 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 2 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 3 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 4 TESTING AND VALIDATION 9

Basis and Types of Testing, Hardware Verification and Data Analysis, Software Verification and Data Analysis.

UNIT 5 DESIGN TRANSFER AND MANUFACTURING 9

Transfer to Manufacturing, Hardware Manufacturing, Software Manufacturing, Configuration Management, Intellectual Property-Copy Rights-Trademarks-Trade Secrets. Case study.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Zenios, Makower and Yock, ―Biodesign – The process of innovating medical technologies‖, Canbridge University Press, 2009
2. Peter Ogrodnik,Medical Device Design Innovation from Concept to Market, Elsevier, 2013
3. Theodore R. Kucklick , The Medical Device R&D Handbook, Second Edition, CRC Press, 2012.

REFERENCES:

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. Jagdish Chaturvedi, Inventing medical devices: A perspective from India, Create Space Independent Publishing Platform, 1st edition, 2015.

e-Resources:

1. https://www.digimat.in/nptel/courses/video/127106010/L11.html, "NOC:Regulatory Requirements for Medical Devices and IVD kits in India, IIT Bombay.
2. https://onlinecourses.nptel.ac.in/noc21_de12/preview, "Introduce Engineering Design as a structured process, different from the Conventional Design Engineering., IIT-Bombay.

21MDE10	BioMEMS	L	T	P	C
		3	0	0	3

Preamble

To expose the knowledge on BioMEMS, miniaturization techniques and its application in biomedical engineering.

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

CO1 Explain the basics of mems and microsystems.

CO2 Describe the functions, properties of micro sensors and thermo fluid engineering.

CO3 Discuss the different types of materials used in the miniaturization process.

CO4 llustrate the manufacturing and fabrication of micro systems.

CO5 Explain the process of packaging and its types.

UNIT 1 OVERVIEW OF MEMS AND MICROSYSTEMS 9

Introduction- MEMS and Microsystems– Microsystem products– Principles of Micro systems- Microsensors - acoustic wave sensors, chemical sensors– optical sensors– Pressure sensors– thermal sensors– Microactuation– MEMS with Microactuators– Microaccelerometers– Microfludics. Micro system design and fabrication- Ion and Ionization– Electrochemistry

UNIT 2 MICROSYSTEMS AND THERMO FLUID ENGINEERING 9

Introduction – Static bending of Thin plates– Mechanical vibration– resonant vibration– Thermo mechanics– Thermal Effects on mechanical strength of materials– creep deformation– Thermal stresses. Fracture Mechanics– Thin Film mechanics– equations in continuum fluid dynamics– computational fluid dynamics–Incompressible fluid flow in microconduits.

UNIT 3 MATERIALS FOR MINIATURIZATION 9

Substrates and wafers– active substrate materials– Silicon substrate material– Silicon compounds– silicon piezoresistors– gallium arsenide– quartz– piezoelectric crystals- Polymers for MEMS and Microsystems– conductive polymers– Langmuir – Boldgent film– Laws for miniaturization– Scaling- geometry– rigid body dynamics– electrostatic forces– electromagnetic forces– electricity– fluid mechanics– heat transfer

UNIT 4 MICROSYSTEM FABRICATION AND MICRO MANUFACTURING 9

Photolithography– ion implantation– diffusion– oxidation. Vapor deposition – physical and chemical– sputtering– etching- chemical etching and plasma etching. Bulk micro manufacturing surface micro machining– LIGA process– SLIGA process.

UNIT 5 MICROSYSTEM PACKAGING 9

Design of micro fluidic network systems– design constraints and selection of materials. Packaging of microelectronics– microsystem packaging– interfaces– three dimensional packaging– assembly of micro systems. Pressure sensor packaging

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Tai- Ran Hsu "MEMS & Microsystems design and manufacture"– Tata McGraw- Hill, New Delhi,2007.
2. Steven s Saliterman, "Fundamentals of Biomems and Medical Microdevices", Spie press , USA, 1 st edition, 2006.

REFERENCES:

1. Wanjun Wang and Steven A.Soper "Bio- MEMS technologies and applications", CRC Press, 1 st Edition,2007
2. P.Rai- Choudhury " MEMS and MOEMS Technology and Applications", PHI Learning , New delhi, 2000.

e-Resources:

1. NPTEL Video https://nptel.ac.in/courses/112/104/112104181/ " BioMEMS and Microsystems " , Dr.Shantanu Bhattacharya, Department of Mechanical Engineering, IIT Kharagpur.
2. NPTEL Video https://nptel.ac.in/courses/117/105/117105082/ "MEMS and Micro systems"Prof.Santiram Kal , Dept of EEE, IIT Kharagpur.

21MDE11	ASSISTIVE DEVICES	L	T	P	C
		3	0	0	3

Preamble

This course introduces the basic hardware requirement along with various assistive devices. It also provides the prosthetic and orthotic devices knowledge in assistive devices.

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

CO1 Interpret the various mechanical techniques that will help in assisting the heart functions

CO2 Describe the underlying principles of hemodialyzer machine.

CO3 Indicate the methodologies to assess the hearing loss.

CO4 Evaluate the types of assistive devices for mobilization.

CO5 Explain about TENS and biofeedback system.

UNIT 1 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 2 HEMODIALYSERS 9

Artificial kidney, Dialysis action, hemodialyser unit, membrane dialysis, portable dialyser monitoring and functional parameters.

UNIT 3 HEARING AIDS 9

Common tests – audiograms, air conduction, bone conduction, masking techniques, SISI, Hearing aids – principles, drawbacks in the conventional unit, DSP based hearing aids.

UNIT 4 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 5 RECENT TRENDS 9

Transcutaneous electrical nerve stimulator, bio-feedback, Recent trends in assistive technology for mobility, Adaptability of Assistive Mobility Devices and the Role of the Internet of Medical Things.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, Clinical Engineering, CRC Press, 1st edition,2010.
2. Marion. A. Hersh, Michael A. Johnson,Assistive Technology for visually impaired and blind,Springer Science & Business Media, 1st edition, 12-May-2010

REFERENCES:

1. Kenneth J. Turner Advances in Home Care Technologies: Results of the match Project, Springer, 1stedition, 2011.
2. 3D Printing in Orthopaedic Surgery, Matthew Dipaola , Elsevier 2019 ISBN 978 -0-323- 662116
3. Gerr M. Craddock Assistive Technology-Shaping the future, IOS Press, 1st edition, 2003

e-Resources:

1. https://nptel.ac.in/courses/109106168, “Disability Studies: An introduction”, Prof. Hemachandran Karah, IIT Madras.
2. https://onlinecourses.swayam2.ac.in/aic19_ge01/preview, “Development of Assistive technology for persons with Disabilities”, Indumathi Rao, C B R Network.

21MDE12	ICU AND OT EQUIPMENT	L	T	P	C
		3	0	0	3

Preamble

This course offers clear understanding of various intensive care equipment and their working.It enables the students to understand the necessity of different operation theatre equipment.

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

CO1 Apply the knowledge acquired, in designing new monitoring devices for ICU and assist the medical personnel's during emergency situations

CO2 Suggest suitable surgical instruments and operational devices.

CO3 Compare the various techniques for clinical diagnosis, therapy and surgery, and its recent methods

CO4 Assess the merits of the operation theatre equipment based on its applications

CO5 Design the devices for the particular application based on given specifications.

UNIT 1 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 2 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 3 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 4 CENTRALISED SYSTEMS 9

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

UNIT 5 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 : 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.

REFERENCES:

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.

e-Resources:

1. https://onlinecourses.nptel.ac.in/noc20_ge14/preview, "Regulatory requirements for medical devices including in vitro diagnostics in India", Shri Aseem Sahu, Shri. Malay Mitra, CDSCO,Ministry of Health & Family Welfare.
2. https://nptel.ac.in/courses/127106010, "Regulatory requirements for medical devices and IVDs in India", Prof. A. B. Ramteke, Prof. Malay Mitra, CDSA,DBT.

21MDE13	ANALYTICAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

Preamble

The course is designed to equip the students with an adequate knowledge on analytical tools that are being used for clinical analysis in hospitals, drugs and pharmaceutical laboratories and above all for radiation monitoring and control.

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

CO1 Classify different types of materials and its application in biomedicine.

CO2 Analyze the structure, properties , synthesis process of metals, ceramics and carbon to provide

CO3 Analyze the roles of the natural and synthetic polymer in developing the medical devices.

CO4 ChoosematerialsfordesignofimplantsintissuereplacementandEvaluateresponseofbiomaterials in living system

CO5 Summarize Methodstorepairandregenerateinjuredorlostfunctionaltissuewithmaterials, stem cells.

UNIT 1 COLORIMETRY AND SPECTROPHOTOMETRY 9

Special methods of analysis – Beer-Lambert law , Colorimeters – UV-Vis spectrophotometers – Single and doublebeam instruments – Sources and detectors – I spectrophotometers – Types – Attenuated total reflectance flame photometers – Atomic absorption spectrophotometers – Sources and detectors – FTIR spectrophotometers – Flame emission photometers.

UNIT 2 CHROMATOGRAPHY 9

Different techniques – Gas chromatography – Detectors – Liquid chromatographs – Applications – High-pressure liquid chromatographs – Applications.

UNIT 3 GAS ANALYZERS AND POLLUTION MONITORINGINSTRUMENTS 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 4 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 analyze

UNIT 5 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 : 45 PERIODS

TEXT BOOKS:

1. R.S. Khandpur, “Handbook of Analytical Instruments”, Tata McGraw Hill publishing Co. Ltd.,3rdEdition, 2015.
2. Douglas A. Skoog, F. James Holler, and Stanley R. Crouch “Principles of Instrumental Analysis”, Cengage Learning,7th Edition, 2018..

REFERENCES:

1. Xingdong Zhang, David Williams, “Definitions of Biomaterials for the Twenty-First Century”,Elsevier,1st Edition,2019.
2. Karoly Vekey, Andreas Telekes, Akos Vertes, “Medical Applications of Mass Spectrometry,Elsevier ”, 1st Edition,2008.
3. James keeler ,“Understanding NMR Spectroscopy”, 2ndJohn Wiley & Sons, 2010.

e-Resources:

1. NPTEL Videos https://nptel.ac.in/courses/103/108/103108100/ “Modern Instrumental Methods of Analysis”,Dr. J.R.Mudakavi ,Department of Chemical Engineering, IISC Bangalore.
2. NPTEL Videos https://nptel.ac.in/courses/104/101/104101117/ “NMR spectroscopy for Chemists and Biologists”,Dr.Ashutosh Kumar, Department of Biosciences and Bioengineering, IIT Bombay.

21MDE14 MEDICAL EQUIPMENT MAINTENANCE AND TROUBLESHOOTING

L	T	P	C
3	0	0	3

Preamble

This course intends to provide an understanding about maintenance and trouble shooting of Medical Equipment.

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

CO1 Identify major reasons for equipment failure.

CO2 Compare general testing and troubleshooting of equipment.

CO3 Understand testing of OT instruments

CO4 Discuss about the troubleshooting of medical equipment and safety standards

CO5 Analyze the management issues pertaining to medical instruments.

UNIT 1 INTRODUCTION **9**

Testing of electrical equipments: AC, DC power supply, Grounding, shielding, Guarding, insulation testing, insulation resistance measurement, Types of Circuit Breakers, Rating - Testing of circuit breakers – Tranformer testing- Earthing – Earth wires - Earthing of appliances – contactor, relay testing–CT and PT, Panel wiring-Megger-Testing equipments and instruments.

UNIT 2 TESTING AND TROUBLESHOOTING **9**

Testing of electronic components: 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 3 TESTING OF MEDICAL EQUIPMENT **9**

Testing of surgical Equipment: Functions and operating procedure-Testing and maintenance of Heart lung machine, surgical
lights, ventilator, patient monitor, anesthesia machine, dialyzer, surgical tools.

UNIT 4 TROUBLESHOOTING OF MEDICAL EQUIPMENT **9**

Troubleshooting of equipments: X-ray machines, Troubleshooting of ECG recorders, incubator, baby warmer, infusion pumps, annual maintenance, contract requirements, vendor services, and quality and safety standards.

UNIT 5 MAINTENANCE MANAGEMENT **9**

Life cycle management of medical equipment: 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 : 45 PERIODS

TEXT BOOKS:

1. Operating guide for medical Equipment Maintenance,Headquarters department of Army, 1998
2. Binseng Wang, " Medical Equipment Maintenance", Springer International Publishing, 2022

REFERENCES:

1. Ernesto Iadanza, "Clinical Engineering Handbook", Second Edition,Elsevier Science, 2019.
2. Maintenance Management Procesures for Medical Equipment,Headquaters, Department of the Army, University of Virginia, 2008
3. Josph.J.Carr, " Introduction to Biomedical Equipment Technology", Pearson Education, Fourth Edition, 2002.

e-Resources:

1. https://www.youtube.com/watch?v=XEv4K1gHUEo, "Recording a 12 lead ECG", Nick smith, Central Manchester
   University hospitals.
2. https://www.youtube.com/watch?v=2Cs4CJBaTN4, "Introduction to Biopotentials", Sarwar K, University of Texas.

21MDE15	FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

Preamble

This course introduces engineering students to the foundational concepts, methods, and tools involved in integrated product development. It focuses on developing the skills necessary to design, develop, and bring innovative products to market while considering various factors such as customer needs, technical feasibility, cost, and time constraints.

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

CO1	Understand the key concepts and principles of integrated product development.
CO2	Apply systematic and structured approaches to product development.
CO3	Utilize appropriate tools and techniques for product design, analysis, and evaluation.
CO4	Collaborate effectively in cross-functional teams for product development projects.
CO5	Communicate product ideas, specifications, and requirements through effective documentation and presentations.

UNIT 1 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 2 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 3 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 - S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – Prototyping - Introduction to Rapid Prototyping and Rapid Manufacturing

UNIT 4 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 5 BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY **9**

The Industry - Engineering Services Industry - Product Development in Industry versus Academia –The IPD Essentials - Introduction to Vertical Specific Product Development processes - Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Book specially prepared by NASSCOM as per the MoU
2. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Edition, 2011.
3. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 2005.

