VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF ELECTRONICS ENGINEERING

B. Tech Electronics and Communication Engineering with Specialization in BiomedicalEngineering

Curriculum

(*2020-2021 admitted students*)

VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

World class Education: Excellence in education, grounded in ethics and critical thinking, for improvement of life.

Cutting edge Research: An innovation ecosystem to extend knowledge and solve critical problems.

Impactful People: Happy, accountable, caring and effective workforce and students.

Rewarding Co-creations: Active collaboration with national & international industries & universities for productivity and economic development.

Service to Society: Service to the region and world through knowledge and compassion.

VISION STATEMENT OF THE SCHOOL OF ELECTRONICS ENGINEERING

To be a leader by imparting in-depth knowledge in Electronics Engineering, nurturing engineers, technologists and researchers of highest competence, who would engage in sustainable development to cater the global needs of industry and society.

MISSION STATEMENT OF THE SCHOOL OF ELECTRONICS ENGINEERING

- Create and maintain an environment to excel in teaching, learning and applied research in the fields of electronics, communication engineering and allied disciplines which pioneer for sustainable growth.
- Equip our students with necessary knowledge and skills which enable them to be lifelong learners to solve practical problems and to improve the quality of human life.

B. Tech Electronics and Communication Engineering with Specialization in Biomedical Engineering

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will be engineering practitioners and leaders, who would help solve industry's technological problems

2. Graduates will be engineering professionals, innovators or entrepreneurs engaged in technology development, technology deployment, or engineering system implementation in industry

3. Graduates will function in their profession with social awareness and responsibility

4. Graduates will interact with their peers in other disciplines in industry and society and contribute to the economic growth of the country

5. Graduates will be successful in pursuing higher studies in engineering or management

6. Graduates will pursue career paths in teaching or research

B. Tech Electronics and Communication Engineering with Specialization in Biomedical Engineering

PROGRAMME OUTCOMES (POs)

PO_01: Having an ability to apply mathematics and science in engineering applications.

PO_02: Having a clear understanding of the subject related concepts and of contemporary issues and apply them to identify, formulate and analyse complex engineering problems.

PO_03: Having an ability to design a component or a product applying all the relevant standards and with realistic constraints, including public health, safety, culture, society and environment

PO_04: Having an ability to design and conduct experiments, as well as to analyse and interpret data, and synthesis of information

PO_05: Having an ability to use techniques, skills, resources and modern engineering and IT tools necessary for engineering practice

PO_06: Having problem solving ability- to assess social issues (societal, health, safety, legal and cultural) and engineering problems

PO_07: Having adaptive thinking and adaptability in relation to environmental context and sustainable development

PO_08: Having a clear understanding of professional and ethical responsibility

PO_09: Having cross cultural competency exhibited by working as a member or in teams

PO_10: Having a good working knowledge of communicating in English – communication with engineering community and society

PO_11: Having a good cognitive load management skills related to project management and finance

PO_12: Having interest and recognise the need for independent and lifelong learning

B. Tech Electronics and Communication Engineering with Specialization in Biomedical Engineering

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On the completion of B.Tech Electronics and Communication Engineering with Specialization in Biomedical Engineering degree, Students will be able to

PSO1. Design and develop variety of biomedical components and systems.

PSO2. Apply modern engineering tools to solve complex Electronics & Communication Engineering and biomedical problems.

PSO3: Use modern tools and techniques to solve contemporary problems in the field of biomedical engineering.

B. Tech Electronics and Communication Engineering with Specialization in Biomedical Engineering

CREDIT STRUCTURE

Category-wise Credit distribution

Category	Credits
University core (UC)	**53**
Programme core (PC)	**68**
Programme elective (PE)	**27**
University elective (UE)	**12**
Bridge course (BC)	-
Total credits	**160**

B. Tech Electronics and Communication Engineering with Specialization in Biomedical Engineering

DETAILED CURRICULUM

University Core - 53

S. No.	Course Code	Course Title	L	T	P	J	C
1.	CHY1002	Environmental Sciences	3	0	0	0	3
2.	CHY1701	Engineering Chemistry	3	0	2	0	4
3.	CSE1001	Problem Solving and Programming	0	0	6	0	3
4.	CSE1002	Problem Solving and Object Oriented Programming	0	0	6	0	3
5.	EEE3099	Industrial Internship	0	0	0	0	2
6.	EEE3999	Technical Answers for Real World Problems (TARP)	1	0	0	8	3
7.	EEE4098	Comprehensive Examination	0	0	0	0	2
8.	EEE4099	Capstone Project	0	0	0	0	20
9.	ENG1011	English for Engineers	0	0	4	0	2
10.	HUM1021	Ethics and Values	2	0	0	0	2
11.	MAT1011	Calculus for Engineers	3	0	2	0	4
12.	MAT2001	Statistics for Engineers	2	1	2	0	4
13.	MGT1022	Lean Start-up Management	1	0	0	4	2
14.	PHY1701	Engineering Physics	3	0	2	0	4
15.	PHY1999	Introduction to Innovative Projects	1	0	0	4	2
16.	FLC4097	Foreign Language	2	0	0	0	2
17.	EXC4097	Extra / Curricular Activity Basket	0	0	0	0	2
18.	STS4097	Soft Skills	0	0	0	0	6

B. Tech Electronics and Communication Engineering with Specialization in Biomedical Engineering

Programme Core - 68

S. No.	Course Code	Course Title	L	T	P	J	C
1.	CSE2003	Data Structures and Algorithms	2	0	2	4	4
2.	CSE4033	Cloud Computing and Information Security	2	0	2	0	3
3.	ECE1013	Electronic Circuits	2	0	2	4	4
4.	ECE1017	Electromagnetic Field Theory and Transmission Lines	3	0	0	0	3
5.	ECE1018	Signal Analysis and Processing	2	0	2	4	4
6.	ECE2010	Control Systems	3	0	0	4	4
7.	ECE2023	Principles of Sensors and Data Acquisition	3	0	2	0	4
8.	ECE2024	Principles of Communication Engineering	2	0	0	0	2
9.	ECE2026	Digital Circuit Design	2	0	2	4	4
10.	ECE3026	IoT System Architecture	2	0	0	4	3
11.	ECE3029	Graphical System Design for Communication Engineers	0	0	4	0	2
12.	ECE3030	Principles of Computer Communication	3	0	2	0	4
13.	ECE3031	Microcontroller and Embedded Systems	2	0	2	4	4
14.	ECE3032	Sensor Technology	2	0	2	0	3
15.	EEE1001	Basic Electrical and Electronics Engineering	2	0	2	0	3
16.	MAT2002	Applications of Differential and Difference Equations	3	0	2	0	4
17.	MAT3004	Applied Linear Algebra	3	2	0	0	4

B. Tech Electronics and Communication Engineering with Specialization in Biomedical Engineering

Programme Elective - 27

S. No.	Course Code	Course Title	L	T	P	J	C
1.	CSE3019	Data Mining	2	0	2	4	4
2.	CSE4034	IoT Edge Nodes and its Applications	2	0	2	0	3
3.	CSE4035	Mobile App Development for IoT	2	0	0	4	3
4.	ECE2025	Probability and Statistical Theory of Communication	1	0	2	0	2
5.	ECE2027	EMC and EMI	2	0	2	0	3
6.	ECE2033	Introduction to Data Analysis	2	0	2	0	3
7.	ECE3002	VLSI System Design	3	0	2	0	4
8.	ECE3010	Antenna and Wave Propagation	3	0	0	0	3
9.	ECE3011	Microwave Engineering	3	0	2	4	5
10.	ECE3033	IoT in Automotive Systems	2	0	2	0	3
11.	ECE3034	IoT for Industrial Systems	2	0	2	0	3
12.	ECE3035	RFID and Flexible Sensors	3	0	0	0	3
13.	ECE3036	Sensors for Structural Health Monitoring	2	0	0	4	3
14.	ECE3037	Wireless Sensor Networks and IoT	2	0	0	4	3
15.	ECE3038	MEMS and Nano Sensors	3	0	0	0	3
16.	ECE3039	Chemical and Bio-sensors	3	0	0	0	3
17.	ECE3040	Wireless Technologies for IoT	3	0	0	0	3
18.	ECE4002	Advanced Microcontrollers	3	0	0	4	4
19.	ECE4005	Optical Communication and Networks	2	0	2	4	4
20.	ECE4007	Information Theory and Coding	3	0	0	4	4
21.	ECE4009	Wireless and Mobile Communication	3	0	2	4	5
22.	ECE4025	Embedded Programming	2	0	2	0	3

23.	ECE4026	M2M Communication	2	0	0	4	3
24.	ECE4027	Embedded Sensing Technologies	2	0	0	4	3
25.	ECE4028	Smart IoT Applications	2	0	0	4	3
26.	ECE4030	Building Management Systems	1	0	0	0	1
27.	ECE4031	Artificial Intelligence with Python	3	0	2	0	4
28.	ECE4032	Neural Networks and Deep Learning	3	0	0	4	4
29.	MAT3005	Applied Numerical Methods	3	2	0	0	4
30.	ITE1002	Web Technologies	2	0	0	4	3
31.	ITE1020	Geographical Information System	2	0	0	4	3

University Elective Baskets -12

Management courses

Sl.No	**Code**	**Title**	**L**	**T**	**P**	**J**	**C**
1	MGT1001	Basic Accounting	3	0	0	0	3
2	MGT1002	Principles of Management	2	0	0	4	3
3	MGT1003	Economics for Engineers	2	0	0	4	3
4	MGT1004	Resource Management	2	0	0	4	3
5	MGT1005	Design, Systems and Society	2	0	0	4	3
6	MGT1006	Environmental and Sustainability Assessment	2	0	0	4	3
7	MGT1007	Gender, Culture and Technology	2	0	0	4	3
8	MGT1008	Impact of Information Systems on Society	2	0	0	4	3
9	MGT1009	Technological Change and Entrepreneurship	2	0	0	4	3
10	MGT1010	Total Quality Management	2	2	0	0	3
11	MGT1014	Supply Chain Management	3	0	0	0	3
12	MGT1015	Business Mathematics	3	0	0	0	3
13	MGT1016	Intellectual Property Rights	3	0	0	0	3
14	MGT1017	Business Regulatory Framework For Start-ups	3	0	0	0	3
15	MGT1018	Consumer Behaviour	3	0	0	0	3
16	MGT1019	Services Marketing	3	0	0	0	3

17	MGT1020	Marketing Analytics	2	0	2	0	3
18	MGT1021	Digital and Social Media Marketing	3	0	0	0	3
19	MGT1022	Lean Start-up Management	1	0	0	4	2
20	MGT1023	Fundamentals of Human Resource Management	3	0	0	4	4
21	MGT1024	Organizational Behaviour	3	0	0	4	4
22	MGT1025	Foundations of Management And Organizational Behaviour	3	0	0	4	4
23	MGT1026	Information Assurance and Auditing	2	0	0	4	3
24	MGT1028	Accounting and Financial Management	2	2	0	4	4
25	MGT1029	Financial Management	2	1	0	4	4
26	MGT1030	Entrepreneurship Development	3	0	0	4	4
27	MGT1031	International Business	3	0	0	4	4
28	MGT1032	Managing Asian Business	3	0	0	4	4
29	MGT1033	Research Methods in Management	2	1	0	4	4
30	MGT1034	Project Management	3	0	0	4	4
31	MGT1035	Operations Management	3	0	0	0	3
32	MGT1036	Principles of Marketing	3	0	0	4	4
33	MGT1037	Financial Accounting and Analysis	2	1	0	4	4
34	MGT1038	Financial Econometrics	2	0	0	4	3
35	MGT1039	Financial Markets and Institutions	2	0	0	4	3
36	MGT1040	Personal Financial Planning	2	0	0	4	3
37	MGT1041	Financial Derivatives	2	1	0	4	4
38	MGT1042	Investment Analysis and Portfolio Management	2	0	0	4	3
39	MGT1043	Applications in Neuro Marketing	3	0	0	4	4
40	MGT1044	Global Brand Marketing Strategies	3	0	0	4	4
41	MGT1045	Industrial Marketing	3	0	0	4	4
42	MGT1046	Sales and Distribution Management	3	0	0	4	4
43	MGT1047	Social Marketing	3	0	0	4	4

44	MGT1048	Political Economy of Globalization	3	0	0	4	4
45	MGT1049	Sustainable Business Models	3	0	0	4	4
46	MGT1050	Software Engineering Management	2	0	0	4	3
47	MGT1051	Business Analytics for Engineers	2	2	0	0	3
48	MGT1052	Bottom of the Pyramid Operations	3	0	0	0	3
49	MGT1053	Entrepreneurship Development, Business Communication and IPR	1	0	2	0	2
50	MGT1054	Product Planning and Strategy	2	2	0	0	3
51	MGT1055	Design Management	2	2	0	0	3
52	MGT1056	Accounting and Financial Management	3	0	0	4	4
53	MGT6001	Organizational Behaviour	2	0	0	4	3

Humanities courses

Sl.No	**Code**	**Title**	**L**	**T**	**P**	**J**	**C**
1	HUM1001	Fundamentals of Cyber Laws	3	0	0	0	3
2	HUM1002	Business Laws	3	0	0	0	3
3	HUM1003	Basic Taxation for Engineers	3	0	0	0	3
4	HUM1004	Corporate Law for Engineers	3	0	0	0	3
5	HUM1005	Cost Accounting for Engineers	3	0	0	0	3
6	HUM1006	Business Accounting for Engineers	3	0	0	0	3
7	HUM1007	Contemporary Legal Framework for Business	3	0	0	0	3
8	HUM1009	International Business	3	0	0	0	3
9	HUM1010	Foreign Trade Environment	3	0	0	0	3
10	HUM1011	Export Business	3	0	0	0	3
11	HUM1012	Introduction to Sociology	3	0	0	0	3
12	HUM1013	Population Studies	3	0	0	0	3
13	HUM1021	Ethics and Values	2	0	0	0	2
14	HUM1022	Psychology in Everyday Life	2	0	0	4	2
15	HUM1023	Indian Heritage and Culture	2	0	0	4	2

16	HUM1024	India and Contemporary World	2	0	0	4	2
17	HUM1025	Indian Classical Music	1	0	2	4	1
18	HUM1033	Micro Economics	3	0	0	0	3
19	HUM1034	Macro Economics	3	0	0	0	3
20	HUM1035	Introductory Econometrics	2	0	2	0	2
21	HUM1036	Engineering Economics and Decision Analysis	2	0	0	4	2
22	HUM1037	Applied Game Theory	2	0	0	4	2
23	HUM1038	International Economics	3	0	0	0	3
24	HUM1039	Community Development in India	2	0	0	4	2
25	HUM1040	Indian Social Problems	3	0	0	0	3
26	HUM1041	Indian Society Structure and Change	3	0	0	0	3
27	HUM1042	Industrial Relations and Labour Welfare in India	3	0	0	0	3
28	HUM1043	Mass Media and Society	2	0	0	4	2
29	HUM1044	Network Society	3	0	0	0	3
30	HUM1045	Introduction to Psychology	2	0	2	0	2
31	HUM1706	Business Accounting for Engineers	3	0	0	0	3

Course code	Course title	L	T	P	J	C
BMD0001	Life Sciences for Biomedical Engineers	4	0	0	0	NA
Pre-requisite	NIL	Syllabus version				
		v1.0				

Course Objectives:

1. To define the basic concepts of anatomical and physiological terminologies relating to cell, blood components and joints with their functions.
2. To describe the chemical coordination of human endocrine systems, hormones and its functions, male and female reproductive organs.
3. To brush the basics of anatomical and physiological functions of cardiovascular system, blood pressure with factors affecting it, Human Respiratory system, mechanism of breathing and gaseous exchange.
4. To discuss about the human Nervous system, physiology and terminologies involved in it, Functions of brain, vision, hearing, taste and smell, Urinary System, functions of kidney and urine formation Functions and absorption property of digestive system and its movement.

Expected Course Outcome:

1. Comprehend the basic concepts of cell and its organelles, biomolecules and nucleic acids.
2. Ability to understand the basic physiological function about endocrine, digestive and circulatory system.
3. Comprehend the mechanism about the kidney function and urine formation.
4. Comprehend the concepts about the body fluids and its circulatory pathways in human body.
5. Comprehend the basic concepts on the human body mechanics, locomotion, bones and joints involved in its movement.
6. Comprehend the breathing mechanism, gaseous exchange, human neural system and its conduction of nerve impulse.
7. Ability to understand the necessary information about the human body mechanism with its physiological functions.

Module:1	**Cell & Biomolecules**	**10 hours**

An overview of cell, cell theory, cell organelles, cell division, cell envelope and its modifications, Proteins, Polysaccharides, Nucleic acids, DNA, RNA, Enzymes, Metabolism.

Module:2	**Chemical Coordination and Integration**	**10 hours**

Introduction to Endocrine system, Hypothalamus, Pituitary, Pineal, Thyroid, Parathyroid, Thymus, Pancreas, Adrenal, Testis and Ovary.

Module:3	**Digestion and Absorption**	**8 hours**

Alimentary canal, digestive glands, digestion of food, absorption of digested products, disorders of digestive system, Urine formation, Ultrafiltration, Kidney function and Diseases.

Module:4	**Breathing and Exchange of Gases**	**8 hours**

Mechanism of breathing, exchange and transport of gases, volumes and capacities, regulation of respiration and respiratory disorders.

Module:5	**Body fluids and Circulation**	**8 hours**
Blood, Plasma, Blood groups, Coagulation, Circulatory pathways, Cardiac cycle.		
Module:6	**Locomotion and Movement**	**7 hours**
Types of movement, Mechanics of Muscle Contraction, Skeletal System, Joints, Disorders.		
Module:7	**Neural Control and Coordination**	**7 hours**
Human Neural System, Neuron, Generation and Conduction of nerve impulse, Transmission of impulse, Reflex Action, Sensory Reception and Processing, Eye, Ear.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**60 hours**

Text Book	
1.	Ross and Wilson, Anatomy and Physiology in Health and Illness, International Edition Paperback, 13th Edition, Elsevier, June 2018
Reference Books	
1.	Guyton and Hall, Textbook of Medical Physiology, 13th Edition, Jun 2015
2.	Tortora G.J, Anatomy & Physiology with Workbook, 2014

Mode of Evaluation: Continuous Assessment Test, Quiz, Digital Assignment, Final Assessment Test, Additional Learning (MOOC / Conference, Journal Publications / Make a thon / Project competition and more)

Recommended by Board of Studies	23-02-2018		
Approved by Academic Council	49	Date	15-03-2018

Course code	DATA STRUCTURES AND ALGORITHMS	L	T	P	J	C
CSE2003		2	0	2	4	4
Pre-requisite	NIL	Syllabus version				
		v1.0				

Course Objectives:

1. To impart the basic concepts of data structures and algorithms.
2. To assess how the choice of data structures and algorithm design methods impacts the performance of programs.
3. To provide an insight into the intrinsic nature of the problem and to develop software systems of varying complexity.

Expected Course Outcome:

1. Evaluating and providing suitable techniques for solving a problem using basic properties of Data Structures.
2. Analyse the performance of algorithms using asymptotic notations.
3. Demonstrate knowledge of basic data structures and legal operations on them.
4. Illustrate different types of algorithmic approaches to problem solving and assess the trade-offs involved.
5. Analyse basic graph algorithms, operations and applications through a structured (well-defined) algorithmic approach.
6. Categorize the feasibility and limitations of solutions to real-world problems.
7. Provide efficient algorithmic solution to real-world problems.

Module:1	Introduction to Data structures and Algorithms	1 hour

Overview and importance of algorithms and data structures, Stages of algorithm development for solving a problem: Describing the problem, Identifying a suitable technique, Design of an Algorithm, Proof of Correctness of the Algorithm, Computing the time complexity of the Algorithm.

Module:2	Analysis of Algorithms	3 hours

Asymptotic notations and their significance, Running time of an algorithm, Time-complexity of an algorithm, Performance analysis of an algorithm, Analysis of iterative and recursive algorithms, Master theorem (without proof).

Module:3	Data Structures	7 hours

Importance of data structures, Arrays, Stacks, Queues, Linked list, Trees, Hashing table, Binary Search Tree, Heaps.

Module:4	Algorithm Design Paradigms	8 hours

Divide and Conquer, Brute force, Greedy, Recursive Backtracking and Dynamic programming.

Module:5	Graph Algorithms	4 hours

Breadth First Search (BFS), Depth First Search (DFS), Minimum Spanning Tree (MST), Single Source Shortest Paths.

