ಬಿ.ಎಂ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ, ಬೆಂಗಳೂರು
(ಸ್ವಾಯತ್ತ ವಿದ್ಯಾ ಸಂಸ್ಥೆ)
ಬುಲ್ ಟೆಂಪಲ್ ರಸ್ತೆ, ಬೆಂಗಳೂರು – ೫೬೦ ೦೧೯

B.M.S. COLLEGE OF ENGINEERING

(Autonomous Institute, under VTU)

DEPARTMENT OF

MEDICAL ELECTRONICS ENGINEERING

Scheme and syllabus III-VIII Semesters

For the UG Batches

2022-2026 AND 2023-27

DEPARTMENT VISION & MISSION

VISION

To promote quality education in Medical Electronics Engineering for health and well-being of humankind through teaching and research platforms.

MISSION

The department will achieve the Vision through:

M1	Provide professional education in Medical Electronics Engineering, through Curriculum design and its effective implementation for holistic development.
M2	Cater to the current healthcare-necessities of the society, through innovation and research in collaboration with Healthcare providers, Industry, Academia and Alumni.
M3	Emphasis on professional ethics, contribution to society and concern for sustainable environment.

Program Educational Objectives (PEOs)

PEO1	Graduates will build career in Medical Electronics Engineering and allied disciplines.
PEO2	Graduates will pursue higher education and/or engage in continuous up gradation of their professional skills.
PEO3	Graduates will communicate effectively and demonstrate professional behavior while working in diverse teams.
PEO4	Graduates will exhibit concern for society, sustainable environment, and ethical behavior.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1	Formulate, Design, Analyze and demonstrate applications of Electronics in building Biomedical Systems.
PSO2	Specify architect and prototype health-care solutions by applying Biosignal and Medical Image Processing techniques.
PSO3	Design, Develop, Verify processes and Algorithms for Healthcare Applications.

PROGRAMME OUTCOMES (POs)

PO1	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO1 0	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO1 1	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Credit Distribution of the UG Program -
Medical Electronics Engineering

Curricular Component/ Semester	I	II	III	IV	V	VI	VII	VIII	Total Credits
Basic Science Course (BS)	8	8	3	3					22
Engineering Science Course (ES)	9	9	3	3					24
Professional Core Course (PC)			15	14	14	11	6		60
Professional Elective Course (PE)					3	3	3	3	12
Open Elective Course (OE)						3	3	3	9
Project/ Mini-Project (PW)					2	2	8		12
Internship (Re/Ru/In)								6	6
Humanities and Social Sciences, Management Course (HS)	1	1			1				3
Ability Enhancement Course /SDC	2	2	1	1	2	3			11
UHV Courses				1					1
Non-Credit Mandatory Course	-	-	NC	NC	NC	NC	-	-	-
Total Credits	20	20	22	22	22	22	20	12	160

COURSE TYPES: -

Basic Science Course	BS
Engineering Science Course	ES
Professional Core Course	PC
Professional Elective Course	PE
Open Elective Course	OE
Ability Enhancement Course	AE
Project/ Mini-Project	PW
Seminar –Internship	SR
Humanities and Social Sciences, Management Course	HS
Non-Credit Mandatory Course	NCMC

SCHEME OF STUDY

III Semester Scheme:

Course Code	Course Title	Type	L:T:P	Credits	Hours	CIE	SEE	Total
23MA3BSTFN	Transform Calculus, Fourier Series And Numerical Techniques	BS	2:1:0	3	4	50	50	100
23MD3ESHBS	Human Biological Systems	ES	2:1:0	3	4	50	50	100
23ES3PCAME	Analog Microelectronics	PC	3:0:1	4	5	50	50	100
23ES3PCDEC	Digital Electronics Circuits	PC	3:0:1	4	5	50	50	100
23ES3PCNAL	Network Analysis	PC	2:1:0	3	4	50	50	100
23MD3PCBSM	Biomedical Sensors and Measurements	PC	3:0:1	4	5	50	50	100
23MD3AESIL	Simulation Lab	AE	0:0:1	1	2	50	50	100
23NCMC3NS1 23NCMC3PE1 23NCMC3YG1 24NCMC3IM1 24NCMC3WM1 24NCMC3ID1 24NCMC3WD1 24NCMC3TA1 24NCMC3FA1 24NCMC3MM1	NSS-1 Physical Education-1 Yoga-1 Indian Music-1 Western Music - 1 Indian Dance- 1 Western Dance - 1 Theatre Arts -1 Fine Arts -1 Multimedia - 1	NCMC	-----	-----	----	P/NP	----	----
Total			**15:3:4**	**22**	**29**	**350**	**350**	**700**

IV Semester Scheme:

Course Code	Course Title	Type	L:T:P	Credits	Hours	CIE	SEE	Total
23MA4BSMMD	Mathematical Methods for Medical Electronics Engineering	BS	2:1:0	3	4	50	50	100
23MD4ESPCS	Physiological Control system	PC	2:1:0	3	4	50	50	100
23MD4PCDTE	Diagnostic and Therapeutic Equipments	PC	3:0:1	4	5	50	50	100
23ES4PCAPP	ARM Processor and Programming	PC	3:0:1	4	5	50	50	100
23ES4PCLIC	Linear Integrated Circuits	PC	3:0:1	4	5	50	50	100
23MD4PCDCH	Data Communication in Healthcare	PC	2:0:0	2	2	50	50	100
23MA4AEUHV	Universal Human Values	AE	0:1:0	1	2	50	50	100
23MD4AEBSL	Biostatistics Lab	AE	0:0:1	1	2	50	50	100
23NCMC4NS2 23NCMC4PE2 23NCMC4YG2 24NCMC4IM2 24NCMC4WM2 24NCMC4ID2 24NCMC4WD2 24NCMC4TA2 24NCMC4FA2 24NCMC4MM2	NSS-2 Physical Education-2 Yoga-2 Indian Music-2 Western Music - 2 Indian Dance- 2 Western Dance - 2 Theatre Arts - 2 Fine Arts - 2 Multimedia - 2	NCMC	----	----	----	P/NP	----	----
Total			**15:3:4**	**22**	**29**	**400**	**400**	**800**

V Semester Scheme

Course Code		Course Title	Type	L:T:P	Credits	Hours	CIE	SEE	Total
23MD5PCESD		Embedded System Design	PC	2:1:0	3	4	50	50	100
23MD5PCSGP		Signal Processing	PC	3:0:1	4	5	50	50	100
23MD5PCDSA		Data Structures and Algorithms	PC	3:0:1	4	5	50	50	100
23MD5PCMIM		Medical Imaging Modalities	PC	3:0:0	3	3	50	50	100
23CV5HSEVS		Environmental Studies (CV/CH)	PC	1:0:0	1	1	50	50	100
**23MD5PE1XX	DV	Digital System Design Using Verilog	PE-1	3:0:0	3	4	50	50	100
	MI	Medical Informatics							
23MD5PWMPR		Mini Project	PW	0:0:2	2	4	50	50	100
23ES5HSPMF		Project Management and Finance (Common To All)	HS	2:0:0	2	2	50	50	100
23NCMC5NS3 23NCMC5PE3 23NCMC5YG3 24NCMC5IM3 24NCMC5WM3 24NCMC5ID3 24NCMC5WD3 24NCMC5TA3 24NCMC5FA3 24NCMC5MM3		NSS-3 Physical Education-3 Yoga-3 Indian Music-3 Western Music - 3 Indian Dance- 3 Western Dance - 3 Theatre Arts - 3 Fine Arts - 3 Multimedia - 3	NCMC	----	--	P/NP	----	----	-----
Total				**17:1:4**	**22**	**28**	**400**	**400**	**800**

Program Electives will have an integrated Lab and will be conducted as 2-0-1 (2 Hrs theory and 1 Lab session per week)

VI Semester Scheme

Course Code		Course Title	Type	L:T:P	Credits	Hours	CIE	SEE	Total
23MD6PCMIP		Medical Image Processing	PC	3:0:1	4	5	50	50	100
23MD6PCMLM		Machine Learning for Medical Engineering	PC	3:0:1	4	5	50	50	100
23MD6PCBSP		Biomedical Signal Processing	PC	2:1:0	3	4	50	50	100
**23MD6PE2XX	VD	VLSI Design	PE-2	3:0:0	3	4	50	50	100
	BC	Brain Computer Interface							
23MD6OE1XX	ME	Introduction to Medical Engineering	OE-1	3:0:0	3	3	50	50	100
	ER	Ergonomics							
23MD6PWPJ1		Project work -1	PW	0:0:2	2	4	50	50	100
23MD6AEJPR		Java Programming	AE	0:0:1	1	2	50	50	100
23MD6AERMI		Research Methodologies and IPR	AE	2:0:0	2	2	50	50	100
23NCMC6NS4 23NCMC6PE4 23NCMC6YG4 24NCMC6IM4 24NCMC6WM4 24NCMC6ID4 24NCMC6WD4 24NCMC6TA4 24NCMC6FA4 24NCMC6MM4		NSS-4 Physical Education-4 Yoga-4 Indian Music-4 Western Music - 4 Indian Dance- 4 Western Dance - 4 Theatre Arts - 4 Fine Arts - 4 Multimedia - 4	NCMC	----	--	P/NP	----	----	-----
Total				**16:1:5**	**22**	**29**	**400**	**400**	**800**

VII Semester Scheme

Course Code		Course Title	Type	L:T:P	Credits	Hours	CIE	SEE	Total
23MD7PCMDD		Medical Device Development	PC	3:1:0	4	5	50	50	100
23MD7PCFMR		Fundamentals of Medical Device Regulations and Standards	PC	2:0:0	2	2	50	50	100
23MD7/8 PE3/4 XX	MR	Medical Robotics	PE-3	3:0:0	3	3	50	50	100
	IP	Advanced Image Processing							
23MD7/8OE 2/3 XX	IH	IoT in Healthcare	OE-2	3:0:0	3	3	50	50	100
	FS	Forensic Science							
25MA7HSIKL		Indian Knowledge system	HS	1:0:0	1	1	50	50	100
23MD7PWPJ2		Project -2	PW	0:0:7	7	14	50	50	100
Total				**12:1:7**	**20**	**28**	**300**	**300**	**600**

VIII Semester Scheme:

Course Code		Course Title	Type	L:T:P	Credits	Hours	CIE	SEE	Total
23MD7/8PE 3/4 XX	BA	Biomaterials and Artificial Organs	PE-4	3:0:0	3	3	50	50	100
	BC	Biometric Systems							
23MD7/8O E2/3 XX	IR	Introduction to Robotics	OE-3	3:0:0	3	3	50	50	100
	I4	Industry 4.0							
23MD8SRINT		Internship (16-20 weeks)	PW	0:0:6	6	12	50	50	100
Total				**6:0:6**	**12**	**18**	**150**	**150**	**300**

III

Semester Syllabus

(COMMON TO ALL BRANCHES EXCEPT CS-STREAM)

Course Title	TRANSFORM CALCULUS, FOURIER SERIES AND NUMERICAL TECHNIQUES	**Course Code**	**23MA3BSTFN**
Credits	**03**	**L – T – P**	**2-1-0**
Contact Hours	**40**		

COURSE OBJECTIVES: The purpose of the course is to facilitate the learners to:

- Appreciate the importance of Series, Transforms and Numerical Techniques in Engineering Problems.
- Acquire the knowledge of Series, Transforms and Numerical Techniques to apply them in their core domain.
- Improve their Mathematical thinking and acquire skills required for sustained lifelong learning.

TEACHING-LEARNING PROCESS (General Instructions):

These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.

1. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons develop students' theoretical and applied mathematical skills.
2. State the need for Mathematics with Engineering Studies and provide real-life examples.
3. Encourage the students for group learning to improve their creative and analytical skills.

Module-1

LAPLACE TRANSFORMS: **[08 hours]**

Definition and Laplace transforms of standard functions (statements only). Problems on Laplace transform of $e^{at} f(t)$, $t^n f(t)$, $\frac{f(t)}{t}$. Laplace transforms of derivatives and integrals. Laplace Transform of periodic functions (statement only) and unit-step function – Problems.

Inverse Laplace transforms: definition and problems. solution of differential equations.

Teaching-Learning Process	Chalk and talk method / Power Point Presentation

Module-2

FOURIER SERIES: **[08 hours]**

Introduction to trigonometric polynomial, trigonometric series. Dirichlet's conditions. Fourier series of periodic functions with period 2π and arbitrary period. Complex Fourier series. Practical harmonic analysis.

Teaching-Learning Process	Chalk and talk method / Power Point Presentation

Module-3

FOURIER TRANSFORMS: **[08 hours]**

Definition and problems on Fourier Transform. Fourier sine and cosine transforms – Problems.
Inverse Fourier transform, Inverse Fourier cosine and sine transforms - Problems. Convolution theorem (only statement) – problems.

Teaching-Learning Process	Chalk and talk method / Power Point Presentation

Module-4

NUMERICAL SOLUTION OF PDE: **[08 hours]**

Classification of second-order partial differential equations, finite difference approximation of derivatives. Solution of one-dimensional heat equation by Schmidt and Bendre-Schmidt explicit formulae. Solution of one-dimensional wave equation using finite difference method.

Teaching-Learning Process	Chalk and talk method / Power Point Presentation

Module-5

CALCULUS OF VARIATIONS: **[08 hours]**

Definition, Variation of a functional, Euler's equation, variational problems.
Applications: Hanging cable problem, Brachistochrone problem.

Z-TRANSFORMS:

Definition, Standard Z-transforms, Damping rule, Shifting rule. Inverse Z-transform and applications – Solution of difference equations.

Teaching-Learning Process	Chalk and talk method / Power Point Presentation

Course outcomes (Course Skills Set)

After successfully completing the course, the student will be able to understand the topics:

Course Code	CO	COURSE OUTCOME (CO)	PO	Strength
23MA3BSTFN	CO 1	Apply the concepts of Series, Transform Techniques, Calculus of Variation and Finite Difference Methods to solve engineering problems.	1	3
	CO 2	Demonstrate the importance of Transform Techniques, Calculus of Variation and Finite Difference Methods in engineering using modern engineering and IT tools.	1 & 5	3

Assessment Details (both CIE and SEE)

Component	Type of assessment	Max. Marks	Total	50 % Weightage	Total
CIE – Theory	Quiz	10	100	5	50
	AAT	10		5	
	Test 1	40		20	
	Test 2	40		20	
SEE	End Exam	100		50	

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the

outcome defined for the course.

SEMESTER END EXAMINATION:

- Each unit consists of one full question.
- Five full questions to be answered.
- To set one question each from Units 2, 3 & 4 and two questions each from Unit 1 and Unit 5.

SUGGESTED LEARNING RESOURCES:

TEXT BOOKS:

1. B. S. Grewal: "Higher Engineering Mathematics", Khanna publishers, 44th Ed.2018
2. E. Kreyszig: "Advanced Engineering Mathematics", John Wiley & Sons, 10th Ed. (Reprint), 2016.

REFERENCE BOOKS:

1. B.V. Ramana: "Higher Engineering Mathematics", McGraw-Hill Education, 11th Ed.
2. Srimanta Pal & Subodh C. Bhunia: "Engineering Mathematics" Oxford University Press, 3rd Reprint, 2016.
3. N. P Bali and Manish Goyal: "A textbook of Engineering Mathematics", Laxmi Publications.
4. C. Ray Wylie, Louis C. Barrett: "Advanced Engineering Mathematics", McGraw–Hill Book Co. New York, 6th Edition.
5. Gupta C.B, Sing S. R. and Mukesh Kumar: "Engineering Mathematics for Semester I and II", Mc-Graw Hill Education (India) Pvt. Ltd 2015.
6. H. K. Dass and Er. Rajnish Verma: "Higher Engineering Mathematics", S. Chand Publication (2014).
7. James Stewart: "Calculus" Cengage publications, 7th edition, 4th Reprint 2019.

WEB LINKS AND VIDEO LECTURES (E-RESOURCES):

1. http://www.class-central.com/subject/math(MOOCs)
2. http://academicearth.org/
3. http://www.bookstreet.in.
4. VTU e-Shikshana Program
5. VTU EDUSAT Program

Semester	III		
Course Title	Human Biological Systems	Course Code	23MD3ESHBS
Credits	3	L-T-P	2:1:0
Pre Requisites: Basic concepts of Biological Science.			
Course Outcomes			
CO1	Apply the concepts of science in understanding human anatomy and physiology		
CO2	Identify and analyze various human anatomical systems to understand their functionality		
CO3	Communicate information related to various organ systems through written, verbal, or multimedia formats, in order to assess current knowledge and explore new questions for additional research.		
CO4	Analyze the effect of major diseases affecting the human organ systems.		
CO5	Demonstrate the working organ systems using software simulations		

CO-PO/PSO mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3													
CO3				3					3	3					
CO4		3													
CO5															
Avg	3	3		3					3	3					

Module 1	
Metabolic system: The Cell, Functions of the Cell Membrane, Movement across the Cell Membrane: Different mechanisms. Action potentials, Homeostasis, Controls and Feedbacks. Metabolic Rate: Definition, Methods of determination of Metabolic Rate: Direct and Indirect methods, Respiratory Quotient (RQ): Measurement of RQ, BMR; Factors influencing BMR.	**[5 hours]**
Module 2	
Cardiovascular system: Electrophysiological properties of heart, Frank Starling Mechanism, Heart as Pump, Pressure and Volume changes during a Cardiac cycle, Work done by the Heart. Mechanism of Control of Heart Rate, Conditions affecting the Heart Rate, Blood Pressure, Clinical Electrocardiography.	**[6 hours]**
Module 3	

Respiratory system: Anatomy of respiratory system with special reference to anatomy of lungs, Ventilation and its mechanism: Intra Pleural Pressure, Compliance and factors affecting it. Role of chest wall, Airway resistance, Work done in Breathing, Alveolar Ventilation, Ventilation Perfusion Ration. Discussion on Hypoxia, High Altitude Sickness, Pulmonary Edema, Asthma, Sleep Apnea, ARDS.	**[5 hours]**
Module 4	
Skeletal, Muscular and Nervous System: Skeletal muscle: Contraction and relaxation, Neuromuscular junction: Receptors, transmissions. Characteristics and Properties of Skeletal muscles. Smooth muscle; properties of smooth muscle, Neuro effector junction. Nervous system: Organization of nervous system, neuron, neuroglia, classification and properties of nerve fiber, electrophysiology, action potential, nerve impulse, receptors, synapse, neurotransmitters.	**[5 hours]**
Module 5	
Endocrine, Urinary and Reproductive System: Urinary system: Anatomy of urinary tract with special reference to anatomy of kidney and nephrons, functions of kidney and urinary tract, physiology of urine formation. Endocrine system: Classification of hormones, mechanism of hormone action, structure and functions of pituitary gland, thyroid gland, parathyroid gland, adrenal gland, pancreas, pineal gland.	**[6 hours]**

Tutorial Session:

** **Experiments using MATLAB** Simulation of neuron action potential firing.

1. Simulation of Respiratory Mechanics
2. Simulation of human cardiovascular system

** **Virtual Lab Experiments: Cell Biology**

3. Cell Organization and Sub Cellular Structure Studies
4. Hemo cytometer (Counting of Cells)
5. Modeling resting potentials in Neurons
6. Modeling action potentials
7. Voltage Clamp Technique
8. Simple Neuron Model - the HH neuron

Text Books

1	Principles of anatomy and physiology, Gerard j. Tortora, Bryan derrickson, 13th Edition, john Wiley & sons, Inc.	
2	Essentials of Medical Physiology by K. Sembulingam and P. Sembulingam. Jaypee brothers medical publishers, New Delhi.	

Reference Books:

1	Text book of Medical Physiology- Arthur C,Guyton andJohn.E. Hall. Miamisburg, OH, U.S.A.	
2	Hole's human anatomy & physiology, David n. Shier, Jackie l. Butler, ricki Lewis, isbn-13: 978-0078024290, McGraw-Hill education; 14th Edition.	

Online courses:

1	Unit 1: https://oli.cmu.edu/jcourse/webui/syllabus/module.do?context=0477224b0a0001dc579a352e89762e86	
2	Unit 2: https://oli.cmu.edu/jcourse/webui/syllabus/module.do?context=0477212a0a0001dc3adf3212071a87ed	
3	Unit 3: https://oli.cmu.edu/jcourse/webui/syllabus/module.do?context=0477220430a0001dc408737120e19098a	
4	Unit 4: https://oli.cmu.edu/jcourse/webui/syllabus/module.do?context=04771e380a0001dc6a6e5999efc27662	
5	Unit 5: https://oli.cmu.edu/jcourse/workbook/activity/page?context=04771fb00a0001dc654345b7b912c029&view=frameset	
E-Books:		
1	https://openstax.org/details/books/anatomy-and-physiology-2e	
2	https://open.umn.edu/opentextbooks/textbooks/fundamentals-of-anatomy-and-physiolog	
Alternate Assessment Test1:- Theme: Develop a video /animation with duration less than 5Minutes to explain the physiology and anatomy of anyone system in human body by forming a team. The theme will be assigned to students in the first week of the course. Submission date will be within 30 days.		
Alternate Assessment Test2 :- (applicable if course is non-integrated) Theme: Submit case study report on a major disease that affects any one human system discussed in the course by forming a team. The theme will be assigned to students in the first week of the course. Submission date will be within 50 days.		
Module Choice for SEE – Every module		

Medical Electronics Engineering 2022-26

(Common to Med.Elns and EIE)

Semester	III			
Course Title	**Analog Microelectronics**	**Course Code**	23ES3PCAME	
Credits	4	**L-T-P**	3-0-1	**Total Hrs**:50
Pre-Requisites: Basic concepts of Trigonometry, methods of differentiation, methods of integration, solution of ordinary differential equations.				
Course Outcomes: At the end of the course the students will be able to,				
CO1	Apply the Network concepts to obtain solutions to analog electronic circuits of BJTs and MOSFETs.			
CO2	Analyse analog electronic circuits of BJTs and MOSFETs for given specifications.			
CO3	Design solutions of engineering problems and system components for the specific needs.			
CO4	Design and Conduct experiments by discrete components and Modern tools. Demonstrate, document and Present a report.			
CO5	Formulate and implement open ended experiment. Document and present the same in a Team.			