REFERENCES:

1. Hiriyappa B, “Corporate Strategy – Managing the Business”, Author House, 2013.
2. Peter F Drucker, “People and Performance”, Butterworth – Heinemann [Elsevier], Oxford, 2004.
3. Vinod Kumar Garg and Venkita Krishnan N K, “Enterprise Resource Planning – Concepts”, Second Edition, Prentice Hall, 2003.

e-Resources:

1. https://onlinecourses.nptel.ac.in/noc21_me83/preview , “ Product Design and Development” By Prof. Inderdeep Singh , IIT Roorkee.
2. https://www.academia.edu/33089267/FOUNDATION_SKILLS_IN_INTEGRATED_PRODUCT_DEVELOPMENT , SriRam Kumar, P Krishna Sankar.

21MDE16	PATIENT SAFETY, STANDARDS AND ETHICS	L	T	P	C
		3	0	0	3

Preamble

This course enables students to understand the importance of patient safety against electrical hazards and to explain the patient safety laws and regulations.

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

CO1 Outline the importance of patient safety against electrical hazards.

CO2 Brief out the patient safety laws and regulations.

CO3 Explain the standards and testing of patient.

CO4 Understand the concept of the patient safety specialities in clinical.

CO5 Know about various health care organization.

UNIT 1 EFFECTS OF ELECTRICITY 9

Physiological effects of electricity - important susceptibility parameters - micro shock - macro shock hazards - patients electrical environment - isolated power system - conductive surfaces

UNIT 2 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 Reporting, Patient safety Goals and standards, The Quality Assessment and performance Improvement rule.

UNIT 3 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 4 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 5 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 : 45 PERIODS

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.

REFERENCES:

1. Fay A. Rozovsky, James R. Woods, Jr, “ The Handbook of Patient Safety Compliance”, 2016
2. Bill Runciman, Merrilyn Walton, “Safety and Ethics in Healthcare: A Guide to Getting it Right”, CRC Press,2017.

e-Resources:

1. https://archive.nptel.ac.in/courses/109/104/109104032/Ethics, Dr. Sreekumar Nellickappilly,IIT Madras.
2. https://onlinecourses.nptel.ac.in/noc19_hs35/preview, Ethics in Engineering Practice,Prof. Susmita Mukhopadhyay, IIT Kharagpur.

21MDE17	MEDICAL DEVICE REGULATIONS	L	T	P	C
		3	0	0	3

Preamble

This course provides an in-depth understanding of the regulatory requirements and standards governing the design, development, and manufacturing of medical devices. Students will learn about the global regulatory landscape, quality management systems, risk management, and other essential aspects of medical device regulations.

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

CO1 Define and explain the basic concepts of medical device regulations.
CO2 Decipher the meaning of ISO standards from a regulatory perspective.
CO3 Explain US-FDA, IEC and European regulations.
CO4 Discuss regulations in India.
CO5 Explain the regulatory aspects of clinical trials and digital alternatives

UNIT 1 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 2 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 3 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 4 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 5 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 : 45 PERIODS

TEXT BOOKS:

1. Medical Regulatory Affairs: An International Handbook for Medical Devices and Healthcare Products, 3rd Edition, Taylor & Francis Group, 2021
2. Reliable Design of Medical Devices, Second Edition by Richard Fries, CRC Press, 2006

REFERENCES:

1. Medical Device Quality Assurance and Regulatory Compliance by Richard C Fries, CRC Press, 1998.
2. Product Safety in the European Union by GaborCzitan, Attila Gutassy, Ralf Wilde, TUVRheinlandAkademia, 2008.

e-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, http://www.fda.gov/medicaldevices/deviceregulationandguidance/default.html.

21MDE18	ELECTRICAL SAFETY AND QUALITY ASSURANCE	L	T	P	C
		3	0	0	3

Preamble

To provide basic knowledge on the concept of Healthcare Quality management towards continuous improvement of patient care and make the students aware of the role of biomedical engineer in hospitals, especially in the management of electrical supply, maintenance of electrical safety. The purpose of this course is to help students to develop knowledge and insight into the procedures used in quality control and assurance activities as well as safety measures to be followed in hospitals.

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

CO1 Interpret quality assurance for medical imaging and nuclear medicine equipments available in hospitals.
CO2 Acquire knowledge on Accreditation procedures and regulatory codes for hospitals.
CO3 Discriminate between safety measures and disposal of biomedical wastes.
CO4 Interpret the precautionary steps and action taken for electrical fire hazards in hospital.
CO5 Develop knowledge into the procedures used in quality control and assurance activities to be followed in hospitals.

UNIT 1 STANDARDIZATION OF QUALITY MEDICAL CARE IN HOSPITALS 9

Define Quality–Need for Standardization & Quality Managemen–TQM in Health care organization– Quality assurance methods– QA in (Medical Imaging & Nuclear medicine) Diagnostic services – Classification of equipments.

UNIT 2 REGULATORY REQUIREMENT FOR HEALTH CARE 9

FDA regulations– Accreditation for hospitals–JCI, NABH and NABL– Other regulatory Codes.

UNIT 3 HOSPITAL SAFETY 9

Security & Safety of Hospital –Property, Staff & Patients**,** Radiation safet–Safety precautions–Hazardous effects of radiation–Levels of radiation–ICRP regulations for radiation safety–Disposal of Biological waste.

UNIT 4 ELECTRICAL & FIRE SAFETY 9

Sources of shocks– macro & micro shocks–Hazards–Monitoring and interrupting the Operation from leakage current–Elements of fire–causes of fire–Action to be taken in case of fire in a Hospital.

UNIT 5 ASSESSING QUALITY HEALTH CARE 9

Patient Safety Organization- Governmental & Independent, Measuring Quality care – Evaluation of hospital services – six sigma way, Quality Assurance in Hospitals Sop‘s – Patient Orientation for Total Patient Satisfaction. 5S techniques.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Cesar A. Caceres,“Medical Devices: Measurements, Quality Assurance, and Standards”,ASTM International, 2017
2. Sharon Myers ―Patient Safety & Hospital Accreditation - A Model for Ensuring Success‖ Springer Publishers 2012 .

REFERENCES:

1. Steli Loznen, Constantin Bolintineanu, Jan Swart, “Electrical Product Compliance and Safety Engineering”,Artech House, 2017.
2. Joseph D. Bronzino, “Management of Medical Technology: A Primer for Clinical Engineers”,Butterworth-Heinemann, 2014.
3. Joseph Dyro, “Clinical Engineering Handbook”,Elsevier, 2014.

e-Resources:

1. https://www.creativesafetysupply.com/resources/electrical-safety/ “Electrical Safety”.
2. https://www.ehs.washington.edu/fire-life/basic-electrical-safety “Basic Electrical Safety”, Environmental Health & Safety, University of Washington.
3. https://www.osha.gov/Publications/3075.html “Controlling Electrical Hazards”, Occupational Safety & Health Administration,U.S. Department of Labor.

21MDE19	MEDICAL INNOVATION AND ENTREPRENEURSHIP	L	T	P	C
		3	0	0	3

Preamble

This course is designed to provide engineering students with an understanding of medical innovation and entrepreneurship in the healthcare industry. Students will learn about the latest advancements in medical technology, explore the process of developing and commercializing medical devices, and gain knowledge about the key principles of entrepreneurship in the healthcare sector. The course will cover topics such as market analysis, intellectual property, regulatory requirements, business models, funding strategies, and ethical considerations in medical innovation.

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

CO1 Describe the role of biomedical engineers in entrepreneurship

CO2 Interpret the background for biomedical engineers in entrepreneurship

CO3 Acquire the skills and techniques required towards innovation

CO4 Categorize the resources and funding agencies and judge the right product based on market needs

CO5 Compile and quantify the opportunities and challenges

UNIT 1 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 2 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 3 NEW VENTURE **9**

Developing an Effective Business Model: The Importance of a 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 4 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 5 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 : 45 PERIODS

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.

REFERENCES:

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.

e-Resources:

1. https://www.digimat.in/nptel/courses/video/110107094/L01.html , “ Innovation, Business Models and Entrepreneurship” By Prof. Rajat Agrawal, Prof. Vinay Sharma , IIT Roorkee.
2. https://onlinecourses.nptel.ac.in/noc22_de08/preview , “ Understanding Incubation and Entrepreneurship” By Prof. B.K. Chakravarthy, IIT Bombay.

21MDE20	INTELLECTUAL PROPERTY RIGHTS	L	T	P	C
		3	0	0	3

Preamble

The course is designed to provide engineering students with an understanding of intellectual property rights (IPR) and their role in innovation and technology commercialization. The course will cover the fundamentals of patent, copyright, trademark, and trade secret law, as well as international IPR regimes. Students will learn how to identify, protect, and manage intellectual property assets in the engineering field.

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

CO1 Classify different types of materials and its application in biomedicine.

CO2 Analyze the structure, properties , synthesis process of metals, ceramics and carbon to provide

CO3 Analyze the roles of the natural and synthetic polymer in developing the medical devices.

CO4 Choose materials for design of implants in tissue replacement and Evaluate response of biomaterials in living system.

CO5 Summarize Methods to repair and regenerate injured or lost functional tissue with materials, stem cells.

UNIT 1 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 2 REGISTRATION OF IPRs **9**

Meaning and practical aspects of registration of Copy Rights– Trademarks– Patents–Geographical Indications– Trade Secrets and Industrial Design registration in India and Abroad.

UNIT 3 AGREEMENTS AND LEGISLATIONS **9**

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 4 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 5 ENFORCEMENT OF IPRs **9**

Infringement of IPRs– Enforcement Measures– Emerging issues – Case Studies.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Vinod V. Sople, Managing Intellectual Property The Strategic Imperative, PHI Learning, 4th Edition, 2014.
2. V. Satakar, “Intellectual Property Rights and Copy Rights”, Ess Ess Publications, New Delhi,2003

REFERENCES:

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, 1st Edition, 2017.
3. Derek Bosworth and Elizabeth Webster, “The Management of Intellectual Property”, Edward Elgar Publishing Ltd., 2006.

e-Resources:

1. NPTEL Videos https://nptel.ac.in/courses/110/105/110105139/, “Intellectual property rights and competition law”, Prof.K.D.Raju, IIT Kharagpur.
2. NPTEL Videos https://nptel.ac.in/courses/127/105/127105008/, “Roadmap for patent creation”,Prof.Gouri Gargate,IIT Kharagpur.

21MDE21	MEDICAL DEVICE PACKAGING	L	T	P	C
		3	0	0	3

Preamble

Medical Device Packaging is an important factor to place the device in the market safe and secured during the shelf life. This course enables the students to understand medical device packaging, giving them an idea of the dynamic opportunities available to medical device packaging engineers.

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

CO1 Identify major reasons for equipment failure.

CO2 Compare general testing and troubleshooting of equipment.

CO3 Understand testing of OT instruments

CO4 Discuss about the troubleshooting of medical equipment and safety standards

CO5 Analyze the management issues pertaining to medical instruments.

UNIT 1 INTRODUCTION **9**

Medical Device Packaging- Medical Device Packaging Types-MDR Requirements-Packaging Standards-Process Validation.Non- Sterile Packaging Requirements-Benefits of packaging

UNIT 2 MEDICAL DEVICE PACKAGING **9**

Regulations of Medical devices- medical device definition- testing standards-good manufacturing compliance-establishment registration-medical device reporting.

UNIT 3 PACKAGE VALIDATION **9**

.Overview of package validation- Elements of package validation-validation testing-process sampling-validation reporting-ISO S

UNIT 4 LABELS AND LABELLING **9**

Labelling Requirements- NDC Number-Label Construction- Bar code administration-universal product code number-global trade item number-barcodes.

UNIT 5 STERILIZATION OF MEDICAL DEVICES **9**

Sterilization Requirements- Types of Sterilizing medical devices on packaging-Monitoring Sterilization Processes-Mechanical, Chemical, and Biologic Indicators.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Edward.J.Bauer, “Pharmaceutical Packaging Handbook”, Informa Healthcare USA, Inc,2017.
2. Max Sherman, “ Medical Device Packaging Handbook”, Second Edition, CRC Press, 2016

REFERENCES:

1. H.Lockhart,” Packaging of pharmaceuticals and Healthcare Products”,Springer, 2018.
2. Ronald Pilchik,” Validating Medical Packaging”, CRC Press, 2012.

e-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

21MDE22	HOSPITAL PLANNING AND MANAGEMENT	L	T	P	C
		3	0	0	3

Preamble

The course enables the students to explore various information management systems and relative supportive services.

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

CO1	Describe hospital planning and administration to meet the requirements of accreditation.
CO2	Identify the importance of human resource management to recruit, select, train and evaluate the performance of a healthcare professional.
CO3	Discuss the role of medical and support services used for proper functioning of the hospitals.
CO4	Interpret various Engineering and other essential services of a hospital
CO5	Explain the benefits of hospital quality management system, ISO certification, accreditation and safety management system.

UNIT 1 OVERVIEW OF HOSPITAL ADMINISTRATION 9

Planning the Hospital - Guiding Principles in Planning Hospital Facilities and Services - Preliminary Survey - Financial Planning - Equipment Planning - Purchase of Capital Equipment - Organizational Structure - Management Structure - Organizational Charts

UNIT 2 HUMAN RESOURCE MANAGEMENT IN HOSPITAL 9

Principles of HRM - Functions of HRM - Profile of HRD Manager - Tools of HRD - Human Resource Inventory - Manpower Planning. Recruitment - Selection - Training - Grooming Leaders - Promotion - Transfer - Dismissal/Resignation - Communication: nature, scope, purpose, barriers, styles and modes of communication.

UNIT 3 MEDICAL AND SUPPORTIVE SERVICES 9

Outpatient Services - Clinical Laboratory Services – Surgical Department - Hospital Information System - General Nursing units - Intensive Care Units - Medical Records - Pharmacy - Central Sterile Supply Department (CSSD) - Materials Management - Hospital Linen and Laundry Services – House Keeping.