Module:6	Computational Complexity classes	5 hours

Tractable and Intractable Problems, Decidable and Undecidable problems, Computational complexity

Classes: P, NP and NP complete - Cooks Theorem (without proof),3-CNF-SAT Problem, Reduction of 3-CNF-SAT to Clique Problem, Reduction of 3-CNF-SAT to Subset sum problem.			
Module:7	**Recent Trends**		**2 hours**
Algorithms related to Search Engines			
	Total Lecture hours:	**30 hours**	
Text Book(s)			
1.	Thomas H. Cormen, C.E. Leiserson, R L.Rivest and C. Stein, Introduction to Algorithms, Third edition, MIT Press, 2009.		
Reference Books			
1.	Sanjoy Dasgupta, C.Papadimitriou and U.Vazirani , Algorithms , Tata McGraw-Hill, 2008.		
2.	A. V. Aho, J.E. Hopcroft and J. D. Ullman, Data Strucures and Algorithms ,Pearson India, Ist Edition, 2002		
3.	A. V. Aho, J.E. Hopcroft and J. D. Ullman, The Design and Analysis of Computer Algorithms ,Pearson,1st edition, 2006.		
4.	Sara Baase , Allen Van Gelder, Computer Algorithms, Introduction to Design and Analysis, 3rd edition, Wesley Longman Publishing, 1999.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
List of Challenging Experiments (Indicative)			
1.	Extract the features based on various color models and apply on image and video retrieval		
2.	Arrays, loops and Lists		2 hours
3.	Stacks and Queues		2 hours
4.	Searching and Sorting		3 hours
5.	Linked List and operations		4 hours
6.	Brute force technique		2 hours
7.	Greedy Technique		2 hours
8.	Backtracking		2 hours
9.	Dynamic Programming		2 hours
10.	Trees and Tree Operations		3 hours
11.	BFS and DFS		2 hours
12.	Minimum Spanning Tree		2 hours
		Total Laboratory Hours	26 hours
Mode of assessment: Project/Activity			
Recommended by Board of Studies	04-04-2014		
Approved by Academic Council	No. 37	Date	16-06-2015

Course code	Course Title	L	T	P	J	C
ECE1004	Signals and Systems	2	0	0	4	3
Pre-requisite	MAT1001 : Calculus for Engineers	Syllabus version				
		2.0				

Course Objectives:

1. To introduce the students to fundamental signals like unit impulse, unit step, ramp and exponentials and various operations on the signals.
2. To acquaint students to static, linear, time invariant, causal and stable systems.
3. To introduce the students to the processing of signals through systems using convolution, correlation operations.
4. To analyze the systems using Laplace and Z Transform.

Expected Course Outcomes:

1. Differentiate between various types of signals and understand the implication of operations of signals
2. Understand and classify systems based on the impulse response behavior of both continuous time and discrete time systems
3. Perform domain transformation from time to frequency and understand the energy distribution as a function of frequency
4. Apply Fourier transform for discrete time signals and understand the difference between CTFT and DTFT.
5. Usefulness of convolution for analysing the LTI systems and understand the concepts of power spectral density through correlation.
6. Solve differential and difference equations with initial conditions using Laplace and Z transforms.
7. Design a system based on the concepts of system properties.

Module:1	Introduction to Continuous-time and Discrete-time Signals	3 hours

Representation of signals, Signal classification, Types of signals, Operations on signals - Scaling, Shifting, Transformation of independent variables, Sampling.

Module:2	Introduction to Continuous-time and Discrete-time Systems	3 hours

Classification of systems - Static and dynamic, Linear and non-linear, Time-variant and time-invariant, Causal and non-causal, Stable and unstable, Impulse response and step response of systems.

Module:3	Fourier Analysis of Continuous-time Signals	4 hours

Introduction to Fourier series, Gibbs Phenomenon, Continuous-time Fourier transform (CTFT), Existence, Properties, Magnitude and phase response, Parseval's theorem, Inverse Fourier transform.

Module:4	Fourier Analysis of Discrete-time Signals	4 hours

Discrete-time Fourier transform (DTFT), Properties, Inverse discrete-time Fourier transform, Comparison between CTFT and DTFT.

Module:5	Convolution and Correlation	4 hours

Continuous-time convolution, Convolution sum, Correlation between signals, Cross correlation,

Autocorrelation, Energy spectral density, Power spectral density		
Module:6	**System Analysis using Laplace transform**	**5 hours**
Relation between Laplace and Fourier transforms, Properties, Inverse Laplace transform, Solution to differential equations using Laplace transform, Region of convergence, Stability analysis.		
Module:7	**System Analysis using z-Transform**	**5 hours**
z-transform, Properties, s-plane to z-plane mapping, Inverse z-transform, Solution to difference equations using z-transform, Region of convergence, Stability analysis.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture Hours:	**30 hours**

Text Book

1.	P. Rama Krishna Rao and Shankar Prakriya, "Signals and Systems", 2013, second edition, Mc-Graw Hill.

Reference Books

1.	Alan. V. Oppenheim, Alan. S. Willsk,S. Hamid Nawab, "Signals and systems", 2001, second edition- PHI learning Pvt. ltd.
2.	B. P. Lathi,"Signal processing and linear systems", 2009, Oxford university press.
3	Simon Haykin and Barry VanVeen, "Signals and systems", 2007, second edition, Wiley, India.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

Typical Projects

1. a) Prove any five Fourier series properties for continuous time signals.

b) Write a Matlab script to generate and plot the following discrete time signals for $-10 \le n \le 10$. Also compute their energies and display them on command prompt.

a) i) $\delta(n)$ ii) $\delta(n-2)$ iii) $\delta(n+3)$

b) i) $u(n)$ ii) $u(n-3)$ iii) $u(n+4)$

c) i) $r(n)$ ii) $r(n-3)$ iii) $r(n+2)$

2. a) Analysis of Power spectral density for deterministic signals and random signal.

b) Let $x(n) = \{1, 4, 3, 5, 7, 6, 5, 4\}$ (↑ at 7). Write a Matlab script to determine and plot the following sequences. (select suitable time scale)

i) $y(n) = 3x(n+2) - x(n-2)$

ii) $y(n) = x(n)x(n-2)$

iii) $y(n) = x(4-n) + x(n)x(n+2)$

3. a) Write a Matlab script to generate and plot the following discrete time signals for $-10 \le n \le 10$. Also compute their energies and display them on command prompt.

i) $x(n) = (0.8)^{n-1}$

ii) $x(n) = \exp((1+j)*n)$ (plot the magnitude, phase, real and imaginary parts on four different subplots)

iii) $x(n) = 2\delta(n-2) - \delta(n+4)$

iv) $$x(n) = \frac{5\sin\left(\frac{\pi}{2}n\right)}{\pi n}$$

b) Prove any five Fourier series properties for discrete time signals.

4. a) Perceval's theorem for both Continuous and discrete time signals in Fourier transform.

b) Let $x(n) = u(n) - u(n-10)$. Write a Matlab script to decompose $x(n)$ into even and odd components and plot them on two separate subplots.

5. a) Convolution for both Continuous and discrete time signals.

b) Generate and plot the signal: $x(t) = \sin(2\pi t)$, for $0 \le t \le 2$ with an increment of 0.01. Find the scaled versions of $y_1(t) = x\left(\frac{t}{2}\right)$ & $y_2(t) = x\left(\frac{t}{16}\right)$ and plot them.

6. a) Correlation for both Continuous and discrete time signals.

b) The sinusoidal Fourier series of any periodic continuous waveform with period 'T=1 sec' is given by

$$x(t) = a_0 + \sum_{n=1}^{N} a_n \cos\left(\frac{2n\pi t}{T}\right) + \sum_{n=1}^{N} b_n \sin\left(\frac{2n\pi t}{T}\right)$$ where

$$a_0 = 0, a_n = 0, b_n = \begin{cases} \frac{4}{n\pi}, \text{for } n = 1,3,5,7.... \\ 0 \quad \text{for } n = 2,4,6,.... \end{cases}$$ (for square wave)

Consider 't' form -3sec to 3sec in steps of 0.01. Compute and plot $x(t)$ for the upper limit of n=15

7. a) Prove any five Fourier transforms properties for discrete time signals.

b) The sinusoidal Fourier series of any periodic continuous waveform with period 'T=1 sec' is given by

$$x(t) = a_0 + \sum_{n=1}^{N} a_n \cos\left(\frac{2n\pi t}{T}\right) + \sum_{n=1}^{N} b_n \sin\left(\frac{2n\pi t}{T}\right)$$ where

$$a_0 = 0, a_n = 0, b_n = -\frac{1}{n\pi}$$ (for saw tooth wave)

Consider 't' form -3sec to 3sec in steps of 0.01. Compute and plot $x(t)$ for the upper limit n=25.

8. a) Analysis of system stability and causality issues in Z-Transform.

b) The sinusoidal Fourier series of any periodic continuous waveform with period 'T=1 sec' is given by

$$x(t) = a_0 + \sum_{n=1}^{N} a_n \cos\left(\frac{2n\pi t}{T}\right) + \sum_{n=1}^{N} b_n \sin\left(\frac{2n\pi t}{T}\right)$$ where

$$a_0 = 0, a_n = 0, b_n = (-1)^{\frac{n-1}{2}} \frac{8}{n^2\pi^2}$$ (for triangular wave)

Consider't' form -3sec to 3sec in steps of 0.01. Compute and plot $x(t)$ for the upper limit n=35.

9. a)Consider the difference equation of a causal system:

$y(n) - y(n-1) + 0.9y(n-2) = x(n)$ for all n

I) Calculate and plot the impulse response $h(n)$ for $-20 \le n \le 100$

II) Calculate and plot the unit step response $s(n)$ for $-20 \le n \le 100$

III) Find out the stability of the system.

b) Let $x(n) = u(n) - u(n-9)$ and $h(n) = (0.9)^n$. Write a Matlab script to find out the linear convolution of $y(n) = x(n) * h(n)$ and plot $x(n), h(n)$ and $y(n)$ in different subplots.

10. a) Evaluate the DTFT of $x(n) = (0.9)^n u(n)$, at 512 equidistant points between $[-\pi, \pi]$ and plot its magnitude, phase, real and imaginary parts on four different subplots.

Extend the computation to 1024 equidistant points between $[\pi, 5\pi]$, and observe its

periodicity and conjugate symmetry properties by plotting suitable plots.

b) Study the characteristics of EEG signal.

11. a) A third order system is described by the difference equation

$$y(n) = 0.0181x(n) + 0.0543x(n-1) + 0.0543x(n-2) + 0.0181x(n-3)$$
$$+1.76\,y(n-1) - 1.1829\,y(n-2) + 0.2781y(n-3)$$

Plot the magnitude and phase response of this system and verify that it is a low pass filter.

b) The sinusoidal Fourier series of any periodic continuous waveform with period 'T=1 sec' is given by.

$$x(t) = a_0 + \sum_{n=1}^{N} a_n \cos\left(\frac{2n\pi t}{T}\right) + \sum_{n=1}^{N} b_n \sin\left(\frac{2n\pi t}{T}\right)$$

where

$$a_0 = \frac{1}{\pi}, a_n = \begin{cases} -\frac{2}{\pi(n^2-1)}, \text{for } n = 2,4,6,8.... \\ 0 \quad \text{for } n = 1,3,5,7,.... \end{cases}, b_n = \begin{cases} \frac{1}{2}, \text{ for } n = 1 \\ 0 \quad \text{for } n > 1 \end{cases}$$

(Half wave Rectified sine wave)

Consider 't' form -3sec to 3sec in steps of 0.01. Compute and plot $x(t)$ for the upper limit n=35.

12. a) Spectrogram and magnitude response analysis for different speech signals.

b) Two different signals $x_1(n) = \cos(0.1\pi n)$ and $x_2(n) = \cos(0.4\pi n)$.

Compute and plot the sequence $x(n) = 3x_1(n) - 2x_2(n)$ and its delayed version $x_d(n) = x(n-5)$

Mode of Evaluation: Review I, Review II and Review III

Approved by Academic Council	No. 39	Date	17-12-2015

Course Code	Course Title	L	T	P	J	C
ECE1017	ELECTROMAGNETIC FIELD THEORY AND TRANSMISSION LINES	3	0	0	0	3
Pre-requisite	PHY 1001-Engineering Physics				Version : 1	

Course objectives (CoB):

The course is aimed to

1. Acquaint the students with basic concepts and properties of Electrostatics & Magnetostatics.
2. Making the students to understand the propagation of EM wave through time varying Maxwell's equations and to analyze the EM Wave propagation in different conducting and dielectric media.
3. Making the students to comprehend the concept of transmission and reflection in various transmission lines and to design different transmission lines and matching circuits using Smith chart

Course Outcomes (CO):

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

1. Evaluate and analyze Electric Fields & Electric Potential due to different Charge distributions.
2. Compute and analyze magnetic fields in different material media.
3. Understand the propagation of EM wave through time varying Maxwell's equations
4. Comprehend the EM wave propagation in conducting as well as in dielectric materials.
5. Calculate power of an EM wave while propagating through different materials.
6. Illustrate the wave mechanism in different transmission lines at high frequencies using transmission line parameters.
7. Design Impedance matching circuits using Smith chart.

Module:1	**Electrostatics**	**6 hours**	

Coulomb's Law, Electric Fields due to Different Charge Distributions, Gauss Law and Applications, Electrostatic Potential and Equipotential surfaces, Energy Density, Poisson's and Laplace's Equations; Capacitance – Parallel Plate, Coaxial, Spherical Capacitors, Method of Images. Convection and Conduction currents, Continuity Equation, Relaxation Time, Joules Law, Analogy between D and J.

Module:2	**Magnetostatics**	**6 hours**	

Biot-Savart's Law, Ampere's Circuital Law and Applications, Magnetic Flux Density, Maxwell's Two Equations for Magnetostatic Fields, Magnetic Scalar and Vector Potentials, Forces due to Magnetic Fields, Ampere's Force Law, Inductances and Magnetic Energy.

Module:3	**Maxwell's Equations (Time Varying Fields)**	**6 hours**	

Faraday's Law and Transformer emf, Inconsistency of Ampere's Law and Displacement Current Density, Maxwell's Equations in Different Final Forms and Word Statements, Conditions at a Boundary Surface : Dielectric-Dielectric and Dielectric-Conductor Interfaces.

Module:4	**EM Wave Characteristics - I**	**7 hours**	

Wave Equations for Conducting and Perfect Dielectric Media, Uniform Plane Waves – Definition, All Relations Between E & H, Sinusoidal Variations, Wave Propagation in Lossless and Conducting Media, Conductors & Dielectrics – Characterization, Wave Propagation in Good Conductors and Good Dielectrics, Polarization, Illustrative Problems.

Module:5	**EM Wave Characteristics – II**	**7 hours**	

Reflection and Refraction of Plane Waves – Normal and Oblique Incidences, for both Perfect Conductor and Perfect Dielectrics, Brewster Angle, Critical Angle and Total Internal Reflection, Surface Impedance, Poynting Vector and Poynting Theorem – Applications, Power Loss in a Plane Conductor, Illustrative Problems.			
Module:6	**Transmission Lines - I**	**6 hours**	
Types, Parameters, Transmission Line Equations, Primary & Secondary Constants, Expressions for Characteristic Impedance, Propagation Constant, Phase and Group Velocities, Infinite Line Concepts, Losslessness/Low Loss Characterization, Distortion – Condition for Distortionlessness and Minimum Attenuation, Loading - Types of Loading, Illustrative Problems.			
Module:7	**Transmission Lines – II**	**5 hours**	
Input Impedance Relations, SC and OC Lines, Reflection Coefficient, VSWR, UHF Lines as Circuit Elements: λ/4, λ2, λ/8 Lines – Impedance Transformations, Significance of Z_{min} and Z_{max} Smith Chart – Configuration and Applications, Single and Double Stub Matching, Illustrative Problems.			
Module:8	**Contemporary issues:**	**2 hours**	
Total Lecture Hours: 45 hours			
Text Book(s) **1.** Matthew N.O. Sadiku, Elements of Electromagnetics, 2014, 6th Edition, Oxford University Press, India **2.** E.C. Jordan and K.G. Balmain, Electromagnetic Waves and Radiating Systems, 2015, 2nd Edition, PEI, India			
Reference Books 1. Umesh Sinha, Transmission Lines and Networks, 2010, Satya Prakash Publication, New Delhi.			
Mode of Evaluation: Continuous Assessment Test, Digital Assignment, QUIZ, FAT			
Recommended by Board of Studies :		26-11-2016	
Approved by Academic Council :	43	Date :	12/12/2016

Course code	Course Title	L	T	P	J	C
ECE2010	Control Systems	3	0	0	4	4
Pre-requisite	ECE1004 -Signals and Systems MAT2002 - Applications of Differential and Difference Equations	Syllabus version				
		2.0				

Course Objectives:

1. To understand the use of transfer function models for the analysis of physical systems and to introduce the components of control system.
2. To provide adequate knowledge in the time response of systems and steady state error analysis along with the understanding of closed loop and open loop in frequency domain.
3. To introduce the design of compensators and controllers for the stability analysis.
4. To introduce state variable representation of physical systems and study the effect of state feedback

Expected Course Outcomes:

1. Differentiate real-time applications as open loop or closed loop systems.
2. Analyze the system from the transfer function.
3. Design of compensators and controllers and find the stability of these control systems.
4. Ability to compute steady state and transient response of the different order of the system and also to analyze its error coefficients.
5. Analyze the frequency domain response of the control systems.
6. Apply various control systems concepts to analyze and find the stability of control systems.
7. Analyze the observability of the system in state modeling.

Module:1	Introduction to Control Systems	3 hours

Basic block diagram of control system, Control schemes – Open loop and closed loop, Applications and scope.

Module:2	Mathematical Modeling of Physical Systems	8 hours

Uncertainty, self-information, average information, mutual information and their properties - Entropy and information rate of Markov sources - Information measures of continuous random variables.

Module:3	Controller and Compensator Design	8 hours

Controllers – P, PI, PID controllers, Realization of basic compensators, Cascade compensation in time domain and frequency domain, Feedback compensation, Design of lag, lead, lag-lead series compensator, Introduction to control system components: DC and AC Servo motors, Stepper motor and Synchros.

Module:4	Time Domain Response	6 hours

Steady state and transient response, Time domain specifications, Types of test inputs, Response of first order and second order systems, Steady state error, error constants, generalized error coefficient.

Module:5	Characterization of Systems	4 hours

Stability – Concept and definition, Poles, Zeros, Order and Type of systems; R-H criteria, Root locus analysis.

Module:6	Frequency Domain Response	8 hours

Frequency response – Performance specifications in the frequency domain, Phase margin and gain

margin, Bode plot, Polar plot and Nyquist plot, Stability analysis in frequency domain.			
Module:7	**State Space Analysis**		**6 hours**
Concept of state and state variable, Modeling of systems using state variables, Coordinate transformations and canonical realizations, Solution of state variables, Controllability and observability.			
Module:8	**Contemporary Issues**		**2 hours**
	Total Lecture Hours:		**45 hours**
Text Book(s)			
1.	Norman S. Nise, "Control Systems Engineering", 2014, 7th Edition, John Wiley & Sons, New Jersey, USA		
1.	I.J. Nagarth and M. Gopal, "Control Systems Engineering", 2017, 6th Edition, New Age International, New Delhi, India.		
2.	Farid Golnaraghi and Benjamin C Kuo, "Automatic Control Systems", 2014, 9th Edition, **Wiley India Pvt. Ltd**, New Delhi, India.		
Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).			
Approved by Academic Council	No. 40	Date	18-03-2016

Course code	Course title	L	T	P	J	C
ECE2017	PHYSIOLOGICAL SYSTEM MODELING	2	0	2	0	3
Prerequisite	ECE2012-Control Systems Engineering	Syllabus version				
		v.2.0				

Course Objectives:

1. To introduce the basic system concepts and differences between an engineering and physiological control systems.
2. To acquaint students with different mathematical techniques applied in analysing a system and the various types of nonlinear modelling approaches.
3. To teach neuronal membrane dynamics and to understand the procedures for testing, validation and interpretation of physiological models.
4. To study the cardiovascular model and apply the modelling methods to multi input and multi output systems.

Expected Course Outcome:

The student will be able to

1. Understand the basic system concepts and differences between an engineering and physiological control systems.
2. Apply different mathematical techniques to analyze a system.
3. Comprehend the various nonlinear modelling approaches.
4. Understand the neuronal membrane dynamics.
5. Apply the procedures for testing, validation and interpretation of physiological models.
6. Comprehend the cardiovascular model.
7. Analyse the modelling methods to multi input and multi output systems.

Module:1	**System Modeling in Physiology**	**5 hours**

The problem of system modeling in physiology - Need for modeling - Conceptual and mathematical models – Modeling - experiments and simulation - Feedback control systems - Difference between engineering and physiological control systems.

Module:2	**Physiological Modeling**	**5hours**

Deductive and Inductive modeling - Characteristics of a reliable physiological model - Modeling a simple reflex - Mathematical modeling.

Module:3	**Nonlinear Modeling**	**4hours**

System Identification, Model Specification, Model estimation. Types of nonlinear modeling approaches. Non parametric modeling. Volterra and Wiener models. Volterra Kernels. Modeling the vertebrate retina. Analysis of estimation errors.

Module:4	**Modeling of Neuronal Systems**	**4 hours**

A general model of the nerve membrane - Action potential and synaptic dynamics - Functional integration in the single neuron -Neuronal systems with point process inputs - Conduction in nerve fibres - Voltage clamp experiment - Hodgkin Huxley (H-H) model - Circuit analog of the H-H nerve membrane model.

Module:5	**Systems Identification in Physiology**	**4 hours**

System characteristics -System parameters - System functional properties -Input characteristics -

Experimental considerations -Data preparation -Data consolidation -Model specification and estimation tasks - Model validation and interpretation.		
Module:6	**Modeling of Cardiovascular Systems**	**3 hours**
Cardiovascular systemic and pulmonary circulation - Lumped model of the cardiovascular system - Pulmonary physiology - Respiratory control system.		
Module:7	**Multi Input/ Output Systems**	**3 hours**
Modeling of multi input/ multi output systems -The Two-input case - Applications of Two-input modeling to physiological systems.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book	
1.	Michael C.K. Khoo, "Physiological Control Systems: Analysis, Simulation and Estimation,"2011, 1st edition, Prentice Hall of India, New Delhi.
Reference Books	
1.	Suresh Devasahayam, "Signal Processing and Physiological Systems Modeling", 2013, 1st edition, Springer, New York.
2.	Joseph D. Bronzino and Donald R. Peterson, "The Biomedical Engineering Handbook", 2015, 4thedition, CRC Press, Florida.