CO-PO-PSO-Mapping:-22ES3PCAME

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2		3											3		
CO3			3										3		
CO4				3	3								3		
CO5		2	2						2	2		2	2		
AVG	**3**	**3**	**3**	**3**	**3**				**2**	**2**		**2**	**3**		

Module 1	
Diode applications: - Introduction, load line analysis, Series diode configurations, Parallel and series –parallel configurations, clippers, Clampers. **Bipolar Junction Transistor (BJTs):-** DC biasing– Introduction , operating point voltage divider Bias configuration **BJT AC Analysis :-** Introduction , Application in the AC Domain, BJT Transistor Modeling, the r_e Transistor model ,Voltage Divider Bias .	10Hrs
Module 2	
BJT Frequency Response :- Introduction, Logarithms, Decibels , Low frequency Response-BJT Amplifier, Miller effect Capacitance, High Frequency response – BJT Amplifier **Feedback concepts:-** Feedback connection types- Voltage series, Voltage-shunt , Current Series and Current Shunt Feedback.	10Hrs
Module 3	

Power Amplifiers:- Introduction- Definitions and Amplifier Types, Amplifier Efficiency **Series-Fed Class A Amplifier**: DC Bias Operation, AC operation, Power Consideration, Efficiency. **Transformer coupled Class A Amplifier :** Operation of Amplifier Stage : DC load line, Quiescent operating point, AC load line , Signal Swing and Output AC power. **Class B operation:** Class B Amplifier Circuits- Transformer coupled Push- Pull Circuits, Complementary Symmetry Circuits, Amplifier Distortion.	10Hrs
Module 4	
MOSFETS:- Introduction ,**Device structure and physical operation** ---- Device structure, operation with no gate voltage, creating a channel for current flow, Applying a small VDs, Operation as VDs is increased, Derivation of the id – V_{DS} relationship, The P- Channel MOSFET, Complementary MOS or CMOS, operating the MOS transistor in the sub-threshold region . **Current voltage Characteristics---**Circuit symbol, id – V_{DS} characteristics, characteristics of the P-Channel MOSFET **MOSFET Circuits at DC** **The MOSFET as an amplifier and as a switch** --- Large – signal operation , Graphical derivation of the transfer characteristic, operation as a switch, operation as a linear amplifier. **Biasing in MOS amplifier circuits---**Biasing by fixing V_{GS}, Biasing by fixing V_G and connecting a resistor in the source , Biasing using a drain to gate feedback resistor, biasing using a current source.	10Hrs
Module 5	
Small – signal operation and models of MOSFETs---The DC bias point, the signal current in the drain terminal ,the voltage gain, separating dc analysis and the signal analysis, small signal equivalent circuit models, the transconductance g_m, the T equivalent circuit model. **Single stage MOS amplifiers---**The basic structure, characterizing amplifiers, The CS amplifier, The CS amplifier with a source resistance. Common gate (CG) Amplifier, The common Drain or source follower Amplifier. CS Amplifier Frequency Response: High Frequency and Low frequency response. Oscillators: FET based Phase shift oscillator, LC and Crystal Oscillators (no derivation) **IC Biasing**: – **Current sources, current mirror and current steering circuits---** The basic MOSFET current source, MOS current steering circuits **Current mirror circuit with improved performance** --- The Wilson MOS mirror **IC Biasing:** Current sources, current mirror and current steering circuits: The basic MOSFET current source, MOS current steering circuits	**10Hrs**
Text Books:	
1	Electronic Devices and Circuit Theory-Robert L.Boylestad and Louis Nashelsky-10th edition (PEARSON EDUCATION)

2	Microelectronic Circuits-Theory and applications by Adel S. Sedra And Kenneth C.Smith Fifth Edition (Oxford International Student Edition	
Reference Books:		
1	Electronic Devices and Circuits, S. Salivahanan , N. Sereshkumar , McGraw Hill Education (India) Private Limited, ISBN - 9781259051357	
2	Electronic Devices and Circuits- Millman and Halkias, TMH	
3	Electronic Devices and Circuits- David A Bell - PHI 4th edition	
Online courses:		
1	**MOOCs:** https://www.mooc-list.com/course/electronic-systems-and-digital-electronics-uninettuno?static=true	
2	http://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-012-microelectronic-devices-and-circuits-spring-2009/	
Module Choice for SEE	**Every module**	

(Common to EEE, ETE, Med.Elns and EIE)

Semester	**III**		
Course Title	**DIGITAL ELECTRONIC CIRCUITS (Common for EEE,EIE,ETE and MD)**	**Course Code**	**23ES3PCDEC**
Credits	**4**	**L-T-P**	**3:0:1**
Total Hours of Pedagogy :40Hrs			
Pre Requisites: Basic Digital Electronics			
Course Outcomes			
CO1	**Apply** the knowledge of logic functions to realize basic building blocks in digital logic circuits.		
CO2	**Analyze** and realize logic functions to reach substantiated conclusion.		
CO3	**Design** a digital circuit for a given specification.		
CO4	**Conduct** experiments using digital ICs and simulation tools for a given problem statement.		
CO5	**Work individually/in a team** to demonstrate an open-ended experiment and document the same.		

CO-PO/PSO mapping

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

Module 1	
Introduction: Review of Boolean algebra, logic gates. Simplification of Boolean functions: Three Variable, Four Variable and Five Variable K-Maps, The Tabulation Method, Design with Basic gates, NAND gates and NOR gates.	**[8hours]**
Module 2	
Combinational Logic Circuits: Introduction, Parallel Adders (Carry Look Ahead Adder and Ripple carry adder), Decimal Adder, Code conversion, Magnitude Comparator, Decoders, Multiplexers, Read Only memories (ROM), Programmable Logic Arrays (PLAs).	**[8hours]**
Module 3	
Sequential Logic Circuits:	**[8 hours]**

The Basic Flip-flop circuit, Clocked Flip-flops, Triggering of Flip-flops: Master Slave Flip-Flops, Edge Triggered Flip-Flops, Characteristic Equations, Conversion of flipflops, Shift Registers, Ripple Counters, Synchronous Counters.		
Module 4		
Sequential systems: Analysis of Clocked Sequential circuits, State Reduction and Assignment, Design Procedure, Design with State Equations, Sequence detector.		**[8hours]**
Module 5		
Introduction to HDL: Structure of Verilog module, Operators, Data Types. Styles of Description: Dataflow, Behavioral and structural with examples.		**[8 hours]**
Text Books		
1.	Digital Logic and Computer Design- M. Morris Mano, Prentice Hall – Pearson Education.	
2.	Digital Principles and Design- Donald Givone, Tata McGraw Hill 3.	
3.	Verilog HDL-A Guide to Digital Design and Synthesis, Sameer Palnitkar, 2nd Edition, Pearson Edition 2003.	
Reference Books:		
1.	Fundamental of Logic Design- Charles Roth Jr., Thomas Learning.	
2.	Fundamentals of Digital Logic with Verilog Design", Stephan Brown and Zvonk Vranesic, 2nd Edition, McGraw-Hill, 2008.	
Online courses:		
1.	https://nptel.ac.in/courses/108105113/	
2.	https://nptel.ac.in/courses/106105185/	
E-Books:		
1.	https://www.panstanford.com/pdf/9789814364591fm.pdf	
2.	https://easyengineering.net/digital-logic-and-computer-design-by-morris-mano/	
3.	https://www.sciencedirect.com/book/9780750645829/digital-logic-design	
4.	https://easyengineering.net/fundamentals-of-digital-circuits-by-anand-kumar/	
Lab Component (Applicable if course is integrated)		
List of Experiments: – To realize		
1.	Half/full adder and half subtractor using logic gates.	
2.	Parallel adder/subtractor and magnitude comparator using IC 7483	
3.	Code converters using MUX & DEMUX	
4.	Decoder to Drive Seven Segment Display& Implementation of Priority Encoder	
5.	Flip-flops	
6.	Asynchronous Counters	
7.	Synchronous Counters	
8.	Shift registers	

9.	Design and Implementation of ALU	
10.	Demonstration of Verilog Programs	
Alternate Assessment Test1:- The topic will be announced in the first week of the semester. Using the concepts studied students are expected to design any system for a specific application-5M.		
Module Choice for SEE **Every module**		
Changes made in the existing Syllabus: 1. **Unit-1** remains as per previous syllabus with Verilog content shifted to Unit-5. 2. **Unit-2** Unit2 & Unit 3 merged of the previous syllabus with Verilog content shifted to Unit-5. 3. **Unit-3** Unit 4 of the previous syllabus with Verilog content shifted to Unit-5. 4. **Unit-4** Newly added to suit industry requirement. 5. **Unit-5** Merging of Unit 1, Unit 2 and Unit 4 of the previous syllabus. Unit 5 contents of the previous syllabus removed.		

Semester	**III**		
Course Title	**Biomedical Sensors and Measurements**	**Course Code**	**23MD3PCBSM**
Credits	**4**	**L-T-P**	**3-0-1**
Total Hours of Padagogy	**50**		

Pre Requisites: Basic Principles of physics, chemistry and measurements.

Course Outcomes

CO1	Apply principles and concepts of sensing and engineering to design diagnostic devices for sensing biomedical signals and evaluate quality of measurements.
CO2	Identify and analyze engineering problems to arrive at suitable techniques for the measurement of biomedical parameters using the appropriate sensors and techniques.
CO3	Design solutions by recognizing sensors and electrodes for the given requirements, and improve their designs for improved measurements.
CO4	Conduct experiments on biomedical sensors for specific parameters, analyze and interpret the test results.
CO5	Work with sensors and measurement systems both individually and in teams, document the activity and communicate the outcome to an engineering community.

CO-PO/PSO mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2		3											3		
CO3			3										3		
CO4				3									3		
CO5									2	3			3		
Avg	3	3	3	3					2	3			3		

Module 1	
Introduction to Measurements: Introduction, Classification of Instruments based on applications, Sensor Characteristics and Terminology: Static Characteristics, Dynamic Characteristics – Zero, first and second order systems, and their Step responses. Measurement Errors. Improvement of Sensor Measurement System.	**[8 hours]**
Module 2	

Sensors and Classification: Definition, Classification as Mechanical and Electrical, Active and Passive sensors. Types of Active sensors – Basic Theory with examples: Resistive –Strain Gauge Theory and basic types, Bridge circuits. Invasive Blood pressure measurement. Inductive – Basics, LVDT and its signal conditioning, respiratory inductance plethysmography (RIP). Capacitive – Basic Principles, Pressure sensor. Passive Sensors – Piezoelectric sensors.		**[8 hours]**
Module 3		
Temperature and Photoelectric Sensors Introduction to Body and skin temperature measurements. Principles, Characteristics and materials for RTDs, Thermistors and Thermocouples. P-N junction diodes and transistors, Examples of Integrated circuits sensing devices AD590. ***Photoelectric Sensors:*** Photoresistor, Photodiodes and Phototransistors. Photovoltaic Sensors. Applications of Photoelectric Sensors – Pulse Oximetry, Fiber optic Temperature sensors.		**[8 hours]**
Module 4		
Bioelectric Signals and Electrodes: Action potential generation, Bioelectric signals – Origin, Primary signal charactersitics and generation of ECG, EEG, and EMG. **Recording *Electrodes:*** Electrode-Tissue interface, Polarization, Skin contact impedance. Ag-AgCl electrodes. The Einthoven triangle and ECG leads. Effects of atefacts on ECG recordings. The 10-20 system for placement of EEG electrodes.		**[8 hours]**
Module 5		
Chemical sensors and Biosensors: ***Chemical sensors*** : History, Sensing principle, classification and characteritics, Ion-Selective Field-Effect Transistors. Optically based chemical sensors – Spectrophotometric Chemical analysis. ***Biosensors*** : Concepts, Components and Properties of Biosensors, Enzyme biosensors, Clark electrode for glucose detecting, The respiratory activity microorganism sensors, Immunosensors, SPR-based Immunosensor, QCM-based Immunosensor		**[8 hours]**
Text Books		
1	Ping Wang & Qingjun Liu, Biomedical Sensors and Measurement, Springer, 2016	
2	R.S. Khandpur, Handbook of Biomedical Instrumentation, 3-e, McGraw Hill, 2014	
Reference Books:		
1	Tatsuo Togawa, Toshiyo Tamura, P. Ake Oberg, Biomedical sensors and Instruments, 2-e, CRC Press, 2011	
2	D.V.S Murthy, Transducers and Instrumentation, 2-e, PHI, 2009	
Online courses:		

1	https://skill-lync.com/medical-technology-courses/medical-instrumentation-biomedical-signals	
2	https://ep.jhu.edu/courses/585613-medical-sensors-devices/	
E-Books:		
1	https://www.acsce.edu.in/acsce/wp-content/uploads/2020/03/Biomedical-Sensors-Instruments.pdf	
2	https://www.intechopen.com/chapters/48226	
Lab Component		
List of Experiments: – 1. Characteristics of RTD, Thermistor and Thermocouples 2. Dynamic response of first order system 3. Dynamic response of second order system 4. Force/Pressure measurement using Strain Gauges 5. Temperature Measurement using AD590 6. ECG, EMG and EEG acquisition 7. Electrochemical Sensor characteristics 8. Measurements using pH Sensor Laboratory Conduction and Record: 10 marks Laboratory Test : 05 marks		
Module Choice for SEE : Every module		

(Common to All Electrical cluster Branches)

Semester	**III**			
Course Title	Network Analysis	**Course Code**	23ES3PCNAL	
Credits	3	**L-T-P**	**2:1:0**	Total Hours: 25 + T
Pre Requisites: Basic Electrical Engineering, Engineering Mathematics.				
Course Outcomes				
CO1	Apply the knowledge of mathematics and analytical techniques to analyze the electrical networks			
CO2	Formulate equations based on physical laws and theorems for the analysis of electric circuits.			
CO3	Apply mathematical and analytical techniques to analyze circuits and systems in time and frequency domain.			
CO4	Evaluate the electrical circuit using modern tools for comparative study			
CO5	Document and present the comparative study of practical and theoretical implementation of electrical circuits			

CO-PO-PSO-Mapping:-22ES3PCNAL

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	
CO1	3												3		
CO2		3											3		
CO3	3												3		
CO4				2									2		
CO5									2	2			2		
Avg.	3	3		2					2	2			3		

Module 1	
Basic Concepts: Active and passive elements, Concept of ideal and practical sources. Source transformation and Source shifting, Concept of SuperMesh and Super node analysis. Analysis of networks by (i) Network reduction method including star – delta transformation, (ii) Mesh and Node voltage methods for AC and DC circuits with independent and dependent source**s.**	8Hrs
Module 2	
Network Theorems: Super Position theorem, Reciprocity theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem	8Hrs
Module 3	
Resonant Circuits: Analysis of simple series RLC and parallel RLC circuits under resonances. Problems on Resonant frequency, Bandwidth and Quality factor at resonance.	7Hrs

Module 4		
Laplace Transformation: Laplace transformation (LT), LT of Impulse, Step, Ramp, Waveform synthesis. Initial and Final value theorems. Solution for RL, RC networks for DC excitation. **Transient Analysis:** Transient analysis of RL and RC circuits under DC excitations: Behavior of circuit elements under switching action (t=0 and t=∞), Evaluation of initial conditions.		8Hrs
Module 5		
Two Port networks: Definition, Open circuit impedance, short circuit admittance, hybrid and Transmission parameters. Relation between the different parameters. Evaluation of electrical circuits for Independent sources only.		8Hrs
Text Books		
1	Engineering Circuit Analysis William H Hayt et al. Mc Graw Hill 8th Edition, 2014.	
2	Circuit Theory Analysis and Synthesis Chakrabarti, A Dhanpat Rai & amp Co. Seventh – Revised edition, 2018	
Reference Books:		
1	Networks and systems. D. Roy Choudhary New Age International Publishers	
Online courses:		
1	Provide Unit wise online course or for entire syllabus	
2	https://www.coursera.org/courses?query=circuit%20analysis	
3	https://www.coursera.org/courses?query=network%20analysis&languages=de	
E-Books:		
1	https://b-ok.asia/book/2050320/7e774a	
2	https://b-ok.asia/book/1188635/3ce180?dsource=recommend	
Module Choice for SEE	**Every module**	

COURSE TITLE	SIMULATION LAB				
COURSE CODE	23MD3AESIL	Credits	1	L-T-P	0:0:1
Total Hours of Pedagogy	15 Hrs.				
Pre-Requisites: Basics of Analog and Digital electronics circuits					

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

CO1	Analyze analog and digital circuits using Multisim, with an emphasis on accurate measurement of AC/DC voltages and currents.
CO2	Design and simulate digital systems using Multisim and Matlab Simulink, by emphasizing logical reasoning and efficient simulation techniques.
CO3	Develop skills in basic arithmetic programming and implementing essential input/output interfacing
CO4	Demonstrate proficiency in designing logic circuits using virtual instruments in NI LabVIEW, creating virtual instruments and document the same.

CO-PO-PSO-Mapping:-

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1		3			3								2		
CO2			3		3								2		
CO3			3		3								2		
CO4				2	3					2			2		
Avg.		**3**	**3**	**2**	**3**					**2**			**2**		

	Hours
List of Experiments: **1. Analog Circuit Analysis using Multisim:** Transistor Application- Amplifiers and Oscillators **2. Digital Circuit Design with Multisim:** Simplify the given Boolean function and verify the same. Implement Combinational and Sequential circuits. **3. Linear Integrated Circuit Design with Multisim:** Design and simulate inverting and non-inverting amplifier circuits. Analysis of op-amp circuits: Isolation amplifier, Instrumentation amplifier and Multivibrators	**15 Hrs**

4. MATLAB/Simulink for Signal Processing and Digital Systems:
Generation of basic signal functions.
Generation of square, sawtooth, sine and triangular signals.

5. Embedded C Programming for Microcontrollers:
Basic arithmetic and logical operations programs using Keil software.
LED blinking and basic input/output interfacing.

6. Simulation using NI LabVIEW:
Create a LabVIEW VI to collect temperature data, create a virtual instrument to simulate ADC and DAC operations, Bio-Medical Signal Processing -ECG Feature Extraction, Blood Pressure Analyzer.

7. Virtual Labs at IIT Kharagpur:
Simulate Full Wave Rectifier Circuits, Quine - Mc Clusky Algorithm, Carry-Look-Ahead Adder, Arithmetic Logic Unit (ALU), Memory Design, Associative Cache design, Direct Mapped Cache design, CPU Design

TEXT BOOKS:

1.	MATLAB for Engineers, Holly Moore by 5th edition Published by Pearson, 2017.
2.	Digital Design: Principles and Practices by John F. Wakerly, 5th edition Published by Pearson 2021,

REFERENCE BOOKS:

1.	Electronic Devices and Circuit Theory" by Robert L. Boylestad and Louis Nashelsky
2.	Labview for Everyone : Graphical Programming Made Easy and Fun by Travis Jeffrey and Jim Kring, 3rd ed. Prentice Hall 2007.

ONLINE COURSES:

1.	https://matlabacademy.mathworks.com/details/matlab-programming-techniques/mlpr
2.	https://alison.com/course/labview-a-creative-approach-to-a-real-world-problem

E-BOOKS:

1.	Essential Circuit Analysis using NI Multisim™ and MATLAB® by Farzin Asadi, DOI:https://doi.org/10.1007/978-3-030-89850-2,Publisher-Springer Cham
2.	A Brief Introduction to Engineering Computation with MATLAB by Serhat Beyenir - Rice University , 2012

Semester	**III**		
Course Title	NSS /Physical Education/Yoga	Course Code	23NCMC3NS1/ 23NCMC3PE1/ 23NCMC3YG1
Credits	NCMC	L-T-P	-----
Students can opt for either NSS/Physical Education/ Yoga Students will continue with the same stream in IV V and VI semesters There will be separate activity under each stream from III to VI semesters Students must attend all activities under the selected stream to Pass this course			

IV

Semester Syllabus

Semester	**IV**		
Course Title	**Mathematical Methods for Medical Electronics Engineering**	**Course Code**	**23MA4BSMMD**
Credits	**03**	**L – T – P**	**2-1-0**
Contact Hours	**40**		

COURSE OBJECTIVES: The goal of the course is to:

- Appreciate the importance of Complex Analysis, Special Functions, Probability and Statistics in Engineering.
- Acquire the knowledge of Complex Analysis, Special Functions, Probability and Statistics applied in their core domain.
- Improve their Mathematical thinking and acquire skills required for sustained lifelong learning.

TEACHING-LEARNING PROCESS (General Instructions):

These are sample Strategies, that teachers can use to accelerate the attainment of the various course outcomes.

4. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the delivered lessons shall develop students' theoretical and applied mathematical skills.
5. State the need for Mathematics with Engineering Studies and Provide real-life examples.
6. Encourage the students for group learning to improve their creative and analytical skill.

Module-1

COMPLEX ANALYSIS: **[08 hours]**

Review of a function of a complex variable, limits, continuity and differentiability.

Analytic functions, Cauchy-Riemann equations in Cartesian and polar forms and consequences. Construction of analytic functions by Milne-Thomson method-Problems.

Conformal mapping: $w = z^2$ and $w = z + \frac{k^2}{z}\ (z \neq 0)$.

Complex integration: Line integral of a complex function, Cauchy's theorem, Cauchy's integral formula and problems.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and Board, Problem based learning / Presentation

Module-2

STATISTICAL METHODS: **[08 hours]**

Curve Fitting: Fitting the straight line, parabola and geometric curve ($y = a\,x^b$) by the method of least squares.

Correlation and regression - Karl Pearson's coefficient of correlation and rank correlation-problems. Lines of regression, angle between two regression lines - problems.

Teaching-Learning Process	Chalk and Board, Problem based learning / Presentation

Module-3

PROBABILITY DISTRIBUTIONS: **[08 hours]**

Review of basic probability theory. Random variables (discrete and continuous), probability mass and density functions. Mathematical expectation, mean and variance. Poisson and normal distributions- problems - Illustrative examples.

Joint probability distribution: Joint Probability distribution for two discrete random variables, expectation, covariance and correlation.

Teaching-Learning Process	Chalk and Board, Problem based learning / Presentation

Module -4

STATISTICAL INFERENCE-1: **[08 hours]**

Sampling Theory: Introduction to sampling distributions, standard error, Type-I and Type-II errors. Test of hypothesis for means (single mean and difference between two means), student's t-distribution (single mean and difference between two means), paired t- test.

(RBT Levels: L1, L2 and L3)

Teaching-Learning Process	Chalk and Board, Problem based learning / Presentation

Module -5

STATISTICAL INFERENCE -2: **[08hours]**

Test of significance for single proportion [Large sample], difference between two proportions [Large sample], ratio of variances (F- distribution), Chi -Square distribution-goodness of fit. Analysis of variance (one-way).

Teaching-Learning Process	Chalk and Board, Problem based-learning / Presentation

Course outcomes (Course Skills Set)

After successfully completing the course, the student will be able to understand the topics:

Course Code	CO	COURSE OUTCOME (CO)	PO	Strength
22MA4BSCPS	**CO 1**	Apply the concepts of complex variables, probability and statistics to solve engineering	1	3

		problems.		
	CO 2	Demonstrate the importance of complex variables, and statistical methods using programing tools.	1 & 5	3

Assessment Details (both CIE and SEE)

Component	Type of assessment	Max. Marks	Total	50 % Weightage	Total
CIE – Theory	Quiz	10	100	5	50
	AAT	10		5	
	Test 1	40		20	
	Test 2	40		20	
SEE	End Exam	100		50	

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

SEMESTER END EXAMINATION:

- Each unit consists of one full question.
- Five full questions to be answered.
- To set one question each from Units 3, 4, 5 and two questions each from Units 1 and 2.