UNIT 4 HOSPITAL SERVICE MANAGEMENT 9

Engineering Department - Maintenance Management - Clinical Engineering - Electrical System - Air Conditioning System - Water Supply and Sanitary System - Centralized Medical Gas System - Communication System - Solid Waste Management - Transportation.

UNIT 5 QUALITY AND SAFETY ASPECTS IN HOSPITAL 9

Quality management system: Elements, Implementation, Documentation, Auditing – ISO Certification for Hospitals - Accreditation: NABH, JCI, NABL - Safety in Hospital – Security and Loss Prevention Programme - Fire safety - Alarm system - Disaster management.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. D. K. Sharma and R. C. Goyal, “Hospital Administration and Human Resource Management”, PHI, 7th Edition, 2017.
2. G. D. Kunders, “Hospitals - Facilities - Planning and Management”, McGraw Hill Education, 1st Edition, 2017.

REFERENCES:

1. Cesar A. Caceres and Albert Zara, “The Practice of Clinical Engineering”, Academic Press, New York, 1977.
2. Norman Metzger, “Handbook of Health Care Human Resources Management” , 2nd Edition , Aspen Publication Inc. Rockville, Maryland, USA, 1990.
3. B. M. Sakharkar, “Principles of Hospital Administration and Planning”, Jaypee Brothers Medical Publishers Pvt Limited, 2nd Edition, 2009.

e-Resources:

1. https://onlinecourses.swayam2.ac.in/arp19_ap47/preview, “Emerging Areas In Hospital Planning Design Construction And Facilities Management”, Dr.Anil Dewan, School of Planning and Architecture, New Delhi
2. https://nptel.ac.in/courses/110/104/110104095/, “Economics of Health and Healthcare”, Dr.Angan Sengupta, IIT Kanpur.

21MDE23	HEALTH MANAGEMENT INFORMATION SYSTEMS	L	T	P	C
		3	0	0	3

Preamble

This course imparts knowledge on the theories and practices adopted in hospital management information systems (HMIS) in the light of medical standards, medical data formats and recent trends adopted in hospitals, data storage and retrieval. It also focuses on ICT applications to healthcare professionals where they frequently come across information systems for the support of patient care, assessment of quality of care, medical research, decision-making, management and planning.

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

CO1	Categorize different functional areas such as inpatient and outpatient areas to integrate the clinical work flow.
CO2	Implement different modules of computerized system in hospital to support clinical activity.
CO3	Identify and interpret the impact of computers on continuing medical education programmes to accelerate the knowledge base to patient care.
CO4	Summarize and compare RIS, HIS and PACS.
CO5	Illustrate the strategy of acquisition, processing and transformation of clinical data into information data to improve medical care.

UNIT 1 INTRODUCTION TO HMIS **9**

Introduction - Need - Benefits and capabilities of HMIS - Development of HMIS - Functional Areas -Modules forming HMIS - Computerized Physician Order Entry System (CPOE) - HMIS and Internet -Integrated Information system.

UNIT 2 HIS MODULES **9**

Hospital Information System - Structure of HIS - Modules of HIS - Department Management - Organization Charts - Department Workflow - Evaluation of Department Operation and Services - Department Equipment and Supplies - Training and Development.

UNIT 3 COMPUTER BASED PATIENT RECORDS AND CODES **9**

Computer Patient Records (CPR) - Evolution and Need - Development tools - CPR in Radiology - Legal - Security - Privacy Issues - Coding - Nomenclature and Classification - General Purpose Code Sets -Special Purpose Code Sets.

UNIT 4 RADIOLOGICAL INFORMATION SYSTEM **9**

Radiological Information System- PACS - Components, Importing and Exporting Images to PACS, RIS, MPI and other Text Systems, Integrating with Other Systems. DICOM, HL-7.

UNIT 5 HEALTH INFORMATION PROCESSING AND ISSUES **9**

Health Data Quality - Post Discharge Processing - Health Data scanning and Indexing - Record Analysis - Coding - Abstracting - Storage - Retention and Transcription - Confidentiality and Compliance -Preparing a record for release - Internal request for information – Federal, Corporate and facility compliance.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Nadinia Davis and Melissa LaCour, Health Information Technology, Elsevier, 3rd Edition, 2014.
2. Dinesh Bhatia, “Medical Informatics”, PHI Learning Pvt. Ltd., Delhi, 2015.

REFERENCES:

1. Edward H. Shortliffe, Leslie E. Perreault, “Medical Informatics: Computer Applications in Health Care and Biomedicine”, Springer, 2013.
2. Ramachandra Lele, Computers in Medicine Progress in Medical Informatics, Tata McGraw Hill Publishing Company, New Delhi, 2005.

3. Alain Venot -Medical Informatics, e-Health, Fundamental and Applications, Springer-Verlag Paris, 2013.

e-Resources:

1. https://www.udemy.com/course/introduction-to-hospital-information-system/, "Introduction to Hospital Information Systems", by Professor Candelario.
2. https://www.digimat.in/nptel/courses/video/102106065/L01.html, "Concepts and Importance of Bioinformatics", by Prof. M. Michael Gromiha, IIT Madras.

21MDE24	MEDICAL WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

Preamble

This course enables the students to understand various waste disposal procedures and management.

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

CO1	Categorize different biomedical wastes based on its properties
CO2	Describe the different methods used for waste disposal and basic principle of sterilization to avoid disease transmission
CO3	Analyze various hazards, accidents and its control
CO4	Explain the controls applied to waste management to prevent infectious diseases
CO5	Summarize the patient safety in hospitals

UNIT 1 BIOMEDICAL WASTE MANAGEMENT 9

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 2 DISPOSAL OF WASTE AND PRINCIPLES OF STERILIZATION 9

Disposal methods - Incinerator - Hazardous waste - Radioactive waste - Liquid waste destruction - Landfill. Disease Transmission - Disinfection methods - Sterilization - Steam sterilizing (Autoclaving).

UNIT 3 HAZARDOUS MATERIALS 9

Hazardous substance safety - OSHA hazard communication standard - DOT hazardous material regulations - Healthcare hazardous materials - Medical gas systems - Respiratory Protection.

UNIT 4 INFECTION CONTROL AN D PREVENTION 9

Healthcare immunizations - Centers for disease control and prevention - Disinfectants, Sterilants, and antiseptics - OSHA bloodborne pathogens standard - Tuberculosis - Healthcare opportunistic infections - Medical waste.

UNIT 5 PATIENT SAFETY 9

An organizational function - Errors and adverse events - Safety cultures – Patient centered healthcare - Quality improvement tools and strategies - Medication safety – Emergency department patient safety – Ambulatory care patient safety.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Anantpreet Singh and Sukhjit Kaur, “Biomedical Waste Disposal”, Jaypee Brothers Medical Publishers Pvt. Ltd., 2012
2. James T. Tweedy, “Healthcare Hazard Control and safety Management”, CRC Press, Taylor and Francis Group, 2014.
3. Calvin R. Brunner, “Medical Waste Disposal”, Incinerator Consultant incorporated, 1996.

REFERENCES:

1. Yves Chartier, “Safe Management of Wastes from Health-Care Activities”, World Health Organization, 2nd Edition, 2014.
2. V. J. Landrum, “Medical Waste Management and disposal”, William Andrew Publisher, 1st Edition, 1991

e-Resources:

1. https://nptel.ac.in/courses/105/106/105106056/, “Solid and Hazardous Waste Management”, by Dr.Indumathi Nambi, IIT Madras
2. https://swayam.gov.in/nd2_cec20_ge13/preview, "Solid and Hazardous Waste Management", by Prof. V. K. Garg, Professor and Dean, School of Environment and Earth Sciences, Central University of Punjab, Bathinda.

21MDE25	MEDICAL ETHICS AND STANDARDS	L	T	P	C
		3	0	0	3

Preamble

This course enables the students to learn the legal and ethical principles in health care settings, medical standards that to be followed in hospitals, Professional ethics to be followed by Medical Electronics Engineers, patient safety and regulatory aspects followed in hospitals.

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

CO1 Identify the scope of medical ethics

CO2 Discuss social responsibility in healthcare systems

CO3 Recommend the suitable principles of medical equipment safety standards in hospitals

CO4 Outline the standards for Medical device maintenance.

CO5 Explain hospital accreditation and safety standards

UNIT 1 MEDICAL ETHICS **9**

Definition of Medical Ethics - Scope of Ethics in Medicine - International Code of Ethics for Occupational Health Professionals - Ethical Theories - Deontology & Utilitarianism - Casuist theory - Virtue Theory - The Right Theory - Role of Ethics in Healthcare workplace - Autonomy - Non-Malfeasance - Beneficence - Veracity - Justice - OSHA - Decision Model for Healthcare Dilemmas - Applications of Plus Decision Making Model.

UNIT 2 CODE OF ETHICS **9**

Bioethics - The principle of Double Effect - Code of Hammurabi - Engineering Competence - Ethical Issues in Biomedical Research - Cloning and Stem Cell Research - Neuro Ethics - Organ Transplantation - Hypothetico-Deductive Method - Research Conflict of Interest - Medical Device Failure - Five Failure Types - Bio-Terrorism - Sustainable Bioethics - Life cycles and Concurrent Engineering - Environmental Health - Case Studies

UNIT 3 MEDICAL DEVICE SAFETY **9**

Shared Responsibility for Medical Device Safety - WHO - International Health Regulations (IHR) - Stages of Regulatory Control of Medical devices - Ethics Committee - its Members and Functions, Global Harmonization Task Force (GHTF) - Quality Systems Requirement - ISO - Voluntary and Mandatory Standards - Collateral Standards - EMC Radiation Protection & Programmable Medical Device System - Particular Standards - Type of Medical Device

UNIT 4 REGULATORY STANDARDS FOR MEDICAL DEVICE MAINTENANCE **9**

International Standards - Medical Device Directive 93/42/EEC - Medical Electrical Equipment ISO 60601 - Safety Testing of Medical Devices ISO 62353 - Medical Device Inspection ISO17020 - Indian Standards - National Health Mission - Biomedical Equipment Management and Maintenance Program (BMMP) - ISO 9001-2008 - AERB Compliance - Radiation Protection AE(RP)R-2004 - Safety Code AE/RF-MED/SC-3.

UNIT 5 HOSPITAL ACCREDITATION AND SAFETY STANDARDS **9**

Accreditation - JCI Accreditation & its Policies - Life Safety Standards - Protecting Occupants - Protecting the Hospital and Individuals from Fire, Smoke, and Heat - Managing Hazardous Medical Material and Waste - Laboratory and Radiation safety - Health and Safety Hazards of Shift Work - Patient Safety - Human Factors – Reliability - Evidence Based Medicine - Root Cause Analysis.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. William Charney, “Handbook of Modern Hospital Safety’’, CRC Press, 2nd Edition, 2009
2. Almira Badnjevic, Mario Cifrek, Ratko Magjarevic, Zijad Dzemic, “Inspection of Medical Devices: For Regulatory Purposes”, Springer Nature, 2018.
3. Domiel A Vallero , “Biomedical Ethics for Engineers”, Elsevier Pub.1st Edition, 2007.

REFERENCES:

1. Eileen E.Morrison, “Ethics in Health Administration: A Practical Approach for Decision Makers”,Jonnes and Bartletts’ Publication, 2nd Edition, 2011.

2. Robert M Veatch, “Basics of Bio Ethics’’, Prentice- Hall, Inc., 2nd Edition, 2003.
3. Physical Environment Online: A Guide to The Joint Commission‘s Safety Standards, HCPro, Inc., 2010.
4. Joint Commission Accreditation Standards for Hospitals, 6th Edition, 2017.

e-Resources:

1. https://www.udemy.com/course/probity-and-ethics-for-healthcare-professionals/, “Probity and Ethics for Healthcare Professionals”, by Dr.N.Kumar.
2. https://www.udemy.com/course/ethics-and-ethical-standards-for-uk-healthcare-professional/, Ethics and Ethical Standards for HCPs with Evaluation”, by Dr.N.Kumar.

21MDE26	FORENSIC SCIENCE IN HEALTHCARE	L	T	P	C
		3	0	0	3

Preamble

This course enables the students to learn the history of the forensic sciences and its place in popular culture, roles of different types of professionals involved in evaluating a crime scene and the collected evidence, forensic microscope and Anthropology, Blood stain identification and the methodology of collecting & interpreting data for fingerprint application.

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

CO1 Explain the significance of forensic sciences

CO2 Observe and document crime scenes

CO3 Determine Trauma and Diseases

CO4 Describe the various sources of medical data related to forensic science

CO5 Demonstrate the visual analytical procedure of finger print application

UNIT 1 BASICS OF FORENSIC SCIENCE 9

Introduction to the Forensic Sciences - History and Development of Forensic Science - Deductive Reasoning - Organization of 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 2 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 3 FORENSIC MICROSCOPE AND ANTHROPOLOGY 9

Forensic Use of the Microscope - 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 4 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 5 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 : 45 PERIODS

TEXT BOOKS:

1. Nanda, B.B. and Tewari, R.K., "Forensic Science in India: A Vision for the Twenty First Century" Select Publisher, New Delhi, 2014.
2. James, S.H and Nordby, J.J., "Forensic Science: An Introduction to Scientific and Investigative Techniques" CRC Press, 2015.

REFERENCES:

1. Sharma, B.R., "Forensic Science in Criminal Investigation and Trials, Central Law Agency", Allahabad, 1974.
2. Saferstein, "Criminalistics", Prentice Hall Inc., USA, 1976
3. Deforest, Gansellen & Lee, "Introduction to Criminalistics", McGraw-Hill, 1983.

e-Resources:

1. https://onlinecourses.swayam2.ac.in/cec20_ge10/preview, "Introduction of Forensic Science Services & Police Organization", by Prof. Devasish Bose, Dr. Harisingh Gour Vishwavidyalaya, Sagar M.P.
2. https://www.coursera.org/learn/forensic-science, "Introduction of Forensic Science", by Roderick Bates

21MDE27	BIOSTATISTICS	L	T	P	C
		3	0	0	3

Preamble

This course enables to explain the techniques used in statistical & regression analysis and compare the various parameters used in statistical significance.