Mode of Evaluation: CAT, Digital Assignment, Quiz and FAT

List of Challenging Experiments (Indicative)		
1.	The pupillary light reflex is a classic example of a negative feedback control system. Design a control system model for the light reflex system in the retina.	6 hours
2.	Develop a model for a system where the glucose uptake is dependent on insulin concentration in the plasma and that insulin production rate is dependent on the glucose concentration in the plasma.	6 hours
3.	The Bainbridge reflex is a cardiac reflex that aids in matching of cardiac output (the flow rate at which blood is pumped out of the heart) to venous return (the flow rate at which blood returns to the heart). Design a servomechanism model to adjust the cardiac output to track venous return.	6 hours
4.	Several types of physiological receptors exhibit the property of rate sensitivity. Carbon dioxide receptors have been found in the lungs of humans, birds and reptiles. Design a model in which ventilation may be controlled by the intrapulmonary receptors following denervation of the carotid bodies.	6 hours
5.	The regulation of water balance in the body is intimately connected with the control of sodium excretion. One major mechanism of sodium reabsorption involves the renin-angiotensin-aldosterone system. Design a model to describe the regulation process in the kidney.	6 hours
	Total Laboratory Hours	30 hours

Mode of Evaluation: Continuous Assessments and FAT

Recommended by Board of Studies	21-08-2017		
Approved by Academic Council	No. 47	Date	5-10-2017

Course Code	Course Title	L	T	P	J	C
ECE2024	PRINCIPLES OF COMMUNICATION ENGINEERING	2	0	0	0	2
Pre-requisite	ECE1013 - Electronic Circuits	Version : 1.1				

Course Objectives:

The course is aimed at making the students to
1. Study about the elements and the types of communication systems.
2. Know about the concepts of synchronization schemes in communication system
3. Familiarize with the concepts of spread spectrum technique

Expected Course Outcome:

At the end of the course, the Students will be able to
1. Acquionte the spectrum of amplitude modulated signals and design systems for generation and demodulation of amplitude modulated signals.
2. Understand the importance of power efficient amplitude modulation schemes and use them for analog data transmission
3. Familiarize with fundamental concepts and design issues in modulation and demodulation process of angle modulation
4. Know about digital modulation techniques and apply them for digital data transmission.
5. Identity the significance of synchronization technique in communication.
6. Study the concepts behind spread spectrum communication systems.

Module:1	**Amplitude Modulation**	**4 hours**	

Modulation – Need for modulation- Elements of Communication system-Types of modulation - Amplitude Modulation (AM) – frequency spectrum of AM– Power in AM wave – Generation of AM signal - Square law modulator, switching modulator, AM demodulation - Envelope and square law demodulation.

Module:2	**Power Efficient in AM system**	**3 hours**	

DSB-SC - SSB-SC and VSB modulation- generation and demodulation. Power and bandwidth calculation of linear modulation systems.

Module:3	**Angle Modulation and Demodulation**	**5 hours**	

Principle of Frequency Modulation (FM) and Phase Modulation (PM) – Relation between FM and PM – Frequency deviation, Bandwidth of FM – Narrow band and wide band FM, FM transmitter, FM detectors – slope detectors – Phase discriminators – Ratio detectors - Phase Locked Loop (PLL)- Pre-emphasis and de-emphasis.

Module:4	**Digital Transmission**	**3 hours**	

Introduction- Sampling – Quantization - PCM – Differential Pulse Code Modulation (DPCM) - Delta Modulation (DM)- Adaptive Delta Modulation (ADM)-Companding.

Module:5	**Digital Modulation Scheme**	**5 hours**	

Gram-Schmidt orthogonalization procedure –Generation and Detection of Coherent system (BASK, BFSK, BPSK, QPSK, MSK) – Error performance- Correlation Receiver.

Module:6	**Synchronization Techniques**	**4 hours**	

Receiver Synchronization- Time and Frequency synchronization techniques- PLL- Network and Frame synchronization- Early Late Gate synchronization- Costas Loop.

Module:7	**Spread Spectrum Communication**	**4 hours**	

PN Sequences – properties- Design principles- Direct sequence (DS) and Frequency Hopping (FH) spread spectrum -Code Division Multiple Access (CDMA) - RAKE receiver structures- SSTDR.

Module:8	**Contemporary issues:**	**2 hours**	
	Total Lecture hours:	**30 hours**	

Text Book(s)			
1.Simon Haykins, Communication Systems, 2013, 4th Edition, Wiley, USA.			
Reference Books			
1.John G. Proakis, Digital Communication, 2014, 5th Edition, McGraw-Hill, India. 2. Sklar, Digital Communications: Fundamentals and Applications, 2009, 2nd Edition, Pearson Education, India.			
Mode of Evaluation :Continuous assessment test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies :		23-02-2018	
Approved by Academic Council :	43	Date :	12-12-2016

Course Code	Course Title	L	T	P	J	C
ECE2024	PRINCIPLES OF COMMUNICATION ENGINEERING	2	0	0	0	2
Pre-requisite	ECE1013 - Electronic Circuits	Version : 1.1				

Course Objectives:

The course is aimed at making the students to
1. Study about the elements and the types of communication systems.
2. Know about the concepts of synchronization schemes in communication system
3. Familiarize with the concepts of spread spectrum technique

Expected Course Outcome:

At the end of the course, the Students will be able to
1. Acquionte the spectrum of amplitude modulated signals and design systems for generation and demodulation of amplitude modulated signals.
2. Understand the importance of power efficient amplitude modulation schemes and use them for analog data transmission
3. Familiarize with fundamental concepts and design issues in modulation and demodulation process of angle modulation
4. Know about digital modulation techniques and apply them for digital data transmission.
5. Identity the significance of synchronization technique in communication.
6. Study the concepts behind spread spectrum communication systems.

Module:1	**Amplitude Modulation**	**4 hours**	
Modulation – Need for modulation- Elements of Communication system-Types of modulation - Amplitude Modulation (AM) – frequency spectrum of AM– Power in AM wave – Generation of AM signal - Square law modulator, switching modulator, AM demodulation - Envelope and square law demodulation.			
Module:2	**Power Efficient in AM system**	**3 hours**	
DSB-SC - SSB-SC and VSB modulation- generation and demodulation. Power and bandwidth calculation of linear modulation systems.			
Module:3	**Angle Modulation and Demodulation**	**5 hours**	
Principle of Frequency Modulation (FM) and Phase Modulation (PM) – Relation between FM and PM – Frequency deviation, Bandwidth of FM – Narrow band and wide band FM, FM transmitter, FM detectors – slope detectors – Phase discriminators – Ratio detectors - Phase Locked Loop (PLL)- Pre-emphasis and de-emphasis.			
Module:4	**Digital Transmission**	**3 hours**	
Introduction- Sampling – Quantization - PCM – Differential Pulse Code Modulation (DPCM) - Delta Modulation (DM)- Adaptive Delta Modulation (ADM)-Companding.			
Module:5	**Digital Modulation Scheme**	**5 hours**	
Gram-Schmidt orthogonalization procedure –Generation and Detection of Coherent system (BASK, BFSK, BPSK, QPSK, MSK) – Error performance- Correlation Receiver.			
Module:6	**Synchronization Techniques**	**4 hours**	
Receiver Synchronization- Time and Frequency synchronization techniques- PLL- Network and Frame synchronization- Early Late Gate synchronization- Costas Loop.			
Module:7	**Spread Spectrum Communication**	**4 hours**	
PN Sequences – properties- Design principles- Direct sequence (DS) and Frequency Hopping (FH) spread spectrum -Code Division Multiple Access (CDMA) - RAKE receiver structures-SSTDR.			
Module:8	**Contemporary issues:**	**2 hours**	

	Total Lecture hours:	**30 hours**	
Text Book(s)			
1.Simon Haykins, Communication Systems, 2013, 4th Edition, Wiley, USA.			
Reference Books			
1.John G. Proakis, Digital Communication, 2014, 5th Edition, McGraw-Hill, India. 2. Sklar, Digital Communications: Fundamentals and Applications, 2009, 2nd Edition, Pearson Education, India.			
Mode of Evaluation :Continuous assessment test, Digital Assignment, Quiz and Final Assessment Test			
Recommended by Board of Studies :		20-11-2016	
Approved by Academic Council :	43	Date :	12-12-2016

Course Code	Course Title	L	T	P	J	C
ECE2026	DIGITAL CIRCUIT DESIGN	2	0	2	4	4
Pre-requisite	ECE1013 - Electronic Circuits	Syllabus Version				
		1.1				

Course Objectives:

The course is aimed at
1. Introducing the concepts of digital and binary systems.
2. Enabling design and analysis of combinational and sequential logic circuits.
3. Learning basic software tools for the design and implementation of digital circuits and systems.

Expected Course Outcome:

The students will be able to
1. Understand the number systems and concepts of digital logic families to delve into its hardware aspects.
2. Use Boolean algebra in digital logic circuit design.
3. Design and analyze combinational logic and sequential logic digital circuits
4. Understand the basic software tools for the design and implementation of digital circuits and systems.
5. Design and analyze sequential logic circuits.
6. Use Hardware Description Language in the design and implementation of digital circuits, both combinational and sequential.
7. Reinforce theory and techniques related to digital circuits and systems through experiments and work on rudimentary projects.

Module:1	**Logic Families & Programmable Logics**	**3 hours**	
Brief review of Number Systems, Digital Logic Gates and its electrical characteristics, Review of RTL, DTL, TTL, ECL, CMOS families, PAL, PLD, CPLD and FPGA Generic Architecture.			
Module:2	**Boolean algebra &Gate-Level Minimization**	**3 hours**	
Basic Definitions, Axiomatic Definition of Boolean Algebra, Basic Theorems and Properties of Boolean Algebra, Boolean Functions, Canonical and Standard Forms. The Map Method - K-map, Product of Sums and Sum of Products Simplification, NAND and NOR Implementation			
Module:3	**Design of Combinational Logic Circuits**	**4 hours**	
Design Procedure, Binary Adder-Subtractor, Parallel Adder, Binary Multiplier, MagnitudeComparator-4 bit, Decoders, Encoders, Multiplexers, De-multiplexer, Parity generator and checker. Application of Mux and Demux.			
Module:4	**Hardware description Language (HDL)**	**6 hours**	
Lexical Conventions, Ports and Modules, Gate Level Modeling, Operators, Data Flow Modeling, Behavioral level Modeling, Testbench.			
Module:5	**Design of Sequential Logic Circuits:**	**6 hours**	
Latches, Flip-Flops-SR, D, JK & T, Shift Registers-SISO, SIPO, PISO,PIPO, Design of synchronous sequential circuits- State table and state diagrams, Design of counters-Modulo-n, Johnson, Ring, Up/Down, Design of Mealy and Moore FSM -Sequence detection.			
Module:6	**Modeling of Combinational Logic Circuits using HDL**	**3 hours**	
Design of Comparators, 8-bit Carry Look Ahead adders and Array multiplier.			
Module:7	**Modeling of Sequential Logic Circuits using HDL**	**3 hours**	
Sequence detector and vending machine design using FSM.			

Module:8	**Contemporary issues:**	**2 hours**	
	Total Lecture hours:	**30 hours**	
Text Book(s)			
1. M. Morris R. Mano and Michael D. Ciletti , Digital Design With an Introduction to the Verilog HDL,2014, 6th Edition, Prentice Hall of India Pvt. Ltd., India.			
Reference Books			
1. Pedroni V.A, Circuit Design and Simulation With VHDL, 2011, 2nd Edition, Prentice Hall India. 2. Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, 2010, 2nd Edition, Prentice Hall of India Pvt. Ltd., India.			
Mode of Evaluation :Continuous assessment test, Digital Assignment, Quiz and Final Assessment Test			
List of Challenging Experiments (Indicative)			
1.	Implementation of Full adder, Full subtractor using MUX/Decoder ICs (Hardware)		4 hours
2.	Design of Universal shift register, based on the control input it should function as anyone of the following shift registers, Serial in Serial out, Serial in serial out, Parallel in Parallel out and Parallel in Serial out.		6 hours
3.	Design 4 bit adder and 4 bit array Multiplier using basic logic gates and implement the design in Altera FPGA		6 hours
4.	Design a FSM that has an input *w* and output *z*. The machine is a sequence detector that produces $z = 1$ when the previous two values of *w* were 00 or 11 otherwise $z = 0$		6 hours
5.	Design of a circuit that controls the traffic lights at the intersection of two roads. The circuit generates the outputs G1, Y1, R1 and G2, Y2, R2. These outputs represent the states of the green, yellow, and red lights, respectively, on each road. (a) Give an ASM chart that describes the traffic-light controller. Assume that two down counters exist, one that is used to measure the t1 delay and another that is used to measure t2. Each counter has parallel-load and enable inputs. These inputs are used to load an appropriate value representing either the t1 or t2 delay and then allow the counter to count down to 0. (b) Give an ASM chart for the control circuit for the traffic-light controller. (c)Write complete Verilog code for the traffic-light controller, including the control circuit from part (a) and counters to represent t1 and t2. Use any convenient clock frequency to clock the circuit and assume convenient count values to represent t1 andt2. Give simulation results that illustrate the operation of your circuit.		8 hours
		Total Laboratory Hours	30 hours
Mode of Evaluation :Continuous assessment test and Final Assessment Test			
Typical Projects			

1. Design a Voting Machine using verilog HDL and implement the system on FPGA. The system should support to add upto ten candidates and should take the number of voters and display the result after providing a passcode
2. Design and implement a 7 segment LED matrix based display system, which is developed to display information regularly or the message in scrolling form. The system takes input directly from the keyboard and the typed message is displayed.
3. Design a 24 hour Digital Clock that has a format of HH:MM:SS using Verilog HDL Code using counters.
4. Design a calculator using verilog HDL which will be able to perform unsigned and signed

addition/subtraction, multiplication of unsigned and signed numbers with 8 bit inputs.			
Mode of Evaluation : Continuous Assessment Reviews			
Recommended by Board of Studies :		20-11-2016	
Approved by Academic Council	:43	Date :	12-12-2016

Course Code	Course Title	L	T	P	J	C
ECE2028	ANALOG CIRCUITS	2	0	2	4	4
Pre-requisite	EEE1001 - Basic Electrical and Electronics Engineering	Syllabus Version				
		2.0				

Course Objectives:

1. Analysis the operation of BJT, MOSFET, I_V characteristics and the biasing techniques for BJT based amplifier circuits.
2. Discuss the small-signal analysis of amplifier circuits using hybrid models and the frequency response of amplifiers.
3. Explore the concept of feedback, types and its application in different amplifier and oscillator circuits.
4. Explain the operation of a differential amplifier with dc characteristics and small-signal analysis.

Expected Course Outcome:

The students will be able to

1. Design and analyze the basic characteristics of BJT and MOSFET in different configurations, apply suitable biasing techniques and be able to use hybrid models of BJT and MOSFET.
2. Determine the small signal parameters of amplifiers in CE and CS mode using ac equivalent circuits and use it for frequency response.
3. Comprehend the need for multistage amplifiers and be able to suggest a suitable configuration for specific applications.
4. Understand the different classes of power amplifier circuits, their designs and power conversion efficiencies.
5. Comprehend the feedback concepts, feedback topologies and design of oscillators.
6. Determine the dc characteristics of MOSFET differential amplifier, small signal analysis and its frequency response.
7. Design and conduct experiments using BJT, MOSFET, to analyze the characteristics and interpret its operation as amplifiers and oscillators.
8. Design and implement an idea suitable for a specified application.

Module:1	**BJT Biasing and BJT amplifiers**	**4 hours**
Operation of BJT, I_V Characteristics of BJT in CE mode, Q-point, Self Bias-CE,CE amplifier andEmitter follower,hybrid-model of BJT.		
Module:2	**MOSFET Biasing and MOSFET amplifiers**	**4 hours**
Operation of MOSFET (Enhancement mode), DC Characteristics of MOSFET, Self bias of CS mode, CS amplifier and Source follower circuit, hybrid model of MOSFET		
Module:3	**Small signal analysis of amplifiers**	**3 hours**
Small signal analysis of amplifiers in CE mode and CS mode: voltage and current gain, input and output impedance;Frequency response of CE and CS amplifiers.		
Module:4	**Multistage amplifiers**	**3 hours**
Frequency response of a two stage RC coupled amplifier (BJT & MOSFET), bandwidth of cascaded amplifiers, concept of wide band amplifier and Darlington pair.		
Module:6	**Feedback Amplifiers & Oscillators**	**5 hours**

Feedback concept, negative & positive feedback, voltage/ current, series/shunt feedback, Barkhausen criterion, Colpitts, Hartley's, Phase shift, Wein bridge and crystal oscillators.		
Module:5	**Power amplifiers**	**4 hours**
Classification of large signal amplifiers, Class A, B, AB, C, Conversion efficiency, Tuned amplifier.		
Module:7	**MOSFET differential amplifiers**	**5 hours**
Basic MOSFET differential pair, DC characteristics of differential amplifier, small signal analysis of differential amplifier, frequency response of differential amplifier.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Adel S. Sedra& Kenneth C. Smith, Microelectronic Circuits, 2017, 7th edition, Oxford University Press, USA.
Reference Books	
1.	D. A. Neamen, "Electronic Circuit Analysis and Design" 3/e, Tata McGraw-Hill, New Delhi, 2007.
2.	T. F. Boghart, J. S. Beasley and G. Rico,Electronic Devices and Circuits, Pearson Education, 6/e, Delhi, 2004
3.	Robert L. Boylestad& Louis Nashelsky, Electronic Devices and Circuit Theory, 2015, 11th edition, Pearson Education, India.

Mode of Evaluation: Theory: Continuous Assessment Test, Quiz, Digital Assignment, Final Assessment Test, Additional Learning (MOOC / Conference, Journal Publications / Makethon / Project competition and more)

List of Challenging Experiments (Indicative)		
1.	Design of small signal BJT and MOSFET amplifiers using self bias technique and analyzing the effect of capacitors on voltage gain and frequency response of the amplifiers.	6 hours
2.	Design of Multistage amplifiers to improve the frequency response, input impedance and enhance the voltage gain using two stage RC coupled amplifier, Cascode amplifier and Darlington pair.	6 hours
3.	Design of Power amplifiers using BJT/MOSFET for high power applications and analyzing the non - linear distortions occurring in those amplifiers. Suggesting suitable technique to eliminate the distortions and also to improve the power conversion efficiency.	6 hours
4.	Design of differential amplifier circuits to improve the CMRR and estimating the effect of mismatch in the load resistance and transconductance of the transistors	6 hours

List of Projects

1. Design of a regulated DC power supply system of various ranges using discrete devices like diodes, capacitors and resistors.
2. Design a system that will automatically sense the rain and in turn enables the wiper system in automobiles.
3. Design of smart Home automation system using basic sensors, relays and controller units.
4. Design of an Electronic code lock circuit using transistors and basic discrete components that provides high level security.
5. Design of a public addressing system employing small signal and large signal BJT/MOSFET amplifiers.
6. Design an automatic temperature sensing and controlling system for a boiler unit using thermocouple and signal conditioning circuit.

Recommended by Board of Studies :	23-02-2018		
Approved by Academic Council :	49	Date	15-03-2018

Course code	Course title	L	T	P	J	C
ECE2029	Sensors and Transducers for Healthcare	2	0	2	0	3
Prerequisite:	EEE1001 Basic Electrical and Electronics Engineering	Syllabus version				
		v1.0				

Course Objectives:

1. Develop a comprehensive understanding of the technologies behind the embedded systems
2. Discover the programming concepts and embedded programming in linux
3. Discuss the overview of embedded networking
4. Introduce student to the Internet of things (IOT) with interfacing sensors, actuators for portable gadgets.

Expected Course Outcome:

1. Gain the basic idea of measurements and the errors associated with measurement
2. Differentiate between the types of sensors available
3. Select a suitable sensor for a given application
4. Apply the knowledge about the measuring instruments to use them more effectively
5. Relate the self-generating sensors with passive sensors
6. Comprehend the basics of signal conditioning
7. Comprehend the operation and characteristics of special measurement systems

Module:1	Introduction to Sensors and Transducers	3 hours

General concepts and terminology of Sensor systems, Transducers classification-sensors and actuators, General input-output configurations, Static and dynamic characteristics of measurement system.

Module:2	Principles of Measurement and Analysis	3 hours

Units and standards, Errors , Functional Elements of a Measurement System and Instruments, Applications and Classification of Instruments, Types of measured Quantities, Measures of Dispersion, Sample deviation and sample mean, Calibration and standard.

Module:3	Resistive Sensors	4 hours

Resistive sensors- Potentiometers, strain gages (piezo-resistive effect), resistive temperature detectors (RTD), thermistors, magnetoresistors, light dependent resistor (LDR), resistive hygrometers, resistive gas sensors.

Module:4	Reactive Sensors:	4 hours

Inductive sensors - variable reluctance sensors, Hall effect, Eddy current sensors, Linear variable differential transformers (LVDT), variable transformers, magneto-elastic, magneto-resistive, and magnetostrictive sensors. Capacitive sensors- variable capacitor, differential capacitor.