SUGGESTED LEARNING RESOURCES:

TEXT BOOKS:

1. Higher Engineering Mathematics, B. S. Grewal Khanna Publishers 44th Edition, 2017.
2. Advanced Engineering Mathematics, E. Kreyszig: John Wiley & Sons, 10th Ed. (Reprint), 2016.

REFERENCE BOOKS:

1. Advanced Engineering Mathematics C. Ray Wylie, Louis C.Barrett McGraw-Hill 6th Edition 1995.
2. Higher Engineering Mathematics B. V. Ramana McGraw-Hill 11th Edition,2010.
3. A Text-Book of Engineering Mathematics, N. P. Bali and Manish Goyal Laxmi Publications 2014.
4. Advanced Engineering Mathematics, Chandrika Prasad and Reena Garg Khanna Publishing, 2018.

WEB LINKS AND VIDEO LECTURES (E-RESOURCES):

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org/
4. http://www.bookstreet.in.
5. VTU EDUSAT PROGRAMME – 20
6. VTU e-Shikshana Program

Semester	**IV**				
COURSE TITLE	**PHYSIOLOGICAL CONTROL SYSTEM**				
COURSE CODE	**23MD4ESPCS**	**Credits**	**3**	**L-T-P**	**2-1-0**
Total Hours of Pedagogy	**40**				
Pre-Requisites: Calculus and differential equations, Advanced calculus and numerical methods, Engineering Mathematics and Linear Circuit Analysis					

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

CO1	Apply the knowledge of engineering and mathematics to develop mathematical models for classical and physiological control systems
CO2	Identify and analyse the time responses of conventional and physiological control systems.
CO3	Design and Investigate the stability of control systems using both time response and frequency response analysis.
CO4	Analyse the complex problems in physiological control systems through parametric and nonparametric identification methods
CO5	Implement the control theory concepts using modern tools (MATLAB/OPEN-SOURCE TOOL/LAB VIEW) working in a team for the chosen control system problems and write report of the same.
CO6	Function effectively to communicate as an individual to present the outcome of the implemented work in a team.

CO-PO-PSO-Mapping: -

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2		3											3		
CO3			3										3		
CO4				2									2		
CO5					2					2			2		
CO6									2	2			2		
Avg.	**3**	**3**	**3**	**2**	**2**				**2**	**2**			**3**		

Module 1	8
Introduction: Examples of Control Systems, open loop vs. Closed loop Systems, Mathematical Modelling of Linear Systems: Transfer functions, Mechanical Systems Analogous Systems, Block diagram, Signal Flow graph. Difference between Engineering and Physiological Control Systems. **Case Study:** Block diagram representation of the muscle stretch reflex, contributions of the muscle stretch reflex, adaptive characteristics of the muscle stretch reflex. Linear model of respiratory mechanics, linear model of muscle mechanics, lumped and distributed parameter of an unmyelinated nerve fiber.	
Module 2	8
Time Response Analysis of the Control System: Step response of first order, second order systems, response specification, steady state error and error constants. **Case Study:** Steady State Characteristics of the Muscle Stretch Reflex Model components, Regulation of Cardiac Output, Regulation of Glucose and Insulin, Steady State Closed Loop Analysis of Cardiac Output Regulation, chemical regulation of ventilation, Response of Lung Mechanics Model.	
Module 3	8
Stability Analysis: Concept of stability, RH criterion, applications of RH criterion with limitations. Root locus technique: Introduction to root locus concepts, Construction rules, Analysis of stability by root locus plot. **Case Study:** Stability analysis of the pupillary reflex.	
Module 4	8
Identification of Physiological Control Systems: Basic problems in physiological system analysis, Nonparametric and parametric identification of methods: - list of various methods only. Identification of closed loop systems **Case Studies:** The starling Heart-Lung Preparation, Kao's cross circulation experiments, minimal model of blood glucose regulation, respiratory control system.	
Module 5	8
Frequency Response Analysis: Bode plots and Frequency domain specification.	

Case studies : Bode plots and frequency responses of the linearized lung mechanics, heart rate and arterial blood pressure, glucose-insulin regulation model in Type-2 diabetic**.**		
TEXT BOOKS		
1	Engineering control systems - Norman S. Nise, John WILEY & Sons , fifth Edition.	
2	Physiological control system- Michael. C.K .Khoo.	
REFERENCE BOOKS		
1	Modern control Engineering- Ogata, Prentice Hall	
2	Control Engineering by Nagrath & Gopal, New Age International Publishers	
Online courses		
1	www.nptel.com/IITK	
2	http://nptel.ac.in/courses/108103007/1	
E-Books:		
1	http://www.electrical4u.com/control-system-closed-loop-open-loop-control-system/#practical-examples-of-open-loop-control-system	
2	http://www.facstaff.bucknell.edu/mastascu/eControlHTML/CourseIndex.html	
Module Choice for SEE: Every module		

Semester	**IV**			
Course Title	**Diagnostic and Therauptic Equipments**	**Course Code**	**23MD4PCDTE**	
Credits	4	**L-T-P**	**3-0-1**	**Total Hrs: 50**
Pre Requisites: **Physiological systems and Bio signal Measurements.**				
Course Outcomes				
CO1	Apply the engineering fundamentals in designing, analysing and working of biomedical circuits and instruments			
CO2	Apply the reasoning for the health, safety, Environmental and ethical issues while Designing/working with Diagnostic and Therapeutic equipment			
CO3	Conduct experiments using modern equipments & tools.			
CO4	Use current techniques, modern tools and computing practice to improve Health care instruments through hospital visits			
CO5	Present and document the case study on usage of Diagnostic and Therapeutic equipments			

Module 1	
Bio-signals characteristics and Amplifiers – frequency and amplitude ranges, and charactestics of bio signals Need for bio-amplifier — single ended bio-amplifier, differential bio-amplifier – right leg driven ECG amplifier. Band pass filtering, isolation amplifiers – transformer and optical isolation — isolated DC amplifier and AC carrier amplifier. Chopper amplifier. Power line interference. **Patient monitoring System concepts,** cardiac monitor, bedside patient monitoring system, central monitors, measurement of heart rate, measurement of pulse rate, blood pressure measurement, measurement of temperature, measurement of respiratory rate, catheterization laboratory instrumentation	10Hrs
Module 2	
Diagnostic Instruments: Oximeters: Oximetry, ear oximeter, pulse oximeter, skin reflectance oximeter and intravascular oximeter. Blood Flow Meters: Electromagnetic blood flow meters different types, Ultrasonic blood flow meters, NMR blood flow meters and Laser Doppler blood flow meters. **Blood Gas Analyzers**: Acid-base balance, blood pH measurement, measurement of blood pCO2, intra-arterial blood gas monitoring, complete blood gas analyzer. Audiometer and Hearing Aids: Mechanism of hearing, measurement of sound, basic audiometer, pure-tone audiometer, speech.	10Hrs
Module 3	

Cardiac assist devices: Cardiac pacemakers-Need, types and functional characteristics, AC Cardiac defibrillators, disadvantages, DC defibrillator, types- Instantaneous, Synchronized **Cardiac output measurements**: Indicator dilution method, Dye dilution method, Thermal dilution techniques, Measurement of continuous cardiac output derived from the aortic pressure waveform, Impedance technique. Pulmonary Function Analyser: Pulmonary function measurement, Spirometer, Pneumotachometer, Measurement of volume by Nitrogen washout technique		10Hrs
Module 4		
Therauptic Equipment: Short wave diathermy, ultrasonic diathermy, Microwave diathermy, Electro surgery machine — Current waveforms, Tissue Responses, Electro surgical current level, Hazards and safety procedures. Effects of ionizing radiation, Radiation therapy – Cobalt Caesium therapy, linear accelerator, **Patient Safety:** Electric shock hazards, Leakage currents, safety codes and analyser. Ethical issues in the design of Biomedical Instruments.		10 Hrs
Module 5		
Hemodialysis and heart lung machine : Indication and principle of Hemodialysis, Dialysate, different types of Hemodialysis, monitoring systems, Need for heart lung machine, functioning of bubble, disc type and membrane type oxygenators, finger pump, roller pump, monitoring systems. **Respiratory aids** : Ventilator- Need, Types, Intermittent positive pressure, breathing apparatus operating sequence, electronic IPPB unit with monitoring for all respiratory parameters, Humidifier, Nebulizer, Aspirator.		10Hrs
Text Books		
1	R.S. Khandpur, Handbook of Biomedical Instrumentation, 3-e, McGraw Hill, 2014	
2	Joseph .J.Carr and John .M.Brown, “Introduction to Biomedical Equipment Technology,” John Wiley&Sons Inc, New York-2002on protection principles.	
Reference Books:		
1	John G. Webster, “Medical Instrumentation Application and Design”, John Wiley and sons, New York, 2004.	
2	Leslie Cromwell, Fred. J. Weibel, Erich.A.Pferffer, “Biomedical Instrumentation and Measurements,” Prentice Hall India, NewDelhi-2001.	
Online courses:		
1	Ma, Hongshen. 2.996 Biomedical Devices Design Laboratory, Fall 2007. (MIT OpenCourseWare: Massachusetts Institute of Technology), 2006	
2	http://ocw.mit.edu/courses/biological-engineering/20-010j-introduction-to-bioengineering-be-010j-spring-2006 (Accessed 26 Jul, 2014). License: Creative Commons BY-NC-SA.	
3	http://oyc.yale.edu/biomedical-engineering/beng-100	

4	Biomedical virtual laboratory link.http://vlab1.iitr.ac.in/	
E-Books:		
1	E-book 1http://www.ebook3000.com/Introduction-to-Biomedical-Instrumentation—The-Technology-of-Patient-Care_51854.html	
2	Barbara Christe, Introduction to Biomedical Instrumentation: The Technology of Patient Care, Cambridge University Press | 2009 | ISBN: 0521515122	
Lab Component:		
List of Experiments: – LIST OF EXPERIMENTS: 1. Measurement of EMG Signal using Bio-Pac –Acquisition System 2. Measurement of EEG Signal using Bio-Pac –Acquisition System 3. Design of Instrumentation Amplifiers 4. Design of Isolation Amplifiers 5. Surgical Diathermy 6. Study Experiment on Pacemakers 7. Study Experiment on Defibrillators 8. EEG signal Acquisition using Power lab 9. EEG signal Acquisition using ENO-BIO software 10. EEG signal measurement using Neuro- feedback and Bio-feedback 11. Multipara meter monitoring system for vital parameters		
Module Choice for SEE- Every module		

(Common to ALL Electrical Cluster Braches)

Course Title	ARM PROCESSOR AND PROGRAMMING				
Course Code	23ES4PCAPP	Credits	4	L-T-P	3:0:1
CIE	100 Marks (50% weightage)	SEE	100 Marks (50% Weightage)		
Prerequisites: Digital Electronic Circuits					

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

CO1	Apply knowledge of functional blocks of computers in recognizing ARM Design approach.
CO2	Analyse the Architectural features of 32-bit microprocessor with necessary Input/Output and Memory Operations to build an embedded Controller.
CO3	Design simple programming modules in machine and higher-level programming language using simulators to develop logical skills and testing skills.
CO4	Select and implement appropriate Structured and modular programming using techniques such as subroutines, data stores, interrupt service routines, and exception-handling mechanisms
CO5	Build simple Embedded Applications using Input and output devices with ARM core and a controller.

CO-PO-PSO-Mapping:-

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3													2	
CO2		3												2	
CO3			2											2	
CO4				2										2	
CO5					3				2	2				2	
Avg.	**3**	**3**	**2**	**2**	**3**				**2**	**2**				2	

Module -1	**8 Hrs**
ARM Processor fundamentals –Basic Structure of computers- Von Neumann and Harvard Architecture,, Basic Processing Unit, Bus Structure, RISC and CISC Architecture, RISC and ARM Design philosophy, ARM core Dataflow model, programming model, processor states and operating modes, ARM pipeline	
Module-2	**8 Hrs**
ARM Assembly Programming: load/store architecture, ARM instruction set, Assembler rules and Directives, ARM-THUMB interworking, Assembly Language Programs	

Module-3	8 Hrs
Embedded C Programming: Basic C data types, Local variable types, C compiler, Optimization; C looping and structures, Registrar allocation, function calls, Writing and optimizing assembly codes, mixing C and Assembly programming, Instruction scheduling.	
Module-4	**8 Hrs**
Subroutines and stacks-introduction, stack, subroutines, passing parameters to Subroutines, Exception and interrupt handling- Vector Table, Exception priorities, link register offsets, interrupts. Interrupt handling schemes-Non Nested	
Module -5	**8 Hrs**
Application of ARM controller LPC 2148: Memory map, memory and I/O mapped peripherals, ADC, DAC and UART-Interfacing Programs, firmware and boot loader, introduction to Embedded Operating System	

LAB EXPERIMENTS:

PART 1 – Assemble Language Programs

1. Program to analyse data transfer instructions
2. Program to analyse addressing modes
3. Program to transfer a block of data using LDMIA/STMIA instruction.
4. Program to add an array of 16-bit numbers and store the 32-bit result in internal RAM.
5. Program to find Factorial of a positive / Negative number
6. Code conversion: Hex to ASCII / ASCII to Hex
7. **Program to arrange a series of 32-bit numbers in ascending / descending order.**
8. **Program to count the number of ones and zeros in two consecutive memory locations.**

PART 2 – EMBEDDED C PROGRAMS

1. Unsigned/ signed bitwise operations
2. Masking & shifting operations
3. Led blinking
4. Sine waveform / triangular / square wave generation using DAC
5. Seven segment display interface.

Module Choice for SEE- Every module

Common to Med. Elns. and EIE)

Semester	IV		
Course Title	Linear Integrated Circuits **(common to MD and EIE)**	**Course Code**	23ES4PCLIC
Credits	4	**L-T-P**	3-0-1
Total Hours of Padagogy	50		

Pre Requisite: Basic concepts of analog electronic circuits and their analysis.

Course Outcomes

CO1	Apply the knowledge of electronic engineering fundamentals to comprehend linear integrated circuit based systems.
CO2	Analyze and interpret the effects of DC and AC limitations of Operational Amplifiers using the first principles of electronics.
CO3	Design and develop analog sub-circuits for linear and non-linear applications in the areas of sourcing, signal - generation, conditioning, and communication.
CO4	Conduct investigations by designing experiments and solutions for analog signal processing using filters and data converters.
CO5	Experiment, document and present the test results of various applications of linear integrated circuits, and open-ended experiments, working both independently and in teams.

CO-PO/PSO mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2		3											3		
CO3			3										3		
CO4				3									3		
CO5	2								3	2			3		
Avg	3	3	3	3					3	2			3		

Module 1	
Operational Amplifier Characteristics and Basic Applications: Introduction, Internal block diagram of Op-amp, DC and AC Characteristics – definitions, ideal and typical practical values. Basic Closed loop configurations, and errors in practical circuits, Frequency Compensation. DC Applications: V to I, and I to V converters, Series Voltage regulator using Op-Amp. Instrumentation Amplifiers (IA), IA Chip – AD620. AC Applications: Precision half wave and full wave rectifiers, Sample and Hold circuits.	**[10 hours]**

Module 2		
Comparators and Waveform Generators: Introduction, Comparators, Inverting Schmitt Trigger, Triangular waveform generator, Sinusoidal oscillators: RC phase-shift and Wien bridge oscillators. 555 Timer: Functional block diagram, Astable and Monostable Multivibrators using timer.		**[10 hours]**
Module 3		
Active Filters: Introduction, Classification of Filters. Active Filters: Design of First, Second and Fourth order Butterworth Low pass and high pass filters. All pass filters - Phase shift lead and lag types. Differentiator and Integrator Circuits: Ideal and Practical.		**[10 hours]**
Module 4		
Data Converters: Introduction, Digital-to-analog converters (DAC): Specifications, basic DAC techniques-weighed resistor DAC, R-2R ladder DAC, and Inverted Ladder DAC. Analog-to-digital Converters (ADC): Specifications, Types of ADCs - Counter type, Successive Approximation, Dual slope, Flash, and Sigma – delta. Applications of DACs and ADCs. Introduction to Data Acquisition systems.		**[10 hours]**
Module 5		
Phase Locked Loops: Basic Principle, PLL Components: Analog and Digital Phase detectors, Voltage Controlled Oscillator VCO – SE566, Low Pass Filter. Applications of PLL in Frequency multiplication, division, and translation.		**[10 hours]**
Text Books		
1	D.Roy Choudhury and Shail B.Jain, Linear Integrated Circuits, 4e, New Age International Publishers, 2010	
2	S.Salivahanan & V.S.Kanchana Bhaaskaran, Linear Integrated Circuits, 2e, McGraw - Hill Publication	
Reference Books:		
1	Ramakanth A.Gayakwad, Op-Amps and Linear Integrated Circuits,4th ed, PHI	
2	James M. Fiore, Op Amps and Linear Integrated Circuits- Concepts and Applications, Cengae Learning, 2011	
Online courses:		
1	https://swayam.gov.in/nd1_noc19_ee39/preview – op amp practical applications: design, simulation and implementation by Dr. Hardik J. Pandya , IISc Bangalore	
2	https://www.udemy.com/course/operational-amplifiers-linear-integrated-circuits/	
3	http://www.pannam.com/blog/free-resources-to-learn-electrical-engineering/	

E-Books:		
1	https://web.mit.edu/6.101/www/reference/op_amps_everyone.pdf	
2	https://electronicsforu.com/resources/7-free-ebookstutorials-on-op-amp	
3	https://www.analog.com/en/education/education-library/tutorials/analog-electronics.html	
Lab Component (25 Marks)		
List of Experiments: – 1. Inverting and non-inverting amplifier, voltage follower 2. Instrumentation Amplifier 3. Precision half wave and full wave rectifier 4. Voltage Comparators and Schmitt Trigger 5. Series Voltage Regulator using Op-Amp 6. Square waveform generator using 555 Timer 7. Triangular waveform Generator 8. RC- Phase shift and Wien bridge Oscillators 9. First and Second order low pass and high pass filters 10. Second Order Low pass filter		
Module Choice for SEE- Every module		

Semester	IV		
Course Title	**Data Communication in Healthcare**	Course Code	23MD4PCDCH
Credits	2	L-T-P	2-0-0
Pre Requisites	Signals and systems, Analog and Digital communication		
Course Outcomes			
CO 1	Interpret the state of the art in network protocols, architectures and applications.		
CO 2	Identify the network functional components and their interaction.		
CO3	Apply the use of health care informatics for data communication		
CO 4	Analyze the importance of data communication in health care for mobile technology		

	Hours
Module 1	6
Introduction: OSI Model, Layers in OSI model, TCP/IP Suite, Addressing, THE PHYSICAL LAYER: Theoretical basis for communication, guided transmission media, wireless transmission, the public switched telephone networks, mobile telephone system.Data link control: Framing, Flow and error control, Protocols, Noiseless channels and noisy channels, HDLC.	
Module 2	6
NETWORK LAYER- Unicast Routing Protocols, Multicast Routing protocols, Logical addressing, Ipv4, Ipv6 format & addressing, Delivery, Forwarding. TRANSPORT LAYER: Transport layer Process to process Delivery, UDP, TCP, SCTP, Congestion, QOS. APPLICATION LAYER: Client Server Model, Domain Name Space (DNS), Electronic mail, HTTP, world wide web (www)	
Module 3	6
NETWORK STANDARDS: Wired LAN, Ethernet, IEEE standards, Standard Ethernet. Wireless LAN IEEE 802.11. Connecting LANs, Backbone and Virtual LANs, Connectingdevices, Back bone Networks Virtual LANs	
Module 4	6
MULTI-USER RADIO COMMUNICATION: global system for mobile communications (gsm) – code division multiple access (cdma) – cellular concept and frequency reuse – channel assignment and handover techniques – overview of multiple access schemes – satellite communication – bluetooth.: **Biotelemetry- ECG** telemetry system, temperature telemetry system,. multi-channel wireless telemetry system, transmission of physiological signals over telephone . telemedicine .wireless telemetry	
Module 5	6
Mobile Applications in Healthcare: Mobile Technology and mHealth, Online Medical Resources, Introduction to mobile applications in heaalthcare,Characteristics and Benefits, Application Model, Infrastructure and Managing Resources, Mobile Software Engineering, Frameworks and Tools, Mobile devices Profiles, Basic mobile based applications in healthcare industry	
TEXT BOOKS	
1 Data Communication and Networking, B Forouzan, 4th Ed, TMH 2006	

2	Computer networks – An1. Health Informatics: Practical Guide for Healthcare and Information Technology rofessionals (Sixth Edition). By Robert E. Hoyt and Ann K. Yoshihashi	
3	R.S Khanpur Handbook of Biomedical instrumentation	
REFERENCE BOOKS		
1	Introduction to Data communication and Networking, Wayne Tomasi: Pearson education 2007	
2	Mobile Health Solutions for Biomedical Applications by Phillip Olla.	
3	Healthcare data analytics and management 1ST Edition by Nilanjan Dey, Amira S Ashour, Simon James Fong, Chinthon Bhatt.	
Online course		
1	https://freevideolectures.com/course/2278/data-communication	
2	https://freevideolectures.com/course/2278/data-communication	
E-Books:		
1	https://archive.mu.ac.in/myweb_test/syllFybscit/dcn.pdf	
2	https://www.vikaspublishing.com/books/computer-science/networkingcommunication/data-communication-computer-networks/9788125915973/	
Module Choice for SEE	**Every module**	

Semester	IV		
Course Code	23MA4AEUHV	Course Name	Universal Human Values
Credits	01	L-T-P	0-1-0
Total Number of hours		15	

Course Objectives
To develop a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence.

Module – 1

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education

1. Purpose and motivation for the course, recapitulation from Universal Human Values-I
2. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential
   Validation- as the process for self-exploration
3. Continuous Happiness and Prosperity- A look at basic Human Aspirations
4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority
5. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario
6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels. Include practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking

Module – 2

Understanding Harmony in the Human Being - Harmony in

Myself!

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

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

Module – 3

Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship 1. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship 2. Understanding the meaning of Trust; Difference between intention and competence 3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship 4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals 5. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family. nclude practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives
Module – 4
Understanding Harmony in the Nature and Existence - Whole existence as Coexistence 1. Understanding the harmony in the Nature 2. Holistic perception of harmony at all levels of existence.
Module – 5
Implications of the above Holistic Understanding of Harmony on Professional Ethics 1. Natural acceptance of human values 2. Definitiveness of Ethical Human Conduct Include practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions eg. To discuss the conduct as an engineer or scientist etc.