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

CO1	Introduce strengths and limitations of measures of central tendency and measures of variability.
CO2	Classify common statistical tests and tools.
CO3	Distinguish between p-values and confidence intervals as measures of statistical significance.
CO4	Interpret commonly used regression analysis.
CO5	Evaluate commonly used statistical and epidemiologic measures.

UNIT 1 INTRODUCTION **9**

Introduction– Some basic concepts–Measurement and Measurement Scales– Simple random sample, Computers and biostatistical analysis– Introduction to probability– likelihood & odds– distribution variability.

UNIT 2 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 3 REGRESSION ANALYSIS **9**

Introduction– regression model–sample regression equation– evaluating the regression equation–using the regression equation– correlation model– correlation coefficient.

UNIT 4 INTERPRETING DATA **9**

Interpreting life tables clinical trials–Epidemical reading and interpreting of epidemical studies–Application in community health.

UNIT 5 META ANALYSIS **9**

META analysis for research activities–Purpose and reading of META analysis–Data used for META analysis–Randomized design–Randomized complete block design–Repeated measures design–Factorial experiment.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Brian Williams, "Biostatistics: Concepts and Applications for Biologists", CRC Press, 1st Edition**,** 2017
2. Gerald van Belle, Lloyd D. Fisher, Patrick J. Heagerty, Thomas Lumley, 'Biostatistics: AMethodology For the Health Sciences', John Wiley & Sons, 2004.

REFERENCES:

1. Bernard Rosner, "Fundamentals of Biostatistics", Cengage Learning, 7th edition, 2015.
2. Dr.Indranil Saha, "Biostatistics", Academic Publishers, 2010.
3. Ray M. Merrill, 'Fundamentals of Epidemiology and Biostatistics, Jones & Bartlett Learning, 1st Edition,2013.

e-Resources:

1. https://onlinecourses.nptel.ac.in/noc21_cs45/preview
2. https://nptel.ac.in/courses/106107220
3. https://bms.ucsf.edu/resources-learning-biostatistics "Resources For Learning Biostatistics"
4. https://www.imedicalapps.com/ "Health and Medicine Apps for iOS and Android"

21MDE28	DIGITAL HEALTHCARE TECHNOLOGIES	L	T	P	C
		3	0	0	3

Preamble

This course enables the students to learn the concepts in digital healthcare and digital hospitals. It develops skills of a student to apply interdisciplinary software and hardware tools in design, testing and developing digital healthcare equipment.

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

CO1	Interpret the need for digital methods of handling medical records
CO2	Explain the digital radiology
CO3	Modify the tools and methods for work flow in E-Health
CO4	Identify the available technology for wearable healthcare devices
CO5	Compare various standards for inter-operability of devices, quality and safety standards for developing healthcare systems

UNIT 1 DIGITAL HEALTH **9**

Digital Health: Requirements and Best Practices, Laws and Regulations in Digital Health, Ethical Issues, Barriers and Strategies for Innovation.

UNIT 2 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 3 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 4 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 - Case Study

UNIT 5 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 : 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

REFERENCES:

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 ”, Third Edition. Tata Mc Graw Hill Pub. Co., Ltd. 2014
3. John, G. Webster. Medical Instrumentation: Application and Design. Second Edition. Wiley Publisher, New Delhi. 2013.

e-Resources:

1. https://www.coursera.org/specializations/digitalhealth, “Digital Health”, by Lisa Danquah
2. https://www.coursera.org/learn/ehealth, “ eHealth”, by Tim Shaw

21MDE29	SPEECH AND AUDIO SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

Preamble

This course introduces the fundamentals of speech and audio signal processing, focusing on the analysis, synthesis, and manipulation of speech and audio signals. It covers the theory, algorithms, and practical applications of signal processing techniques used in various domains, such as telecommunications, multimedia systems, speech recognition, and audio processing. Students will gain a solid understanding of the principles and techniques used in speech and audio signal processing, as well as hands-on experience with relevant software tools.

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

CO1 Examine auditory models to design perceptual audio quality measure.

CO2 Design analysis-by-synthesis model for speech perception.

CO3 Analyze and design algorithms for speech and audio coding.

CO4 Analyze and design algorithms for extracting parameters from the speech signal.

CO5 Implement pitch detection and formant analysis in speech signals.

UNIT 1 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 – Non simultaneous Masking – Perceptual Entropy - Basic measuring philosophy -Subjective versus objective perceptual testing – The perceptual audio quality measure (PAQM) – Cognitive effects in judging audio quality.

UNIT 2 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– Tree- Structured QMF and CQF M-band Banks – Cosine Modulated "Pseudo QMF" M-band Banks – Discrete Fourier and Discrete Cosine Transform – Pre-echo Distortion– Pre-echo Control Strategies.

UNIT 3 AUDIO CODING AND TRANSFORM CODERS 9

Lossless Audio Coding–Lossy Audio Coding– ISO–MPEG–1A–Dolby Audio Coding Standards–Dolby AC-2, AC-2A– 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 4 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 Time Fourier analysis – Formant extraction – Pitch Extraction using time and frequency domain methods

UNIT 5 LINEAR PREDICTIVE ANALYSIS 9

Formulation of Linear Prediction problem in Time Domain – Basic Principle of Linear Predictive Analysis – Auto correlation method – Covariance method – Solution of LPC equations – Cholesky method – Durbin's Recursive solution for the Autocorrelation Equation– lattice formation and solutions –Comparison between the methods of solution of the LPC Analysis Equation – Application of LPC parameters –VELP .

Total : 45 Periods

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

REFERENCES:

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. Jagdish Chaturvedi, Inventing medical devices: A perspective from India, Create Space Independent Publishing Platform, 1st edition, 2015.

e-Resources:

1. https://onlinecourses.nptel.ac.in/noc22_ee117/preview , “Digital Speech Processing” By Prof. Shyamal Kumar Das Mandal , IIT Kharagpur.
2. https://www.ee.iitb.ac.in/student/~daplab/ , “Digital Audio Processing Lab”.

21MDE30	COMPUTER VISION	L	T	P	C
		3	0	0	3

Preamble

The Course enables the students to understand the fundamental concepts related to multi-dimensional signal and image processing feature extraction, pattern analysis visual geometric modeling and stochastic optimization. It provides students to realize about different models for detection and recognition for developing algorithms.

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

CO1	Implement fundamental image processing techniques required for edge and point detection.
CO2	Compute shapes, contours and boundary features from the detected image and represent the regions using chain codes and Fourier descriptors.
CO3	Apply Hough Transform to detect lines, circles and ellipses for human iris images.
CO4	Contrast the shape from texture, focusing and shading and apply reconstruction techniques to the image.
CO5	Develop algorithms for face detection, recognition and human gait analysis.

UNIT 1 IMAGE PROCESSING FOUNDATIONS **9**

Review of image processing techniques – classical filtering operations –Image Restoration-Blur Identification-Superresolution method. Image Segmentation- Watershed method, k-means clustering method–Topological Derivativebased segmentation..

UNIT 2 SHAPES AND REGIONS **9**

Binary shape analysis – connectedness – object labeling and counting – size filtering – distancefunctions skeletons and thinning – deformable shape analysis – boundary tracking procedures – active contours – shapemodelsandshaperecognition–centroidalprofiles–handlingocclusion–boundarylengthmeasures boundarydescriptors – chain codes – Fourier descriptors – region descriptors –moments.

UNIT 3 HOUGH TRANSFORM **9**

Line detection – Hough Transform (HT) for line detection – foot-of-normal method – line localization – line fitting – RANSAC for straight line detection – HT based circular object detection – accurate center location – speed problem – ellipse detection – Case study: Human Iris location

UNIT 4 3D VISION AND MOTION **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 – introduction to motion – triangulation – bundle Adjustment – translational alignment – parametric motion – spline-based motion.

UNIT 5 APPLICATIONS **9**

Application: Photo album – Face detection – Face recognition – Eigen faces – Active appearance and 3D shape models of faces Application: Surveillance – foreground-background separation – particle filters – Chamfer matching, tracking, and occlusion–combine views from multiple cameras–humangaitanalysis Application- In-vehicle vision system.

Total : 45 Periods

TEXT BOOKS:

1. Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer Science & Business Media, 2010
2. Rajalingappaa Shanmugamani, “Deep Learning for Computer Vision”, Springer Science & Packt Publishing Ltd, 2018.
3.

REFERENCES:

1. Simon J. D. Prince, “Computer Vision: Models, Learning, and Inference”, Cambridge University Press, 1st

Edition, 2012.
2. Jason Brownlee, “Deep Learning for Computer Vision: Image Classification, Object Detection, and Face Recognition in
Python”, Edition: v1.7, Machine Learning Mastery, 2019.

e-Resources:

1. NPTEL Videos https://www.youtube.com/watch?v=7xKhYfPel9w, “Image Segmentation”, Prof. P.K. Biswas , Department of Electronics & Electrical Communication Engineering, IIT Kharagpur.
2. NPTEL Videos http://www.digimat.in/nptel/courses/video/117105135/L57.html, “Hough Transform”, Prof. Prabir umar biswas, IIT Kharagpur.

21MDE31	MEDICAL IMAGE SYSTEM	L	T	P	C
		3	0	0	3

Preamble

Medical image system provides an introduction to the basic concepts of image processing methods and to acquire knowledge of processing of digital and medical images using various transformation techniques. It provides students to realize about different filters and to develop algorithms for image processing. In order to understand the analysis of entire image in frequency domain it is essential to learn the various image transforms. Also, it is necessary to learn the concepts of image enhancement, segmentation and compression.

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

CO1	Describe the working principle of the X-ray machine and its application.
CO2	Illustrate the principle computed tomography.
CO3	Interpret the technique used for visualizing various sections of the body using Magnetic Resonance Imaging.
CO4	Demonstrate the applications of radionuclide imaging.
CO5	Analyze different imaging techniques and choose appropriate imaging equipment for better diagnosis and outline the methods of radiation safety.

UNIT 1 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 2 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 3 MAGNETIC RESONANCE IMAGING **9**

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 4 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, and photomultiplier tube, X-Y positioning circuit, pulse height analyzer. Principles of SPECT and PET.

UNIT 5 RADIATION THERAPY AND RADIATION SAFETY **9**

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 : 45 PERIODS

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.

REFERENCES:

1. Khin Wee Lai, DyahEkashantiOctorinaDewi “Medical Imaging Technology”, Springer Singapore, 2015.
2. Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw – Hill, New Delhi, 2003.
3. Dougherty, Geoff (Ed.), “Medical Image Processing - Techniques and Applications “,Springer-Verlag New York, 2011

e-Resources:

1. NPTEL Video https://nptel.ac.in/courses/117105079/ “Introduction to Digital Image System”,Prof.Prabir Kumar Biswas,IIT Kharagpur.
2. NPTEL Video https://www.digimat.in/nptel/courses/video/108105091/L01.html“Introduction to Medical Image Analysis”, Prof.Debdoot Sheet, IIT Kharagpur.

21MDE32 ADVANCED DIGITAL SIGNAL PROCESSING

L	T	P	C
3	0	0	3

Preamble

Advanced digital signal processing learns and understands the concepts of stationary and non-stationary random signals and analysis & characterization of discrete-time random processes. It enunciates the significance of estimation of power spectral density of random processing. In order to understand the principles of adaptive filters and their applications to communication engineering. Also, it is necessary to learn the concepts of the concepts of multi-resolution analysis.

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

CO1 Articulate and apply the concepts of special random processes in practical applications.

CO2 Choose appropriate spectrum estimation techniques for a given random process.

CO3 Apply optimum filters appropriately for a given communication application.

CO4 Apply appropriate adaptive algorithm for processing non-stationary signals.

CO5 Apply and analyses wavelet transforms for signal and image processing based applications.

UNIT 1 DISCRETE-TIME RANDOM PROCESSES 9

Random variables - ensemble averages a review, random processes - ensemble averages, autocorrelation and autocovariance matrices, ergodic random process, white noise, filtering random processes, spectral factorization, special types of random processes - AR, MA, ARMA

UNIT 2 SPECTRUM ESTIMATION 9

Bias and consistency, Non-parametric methods - Periodogram, modified-Periodogram - performance analysis. Bartlett's method, Welch's method, Blackman-Tukey method. Performance comparison. Parametric methods - autoregressive (AR) spectrum estimation - autocorrelation method, Prony's method, solution using Levinson Durbin recursion.

UNIT 3 OPTIMUM FILTERS 9

Wiener filters - FIR Wiener filter - discrete Wiener Hopf equation, Applications - filtering, linear prediction. IIR Wiener filter - causal and non-causal filters. Recursive estimators - discrete Kalman filter.

UNIT 4 ADAPTIVE FILTERS 9

Principles and properties of adaptive filters - FIR adaptive filters. Adaptive algorithms - steepest descent algorithm, the LMS algorithm - convergence. Applications of adaptive filtering - noise cancellation, channel equalization.

UNIT 5 MULTIRESOLUTION ANALYSIS 9

Short-time Fourier transforms - Heisenberg uncertainty principle. Principles of multi-resolution analysis - sub-band coding, the continuous and discrete wavelet transform - properties. Applications of wavelet transform - noise reduction, image compression.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Monson H. Hayes, "Statistical digital signal processing and modeling", John Wiley and Sons Inc. New York, Indian reprint 2008.
2. P. P. Vaidyanathan, "Multirate systems and filter banks", Prentice Hall Inc. 1993.

REFERENCES:

1. John G. Proakis & Dimitris G.Manolakis, ―Digital Signal Processing – Principles, Algorithms & Applications‖, Fourth Edition, Pearson Education / Prentice Hall, 2007.
2. Sophoncles J. Orfanidis, "Optimum signal processing", McGraw Hill, 2000

e-Resources:

1. NPTEL Video https://nptel.ac.in/courses/117105079/ “Introduction to Digital Image System”,Prof.Prabir Kumar Biswas,IIT Kharagpur.
2. NPTEL Video https://www.digimat.in/nptel/courses/video/108105091/L01.html“Introduction to digital signal processing”, Prof.Debdoot Sheet, IIT Kharagpur.