Module:5	Self generating Sensors:	4 hours

Thermoelectric sensors, piezo-electric sensors, pyroelectric sensors, photovoltaic sensors, electrochemical sensors

Module:6	Bio-Instrumentation and Sensors for Healthcare	5 hours

Types of electrophysiological measurements, Electrocardiography (ECG), Electroencephalography (EEG), Electromyography (EMG); The origin of biopotentials, Measurement of biopotentials, Resting and Action Potentials, Propagation of Action Potentials, Examples of biopotential electrodes and signals, Microelectrodes; Introduction to Biosensors.		
Module:7	**Advanced Sensors**	**5 hours**
Optical Sensors, Chemical and Gas Sensors, Accelerometers, MEMS, BioMEMS		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture:	**30 hours**
Text Books:		
1.	B. C. Nakra, K.K. Choudhury, "Instrumentation, Measurement and Analysis" -3rd Edition, Tata McGraw, 2009	
Reference Books:		
1.	A.K. Sawhney, "Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai.	
2.	Er. R.K. Rajput, "Electronic Measurements and Instrumentation", S. Chand & Company Ltd. 3rd Edition.	
3.	Bentley, John P., "Principles of Measurement Systems", 4thedition, Pearson/Prentice Hall, 2005.	
4.	Jon. S. Wilson, "Sensor Technology Hand Book", Elsevier Inc., 2005.	
Mode of Evaluation: Continuous Assessment Test, Quiz, Digital Assignment, Final Assessment Test, Additional Learning (MOOC / Conference, Journal Publications / Make a thon / Project competition and more)		
List of Experiments (Indicative)		
1. Strain gauge sensors for measurement of normal strain.		3 hrs
2. Strain gauge sensors for measurement of Shear strain and Angle of twist.		4 hrs
3. Displacement measurement using LVDT		3 hrs
4. Displacement measurement using Hall effect sensor		3 hrs
5. Displacement measurement using LDR		3 hrs
6. Temperature measurement using RTD		3 hrs
7. Temperature measurement using Thermistor		3 hrs
8. Temperature measurement using Thermocouple		3 hrs
9. Static and Dynamic characteristics for Piezoelectric sensors		5 hrs
	Total Laboratory Hours	30 hrs
Mode of Evaluation: Continuous Assessments and FAT		
Recommended by Board of Studies :	23-02-2018	
Approved by Academic Council : 49	Date :	15-03-2018

Course code	Course Title	L	T	P	J	C
ECE2030	PHYSIOLOGICAL SIGNAL PROCESSING	2	0	2	0	3
Prerequisite:	ECE1004-Signals and Systems	Syllabus Version 1.0				

Course Objectives:

1. To understand the fundamentals of biomedical signal acquisition and signal classification
2. To impart knowledge about physiological signal processing and analysis
3. To apply adaptive filtering techniques for cancelling noise and interference in the various bio-signals

Expected Outcomes:

The student will be able to

1. Examine the basic signal processing for bio-signals
2. Illustrate the knowledge about spectral analysis
3. Comprehend cardialogical signal processing methods
4. Formulate an algorithm for bio-signal processing in frequency domain
5. Describe an adaptive filtering algorithms for biosignals
6. Comprehend the classification of bio signals using wavelets
7. Demonstrate the feature reduction methods for different bio signlas

Module:1	**Physiological Signal Characteristics**	**3 Hours**

Characteristics of dynamic biomedical signals – Noises-random – Structured and Physiological noises – Filters – IIR and FIR filters.

Module:2	**Spectrum Analysis**	**4 Hours**

Spectrum – Power Spectral Density function –Cross Spectral Density and Coherence function – Cepstrum and Homomorphic filtering – Estimationof mean of finite time signals.

Module:3	**Time Series Analysis**	**4 Hours**

Time series analysis – Linear prediction models – Processorder estimation – Lattice representation –Non-stationary process –Fixedsegmentation – Adaptive segmentation –Application in EEG, PCG signals – Timevarying analysis of Heart-rate variability –Modelbased ECG simulator.

Module:4	**Frequency Domain Analysis**	**4 Hours**

Spectral estimation – Blackman Tukey method – Periodogram – Model based estimation – Application in heart rate variability, PCG signals.

Module:5	**Adaptive Filtering**	**3 Hours**

Filtering – LMS adaptive filter –Adaptive noise canceling in ECG – Improvedadaptive filtering in FECG.

Module:6	**Wavelet Detection and Bio-signal Classification**	**5 Hours**

Wavelet detection in ECG – Structural features – Matchedfiltering – Adaptivewavelet detection –Detection of overlapping wavelets – Signalclassification and recognition – Statistical signal classification –Linear discriminant function –Directfeature selection and ordering.

Module:7	**Time Frequency and Multivariate Analysis**	**5 Hours**

Back propagation neural network based classification – Applicationin Normal versus Ectopic ECG beats – Timefrequency representation – Spectrogram – Wignerdistribution – Time-Scale representation – Scalogram – Waveletanalysis – Data reduction techniques – ECG data compression – ECGcharacterization – Featureextraction – Wavelet packets – Multivariatecomponent analysis –PCA – ICA.

Module:8	**Contemporary Issues**	**2**		
	Total Lecture:	**30**	**Hours**	

Text Book:		
1.	Rangaraj.M.Rangayyan, "Biomedical Signal Processing",2014,1st edition, IEEE press, New York.	
Reference Book:		
1.	N.Vyas, "Biomedical Signal Processing", 2011,1st edition,University Science Press, New Delhi.	
Mode of Evaluation: CAT, Digital Assignment, Quiz and FAT		
List of Challenging Experiments: (Indicative)		
1.	Acquire two ECG samples from same and two different individuals. Perform correlation between the samples. Tabulate and interpret the results.	6 hours
2.	Acquire the ECG signal and add 60 Hz sine wave to it. Plot the PSD to show the noise on the mixed signal. Design an appropriate filter to remove the noise and plot the PSD of the filtered signal to show that noise is removed. Explain the design aspect of the filter.	6 hours
3.	Consider the ECG, EMG, and EEG Signals. Apply different compression techniques like TP, AZTEC and CORTES on them and compute the compression ratio. Now reconstruct the compressed signal with the original and identify the percentage of data lost.	6 hours
4.	Process a bio-signal and extract any feature from it. Explain the preprocessing and the feature extraction methods used.	6 hours
5.	Record your own speech in three different media and compare the speech signals. Estimate the h(n) of your two medias (different mobiles) by assuming one of them as your x(n). Use a linear approach in obtaining the result 1 and use deconvolution to obtain the result 2 and compare both the results.	6 hours
	Total Laboratory Hours	30 hours
Mode of Evaluation: CAT and FAT		

Recommended by Board of Studies :		23-02-2018	
Approved by Academic Council :	49	Date :	15-03-2018

Course code	Course Title	L	T	P	J	C
ECE2031	Antenna and Microwave Engineering	3	0	0	0	3
Prerequisite:	ECE1017-Electromagnetic Field Theory and Transmission	Syllabus Version				
		1.00				

Course Objectives:

4. To introduce and discuss the mechanism for antenna parameters, radiating principles and fundamental characteristics.
5. To comprehend operational principles of microwave sources and to characterize microwave networks.
6. To design and analyse various passive and active microwave circuits.

Expected Outcomes:

The student will be able to

1. Identify basic antenna parameters and comprehend the radiation mechanism of various antennas
2. Design and analyze antenna arrays and wire antennas
3. Design and analyze aperture antennas and patch antennas for microwave applications
4. Identify various microwave sources and measurement schemes for microwave circuits.
5. Analyze microwave circuits with power dividers and ferrite devices using scattering parameters
6. Understand the importance of filters and high frequency transistors to design microwave amplifiers.

Module:1	EM Radiation and Antenna Parameters	7 Hours

Radiation mechanism-single wire, two wire, dipole and current distribution on thin wire, Radiation pattern, beam width, field region, radiation power density, directivity and gain, bandwidth, polarization - co polarization and cross polarization level, input impedance, efficiency, antenna effective length and area, antenna temperature. Friss Transmission, Radar range equation.

Module:2	Linear and Planar Arrays	6 Hours

Two element array, N-element linear array- broadside array, End fire array-Directivity, radiation pattern, pattern multiplication. Non-uniform excitation- Binomial, Chebyshev distribution, Planar array, circular array –array factor, directivity – Phased Array antenna

Module:3	HF, UHF and Microwave Antennas	6 Hours

Wire Antennas - long wire, V-Antenna, rhombic antenna, loop antenna-helical antenna, Yagi-Uda antenna, Frequency independent antennas - spiral and log periodic antenna- Aperture antennas – Horn antenna, Parabolic reflector antenna- Microstrip antenna.

Module:4	Microwave Sources	6 Hours

Microwave frequencies (IEEE Standards), Microwave Tubes: TWT, Klystron amplifier, Reflex Klystron, Magnetron. Semiconductor Devices: Gunn diode, Tunnel diode, IMPATT-TRAPATT-BARITT diodes, PIN Diode.

Module:5	Microwave Network Analysis	5 Hours

Scattering matrix - reciprocal networks and lossless networks, generalized S-parameters - signal flow graph – decomposition of signal flow graphs.

Module:6	Power dividers and ferrite devices	6 Hours

S-matrix analysis of E-Plane Tee, H-Plane Tee, Magic Tee, Multi-hole directional coupler. Introduction to Microstrip lines. T junction and resistive power divider, Wilkinson power divider, branch line coupler (equal & unequal), Rat Race Coupler (180^o hybrid coupler). principle of faraday rotation, isolator, circulator and phase Shifter.

Module:7	Microwave filters and Amplifiers	7 Hours

Filter design , Low pass filter implementation (Butterworth and Chebyshev) - Richards transformation, Microwave Transistors: BJT, FET, MESFET. Microwave amplifiers: Two port power gains, stability of the amplifier- design of single stage amplifier for maximum gain.		
Module:8	**Contemporary Issues**	**2 Hours**
	Total Lecture:	**45 Hours**
Text Book:		
1.	C.A. Balanis, "Antenna Theory - Analysis and Design", 2016, 3rd edition, Wiley & Sons, New York, USA.	
2.	D. M. Pozar, "Microwave engineering", 2012, 4th edition, John Wiley & Sons, USA	
3.	Samuel Y. Liao, "Microwave Devices and Circuits", 2015 (Reprint), 3rd edition, Pearson Education, UK.	
Reference Book:		
1.	N.Vyas, "Biomedical Signal Processing", 2011,1st edition,University Science Press, New Delhi.	
2.	Warren L. Stutzman and Gary A. Thiele, "Antenna theory and Design", 2013, 3rd edition, Wiley & Sons, New York, USA.	
3.	Annapurna Das and S.K. Das, "Microwave Engineering", 2017, 3rd edition, Tata McGraw- Hill, India.	
4.	Albert Sabban, "Wideband RF Technologies and Antennas in Microwave Frequencies", 2016, Wiley, New York USA.	
Mode of Evaluation: CAT, Digital Assignment, Quiz and FAT		
Recommended by Board of Studies :		
Approved by Academic Council :	49	Date :

Course Code	Course Title	L	T	P	J	C
ECE3030	PRINCIPLES OF COMPUTER COMMUNICATION	3	0	2	0	4
Pre-requisite	ECE2024 - Principles of Communication Engineering	Version : 1.1				

Course Objectives:

The course is aimed at

1. Teaching the students the basic terminologies and concepts of OSI, TCP/IP reference model and functions of various layers.
2. Making the students to understand the protocols, design and performance issues associated with the functioning of LANs and WLANs.
3. Introducing the students to queuing models and basic concepts of network security.

Expected Outcomes:

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

1. Explain the functions of the OSI, TCP/IP reference models and differentiate between various switching techniques and internetworking devices
2. Analyze the performance of data link layer protocols, LAN and WLAN standards
3. Design subnets using routing techniques
4. Demonstrate the functioning of TCP and UDP
5. Deduce the performance of queuing models
6. Tackle the issues related to network security
7. Carry out the analysis the performance of internetworking devices, various LAN, WLAN and routing protocols using simulation tools

Module:1	**Introduction to Data Communication and Networking Devices**	**7 hours**	

Evolution of data Networks – Switching Techniques – Network Topologies – Categories of Networks – ISO/OSI Reference Model – TCP/IP Model – Inter Networking Devices – Repeaters – Hubs – Switches – Bridges: Transparent Bridges, Spanning tree algorithm.

Module:2	**Data Link Layer**	**6 hours**	

Logical Link Control – Error Detection Techniques (only CRC and checksum) – ARQ protocols– Framing – HDLC. Medium Access Control – Random access Protocols – Scheduling approaches to MAC.

Module:3	**Local Area Networks**	**6 hours**	

Ethernet – Virtual LAN – Wireless LAN-Zigbee

Module:4	**Network layer**	**6 hours**	

Internetworking – IP Addressing – Subnetting – IPv4 and IPv6 – Routing – Distance Vector and Link State Routing – Routing Protocols.

Module:5	**Transport Layer**	**6 hours**	

Connection oriented and Connectionless Service – User Datagram Protocol – Transmission Control Protocol.

Module:6	**Queueing models**	**6 hours**	

Markov chain theory - Queueing model basics and Little's law - M/M/1 and its variants - M/G/1, G/M/1, FIFO, WFQ and priority queues.

Module:7	**Network Security**	**6 hours**	

Basic concepts: confidentiality, integrity, availability, security policies, security mechanisms, assurance: Transposition/Substitution, Caesar Cipher, Introduction to Symmetric crypto primitives, Asymmetric crypto primitives, and Hash functions: Data Encryption Standard (DES).

Module:8	**Contemporary issues:**	**2 hours**	

	Total Lecture:	**45 hours**	
Text Book(s)			
1.Alberto Leon-Garcia, Communication Networks, 2012, Ninth Reprint, Tata McGraw-Hill, India.			
Reference Books			
1. Robert Gallager, Data Networks, 2010, 2nd edition, Prentice Hall, India. 2. W. Stallings, Data and Computer Communications, 2004, Prentice Hall, India. 3. Behrouz A. Foruzan, Cryptography and Network Security, 2007, Tata McGraw-Hill, India.			
Mode of Evaluation: Continuous assessment test, Digital Assignment, Quiz, Final Assessment Test			
List of Challenging Experiments (Indicative)			
1.	Analyze the Performance of a Local Area Network interconnected by switches and Hubs		6 hours
2.	Analyze and evaluate the performance of the data packet using CSMA-CA and CSMA-CD		6 hours
3.	Estimate the shortest path from source to destination using Routing Information Protocol.		6 hours
4.	Design and analyze the performance of Queuing Disciplines (M/M/1 and M/G/1)		6 hours
5.	Analyze the performance of 802.11g with different nodes		6 hours
		Total Laboratory Hours	30 hours
Mode of Evaluation: Continuous assessment task, Final Assessment Test			
Recommended by Board of Studies :	26-02-2017		
Approved by Academic Council:	44	Date :	16-03-2017

Course Code	Course Title	L	T	P	J	C
ECE3031	MICROCONTROLLER AND EMBEDDED SYSTEMS	2	0	2	4	4
Pre-requisite	ECE2026 - Digital Circuit Design	Syllabus Version				
		1.1				

Course Objectives:

The course is aimed at

1. Acquainting students with the basic concepts of architecture 8085, 8086 and ARM processors and 8051 microcontroller – with its organization and architecture and also the RAM-ROM organization.
2. Enabling the students to work with 8051 microcontroller and its instruction set as well programming to accomplish simple tasks about? explain
3. Familiarizing about timer, ports, serial communication and peripherals interrupts available in 8051.
4. Knowing about the peripherals interfaced with 8051 microcontroller and, various embedded system design for simple applications using 8051 and others. Statement is improper

Course Outcome:

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

1. Know about the various microprocessor and microcontroller architectures
2. Understand techniques for accessing data from RAM/ ROM of 8051 microcontrollers
3. Know about various 8051 instructions and addressing modes for suitably programming the microcontroller for a task.
4. Comprehend the operation of timer and ports, peripherals in 8051 with various modes of operation and at different baud rates
5. Study about the various 8051 interrupts and their uses.
6. Know the methodology to handle data conversion: Analog to Digital (A/D) and vice-versa.
7. Acquire the overview of various embedded system design using 8051 and other microcontrollers targeting simple applications
8. Write efficient codes and be able to interface the hardware with 8051 microcontrollers. Should be able to design a real time project prototypes which includes 8051 as one of the hardware component.

Module:1	**Introduction to Processors**	**2 hours**	
Introduction to Microprocessors and Microcontrollers, 8-bit/16-bit/32-bit Microprocessor Architectures 8085, 8086, ARM.			
Module:2	**8051 Architecture**	**4 hours**	
8051 -organization and architecture. RAM-ROM organization, Machine cycle			
Module:3	**8051 Instruction set**	**8 hours**	
Data Processing-Stack, Arithmetic, Logical ; Branching-unconditional, conditional			
Module:4	**8051 Peripherals: Timer and ports**	**3 hours**	
Peripherals: I/O Ports, Timers-Counters			
Module:5	**8051 Peripherals: Serial and Interrupt**	**3 hours**	
Peripherals: Serial Communication, Interrupts			

Module:6	**Peripheral Interfacing**	**6 hours**	
Interfaces: LCD, LED, Keypad, ADC, DAC ,SENSOR with Signal Conditioning Interface			
Module:7	**Embedded System Design**	**2 hours**	
Embedded system design using 8051 and other microcontrollers			
Module:8	**Contemporary issues:**	**2 hours**	
			Total Lecture hours: 30 hours

Text Book(s)

1. Mohammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D Mc Kinlay, The 8051 Microcontroller and Embedded Systems, 2014, Pearson Education Limited, India.

Reference Books

1. Swapnil Mahtre, Microprocessors and Interfacing Techniques, 2012, Navigator Series, Mumbai University, India
2. Douglas V. Hall, Microprocessors and interfacing: Programming and hardware, 2011, Tata McGraw Hill, India
3. Soumitra Kumar Mandal Microprocessors And Microcontrollers Architecture, Programming & Interfacing Using 8085, 8086 And 8051, 2011, Tata McGraw Hill, India

Mode of Evaluation: Continuous assessment test, Digital Assignment, Quiz, Final Assessment Test

List of Challenging Experiments (Indicative)		
1.	Write an 8051 ALP to transfer a string of data from code space starting at address 200H to RAM locations starting at 40H. The data is as shown below: 0200H:DB VIT UNIVERSITY using the simulator, single-step through the program and examine the data transfer and registers. Add the following subroutine to the program ,single-step through the subroutine and examine the RAM locations. After data has been transferred from ROM space into RAM, the subroutine should copy the data from RAM locations starting at 40H to RAM locations starting at 60H.	6 hours
2.	Write an 8051 ALP to add two multi-byte BCD numbers together and store the result in RAM locations 40H - 44H. The two multi-byte items are stored in the ROM space starting at 120H and 150H. See the following example data. ORG 120H DATA_1: DB 54H,76H,65H,98H ;number 98657654H DATA_2 DB 93H,56H,77H,38H ;number 38775693H Pick your own data for your program. Notice that you must first bring the data from ROM space into the CPU's RAM and then add them together. Use a simulator to single-step the program and examine the data.	4 hours
3.	Write an 8051 ALP using interrupts to do the following: (a) Receive data serially and sent it to P0, (b) Have port P1 read and transmit serially, and a copy is given to P2, (c) Make timer 0 generate a square wave of 5kHz frequency on P3.1. Assume that XTAL-11.0592MHZ. Set the baud rate at 4800.	4 hours
4.	Write and assemble a program to toggle all the bits of P0, P1, and P2 continuously by sending 55H and AAH to these ports. Put a time delay between the on and off states. Then, using the simulator, single-step through the program and examine the ports. Do not single-step through the time delay	4 hours

	call. Get the Data From Port P1 and Send it to Port P2,Note:P1 as input Port and P2 as Output Port	
5.	Write a program to send the message 'India is our Country' to a serial port. Assume a SW is connected to pin P1.2.Monitor its status and set the baud rate as Follows: SW = 0, 4800 baud rate SW = 1, 9600 baud rate Assume XTAL = 11.0592 MHz, 8-bit data, and 1 stop bit.	4 hours
6.	Write an 8051 ALP using interrupts to do the following: (a) Receive data serially and sent it to P0, (b) Have P2 port read and transmitted serially, and a copy given to P1, (c) Make timer 1 generate a square wave of 3Khz frequency on P3.5. Assume that XTAL-11.0592MHz. Set the baud rate at 9600.	4 hours
7.	Assume that the 8051 serial port is connected to the COM port of IBM PC, P1 and P2 of the 8051 are connected to LEDs and switches, respectively. Write an 8051 assembly program to (a) send to PC the message We Are Ready, (b) receive any data send by PC and put it on LEDs connected to P1, and (c) get data on switches connected to P2 and send it to PC serially.	4 hours
		Total Laboratory Hours : 30 hours

Mode of Evaluation: Continuous assessment task, Final Assessment Test			
Recommended by Board of Studies :		20-11-2016	
Approved by Academic Council :	43	Date :	12-12-2016

Course code	Course title	L	T	P	J	C
ECE3029	Graphical System Design for Communication Engineers					
		0	0	4	0	2
Prerequisite	ECE 2024 Principles of Communication Engineering	Version :				
Course Objectives:		1.1				

The course is aimed at

1. Training students in virtual instrumentation tools like Lab View
2. Imparting hands – on training in developing various analog communication systems
3. Imparting the fundamental concepts of Communication in Virtual Instrumentation

Course Outcome:

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

1. Code a labview program for Amplitude modulation.
2. Demonstrate simulation of Single Sideband Transmission and its characteristics
3. Code a labview program for Frequency modulation.
4. Analyse the Harmonics of modulated waveforms.
5. Design, simulate and analyse Super heterodyne receiver.
6. Construct PPM and PWM signals.
7. Simulate and carry out a study on TDM and FDM systems.

Task:1	**8 hours**	

Amplitude Modulation and demodulation

a) Design and analyze the performance of Amplitude Modulation (AM)
   (i) Time domain
   (ii) Frequency domain
b) Analyze and study the significance of modulation index(m) of AM
   (i) m<1
   (ii) m= 1
   (iii) m>1

Task:2	**8 hours**	

Single sideband Transmission

a)Design and analyze the performance of Single Side Band (SSB) Transmission.
(i) Time domain
(ii) Frequency domain
b) Compare and analyze the performance of AM, AM-SSB and VSB.

Task:3	**8 hours**	

Frequency Modulation and demodulation

a) Design and analyze the performance of FM receiver
b) Compare and analyze the performance of AM and FM.