At the end of the course, the student will have the ability to

CO1	Conduct self-exploration and distinguish between values and skills, happiness and accumulation of physical facilities, the self and the body, Intension and Competence of an individual
CO2	Analyze the value of harmonious relationship based on trust and respect in personal and professional life
CO3	Examine the role of a human being in ensuring harmony in society and nature
CO4	Apply the understanding of ethics in life and profession

Assessment Details (both CIE and SEE)

Component	Type of assessment	Max. Marks	Total
CIE – Theory	AAT 1	10	100
	Test 1	40	
SEE	End Exam	50	

Only one CIE shall be conducted after CIE2 and before CIE 3. SEE paper shall be set for 50 Questions,

each of the 01 marks. The pattern of the Question paper is MCQ (Multiple Choice Questions). The time allotted 01 hour.

TEXT BOOKS:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

REFERENCE MATERIAL:

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

Semester	IV		
Course Title	Biostatistics Lab	**Course code**	23MD4AEBSL
Credits	1	**L-T-P**	0-0-1
Total Hours of Pedagogy	15		
Pre Requisite: Engineering Mathematics			
Course Outcomes			
CO1	Apply the knowledge to understand the concept of descriptive statistics for application in biostatistics.		
CO2	Analyze probability concepts to biological problems.		
CO3	Design and conduct hypothesis tests for various scenarios in clinical research and use a t-test or ANOVA to analyze the data and draw conclusions based on the results.		
CO4	Analyze confidence intervals to estimate the true population parameter with a certain level of confidence.		
CO5	Analyze linear regression and correlation analysis and make inferences about the relationships.		

CO-PO/PSO mapping

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

List of Experiments

Lab Experiment 1: Descriptive Statistics

- To calculate measures of central tendency (mean, median, mode) and measures of dispersion (range, variance, standard deviation) for biological data.
- Measure the heights and weights of a sample of students and calculate various descriptive statistics, such as the mean, median, mode, range, variance, and standard deviation.

Lab Experiment 2: Probability

- To calculate probabilities using the rules of probability and apply probability concepts to biological problems.

Lab Experiment 3: Hypothesis Testing

- To conduct hypothesis tests using statistical software to biological data.
- Test the null hypothesis that there is no difference in the mean weight of male and female students. Use a t-test or ANOVA to analyze the data and draw conclusions based on the results.

Lab Experiment 4: Confidence Intervals

- To calculate confidence intervals for means and proportions and interpret confidence intervals in the context of biological data.
- Calculate a confidence interval for the mean height of students in your class. Interpret the confidence interval and explain its meaning.

Lab Experiment 5: Correlation and Regression

- To calculate correlation coefficient and perform simple linear regression to model the relationship between two variables.
- Investigate the relationship between the height and weight of students in your class. Calculate the correlation coefficient and create a scatter plot of the data. Perform a simple linear regression analysis and interpret the results.

Lab Experiment 6: Analysis of Variance (ANOVA)

- Use a one-way ANOVA to analyze the data and determine if there is a significant difference between the groups.

Open Ended Experiment on Biomedical Data for SEE Evaluation to be done individually

Text Books		
1	Biostatistics: A Foundation for Analysis in the Health Sciences, 11th Edition Wayne W. Daniel, Chad L. Cross, Wiley publishers, 2018.	
2	Biostatistics, 20th Edition,Arora and Malhan,Himalaya Publishing House,2020.	
Reference Books:		
1	Biostatistics for the Biological and Health Sciences, 2nd edition by Marc M. Triola, Mario F. Triola, Jason Roy, Pearson publishers, 2017	
2	Rosner B. Fundamentals of Biostatistics, 8th ed. Cengage Learning, Boston, MA, 2016	
Online courses:		
1	Online course Introduction to Applied Biostatistics: Statistics for Medical Research edX	
2	Introduction to Biostatistics - Course – Swayam.	
E-Books:		
1	Biostatistics: New CD-ROM for self-learning – WHO	

Semester	IV		
Course Title	NSS /Physical Education/Yoga	Course Code	23NCMC4NS2/ 23NCMC4PE2/ 23NCMC4YG2
Credits	NCMC	**L-T-P**	-----

- Students can opt for either NSS/Physical Education/ Yoga
- Students will continue with the same stream in IV V and VI semesters
- There will be separate activity under each stream from III to VI semesters
- Students must attend all activities under the selected stream to Pass this course

V

Semester Syllabus

Semester	**V**				
COURSE TITLE	**Embedded System Design**				
COURSE CODE	**23MD5PCESD**	**Credits**	**3**	**L-T-P**	**2-1-0**
Total Hours of Pedagogy	**40**				
Pre-Requisites: Basic Electronics, ARM Processor and Programming					

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

CO1	Apply the knowledge of electronics engineering, communication protocols to design embedded systems
CO2	Design and analyze computational models for embedded systems
CO3	Evaluate performance of real time operating systems by applying knowledge of multitasking principles
CO4	Demonstrate Embedded system Design through case studies and simulation platform; present a report on the activity in a team.

CO-PO-PSO-Mapping:-

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3													
CO3		3													
CO4			3		3								3		3
Avg.	**3**	**3**	**3**		**3**								**3**		3

MODULE 1	8Hrs
Embedded System Components: Embedded Vs General computing system, Classification of Embedded systems, Major applications and purpose of ES. Core of an Embedded System including all types of processor/controller, Memory, Sensors, Actuators Communication Interface (on-board and external types), I2CBus, SPI Bus, Embedded firmware, Other system components- Reset Circuit, Brown- out Circuit, Oscillator Unit, Real Time Clock(RTC), Watchdog Timer	
MODULE 2	8Hrs
Embedded System Design Concepts: Characteristics and Quality Attributes of Embedded Systems, Operational and non-operational quality attributes, Embedded Systems-Application and Domain specific, Fundamental issues in Hardware Software Co-Design, Computational models in embedded design- Source file to object file translation file systems	

MODULE 3	8Hrs
The Embedded System Development Environment: The Integrated Development Environment (IDE), file systems, types of Files Generated on Cross-Compilation, Disassembler/Decompile, Simulators, Emulators and Debugging, Target Hardware Debugging. **Integration and Testing of Embedded Hardware and Firmware**- Out-of-Circuit Programming, In System Programming (ISP), In Application Programming (IAP), BOARD BRING UP	
MODULE 4	8Hrs
RTOS based Embedded System Design - Operating System basics, Types of operating systems, Task, process and threads, Multiprocessing and multitasking, Types of multitasking, Task scheduling, Non-preemptive scheduling, priority based scheduling, Round Robin scheduling, Task Communication, Task synchronization issues – Racing and Deadlock, Task synchronization techniques-Concept of Binary and counting semaphores	
MODULE 5	8Hrs
Case studies of Embedded system Design (Hardware and Software Architecture)- Automated Chocolate Vending Machine, Digital camera, Embedded system for Adaptive Cruise control system in a Car	

TEXT BOOKS	
1	"Introduction to Embedded Systems", by Shibu K V, Tata McGraw Hill Education Private Limited, 2nd Edition
2	Embedded systems by Raj Kamal TMH, 2nd Edition.
REFERENCE BOOKS	
1	Embedded System Design – A unified hardware and software introduction: F. Vahid (John Wiley) , 2nd edition 2018
2	Embedded Systems Design: An Introduction to Processes, Tools, and Techniques by Arnold S. Berger
Online courses	
1	https://onlinecourses.nptel.ac.in/noc20_ee98/preview
2	https://www.coursera.org/learn/introduction-embedded-systems
E-Books:	
1	http://esd.cs.ucr.edu/
2	http://dsp-book.narod.ru/ESDIPTT.pdf
Choice of Module	**Every module**

Semester	V				
COURSE TITLE	SIGNAL PROCESSING				
COURSE CODE	23MD5PCSGP	Credits	4	L-T-P	3-0-1
Total Hours of Pedagogy	50				

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

CO1	Apply the knowledge of Mathematics and Engineering to determine the types of signals and Systems.
CO2	Analyze, formulate problems to compute the output of an LTI system using the time domain and the frequency domain representation.
CO3	Design and Implement the FFT algorithms to reduce the computational complexity and to enhance the speed of operation
CO4	Conduct experiments and apply signal processing to interpret data for health and safety.
CO5	Use current techniques and modern tools to improve the Medical data analysis, document and present the same as team.

CO-PO-PSO-Mapping:-

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3											3		
CO3			3												3
CO4				3										3	
CO5					3				3	3					
Avg.	3	3	3	3	3				3	3			3	3	3

MODULE 1	10 Hrs
SIGNALS: Definition of signals and systems, Classification of signals, Basic operations on signals. Elementary signals Systems viewed as interconnection of operations, Properties of systems. **SYSTEMS:** Introduction, Time domain representation for LTI systems, Introduction to Convolution, Impulse response representation, Properties of impulse response. Convolution sum, Convolution integral. Differential and Difference equations representations, Block diagram representations.	
MODULE 2	10 Hrs

FOURIER TRANSFORM: Continuous and Discrete Time Fourier transforms & their properties Fourier transform representation of periodic signals. Applications of Fourier transform Frequency response of LTI systems. **Z-TRANSFORMS:** Introduction, Z-Transform, properties of ROC & properties of Z-Transforms. Inverse Z–transforms, Unilateral Z- Transform, Analysis of LTI Systems and application to solve Difference equations.	
MODULE 3	10 Hrs
DISCRETE FOURIER TRANSFORM: Sampling and reconstruction of a signal in the frequency domain. Definition of Discrete Fourier Transform (DFT). Properties of DFT, Circular convolution in the time domain, Use of tabular arrays and circular arrays.	
MODULE 4	10Hrs
APPLICATIONS OF DISCRETE FOURIER TRANSFORM AND FAST FOURIER TRANSFORM Use of DFT in linear filtering, linear convolution of two finite duration sequences, Overlap adds and save methods. Direct computation of DFT. Necessity for efficient computation of DFT. Radix 2, Fast Fourier Transform (FFT) algorithm for DFT computation. Decimation algorithms, Radix 2 FFT algorithm for computation of Inverse Discrete Fourier Transform. (IDFT). DCT(Discrete Cosine Transform) and its Applications (In audio video standards like MPEG, JPEG)	
MODULE 5	10 Hrs
DESIGN AND REALIZATION OF FILTERS: Introduction to realization of digital systems, block diagrams representation, Realization of Infinite Impulse Response (IIR) systems: Direct form, parallel form, cascade form. Introduction to IIR filters, Impulse invariant & Bilinear Transformations, Design of analog and digital Butterworth Filters. **Realization of Finite Impulse Response (FIR) systems:** Direct Form, Linear Phase Form. Introduction to FIR filters, Frequency response of ideal digital low pass filter, high pass filter, Frequency sampling technique of designing FIR filters, Windowing design of FIR filters using Rectangular, Kaiser and Hamming window.	

LAB EXPERIMENTS

1. Display of basic elementary signals, Sampling theorem.
2. Basic operations on sequences: Time shifting, folding, time scaling and multiplication.
3. Linear and circular convolution, Cross correlation and auto correlation.
4. Convolution and correlation using FFT algorithm.
5. FFT of a Sequence, FIR Filter design-LP, HP, BP and Notch filter.
6. FIR filters design using Hamming and Kaiser window for the given order and cut-off frequency.
7. Design of IIR Filters-Butter worth Filters.

TEXT BOOKS

1	Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab, "Signals and Systems" Pearson Education Asia / PHI, 2nd edition, 1997. Indian Reprint 2002	

2	Digital Signal Processing, Principles, Algorithms and Applications, John G. Proakis, Dimitris K Manolakis, Pearson education/PHI, (4th Edition)	
REFERENCE BOOKS		
1	H. P Hsu, R. Ranjan, "Signals and Systems", Scham's outlines, TMH, 2006	
2	Ganesh Rao and SatishTunga, "Signals and Systems", Sanguine Technical Publishers, 2004	
3	Simon Haykin and Barry Van Veen "Signals and Systems", John Wiley & Sons, 2001.Reprint 2002.	
4	Digital Signal Processing, A computer based approach, Sanjit K Mitra, Tata McGrawHill, Third Edition	
VIDEO LINKS:		
1	NPTEL lecture Video on Signals and Systems by Prof. S.C.Dutta Roy, http://www.satishkashyap.com/2012/04/iit-video-lectures-on-signals-and.html	
2	NPTEL lecture Video on Signals and Systems by Prof. T.K. Basu, IIT Kharagpur. http://www.nptel.ac.in/courses/108105065/	
3	NPTEL on line Course Modules–IIT Bombay –Signals and Systems, http://www.cdeep.iitb.ac.in/nptel/Electrical%20&%20Comm%20Engg/Signals%20and%20System/TOC-M1.html	
MOOCs :		
1	https://www.edx.org/course/signals-systems-part-1-iitbombayx-ee210-1x-0	
2	https://www.edx.org/course/signals-systems-part-2-iitbombayx-ee210-2x-0	
3	https://www.coursera.org/course/dsp	
4	https://www.mooc-list.com/course/applied-digital-signal-processing	
E-books:		
1	The Scientist and Engineer's Guide to Digital Signal Processing By Steven W. Smith, Ph.D.	
2	Digital Signal Processing Principles, Algorithms, and Applications: Third Edition John G. Proakis Northeastern University Dimitris G. Manolakis	
Module Choice for SEE- Every module		

Semester	V				
COURSE TITLE	Data Structures and Algorithms				
COURSE CODE	23MD5PCDSA	Credits	4	L-T-P	3-0-1
Total Hours of Pedagogy	40				
Pre-Requisites: C Programming					

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

CO1	Apply principles of OOPs techniques for solving problems.
CO2	Apply principles of Data Structures and Algorithm design techniques for solving problems.
CO3	Analyse and develop operations on linear and non-linear data structures
CO4	Design solutions to computing problems using appropriate data structures and algorithm design techniques.
CO5	Demonstrate data structure and algorithms coding skills on a competitive programming platform.

CO-PO-PSO-Mapping:-

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2		3											3		
CO3		3											3		
CO4			3		3								3		
CO5					3				2	2		2			3
Avg.	**3**	**3**	**3**		**3**				**2**	**2**		2	**3**		3

MODULE 1	8 Hours
Principles of Object Oriented Programming - Basic Concepts of OOPS, OOP Languages, Pre-processors directives and header files, structure of C++ program, compiling and linking, Tokens, keywords, identifiers and constants, data types. **Functions in C++:** Introduction, Main function, function prototype, call by reference, return by reference, inline functions. **Classes and objects:** Specifying a class, member functions, arrays within a class, static data members and member functions, arrays of objects, returning objects.	
MODULE 2	8Hours

Constructors and Destructors - Constructors, parameterized constructors, multiple constructors in a class, dynamic constructors and destructors. **Operator overloading and type conversions:** Overloading unary and binary operators, **Inheritance -** Introduction, defining derived classes, Types of inheritance: Single, multilevel, multiple, hierarchical, hybrid.	
MODULE 3	8 Hours
Introduction to Data Structures: Definition and its classification, Dynamic Memory Allocation Linked List: Definition, Operations on Singly linked list, Doubly linked list, Sorting techniques- bubble, quick, insertion, merge sorting techniques.	
MODULE 4	8 Hours
Stacks: Definition, Stack Operations, Queues: Definition, Queue operations, Circular queue. Binary Search Trees: Definition, Traversals, Insertion, Deletion, Applications	
MODULE 5	8Hours
Fundamentals of Algorithm Analysis: Framework for Analysis of algorithm efficiency, Asymptotic Notations, Mathematical Analysis of Non recursive algorithms and Recursive algorithms.	

TEXT BOOKS	
1	Object oriented Programming with C++, E Balaguruswamy ,TMH publications 6th edition,2015
2	Introduction to the design and analysis of algorithms by Anany Levitin, third Edition, Pearson Education, 2017
REFERENCE BOOKS	
1	Data Structures using C++, D.S. Malik, India edition, CENGAGE Learning, 2003
2	Introduction to Algorithms, Cormen T.H, Leiserson C. E, Rivest R.L, Stein C, 3rd Edition, PHI 2010
3	Object oriented Programming with turbo C++**,** Robert Lafore, GALGOTIA Publications, 2007.
4	Data Structures using C and C++ by Yedidyah, Augenstein, Tannenbaum, 2nd Edition, Pearson Education, 2015
5	Data Structures and Algorithm Analysis in C++, by Mark Allen Weiss, 3rd Edition, Pearson Education, 2007
Online courses	
1	https://www.coursera.org/specializations/data-structures-algorithms
2	https://www.coursera.org/learn/algorithms-part1
E-Books:	
1	https://faculty.washington.edu/jstraub/dsa/Master_2_7a.pdf
2	https://www2.cs.duke.edu/courses/fall08/cps230/Book.pdf
3	Introduction to data structures and algorithms http://nptel.ac.in/courses/106102064/)

List of Experiments: Programs on OOPs, Data Structures and Algorithms
Module Choice for SEE- Every module

Semester	**V**				
COURSE TITLE	**MEDICAL IMAGING MODALITIES**				
COURSE CODE	**23MD5PCMIM**	**Credits**	**3**	**L-T-P**	**3-0-0**
Total Hours of Pedagogy	**40 Hours**				
Pre-Requisites: concepts in Physics					

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

CO1	Compare the basic principles of various medical imaging modalities.
CO2	Recognize the need for different medical imaging modalities.
CO3	Select the most suitable modality for a given clinical case.
CO4	Analyze the biological effects of medical imaging modalities related to human safety.
CO5	Comprehend the published reports and hospital visit observations for the selected imaging modality and document as well as communicate the same to the engineering audience.

CO-PO-PSO-Mapping:-

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3													3	
CO2		2	3											2	
CO3				3											
CO4			3												
CO5									3	3					
Avg.	**3**	**2**	**3**	**3**					**3**	**3**					

UNIT #	Hours
UNIT 1	8
Introduction to imaging, myth busting of imaging, need of multimodality. **X-Rays:** Basic scientific principles of X-rays, X-ray technology, contrast, clinical applications, case study, Advanced X-ray: digital subtraction angiography (DSA), dual energy Xray absorptiometry (DXA), Orthopantomography.	
UNIT 2	8
Computer Tomography (CT): Basic scientific principles of CT, CT Technology,	

Contrast, clinical applications, case study, Advanced section on CT: Back projection, maximum intensity projection reconstruction.	
UNIT 3	8
Ultrasound: Basic scientific principles of ultrasound, Ultrasound technology, clinical applications, case study, Advanced section on Ultrasound: 3D reconstruction	
UNIT 4	8
Magnetic Resonance Imaging (MRI): Basic scientific principles of MRI - The Nuclear Spin, The MR Signal, Relaxation, Spatial Encoding, Contrast, MRI technology, Clinical Applications, case study, Advanced section on MRI: Fourier Transformation, MRI registration.	
UNIT 5	8
Diagnostic Nuclear Medicine: Basic Principles of Diagnostic Nuclear Medicine, SPECT, PET, Quality Control, case study, Advanced section on Diagnostic Nuclear Medicine: PET image reconstruction, attenuation correction. **Overview of OCT(Optical Coherence Tomography) and its Applications**	
TEXT BOOKS	
1. Introduction to Biomedical Imaging by Andrew G. Webb Wiley-IEEE Press, Nov 2017.	
2. Guy, Chris, and Dominic Ffytche. An introduction to the principles of medical imaging. London, Imperial College Press, 2005.	
REFERENCE BOOKS	
1. Smith, Nadine Barrie, and Andrew Webb. Introduction to medical imaging: physics, engineering and clinical applications. Cambridge university press, 2010.	
Online courses	
1. https://www.edx.org/course/introduction-to-biomedical-imaging	
2. https://www.edx.org/course/fundamentals-of-biomedical-imaging-ultrasounds-x-r	
3. https://onlinecourses.nptel.ac.in/noc20_ee40/preview	
E-Books:	
1. Burbridge, Brent, and Evan Mah. Undergraduate diagnostic imaging fundamentals. University of Saskatchewan, 2017. (https://undergradimaging.pressbooks.com/;https://openpress.usask.ca/undergradimaging/	
2. Maier, Andreas, Stefan Steidl, Vincent Christlein, and Joachim Hornegger, eds. "Medical imaging systems: An introductory guide.", 2018. https://link.springer.com/book/10.1007%2F978-3-319-96520-8	
Module Choice for SEE- Every module	

Semester	V				
Course	Environmental studies	Course Code	23CV5HSEVS	SEE Duration	1.5 hours
Credits	1	L:T:P	1:0:0	SEE+ CIE Marks	25+25
Contact hours	15 Hours	CIE	50 Marks	Lab	Nil

COURSE OBJECTIVES: The course enables the students to

Develop a sense of responsibility about the environment, natural resources, their conservation, awareness about ill effects of pollution and understand the concept, structure and function of different ecosystems.

COURSE OUTCOMES: An ability to	
CO1	Identify and discuss the components and impacts of human activities on environment, conservation and on protection of natural resources
CO2	Identify and establish relationship between social, economic and ethical values from environmental perspectives.

CO-PO MAPPING SCALE 1 TO 3

	Environmental studies 23CV5HSEVS													
	PO1	PO2	PO3	P04	PO5	PO6	PO7	PO8	PO9	PO10	PO11	P012	PSO1	PSO2
CO1	2					2	3							1
CO2	2					2	3							1

Unit 1
Unit 1: Introduction to Environment: Definition, about Earth. Atmosphere, Hydrosphere, Lithosphere and Biosphere, Structure of Atmosphere, Internal structure of the Earth Ecosystem, Balanced ecosystem, types of Ecosystem Effects of Human activities on Environment. Environmental Impact Assessment (E I A)
Unit –II
: Natural Resources:Water resources its avaialbility, Mineral resources, Forest resources.
Unit -III
Energy resources:Conventional and Non-conventional energy resources. Hydroelectric, Wind power, solar, Biogas, Fossil fuel based energy resources – Coal, Oil & Gas, Nuclear power, Hydrogen as an alternate future sources of energy.
Unit-IV
Environmental pollution:Effects and control of pollutions i). Water pollution, ii). Land pollution, iii).Noise pollution.
Unit-V

Current environmental issues & importance: Population growth effects & Control, Climatic changes, Global warming. Acid rain Ozone layer depletion & effects, Environmental protection; Role of Government,. initiatives by Non-Govt. Organizations 15 hours

Text book/Codes:

1. Dr. Geetha Balakrishanan, K G Lakshminarayana Bhatta, "**Environmental studies",** S M Publications, 5th Edition, 2017
2. N S Subramanyam, AV S S Sambamurthy, "**Ecology**", Alpha Science International Ltd, 2nd Edition, 2006
3. Dr. J.P.Sharma, "**Environmental studies**". Laxmi Publications, Third Edition, 2009
4. Smriti Srivastava, "**Environment and Ecology",** S K Kataria & Sons, 2023

Reference books:

1. Benny Joseph, "**Environmental Studies**", Mc Graw Hill Education, 3rd Edition, 2017
2. Dr. D.L.Manjunath, "**Environmental Studies**", Pearson Education India, 3rd Impression, 2009

CIE: Minimum two CIE conducted for 20 marks each, consisting of MCQ and descriptive questions. 20 marks is reduced to 10marks. Quiz / AAT for 5 marks. Total CIE marks is 25.