21MDE33	BRAIN COMPUTER INTERFACE AND ITS APPLICATIONS	L	T	P	C
		3	0	0	3

Preamble

This course introduces the basic concepts of brain computer interface and provides knowledge about the signal processing methods used in brain computer interface.

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

CO1 Discuss the basic concepts of brain computer interface.

CO2 Summarize the various signal acquisition methods.

CO3 Summarize the various signal acquisition methods.

CO4 Design classifier for a BCI system.

CO5 Implement BCI for various applications.

UNIT 1 INTRODUCTION TO BCI **9**

Fundamentals of BCI – Structure of BCI system – Classification of BCI: Invasive, , Non-invasive and Partially invasive BCI- Brain signal acquisition, Signal Preprocessing, Artifacts removal.

UNIT 2 ELECTROPHYSIOLOGICAL SOURCES **9**

Sensorimotor activity –Neuronal activity in motor cortex and related areas- Electric and magnetic fields produced by the brain- signals reflecting brain metabolic activity–Mu rhythm–Movement Related Potentials– SlowCorticalPotentials-P300Eventrelatedpotential–VisualEvokedPotential-Activity of Neural Cells – Multiple Neuro-mechanisms.

UNIT 3 FEATURE EXTRACTION METHODS **9**

Time/Space Methods – Fourier Transform–Wavelets– AR, MA, ARMA models, Bandpass filtering, Template matching–Kalman filter–PCA– Laplacian filter – Linear and Non-Linear Features.

UNIT 4 FEATURE TRANSLATION METHODS **9**

Linear Discriminator Analysis –Nearest neighbors– Support Vector Machines – Regression –Learning Vector Quantization – Gaussian Mixture Modeling – Hidden Markov Modeling – Neural Networks.

UNIT 5 APPLICATIONS OF BRAIN-COMPUTER INTERFACES **9**

Functional restoration using Neuroprosthesis –Functional Electrical Stimulation–Visual Feedback and control – External device control–Case study: Brain actuated control of mobile Robot.

Total : 45 Periods

TEXT BOOKS:

1. Claude Clement, "Brain-Computer Interface Technologies: Accelerating Neuro-Technology for Human Benefit", Springer Nature, 2019.
2. Aboul Ella Hassanien, Ahmad Taher Azar, "Brain-Computer Interfaces: Current Trends and Applications"Springer , 2014.

REFERENCES:

1. MaureenClerc,"Brain-ComputerInterfaces:MethodsandPerspectives",JohnWiley&Sons,2016.
2. Nick F.Ramsey, "Brain-Computer Interfaces", John Wiley & Sons, 2020.

e-Resources:

1. https://www.emotiv.com/bci-guide/ "The Introductory Guide to BCI".
2. https://nptel.ac.in/courses/106/105/106105215/ " Deep Learning", Prof. Prabir Kumar Biswa, Department of Electronics and Elecrical Communication Engineering, IIT Kharagpur.

21MDE34	BIOMETRIC SYSTEMS	L	T	P	C
		3	0	0	3

Preamble

This course provides the students to get knowledge on the technologies involved in fingerprint,iris,face and speech recognition.It also enables the students to recognize personal privacy and security implications in biometric basedidentification system to develop biometric systems by minimizing the underlying trade-offs.

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

CO1 Demonstrate the knowledge on principles of biometrics system.

CO2 Understand the feature extraction, classification techniques andapplicationsof fingerprint technology.

CO3 Discuss about the techniques involved in face recognition biometric system.

CO4 Design iris recognition system.

CO5 Develop speech recognition and multimodal biometric systems.

UNIT 1 INTRODUCTION TO BIOMETRICS **9**

Biometric Technologies– passive and active biometrics– Biometrics and traditional techniques. Biometric characteristics– Biometric applications – Biometric Authentication systems- Taxonomy of Application Environment– Performance and Accuracy measures in Biometric Systems–False match rate- False nonmatch rate-Failure to enroll rate– Derived metrics-Biometrics and Privacy.

UNIT 2 FINGERPRINT IDENTIFICATION TECHNOLOGY **9**

General description of fingerprints- fingerprint capture & 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. Fingerprints in forensics and biometrics– similarities and differences

UNIT 3 FACE RECOGNITION **9**

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

UNIT 4 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– futuredirections

UNIT 5 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.

Total : 45 Periods

TEXT BOOKS:

1. James Wayman& Anil Jain, “Biometric Systems- Technology Design and Performance Evaluation”, Springer, First Edition,2011.
2. John R. Vacca, “Biometric Technologies and Verification Systems”, First Edition Elsevier, 2007 .

REFERENCES:

1. G.R.Sinha, Sandeep B.Patel, “Biometrics: Concepts and Applications”, Wiley Publications, First edition,2013
2. Paul Reid, “Biometrics for Network Security”, Pearson Education, 2004.
3. Kisku, Dakshina Ranjan, Gupta, Phalguni, Sing, Jamuna Kanta, “ Design and Implementation of Healthcare Biometric Systems”, IGI Global,2019

e-Resources:

1. NPTEL Video https://nptel.ac.in/courses/106/104/106104119/ “Biometrics ”,Prof. Phalguni Gupta, IIT Kanpur.
2. https://ieeexplore.ieee.org/document/8851272/ Libing Wu, IEEE Transactions onInformation Forensics and Security.

21MDE35	PATTERN RECOGNITION AND NEURAL NETWORKS	L	T	P	C
		3	0	0	3

Preamble

This course provides the fundamentals of pattern recognition and its application and imparts knowledge on the Neural network architectures. It also enables the students to realize the learning algorithms to develop applications in pattern recognition, image processing and computer vision.

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

CO1 Explain the basics of pattern recognition.

CO2 Apply the different pattern recognition techniques to the application of interest.

CO3 Explain the fundamentals of neural networks.

CO4 Explain the function of neural networks of the Back-propagation, Hopfield, CPN and SOM.

CO5 Perform algorithmic training of various neural networks.

UNIT 1 INTRODUCTION AND SUPERVISED LEARNING **9**

Applications of Pattern recognition, Random variables, Types of Pattern recognition, Statistical Decision making – Bayes theorem –multiple features-Decision Boundaries - estimation of error rates, Nonparametric Decision making – Histograms – kernels -window estimators - nearest neighbor classification – Adaptive Decision Boundaries – Adaptive and Minimum Squared error Discriminant functions.

UNIT 2 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, k-means algorithm and Isodata Algorithm.

UNIT 3 INTRODUCTION AND SIMPLE NEURAL NET **9**

Introduction – Artificial Neural Networks– Biological neural network– Comparison– Basic Building blocks– Terminologies– Fundamental Model of Artificial Neural Networks– Perceptron, Adaline and Madaline.

UNIT 4 BACK PROPAGATION AND ASSOCIATIVE MEMORY **9**

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

UNIT 5 NEURAL NETWORKS BASED ON COMPETITION **9**

Kohonen Self organizing map, Learning Vector Quantization, Counter Propagation network.

Total : 45 Periods

TEXT BOOKS:

1. Earl Gose, Richard Johnsonbaugh and Stve Jost, "Pattern Recognition and Image analysis", PHILearning Private Limited, New Delhi, 2009.
2. S.N. Sivanandam, S.Sumathi and S.N. Deepa, "Introduction to Neural Networks using MATLAB 6.0", McGraw Hill Education (India) Private Limited, New Delhi, 2006.

REFERENCES:

1. Duda R.O. Hart P.G, "Pattern Classification and scene analysis", Wiley Edition 2000.
2. Hagan, Demuth and Beale, "Neural network design", Vikas Publishing House Pvt Ltd., New Delhi, 2002.
3. Freeman J.A., and Skapura B.M, "Neural Networks, Algorithms, Applications and Programming Techniques", Addison - Wesley, 2003.

e-Resources:

1. NPTEL Video http://nptel.ac.in/courses/117105101/, "Pattern Recognition and Application", Prof. P. K. Biswas, Indian Institute of Technology, Kharagpur.
2. NPTEL Video http://nptel.ac.in/courses/117105084/, "Neural Networks and Applications", Prof.S. Sengupta, IIT Kharagpur.

21MDE36	MEDICAL INFORMATICS	L	T	P	C
		3	0	0	3

Preamble

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

CO1	Implement different modules of computerized system in hospital to support clinical activity.
CO2	Suggest appropriate medical standards for patient records, medical images and clinical data to store and retrieve for hospital management.
CO3	Illustrate the strategy of acquisition, processing and transformation of clinical data into information data to improve medical care.
CO4	Identify and interpret the impact of computers on continuing medical education programmes to accelerate the knowledge base to patient care.
CO5	Describe the recent materials and methods behind surgery simulators, virtual environment to develop information and communication technology applications in clinical workspace.

UNIT 1 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 2 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 3 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 4 COMPUTER ASSISTED MEDICAL DECISION-MAKING 9

NeurocomputersandArtificialNeuralNetworksapplication,Expertsystem-General model of CMD, Computer–assisted decision support system-production rule system cognitivemodel,semanticnetworks,decisionsanalysisinclinicalmedicine-computersin the care of critically ill patients, Computer aids for the handicapped.

UNIT 5 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 : 45 PERIODS

TEXT BOOKS:

1. Edward H. Shortliffe, Leslie E. Perreault, “Medical Informatics: Computer Applications in Health Care and Biomedicine”, 2nd Edition, Springer 2013.
2. Ramachandra Lele, Computers in Medicine Progress in Medical Informatics, Tata McGraw Hill Publishing Company, New Delhi, 2005.
3. Mohan Bansal, “Medical informatics”, Tata McGraw Hill Publishing Ltd, 2003.

REFERENCES:

1. Dinesh Bhatia, “Medical Informatics”, PHI Learning Pvt. Ltd., 2015.
2. Ken ong, Medical Informatics - An executive Premier, 3rd Edition, HIMSS, 2015.
3. Kathryn J. Hannah, Marion J Ball, “Health Informatics”, 3rd Edition, Springer, 2006.

e-Resources:

1. NPTEL Videos https://www.digimat.in/nptel/courses/video/102106065/L01.html "Concepts and importance of Bioinformatics",Prof.M.Michael Gromiha, IIT Madras.
2. NPTEL Videos https://nptel.ac.in/courses/127/106/127106136/ "Regulatory requirements for medical devices and IVDs in India", Dr.Sucheta Banerjee Kurundkar, IIT Madras.

21MDE37	WEARABLE DEVICES	L	T	P	C
		3	0	0	3

Preamble

The Course enables the students to study about communication, security aspects and applications of wearable devices in the field of medicine

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

CO1 Describe the concepts of wearable system.

CO2 Explain the energy harvestings in wearable device.

CO3 Use the concepts of BAN in health care

CO4 Illustrate the concept of smart textile

CO5 Compare the various wearable devices in healthcare system

UNIT 1 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 2 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 3 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 4 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 5 APPLICATIONS OF WEARABLE SYSTEMS 9

Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, neural recording, Gait analysis, Sports Medicine.

TOTAL : 45 PERIODS

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

REFERENCES:

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.

e-Resources:

1. https://www.coursera.org/learn/mobile-health-monitoring-systems, ‘ The Development of Mobile Health Monitoring Systems’, Evgenii Pustozerov, Department of Biomedical Engineering, Saint Petersburg Electro technical University
2. https://www.mdpi.com/journal/sensors/special_issues/Wearable_Physical_Rehabilitation,“ Wearable Systems in Physical Rehabilitation: Opportunities and Challenges”.

21MDE38	TELEHEALTH TECHNOLOGY	L	T	P	C
		3	0	0	3

Preamble

The Course enables the students to know telemedical standards, telemedical technology, mobile telemedicine and it applications.

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

CO1 Describe the benefits & limitation of telemedicine

CO2 Identify the need of ICI for telemedicine

CO3 Summarize the Ethical and Legal aspects in telemedicine

CO4 Discuss he Picture archiving techniques and technical issues.

CO5 Apply the knowledge in various applications of telemedicine in health care sector.

UNIT 1 FUNDAMENTALS OF TELEMEDICINE **9**

History of telemedicine, definition of telemedicine, tele-health, tele-care, scope, Telemedicine Systems, benefits & limitations of telemedicine.

UNIT 2 TYPE OF INFORMATION & COMMUNICATION INFRASTRUCTURE FOR TELEMEDICINE **9**

Audio, video, still images, text and data, fax-type of communications and network: PSTN, POTS, ANT, ISDN, internet, air/ wireless communications, GSM satellite, micro wave, Mobile health and ubiquitous healthcare.

UNIT 3 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 4 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 5 APPLICATIONS OF TELEMEDICINE **9**

Teleradiology, telepathology, telecardiology, teleoncology, teledermatology, telesurgery, e Health and Cyber Medicine.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Norris A C, “Essentials of Telemedicine and Telecare”, John Wileyand Sons, New York, 2002.
2. H K Huang, “PACS and Imaging Informatics: Basic Principles and Applications”,Wiley, 2nd Edition, 2010.

REFERENCES:

1. Olga Ferrer Roca, Marcelo Sosa Iudicissa, “Handbook of Telemedicine”, IOS Press, Netherland, 2002.
2. Khandpur R S, “Handbook of Biomedical Instrumentation”, Tata McGraw Hill, New Delhi, 3rd Edition ,2003.
3. Keith J Dreyer, Amit Mehta, James H Thrall, “Pacs: A Guide to the Digital Revolution”, Springer, New York, 1st Edition 2002.

e-Resources:

1. https://www.coursera.org/lecture/healthcare-it/module-4-telehealth-IKo2k “ Telehealth”
2. NPTELVideos https://nptel.ac.in/courses/106/105/106105084/ “Introduction to Internet” Prof.Sengupta, IIT Kharagpur.

21MDE39	IoT IN HEALTHCARE	L	T	P	C
		3	0	0	3

Preamble

This course aims to provide recent advances in IoT for biomedical engineering, biometrics, bioinformatics, artificial intelligence and computer vision. It also imparts knowledge on usage challenges and interoperability issues with respect to the cost and accuracy of medical sensors, non-standard IoT system architectures, , huge volume of generated data in healthcare.