Task:4	**8 hours**	

Pulse Modulation Scheme

a) Design and analyze the performance of Pulse Amplitude Modulation (PAM) and demodulation (To detect the original message signal)
b) Using PAM design Pulse Position Modulation (PPM) and detect the original signal.

Task:5	**8 hours**	

Sampling and Quantization

a) Analyze the performance of Sampling, Quantization and Encoding using (i) Sinusoidal Signal (ii) Random signal (Preferably Voice signal)		
Task:6	**8 hours**	
Pulse Code Modulation a) Design a system which coverts analog signal into digital and vice versa. (i) Sinusoidal signal (ii) Voice signal		
Task:7	**4 hours**	
a) Multiplexing Scheme (i) Design and analyze the performance of (ii) Time Division Multiplexing (TDM) (iii) Frequency Division Multiplexing (FDM)		
Task:8	**8 hours**	
Spread Spectrum Communication a) Design the Pseudo Noise (PN) sequence generator (minimum 4 stage shift register) and verify its properties. Design and analyze the performance of Direct Sequence-Spread Spectrum (DS-SS).		
Total Practical Hours:	**60 hours**	
Text Book(s)		
(1) Ian Fairweather, Anne Brumfield, LabVIEW: A Developer's Guide to Real World Integration, 2011, CRC Press, USA.		
Reference Books		
1. Lisa K Wells, LabVIEW for Everyone, 1996, Reprint, Prentice Hall of India, New Delhi. 2. Barry E Paton, Sensor, Transducers and LabVIEW, 2000, Reprint, Prentice Hall, New Delhi. 3. Sanjay Gupta and Joseph John, Virtual Instrumentation Using LabVIEW, 2010, Reprint, Tata McGraw-Hill Co. Ltd., India. 4. Travis, Travis Jeffrey, LabVIEW For Everyone: Graphical Programming Made Easy And Fun, 2017, 3rd Edition, Pearson Education, India.		
Mode of Evaluation : Continuous assessment and Final Assessment Test		
Recommended by Board of Studies :	26-02-17	
Approved by Academic Council : 44	Date:	16-03-2017

Course code	Course title	L	T	P	J	C
ECE3041	Biomedical Instrumentation and Measurements	2	0	2	0	3
Pre-requisite	ECE2029 Sensors and Transducers for Healthcare	Syllabus version				
		v1.0				

Course Objectives:

1. To elaborate the development of biomedical instrumentation and its application in medical field, and the concepts behind measuring the blood pressure, cardiac output and heart sounds.
2. To revise the basics of EEG and to introduce the concepts of measuring the brain activity, and to familiarize them with the basic principle, working and design of various automated diagnostic equipment related to ENT and ophthalmology.
3. To elaborate the need of Scopy techniques in medical field and to develop the understanding towards the medical laboratory equipment.
4. To deliver the awareness towards shocks and hazards.

Expected Outcome:

1. To comprehend the development of biomedical instrumentation and its application in medical field.
2. Excel in measuring the blood pressure, cardiac output and heart sounds and to design small products related to this application.
3. To conceive the basics of EEG and the concepts of measuring the brain activity
4. To understand the basic principle, working and design of various automated diagnostic equipment related to ENT and ophthalmology.
5. Ability to differentiate between different kinds of scopy for several applications.
6. To excel in first level trouble shooting for the breakdown happening with the medical laboratory equipment.
7. Ability to plan, design and implement an instrument for medical applications.

Module:1	Introduction	5 hours

Introduction to Physiological System of Human Body, Development of Biomedical Instrumentation, Man instrument system, Problems encountered in the measurement, Body as a Control System, General constraints in design of medical instrumentation system.

Module:2	Cardiovascular and respiratory Instrumentation	5 hours

Heart and cardiovascular system-model, Physiological Pressures, Blood pressure measurement, Measurement of heart sounds, Systemic and Pulmonary Circulation, Blood flow measurement, Cardiac output, Measurement of Pulmonary function, ECG, Standard Lead System, Respiratory system-model, Spirometer, Plethysmography.

Module:3	Nervous System and Instrumentation	4 hours

Neuronal communication system, The organization of the brain, measurements from the nervous system, EEG, Standard Lead System, Amplitude and Frequency Bands, Evoked Potential Recording, Sensory Measurement, Experimental Analysis of Behavior, Biofeedback Instrumentation.

Module:4	ENT and Ophthalmic Instrumentation	4 hours

Mechanism of hearing, Measurement of Sound, Basic Audiometer, Pure Tone and Speech Audiometer, Hearing Aids, Optometry, EOG

Module:5	**Endocrine and Urological Instrumentation**	**4 hours**
Endocrine system, Glucometer, ELISA, Endoscope, Cystoscope, Urological system: Nephroscope, Resectoscope, Ureteroscope.		
Module:6	**Medical Laboratory Instrumentation**	**3 hours**
Calorimeter, Flame photometer, Spectrophotometer, pH and Blood Gas Analyzer, Auto Analyzer.		
Module:7	**Electrical Safety and Hazards**	**3 hours**
Physiological Effects of Electrical Current, Shock Hazards, Methods of Accident Prevention		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book	
1.	Joseph Carr, Brown, Introduction to Biomedical Equipment, Pearson, 2014
Reference Books	
1.	Leslie Cromwell, "Biomedical Instrumentation and measurement", PHI, New Delhi, 2015
2.	John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2015.
3.	Khandpur R.S Hand Book of Biomedical Instrumentation – Tata McGraw Hill publication , New Delhi, 2014.

Experiments:

1. Recording of Blood Pressure, Heart sounds
2. Recording of ECG Signal
3. Recording of EMG Signal
4. Recording of EEG Signal
5. Measurement of pH and conductivity
6. Study of Endoscopes
7. Measurement of visually evoked potential
8. Pulse oximetry

Mode of Evaluation: Theory: Continuous Assessment Test, Quiz, Digital Assignment, Final Assessment Test, Additional Learning (MOOC / Conference, Journal Publications / Make a thon / Project competition and more)

Recommended by Board of Studies	23-02-2018		
Approved by Academic Council	49	Date	15-03-2018

Course Code	Course Title	L	T	P	J	C
ECE3042	Data Acquisition Techniques	3	0	0	4	4
Pre-requisite	Analog Circuits	Syllabus version				
		v1.0				

Course Objectives:

1. To discuss the principles of operational amplifiers and the type of signal conditioning needed for a specific sensor output
2. To define the principles of analog to digital and digital to analog conversion techniques for data acquisition
3. To compare the communication standards, PC buses and the functioning of distributed and standalone loggers used in data acquisition
4. To introduce students to virtual instrumentation and the hardware interfacing

Expected Course Outcomes:

The students will be able to

1. Comprehend the principles of operational amplifiers and their applications
2. Formulate the type of signal conditioning needed for a specific sensor output
3. Analyze the analog to digital and digital to analog conversion techniques
4. Identify the communication standards and PC buses for data acquisition
5. Discover the functioning of distributed and standalone loggers
6. Design the virtual instrumentation and write software for data acquisition from circuits.
7. Develop a device to measure physical parameters for specific application

Module:1	Operational Amplifier and its applications	6 hours

Ideal OPAMP, Differential Amplifier, CMRR, Open & Closed loop circuits, inverting & non inverting amplifiers, voltage follower/buffer circuit. DC characteristics and AC characteristics of op-amp, Adder, comparator, Instrumentation amplifiers and Schmitt trigger.

Module:2	Design of Signal Conditioning Circuit	5 hours

Signal amplifiers, analog filters, digital and pulse train conditioning, distributed I/O, noise reduction and isolation

Module:3	Analog to Digital Conversion	4 hours

Introduction to ADC, Sampling and Holding, Quantizing and Encoding, Accuracy of A/D converters, Types of A/D converters, Plug-in data acquisition boards- parameter setting- Sampling strategies for multi-channel analog inputs- speed vs throughput.

Module:4	Digital to Analog Conversion	4 hours

Introduction to DAC, Types of DACs, D/A boards-parameter setting - timing circuitry-output amplifier buffer- bus interface, Digital I/O boards. Counter-timer I/O boards.

Module:5	Interface Standards and PC buses	3 hours

RS232, RS422, RS485, GPIB, RJ 11, RJ 45, USB, Firewire; Backplane buses - PCI, PCI-Express, PXI, PXI – Express, VME, VXI; Ethernet –TCP/IP protocols.

Module:6	Distributed and Stand-alone Loggers	2 hours

Programming and logging data using PCMCIA cards- stand-alone operation- direct and remote

connection to host PC, Host software- data loggers vs internal systems		
Module:7	**Virtual Instrumentation**	**4 hours**
Virtual instrument and traditional instrument, Hardware and software for virtual instrumentation, Virtual instrumentation for test, control, and design, Graphical programming.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture:	**30 hours**

Text Book(s)	
1.	Sergio Franco, Design with Operational Amplifiers & Analog Integrated Circuits, 2014, 4th edition, McGraw Hill Higher Education, United States.
2.	Ramon Pallas-Areny and John G Webster, Sensors and Signal Conditioning, 2012, 2nd ed., Wiley India Pvt. Ltd.
3.	John Park and Steve Mackay, Practical Data acquisition for Instrumentation and Control, 2011, 1st ed., Newness publishers, Oxford, UK.
Reference Books	
1.	Maurizio Di Paolo Emilio, Data Acquisition systems- from fundamentals to Applied Design, 2013, 1st ed., Springer, New York.
2.	Robert H King, Introduction to Data Acquisition with LabVIEW, 2012, 2nd ed., McGraw Hill, New York.
3.	Robert F. Coughlin and Frederick F. Driscoll, Operational Amplifiers and Linear Integrated Circuits, 2015, 6th edition, Pearson Education, London.

Mode of Evaluation: Theory: Continuous Assessment Test, Quiz, Digital Assignment, Final Assessment Test, Additional Learning (MOOC / Conference, Journal Publications / Make a thon / Project competition and more)

List of Projects: (Indicative)	
1. Design of differential amplifier and instrumentation amplifier: Build a sensor bridge circuit using Multisim, having 1kΩ elements and sensitivity of 10mV/V with 5V excitation circuit. At full scale, sensors in the bridge exhibit 1% change in resistance value. Design the following amplifier circuits so that the full scale output of the amplifier is 5V. i) Single op amp differential amplifier. ii) Three op amp instrumentation amplifier. Simulate the above circuits to measure the voltage at its full scale.	4 hours
2. Design of signal conditioning circuit for RTD: Design a RTD based temperature measurement circuit to convert 0˚ C to 80 ˚ C into 0 - 5V. Error should not exceed ±1 ˚C. The given RTD has the following specifications: RRTD at 0˚ C is 100Ω, and temperature coefficients of resistance a is 0.004Ω/ ˚C. Build the circuit in Multisim and simulate it.	4 hours
3. Building temperature measurement system using NI Elvis: Design a thermocouple based temperature measurement circuit to convert 0 ˚ C to 50 ˚C into 0- 5V. If the temperature exceeds 60 ˚C then a LED alarm should glow. Build the circuit using NI ELVIS board. Test the performance of the circuit.	4 hours
4. Design of cold junction compensation while using a thermocouple: A K type thermocouple is to be used in the measurement system which must provide an output of 2V at 200 ˚C. A solid state temperature sensor system	4 hours

will be used to provide a reference temperature correction. Temperature sensor has three terminals: supply, output voltage and ground and the output varies as 8mV/ ˚C. Sensitivity of K-type thermocouple is 50µV/˚ C at 200 ˚C. Build the circuit in multisim and simulate it.	
5. Programming with LabVIEW: Signal acquisition and generation: Create a simple VI that simulates an analog signal and plots it on a waveform graph. The VI will give user control of the frequency and amplitude of this wave. Configure the following DAQ cards: i) NI ELVIS, ii) myDAQ and iii) cDAQ to generate the signal simulated by the simple VI. Also configure the DAQ cards to acquire the generated signal and display it on waveform graph.	5 hours
6. Measuring strain, temperature, pressure (various physical parameters) using LabVIEW:	4 hours
7. Design of LabVIEW system using Hall effect sensor: a) Using NI ELVIS tools study the properties of Hall-effect sensor. b) Build a simple gauss-meter and a position measurement system using a linear Hall-effect sensor. Plot the Hall voltage versus distance using the data measured. b) Using NI ELVIS tools study the properties of LDR. b) Build a simple LED light intensity controller, i.e switching on and off LED lights using LDR as a sensor. When there is light available the LED should be off but at night it should be on. c) LabVIEW interface for ultrasonic based distance measurement.	5 hours
Total Laboratory Hours	30 hours

Mode of Evaluation: Theory: Continuous Assessment Test, Quiz, Digital Assignment, Final Assessment Test, Additional Learning (MOOC / Conference, Journal Publications / Make a thon / Project competition and more)			
Recommended by Board of Studies :	23-02-2018		
Approved by Academic Council	49th	Date	15-03-2018

Course code	Course Title	L	T	P	J	C
ECE3043	Digital Image Processing for Medical Applications	2	0	2	0	3
Prerequisite	ECE1018	Syllabus version				
		v1.0				

Course Objectives:

1. To discuss digital image fundamentals and image enhancement techniques
2. To discover the principles filtering techniques in spatial domain and frequency domain for enhancement and restoration
3. To identify the segmentation techniques for feature extraction from images and classification
4. To formulate image registration techniques and virtual reality

Expected Course Outcome:

Student is expected to:

1. Comprehend image sampling and DFT
2. Process the given images to enhance them in spatial and frequency domains
3. Restore degraded images using frequency domain filters such as adaptive and Wiener filters
4. Extract features from a given image by segmentation and classify them
5. Develop algorithms for image compression
6. Register images from different modalities for better visualization and diagnosis
7. Develop algorithms for specific applications

Module:1	**Image Processing Fundamentals**	**2 hours**
Modulating transfer function of visual system, Digitizing an image, medical image formats, image quality and information content- histogram, entropy, Fourier Transform and spectral contents, Signal-to-Noise-Ratio		
Module:2	**Removal of Noise in Medical Images**	**5 hours**
Noise characterization, multi-frame averaging, statistics based filters, frequency domain filters for high frequency noise and periodic noise removal, Wiener filter, adaptive filters		
Module:3	**Medical Image Enhancement**	**5 hours**
Digital subtraction angiography, gray scale transforms, Histogram transformation, convolution mask operators, high frequency emphasis, homomorphic filtering, contrast enhancement		
Module:4	**Image Restoration**	**2 hours**
Modelling image degradation, Inverse filtering, Wiener filtering, motion deblurring, blind deblurring.		
Module:5	**Medical Image Analysis and Classification**	**6 hours**
Image segmentation – pixel based, edge based, and region based, morphological operations. Representation of shapes and contours, shape factors, statistical analysis of texture. Feature extraction and image classification - statistical, rule based and neural network approaches.		
Module:6	**Image Compression**	**5 hours**
Lossy Vs lossless compression, distortion measures and fidelity criteria, Direct source coding, transform coding, predictive coding, Image coding and compression standards		
Module:7	**Image Registration and Visualization**	**3 hours**
Image registration - Rigid body transformation, Principal axis registration, Interactive principal axis registration, Feature based registration, Elastic deformation based registration, Image visualization - Surface rendering, volume rendering, virtual reality		

Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book	
1.	Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing", 2016, 3rd edition, Pearson Education, Noida.
Reference Books	
1.	Anil Jain K. "Fundamentals of Digital Image Processing", 2011, 1st edition, Prentice Hall India Learning Pvt. Ltd, Delhi.
2.	Malay K. Pakhira, "Digital Image Processing and Pattern Recognition", 2011, 1st edition, Prentice Hall India Learning Pvt. Ltd, Delhi.
3.	Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using MATLAB", 2011, 2nd edition, McGraw Hill Pvt. Ltd., New York.
4.	William K Pratt, "Digital Image Processing", 2013, 1st edition, CRC Press, Florida.
Mode of Evaluation: Continuous Assessment Test, Quiz, Digital Assignment, Final Assessment Test, Additional Learning (MOOC / Conference, Journal Publications / Make a thon / Project competition and more)	

List of Challenging Experiments (Indicative)		
1.	Read the given x-ray image using Matlab software and perform contrast enhancement and remove the noise using spatial low pass filters. Compare their performance.	6 hours
2.	Read the CT image of the given lungs image, perform intensity enhancement, and extract the nodules in the lungs using Matlab software.	6 hours
3.	Segment the white matter, gray matter and CSF from the given MRI image using Matlab software.	6 hours
4.	Process the given endoscopic images and extract the tumor detected using Matlab software.	6 hours
5.	Extract the blood vessels from the given retinal image using Matlab software.	6 hours
	Total Laboratory Hours	30 hours
Mode of Evaluation: Continuous Assessments and FAT		

Recommended by Board of Studies	23-02-2018		
Approved by Academic Council	49	Date	15-03-2018

Course code	Course title	L	T	P	J	C
ECE4029	Medical Device Technology	3	0	0	4	4
Pre-requisite	ECE3041 Biomedical Instrumentation and Measurements	Syllabus Version				
		v1.0				

Course Objectives:

Expected Course Outcome:

1. To apply physical science concepts to understand how they can be used in medical diagnostics
2. To compare the functioning of physiological and mechanical cardio vascular system
3. To comprehend and analyze the functioning of respiratory equipment
4. To analyze the machines that are available in intensive care units
5. To comprehend analyze the functioning of Laser and surgical equipment
6. To comprehend and analyze medical imaging devices
7. To choose appropriate technology to construct medical devices

Module:1	Medical Ultrasonography	6 hours

Physics of Sound and Sound Waves, Absorption and Attenuation of Ultrasound, Scan Modes, Biological Effects of Ultrasound, Transducers, Doppler, Flowmeters, Echo Encephalograph

Module:2	Cardiac Assistive and Coronary Care Devices	6 hours

Cardiac Defibrillator, AC & DC Defibrillator, Implantable Defibrillator, Cardiac Pacemaker, External, Internal, Implantable Pacemakers, Heart Lung Machine, Holter monitoring.

Module:3	Respiratory Therapy Equipment	6 hours

Classification of Ventilators, Types, Artificial Ventilation, Humidifiers, Nebulizers, Aspirators, Anesthesia Machine, Oximeters

Module:4	Intensive Care Devices	6 hours

Dialyzers, Portable Kidney Machines, Infusion Pumps, Automated Drug Delivery Systems, Bedside Monitors, Central Monitoring Consoles, Fetal Monitoring, Wireless Telemetry, Multi patient Telemetry

Module:5	Laser and Surgical Instruments	6 hours

Surgical Diathermy, Shortwave Diathermy, Microwave Diathermy, Lithotripsy, Safety aspects in Electro Surgical Units, Introduction to Lasers, Application of Pulsed Ruby, Nd-YAG, Helium-Neon, Argon, CO_2, Excimer Lasers.

Module:6	Radiology and Nuclear Medicine	7 hours

Electromagnetic Radiation, Nature and types of Nuclear Radiation, Units for measuring radioactivity, Origin and nature of X-Rays, X – Ray Tube, Fluoroscopy, Effect of Nuclear Radiation on Human Body, Computed Tomography - System Components, Gantry Geometry, Patient Dose, Pulse Height Analyzer, Radio Isotope Rectilinear Scanner, Gamma Camera, ECT, SPECT, PET

Module:7	Magnetic Resonance and Thermal Imaging	6 hours

Principles of NMR in Imaging Reconstruction Techniques, NMR Components, Biological Effects of

NMR, Advantages of NMR, Medical Thermography, Mammography, Infra-Red Detectors, Quantitative Medical Thermography		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book

1.	Leslie Cromwell, "Biomedical Instrumentation and measurement", PHI, New Delhi, 2015

Reference Books

1.	John G. Webster, "Medical Instrumentation Application and Design", John Wiley and sons, New York, 2015.
2.	Joseph Carr, Brown, Introduction to Biomedical Equipment, Pearson, 2014

List of Projects: (Indicative)

1. Design a VVI based Pacemaker for patients who need Right and Left ventricles to be paced.
2. Design a pulse detector based on ultrasound Doppler effect.
3. Design a synchronous defibrillator which depends on the appearance of R wave of every cycle.
4. Design the upper and lower discriminator circuit which can be applied for energy discrimination in radiation detector.
5. Design a circuit that can be applied as Electro surgical Unit analyser.