SEE paper pattern: SEE conducted for 50 marks, with MCQ for 20 marks, descriptive for 30 marks. SEE duration is 1.5 hours.

Semester	**V**				
COURSE TITLE	**Digital System Design Using Verilog**				
COURSE CODE	**23MD5PE1DV**	**Credits**	**3**	**L-T-P**	**3:0:0**
Total Hours of Pedagogy	**40**				
Pre- requisites - Concepts of Digital Electronics					

Course Outcomes: At the end of the course, the student will have the ability to:	
CO1	Apply the knowledge of HDL for modelling and functional verification of digital circuits.
CO2	Analyze digital circuits using suitable Verilog HDL modelling.
CO3	Design a digital circuit for complex systems using Verilog HDL and state machines.
CO4	Program a given application/problem statement using EDA tools.

CO-PO/PSO mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3											2		
CO3			3										2		
CO4					3										

MODULE 1	Hours
Introduction to Verilog: Design Methodology-An Introduction Verilog History, System representation, Numberrepresentation and Verilog ports. Verilog Data Types: Net, Register and Constant. Verilog Operators: Logical, Arithmetic, Bitwise, Reduction, Relational, Concatenation and Conditional. Verilog Primitives.	**8**
MODULE 2	
Modeling Styles: Dataflow Modeling: Boolean Equation-Based Models of Combinational Logic,Propagation Delay and Continuous Assignments. Structural Modeling: Design of Combinational Logic, Verilog Structural Models, Module Ports, Top-Down Design and Nested Modules. Gate level modelling.	**8**
MODULE 3	
Behavioral Modeling: Behavioral Models of Flip-Flops and Latches, Comparison of Styles for Behavioral modeling, Behavioral Models of Multiplexers, Encoders, and Decoders.	**8**
MODULE 4	

Synchronous sequential circuits: Moore and Mealy FSM, Design and implementation of sequence detector, serial adder, code converter.		**8**
MODULE 5		
Implementation Fabrics: Introduction of Programmable Logic Array (PLA), Programmable Array Logic (PAL), Programmability of PLDs. Complex PLDs (CPLDs), Field-Programmable Gate Arrays (FPGA).The Role of FPGAs in the ASIC Market, FPGA Technologies. Comparisonof design implementation using CPDs, FPGA and ASIC.		**8**
Text Books		
1	Samir Palnitkar, "Verilog HDL: A Guide to Digital Design & Synthesis", SunSoft Press, 2ndEdition, 2009, ISBN: 978-81-7758-918-4.	
2	Stephan Brown and Zvonk Vranesic, "Fundamentals of digital logic with Verilog design", 2nd edition MGH, 2008.	
Reference Books:		
1	Roth, Charles; John, Lizy K.; Kil Lee, Byeong Digital Systems Design Using Verilog ISBN 10: 1285051076 / ISBN 13: 9781285051079.	
2	M.D. Ciletti Advanced Digital Design with the Verilog HDL Published byPrentice Hall PTR -2nd Edition ISBN: 0136019285.	
Online courses:		
1	ElectronicDesignAutomationhttp://nptel.ac.in/courses/106105083	
2	DigitalsystemdesignwithPLDsandFPGAshttp://nptel.ac.in/courses/117108040/ Fundamentals of HDL (Lecture #008)	
3	https://www.youtube.com/watch?v=rdAPXzxeaxs&index=8&list=PLE3BC3EB C9CE 15FB0	
E-Books:		
1	http://access.ee.ntu.edu.tw/course/dsd_99second/2011_lecture/W2_HDL_Fundamentals_2011-03-02.pdf	
2	http://ece.niu.edu.tw/~chu/download/fpga/verilog.pdf	
Module Choice for SEE- Every module		

Semester	**V**				
COURSE TITLE	**Medical Informatics**				
COURSE CODE	**23MD5PE1MI**	**Credits**	**3**	**L-T-P**	**3:0:0**
Total Hours of Pedagogy	**40**				
- Pre Requisites:DBMS,biomedical concepts, Management principles					

Course Outcomes:	
CO1	Explore how technology can be used to improve health care and delivery in organizations
CO2	Applying the breadth of knowledge on the principles of health informatics.
CO3	Develop basic skills in using health informatics principles to improve practice
CO4	Acquire a conceptual and theoretical framework of the design, development, and implementation of health information systems
CO5	Implementation on Medical informatics using programming and document and Present the same in groups.

CO-PO/PSO mapping: At the end of the course the students will be able to,

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3					2							3		
CO2	3												3		
CO3		3					2						3		
CO4		3			3	2							3		
CO5			3		3	2			2	2			3		
AVG	3	3	3		3	2	2		2	2			3		

MODULE 1	**Hours**
INTRODUCTION : Historical highlights and Evolution of Health informatics, Hospital Information System – its characteristics and functional online and offline modules, Health Informatics, Bioinformatics, Medical Informatics, Clinical Informatics, imaging Informatics, Nursing Informatics, Public Health Informatics, e – health services, Evidence Based Medicine, Bioethics, Virtual Hospital, Consumer Health Informatics and Healthcare Data Analytics.	8
MODULE 2	
ELECTRONICS PATIENT RECORDS AND STANDARDS Electronic Patient Record, Medical data formats, – Medical Standards and Organizations – HL7 – DICOM - IRMA - LOINC - PACS - Medical Standards for Vocabulary - ICD 10, DRGs, MeSH, UMLS, SNOMED – JCAHO – HIPAA.	**8**
MODULE 3	

BIOINFORMATICS AND TECHNOLOGIES: Bio-information technologies, Semantic web and Bioinformatics, Genome projects - Education and Training - Nano technology in Healthcare - Nanomedicine, Nanopharma, CNT based Nano sensor, BioCom chip, Medical Nanorobotics -		8
MODULE 4		
JAVA PROGRAMMING - Design and Development of Hospital Information Systems – Developing front-end, back-end and Client – Server interface programs in Java Environment – SQL.		8
MODULE 5		
INTERNET AND WEB - Medical Networks - Java script programming - Web Design and programming - Design of Web portal services in médicine		8
Text Books		
1	1. Robert E Hoyt, Ann Yoshihashi, Health Informatics: Practical Guide for Healthcare and Information Technology Professionals, 6th Edition, lulu.com, 2014.	
2	Mohan Bansal M S, Medical Informatics, Tata McGraw Hill Publishing Company, New Delhi, 2005.	
3	Herbert Schildt, The Complete Reference – JAVA, Tata McGraw Hill Publishing Company, New Delhi, 2005	
Reference Books:		
1	Yi-Ping Phoebe, Bioinformatics Technologies, Springer International, New Delhi, 2007.	
2	Orpita Bosu, Bioinformatics – Databases, Tools and Algorithms, Oxford University Press, 2007.	
3	H M Dietel, Internet and World Wide Web, AB Goldberg publishers, New Delhi, 2007	
Online courses:		
1	www.bu.edu › BU Online Home › Programs study.com/.../Online_Graduate_Courses_and_Classes_in_Healthcare_Inf...	
2	https://www.umb.edu/academics/caps/certificates/healthcare_informatics	
E-Books:		
1	Provide linkwww.springer.com/in/book/9782817804774	
2	ebooks.himss.org/product/medical-informatics-executive-primer	
Module Choice for SEE- Every module		

Semester	V		
Course Title	Mini Project	Course Code	23MD5PWMPR
Credits	2	L-T-P	0-0-2

Course Outcomes	
CO1	Ability to apply knowledge to identify, gather information and analyse to formulate the unmet need and problem definition for project through survey
CO2	Ability to use appropriate tool/tools to implement and demonstrate the project.
CO3	Ability to design and develop sustainable solution/system for the biomedical applications.
CO4	Ability to make effective presentation of the work abiding professional ethics as an individual and a team member.
CO5	Ability to develop systems with scope for enhancement and continue life-long learning.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3		3									3	3	3
CO2					3								3	3	3
CO3			3			3	3						3	3	3
CO4								3	3	3	3				
CO5												3			
Avg.	**3**	**3**	**3**	**3**	**3**	3	3	3	**3**	**3**	3	3	**3**	3	3

Guidelines for Mini Project (23MD5PWMPR)
Objective: The objective of this open ended mini project is to let the students apply the knowledge of the engineering subjects into a **real- world situation/problem**.
Guidelines:
1. The mini project to be done in a group of 3 / 4 students.
2. Mini project can be done in the area of medical electronics engineering using the knowledge gained from the courses studied in the lower semesters .
3. Mini project must be hardware project with associated software component for it. **(**considering current technology/situation)
4. Each group will be allotted a **Guide**. Students in that group must discuss the project idea with Guide before finalizing it.
5. Each group will present the idea of the project and will submit 1 - 2 page(s) of an **Abstract** of the mini project work.

6. Every week, project group will report progress of the project to allotted Guide.
7. Each group will give progress presentations according to the schedule. .
8. At the end of the project, all groups will submit video of the working model and technical report in the format shared.
9. Final SEE will be conducted for 50 marks.

Semester	V				
Course Title	PROJECT MANAGEMENT AND FINANCE				
Course Code	23ES5HSPMF	Credits	2	L – T – P	2:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites: Personality Development Course, Soft-skills

Course Outcomes:
At the end of the course, students will have the ability to:

Sl. No	Course Outcomes	PO	PSO
CO1	Apply the knowledge of project management principles and to study the current market trends	1	-
CO2	Implement project management methodologies ethically for successful project completion	2, 8, 9	-
CO3	Identify the investment opportunities and to formulate the projects	11	-
CO4	Choose projects which benefit the society and organization and apply project phases and document them for future reference	6, 10, 12	-

UNIT – I
Concepts of Project Management: Concepts of project, Categories of project, Project life cycle phases, Project management concepts, Tools and techniques for project management, The project manager, Need, Roles and responsibilities of project manager. Project Leadership and Ethics: Introduction to project leadership, ethics in projects, Multicultural and virtual projects.
UNIT – II
Establishing the Project - Scope, Time, Cost, and performance goals, Feasibility report, Financing Arrangements, Preparation of cost estimates, Finalization of project implementation schedule, Evaluation of the project profitability, Fixing the Zero date.
UNIT – III
Organizing Human Resources and Contracting - Delegation, Project manager's authority, Project organization, Contract, Contract Planning, Tendering and Selection of Contractor, Team building.
UNIT – IV
Organizing Systems and Procedures for Project Implementation – Working of

Systems, Work break down structure, Planning, Scheduling and Monitoring, Critical Path Method, Gantt Chart/Time Chart, PERT, Project diary.
UNIT – V
Financing of Projects - Capital structure, Menu of financing, Internal accruals, Equity capital, Preference capital, Debentures (or bonds), Methods of offering term loans, Working capital advances, Miscellaneous sources, Raising venture capital, Project financing structures, Financial closure, Financial institutions.

Text Books:

1. "Project Management", S Choudhury, Tata McGRAW Hill Publishing Company Limited
2. "Project Planning, Analysis, Selection, Financing, Implementation and Review", Dr. Prasanna Chandra McGRAW Hill Publishing Company Limited
3. "Project Management Institute: A Guide to the Project Management Body of Knowledge", PMBOK Guide (Sixth Edition), Sept 2017

Reference Books:

1. "Fundamentals of Project Management", Dr.Vijay Kanabar
2. "Project Management", David I Cleland, Mcgraw Hill International edition
3. "Project Management", Gopalakrishnan, Mcmillan India Ltd
4. "Project Management", Harry Maylor, Pearson Publication

E Books:

1. https://www.youtube.com/watch?v=5d16JwWwjKo
2. NPTEL lecture on Introduction to Project Management by Prof. Arun Kanda https://www.youtube.com/watch?v=5pwc2DYlKQU

Semester	V		
Course Title	NSS /Physical Education/Yoga		23NCMC4NS3/ 23NCMC4PE3/ 23NCMC4YG3
Credits	NCMC	**L-T-P**	-----

- Students can opt for either NSS/Physical Education/ Yoga
- Students will continue with the same stream in IV V and VI semesters
- There will be separate activity under each stream from III to VI semesters
- Students must attend all activities under the selected stream to Pass this course

VI

Semester Syllabus

Semester	**VI**				
COURSE TITLE	**Medical Image Processing**				
COURSE CODE	**23MD6PCMIP**	**Credits**		**L-T-P**	**3-0-1**
Total Hours of Pedagogy	**50**				
Pre-Requisites: Medical Imaging , Signal Processing					

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

CO1	Apply the basic concepts of digital image representation and understand the objectives of biomedical image analysis and CAD.
CO2	Apply digital image processing algorithms for medical image enhancement, restoration and segmentation
CO3	Conduct experiments for medical image analysis using modern tools
CO4	Develop Graphical user interface based mathematical models for medical image enhancement and segmentation.
CO5	Implement an open ended experiment for medical image segmentation and prepare the technical document on it.

CO-PO-PSO-Mapping:-

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3													
CO3		3			3				3					**3**	3
CO4			3		3				3					**3**	3
CO5	3	3	3	3	3				3					**3**	3
Avg.	**3**	**3**	**3**	**3**	**3**				**3**					**3**	**3**

MODULE 1	10 Hrs
Fundamentals: Introduction, Fundamental steps in DIP, Components of DIP system, A simple image formation model, Image sampling and quantization, Basic relationship between pixels, Color image processing fundamentals related with all color Models, Types of Medical Images, Objectives of Biomedical Image Analysis, Computer Aided Diagnosis, Image Quality and Information Content	
MODULE 2	10Hrs

Image Enhancement in Spatial Domain: Background, Point processing – Image negatives, Log transformations, Power law transformations, Contrast stretching, Gray level slicing, Bit plane slicing, Histogram processing–Histogram equalization, Local enhancement, Arithmetic/Logic operations – Image subtraction, Image averaging, Basics of spatial filtering, Smoothing spatial filters – Smoothing linear filters, order statistics filters Sharpening spatial filters – Foundation, The Laplacian, The Gradient.	
MODULE 3	10Hrs
Image Enhancement in Frequency Domain: Background, Basic properties of the frequency domain, Basic filtering in the frequency domain, Basic filters and their properties,Smoothing frequency domain filters – Ideal low pass filters, Butterworth lowpass filters,Gaussian lowpassfilters, Sharpening frequency domain filters – Ideal high pass filters,Butterworth highpassfilters, Gaussian highpass filters, Homomorphic filtering.	
MODULE 4	10 Hrs
Image Restoration: Characterization of Artifacts, Image degradation /restoration model, Examples of noise PDFs, Structured noise Physiological interference, Other types of noise and artifact, Restoration using spatial filtering – Mean filters, Geometric mean filters, Harmonic mean filters, Median filter, Max & min filters, Midpoint filter, Inverse Filtering, Minimum Mean Square Error (Wiener) Filtering	
MODULE 5	10 Hrs
Detection of Regions of Interest: Thresholding and Binarization, Optimal thresholding Detection of Isolated Points and Lines, Edge Detection, Image Representation and Description: Representation, Boundary descriptors.	

TEXT BOOKS

1.	Digital Image Processing by Rafael C. Gonzalez & Richard E. Woods, Third Edition, Pearson Education Inc.
2.	Biomedical Image Analysis by Rangaraj M Rangayan by CRC Press 2004

REFERENCE BOOKS

1.	Image Processing, Analysis and Machine Vision by Milan Sonka, Third edition on, The MIT Press
2.	Handbook of Medical Image Processing and Analysis, 2nd Edition, Academic Press

Online courses

1.	https://www.coursera.org/course/images.
2.	https://nptel.ac.in/courses/108/105/108105091/

E-Books:

1.	http://ultra.sdk.free.fr/docs/DxO/Digital%20Image%20Processing%20for%20Medical%20Applications.pdf
2.	www.dcc.uchile.cl/~jsaavedr/libros/dip_gw.pdf
3.	iclass.iuea.ac.ug

List of Experiments:

1. Image Display, conversion to different color space models, image negative
2. Medical Image enhancement in spatial domain
3. Implementation of spatial filters on medical images
4. Implementation of algorithms for image enhancement in frequency domain
5. Image restoration for medical images
6. Medical Image segmentation using various algorithms

In each experiment various subparts will be included

Module Choice for SEE- Every module

Semester	**VI**		
Course Title	**Machine Learning for Medical Engineering**	**Course Code**	23MD6PCMLM
Credits	3	**L-T-P**	**3:0:1**
Total Hours of Pedagogy	**40**		
Pre Requisites: Linear Algebra and Probability concepts			
Course Outcomes: At the end of the course the students will be able to,			
CO1	Formulate any given data-oriented problem as a machine learning and deep learning problem		
CO2	Choose and perform the different types of data pre-processing required to clean the data and remove noise.		
CO3	Choose and perform the suitable feature extraction and machine learning model on the given data.		
CO4	Formulate experiments and analyze the practical performance of the machine learning model for a given task.		

CO-PO/PSO mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3													
CO3			3												
CO4				3	2										3
Avg.	**3**	**3**	**3**	**3**	**2**										**3**

MODULE 1	**10 Hrs**
Introductory class: Overview of the required math, Introduction to Machine Learning, what will be covered in the class, Introduction to python and Scikit-Learn package. **Components of a machine learning project:** Working with real data, Get and visualize the data, Prepare the data for machine learning, Select train and fine tune your model. **Linear and polynomial regression.**	
MODULE 2	**10Hrs**
Classification: Binary classification, Multi-label classification, Performance measures: confusion matrix, ROC curve. **Support Vector Machines (SVM):** Linear SVM classification, Nonlinear SVM classification, SVM regression **Application: Cognitive State detection**	
MODULE 3	**10 Hrs**

Decision Trees: Training and visualizing a decision tree, making predictions, Estimating class probabilities, The CART algorithm k-nearest neighbours (knn), Bias-Variance trade-off and error analysis, Model selection and feature selection **Application: Tumor Type Prediction, Bioinformatics, fMRI data**	
MODULE 4	**10 Hrs**
K-means clustering: Algorithm, Initialization, Getting stuck, K-means for image segmentation. **Application: Gene Expression** **Dimensionality reduction:** Approaches -- projection and manifold learning, Principal Component Analysis (PCA), Choosing the right number of dimensions, PCA for compression. **Application: drug discovery, EEG analysis**	
MODULE 5	**10 Hrs**
Deep Learning (DL) and Neural Networks: Introduction to DL, Neural Network Basics, Different DL architectures and intro to DL frameworks, fully connected Deep Network, Convolutional Neural Network. Evaluating and debugging learning algorithms, Practical advice on structuring an ML project **Application: Medical Imaging, ECG, EEG data**	
Text Books	
1	Theobald, Oliver. Machine learning for absolute beginners: a plain English introduction. Scatterplot press, 2017.
2	Müller, Andreas C., and Sarah Guido. Introduction to machine learning with Python: a guide for data scientists. " O'Reilly Media, Inc.", 2016.
Reference Books:	
1	Géron, Aurélien. Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow. " O'Reilly Media, Inc.", 2022.
Online courses:	
1.	https://www.simplilearn.com/learn-machine-learning-basics-skillup
2.	https://developers.google.com/machine-learning/crash-course
E-Books:	
1.	https://mml-book.github.io/book/mml-book.pdf
2.	https://www.ibm.com/downloads/cas/GB8ZMQZ3
3.	https://www.deeplearningbook.org/
Lab Experiments 1. Introduction to Python: Data preprocessing, Exploratory Data Analysis 2. Data Processing: Missing valuesa and data preparation. 3. Linear Regression 4. Multiple regression 5. Support vector machine 6. Logistic Regression 7. Navie Bayes Classification 8. Decision Trees 9. Random Forest Classification 10. Feature Selection Techniques	
Module Choice for SEE- Every module	

Semester	**VI**		
Course Title	**Biomedical Signal Processing**	**Course Code**	**23MD6PCBSP**
Credits	**3**	**L-T-P**	**2-1-0**
Total Hours of Pedagogy	**50**		

Pre Requisites: Biomedical instrumentation, signal and systems,DSP

Course Outcomes:

CO1	Apply knowledge of mathematics, Engineering science to solve the problems in biomedical signal processing steps.
CO2	Analyze a problem and formulate appropriate solution for biomedical signal applications.
CO3	Applications to the biomedical signals and analyze them through computer based process through signal processing algorithms.
CO4	Design formulate and implement experiments using modern tools to meet the desired needs in healthcare.
CO5	Perform simulation on the problems related to biomedical signals and present and document the same in groups.