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

CO1	Discuss IoT healthcare functional architecture and map its components with respect to requirement analysis and wearable characteristics.
CO2	Summarize the process of medical big data analytics for diagnosis of abnormalities.
CO3	Compare the IoMT technologies associated with biomedicine and contrast working methodologies with respect to healthcare.
CO4	Illustrate artificial intelligence and computer vision techniques employed in biomedical sciences.
CO5	Design and develop an IoT based health monitoring system using Arduino.

UNIT 1 OVERVIEW OF INTERNET OF THINGS **9**

Introduction-Healthcare architecture in Internet of Things-Communication between devices-Medical body area networks-Architecture Requirements-Healthcare Ecosystem– Health Care Applications using IoT– Health Application Requirements– Opportunities And Challenges.

UNIT 2 MEDICAL BIG DATA **9**

Big Data dimensions Big Data for Medical Industry– Information Processing in Health Care Analytics– Data Mining Process for Medical Big Data– Medical Big Data Analytics– Medical Big Data- Applications and Challenges.

UNIT 3 IoT TECHNOLOGIES AND CHALLENGES **9**

IoMT system Architecture– Components of system architecture– IoT Healthcare solutions– Enhanced medicine management– Technologies used in IoT-based applications.

UNIT 4 AI IN BIOMEDICINE **9**

AI and Computer Vision in biomedicine-Principal Disciplines of AI and Computer Vision-Machine learning– Classification and Regression– Predictive Analysis. Biomedical applications and solutions-Medical Imaging– Pattern Recognition– Abnormality Detection.

UNIT 5 IoT IN HEALTHCARE APPLICATIONS **9**

IoT based smart and secure health monitoring system– Development of obstacle avoiding robots based on sensors and IoT– Patient health monitoring system using Arduino and Android– detection of atrial fibrillation– fall detection using IoT technologies.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Valentina E. Balas, Le Hoang Son, “Internet of Things in Biomedical Engineering”, Academic Press,1 st Edition, 2019.
2. Chintan Bhatt, Nilanjan Dey, “Internet of Things and Big Data Technologies for Next Generation Healthcare”, Springer- Technology & Engineering, 2017.

REFERENCES:

1. Nilanjan Dey, Amira S. Ashour, “Wearable and Implantable Medical Devices: Applications and Challenges”, Academic Press,1 st Edition, 2019.
2. Singh, Rajesh, Gehlot, Anita, Jain, Vishal, Malik, Handbook of Research on the Internet of Things Applications in Robotics and Automation, IGI Global,1 st Edition, 2019.
3. Jamil Y. Khan, Mehmet R. Yuce, “Internet of Things (IoT): Systems and Applications”, CRC Press, 1 st Edition,2019.

e-Resources:

1. NPTEL Videos https://nptel.ac.in/courses/106/105/106105166/ “Introduction to IoT”,Prof.Sudip Misra, IIT

Kharagpur.
2. NPTEL Videos https://freevideolectures.com/course/4638/nptel-introduction-internet-things/58 " Case Study: Healthcare" Prof.Sudip Misra, IIT Kharagpur.

21MDE40	CLOUD COMPUTING FOR HEALTHCARE	L	T	P	C
		3	0	0	3

Preamble

This course provides understanding about the cloud computing in healthcare applications.

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

CO1 Explain the fundamentals of cloud computing

CO2 Explain virtualization and Differentiate Various cloud platforms used in industry

CO3 Illustrate the cloud application programming

CO4 Describe the platforms for development of cloud applications

CO5 Apply the technology for healthcare applications

UNIT 1 CLOUD COMPUTING ARCHITECTURE 9

Cloud Computing at a Glance, The Vision of Cloud Computing, Cloud Computing Reference Model, Layered Cloud Architecture Design, NIST Cloud Computing Reference Architecture, Public, Private and Hybrid Clouds, Cloud ecosystem.

UNIT 2 DISTRIBUTED SYSTEMS AND VIRTUALIZATION 9

Web 2.0, Service-Oriented Computing, Utility-Oriented Computing, Building Cloud Computing Environments, Application Development, Infrastructure and System Development, Computing Platforms and Technologies, Amazon Web Services (AWS), Google AppEngine, Microsoft Azure, Hadoop Virtualization and Cloud Computing, Pros and Cons of Virtualization, Technology Examples Xen: Para virtualization, VMware: Full Virtualization, Microsoft Hyper-V.

UNIT 3 CONCURRENT COMPUTING 9

Thread Programming, Programming Applications with Threads, Thread APIs, Techniques for Parallel Computation with Threads, Multithreading with Aneka, Introducing the Thread Programming Model, Aneka Thread vs. Common Threads, Domain Decomposition: Matrix Multiplication, Functional Decomposition: Sine, Cosine, and Tangent. High-Throughput Computing: Task Programming, Task Computing, Characterizing a Task, Computing Categories, Frameworks for Task Computing, Task-based Application Models, Parameter Sweep Applications, MPI Applications, Workflow Applications with Task Dependencies.

UNIT 4 DATA INTENSIVE COMPUTING 9

Map-Reduce Programming, Introduction to Data Intensive Computing - Characterizing Data-Intensive Computations, Challenges Ahead, Historical Perspective, Technologies for Data-Intensive Computing, Storage Systems, Programming Platforms, Aneka MapReduce Programming, Introducing the MapReduce Programming Model, Example Application.

UNIT 5 HEALTHCARE APPLICATIONS CASE STUDIES 9

An Adaptive Cloud Prototype Model for Health Care system using Software Defined Network (SDN), Big Data Analytics for Childhood Pneumonia monitoring, Diabetes, Patient monitoring by Cloud Computing, Trust-Privacy Issues in Cloud Based Healthcare Services.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Rajkumar Buyya, Christian Vecchiola, and Thamarai Selvi "Mastering Cloud. Computing" McGraw Hill Education, 2016.
2. Chintan M. Bhatt S. K. Peddoju, "Cloud Computing Systems and Applications in Healthcare", 2019.
3. Derrick Rountree and Ileana Castrillo "The Bascis of Cloud Computing" Springer, 2015

REFERENCES:

1. Dan C. Marinescu, Cloud Computing Theory and Practice, Morgan Kaufmann, Elsevier 2013

e-Resources:

1. https://www.digimat.in/nptel/courses/video/106105167/L01.html
2. https://nptel.ac.in/courses/106105167

21MDE41	AUGMENTED REALITY AND VIRTUAL REALITY IN HEALTHCARE	L	T	P	C
		3	0	0	3

Preamble

The Course enables the students to Understand virtual reality, augmented reality and using them to build Biomedical engineering applications.

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

CO1	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
CO2	Understand virtual reality, augmented reality and using them to build Biomedical engineering applications
CO3	Know the intricacies of these platform to develop PDA applications with better optimality.
CO4	Learn the various applications of VR.
CO5	Learn the possibilities of implementing target-specific VR applications on mobile

UNIT 1 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 2 VR DEVELOPMENT PROCESS **9**

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

UNIT 3 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 4 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 5 APPLICATIONS **9**

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

TOTAL : 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.

REFERENCES:

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.

e-Resources:

1. https://nptel.ac.in/courses/106106138
2. http://www.vrtechnology.org/resources.html
3. https://www.simlab-soft.com

21MDE42 CYBER SECURITY FOR MEDICAL SYSTEMS

L	T	P	C
3	0	0	3

Preamble

This course has been developed to raise awareness and understanding the role of cyber security in healthcare and the challenges that surround it. It explains how the rise of technologies and proliferation of medical data has become an attractive target to cybercriminals, which is essential in understanding why adequate Cyber Security measures are critical within the healthcare environment.

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

CO1 Identify possible ways the hackers can hack hospital and healthcare facility equipment

CO2 Summarize the possibilities of weaponization of medical device by hackers

CO3 Discuss medical facility cyber-physical attacks

CO4 Detect and prevent cyber attacks

CO5 Create a response and recovery plan to manage cyber attacks

UNIT 1 HACKERS RECONNAISSANCE TO HOSPITAL NETWORK 9

Footprinting - Scanning - Enumeration - Network Mapping - Cyber Threat Actors - Phishing Attack - Email Phishing Attack - Man-in-the-Middle Attack - Pharming Attack - Indirect Cyber Attack - Scareware - Ransomware - USB Stick - Auto-Hacking Attack - Backdoors - Ad Hoc Network - Unpatched Vulnerabilities - Appliance Hacks - Password Cracker - Denial-of-Service Attack - Black Hole Attack - Secondary Entry Points - Modems - Rouge Access Points.

UNIT 2 ACTIVE MEDICAL DEVICE CYBER ATTACKS 9

Magnetic Resonance Imaging - X-ray Generator - Infusion Pump - Positron Emission Tomography Scanner - X-ray Computer Tomography Scanner - Defibrillators - Medical Ventilator - Anesthetic Machine - Heart-Lung Machine - Extracorporeal Membrane Oxygenation - Dialysis Machine - Medical Lasers - Robotic Surgical Machine - Medical Device Data Systems - Active Patient Monitoring Devices - Interoperable Medical Devices - Medical Image Storage Devices - Medical Image Communication Devices - Medical Laboratory - Electronic Health Records - Barcode Scanning Systems.

UNIT 3 MEDICAL FACILITY CYBER-PHYSICAL ATTACKS 9

Building Control System (BCS) - Facility Equipment Controlled by the BCS - BCS Network Vulnerabilities - Preventing Hospital Building Equipment Damage - Facility Equipment Cyber-Physical Attacks - Steam Boilers - Boiler Sequence Controller Hack - Hot Water Heater Explosion - Chillers - Cooling Tower - Backup Generator.

UNIT 4 DETECTION AND PREVENTION OF CYBER ATTACKS 9

Indicators of Possible Cyber Attack - Cyber Attack Detection Tools - Intrusion Detection Systems - Intrusion Detection Systems Alarms - Intrusion Prevention System - Forensic Evidence of a Cyber Attack - Cyber Hygiene - Network Procurement Documentation - Discontinue Remote Connections to the Medical Equipment Network - Implement Application Whitelisting - Systematic Patch Management Regimen - Attack Surface Reduction - Building a Defendable Network Environment – Manage Authentication - Monitor and Respond - Cyber Security Analysis Tools - Phishing Scam Avoidance.

UNIT 5 HOSPITAL INSIDER THREATS & CYBER ATTACK MANGEMENT 9

Types of Insider Threats - Types of Insider Cyber Attacks - Insider Hacking Tools - Developing a Response and Recovery Plan - Incident Response Team - Recovery Phases - After Action Report - Cyber Attack Response Procedures Chart - Intrusion Detection System Alerts.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Luis Ayala, “Cybersecurity for Hospitals and Healthcare Facilities:A Guide to Detection and Prevention”, Apress., 2016
2. W. Andrew H. Gantt, “Healthcare Cybersecurity”, American Bar Association, 2021.

REFERENCES:

1. Pierguido Iezzi, “Healthcare Cybersecurity”, Youcanprint, 2018.
2. Nina Godbole, “Cyber Threats in Healthcare”, Wiley, 2021.

e-Resources:

1. https://www.udemy.com/course/h17-cyber-security-in-healthcare-part-1-plain-simple/, “Intro to Cybersecurity in Healthcare”, by Thomas Giordano.
2. https://www.coursera.org/learn/cybersecurity-in-healthcare, "Cybersecurity in Healthcare ", by Jason H. Pridmore and Tessa A. P. Oomen.

21MDO01 **INTRODUCTION TO MEDICAL ELECTRONICS** **L T P C**

3 0 0 3

Preamble:

Medical Electronics concerned with describing the application of technological methodsto medical diagnosis and therapy.Tremendous increase in use of modern medical equipment in hospitals, research institutes has made every engineer to understand the design and functioning of various medical equipments.The courses will focus strongly on the medical assist devices,diagnosis and therapeutic equipments suitable to deliver quality patient care in hospitals and laboratories.

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

1. Illustrate the factors required to design medical instruments with suitable requirements of the normal physiological system.
2. Suggest an appropriate medical preamplifiers to improve the quality of biosignal acquisition in medical recorders and instruments.
3. Differentiate the principle of pacemakers, Defibrillators, Heart-Lung machine to suggest a proper assist device for a patient in critical care.
4. Identify and measure the chemical and radiation parameters to monitor patients in critical conditions.
5. Interpret the novel methods of diagnosis and therapy in medical devices to improve patient care and quality.

UNIT 1 MEDICAL ELECTRONICS-AN OVERVIEW 9

Introduction – Design of Medical Instruments – Block diagram of generalized Medical Instruments Systems – Components of Medical Instruments – Electrodes – Types of Electrodes – Micro Electrodes-Depth and needle Electrodes – Surface Electrodes –Distortion in the measured Bioelectric Signals using electrodes.

UNIT 2 BIOSIGNAL ACQUISITION AND RECORDERS 9

Biosignal Acquisition – Medical Preamplifier design (Instrumentation Amplifier)–ECG Isolation Amplifier Circuit – Signal recovery and Data acquisition –Biopotential Recorders – Characteristics of the Recording System – ECG,EEG– typical waveform and Signal Characteristics.

UNIT 3 MEDICAL ASSIST DEVICES 9

Introduction– Pacemakers – Energy requirements to excite heart muscle – Methods of stimulation –Artificial Heart valves–Defibrillators: AC and DC types – Heart Lung Machine (HLM) –Systematic Cardiovascular Circulation– Ventilators: Servo Controlled ventilators type.

UNIT 4 SPECIALISED MEDICAL EQUIPMENTS 9

Introduction –Blood Cell Counter – Digital Thermometer –Electronic thermometer – Automatic Bekesy audiometer –X-ray Machine – Image Intensifier in fluoroscopy.

UNIT 5 ADVANCEMENTS IN MEDICAL INSTRUMENTATION 9

Computers in medicine–digitalcomputer –CryogenicSurgery –Endoscopes –Endoscopic laser Coagulator– ComputedTomography –CT Scanner –MRI Instrumentation–Bio-feedback Instrumentation.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, 4 thEdition 2015.
2. Dr.M.Arumugam, "Biomedical Instrumentation",Anuradha Publishers,2014.