Mode of Evaluation: Theory: Continuous Assessment Test, Quiz, Digital Assignment, Final Assessment Test, Additional Learning (MOOC / Conference, Journal Publications / Make a thon / Project competition and more)

Recommended by Board of Studies	23-02-2018		
Approved by Academic Council	49	Date	15-03-2018

Course Code	Course title	L	T	P	J	C
MAT-1001	Fundamentals of Mathematics	3	2	0	0	4
Pre-requisite	None	Syllabus Version				
		1.0				

Course Objectives

The course is aimed at providing

1. necessary and relevant background to understand the other important engineering mathematics courses
2. basic knowledge for the non-mathematics students to learn further topics and apply it in solving real-world engineering problems

Course Outcomes

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

1. Solve a system of linear equations by matrix method
2. Apply the techniques of differentiation to find maxima and minima, and techniques of integration to evaluate areas and volumes of revolution
3. Understand the concept of ordinary differential equations, and first and second order linear differential equations
4. Have a clear understanding of analytic geometry and vector algebra
5. Apply concepts of mathematical logic and elementary probability to real life problems

Module:1	Matrices	5 hours	

Matrices - types of matrices - operations on matrices - determinants - adjoint matrix – inverse of a matrix - solution of a system of linear equations by inversion method – elementary transformations – rank of a matrix - consistency and inconsistency of system of equations

Module:2	Differential Calculus	6 hours	

Differentiation of functions of single variable – differentiation techniques physical interpretations - differentiation of implicit functions – higher order derivatives – Taylor's, McClaurin's series - maxima and minima of functions of a single variable

Module:3	Integral Calculus	6 hours	

Partial fractions - Integration- integration techniques- integration by parts- definite integrals – properties- evaluation of area and volume by integration

Module:4	Linear Ordinary Differential Equations	6 hours	

Differential equations-definition and examples- formation of differential equation- solving differential equations of first order - solving second order homogenous differential equations with constant coefficients

Module:5	**Analytic geometry**	**5 hours**	
Analytic geometry of three dimensions - direction cosines and direction ratios - plane, straight line and sphere, distance between points, distance to a plane			
Module:6	**Vector Algebra**	**7 hours**	
Vectors–operations on vectors-angle between two vectors-projection of one vector on another vector –equations of plane, straight line and sphere in vector forms-shortest distance between two skew lines - equation of a tangent plane to a sphere			
Module:7	**Logic and Probability**	**8 hours**	
Mathematical logic – propositions – truth table – connectives– tautology – contradiction. Permutations and combinations – probability – classical approach – addition law - conditional probability - multiplicative law - Bayes' theorem and applications			
Module:8	**Contemporary Issues**	**2 hours**	
Industry Expert Lecture			
	Total Lecture hours:	**45 hours**	
Tutorial	• A minimum of 10 problems to be worked out by students in every Tutorial Class • Another 5 problems per Tutorial Class to be given as home work Mode: Individual Exercises, Team Exercises, Online Quizzes, Online Discussion Forums	**30 hours**	

Text Book(s)

1. Engineering Mathematics, K. A. Stroud and Dexter J. Booth, 7th Edition, Palgrave Macmillan (2013).

Reference Books

1. Elementary Engineering Mathematics, B. S. Grewal, 43rd edition, Khanna Publications, (2015).
2. Discrete Mathematics, Seymour Lipschutz and Marc Lipson, 6th Edition, Tata McGraw - Hill (2017).
3. Introduction to Probability and Statistics, Seymour Lipschutz and John Schiller, 3rd Indian Edition, Tata McGraw -Hill (2017).

Mode of Evaluation

Digital Assignments (Solutions by using soft skill), Quiz, Continuous Assessments, Final Assessment Test

Recommended by Board of Studies	25-02-2017		
Approved by Academic Council	No. 47	Date	05-10-2017

Course code	Course Title	L	T	P	J	C
BIT1016	BIOCHEMICAL ANALYSIS AND TECHNIQUES	3	0	2	0	4
Prerequisite	Nil	Syllabus version				
		v.1.1				

Course objectives:

1. To describe the students with basic concepts of biomolecules, their structural classification and its metabolism.
2. To define the biology of enzymes, hormones, its classification with properties, composition and functions of blood and urine.
3. To investigate on clinical analytical methods used in biochemical techniques like hemocytometer, urine analysis and organ function tests – Liver, kidney, thyroid, pancreas and gastric system.
4. To interpret on analytical techniques like microscopy, chromatography, electrophoresis, blood gas analyzers and analytical applications of spectrophotometry, fluorometry, atomic absorption and atomic emission spectroscopy.

Expected course outcome:

The student will be able to

1. Comprehend the basic concepts of biomolecules and its functional classification
2. Ability to understand the metabolism of carbohydrates, proteins and fats with its factors affecting and deficiency disorders.
3. Comprehend the mechanism of enzymes and its classification with its modes of action.
4. Ability to understand the concepts and types of hormones, its physiological actions and immune system
5. Comprehend the knowledge on composition and functions of blood, formation of urine, composition of urine – creatinine, urea, albumin and sugar.
6. Ability to understand the instrumentation and principle concepts of Hemocytometer, organ function tests, microscopy and various analytical techniques.
7. Ability to understand the knowledge about analytical techniques and its significant usage in medicine.

Module:1	Biomolecules	5 hours

Carbohydrates – General classification - Structure and functions - Lipids structure and function - storage lipids - Structure of proteins and amino acids – Conformation – Classification - Denaturation.

Module:2	Metabolism	6 hours

Carbohydrate - Blood glucose regulation - Hypo and hyperglycemia - Diabetus mellitus-types - Clinical features - Metabolic changes – Glycosuria – GTT – Aminoacids – Phenylketonuria - Lipids and Lipoproteins- Cholesterol- Factors affecting the level - Plasma lipoprotein – Types - Hyper and hypo-lipo proteinemias - Risk factor - Atheroscelorosis and fatty liver.

Module:3	Introduction to enzymes and hormones	6 hours

Classification – chemistry - Nomenclature properties and mode of action of enzymes - Factor affecting enzyme activity - Concepts and types of hormones - Hormone actions – Pituitary – Thyroid – Parathyroid - Endocrine pancreas - Blood glucose regulation - Sex hormones and their functions - Immune system.

Module:4	**Blood and urine identification factors**	**6 hours**
Blood and urine - Composition and functions - Types and functions of RBC - WBC and platelet - Urine profile (creatinine – urea – albumin - sugar) - Color of urine - Specific gravity.		
Module:5	**Clinical analytical methods**	**6 hours**
Hemocytometer - Orine analysis - Organ function tests - Liver function tests - Kidney function tests - Thyroid function tests - Adrenal function tests - Pancreatic function tests - Gastric function tests.		
Module:6	**Biological and physiochemical parameters**	**6 hours**
Water quality assessment for biological and physiochemical parameters - Buffers and saline solutions - Body fluids - pH Isoelectronic/Isotonic point- Concept and determination".		
Module:7	**Analytical techniques**	**8 hours**
Microscopy - Principles of phase contrast - Interference and polarized light microscopy - Principle and applications of Chromatography – Electrophoresis - Flame photometry – Auto analyzers -Blood gas analyzers – Principle - Instrumentation and analytical applications for spectrophotometry – Fluorometry - Atomic absorption spectroscopy - Inductively coupled plasma - Atomic emission spectroscopy.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book		
1.	David L. Nelson and Michael M. Cox (University of Wisconsin-Madison), "Lehninger Principles of Biochemistry", 2017, 7th edition, Wisconsin.	
Reference Books		
1.	Victor W. Rodwell, David A. Bender, Kathleen M. Botham, Peter J Kennelly and P. Anthony Weil, "Harpers Illustrated Biochemistry", 2015, 30th edition, McGraw Hill Education, Columbus, USA.	
2.	Satyanarayana, "Biochemistry", 2017, 5th edition, Elsevier, Amsterdam.	
Mode of Evaluation: CAT, Digital Assignment, Quiz and FAT		
List of Challenging Experiments (Indicative)		
1.	A 29-year old Canadian woman was referred to a general internal medicine clinic for evaluation of a low serum albumin level. With a given serum sample, identify and estimate the role of albumin in serum (BCG method).	6 hours
2.	A 50-year old female was brought to an emergency department because of conscious disturbance on the previous night. The patient denied a history of diabetes mellitus and any use of medication. With a given sample of serum, estimate the amount of glucose in serum (GOD Method).	6 hours
3.	Increase in plasma protein concentration is generally due to an increase in total globulins and the concentration of albumin remains same or decreases. A decrease in total protein concentration is due to fall in albumin and sometimes globulin. In such conditions, how will you employ Biuret method to estimate the total protein in serum? Also report the normal range of protein in serum.	6 hours
4.	Bile salts malabsorption has been shown to induce diarrhea in various conditions. The underlying mechanisms of induction of diarrhea by bile salts are not fully known and may involve decrease in NaCl absorption as well as	6 hours

	increased Cl- secretion in the intestine. Explain the methods to identify bile salts in bile juice.	
5.	A 35-year old woman became severely depressed after the sudden death of her husband. Two months later, she was brought to an emergency room because of extreme weakness and lethargy. She appeared thin and pale. Questioning revealed that she had not eaten for several weeks. Although much feared by clinicians, the ability to produce ketones has allowed humans to withstand prolonged period of starvation. In such cases, identify the role of ketone bodies in urine and its analysis with a given urine sample (Rothera's test).	6 hours
Total Laboratory Hours		30 hours
Mode of Evaluation: Continuous Assessment and FAT		
Recommended by Board of Studies	21-08-2017	
Approved by Academic Council	No. 47	Date 5-10-2017

Course code	Course Title	L	T	P	J	C
BIT1025	HOSPITAL MANAGEMENT	2	0	0	0	2
Prerequisite	Nil	Syllabus version				
		v.2.0				

Course Objectives:

1. With an objective of imbibing a professional approach amongst students towards hospital management.
2. The subject encompasses management principles, staffing and marketing processes, discussing their significance and role in effective and efficient management of health care organizations.

Expected Course Outcome:

The student will be able to

1. Understand the basic principles in hospital system management.
2. Apply the system development life cycle concepts.
3. Comprehend the disposal and hospital waste management mechanisms.
4. Analyse the electrical and fire safety measures.
5. Understand the principles of material management in a hospital.
6. Analyse the financial and legal aspects in hospital management.

Module:1	Principle of Hospital Management	4 hours

Importance of management and Hospital-Management control systems-Forecasting techniques decision-making process-Staffing pattern in hospitals-Selection-Recruiting process-Training of staff-Organizational structures.

Module:2	Computers in Hospital Management	4 hours

System Development life cycle-Reasons to use computers in hospital-Main categories of information systems in hospitals-EPR-E health care.

Module:3	Sterilization and waste management	4 hours

Disease Transmission - Disinfection methods – Sterilization - steam sterilizing (Auto claving) - Microwave (Non-burn treatment technology).-Disposal methods - Incinerator - Hazardous waste-Radioactive waste-Liquid waste destruction landfill-Air pollution and Emission control-Instrumentation and monitoring-Crematories.

Module:4	Electrical and fire safety	4 hours

Sources of shocks, macro & micro shocks-Hazards, monitoring and interrupting the Operation from leakage current- Elements of fire-causes of fire-Action to be taken in case of fire in a hospital.

Module:5	Assessing Quality Health Care	4 hours

Patient Safety Organization-Governmental & Independent-Measuring Quality care-Evaluation of hospital services – Six sigma way-Quality assurance in hospitals – Patient Orientation for total patient satisfaction-5S techniques

Module:6	Material Management	4 hours

Classification of Materials-Purchase Management- Purchase system (Centralized, Decentralized, Local purchase)-Purchase Procedures:-Selection of Suppliers-Tendering procedures-Analyzing bids-Price

negotiations-Issue of purchase orders-Rate Contracts-Follow up action.			
Module:7	**Finance and Legal Aspects in a Hospital**	**4 hours**	
Introduction to principal and methods of budgeting-internal and external auditing-Medico legal aspects-Preventive Steps for Doctors/Hospitals to Avoid Litigation-Consent Form-Life Support Dying Declaration-Death Certificate-Post Mortem			
Module:8	**Contemporary issues:**	**2 hours**	
	Total Lecture hours:	**30 hours**	
Text Book			
1.	K. V. Ramani, "Hospital Management: Text and Cases", 2013, 1st edition, Pearson Education, New Delhi, India.		
Reference Books			
1.	G. D Kunders, "Hospitals - Facilities Planning & Management", 2017,1st edition, Tata McGraw Hill Education, New Delhi, India		
2	Sharon Bell Buchbinder, Nancy H. Shanks, "Introduction to Health Care Management", 2011, 1st edition, Jones & Bartlett Publishers, Boston, USA.		
Mode of Evaluation: CAT, Digital Assignment, Quiz and FAT			
Recommended by Board of Studies	21-08-2017		
Approved by Academic Council	No. 47	Date	5-10-2017

Course code	Course title	L	T	P	J	C
BMD1001	Tissue Engineering	3	0	0	0	3
Pre-requisite	Nil	Syllabus version				
		v1.0				

Course Objectives:

1. To learn the fundamentals of tissue engineering and tissue repairing
2.To acquire knowledge on clinical applications of tissue engineering
3.To understand the basic concept behind tissue engineering focusing on the stem cells, biomaterials and its applications

Expected Course Outcome:

At the end of the course, students should be able to:
1. Multidisciplinary aspects in tissue engineering to solve healthcare problems
2.Identify sources of cells, bioactive molecules and materials
3.Design and develop scaffolds using conventional and advanced fabrication methods
4.Evaluate biological outcomes of tissue engineering strategies
5.Describe the regulatory aspects to commercialize products
6.Define site and patient specific applications

Module:1	Introduction and History	6 hours

Introduction to tissue engineering:Basic definition; current scope of development; Tissue and organ banking; limitations of banking; types of tissues; organ and tissue culture invitro; origin of tissue engineering; history (with respect to artificial skin);

Module:2	Tissue Architecture	9 hours

Tissue types and Tissue components,Tissue repair,Engineering wound healing and sequence of events. Basic wound healing Applications of growth factors.scopesuse in therapeutics, cells as therapeutic agents, cell numbers and growth rates, measurement of cell characteristics morphology, numberviability,motility and functions. Measurement of tissue characteristics, appearance, cellular component,ECM component, mechanical measurements and physical properties.

Module:3	Morphogenesis &Cell sources	8 hours

Morphogenesis and organ development in human; repair and regeneration; cell sources; stem cells and its types; Differentiation, differentiation and trans-differentiation; Intercellular communication- gap junctional and microvescular; Cell aggregation; adhesion dependence; Role of ECM in term of decellularizedallo-/xeno-genic tissues in tissue engineering

Module:4	Scaffolds and bioreactors	6 hours

Classification of scaffold materials, criteria for ideal scaffold, various types of scaffolds, various types of bioreactor configurations for cell cultures and advantages/disadvantages of the same. Definition, 3-dimentionality; porosity and pore-size; fabrication technology: conventional (such as Solvent-casting particulate-leaching Gas foaming, electrospinning, fiber meshes/ fiber bonding, phase separation, freeze drying, solution casting) and solid free form technology (such as stereolithography, 3D printing, fused deposition modeling, phase-change jet printing)

Module:5	Biomaterials and Transplantation of Engineered Cells and Tissues	6 hours

Definition, ideal properties and types; biomimetics; Properties like -- mechanical property, wetability, biodegradability and surface property; Types -- polymeric (natural and synthetic), nano-materials, ceramic, composites, hydrogels and metallic		
Module:6	**Clinical implementation**	**6 hours**
Examples of various types of engineered tissues, the latest developments / commercial successes in the area.		
Module:7	**Introduction to Stem Cells, Gene Therapy, Regulation and ethics**	**2 hours**
Gene therapy and types of gene therapy. Examples of gene therapy in current science. M*oral* and risk evaluation of conducting *gene therapy*.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Principles of Tissue Engineering, 4th Edition Robert Lanza, Robert Langer, Joseph P. Vacanti, Academic Press; 4 edition (2015)
2.	3D Bioprinting and Nanotechnology in Tissue Engineering and Regenerative Medicine Lijie Grace Zhang John Fisher Kam Leong, 1st EditionAcademic Press (2015)
Reference Books	
1.	Ravi Birla, (2014) Introduction to Tissue Engineering: Applications and Challenges, Wiley-IEEE Press. Robert A. Brown, (2012) Extreme Tissue Engineering: Concepts and Strategies for tissue fabrication, Wiley Blackwell.
Mode of Evaluation: Continuous Assessment Test, Quiz, Digital Assignment, Final Assessment Test, Additional Learning (MOOC / Conference, Journal Publications / Make a thon / Project competition and more)	
Mode of Evaluation: Continuous Assessments and FAT	

Recommended by Board of Studies :	19-09-2019		
Approved by Academic Council	No. 56	Date	24-09-2019

Course code	Course title	L	T	P	J	C
BMD1002	Bioinformatics	2	0	0	4	3
Pre-requisite	Nil				Syllabus version	
						v1.0

Course Objectives:

1. Apply basic knowledge of various computational algorithms on areas of applications in bioinformatics.
2. Analyze common problems in bioinformatics, alignment techniques, ethical issues, public data sources and evolutionary modelling.
3. Discover the practical use of tools for specific bioinformatic areas.

Expected Course Outcomes:

1. Evaluate the main databases at the NCBI and EMBL-EBI resources.
2. Compare the databases, tools, repositories and be able to use each one to extract specific information.
3. Demonstrate the selected tools at NCBI and EBI to run simple analyses on genomic sequences.
4. Apply knowledge of bioinformatics in a practical project.
5. Develop the ability for critical assessment of scientific research publications in bioinformatics.
6. Understanding of the research process in general, such as research methods, scientific writing, and research ethics.

Module:1	**Introduction to Bioinformatics**	**4 hours**

Scope and applications of bioinformatics, Evolutionary Basis - Sequence Homology, Sequence Identity, Sequence Similarity, Biological databases – File formats.

Module:2	**Sequence Alignment**	**4 hours**

Alignment of pairs of sequences, Introduction - Definition of sequence alignment, Methods - Dot matrix sequence comparison. Similarity Searches on Sequence Databases - FASTA and BLAST.

Module:3	**Pairwise Sequence Alignment**	**4 hours**

Dynamic programming algorithm for sequence alignment – Global Alignment: Needleman- Wunsch, Local Alignment: Smith-Waterman, Gap penalty, Assessing the significance of an Alignment.

Module:4	**Multiple Sequence Alignment**	**4 hours**

Dynamic programming, progressive methods, Iterative methods, MSA using CLUSTAL W, PILEUP and CLUSTAL X, purpose and applications of multiple sequence alignment, phylogenetic trees.

Module:5	**Scoring Matrices**	**4 hours**

Similarity searches - PAM and BLOSUM matrix, Dayhoff mutation matrix, construction of PAM and BLOSUM matrix. Differences between PAM & BLOSUM.

Module:6	**Neural Networks**	**4 hours**

Introduction – Priors & likelihoods - Learning algorithms: Backpropagation - Sequence encoding & output interpretation - Sequence correlations & Hidden Markov Models.

Module:7	**Structural Bioinformatics**	**4 hours**
Conceptual model of protein structure, protein structure prediction and modelling - Protein Structure Visualization, Comparison and Classification. Rational Drug Design and discovery.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Bioinformatics and Functional Genomics by Pevsner J, 3rd Ed., 2019.
2.	Introduction to Bioinformatics by Arthur M. Lesk, 2014
Reference Books	
1.	Artificial Neural Networks: Methods and Applications (Methods in Molecular Biology) by David J. Livingstone, 2011.
2.	Bioinformatics Challenges at the Interface of Biology and Computer Science: Mind the Gap by Teresa K. Attwood, Stephen R. Pettifer, et al., 2016.

Mode of Evaluation: Continuous Assessment Test, Quiz, Digital Assignment, Final Assessment Test, Additional Learning (MOOC / Conference, Journal Publications / Make a thon / Project competition and more)

List of Challenging Experiments (Indicative)	
1.	Retrieval of data and exploration of nucleotide databases (NCBI/DDBJ/EMBL).
2.	Study of protein database (UniProt) and Insights on structure database (PDB).
3.	Heuristic sequence alignment using BLAST/ FASTA and Multiple sequence alignment.
4.	Construction of phylogentic tree and Gene prediction analysis.
5.	Prediction and Visualization of protein Structure.

Mode of assessment: CAT, Digital Assignments, Quiz, FAT, Project.

Recommended by Board of Studies :	19-09-2019		
Approved by Academic Council	No. 56	Date	24-09-2019

Course code	Course Title	L	T	P	J	C
CSE2004	DATABASE MANAGEMENT SYSTEM	2	0	2	4	4
Pre-requisite	NIL	Syllabus version				
		v1.0				

Course Objectives:

1. To understand the concept of DBMS and ER Modeling.
2. To explain the normalization, Query optimization and relational algebra.
3. To apply the concurrency control, recovery, security and indexing for the real time data.

Expected Course Outcome:

1. Explain the basic concept and role of DBMS in an organization.
2. Illustrate the design principles for database design, ER model and normalization.
3. Demonstrate the basics of query evaluation and heuristic query optimization techniques.
4. Apply Concurrency control and recovery mechanisms for the desirable database problem.
5. Compare the basic database storage structure and access techniques including B Tree, B+
    a. Tress and hashing.
6. Review the fundamental view on unstructured data and its management.
7. Design and implement the database system with the fundamental concepts of DBMS.

Module:1	DATABASE SYSTEMS CONCEPTS AND ARCHITECTURE	5 hours

History and motivation for database systems -characteristics of database approach - Actors on the scene - Workers behind the scene - Advantages of using DBMS approach– Data Models, Schemas, and Instances– Three-Schema Architecture and Data Independence– The Database System Environment– Centralized and Client/Server Architectures for DBMSs– Classification of database management systems.

Module:2	DATA MODELING	4 hours

Entity Relationship Model : Types of Attributes, Relationship, Structural Constraints - Relational Model, Relational model Constraints - Mapping ER model to a relational schema - Integrity constraints

Module:3	SCHEMA REFINEMENT	6 hours

Guidelines for Relational Schema – Functional dependency; Normalization, Boyce Codd Normal Form, Multi-valued dependency and Fourth Normal form; Join dependency and Fifth Normal form.