CO-PO/PSO mapping : At the end of the course the students will be able to,

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2	3	3											3		
CO3			3										3		
CO4				3	3					3	3		3		
CO5										3	3		3		
Avg	3			3	3					3	3		3		

MODULE 1	8Hours
Preliminaries: Biomedical signal origin & dynamics: Filtering for Removal of artefacts: Statistical Preliminaries, Time domain filtering -Synchronized Averaging, Moving Average, Time domain filtering-Moving Average Filter to Integration, Derivative-based operator, Frequency Domain Filtering -Notch Filter, Optimal Filtering, The Weiner Filter. Adaptive Filtering. Principle of an adaptive filter, the steepest descent algorithm, adaptive noise canceller, cancellation of 50 Hz and power line interference in electrocardiography, applications of adaptive filters.	
MODULE 2	8Hours

Data Compression Techniques: ECG Data Reduction: Direct data compression Techniques: Turning Point, AZTEC, Cortes, FAN, Transformation Compression Techniques: Karhunen - Loeve Transform, Other data compression Techniques: DPCM, Huffman coding, Data compression Techniques comparison. **Signal Averaging**: Basics of signal averaging, Signal averaging as a digital filter, A typical averager, Software and limitations of signal averaging.		
MODULE 3		8Hours
Cardio logical Signal Processing: ECG waveform analysis, ECG Parameters and their estimations: ECG QRS Detection techniques, estimation of R-R interval, estimation of ST segment inclination, Rhythm analysis, arrhythmia analysis monitoring, long term continuous ECG recording, ECG signal analysis case studies		
MODULE 4		8Hours
Neurological signal processing: Introduction, Linear prediction theory, The Autoregressive (AR) method, Recursive estimation of AR parameters, Spectral error measure, Adaptive segmentation, EEG Transient detection and elimination in epileptic patients and its overall performance. Illustration of the Problems in an EEG signals with Case Studies.		
MODULE 5		8Hours
PSD estimation methods : Event Detection and waveform analysis: Need for event detection, Detection of events & waves, Correlation analysis of EEG signals, The matched filter, Detection of the P wave, Identification of heart sounds, Morphological analysis of ECG waves, analysis of activity. **Sleep EEG**: Data acquisition and classification of sleep stages, The Markov model and Markov chains, Dynamics of sleep-wake transitions, Hypnogram model parameters, Event history analysis for modelling sleep. Monitoring of sleep apnea by polysomnography.		
Text Books		
1	Biomedical Signal Processing- principles and techniques, by D.C.Reddy, Tata McGraw-Hill, 2005	
2	Biomedical Signal Processing Time and Frequency Domains Analysis (Volume I)- Arnon Cohen, CRCpress, 1986.	
3	Rangaraj M. Rangayyan – Biomedical Signal Analysis. IEEE Press, 2015 .	
Reference Books:		
1	Biomedical Digital Signal Processing, Willis J.Tompkins, PHI	
2	Biomedical Signal Processing in Cardiac and Neurological Applications", Leif Sörnmo & Pablo Laguna, 1stedition, Academic Press, 2005	
Online courses:		
1	ocw.mit.edu › Courses › Health Sciences and Technology MIT Open Course Warhttp://ocw.mit.edu	
2	www.vub.ac.be/en/study/fiches/30340/biomedical-signals-and-images www.crcpress.com › Biomedical Science › Biomedical Imaging downloads.hindawi.com/journals/special issues/129194.pdf	
E-Books:		
1	Advanced Methods of Biomedical Signal Processing edited by Sergio Cerutti, Carlo Marchesi Biological Signal Analysis By Ramaswamy Palaniappan	

Lab Component (will be taken during Tutorial Hours)	
List of Experiments: 1. To Read and Plot ECG data with Random noise 2. To Read and Plot ECG data with 50Hz sinusoidal noise 3. Signal Averaging method for a given data 4. Design of Notch- filter to remove noise in ECG 5. Convolution Property of ECG signals 6. Study experiment on Adaptive filters 7. Design of FIR filter to remove noise in ECG 8. Design of IIR filter to remove noise in ECG 9. Data compression using Turning Point Algorithm using C and Matlab 10. QRS Detection Method1 11. QRS Detection Method2 12. To Read and Plot EEG data, Power Spectrum of EEG **13.** Study experiment on Adaptive-segmentation	
Module Choice for SEE- Every module	

Semester	**VI**				
COURSE TITLE	**VLSI Design**				
COURSE CODE	**23MD6PE2VL**	**Credits**	**3**	**L-T-P**	**3:0:0**
Total Hours of Pedagogy	**40**				
Pre-Requisites: Basic Electronics and Digital Electronics					

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

CO1	Apply the knowledge of digital electronics fundamentals for VLSI design.
CO2	Design CMOS based circuits for given specifications.
CO3	Analyze and evaluate the performance and characteristics of VLSI designs.
CO4	Evaluate basic circuit concepts in CMOS Design and the Scaling of MOS Circuits with scaling factors for device parameters in MOS circuits.
CO5	Conduct experiments using appropriate tools to verify the correctness and functionality of CMOS circuits.

CO-PO-PSO-Mapping:-

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2			3												
CO3		3													
CO4				3					3	3					
CO5					3										2
Avg.	**3**	**3**	**3**	**3**	**3**				**3**	**3**					**2**

MODULE 1	**8hours**
Logic Design with MOSFETs: MOSFETs as Switches, Basic logic gates in CMOS, Complex logic gates in CMOS, Transmission Gate Circuits.	
MODULE 2	**8hours**
Physical Structure of CMOS Integrated Circuits: Integrated Circuit Layers, Interconnect Resistance and Capacitance, MOSFETs CMOS layers, Designing FET Arrays, Complex logic gates, Gate layout geometry, Euler graph.	
MODULE 3	**8hours**
Electronic Analysis of CMOS Logic Gates: DC Characteristics of the CMOS inverter, Inverter Switching Characteristics, Power dissipation, DC Characteristics: NAND and NOR Gates.	

MODULE 4	8hours
Basic circuit concepts: sheet resistance R, sheet resistance concept applied to MOS transistor and inverter, area capacitances of layers, standard unit of capacitance Cg, some area capacitance calculation, the delay unit τ, inverter delays, driving large capacitance loads, propagation delays, wiring capacitance, choice of layers.	
MODULE 5	**8 hours**
Scaling of MOS circuits: Scaling models and scaling factors for device parameters, some discussions on scaling and limitations of scaling, subsystem design and layout. Some architectural issues switch logic gate restoring logic. Examples of structured design	

TEXT BOOKS	
1	John P. Uyemura, "Introduction to VLSI Circuits & Systems", Wiley India Edition, 2007, ISBN: 978-81-265-0915-7
2	Basic VLSI design- Dougles A Pucknell, 3rd edition, PHI
REFERENCE BOOKS	
1.	Principles of CMOS VLSI design-Neil West and Eshranghian, 2nd edition, Addison Wesley, 2002.
2.	M.S.Suma,Poornima M,Namita Palecha,CMOS VLSI Design, New Age International,1st Edition 2017.
Online courses	
1.	ElectronicDesignAutomationhttp://nptel.ac.in/courses/VLSI Fundamentals
E-Books:	
1	http://access.ee.ntu.edu.tw/course/dsd_99second/2011_lecture/W2_HDL_Fundamentals_2011-03-02.pdf

List of Experiments: Tools -Any EDA tool

UNIT 1: MOSFETs as Switches

i. Experiment 1: Study of the characteristics of n-MOS and p-MOS transistors as switches.
ii. Experiment 2: Design and construction of a CMOS inverter.
iii. Experiment 3: Study of the switching characteristics of a CMOS inverter.

UNIT 2: Physical Structure of CMOS Integrated Circuits

i. Experiment 4: Study of the different layers used in CMOS integrated circuits.
ii. Experiment 5: Measurement of the resistance and capacitance of the different layers.
iii. Experiment 6: Design and construction of a CMOS logic gate.

UNIT 3: Electronic Analysis of CMOS Logic Gates

i. Experiment 7: Study of the DC characteristics of a CMOS inverter.
ii. Experiment 8: Study of the switching characteristics of a CMOS inverter.
iii. Experiment 9: Measurement of the power dissipation of a CMOS logic gate.

UNIT 4: Basic Circuit Concepts

i. Experiment 10: Study of the sheet resistance concept.
ii. Experiment 11: Calculation of the area capacitances of the different layers.

iii. Experiment 12: Measurement of the delay of a CMOS inverter.

UNIT 5: Scaling of MOS Circuits

i. Experiment 13: Study of the scaling models for MOS circuits.
ii. Experiment 14: Design and construction of a scaled CMOS logic gate.

Experiment 15: Study of the limitations of scaling CMOS circuits.

Module Choice for SEE- Every module

Semester	**VI**				
COURSE TITLE	**Brain Computer Interface**				
COURSE CODE	**23MD6PE2BC**	**Credits**	**3**	**L-T-P**	**3:0:0**
Total Hours of Pedagogy	**40**				
Pre-Requisites: Anatomy and Physiology of Brain. Knowledge of Biomedical signals and Transducers used for the biomedical signal acquisition.					

CourseOutcomes: Attheendofthecoursethestudentswillbeableto,

CO 1	Apply the knowledge of mathematics science and engineering fundamentals to understand the Brain Organization, Anatomy, and Function.
CO 2	Process and analyze the brain signals for artifact reduction.
CO 3	Apply Machine Learning Techniques for the analysis of brain signals
CO 4	Learn the principles of BCI System, applications and ethics.
CO 5	Apply BCI Techniques using modern tools, present and submit the report.

CO-PO-PSO-Mapping:-

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														3
CO2		3													3
CO3		3													3
CO4								3							3
CO5			3	3	3				2	2					3
Avg.	**3**	**3**	**3**	3	**3**			**3**	**2**	**2**					**3**

MODULE 1	8
Basic Neuroscience : Neurons ,Action Potentials or Spikes , Spike Generation ,Adapting the Connections. Brain Organization, Anatomy and Function . Recording and Stimulating the Brain ,Invasive Techniques ,Non-invasive Techniques Multielectrode Arrays, Signal Processing ,Spike Sorting.	

MODULE 2	8
Frequency Domain Analysis :Discrete Fourier Transform ,Fast Fourier Transform, Spectral Features ,Wavelet Analysis, Time Domain Analysis ,Hjorth Parameters , Fractal Dimension Bayesian Filtering ,Kalman Filtering , Particle Filtering ,Spatial Filtering , Bipolar, Laplacian, and Common Average Referencing. Artefact Reduction Techniques : Thresholding ,Band-Stop and Notch Filtering, Linear Modelling Principal Component Analysis ,Independent Component Analysis**.**	
MODULE 3	8
Machine Learning: Classification Techniques , Binary Classification ,Ensemble Classification Techniques ,Multi-Class Classification , Evaluation of Classification Performance ,Regression ,Linear Regression ,Neural Networks and Back propagation , Radial Basis Function (RBF) Networks ,Gaussian Processes	
MODULE 4	8
Building a BCI :Major Types of BCIs ,Brain Responses Useful for Building BCIs ,Imagined Motor and Cognitive Activity, Stimulus-Evoked Activity. Invasive BCIs: Two Major Paradigms in Invasive Brain-Computer Interfacing ,BCIs Based on Operant Conditioning ,BCIs for Prosthetic Arm and Hand Control ,BCIs for Lower-Limb Control ,BCIs for Cursor Control ,Cognitive BCIs ,Cognitive BCIs in Humans , Establishing New Connections between Brain Regions.	
MODULE 5	8
Applications and Ethics: Applications of BCIs ,Medical Applications ,Sensory Restoration , Rehabilitation ,Restoring Communication with Menus, Lie Detection and Applications in Law ,Monitoring Alertness ,Estimating Cognitive Load , Ethics of Brain-Computer Interfacing Medical Health, and Safety Issues :Balancing Risks versus Benefits , Informed Consent BCI Security and Privacy , Legal Issues Moral and Social Justice Issues.	
TEXT BOOKS	
1. Brain -Computer Interfacing: An Introduction by Rajesh P. N Rao University of Washington DATE PUBLISHED: September 2013:ISBN:	
2. Brain-Computer Interfaces : Foundations and methods Maureen Clerc, Laurent Bougrain, Fabien Lotte	
REFERENCE BOOKS	
Brain-Computer Interfaces 2: Technology and Applications, Volume 2 Maureen Clerc, Laurent Bougrain, Fabien Lotte John Wiley & Sons, 29-Aug- 2016 - Computers Schalk, G., & Mellinger, J. (2010).	
A Practical Guide to Brain–Computer Interfacing with BCI2000: General-Purpose Software for Brain-Computer Interface Research, Data Acquisition, Stimulus Presentation, and Brain Monitoring. Springer Science & Business Media.	

Online courses		
1.	https://sccn.ucsd.edu/wiki/Introduction_To_Modern_Brain-Computer_Interface_Design	
2.	https://www.udemy.com/course/brain-computer-interface/	

E-Books:		
1	Dornhege, G. (Ed.). (2007). Toward brain-computer interfacing. MIT press.	
2	"Brain-Computer Interfaces: Principles and Practice" ISBN-13: 978-0195388855	
Module Choice for SEE- Every module		

Semester	VI				
COURSE TITLE	Introduction to Medical Engineering				
COURSE CODE	23MD6OE1ME	Credits	3	L-T-P	3:0:0
Total Hours of Pedagogy	40				
Prerequisite :- General measurement and science concepts					

Course Outcomes: At the end of the course the students will be able to -	
CO1	Apply engineering concepts and principles to deal with biomedical measurements
CO2	Demonstrate understanding of Clinical laboratory Measurements, Monitoring and Imaging Equipments
CO3	Understand physiological effects due to electrical shocks and analyse different methods of accident prevention

CO-PO/PSO mapping:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												2		
CO2	3				3				3	3					
CO3	3					2									

MODULE 1	Hours
Components of Medical Instrumentation Systems: Basic Medical Instrumentation System, Static and dynamic characteristics of medical instruments, Bio-signals and characteristics. Problems encountered with measurements from human beings. Sources of Bioelectric Potentials, Resting and Action Potentials.	8
MODULE 2	
Bio-Potential Electrodes and Physiological Transducers: Electrode potential and its equivalent circuit, Types of Electrodes-Surface Electrodes, Needle Electrodes, Micro Electrodes. Biochemical Transducers. Bio-Signal Acquisition: Electrical Conduction system of the heart, Electrocardiogram, ECG leads, Einthoven triangle, Plethysmography, EEG 10-20 lead system, EMG.	8
MODULE 3	
Clinical laboratory Measurements: Blood cell Counter, Blood flow meters- Electromagnetic blood flow meter, Ultrasonic Doppler blood flow meter, automated blood pressure measurements. Physiological Assist Devices & Therapeutic Equipment: Pacemakers -External & internal, Defibrillators- External & internal, Hemodialysis machine.	8

MODULE 4		
Monitoring and Imaging Equipment: Spirometry, Ventilators, Arrhythmia Monitor, Foetal Monitor and Incubator. X-ray machine, Computed Tomography (CT), Ultrasound Imaging system, Magnetic Resonance Imaging System		8
MODULE 5		
Patient Care and Safety: The elements of Intensive Care Monitor, Diagnosis, Calibration and reparability of Patient Monitoring equipment, Shock Hazards and Prevention, Physiological Effects and Electrical Current, Shock Hazards from Electrical Equipment, Methods of Accident Prevention, Isolated Power Distribution System		8
Text Books		
1	Leslie Cromwell, F.J. Weibell, E.A. Pfeiffer, Biomedical Instrumentation and Measurements. 2nd Edition, PHI, 2004	
2	Dr. M. Arumugam, Biomedical Instrumentation. 2nd Edition, Anuradha publications, 2002.	
Reference Books:		
1	R.S. Khandpur, Hand-book of Biomedical Instrumentation. 2nd Edition, TMH, 2003. 2. John G. Webster, Medical Instrumentation, Application and Design. John Wiley, 3rd Edition, 2009.	
2	Onkar N. Pandey, Rakesh Kumar, Bio-Medical Electronics and Instrumentation. 3rd Edition, Katson Books, 2002.	
Online courses:		
1	https://www.coursera.org/learn/foundations-of-healthcare-systems-engineering	
2	https://www.edx.org/learn/biomedical-engineering	
E-Books:		
1	https://www.intechopen.com/books/238	
2	https://www.iitrpr.ac.in/library/SubjectsPlus/subjects/guide.php?subject=CME%20B	
Module Choice for SEE- Every module		

Semester	**VI**				
COURSE TITLE	**Ergonomics**				
COURSE CODE	**22MD6OE1ER**	**Credits**	**3**	**L-T-P**	**3:0:0**
Total Hours of Pedagogy	**40 Hrs.**				
Pre-Requisites: Basic Engineering Science					

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

CO1	Apply the knowledge of mathematics, science and engineering fundamentals to improve the human machine interaction.
CO2	Formulate, design and analyse the work environment that degrade human–machine performance to arrive at better comfort and productivity.
CO3	Apply reasoning by contextual knowledge to meet the needs of the users to assess health safety and ethical issues.
CO4	Communicate and write report of the case studies for the ergonomically designed models through literature survey as a team work.

CO-PO-PSO-Mapping:-

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3												3		
CO2		3											3		
CO3	3					3		3					3		
CO4		2				2			2	2			2		
Avg.	**3**	**3**				**3**		**3**	**2**	**2**			**3**		

MODULE 1	Hours
Introduction to Ergonomics: The focus of ergonomics, Ergonomics and its areas of application in the work system, A brief history of ergonomics, Modern ergonomics, Future directions for ergonomics, Anatomy, posture and body mechanics: Anatomy of the spine and pelvis related to posture, Postural stability and postural adaptation, Low back pain, Risk factors for musculoskeletal disorders in the workplace, Behavioural aspects of posture. **Anthropometric principles in workspace and equipment design:** Designing for a population of users, sources of human variability, Anthropometry and its uses in ergonomics, Principles of applied anthropometry in ergonomics, Application of anthropometry in design, Design for everyone, Anthropometry and personal space.	8
MODULE 2	**8**
Static work: Design for standing and seated workers: Fundamental aspects of standing and sitting, An ergonomic approach to workstation design, Design for standing workers, Design for seated workers, Work surface design, Visual display units, Guidelines for the design of static work. **Design of repetitive tasks:** Introduction to work-related musculoskeletal disorders, Injuries to the upper body at work, Review of tissue path mechanics and WMSDs, Disorders of the neck, Carpal tunnel syndrome, Tennis elbow (epicondylitis), disorders of the shoulder, Lower limbs, Ergonomic interventions, Trends in work-related musculoskeletal disorders, Design of manual handling tasks topic only.	
MODULE 3	**8**
Work capacity, stress and fatigue: Stress and fatigue, Muscles, Structure, Function and capacity, Physical work capacity, Factors affecting work capacity, Industrial applications of physiology. **Heat, cold and the design of the physical environment:** Fundamentals of human thermoregulation, Measuring the thermal environment, Thermoregulatory mechanisms, Work in hot climates, work in cold climates, Skin temperature, Protection against extreme climates, Comfort and the indoor climate, ISO standards.	
MODULE 4	**8**
Vision, light and lighting: Vision and the eye, Measurement of light, lighting design considerations, Visual fatigue, eye strain and near work, Psychological aspects of indoor lighting. **Hearing, sound, noise and vibration:** Terminology, Measurement of sound, Ear protection, Design of the acoustic environment, Industrial noise control, Noise and	

communication, The auditory environment outdoors, Effects of noise on task performance, Non-auditory effects of noise on health, Noise and satisfaction, Vibration.	
MODULE 5	**8**
Human information processing, skill and performance: A general model of human information processing, Long term and short term memory, multichannel view of attention, ROSPA guidelines for the safe use of mobile communications equipment in vehicles. Displays, controls and virtual environments, Human–computer interaction, memory and language Human–machine interaction, human error and safety	

Text Books:	
1.	Introduction to Ergonomics by R.S. Bridger, Taylor & Francis, eBook Published-26 June 2008.
Reference Books:	
1.	Introduction to Human factors and ergonomics for Engineers, 2nd Edition, Marks Lehto, Steven J Landry. CRC press, Taylor and Francis group, March 2013.
2.	Handbook of Human Factors and Ergonomics, 4th Edition, Gavrial Salvendy, March 2012.
Online Courses:	
1.	https://www.derby.ac.uk/online/ergonomic-courses/ergonomics-human-factors-pg-cert-online/
2.	https://www.engineering.pursue.edu/online/courses/human-factors-engineering/
E-Books:	
1.	https://moodle.ufsc.br/pluginfile.php/748673/mod_resource/content/1/ERGO%20%20Handbook%20of%20Human%20Factors%20and%20Ergonomics%20Methods.pdf
2.	https://doi.org/10.1201/9780203489925
3	https://moodle.ufsc.br/mod/resource/view.php?id=387317https://moodle.ufsc.br/mod/resource/view.php?id=387317
Module Choice for SEE- Every module	

Semester	VI		
Course Title	Project work-1	Course Code	23MD6PWPJ1
Credits	2	L-T-P	0-0-2

Course Outcomes	
CO1	Ability to apply knowledge to identify, gather information and analyse to formulate the unmet need and problem definition for project through survey
CO2	Ability to use appropriate tool/tools to implement and demonstrate the project.
CO3	Ability to design and develop sustainable solution/system for the biomedical applications.
CO4	Ability to make effective presentation of the work abiding professional ethics as an individual and a team member.
CO5	Ability to develop systems with scope for enhancement and continue life-long learning.

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3		3									3	3	3
CO2					3								3	3	3
CO3			3			3	3						3	3	3
CO4								3	3	3	3		3	3	3
CO5												3	3	3	3
Avg.	**3**	**3**	**3**	**3**	**3**	3	3	3	**3**	**3**	3	3	3	3	3

Guidelines for Mini Project–1 (23MD6PWPJ1)
Objective: The objective of this open ended mini project is to let the students apply the knowledge of the engineering subjects into a **real- world situation/problem**.
Guidelines:
1. The project be done in a group of 3 / 4 students.
2. Mini project can be done in the area of medical electronics engineering using the knowledge gain from the courses studied in the lower semesters subjects to be studied during implementation .
3. Mini project must be hardware project with associated software component for it. **(**considering current technology/situation)
4. Each group will be allotted a **Guide**. Students in that group must discuss the project idea with Guide before finalizing it.
5. Each group will present the idea of the project and will submit 1 - 2 page(s) of an **Abstract** of the mini project work.

6. Every week, project group will report progress of the project to allotted Guide.
7. Each group will give progress presentations according to the schedule. .
8. At the end of the project, all groups will submit video of the working model and technical report in the format shared.
9. Final SEE will be conducted for 50 marks.

Semester	**VI**				
COURSE TITLE	**Java Programming**				
COURSE CODE	**23MD6AEJPR**	**Credits**	**1**	**L-T-P**	**0:0:1**
Total Hours of Pedagogy	**15**				
Pre requisites- Programming fundamentals					

Course Outcomes:

CO1	To understand Java syntax, data types, control structures, and basic programming constructs for Java programs.
CO2	Develop the ability to create and manipulate classes and objects, utilize inheritance, polymorphism, encapsulation, and abstraction to build modular and reusable code.
CO3	To implement robust error handling using Java's exception handling mechanisms and develop debugging skills to identify and resolve runtime issues efficiently.
CO4	Demonstrate GUI for healthcare application and communicate effectively individually/ in a team

CO-PO/PSO mapping: At the end of the course the students will be able to,

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3													3	
CO2		3												3	
CO3			3											3	
CO4				2	2										2
CO5				3	3				2	2					2
Avg	3	3	3	3	3				2	2				3	2

MODULE 1	**3Hrs**
Introduction to Java - Basic programming - Including identifiers, variables, constants, data types, operator precedence, programming style and documentation.	
MODULE 2	**3Hrs**
Control Structures including selection structures and looping structures, and the use of nested structures. Methods - Including creating and calling, passing parameters, overloading, and method abstraction.	
MODULE 3	**3Hrs**
Programming with Objects and Classes - Including creating objects and classes, garbage collection, constructors, analyzing relationships among objects, the String class, the String Buffer class. Arrays and Vectors - Declaring and creating arrays, processing arrays, arrays of objects	
MODULE 4	**3Hrs**

Inheritance - Superclasses and subclasses, overriding methods, the Object class, abstract classes, polymorphism. Graphics Programming - Introduction to Graphics Programming using containers, components, helpers, and creation of event objects.		
MODULE 5		**3Hrs**
Applets - Conversion of GUI applications to applets - Exception Handling - Use of try, catch, throw, and throws with text based applications, GUI applications, and applets.		
Text Books		
1	Liang, Y Daniel. Introduction to Java Programming: Comprehensive Version, 6th. ed. Prentice Hall	
2	Herbert Schildt, Java The Complete Reference, 7th Edition, Tata McGraw Hill, 2007	
Reference Books:		
1	Harvey Deitel, "Java How to Program", Sixth Edition, Prentice Hall, NJ, 2005	
2	Patrick Naughton, "COMPLETE REFERENCE: JAVA2", Tata McGraw-Hill, 2003.	
Online courses:		
1	http://java.sun.com.	
2	https://www.coursera.org/specializations/object-oriented-programming	
E-Books:		
1	https://moodle.dallastown.k12.pa.us/pluginfile.php/379743/mod_resource/content/1/Java%20Text%20-%20Liang.pdf	
2	https://www.iitk.ac.in/esc101/share/downloads/javanotes5.pdf	

Semester	VI				
Course Title	RESEARCH METHODOLOGY AND IPR				
Course Code	23ES6AERMI	Credits	2	L – T – P	2:0:0
CIE	50 Marks (100% weightage)		SEE	100 Marks (50% weightage)	

Prerequisites:

Basic Engineering Domain knowledge

Course Outcomes:

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

Sl. No.	Course Outcomes	PO	PSO
CO1	Ability to write and present a substantial technical report/document	9	1,2,3
CO2	Able to demonstrate a degree of mastery over the area of specialization	4	1,2,3
CO3	demonstrate the ability to choose methods appropriate to research objectives	12	1,2,3

MODULE - I

Meaning and sources of research problem, Objectives and Characteristics of research – Errors in selecting research problem, Research methods Vs Methodology - Types of research-Criteria of good research – Developing a research plan.