REFERENCES:

1. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 4 thEdition, 2004.
2. R.D.Lele, ―Computers in Medicine, Tata McGraw Hill, Second Reprint 2008..
3. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Pearson India, 2 nd Edition 2015.

e-RESOURCES:

1. NPTEL Videos https://www.digimat.in/nptel/courses/video/108105101/L04.html , "Biomedical Signal origin and dynamics" , Prof.SudiptaMukhopadhyay, IIT Kharagpur.
2. https://emergency-vent.mit.edu/ " MIT Emergency Ventilator- Design Toolbox".

21MDO02 **HOSPITAL WASTE MANAGEMENT** **L T P C**

3 0 0 3

Preamble:

The Course enables the students to understand the handling of medical wastes and procedure for reuse of medicalwastes.

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

1. Categorize different biomedical wastes based on its properties
2. Describe the different methods used for waste disposal and basic principle of sterilization to avoid disease transmission
3. Analyze various hazards, accidents and its control
4. Understand the controls applied to waste management to prevent infectious diseases
5. Summarize the safety facility required in hospitals

UNIT 1 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 anddisposal.

UNIT 2 DISPOSAL OF WASTE AND PRINCIPLES OF STERILIZATION 9

Disposal methods - Incinerator - Hazardous waste, radioactive waste, liquid waste destruction - landfill. Disease Transmission - Disinfection methods, Sterilization - steam sterilizing (Auto claving) .

UNIT 3 HAZARDOUS MATERIALS 9

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

UNIT 4 CONTROLS APPLIED TO WASTE MANAGEMENT 9

Healthcare Immunizations, Centers for Disease Control and Prevention, Air pollution and Emission control, Instrumentation and monitoring, Crematories

UNIT 5 ENVIRONMENTAL SAFETY, RISKS & PUBLIC ISSUES 9

OSHA Blood borne Pathogens Standard, Tuberculosis, Healthcare Opportunistic Infections. Risk management in hospitals - Environment issues in hospitals - Risk analysis

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Tweedy, James T., Healthcare hazard control and safety management-CRC Press_Taylor and Francis , 3rd Edition, 2014.
2. Anantpreet Singh, Sukhjit Kaur, Biomedical Waste Disposal, Jaypee Brothers Medical Publishers , 1st Edition , 2012.
3. C.R.Brunner, Medical Waste Disposable Handbook, Incentrated, Consultant in Corporated, Virginia, 2000.

REFERENCES:

1. Safe management of wastes from health-care activities, 2nd edition, World Health Organization 2014.
2. V.J. Landrum, ―Medical Waste Management and disposal‖, Elsevier, 1991

e-RESOURCES:

1. https://nptel.ac.in/courses/105/106/105106056/, “Hazardous Waste Management” ,IIT Madras
2. https://swayam.gov.in/nd2_cec20_ge13/preview, "Solid and hazardous waste management",By Prof. V. K. Garg , Professor and Dean, School of Environment and Earth Sciences, Central University of Punjab, Bathinda.

21MDO03 **HOSPITAL INFORMATION SYSTEM** **L T P C**

3 0 0 3

Preamble:

This course imparts knowledge on the theories and practices adopted in Hospital Information Systems in the light of medical standards, medical data formats and recent trends in adopted in hospitals data storage and retrieval. It also focuses on ICT applications to health care professionals where they frequently come across information systems for the support of patient care, assessment of quality of care, medical research, decision-making, management and planning.

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

1. Categorize different functional areas such as inpatient and outpatient areas to integrate the clinical work flow.
2. Implement different modules of computerized system in hospital to support clinical activity.
3. Identify and interpret the impact of computers on continuing medical education programmes to accelerate the knowledge base to patient care.
4. Summarize and compare RIS, HIS and PACS.
5. Illustrate the strategy of acquisition,processing and transformation of clinical data into information data to improve medical care..

UNIT 1 HOSPITAL MANAGEMENT AND INFORMATION SYSTEM 9

HMIS-Introduction –Need –Benefits and capabilities of HMIS –Development of HMIS –Functional areas –Modules forming HMIS –Computerized Physician Order Entry System (CPOE) – HMIS and Internet–Integrated Information system.

UNIT 2 HIS MODULES 9

Hospital information system– Structure of HIS – Modules of HIS – Hospital information system –Department Management –Organization charts –Department Workflow –Evaluation of department operation and services – department equipment and supplies –Training and development.

UNIT 3 COMPUTER BASED PATIENT RECORDS AND CODES 9

CPR– Evolution and Need –Development tools – Computer Patient Records (CPR) in Radiology –Legal –Security – Privacy Issues –Coding– Nomenclature and Classification –General purpose code sets –Special Purpose code sets.

UNIT 4 RADIOLOGICAL INFORMATION SYSTEM 9

Radiological Information system- PACS- Components, Importing and Exporting images to PACS.RIS,MPI and other Text Systems, Integrating with other systems. DICOM, HL-7.

UNIT 5 HEALTH INFORMATION PROCESSING AND ISSUES 9

Health data quality – Post Discharge Processing –Health Data scanning and Indexing – Record analysis – Coding – Abstracting –Storage –Retention and transcription –Confidentiality and Compliance –Preparing a record for release – Internal request for information –Federal ,corporate and facility compliance

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Nadinia A.Davis, Health Information Technology, Elsevier Health Sciences,(2014).
2. Dinesh Bhatia, "Medical Informatics", PHI Learning Pvt. Ltd., 2015.

REFERENCES:

1. Edward H. Shortliffe, Leslie E. Perreault, "Medical Informatics: Computer Applications in Health Care and Biomedicine", Springer 2013.
2. Ramachandra Lele, Computers in Medicine Progress in Medical Informatics,Tata McGraw Hill Publishing Company, New Delhi,2005.
3. Alain Venot -Medical Informatics, e-Health, Fundamental and Applications, Springer-Verlag Paris, 2013.

e-RESOURCES:

1. NPTEL Videos https://www.digimat.in/nptel/courses/video/102106065/L01.html "Concepts and importance of Bioinformatics", Prof.M.Michael Gromiha,IIT Madras.
2. https://www.dovepress.com/components-and-implementation-of-a-picture-archiving-and-communication-peer-reviewed-fulltext-article-RMI, " Components and implementation of a picture archiving and communication system in a prototype application", Hasan H Khaleel, Department of Medical Devices Techniques' Engineering, AL-Esraa University College

21MDO04 **IoT APPLICATIONS IN HEALTHCARE** **L T P C**
3 0 0 3

Preamble:

This course focuses on recent advances in the Internet of Things (IoT) in biomedical and healthcare. Artificial intelligence and IoT are set to revolutionize all industries, but perhaps none so much as health care. Both biomedicine and machine learning applications are capable of analyzing data stored in national health databases in order to identify potential health problems, complications and effective protocols, and a range of wearable devices for biomedical and healthcare.

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

1. Discuss IoT healthcare functional architecture and map its components with respect to requirementanalysis and wearable characteristics.
2. Illustrate various IoT techniques to monitor various Biomedical parameters in healthcare.
3. Interpret the Wearable Technologies for Different Body Parts.
4. Compare and contrast various semantic and machine learning approaches to integrate medical data.
5. Discriminate and analyze the research challenges and Opportunities related to IoT in Healthcare

UNIT 1 BASICS OF HEALTHCARE IoT **9**

Introduction – Internet of Things– Healthcare IoT in Brief –IoT Healthcare Services –IoT Healthcare Devices/Applications–IoT architecture –IoT sensor data hierarchy– The Maslow's hierarchy of needs.

UNIT 2 TRANSFORMING HEALTHCARE THROUGH VARIOUS TECHNIQUES IN IoT **9**

Introduction – Understanding the Internet of Things– Internet of Things Applications in Healthcare – IOT Building Blocks Emerging Everywhere – Healthcare: IOT in Action– Reference Platform for Home Health Hub–Health Monitoring Using Wireless Communication– Making the IoT Possible in Healthcare: Enabling Technologies– Health Monitoring Security.

UNIT 3 WEARABLE DEVICES AND IoT **9**

Internet of Things Healthcare –Wearable Technologies for Different Body Parts –Cloud Computing for WIoT– Access Control Based Model – Body cloud –Wearable Glass –Wearable Cloud –Fog Computing for Wearable IoT Device –Big Data for Wearable IoT–Attacks in Wearable IoT Devices- Powering wearables - Energy harvesting.

UNIT 4 IoT SENSOR DATA INTEGRATION IN HEALTHCARE USING SEMANTICS AND MACHINE LEARNING APPROACHES **9**

Introduction – Internet of Things (IoT) in Healthcare – U-Healthcare System – Semantic Technologies – Ontology – RDF– RDF Schema – OWL – Semantic Annotations – Machine Learning Approaches for IoT Healthcare Data Integration – Distribution Based Mechanisms – Centroid-Based Mechanisms – Connectivity-Based Mechanisms – Density-Based Mechanisms – Research Directions.

UNIT 5 CHALLENGES AND OPPORTUNITIES OF INTERNET OF THINGS FOR HEALTH CARE **9**

Healthcare Industry and Resolution in Internet of Medical Thing –Opportunities of IoT in Healthcare– Wearables and Medical Devices– Benefits of IoT in Healthcare– Unlatching the Potential of IoT-Medical Devices – Future of IoT Based Healthcare –Challenges of Internet of Things (IoT) in Healthcare.

TOTAL :45PERIODS

TEXT BOOKS:

1. Chinmay Chakraborty, Amit Banerjee, "Internet of Things for Healthcare Technologies", Springer,2021.
2. Valentina E. Balas,Vijender Kumar Solanki, Raghvendra Kumar, "A Handbook of Internet of Things in Biomedical and Cyber Physical System", Springer, 2020.

REFERENCES:

1. Mobyen Uddin Ahmed,Shahina Begum,Jean-Baptiste Fasquel (Eds.), "Internet of Things(IoT) Technologies for HealthCare",4th International Conference, Springer, 2017.
2. Felicity Smith, Sally-anne Francis, EllenSchafheutle, "International Research in Healthcare",ULLA Pharmacy Series, 2008.
3. Athina Lazakidou, "Handbook of Research on Informatics in Healthcare and Biomedicine",Idea Group Publishing, 2006.

e- RESOURCES:

1. http://onlinecourses.nptel.ac.in/noc20_cs66/preview, "Introduction to Internet of things" Prof. SudipMisra, IIT Kharagpur.
2. NPTEL Videos https://nptel.ac.in/courses/109/106/109106095/ "Health Research Fundamentals"Dr.Sanjay Mehendale, IIT Madras.

21MDV01 CLINICAL PATHOLOGY AND MICROBIOLOGY

L T P C
0 0 2 1

Prerequisite:

Having basic knowledge on cell degeneration, microorganism and microscopy

Preamble:

To develop the knowledge of clinical laboratory skills and techniques related to the isolation, staining, identification, assessment of metabolism, and control of microorganisms

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

1. Correlate the important clinical features of the disease with the pathologic changes
2. Explain the etiology, pathogenesis, gross and microscopic appearances, relevant laboratory investigations, complications and the outcome of common diseases.

Module 1 –Cell Degeneration And Neoplasia **10**

Cell degeneration and regeneration

Hemodynamic derangement

Neoplasia

Module 2 – Microbial Cultures And Staining Techniques **20**

Identification of pathogens in biological sample

Staining methods – simple, gram staining and AFB staining

TOTAL : 30 PERIODS

REFERENCES:

1. Robbins and Cotran Pathologic Basis of Diseases‖, 7th edition, Vinay Kumar, Abul K.Abbas, Nelson Fausto, Saunders, An imprint of Elsevier, 2006.WB Saunders Co. 2005 .
2. Ananthanarayanan and Panicker‘s Textbook of Microbiology, Edited by C K J Paniker, Orient Longman Private Limited, 2005

e-Resources:

1. Microbiology and Immunology On -line from the Department of Pathology, Microbiology and Immunology at the University of South Carolina School of Medicine http://pathmicro.med.sc.edu/book/welcome.htm, comprehensive list of lectures, quizzes and other learning material.
2. http://emedicine.medscape.com/infectious_diseases, (very comprehensive website listing numerous infectious disease agents, with background, differential diagnoses, treatment and follow up)

21MDV02 CALIBRATION AND TESTING OF MEDICAL DEVICES

L	T	P	C
0	0	2	1

Prerequisite:

Having a basic knowledge on measurements, errors and calibration techniques in medical devices.

Preamble:

Medical equipment is prone to wear and tear over time, which directly affects the accuracy and performance. To maintain the equipment effectiveness and decrease the risk of causing harm to a patient, periodic calibration is necessary. Regularly calibrating equipment will ensure that industry defined standards are met and that the equipment functional providing accurate output.

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

1. Understand the importance of testing biomedical equipment and the purpose of quality assurance.
2. Achieve uniformity in selection of equipment, calibration methods, maintaining required environmental conditions in line with national and international standards.

Module 1 – Calibration and Testing of Medical Device **10**

- Simulation of Biological Signals
- Calibration and Testing of ECG machine
- Electrical Safety & Quality Assurance - Electrical Safety Analyzer

Module 2 – Quality Assurance Phantom for Imaging Devices **20**

- Quality Assurance test in X-ray machine
- Designing phantom of various imaging devices

TOTAL : 30 PERIODS

REFERENCES:

1. Joseph. J Carr, John M Brown, "Introduction to Biomedical Equipment Technology", John Wiley& Sons, New York, 4th edition, 2008.

2. Justin Cooper, Alex Dahinten, "Medical Equipment Troubleshooting Flowchart Handbook", Engineering World Health, Version 6, 2013.

e-Resources:

1. https://apps.who.int/iris/bitstream/handle/10665/44587/9789241501538_eng.pdf/jsessionid=156EC3788A40D9EB8B7E9CD5EAA741BB?sequence=1,"Medical equipment maintenance programme overview".
2. https://onlinecourses.nptel.ac.in/noc20_ge14/preview, "Regulatory requirements for medical devices including in vitro diagnostics in India (Version 2.0)", Shri Aseem Sahu, Shri. Malay Mitra, CDSCO, Ministry of Health & Family Welfare, New Delhi.
3. https://bmet.ewh.org/handle/20.500.12091/434 , Fault diagnosis and repair modules ,Engineering World Health,2020.