Module:4	QUERY PROCESSING AND TRANSACTION PROCESSING	5 hours

Translating SQL Queries into Relational Algebra - heuristic query optimization - Introduction to Transaction Processing - Transaction and System concepts – Desirable properties of Transactions - Characterizing schedules based on recoverability - Characterizing schedules based on serializability

Module:5	CONCURRENCY CONTROL AND RECOVERY TECHNIQUES	4 hours

Two-Phase Locking Techniques for Concurrency Control – Concurrency Control based on timestamp – Recovery Concepts – Recovery based on deferred update – Recovery techniques based on immediate

update - Shadow Paging.			
Module:6	**PHYSICAL DATABASE DESIGN**	**3 hours**	
Indexing: Single level indexing, multi-level indexing, dynamic multilevel Indexing			
Module:7	**RECENT TRENDS - NOSQL DATABASE MANAGEMENT**	**3 hours**	
Introduction, Need of NoSQL, CAP Theorem, different NoSQL data models: Key-value stores, Column families, Document databases, Graph databases			
	Total Lecture hours:	**30 hours**	

Text Book(s)	
1.	R. Elmasri S. B. Navathe, Fundamentals of Database Systems, Addison Wesley, 7th Edition, 2015
2.	Raghu Ramakrishnan,Database Management Systems,Mcgraw-Hill,4th edition,2015.
Reference Books	
1.	A. Silberschatz, H. F. Korth S. Sudershan, Database System Concepts, McGraw Hill, 6th Edition 2010.
2.	Thomas Connolly, Carolyn Begg, Database Systems: A Practical Approach to Design, Implementation and Management,6th Edition,2012.
3.	Pramod J. Sadalage and Marin Fowler, NoSQL Distilled: A brief guide to merging world of Polyglot persistence, Addison Wesley, 2012.
4.	Shashank Tiwari ,Professional NoSql,Wiley ,2011
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

List of Challenging Experiments (Indicative)		
1.	DDL and DML	3 hours
2.	Single row and aggregate functions	3 hours
3.	Joins and Sub queries	3 hours
4.	Anonymous blocks and control structures	3 hours
5.	Iterations	3 hours
6.	Cursors	3 hours
7.	Functions and Procedures	3 hours
8.	Exception Handling and triggers	3 hours
9.	DBA Concepts	3 hours
10.	XML, DTD, XQuery Representations	3 hours
Total Laboratory Hours		30 hours
Mode of assessment: Project/Activity		

Recommended by Board of Studies	04-04-2014		
Approved by Academic Council	No. 37	Date	16-06-2015

Course code	Course title	L	T	P	J	C
CSE 3019	DATA MINING	2	0	2	4	4
Pre-requisite	Nil	Syllabus version				
		v. 1.0				

Course Objectives:

1. To introduce the concept of Data Mining and Data Preprocessing
2. To develop the knowledge for application of the mining algorithms for association, clustering
3. To explain the algorithms for mining data streams and the features of recommendation systems.

Expected Course Outcome:

1. Interpret the contribution of data warehousing and data mining to the decision-support systems
2. Apply the various classifications techniques to find the similarity between data items
3. Design the model to sample, filter and mine the Streaming data
4. Apply the link analysis and frequent item-set algorithms to identify the entities on the real world data
5. Evaluate and report the results of the recommended systems
6. Analyse the various data mining tasks and the principle algorithms for addressing the tasks
7. Create the working model as a team to solve the challenging data mining problems

Module:1	**INTRODUCTION**	**3 hours**
Data Mining – Data ware housing-OLAP-Data Preprocessing		
Module:2	**CLASSIFICATION TECHNIQUES AND FINDING SIMILAR ITEMS**	**5 hours**
Classification Techniques: Decision Tree,ID3,K-Nearest Neighbour Classifier, Naive Bayes- Near Neighbour Search – Shingling of Documents - Similarity Preserving – Locality Sensitive Hashing (LSH) –Application and Variance of LSH – Distance Measures – High degrees of similarity		
Module:3	**MINING DATA STREAMS**	**4 hours**
Stream Data model - Sampling Data in a Stream – Filtering Streams – Counting distinct elements in a stream – Estimating Moments – Counting Ones in a window – Decaying windows		
Module:4	**LINK ANALYSIS**	**4 hours**
Page Rank – Link Spam – Hubs and Authorities		
Module:5	**FREQUENT ITEM SETS**	**4 hours**
Market-Basket Model – A-priori Algorithm – Handling larger datasets – Counting Frequent items in a stream – Limited Pass Algorithms		
Module:6	**CLUSTERING**	**4 hours**
Hierarchical Clustering – K-means Algorithm – Clustering in Non-Euclidean spaces, Clustering for Streams and Parallelism		

Module:7	**RECOMMENDATION SYSTEMS**	**4 hours**	
Content based – Collaborative Filtering – Dimensionality reduction-Case study			
Module:8	**Contemporary issues:**	**2 hours**	
	Total Lecture hours:	**30 hours**	

Text Book(s)	
1.	Ian H. Witten, Eibe Frank, Mark A. Hall, Data Mining: Practical Machine Learning Tools and Techniques, Morgan Kaufmann , 2011
Reference Books	
1.	Jiawei Han, Micheline Kamber and Jian Pei, Data Mining: Concepts and Techniques, Morgan Kaufmann 2011
2.	J. Leskovec, A. Rajaraman, and Jeffrey D. Ullman. Mining of Massive Datasets. Cambridge University Press, 2014.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar

List of Challenging Experiments (Indicative)		
1.	Introduction to exploratory data analysis using R	1 hours
2.	Demonstrate the Descriptive Statistics for a sample data like mean, median, variance and correlation etc.,	1 hours
3.	Demonstrate Missing value analysis and different plots using sample data.	1 hours
4.	Demonstration of apriori algorithm on various data sets with varying confidence (%) and support (%).	2 hours
5.	Demo on Classification Techniques using sample data Decision Tree, ID3 or CART.	2 hours
6.	Demonstration of Clustering Techniques K-Mean and Hierarchical.	2 hours
7.	Simulation of Page Rank Algorithm and Demonstration on Hubs and Authorities.	2 hours
8.	Demo on Classification Technique using KNN.	2 Hours
9.	Demonstration on Document Similarity Techniques and measurements.	2 hours
10.	Design and develop a recommendation engine for the given application.	2 hours
Total Laboratory Hours		15 hours

Mode of evaluation: Project/Activity

Recommended by Board of Studies	04-04-2014		
Approved by Academic Council	No. 37	Date	16-06-2015

Course code	Course title	L	T	P	J	C
ECE1023	Biomedical Imaging	2	0	0	4	3
Pre-requisite	ECE 3043 Digital Image Processing for Medical Applications	Syllabus version				
		v. 01				

Course Objectives:

1. To study the production of x-rays and its application in medical imaging
2. To study the different types of Radio diagnostic techniques
3. To study the special imaging techniques used for visualizing the cross sections of the body.

Expected Course Outcome:

The student will be able to

1. To comprehend the acquisition techniques involved in different X Ray medical imaging
2. To conceive the historical evolution of the imaging methods pertaining to computed tomography and to excel with different reconstruction techniques and programming techniques for noise removal.
3. To comprehend the principle of operation of modules employed in magnetic resonance imaging
4. Familiar with all the modules employed in magnetic resonance imaging
5. To manipulate of nuclear radiation fields for diagnostics to be skillful in image generation
6. To comprehend the Ultrasound imaging system.
7. To comprehend the principle of operation of modules employed in thermal imaging

Module:1	**X – Rays**	**4 hours**

Nature of X-Rays - X-ray Absorption - Tissue Contrast. X-Ray Equipment – X-ray Tube, collimator, Bucky Grid, power supply. Digital Radiography - discrete digital detectors, storage phosphor and film Scanning. X-Ray Image intensifier tubes - Fluoroscopy – Digital Fluoroscopy. Angiography, Cine angiography. Digital Subtraction Angiography. Mammography.

Module:2	**Computed Tomography**	**4 hours**

Principles of Tomography - First to Fifth generation scanners – Image reconstruction Technique - Back projection and Iterative method. Spiral CT Scanning - Ultra fast CT Scanners- X-Ray Sources – Collimation – X-Ray Detectors – Viewing System

Module:3	**Magnetic Resonance Imaging**	**4 hours**

Fundamentals of Magnetic Resonance- Interaction of nuclei with static Magnetic Field and Radio frequency wave – Rotation and Precession –induction of a magnetic resonance signal – bulk Magnetization – Relaxation Processes T1 and T2.

Module:4	**MRI System and its components**	**4 hours**

MRI system- System Magnet, generation of Gradient magnetic Fields, Radio Frequency coils, Shim coils, Electronic components

Module:5	**Emission Imaging**	**4 hours**

Alpha, Beta, Gamma Emission, different types of Radiation Detectors, G.M. & Proportional Counters, Pulse Height Analysers, Isotopic, Scanners, Principle of PET and SPECT, PET/CT

Module:6	**Ultrasound Imaging**	**4 hours**

Wave propagation and interaction in Biological tissues, Acoustic radiation fields, continuous and pulsed excitation, Transducers and imaging systems, Scanning methods, Imaging Modes-A, B & M, Principles and theory of image generation		
Module:7	**Thermography**	**4 hours**
Thermography- Principle, detectors and applications.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Paul Suetens, "Fundamentals of Medical Imaging", 2017, 3rd edition, Cambridge University Press, Cambridge, New York.
Reference Books	
1.	Gopal B.Saha, "Physics and Radiobiology of Nuclear Medicine", 2013, 4th edition, Springer-Verlag, New York
2.	Russell K. Hobbie, Bradley J. Roth, "Intermediate Physics for Medicine and Biology", 2015, 1st edition, Springer International Publishing, Switzerland.

Mode of Evaluation: Continuous Assessment Test, Quiz, Digital Assignment, Final Assessment Test, Additional Learning (MOOC / Conference, Journal Publications / Make a thon / Project competition and more)

List of Challenging Experiments (Indicative)		
1.	Digital Subtraction Angiogram Image analysis	5 hours
2.	Computer Tomography Image Reconstruction	5 hours
3.	MRI Image Reconstruction	5 hours
4.	PET/SPECT Image Analysis	5 hours
5.	Ultrasound Image classification	5 hours
6.	Thermography Image Analysis	5 hours
	Total Laboratory Hours	30 hours

Mode of assessment: 3 reviews			
Recommended by Board of Studies :	19-09-2019		
Approved by Academic Council	No. 56	Date	24-09-2019

Course code	Course title	L	T	P	J	C
ECE1024	Wearable Technology	3	0	0	0	3
Pre-requisite	Nil	Syllabus version				
		v1.0				

Course Objectives:

1. Educate the need for wearable devices and introduce the different techniques to measure physiological/ environmental parameters.
2. To provide a clear understanding of the state-of –the-art wearable devices available in the market for various applications.
3. To know about the latest research trends in development of wearable and flexible sensors and its applications in the healthcare industry in particular.

Expected Course Outcome:

1. Introduced the role and importance of wearable technology in our society and its usage in various industrial sectors to the students.
2. Rudiments of various Thin film deposition and polymer materials for electrode fabrication were discussed with students.
3. Comprehensive understanding of power consumption in wearable sensors and need for energy harvesting were provided to the students.
4. Highlighted the students with various Inertial sensors for monitoring of various Physical parameters.
5. Acquainted the students with various wearable sensors for healthcare and biomedical applications
6. Discussed about the applications of wearable sensors in navigation with the students

Module:1	Introduction to Wearable Devices	4 hours

Role of Wearables, Attributes of Wearables, Meta Wearables, Challenges and Opportunities, Future of Wearables, Social Aspects, Wearable Haptics, Intelligent clothing, Industry sectors' overview – sports, healthcare, Fashion and entertainment, military, environment monitoring, mining industry, public sector and safety.

Module:2	Fabrication of Wearable Sensors	8 hours

Working principles of wearable sensors, Characteristics of wearable sensors; Thick-film processing, Thin film processing, overview of Photolithography; Issues in the fabrication of wearable sensors, Substrate selection, Substrate pre-processing, Fabrication of electrodes. Fabrication of wearable sensors using electrical properties.

Module:3	Energy harvesting for wearable devices	5 hours

Energy Expenditure of Body-Worn Devices, Energy and Power Consumption Issues, Design Considerations and need for Energy Harvesting Systems, Energy Harvesting from Temperature Gradient at the Human Body, Foot Motion and Light, Wireless Energy Transmission, Energy.

Module:4	Wearable Inertial Sensors	5 hours

Wearable Inertial Sensors - Accelerometers, Gyroscopic sensors and Magnetic sensors; Modality of Measurement- Wearable Sensors, Invisible Sensors, In-Shoe Force and Pressure Measurement; Applications: Fall Risk Assessment, Fall Detection , Gait Analysis, Physical Activity monitoring: Human Kinetics, Cardiac Activity, Energy Expenditure measurement: Pedometers, Actigraphs.

Module:5	**Wearable Devices for Healthcare-1**	**8 hours**
Wearable ECG devices: Basics of ECG and its design, Electrodes and the Electrode–Skin Interface; Wearable EEG devices: Principle and origin of EEG, Basic Measurement set-up, electrodes and instrumentation; Wearable EMG devices: EMG/ SEMG Signals, EMG Measurement – wearable surface electrodes, SEMG Signal Conditioning, Applications. Smart textile for neurological rehabilitation system (NRS), Study of flexible and wearable EMG sensors. Epidermal electronics system (EES), Study of Multiparametric (ECG, EEG, EMG) Epidermal Electronics Systems.		
Module:6	**Wearable Devices for Healthcare-2**	**6 hours**
Wearable Blood Pressure (BP) Measurement: Cuff-Based Sphygmomanometer, Cuffless Blood Pressure Monitor. Study of flexible and wearable Piezoresistive sensors for cuffless blood pressure measurement. Wearable sensors for Body Temperature measurement: Intermittent and Continuous temperature monitoring.		
Module:7	**Wearable Biochemical Sensors**	**7 hours**
Wearable Biochemical Sensors: Parameters of interest, System Design –Textile based, Microneedle based; Types: Wearable Colorimetric Sensing Platforms, Electrochemical. Wearable pulse oximeter, Wearable capnometer. Wearable sweat analysis, drug monitoring, alcohol testing devices; Sensor Design and Development - Textile Patch, Microfluidic channel.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture Hours:	**45 hours**

Text Book(s)

1.	"Seamless Healthcare Monitoring", Toshiyo Tamura and Wenxi Chen, Springer 2018
2.	"Wearable Sensors -Fundamentals, Implementation and Applications", by Edward Sazonov and Michael R. Neuman, Elsevier Inc., 2014.
3.	"Wearable and Autonomous Biomedical Devices and Systems for Smart Environment", by Aimé Lay-Ekuakille and Subhas Chandra Mukhopadhyay, Springer 2010

Reference Books

1.	"Wearable Sensors - Applications, design and implementation" Subhas Chandra Mukhopadhyay and Tarikul Islam, IOP Publishing Ltd 2017.
2.	"Wearable Electronics Sensors - For Safe and Healthy Living", Subhas Chandra Mukhopadhyay, Springer 2015
3.	"Flexible Electronics: Materials and Applications", William S. Wong and Alberto Salleo, Springer 2009
4.	"Environmental, Chemical and Medical Sensors", by Shantanu Bhattacharya, A K Agarwal, Nripen Chanda, Ashok Pandey and Ashis Kumar Sen, Springer Nature Singapore Pte Ltd. 2018

Mode of Evaluation: Continuous Assessment Test, Quiz, Digital Assignment, Final Assessment Test, Additional Learning (MOOC / Conference, Journal Publications / Make a thon / Project competition and more)

Recommended by Board of Studies :	19-09-2019		
Approved by Academic Council	No. 56	Date	24-09-2019

Course code	Course title	L	T	P	J	C
ECE1025	BioMEMS and Lab-on-Chip	2	0	0	4	3
Pre-requisite	Nil	Syllabus version				
		v1.0				

Course Objectives:

1. Introduce and discuss the historical background of evolution of MEMS and Microsystems and their applications and highlight the scaling effects in miniaturizing devices.
2. Educate on the rudiments of various materials and fundamental concepts used in MEMS and microfluidics fabrication
3. Comprehend various fluidic systems in LoC devices and identify their usage in development of various electrochemical biosensors, paper based microfluidics and chemical analysis.

Expected Course Outcome:

1. Introduced the historical background of evolution of MEMS and Microsystems as well as discussed the scaling effects on different Physical domains to the students.
2. Rudiments of silicon and various polymer materials for MEMS fabrication was discussed with students.
3. Comprehensive understanding of basic microfluidic theory and its fabrication techniques were provided to the students.
4. Highlighted the students with various Fluidic systems for complete microfluidic device development.
5. Acquainted the students with various techniques of developing electrochemical LoC biosensors
6. Discussion about the applications of microfluidics in development of low cost paper-based devices and for chemical synthesis.
7. Design and fabrication of various microfluidic LoC devices.

Module:1	**Introduction to MEMS**	**3 hours**

Historical background of Micro Electro Mechanical Systems-Types of MEMS devices-Applications of MEMS in healthcare industry, Microsystems and Miniaturization.

Module:2	**Scaling Laws in MEMS**	**3 hours**

Introduction to Scaling, Scaling in Geometry-Scaling in Rigid, Body Dynamics, Scaling in Electrostatic Forces, Scaling in Electromagnetic Forces, Scaling in Heat Transfer, Scaling in Fluid Mechanics/ Microfluidics.

Module:3	**Materials for MEMS and Microfabrication Technology**	**4 hours**

Substrates and wafers, Silicon and Silicon compounds, Polymers (SU8, PDMS), Thin film coating: PVD, CVD, Photolithography, Lift-off technique, Etching, Bulk micro machining, Surface micro machining, LIGA process.

Module:4	**Microfluidics: Theory and Fabrication**	**5 hours**

Basic Microfluidics Theory: Fluidic parameters, Equation of motion, Transport modes in microfluidic systems; Micromachining of silicon, glass, rigid and soft polymers for micro total analysis systems, Soft-Lithography: Molding Technology. Surface chemistry in polymer microfluidic system.

Module:5	**Fluidic Systems of Lab-on-Chip devices**	**5 hours**

Lab-On-a-Chip Platforms and Components – Fluidic Platforms-Pressure driven, Capillary flow, Segmented flow, Electrokinetics, Electrowetting on Dielectrics (EWOD), Centrifugal Microfluidics;

Components of LoC Systems- Microvalves, Micropumps-mechanical (membrane type) and non-mechanical (electrical-electroosmosis, electrophoretic, DEP, EHD), Micromixers, Filters, Sensors.		
Module:6	**Electrochemical Lab-on-Chip Biosensors**	**5 hours**
Electrodes Fabrication, Electrochemical Detection Techniques-Amperometric, Potentiometric, Conductimetric, Impedimetric; Applications- Enzymatic-Based LOC Biosensors, Enzyme immobilization techniques, Antibodies-Based LOC-Biosensors, Cell-Based LOC-Biosensors.		
Module:7	**Paper based Microfluidics**	**3 hours**
Low-Cost Diagnostics, Properties of Paper-Based Devices, Current Status of Paper-Based Devices, Technical Achievements and Challenges- Sample preparation, Flow, Detection techniques,		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	Tai-Ran Hsu, "MEMS & Microsystem, Design and manufacture", 2017, 1st Edition, McGraw Hill, New York
2.	Marc J. Madou, "Fundamentals of Microfabrication: The Science of Miniaturization", 2012, 2nd edition, CRC Press, Florida, USA.
3.	Jaime Castillo-León, Winnie E. Svendsen (eds.) "Lab-on-a-Chip Devices and Micro-Total Analysis Systems_ A Practical Guide", 2015, Springer International Publishing

Reference Books

1.	Gary S. May and Simon Sze, "Fundamentals of semiconductor fabrication", 2010, 1st edition John Wiley & Sons, New Jersey, USA.
2.	Francis E. H. Tay, "Microfluidics and Biomems application", 2013, 1st Edition, Springer, Berlin.
3.	Albert Folch, "Introduction to Biomems",2016, 1st Edition, CRC Press, Florida.
4.	Edwin Oosterbroek and Albert van den Berg, "Lab-on-a-Chip: Miniaturized Systems for (Bio) Chemical Analysis and Synthesis", 2011, 1st edition, Elsevier Science, Amsterdam, Netherlands.

Mode of Evaluation: Continuous Assessment Test, Quiz, Digital Assignment, Final Assessment Test, Additional Learning (MOOC / Conference, Journal Publications / Make a thon / Project competition and more)

List of Challenging Projects (Indicative)

1.	Design of T-shaped, Y-shaped and Serpentine Microfluidic channels through micro-molding technique.	6 hours
2.	Design and fabrication of micro-electrodes embedded below a microfluidic channel for Electrochemical Lab-on-Chip Biosensors.	6 hours
3.	Design of a LoC pH sensor using Potentiometric technique.	6 hours
4.	Design of a LoC Biosensor for enzymatic detection of Glucose.	6 hours
5.	Design of a paper-based microfluidic LoC devices for pathogen detection	6 hours
	Total Laboratory Hours	30 hours

Mode of assessment: Continuous Assessments and FAT			
Recommended by Board of Studies :	19-09-2019		
Approved by Academic Council	No. 56	Date	24-09-2019

Course Code	Course Title	L	T	P	J	C
ECE1026	Materials for Organs and Devices	3	0	0	0	3
Pre-requisite	Nil	Syllabus version				
		v. 1.0				

Course Objectives:

1. Understand the properties of the Bio-compatible materials
2. Expose to different types of Biomaterials
3. Estimate artificial organs and its constraints

Expected Course Outcome:

The student will be able

1. To understand and classify biomaterials based on their characteristics property.
2. To justify different metals and ceramics usage based on different application.
3. To decide polymeric materials and its distinctive combinations that could be used as a tissue replacement implants
4. To apply the knowledge in artificial organ using these materials
5. To comprehend the knowledge about the need for artificial organs with its desired design consideration, organ replacement and steps required to evaluate the device.
6. To perceive the basics and concepts of artificial heart, artificial lungs, liver, blood and kidney.

2. Having a clear understanding of the subject related concepts and of contemporary issues
6. Having an ability to design a component or a product applying all the relevant standards and with realistic constraints
12. Having adaptive thinking and adaptability

Module:1	Structure of Biomaterials and Biocompatibility	4 hours	

Definition and classification of biomaterials, mechanical properties, surface and bulk properties of biomaterials, viscoelasticity, wound-healing process, body response to implants, blood compatibility.