MODULE - II

Investigations of a research problem - Selecting the problem - Necessity of defining the problem – Data collections-analysis- Importance of literature review in defining a problem - Survey of literature - Necessary instrumentations

MODULE-III

How to write paper-conference articles-poster preparation, thesis report writing, inclusion of references, journal reviewing process, journal selection process, filling about journal template, developing effective research proposal-plagiarism-research ethics

MODULE - IV

Origin and meaning of the term patent, Objective of a patent law, principles underlying the patent law in India, the legislative provisions regulating patents, Non–patentable inventions.

Procedure for obtaining patent, Provisional and complete specification, Rights conferred on a patentee, Transfer of patent, Infringement of patents, Action for Infringement,. Geographical indications

MODULE - V

Copy Right: Introduction, Ownership of copy right, Rights conferred by copy right, Terms of copy right, License of copy right, Infringement of copy right, Remedies against infringement of copy right.

Trade Marks: Introduction, Statutory authorities, Procedure of registration of trademarks, Rights conferred by registration of trademarks, Licensing in trade mark, Infringement of trade mark and action against infringement.

Module Choice: IV & V

REFERENCE BOOKS:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 420p.
3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications.
5. Subbarau NR-Handbook of Intellectual property law and practice- S Viswanathan Printers and Publishing Private Limited 1998.
6. Basic Principles and Acquisition of Intellectual Property Rights", Dr. T. Ramakrishna, CIPRA, NSLIU-2005.
7. "Intellectual Property Law Handbook", Dr. B. L. Wadehhra, Universal Law Publishing Co. Ltd., 2002.

VII

Semester Syllabus

Semester	**VII**		
Course Title	**Medical Device Development**	**Course Code**	**23MD7PCMDD**
Credits	**4**	**L-T-P**	**3-1-0**
Pre Requisites	**Analog Electronics Circuits Digital Integrated Circuits Human Physiology and Medical Physics**		
Course Outcomes			
CO1	**Search, analyse and document clinical practice, engineering science and relevant literature in order to determine the need for further research and development in a chosen clinical area**		
CO2	**Collect a range of data (both qualitative and quantitative) to analyse critically, reflect on and synthesize complex solutions to concepts and theories in a chosen topic**		
CO3	**Ability to derive specifications and standards of a chosen device**		
CO4	**Design a virtual device that helps to technologically address a clinical need in a team and document the same.**		

CO-PO-PSO Mapping

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

UNIT 1	Hours
MedTech Innovation: Introduction, the status of bio-innovation in India, DALY, MedTech Innovation, New medical device steps, Common Myths, Bio design process, clinical immersion, need filtration, Need Specification document, case studies, Market Segmentation, Concept Generation and Selection, Perfint Maximo Example.	8

UNIT 2	
Product Requirement: Classification of Medical Device (FDA/CE/CDSCO), Requirement Analysis: Functional, Safety, Usability, User interface, Clinical Workflow, Internal Interface, Working environment, Infrastructure, Safety, Adaptability, Availability, User training, Labelling, Operating cost, Disposable, Design Input, ISO 13485.	8
UNIT 3	
Design Engineering: Clinical Workflow, Design for Manufacturing, Design for Serviceability, FMEA, Economy of Scale, Standards in Medtech, Safety and Risk Management, Case studies.	8
UNIT 4	
Human Factor Engineering: HE75, Common UI and UA issues, Economy of Scale, Product Requirements, Design engineering, Practical Development process, Importance of verification and review, Iterative development, Design and development plan, Design Output, Design Process, Design Verification, Design Validation, Design Review, Review versus verification versus validation, Design Transfer, Functional Block Diagram, High-Level Design, Signal flow path / Signal Characteristics.	8
UNIT 5	
Project Management and sustainability: Activity Planning - Objectives, Defining Activities, Project Plan (Gantt Chart), Network Planning models -Critical path management (CPM), Precedence Network, Nodes, Activity network, Forward Pass, Backward Pass, Float, Critical Path and its importance Sustainability: Need, external push towards sustainability, hospital role, barriers, making sustainable devices, examples.	8
TEXT BOOKS	
1	Biodesign: The Process of Innovating Medical Technologies, by Paul Yock, Stefanos A. Zenios, and Todd J. Brinton, Cambridge University Press, 2nd edition, 2015.
2	Inventing Medical Devices: A Perspective from India, by Jagdish Chaturvedi, Notion Press, 2017.
REFERENCE BOOKS	
1	The Medical Device R&D Handbook, by Theodore R. Kucklick, Second Edition, CRC Press, 2012.

Online course		
1	Pharmaceutical and Medical Device Innovations - Coursera	
2	Medical Technology and Evaluation - Coursera	
3	Regulatory requirements for medical devices including in vitro diagnostics in India (Version 2.0) - Course Swayam	
E-Books:		
1	http://ebiodesign.org/	
2	https://generisgp.files.wordpress.com/2016/05/ebook-medical-device-developmentbest-practices.pdf	
	Module Choice for SEE- Every module	

Semester	VII			
Course Title	Fundamentals of Medical Device Regulations and Standards	**Course Code**	23MD7PCFMR	
Credits	2	**L-T-P**	**2:0:0**	**Total Hours: 30**
Pre Requisites: Basic concepts of Medical Electronics Engg.				
Course Outcomes: At the end of the course students will be able to,				
CO1	Explore Medical device and in vitro diagnostic (IVD), classification and types of medical devices**.**			
CO2	Analyze Medical Device Regulatory Strategy and Quality Management System			
CO3	Explore International Perspectives of Medical Device Regulatory and Regulatory aspects of software as a medical device			
CO4	Explore aspects in software as Medical Device and regulations for AI in medical devices.			

CO-PO-PSO-Mapping

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														3
CO2	3														3
CO3	3														3
CO4		3							3	3		3			3
Avg.	**3**								**3**	**3**		**3**			**3**

UNIT 1	
Introduction: Medical Device and in vitro diagnostics, Types of devices including combination devices and Drug Vs device Vs IVD, Medical Device Rules, 2017: Implications on medical devices, Classification. Labeling of medical devices., The Role of the RA Team during the Different Stages of a Product Life	6Hrs
UNIT 2	
Medical Device Regulatory Strategy: What is a regulatory strategy and why it matters Information needed to build a strategy,Product development lifecycle from regulatory perspective, Overview of device standards (IS, ISO, IEC),Quality assurance, testing, and documentation Understanding regulatory compliance, US FDA regulatory pathway (Device classification : 510(k), De Novo, PMA submissions, Medical Device Reporting (MDR), Quality System Regulation (QSR), FDA inspections) **Introduction to AI in Regulatory Strategy**: handling algorithm updates, change control plans (FDA's Pre-Determined Change Control Plan for AI/ML SaMD)	6Hrs
UNIT 3	

Quality Assurance and Quality Management System- Manufacture of Medical Devices and IVDs, ISO 13485 Standard, Structure of ISO 13485, Requirements and Compliance of ISO 13485, Risk Management System for medical devices, ISO 14971: Application of Risk Management to Medical Devices		6Hrs
UNIT 4		
Global Regulatory Practices & Trade: Regulatory inspections of device and IVD manufactures, Import/export requirements and regulatory procédures, International regulatory systems (US (FDA), EU (MDR/IVDR), ASEAN, Japan, Canada),Global convergence efforts – IMDRF, WHO, **International perspectives on AI/ML devices:** Overview of IMDRF SaMD and AI principles, WHO position on A, International inspection expectations for software-driven and AI-enabled products)I in healthcare		6Hrs
UNIT 5		
Software and AI Regulations in Medical Devices: Software as a Medical Device (SaMD) and embedded software Domestic software regulations and standards in India, International software regulations (FDA guidance for SaMD and AI/ML ; EU MDR and AI Act – classification of high-risk AI), Standards applicable to software: (IEC 62304 (software life cycle) ; IEC 82304 (health software)), **AI in Medical Devices:** Regulatory classification and submission pathways, AI/ML-specific risks (bias, drift, cybersecurity), FDA's AI/ML Action Plan, Good Machine Learning Practices (GMLP), Managing change: Predetermined Change Control Plans, Data requirements and real-world performance monitoring,Ethical, safety and transparency expectations from regulators,Indian regulatory landscape for AI devices (within MDR 2017 framework)		6Hrs
Module Choice for SEE- Every module		
Text Books		
1	Medical Device Quality Control and Regulatory Compliance by Richard C. Fries, Taylor & Francis Group	
2	Handbook of Medical Device Regulatory Affairs in Asia by Jack Wong and Raymond Kai Yu Tong Jenny Stanford Publishing, 2018, second Edition	
3	Medical Device Regulatory Practices – An international Perspective by Val Theisz , ISBN 9789814669108 Published August 17, 2015 by Jenny Stanford Publishing	
4	CDSCO- https://cdsco.gov.in/opencms/resources/UploadCDSCOWeb/2022/m_device/Medical%20Devices%20Rules,%202017.pdf	
Reference Books:		
1	World Health Organization. (2003). Medical device regulations: global overview and guiding principles. World Health Organization. https://apps.who.int/iris/handle/10665/42744	
2	"Medical Product Regulatory Affairs Pharmaceuticals, Diagnostics, Medical Devices" by John J. Tobin and Gary Walsh, Wiley Blackwell Publication	

3	https://www.fda.gov/medical-devices/software-medical-device-samd/artificial-intelligence-and-machine-learning-ai/ml-enabled-medical-devices	
4	https://www.fda.gov/media/153486/download	
5	**https://www.iso.org/standard/72704.html**	
6	https://health.ec.europa.eu/system/files/2021-05/mdr_2017-745_en_0.pdf	
7	https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32024R1689	
8	https://www.niti.gov.in/sites/default/files/2022-01/ApproachDocumentforIndiaAIHealthcare.pdf	
Online courses:		
1	https://archive.nptel.ac.in/courses/127/106/127106136/	
E-Books:		
1	John J. Tobin and Gary Walsh, "Medical Product Regulatory Affairs Pharmaceuticals, Diagnostics, Medical Devices"	
2	"Cost-Contained Regulatory Compliance: For the Pharmaceutical, Biologics, and Medical Device Industries, Author(s):Sandy Weinberg ISBN:9780470552353 |DOI:10.1002/9780470933510	

Semester	VII				
COURSE TITLE	MEDICAL ROBOTICS				
COURSE CODE	23MD7/8PE3/4MR	Credits	3	L-T-P	3:0:0
Total Hours of Pedagogy	40				

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

CO1	Apply the knowledge of process automation for the working of robot
CO2	Analyze the function of sensors and actuators in the robot
CO3	Develop a visual system to use a robot for a typical application
CO4	Engage students individually/ in a team to conduct a case study and document the same.

CO-PO-PSO-Mapping:-

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														
CO2		3													
CO3			3												
CO4			2		2				2	2					
Avg.	3	3	3		2				2	2					

UNIT 1	8
BASIC CONCEPTS: Introduction, Classification of Robots, Robot Components, Degrees of freedom, Joints and Coordinates, Reference frames, Programming modes, Robot Characteristics and Application. Robot Kinematics: Position analysis introduction, Robots as mechanisms, Matrix representation, Homogeneous transformation matrices, representation of transformations.	
UNIT 2	8

ACTUATORS: Introduction, Characteristics of Actuating systems, Hydraulic devices, Pneumatic devices, Electric motors, Microprocessor control of Electric motors, Magnetostrictive actuators, Shape-Memory type metals, Speed reduction.		
UNIT 3		8
SENSORS: Sensor characteristics, Position sensors, Velocity sensors, Acceleration sensors, Force and Pressure sensor, Torque sensors, Microswitches, Light and IR sensors, Touch and Tactile sensors, Proximity sensors, Range finders, Sniff sensors, vision systems, voice recognition devices, voice synthesizers.		
UNIT 4		8
VISION SYSTEMS: Image acquisition, Frequency vs. spatial domain, Frequency contents: Noise, edges, Convolution mask, Sampling and quantization, Image processing techniques, Noise reduction, Morphological operation, Object recognition, depth measurement, Real-Time Image processing.		
UNIT 5		8
Case study on Medical Robotics: Robot-assisted laparoscopic surgery, Robotic Heart Surgery: Haptic Feedback, Ultrasound Based Surgical Applications, and Robotic Applications in Neurosurgery.		
TEXT BOOKS		
1	Saeed B. Niku, "Introduction to Robotics", Prentice-Hall India	
2	Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., "Industrial Robotics", Mc Graw-Hill Singapore	
3	Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai	
REFERENCE BOOKS		
1	Deb. S.R.,"Robotics Technology and flexible Automation", John Wiley, USA	
2	Klafter R.D., Chimielewski T.A., Negin M., "Robotic Engineering – An integrated approach", Prentice Hall of India, New Delhi,	
3	Mc Kerrow P.J. "Introduction to Robotics", Addison Wesley, USA	
4	Issac Asimov "Robot", Ballantine Books, New York	
Online courses		
1	https://nptel.ac.in/courses/112105249	
2	https://nptel.ac.in/courses/107106090	
E-Books:		
1	http://www.robot.bmstu.ru/files/books/(Ebook%20-%20English)%20Mcgraw-Hil, %20Pic%20Robotics%20%20A%20Beginner'S%20Guide%20To%20Robotic.pdf	
2	https://downloadmedicalbooks.files.wordpress.com/2011/08/medical-	

	robotics1.pdf	
3	https://doc.lagout.org/science/0_Computer%20Science/8_Electronics%20%26%20Robotics/Robotics%20and%20Automation%20Handbook.pdf	
	Module Choice for SEE- Every module	

Semester	VII		
Course Title	Advanced Image Processing	Course Code	23MD7/8PE3/4IP
Credits	3	L-T-P	3-0-0

Course Outcomes:

At the end of the course students will have ability to:

CO1	Apply knowledge of mathematics and engineering to use image transforms for image Processing.
CO2	Evaluate region based image segmentation and morphological image processing algorithms
CO3	Analyze use of Active Contours and Graph cut algorithms for image segmentation
CO4	Examine image compression techniques for storage requirements
CO5	Analyze suitability of advanced image segmentation algorithms using modern tools

CO-PO-PSO-Mapping

CO-PO-PSO-Mapping															
Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3														3
CO2	3														3
CO3	3														3
CO4	3														3
CO5			3		3				3						3
Avg.	**3**		**3**		**3**				**3**			**3**			**3**

UNIT 1	Hours
Image Transforms: Matrix-based Transforms Rectangular Arrays Complex Orthonormal Basis Vectors, Biorthonormal Basis Vectors Correlation Basis Functions in the Time-	8

Frequency Plane Basis Images Fourier-Related Transforms The Discrete hartley Transform The Discrete Cosine Transform The Discrete Sine Transform Walsh-Hadamard Transforms Slant Transform	
UNIT 2	
Region based Image Segmentation: Region Segmentation Using Clustering and Superpixels, Region Segmentation using K-Means Clustering, Superpixel Algorithm, Specifying the Distance Measure, Region Segmentation Using Graph Cuts, Images as Graphs, Minimum Graph Cuts, Computing Minimal Graph Cuts, Graph Cut Segmentation Algorithm	**8**
UNIT 3	
Morphological Image Processing: Preliminaries, Erosion and Dilation, Duality, Opening and Closing, The Hit-or-Miss Transformation, Basic Morphological Algorithms: Boundary Extraction, Hole Filling, Extraction of Connected Components, Convex Hull, Thinning, Thickening, Skeletons, Pruning, Morphological Reconstruction, Gray-Scale Morphology, Erosion and Dilation, Opening and Closing, Segmentation Using Morphological watersheds, watershed segmentation Algorithm	**8**
UNIT 4	
Image Segmentation using Active Contours: Snakes and Level Sets- Image Segmentation Using Snakes, Explicit (Parametric) Representation of Active Contours Derivation of the Fundamental Snake Equation Iterative Solution of the Snake Equation External Force Based on the Magnitude of the Image Gradient (MOG), External Force Based on Gradient Vector Flow (GVF) Segmentation Using Level Sets, Implicit Representation of Active Contours, Derivation of the Level Set Equation, Discrete (Iterative) Solution of The Level Set Equation, Curvature, Specifying, Initializing, and Reinitializing Level Set Functions, Force Functions Based Only on Image Properties Edge/Curvature-Based Forces , Region/Curvature-Based Forces	**8**
UNIT 5	
Image Compression: Introduction, coding Redundancy, Inter-pixel redundancy, image compression model , Lossy and Lossless compression, Huffman Coding, Arithmetic Coding, LZW coding, Run length coding.	**8**

TEXT BOOKS

1	Digital Image Processing by Rafael C. Gonzalez & Richard E. Woods, 4th Edition. Pearson Education Inc	

2	Image Processing, Analysis and Machine-Vision by Milan Sonka, Vaclav Hlavac & Roger Boyle, Second Edition	
REFERENCE BOOKS		
1	Digital Image Processing by S Jayakumaran, S Esakkirajan, T Veerakumar, Tata McGraw Hill Education Private Ltd	
E-Books		
1	http://kevinluo.net/books/book_Fundementals%20of%20Image%20Processing%20-%20Wiley-Blackwell.pdf	
	Module Choice for SEE- Every module	

Semester	**VII**				
COURSE TITLE	**IOT IN HEALTHCARE**				
COURSE CODE	**23MD7/8OE2/3IH**	**Credits**	**3**	**L-T-P**	**3:0:0**
Total Hours of Pedagogy	**40**				
Pre-Requisites: Digital circuits, Sensors and Actuators					

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

CO1	To understand the emerging applications in Internet of things for healthcare technologies.
CO2	Infer the role of Data Analytics and Security in IoT
CO3	Impact of IoT applications in health care.
CO4	Engage student individually/ in a team to conduct a case study and document the same.

CO-PO-PSO-Mapping:-

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02	PS03
CO1	3														
CO2		3													
CO3			3												
CO4			2		2				2	2					
Avg.	**3**	**3**	**3**		**2**				**2**	**2**					

UNIT 1	8
IoT in Smart Health Care System : Introduction, Classification and Categories of Wearable Devices, Communication Modes of Wearable Devices in IoT, Working Principles of Wearable Devices in IoT, Research Challenges and Open Issues	
UNIT 2	8
IoT devices: Introduction, sensor technology, participatory sensing, Industrial IoT and Automotive IoT, Actuators, Sensor Data Communication Protocols, RFID, WSN Technology	
UNIT 3	8
Prototyping the Embedded Devices for IoT Introduction, Embedded computing basics, Embedded Platforms for prototyping, prototyping embedded device software, devices, Gateways, Cloud services, API and Web API	

UNIT 4	8
Security and Privacy Concern in IoT Health Care: IoT-Enabled Technologies and Services**,** Type of IoT Sensors Relates to Health Care**,** IoT Healthcare Framework Integrated with Cloud Computing, Different Attacks Related to IoT Health Care, Techniques Applied to Resolve the Issues of IoT. Healthcare Personal Data and Health Information Data Encryption and Decryption Techniques to Combat Security Concerns in IoT Health.	
UNIT 5	8
Applications of Internet of Things in Medical Area Medical Sector Due to IoT, Remotely Taking Care of Health, Information Over-Burden and Accuracy, Intense Consistent Glucose Checking (CGM)and Insulin Taking Devices, Associated Respiratory Inhalers, Associated Respiratory Inhalers, Digital Sensor Treatment, Prominence of IoT in Healthcare, IoT Use Cases in Healthcare, Beaming Hospitals, IoT-Related Challenges in Healthcare, Drawbacks of IoT in Healthcare.	
Module Choice for SEE- Every module	

TEXT BOOKS	
1	Chinmay Chakraborty , Amit Banerjee ,Maheshkumar H. Kolekar ,Lalit Garg Basabi Chakraborty, ,"Internet of Things for health care Technologies",Springer, ISSN 2197-6503,Volume 73
2	Raj Kamal,"Internet of Things- Architecture and Design Principles", McGraw Hill,2017
3	Guy, Chris, and Dominic Ffytche. An introduction to the principles of medical imaging. London: Imperial College Press, 2005.
REFERENCE BOOKS	
1	Smith, Nadine Barrie, and Andrew Webb. Introduction to medical imaging: physics, engineering and clinical applications. Cambridge university press, 2010.
2	Introduction to Biomedical Imaging by Andrew G. Webb Wiley-IEEE Press, Nov 2017
Online courses	
1	https://www.edx.org/course/fundamentals-of-biomedical-imaging-ultrasounds-x-r https://onlinecourses.nptel.ac.in/noc20_ee40/preview
2	https://www.edx.org/course/introduction-to-biomedical-imaging
E-Books:	
1	Burbridge, Brent, and Evan Mah. Undergraduate diagnostic imaging fundamentals. University of Saskatchewan, 2017. (https://undergradimaging.pressbooks.com/)
2	https://downloadmedicalbooks.files.wordpress.com/2011/08/medical-robotics1.pdf
3	Maier, Andreas, Stefan Steidl, Vincent Christlein, and Joachim Hornegger, "Medical imaging systems: An introductory guide.", 2018. https://link.springer.com/book/10.1007%2F978-3-319-96520-8

Semester	VII		
Course Code	23MD7/8OE2/3FS	Course Title	Forensic Science
Credits	3	L-T-P	3-0-0
Course Outcomes			
CO1	Apply knowledge of Engineering science to understand the basics of Forensic		
CO2	Explain the interdisciplinary scope of forensic science.		
CO3	Apply forensic methods in crime scene investigation and evidence analysis.		
CO4	Understand the role of engineers in forensic evaluation.		
CO5	Analyse case studies involving engineering, cybercrime, and physical evidence.		