21MDV03 **PCB Design using Altium Designer/OrCAD/EAGLE.** **L T P C**

0 0 2 1

Prerequisite:

Basic knowledge of: Analog devices and ICs specification with Electrical and Mechanical data, digital ICs specification with electrical and mechanical data.

Preamble:

PCB Design is one of the most elementary skills needed for an electronics engineer. This PCB Design course will give the guidelines for designing PCB starting from the fundamentals of printed circuit boards to designing single and double sided PCBs

Course Outcomes: Upon completion of the course, students will be able to design a circuit, create a schematic Capture, layout design and fabricate a PCB.

1. PCB Design Software (Altium Designer/OrCAD/EAGLE)
2. PCB Design Technology

Module 1 – Fundamentals of Platform **10**

- PCB Design Software (Altium Designer/OrCAD/EAGLE)
- PCB Design Technology

Module 2 – Design and Implementation **20**

- Regulator circuit using 7805
- Inverting Amplifier or Summing Amplifier using op-amp
- Full-wave Rectifier
- Astable and Monostable multivibrator using IC555

TOTAL : 30 PERIODS

REFERENCES:

1. Mitzner.K, “Complete PCB Design Using Orcad Capture and Layout”. Elsevier/ Newnes 2007.

e-Resources:

1. http://documentation.circuitstudio.com/display/CSTU/From+Idea+to+Manufacture+-Driving+a+PCB+Design+through+CircuitStudio.
2. http://documentation.circuitstudio.com/display/CSTU/PCB_Cmd-Routing_Composite((Interactive+Routing))_CS

21MDV04	MODELLING SIMULATION AND ANALYSIS OF BIOLOGICAL SYSTEMS USING LabVIEW	L T P C 0 0 2 1

Prerequisite:

Having basic knowledge on biological signals.

Preamble:

To familiarize with the principles of acquiring biological signals using various techniques

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

1. Acquire biological signals using various techniques and process and analyze them
2. Modelling physiological parameters

Module 1 –Basics of LabVIEW and common LabVIEW functions **10**

- LabVIEW terms
- Components of LabVIEW application
- LabVIEW programming tools

Module 2 – Data Acquistion of biosignals using LabVIEW **20**

- Creating an application in LabVIEW
- Acquisition and Analysis of biological signals using LabVIEW
- Modelling of Thermal system using LabVIEW

TOTAL : 30 PERIODS

REFERENCES:

1. Bruce Mihura, "LabVIEW for Everyone: Graphical Programming Made Easy and Fun" (National Instruments Virtual Instrumentation Series), 3rd Edition August 2006
2. Anshuman prakash, Dr.Lovi raj gupta,Dr. Rajesh singh, Dr Anitha Gehlot,Rydhm Beri, "Biomedical sensors data acquisition with LabVIEW", First edition,2020.

e-Resources:

1. https://youtu.be/I8pc8-VcVFo," Beginners LabVIEW Tutorial 1: Getting Started with LabVIEW"
2. http://ece-research.unm.edu/jimp/415/labview/LV_Intro_Six_Hours.pdf

21MDV05 **Arduino Programming For Healthcare Applications** **L T P C**

0 0 2 1

Prerequisite:

Knowledge of C, C++, Electronics, Biomedical Instrumentation, Microprocessors and Microcontrollers.

Preamble:

Arduino is an open source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board or microcontroller and a software, Integrated Development Environment (IDE) that runs on the computer. It is used to write and upload computer code to the physical board. Arduino can interact with buttons, LEDs, motors, speakers, cameras, TV and smart phones etc. It can be used for almost any electronics projects.This course develops skills of students to program, design and implement smart system applications using Arduino.

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

1. Develop programs on Arduino Platform for healthcare applications.
2. Implement a system using Arduino for healthcare applications.

Module 1 – Arduino and Arduino Programming **10**

- Arduino and Arduino IDE
- Arduino Uno PIN specifications
- Arduino programming

Module 2 – Design and Implementation **20**

- Introduction to Autodesk Tinkercad
- Design and simulation of circuits using Arduino in Tinkercad
- Measure and monitor heart rate using Arduino
- Saline bottle weight calculation and alert system based on Arduino
- Automatic mask and sanitizer dispenser using Arduino

TOTAL : 30 PERIODS

REFERENCES:

1. John Nussey, “Arduino for Dummies”, Wiley, 2nd Edition, 2018.
2. Brain Evans, “Beginning Arduino Programming”, Apress, 2011.

e-Resources:

1. https://www.arduino.cc/, “Arduino programming language , Arduino Software (IDE) and Processing”.
2. https://onlinecourses.swayam2.ac.in/aic20_sp04/, “Arduino”, Prof. Kannan Moudgalya, Department of Chemical Engineering, Indian Institute of Technology Bombay.

21MDV06 **Machine Learning using MATLAB/ Python** **L T P C**
0 0 2 1

Prerequisite:

Knowledge on basic probability and statistics, Linear algebra and calculus. Programming skills on Matlab/Python

Preamble:

Machine learning research aims to build computer systems that learn from experience.Learning systems are not directly programmed by a person to solve a problem, but instead they develop their own program based on examples of how they should behave,or from trial-and-error experience trying to solve the problem. These systems requirelearning algorithms that specify how the system should change its behavior as a result ofexperience. Researchers in machine learning develop new algorithms, and try to understand which algorithms should be applied in which circumstances.

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

1 To create Machine Learning solutions using Python/MATLAB.

2 To evaluate and improve the performance of the created solutions.

Module 1 **10**

- Linear Regression and Logistic Regression
- Model selection
- Organizing and preprocessing data
- Clustering data
- Creating classification models
- Interpreting and evaluating models

Module 2 **20**

- Learn how to apply Convolutional Neural networks to computer vision tasks
- To detect anomalies in chest X-ray scans
- Vehicle detection to ascertain the width and strength of the road
- Gesture Recognition system

TOTAL : 30 PERIODS

REFERENCES:

1. Abhishek Kumar Pandey, Pramod Singh Rathore and Dr. S. Balamurugan, "A Practical Approach for Machine Learning and Deep Learning Algorithms: Tools and Techniques Using MATLAB and Python", 1st Edition, Kindle Edition.
2. Michael Paluszek and Stephanie Thomas, MATLAB Machine Learning, Apress, 2017

e-Resources:

1. https://www.appliedaicourse.com/?gclid=CjwKCAjw9aiIBhA1EiwAJ_GTSopHCujFql3NxELvSTkyhmpN7ysLgKUx6OTSEr9suE_6RiKs3WFbghoCzU0QAvD_BwE
2. https://youtu.be/RnFGwxJwx-0
3. https://youtu.be/D2vZmz-JsLw

21MDV07 BIOMEDICAL EQUIPMENT REPAIR AND MAINTENANCE

L	T	P	C
0	0	2	1

Prerequisite:

Knowledge of Basic Electronics, Diagnostic, Therapeutic Equipments and Radiological Equipments.

Preamble:

The Medical Equipment Technology Assistant prepares to install, calibrate, operate, maintain and troubleshoot sophisticated devices and instrumentation, which are critical for effective delivery of health care. Emphasis is placed on proper installation and operation, as well as on troubleshooting, repair, and maintenance to ensure biomedical equipment meets all applicable standards.

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

1. Perform troubleshooting and preventive maintenance of medical equipment.
2. Provide technical assistance and instructions on operation and maintenance of medical equipment to clinicians and technicians

Module 1 –Clinical application and Operation testing of Medical Equipment 10

- Biomedical Instrumentation and Measurement.
- Hands-on with PCB Board level testing and component level testing.
- Familiarization and working with Ultrasound machine, ECG recorders, X ray machines, ventilator, patient
- monitor, dialyzer, surgical tools etc.

Module 2 – Installation, Maintenance of Medical Equipment 20

- Fundamentals of Troubleshooting.
- Installation procedure for Equipments.
- Trouble Shooting & Fault Finding Procedure of Medical Equipment.
- 4. Safety Instrumentation.

TOTAL : 30 PERIODS

REFERENCES:

1. Joseph. J Carr, John M Brown, “Introduction to Biomedical Equipment Technology”, John Wiley& Sons, New York, 4thedition, 2008.

2. Justin Cooper, Alex Dahinten, “Medical Equipment Troubleshooting Flowchart Handbook”, Engineering World Health, Version 6, 2013.

e-Resources:

1. https://onlinecourses.nptel.ac.in/noc20_ge14/preview, “Regulatory requirements for medical devices including in vitro diagnostics in India (Version 2.0)”, Shri Aseem Sahu, Shri. Malay Mitra, CDSCO, Ministry of Health & Family Welfare, New Delhi.

2. https://bmet.ewh.org/handle/20.500.12091/434 , Fault diagnosis and repair modules ,Engineering World Health,2020.

21MDV08 DEVELOPMENT OF ASSISTIVE DEVICES FOR DISABLED PERSONS

L	T	P	C
0	0	2	1

Prerequisite:

Knowledge of C, Biomedical Instrumentation, Electronics and Embedded System.

Preamble:

People with physical disabilities are struggling every day to perform some tasks that the rest of the world find easy and require, for them, no second thoughts. Assistive devices make life easier to those people, by removing barriers and by enhancing their physical and mental capabilities. They greatly improve their quality of life, optimism and mood. This course provides a better understanding of assistive technology devices for enabling and accelerating the educational, social and economic inclusion of persons with disabilities.

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

1. Identify and evaluate technologies that maximize the potential of people with disabilities.
2. Develop assist devices that addresses the needs of disabled persons.

Module 1 – Technology to build assist devices **10**

- Disabilities and its types
- Assistive technologies
- Assistive technology hardware and software

Module 2 – Development of Assistive Devices **20**

- Assist devices for home comfort and care
- Adaptive tools
- Eye trackers
- Speech generation and voice recognition devices
- Mobility aids and communication devices

TOTAL : 30 PERIODS

REFERENCES:

1. Diane Pedrotty Bryant and Brian R. Bryant, “Assistive Technology for People with Disabilities”, Pearson, 2nd Edition, 2012.
2. Emily C. Bouck, “Assistive Technology”, Sage Publications, 2017.

e-Resources:

1. https://onlinecourses.swayam2.ac.in/aic19_ge01/preview, “Development of Assistive technology for persons with Disabilities” Prof. Indumathi Rao, C B R Network.
2. https://www.open.edu/openlearn/education-development/assistive-technologies-and-online learning/content-section-0?active-tab=content-tab

21MDV09	Development of Healthcare Applications	L T P C 0 0 2 1

Prerequisite:

Knowledge of C, C++, Python, Electronics, Biomedical Instrumentation, ZigBee, Microprocessor and Microcontrollers.

Preamble:

Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. Arduino is an open source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board or microcontroller and software. Zigbee is a wireless technology developed as an open global standard to address the unique needs of low-cost, low-power wireless IoT networks.

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

1. Develop programs for healthcare applications.
2. To apply and implement software skills in developing application for solving healthcare related problems in various fields of Medical sector.

Module 1 – Fundamentals of Platform **10**

- Arduino and Arduino IDE
- Raspberry Pi
- Zigbee

Module 2 – Design and Implementation **20**

- Introduction
- Design and simulation of circuits
- Smart healthcare monitoring system using raspberry Pi on IoT platform
- Short Range Centralized cardiac health monitoring system based on Zigbee Communication
- Body Temperature Measurement for Remote Health Monitoring System
- HealthCare System Using Raspberry Pi

TOTAL : 30 PERIODS

REFERENCES:

1. Brain Evans, “Beginning Arduino Programming”, Apress, 2011.
2. Andrew Robinson, Mike Cook , “Raspberry Pi Projects”, John Wiley & Sons , 2013
3. Robert Faludi, “Building Wireless Sensor Networks: with ZigBee, XBee, Arduino, and Processing” , O'Reilly Media, 2010

e-Resources:

1. https://nptel.ac.in/courses/106/105/106105166/ , “ Introduction to Raspberry” ,Prof. Sudip Misra , Indian Institute of Technology, Kharagpur
2. https://www.arduino.cc/, “Arduino programming language, Arduino Software (IDE) and Processing”.
3. https://www.youtube.com/watch?v=UvQFH5RGOnU , “The AmbuSens system for IoT-based health care monitoring”,Indian Institute of Technology.

21MDV10	Designing of Medical Devices using Autodesk Fusion 360.	L T P C 0 0 2 1

Prerequisite:

Ideate, design, prototype, and make medical and health products by Autodesk fusion 360 Software

Preamble:

Fusion 360 is a cloud-based CAD/CAM tool for collaborative product development.Fusion 360 enables exploration and iteration on product ideas and collaboration within distributed product development team.Fusion 360 combines organic shapes modelling, mechanical design and manufacturing in one comprehensive package.In this course students will get the basic knowledge about medical product design in Autodesk Fusion 360.

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

1. to design medical devices that comply with all federal standards using Fusion 360

Module 1 –Fundamentals of Autodesk Fusion 360 **10**

- Introduction to Autodesk Fusion 360
- Workspace and Navigation
- Creating sketched Geometry
- Additional sketching tools

Module 2 – Create Organic Shapes and Hybrid Modeling **20**

- Loft features
- Distributed design
- Multi body design
- Creating the lofted surface body using standard tools
- Creating geometry to connect the bodies

TOTAL : 30 PERIODS

REFERENCES:

1. CameronCoward,“ A Beginner’s Guide to 3D Modeling: A Guide to Autodesk Fusion 360”,No starch press,2019.
2. Sachidanand Jha,”AUTODESK FUSION 360 EXERCISES: 200 Practice Drawings For FUSION 360 and Other Feature-Based Modeling Software” ,2019

e-Resources:

1. https://youtu.be/O9uu6hSWXjE
2. https://youtu.be/c7OlPj2K3Po