	UNIT 1	**Hours**
1	Introduction to Forensic Science, History, Role in Justice System: Definition and scope, Historical development, Role of forensic science in the criminal justice system, Branches of forensic science, Importance for engineers. Crime Scene Investigation: Scene Documentation, Collection & Preservation of Evidence: Types of crime scenes, Securing and documenting the scene, Evidence collection and preservation, Chain of custody, Tools and kits used at crime scenes Physical Evidence: Fingerprints, Tool Marks, Hair, Fibers: Fingerprints: types and collection methods, Tool marks, impressions, Hair, fibers, and soil analysis, Trace evidence and its significance	**8**
	UNIT 2	
2	Forensic Biology: Blood, DNA Profiling, Serology, Blood and body fluid identification, DNA profiling techniques, Collection and storage of biological evidence Case study: Aarushi Talwar case Forensic Chemistry: Toxicology, Drug Identification, Arson, Explosives: Drug analysis, Arson and explosive residue testing, Poison and toxicology reports, Case study: Rajiv Gandhi assassination Forensic Physics: Ballistics, Trajectories, Fracture Analysis: Ballistics and projectile motion, Fracture pattern analysis (glass, metals), Speed and impact calculations, Reconstruction of accidents, Ballistics and projectile motion, Fracture pattern analysis (glass, metals), Speed and impact calculations. Reconstruction of accidents.	**8**
	UNIT 3	
3	Digital Forensics I: Introduction to Cybercrime, Data Recovery, Network Forensics, Email and Mobile Forensics • Introduction to cybercrime • Basics of data storage and recovery • File system and metadata analysis Tools: FTK Imager, Autopsy Forensic Engineering- I: Structural Failure, Material Testing: • Email, mobile, and social media forensics • Malware forensics Case study: Nirav Modi banking fraud Forensic Engineering II: Accident Investigation, Product Liability	**8**

	• Network traffic analysis • Malware forensics Case study: Nirav Modi banking fraud	
	UNIT 4	
4	Instrumentation: GC-MS, FTIR, Microscopy, Spectroscopy, DNA Analysis: • Structural failure investigation • Mechanical/electrical system failures • Product liability and safety compliance • Case study: Bhopal gas tragedy Legal Aspects & Ethics in Forensic Science, Expert Witness Testimony • Microscopy, spectroscopy, chromatography • GC-MS, FTIR, SEM overview • DNA sequencer Demonstration videos/screenshots	**8**
	UNIT 5	
5	Case Studies I: Indian Cases (Aarushi, Bhopal Gas, Rajiv Gandhi, etc.) • Summary of 3–4 major Indian forensic cases • Challenges in the Indian context • Role of CBI and forensic labs • Analysis and lessons learned Case Studies II: International Cases + Student Presentations: • High-profile international forensic cases • Collapse of Tacoma Bridge, Morris Worm • Student group presentations on selected topics Recap and course feedback	**8**
	Module Choice for SEE- Every module	

Textbook (Recommended):

- **B.S. Nabar, *Forensic Science in Crime Investigation***, Asia Law House, Latest Edition.

Additional References:

1. **Richard Saferstein**, Criminalistics: An Introduction to Forensic Science, Pearson.
2. **Houck & Siegel**, Fundamentals of Forensic Science, Academic Press.
3. **Cyber Forensics: Technology and Law**, NIIT, Pearson Education.
4. **Nanda & Tewari**, Forensic Science in India: A Vision for the 21st Century.

INDIAN KNOWLEDGE SYSTEMS (Theory) (Common to All UG Programs)						
Course Code	:	25MA7HSIKL		CIE	:	50 Marks
Credits: L:T:P	:	1: 0: 0		SEE	:	50 Marks
Total Hours	:	15L		SEE Duration	:	02 Hours

Course Learning Objectives: The students will be able to	
1	To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system.
2	To make the students understand the traditional knowledge and analyze it and apply it to their day-to-day life.

Course Outcomes: After completing the course, the students will be able to	
CO1:	Provide an overview of the concept of the Indian Knowledge System and its importance.
CO2:	Appreciate the need and importance of protecting traditional knowledge.
CO3:	Recognize the relevance of Traditional knowledge in different domains.
CO4:	Establish the significance of Indian Knowledge systems in the contemporary world.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	3	-	-	-	1
CO2	-	-	-	-	-	2	-	-	-	-	-	-
CO3	-	-	2	2	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	3	2	-	-	-	-	-

Unit-I	05 Hrs
Introduction to Indian Knowledge Systems (IKS): Overview, Vedic Corpus, Philosophy, Character scope and importance, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge vs. western knowledge.	
Unit – II	05 Hrs
Traditional Knowledge in Humanities and Sciences: Linguistics, Number and measurements- Mathematics, Chemistry, Physics, Art, Astronomy, Astrology, Crafts and Trade in India and Engineering and Technology.	
Unit -III	05 Hrs
Traditional Knowledge in Professional domain: Town planning and architecture- Construction, Health, wellness and Psychology-Medicine, Agriculture, Governance and public administration, United Nations Sustainable development goals.	

Reference Books			
1	Introduction to Indian Knowledge System- concepts and applications, B Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana R N, 2022, PHI Learning Private Ltd, ISBN-978-93-91818-21-0		
	Traditional Knowledge System in India, Amit Jha, 2009, Atlantic Publishers and Distributors (P) Ltd., ISBN-13: 978-8126912230,		
2	Knowledge Traditions and Practices of India, Kapil Kapoor, Avadesh Kumar Singh, Vol. 1, 2005, DK Print World (P) Ltd., ISBN 81-246-0334,		
	Suggested Web Links:		
1.	https://www.youtube.com/watch?v=LZP1StpYEPM		
2.	http://nptel.ac.in/courses/121106003/		
3.	http://www.iitkgp.ac.in/department/KS;jsessionid=C5042785F727F6EB46CBF432D7683B63 (Centre of Excellence for Indian Knowledge System, IIT Kharagpur)		
4.	https://www.wipo.int/pressroom/en/briefs/tk_ip.html		
5.	https://unctad.org/system/files/official-document/ditcted10_en.pdf		
6.	http://nbaindia.org/uploaded/docs/traditionalknowledge_190707.pdf		
7.	https://unfoundation.org/what-we-do/issues/sustainable-development-goals/?gclid=EAIaIQobChMInp-Jtb_p8gIVTeN3Ch27LAmPEAAYASAAEgIm1vD_BwE		
ASSESSMENT AND EVALUATION PATTERN			
WEIGHTAGE		50% (CIE)	50%(SEE)
QUIZZES			
Quiz-I		Each quiz is evaluated for 05 marks adding up to 10 Marks.	*****
Quiz-II			
THEORY COURSE - (Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating)			
Test – I		Each test will be conducted for 25 Marks adding upto 50 marks. Final test marks will be reduced to 20 Marks	*****
Test – II			
EXPERIENTIAL LEARNING		20	*****
Case Study-based Teaching-Learning		--	*****
Sector wise study & consolidation (viz., Engg. Semiconductor Design, Healthcare & Pharmaceutical, FMCG, Automobile, Aerospace and IT/ ITeS)		--	
Video based seminar (4-5 minutes per student)		--	
Maximum Marks for the Theory		---	50 Marks
Practical		--	--
Total Marks for the Course		50	50

High-3 : Medium-2 : Low-1

VIII

Semester Syllabus

Semester	**VIII**				
COURSE TITLE	**Biomaterials and Artificial Organs**				
COURSE CODE	**23MD7/8PE3/4BA**	**Credits**	**3**	**L-T-P**	**3:0:0**
Total Hours of Pedagogy		**40**			
Pre-Requisites: Engineering Physics, Engineering Chemistry, Biology					

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

CO1	Apply the principles and properties of biomaterials used in medical applications.
CO2	Analyze the properties and select appropriate biomaterials based on their mechanical, chemical, and biological properties.
CO3	Analyze the design and development of artificial organs and the challenges associated with their implementation.
CO4	Apply the knowledge of biomaterials and artificial organs to solve practical problems in the medical field.
CO5	Recognize the ethical, regulatory, and safety considerations related to the use of biomaterials and artificial organs.

CO-PO-PSO-Mapping:-

COs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3												2		
CO2		3											2		
CO3		3											2		
CO4	3								3	3			2		
CO5								3					2		
Avg.	3	3						3	3	3			2		

MODULE 1	**8 Hrs**
Introduction to Biomaterials: Definition, classification, and applications, Physical, mechanical, chemical, and biological properties of biomaterials, Biocompatibility and host response to biomaterials, Surface modification techniques for improving biomaterial performance, Regulatory and ethical considerations in biomaterials research and development.	

MODULE 2	8 Hrs
Biomaterials in Medical Devices: Metals, polymers, ceramics, and composites as biomaterials, Selection criteria for biomaterials in medical devices, Biomaterials for cardiovascular applications, Biomaterials for orthopaedic applications, Biomaterials for tissue engineering and drug delivery.	
MODULE 3	**8 Hrs**
Artificial Organs - Design and Development: Introduction to artificial organs and their significance, Biomechanics and materials selection for artificial organs, Artificial organs for the cardiovascular system, Artificial organs for the respiratory system, Artificial organs for the renal system	
MODULE 4	**8 Hrs**
Biocompatibility and Safety Assessment: In vitro and in vivo biocompatibility testing of biomaterials, Toxicity and immunogenicity of biomaterials, Sterilization techniques and their impact on biomaterial properties, Failure analysis and post-implantation considerations, Risk assessment and safety regulations in the use of biomaterials and artificial organs. International Standards and Regulatory Framework: Material standards (ASTM F136, F75) , Biocompatibility standards(ISO 10993 series). Standards for Artificial Organs: Heart valves and cardiovascular devices (ISO 5840, ISO 25539), Implantable electronic devices (ISO 14708).Testing, Quality Assurance, and Risk Management: Biological evaluation and cytotoxicity testing (ISO 10993-1, -5, -10), Mechanical fatigue and wear testing (ASTM F2077), Risk management principles (ISO 14971).	
MODULE 5	**8 Hrs**
Advanced Topics in Biomaterials and Artificial Organs: Biomaterials for neural applications, Nano materials and their applications in biomedicine, Bioresorbable and smart biomaterials, Emerging trends in artificial organs, Case studies and research trends in biomaterials and artificial organs.	
TEXT BOOKS	
1. Biomaterials Science: An Introduction to Materials in Medicine by Buddy D. Ratner, lan S. Hoffman, Frederick J. Schoen, Jack E. Lemons	
2. tificial Organs: Technology and Clinical Applications by Rolf Niedermayr, Rainer Kozlowski, Michael Niedermayr	
REFERENCE BOOKS	
1 Biomaterials: A Basic Introduction by Qizhi Chen.	
2 Biomaterials: Principles and Applications by Joon B. Park, R. S. Lakes.	
Online courses:	
1 ntroduction to Biomaterials" by Courserahttps://www.coursera.org/learn/biomaterials	

2	"Biomaterials for Artificial Organs" by edX Link: https://www.edx.org/course/biomaterials-for-artificial-organs
3	"Biomaterials: Fundamentals and Applications" by NPTEL Link ttps://onlinecourses.nptel.ac.in/noc21_bt40/preview
E-Books:	
1.	"Biomaterials Science: An Introduction to Materials in Medicine" by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen, Jack E. Lemons. Link: https://www.elsevier.com/books/biomaterials-science/ratner/978-0-12-816139-7
2	"Artificial Organs: Technology and Clinical Applications" by Rolf Niedermayr, Rainer Kozlowski, Michael Niedermayr.
	https://ww.springer.com/gp/book/9783319045794
	Module Choice for SEE- Every module

Semester	**VIII**		
Course Title	**Biometric Systems**	**Course Code**	**23MD7/8PE3/4BC**
Credits	**3**	**L-T-P**	**3-0-0**
Total Hours of Pedagogy	**50**		
Pre Requisites: 1.Knowledge on Biometric authentication process, 2. Awareness on different biometric devices			
Course Outcomes: At the end of the course students will have an			
CO1	Ability to apply knowledge of mathematics, science and engineering to understand the concepts of Biometric systems.		
CO2	Ability to analyze and select a methodology of Biometrics.		
CO3	Ability to interpret Biometric concepts and analysis to be used in relevant application.		
CO4	Implement the concept for certain identified application, document and present the same.		

CO PO Mapping												
CO#/ PO#	**PO 1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	2											
CO2		3				3						
CO3			3					3				
CO4					3					3	3	3
Average	2	3	3		3	3		3		3	3	3

MODULE 1	**Hours**
INTRODUCTION:Person Recognition, Biometric Systems, Enrolment and recognition phases, Sensormodule, Feature extraction module, Database module, Matching module, Biometric Functionalities, Verification, Identification, Biometric System Errors, Performancemeasures, The Design Cycle of Biometric Systems, Nature of the application, Choice of biometric trait, Data collection, Choice of features and matching algorithm, Evaluation,Applications of Biometric Systems, Security and Privacy Issues.	**10**
MODULE 2	

FINGERPRINT RECOGNITION:Introduction, Friction Ridge Pattern, Features, Formation, Fingerprint Acquisition, Sensing techniques Image quality, Feature Extraction, Ridge orientation and frequency estimation, Singularity extraction, Ridge extraction, Minutiae extraction, Matching, Alignment , Pairing minutiae, Match score generation, Latent fingerprint matching, Fingerprint individuality, Performance evaluation Fingerprint Indexing, Fingerprint Synthesis, Level 1 feature synthesis, Level m print recognition for access control.	**10**
MODULE 3	
ACE RECOGNITION: Introduction, Psychology of face recognition, Facial features, Design f a face recognition system, Image Acquisition, 2D Sensors 3D Sensors, Video sequences, ace Detection, Viola-Jones face detector, Feature Extraction and Matching, Appearance ased face recognition, Model-based face recognition, Texture-based face recognition, erformance evaluation, Advanced Topics, Handling pose, illumination, and xpressionvariations , Heterogeneous face recognition , Contents xv, Face modelling.	**10**
MODULE 4	
RIS RECOGNITION: Introduction, Design of an Iris Recognition System, Image Acquisition, is Segmentation, Segmentation using the integro-differential operator, Segmentation sing Geodesic Active Contours (GAC), Generating iris masks, Iris Normalization, Iris ncoding and Matching, Iris Quality, Quality assessment techniques, Performance valuation.	**10**
MODULE 5	
MULTIBIOMETRICS, SECURITY SYSTREMS: Introduction, Ear detection, Ear recognition, Challenges in ear recognition, Gait, Feature extraction and matching, Challenges in gait recognition, Hand Geometry, Image capture, Hand segmentation, Feature Extraction, Feature matching, Challenges in hand geometry recognition, Soft Biometrics, Sources of Multiple Evidence, Acquisition and Processing Architecture, Fusion Levels, Adversary Attacks, Insider attacks, Infrastructure attacks, Attacks at the User Interface, Impersonation, Obfuscation, Spoofing, Countermeasure: spoof detection, Attacks on Biometric Processing, Attacks on the system modules, Attacks at the interconnections, Attacks on the Template Database, Countermeasure: biometric template security.	**10**
Text Books	
1. Introduction to Biometrics by Anil K. Jain, Arun A. Ross, Karthik Nandakumar. Springer Publications.	
Reference Books: 1 Biometrics- The Ultimate Reference- John D. Woodward, Jr. Wiley Dreamtech. 2 Personal Identification in Networked Society, Jain, A.K.; R Bolle, Ruud M.; S Pankanti, Sharath, 1st ed. 1999. 2nd printing, 2006, Springer Publications 3 Handbook of Biometrics, Jain, Anil K.; Flynn, Patrick; Ross, Arun A, Springer, 2008.	

Online Support 1. https://nptel.ac.in/courses/106/104/106104119/ 2. //www.coursera.org/lecture/usable-security/biometricauthentication-RXVog 3. "Biometrics"- offered by IIT Kanpur – NPTEL Course 4. "Usable Security" offered by University of MaryLand – Coursera course 5. https://blog.mantratec.com/category/biometric-technology 6. https://www.bayometric.com/biometric-blog/ 7. https://www.aware.com/blog/	

Semester	**VIII**				
COURSE TITLE	**INTRODUCTION TO ROBOTICS**				
COURSE CODE	**23MD7/8OE 2/3IR**	**Credits**	**3**	**L-T-P**	**3:0:0**
Total Hours of Pedagogy	**40**				

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

CO1	Apply the knowledge of process automation for the working of robot
CO2	Analyze the function of sensors and actuators in the robot
CO3	Develop a fuzzy logic to use a robot for a typical application
CO4	Engage students individually/ in a team to conduct a case study and document the same.

CO-PO-PSO-Mapping:-

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3														
CO2		3													
CO3			3												
CO4			2		2				2	2					
Avg.	3	3	3		2				2	2					

UNIT 1	**8**
BASIC CONCEPTS: Introduction, Classification of Robots, Robot Components, Degrees of freedom, Joints and Coordinates, Reference frames, Programming modes, Robot Characteristics and Application. Robot Kinematics: Position analysis introduction, Robots as mechanisms, Matrix representation, Homogeneous transformation matrices, representation of transformations.	
UNIT 2	**8**
ACTUATORS: Introduction, Characteristics of Actuating systems, Hydraulic devices, Pneumatic devices, Electric motors, Microprocessor control of Electric motors, Magneto strictive actuators, Shape-Memory type metals, Speed reduction.	
UNIT 3	**8**

SENSORS: Sensor characteristics, Position sensors, Velocity sensors, Acceleration sensors, Force and Pressure sensor, Torque sensors, Microswitches, Light and IR sensors, Touch and Tactile sensors, Proximity sensors, Range finders, Sniff sensors, vision systems, voice recognition devices, voice synthesizers.		
UNIT 4		**8**
VISION SYSTEMS: Image acquisition, Frequency vs. spatial domain, Frequency contents: Noise, edges, Convolution mask, Sampling and quantization, Image processing techniques, Noise reduction, Morphological operation, Object recognition, depth measurement, Real-Time Image processing.		
UNIT 5		**8**
Fuzzy Logic Control: Introduction, Fuzzy control, Crisp values vs. Fuzzy values, Fuzzy sets, Fuzzification, Inference rule base, Defuzzification, Simulation of Fuzzy logic controller, Applications of Fuzzy logic in Robotics. Case study on Medical Robotics: Robot-assisted laparoscopic surgery, Robotic Heart Surgery: Haptic Feedback, Ultrasound Based Surgical Applications.		
TEXT BOOKS		
1	Saeed B. Niku, "Introduction to Robotics", Prentice-Hall India	
2	Mikell P. Weiss G.M., Nagel R.N., Odraj N.G., "Industrial Robotics", Mc Graw-Hill Singapore	
3	Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai	
REFERENCE BOOKS		
1	Deb. S.R.,"Robotics Technology and flexible Automation", John Wiley, USA	
2	Klafter R.D., Chimielewski T.A., Negin M., "Robotic Engineering – An integrated approach", Prentice Hall of India, New Delhi,	
3	Mc Kerrow P.J. "Introduction to Robotics", Addison Wesley, USA	
4	Issac Asimov "Robot", Ballantine Books, New York	
Online courses		
1	https://nptel.ac.in/courses/112105249	
2	https://nptel.ac.in/courses/107106090	
E-Books:		
1	http://www.robot.bmstu.ru/files/books/(Ebook%20-%20English)%20Mcgraw-Hil,%20Pic%20Robotics%20%20A%20Beginner'S%20Guide%20To%20Robotic.pdf	
2	https://downloadmedicalbooks.files.wordpress.com/2011/08/medical- robotics1.pdf	
3	https://doc.lagout.org/science/0_Computer%20Science/8_Electronics%20%26%20Robotics/Robotics%20and%20Automation%20Handbook.pdf	
	Module Choice for SEE- Every module	

Semester	VIII		
Course Title	Industry 4.0	Course Code	23MD7/8OE2/3I4
Credits	3	L-T-P	3-0-0
Pre Requisites	Nil		

Course Outcomes

CO1	Analyze the evolution of Industry 4.0 and evaluate its strategic opportunities and challenges within the context of the Indian industrial ecosystem.
CO2	Assess a comprehensive conceptual framework and strategic roadmap for the implementation of Industry 4.0 initiatives across various sectors.
CO3	Appraise the role of advanced robotic technologies in shaping the future of Industry 4.0-driven manufacturing and service systems.
CO4	Evaluate critical obstacles and propose framework conditions necessary for successful adoption and scaling of Industry 4.0 solutions.

CO-PO-PSO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3										2		2	
CO2	3	3	3									2		3	
CO3			3									2		2	
CO4			3	3								3		2	

UNIT 1	Hours
Introduction to Industry 4.0: Introduction, core idea of Industry 4.0, origin concept of industry 4.0, Industry 4.0 production system, current state of industry 4.0, Technologies, How is India preparing for Industry 4.0	7
UNIT 2	
A Conceptual Framework for Industry 4.0: Introduction, Main Concepts and Components of Industry 4.0, State of Art, Supportive Technologies, Proposed Framework for Industry 4.0.	8
UNIT 3	

Technology Roadmap for Industry 4.0: Introduction, Proposed Framework for Technology Roadmap, Strategy Phase, Strategy Phase, New Product and Process Development Phase.	8
UNIT 4	
Advances in Robotics in the Era of Industry 4.0: Introduction, Recent Technological Components of Robots- Advanced Sensor Technologies, Internet of Robotic Things, Cloud Robotics, and Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications- Manufacturing, Maintenance and Assembly	8
UNIT 5	
Obstacles and Framework Conditions for Industry 4.0 : Lack of A Digital Strategy alongside Resource Scarcity, Lack of standards and poor data security, Financing conditions, availability of skilled workers, comprehensive broadband infra- structure, state support, legal framework, protection of corporate data, liability, handling personal data.	8

TEXT BOOKS	
1	Ustundag, Alp, and Emre Cevikcan. Industry 4.0: managing the digital transformation. Springer, 2017.
REFERENCE BOOKS	
1	Bartodziej, Christoph Jan. "The concept industry 4.0." In The concept industry 4.0, pp. 27-50. Springer Gabler, Wiesbaden, 2017.
2	Schwab, Klaus. The fourth industrial revolution. Currency, 2017.
Online course	
1	https://www.edx.org/course/industry-40-how-to-revolutionize-your-business
2	https://nptel.ac.in/courses/106105195
E-Books:	
1	https://library.oapen.org/bitstream/handle/20.500.12657/43836/external_content.pdf?sequence=1
	Module Choice for SEE- Every module