Module:2	Metal and Ceramic Materials	6 hours	

Metallic implant materials, stainless steels, co-based alloys, Ti-based alloys, ceramic implant materials, aluminum oxides, hydroxyapatite glass ceramics carbons, medical applications.

Module:3	Polymeric Implant Materials	5 hours	

Polymerization, polyolefin, polyamicles, Acrylic, polymers, rubbers, high strength thermoplastics, natural and synthetic polymer, medical applications.

Module:4	Tissue Replacement Implants	6 hours	

Soft-tissue replacements, sutures, surgical tapes, adhesive, percutaneous and skin implants, maxillofacial augmentation, blood interfacing implants, hard tissue replacement implants, internal fracture fixation devices, joint replacements.

Module 5	Design of Artificial Organs	6 hours	

Substitutive medicine, Biomaterial Concentration, Outlook for Organ Replacement, Design Consideration, Evaluation of Artificial Organs

Module 6	Cardiovascular Implants	6 hours	

Blood clotting, vascular implants, cardiac pacemakers, blood substitutes, artificial heart, extracorporeal blood circulation devices, artificial heart valves.			
Module:7	**Artificial Organs and Devices**	**10 hours**	
Comparison of Artificial Lungs and Natural Lungs, Oxygen Transport, Carbon-di-oxide Transport, Coupling of Oxygen & Carbon-di-oxide Exchange, Shear Induced Transport, Augmentation and Devices for Improved Gas Transport, Artificial Kidney: Renal Transplantation, Mass Transfer in Dialysis, Membranes, Hemofiltration, Adequacy of Dialysis, Peritoneal Dialysis Equipment, Artificial pancreas: Insulin Therapy, Therapeutic options in Diabetes, Insulin Administration System, Insulin Production System, Artificial Liver: Liver Support Systems, Global Liver Function Replacement, Hybrid Liver function Replacement.			
Module:8	**Contemporary issues:**	**2 hours**	
	Total Lecture hours:	**45 hours**	

Text Book(s)	
1.	J. Park, Biomaterials: An Introduction, Springer Science & Business Media, 2012
2.	Michael Lysaght, Thomas J Webster, Biomaterials for Artificial Organs, Elsevier Science, 2018
Reference Books	
1.	Sujata V. Bhatt, Biomaterials Second Edition, Narosa Publishing House, 2005
2.	Standard Handbook of Biomedical Engineering & Design – Myer Kutz, McGraw-Hill, 2003
3.	Introduction to Biomedical Engineering – John Enderle, Joseph D. Bronzino, Susan M. Blanchard, Elsevier, 2005
Mode of Evaluation: CAT, Digital Assignment, Quiz, and FAT	

Recommended by Board of Studies :	19-09-2019		
Approved by Academic Council	No. 56	Date	24-09-2019

Course code	Course title	L	T	P	J	C
ECE1027	Biomechanics & Fluid Dynamics	2	0	0	4	3
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. Introduce the basic concepts of solid mechanics and fluid dynamics with respect to physiological systems.
2. Familiarise students with the mathematical models that can be used in the analysis of physiological systems.
3. Understand the parameters and constraints pertaining to the designing of the physiological tissues and organs.

Expected Course Outcomes:

7. Understand the basic concepts in Biomechanics and Biofluid Dynamics.
8. Comprehend the applications of posture and gait analysis in restoring body functions.
9. Apply the various aspects of embedded technology and IoT in ergonomics.
10. Develop better understanding about various bio fluids.
11. Ability to construct a mathematical model for any solid/ fluid tissue and their interactions.
12. Explore various parameters and constraints that pertaining to FEM and FEA of solid and fluid bio structures.
13. Ability to design and analyse hard, soft and fluid tissues of the body.

Module:1	Introduction to Solid Mechanics	6 hours

Basic Biomechanics: Kinematics, Kinetics; Planes and axes of motion; Newton's law of motion, Translational, Rotational, Curvi-Linear Motions; Types of human joints; Ortho and Osteo kinematics; Types of muscle contraction: Isometric, Isotonic, Isokinetic; Role of skeletal muscles during contraction: Agonist, antagonist, stabilizer, inhibitor; Coplanar, parallel force systems; Resultant forces; Forces: gravitational force, buoyant force; Use of force in improving the work efficiency.

Module:2	Posture & Gait	6 hours

Normal posture, deviations from normal posture; Effects of age, occupation, habit, disease on posture; Normal gait pattern, Influence of posture on gait; Change of posture and gait in certain diseases: scoliosis, kyphosis, lordosis, flat back posture, crossed leg, equinus, flat foot, knock knees, bow legs, sway back; Abnormal gait patterns. Occupational modifications on posture and gait. Variation of posture and gait during pregnancy.

Module:3	Ergonomics	4 hours

Designing of suitable devices for posture and gait correction and modifications; Parameters and Constraints of design; Material choices available for various designs; Wearable devices to enhance the body mechanics, reduction of energy usage, efficient use of human joints and muscles. Use of IoT in ergonomics.

Module:4	Fluid Mechanics	3 hours

Introduction to fluid mechanics: Newton and non-Newton fluids; Laminar and turbulent flow, Viscosity, elasticity, viscoelasticity; Basic laws governing rheology

Module:5	**Bio Fluids**	**3 hours**
Body fluids: blood, plasma, CSF, protoplasm, lymph, synovial fluid, sweat, urine. Aqueous humor, visceral fluids, cystic fluid; Viscosity: definition, factors affecting viscosity of various body fluids; influence of varied viscosity in causing organ/ system dysfunction		
Module:6	**Viscoelastic Models**	**3 hours**
Viscoelasticity of tissues; Mathematical modelling of living tissues: Maxwell, Voigt, Kelvin models. Mathematical equivalent for all the body fluids and their interaction with bones. Detailed study of blood and its properties; Disease of vascular system leading to altered dynamics and vice versa.		
Module:7	**Modelling of Physiological Implants/ System**	**3 hours**
Basics of modelling of solid structures like bones, meniscus, uni-bi-tri axial joints; fluids like blood, CSF, plasma; Construction and assembly of organ systems; Parameters to be considered for analysis of models; Basics of FEM and FEA of orthopaedics and cardiovascular implants.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book	
1.	Susan J Hall, "Basic Biomechanics", 8th Edition, 2019, Mc Graw Hill, USA
2.	Y C Fung, "Biomechanics – Mechanical Properties of Living Tissue" 2nd Edition, 1993, Reprinted in 2016, Springer, USA
Reference Book	
1.	Cynthia Norkins, "Joint Structure and Function: A Comprehensive Analysis", 2019, 6th Edition, F. A. Davis Company, USA

Mode of Evaluation: Theory: Continuous Assessment Test, Quiz, Digital Assignment, Final Assessment Test, Additional Learning (MOOC / Conference, Journal Publications / Make a thon / Project competition and more)

Recommended by Board of Studies :	19-09-2019		
Approved by Academic Council	No. 56	Date	24-09-2019

Course code	Course title	L	T	P	J	C
ECE1028	Biometric Technology and Security Systems	3	0	0	0	3
Pre-requisite	Nil	Syllabus version				
		v1.0				

Course Objectives:

1. To understand the general principles of design of biometric systems, different algorithms applied and its functional blocks.
2. Analyze common problems in biometrics techniques, ethical issues, public data sources and security.
3. To study various Biometric Authentication Methods and security systems.

Expected Course Outcomes:

14. Demonstrate knowledge engineering principles underlying biometric systems.
15. Describe and explain Finger print feature processing and techniques, computer enhancement and modelling.
16. Face recognition, how to perform Feature Extraction, classification of features, training of algorithm using neural network
17. Competing iris Scan technologies, various steps involved in voice scan, challenges related to iris and voice scan. Perceive various areas of physiological and Behavioural Biometrics
18. Biometric system and integration strategies, performance evaluation of biometric system, Statistical Measures of Biometrics. New authentication methods and security systems and futuristic devices.

Module:1	Introduction to Biometric systems	6 hours

Introduction and back ground – Biometric technologies – Passive biometrics – Active biometrics - Biometric systems – Enrollment – Templates – Algorithm – Verification – Biometric applications – biometric characteristics- Authentication technologies –Need for strong authentication – Protecting privacy and biometrics and policy – Biometric applications – Biometric characteristics

Module:2	Fingerprint Biometric systems	6 hours

History of fingerprint pattern recognition - General description of fingerprints - Finger print feature processing techniques - Fingerprint sensors using RF imaging techniques – Fingerprint quality assessment – Computer enhancement and modeling of fingerprint images – Fingerprint enhancement– Feature extraction – Fingerprint classification – Fingerprint matching

Module:3	Face recognition and hand geometry	6 hours

Introduction to face recognition _ Neural networks for face recognition – face recognition from correspondence maps – Hand geometry – Scanning – Feature Extraction - Adaptive Classifiers -Visual-Based Feature Extraction and Pattern Classification - Feature extraction – Types of algorithm – Biometric fusion.

Module:4	Iris, Voice recognition	6 hours

Iris scan - Features – Components – Operation (Steps) – Competing iris Scan technologies – Strength and weakness. Voice Scan - Features – Components – Operation (Steps) – Competing voice Scan (facial) technologies–Strength and weakness.

Module:5	Physiological and Behavioural Biometrics	6 hours

Retina scan – AFIS (Automatic Finger Print Identification Systems) – Behavioral biometrics – Signature scan- Keystroke scan biometrics application – Biometric Solution Matrix – Bio privacy – Comparison of privacy factor in different biometrics technologies.		
Module:6	Multimodal Biometrics	**6 hours**
Introduction to multimodal Biometric system – Integration strategies – Architecture – Level of fusion – Combination strategy –Training and adaptability – Examples of multimodal biometric systems – Performance evaluation- Statistical Measures of Biometrics – FAR – FRR – FTE – EER – Memory requirement and allocation.		
Module:7	Biometric security systems	**6 hours**
Securing and trusting a Biometric transaction – Matching location – local host - authentication server – Match On Card (MOC) – cryptography and Multimodal biometrics and Two-Factor authentication. Biometrics in Cyber Security and Network protection		
Module:8	**Contemporary issues:**	**3 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Nalini K Ratha and Govindraju, "Advances in Biometrics - Sensors, Algorithms and Systems", 2018, 1st edition, Springer, London.
2.	Haizhou Li, Liyuan Li, Kar-Ann Toh**,** Advanced Topics in Biometrics, 2012, 1st edition, World Scientific Publisher, Singapore
Reference Books	
1.	David Check Long, Andre beck ling and Jiankun Hun, Biometric Security, Cambridge scholar publications. 2015
2.	Security and Privacy in Biometrics, Patrizio Campisi, Springer, 2013
Mode of Evaluation: Continuous Assessment Test, Quiz, Digital Assignment, Final Assessment Test, Additional Learning (MOOC / Conference, Journal Publications / Make a thon / Project competition and more)	
Mode of assessment: CAT, Digital Assignments, Quiz, FAT, Project.	
Recommended by Board of Studies :	19-09-2019

Approved by Academic Council	No. 56	Date	24-09-2019

Course code	Course title	L	T	P	J	C
ECE1029	Telemedicine and Virtual Instrumentation	3	0	0	0	3
Pre-requisite	Nil	Syllabus version				
		v1.0				

Course Objectives:

1. To impart the key principle of telemedicine and healthcare.
2. Expound element of tele-radiology systems like image acquisition system, display system and communication networks.
3. Demonstrate the methods and techniques used in virtual instrumentation.

Expected Course Outcome:

4. To teach the key principles of telemedicine-health and its technology.
5. To make the student understand tele-medical technology.
6. To introduce the students with the knowledge of mobile telemedicine and its applications.
7. To study the need for digital imaging and picture archiving and communication systems in telemedicine application.
8. To introduce the student with the significance of Virtual instrumentation.

To teach the key significance and the biomedical equipment applications of Virtual instrumentation.

Module:1	Telemedicine and Health	5 hours

History and Evolution of telemedicine - Tele health - Tele care - Organs of telemedicine - Global and Indian scenario. Ethical and legal aspects of Telemedicine - Social and legal issues - Safety and regulatory issues - Advances in Telemedicine.

Module:2	Telemedical Technology	8 hours

Principles of Multimedia - Text, Audio, Video, data - Data communications and networks - PSTN – POTS – ANT – ISDN – Internet - Air/ wireless communications: GSM satellite - and Micro wave - Modulation techniques, Types of Antenna - Integration and operational issues - Communication infrastructure for telemedicine – LAN and WAN technology - Satellite communication. Mobile hand held devices and mobile communication - Internet technology and telemedicine using world wide web (www) - Video and audio conferencing - Clinical data – Local and centralized.

Module:3	Mobile Telemedicine	6 hours

Tele radiology: Definition, Basic parts of tele radiology system - Image Acquisition system - Display system - Tele pathology - Multimedia databases - Color images of sufficient resolution - Dynamic range - Spatial resolution - Compression methods - Interactive control of color.

Module:4	Information System	5 hours

Medical information storage and management for telemedicine - Patient information medical history - Test reports - Medical images diagnosis and treatment - Hospital information system – Doctors – Paramedics - Facilities available -Pharmaceutical information system.

Module:5	Telemedical Applications	5 hours

Telemedicine access to health care services – Health education and self-care - Introduction to robotics surgery - Tele surgery - Tele cardiology, Tele oncology - Telemedicine in neurosciences - Electronic

Documentation - e - health services, security and interoperability - Telemedicine access to health care services – health education and self-care - Business aspects - Project planning and costing - Usage of telemedicine.		
Module:6	**Virtual Instrumentation and its programming Techniques**	**8 hours**
Virtual Instrumentation: Historical perspective - advantages - block diagram and architecture of a virtual instrument - Conventional Instruments versus Traditional Instruments - data-flow techniques, graphical programming in data flow, comparison with conventional programming. VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, State machine, string and file I/O, Instrument Drivers, Publishing measurement data in the web.		
Module:7	**VI Toolsets and applications**	**6 hours**
Use of Analysis tools, Fourier transforms, power spectrum, correlation methods, windowing and filtering. Application of VI in process control designing of equipments like oscilloscope, Digital multimeter. Distributed I/O modules- Application of Virtual Instrumentation: Instrument Control, Development of process database management system, Simulation of systems using VI, Image acquisition and processing, Motion control. Biomedical Applications: Examination, Monitoring, Biofeedback, Training and education.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Sherry Emery, Telemedicine in Hospitals: Issues in Implementation, 2015, 1st edition, Routledge, Tayor and Francis Group, New York.
2	Jovitha Jerome, Virtual Instrumentation Using LabVIEW, 2011, PHI Learning Private Limited, New Delhi
Reference Books	
1.	Bernard Fong, A.C.M. Fong, C.K. Li, Telemedicine Technologies: Information Technologies in Medicine and Telehealth, 2011, 1st edition, John Wiley & Sons Ltd, New York.

Mode of Evaluation: Continuous Assessment Test, Quiz, Digital Assignment, Final Assessment Test, Additional Learning (MOOC / Conference, Journal Publications / Make a thon / Project competition and more)

Recommended by Board of Studies :	19-09-2019		
Approved by Academic Council	No. 56	Date	24-09-2019

Course code	Course title	L	T	P	J	C
ECE1030	Artificial Intelligence for Biomedical	2	0	0	4	3
Pre-requisite	Nil	Syllabus version				
		v1.0				

Course Objectives:

1. Familiarize students with Artificial Intelligence principles and techniques in Biomedical
2. Introduce the facts and concepts of cognitive science by computational model and their applications in Biomedical
3. Introduce the facts and concepts of cognitive science by computational model and their applications in Biomedical

Expected Course Outcome:

1. Apply knowledge of computing and mathematics appropriate to the medical applications.
2. Analyze a medical problem, identify and define the computing requirements appropriate to its solution
3.To design, implement, and evaluate a computer-based system, process, component, or program to meet Medical needs
4. Design efficient algorithm to achieve optimized solution in complex medical situation
5. Apply heuristic methodologies in state-space medical diagnostic problems
6. Characterize various ways to represent the Medical Learning system
7. Design the Medical adaptive mechanism in case of uncertainty
8. Implement learning algorithms to apply and resolve in Biomedical problems

Module:1	Artificial Intelligence and its Issues	4 hours

Definitions - Importance of AI, Evolution of AI – Medical Applications of AI, Classification of AI systems with respect to environment, Knowledge Inferring systems and Planning, Uncertainty and towards Learning Systems

Module:2	Overview to Problem Solving	4 hours

Medical Problem solving by Search, Problem space - State space, Blind Search - Types, Performance measurement

Module:3	Heuristic Search	4 hours

Types, Game playing – mini-max algorithm, Alpha-Beta Pruning techniques in medical diagnosis and decision making system

Module:4	Knowledge Representation and Reasoning	4 hours

Logical systems – Medical Knowledge Based systems, Propositional Logic – Constraints, Predicate Logic – First Order Logic, Inference in First Order Logic, Ontological Representations and applications. Applications in diagnosis of medical condition.

Module:5	Uncertainty and knowledge Reasoning	4 hours

Overview – Definition of uncertainty, Bayes Rule – Inference, Belief Network, Utility Based System, Decision Network, Applications in Medical Diagnosis.

Module:6	**Learning Systems**	**4 hours**
Forms of Learning – Types - Supervised, unsupervised, reinforcement learning, Learning Decision Trees, Learning Healthcare Systems.		
Module:7	**Expert Systems**	**4 hours**
Expert Systems- Stages in the development of an Expert Systems- Probability based Expert Systems- Expert System Tools-Difficulties in Developing Expert Systems- Applications of Expert Systems in Biomedical		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**30 hours**

Text Book(s)	
1.	Stuart Russell and Peter Norvig Artificial Intelligence - A Modern Approach, Pearson Education, 3rd edition, 2016.
2.	D. Poole and A. Mackworth. Artificial Intelligence: Foundations of Computational Agents, 2nd edition, Cambridge University Press, 2017
Reference Books	
1.	E. Alpaydin. Introduction to Machine Learning. PHI, 3rd edition, 2015
2.	Tony J. Cleophas and Aeilko H. Zwinderman. 2015. Machine Learning in Medicine - a Complete Overview. Springer
3.	Goodfellow, Ian and Bengio, Yoshua and Courville Aaron. Deep Learning . MIT Press (2016).

Mode of Evaluation: Continuous Assessment Test, Quiz, Digital Assignment, Final Assessment Test, Additional Learning (MOOC / Conference, Journal Publications / Make a thon / Project competition and more)

List of Challenging Experiments (Indicative)		
1.	A machine learning approach in Biomedical	5 hours
2.	Classification of objects in medical images based on various object representations	5 hours
3.	Controlling a Surgical Robot Hand in Simulation and Reality	5 hours
4.	Disease Detection by Medical Image Discriminating	5 hours
5.	Wireless AI Based Robot for Surgical Operations	5 hours
6.	Intelligent Biomedical Information System	5 hours
	Total Laboratory Hours	30 hours

Mode of assessment: 3 reviews			
Recommended by Board of Studies :	19-09-2019		
Approved by Academic Council	No. 56	Date	24-09-2019

Course code	Course title	L	T	P	J	C
ECE2008	Robotics and Automation	2	0	0	4	3
Prerequisite:	ECE1005 - Sensors and Instrumentation					

Course objectives (CoB):

1. To provide basic understanding of robotics and their applications.
2. To demonstrate the need for various sensors and drives in robotics.
3. To provide knowledge about the robot kinematics, path planning and different trajectories.
4. To make students understand the basics of programming of robots, contemporary use and design of robots in practice and research.

Course Outcomes (CO):

1. Understand the necessity of robots in various applications.
2. Comprehend the working of basic electric, electronic and other types of drives required in robots.
3. Identify a suitable sensor for a specific robot.
4. Derive the mathematical model of robotic systems and analyze its kinematic behavior.
5. Design robots for diverse environments encompassing all types of motions and paths.
6. Apply the ideas for performing various robotic tasks with the application of programming skills.
7. Design of different types of robots for various applications.

2. Having a clear understanding of the subject related concepts and of contemporary issues
13. Having cross cultural competency exhibited by working in teams
17. Having an ability to use techniques, skills and modern engineering tools necessary for engineering practice.

Module:1	Introduction to Robotics	2 hours

Robots: Basics, Types-Application, Mobility, Terrain, components classification, performance characteristics.

Module:2	Drives for Robotics	3 hours

Drives: Electric, hydraulic and pneumatic drives.

Module:3	Sensors for Robots	4 hours

Tactile sensors - Proximity and range sensors - Acoustic sensors - Vision sensor systems -Image processing and analysis - Image data reduction – Segmentation – Feature extraction -Object recognition.

Module:4	Robot Kinematics and Dynamics	7 hours

Kinematics of manipulators, rotational, translation and transformation, Homogeneous, Transformations, Denavat – Hartenberg Representation, Inverse Kinematics. Linearization of Robot Dynamics – State variable continuous and discrete models.

Module:5	Path Planning	5 hours

Types of trajectories, trajectory planning and avoidance of obstacles, path planning, skew motion, joint integrated motion and straight line motion.

Module:6	**Programming of Robots**	**3 hours**
Robot programming: languages and software packages-MATLAB/Simulink, OpenRDK, Adams.		
Module:7	**Application of Robots**	**4 hours**
Industrial robots used for welding, painting and assembly, remote controlled robots, robots for nuclear, thermal and chemical plants, industrial automation, typical examples of automated industries.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture:	**30 hours**

Text Books:

1.	Mikell P. Groover, "Industrial Robotics: Technology, Programming and Applications", 2012, 2nd Edition, McGraw-Hill Publishers.
2.	John J. Craig, "Introduction to Robotics, Mechanics and Control", 2010, 3rd Edition, Pearson Education.

Reference Books:

1.	M.W. Spong and M. Vidyasagar, "Robot Dynamics and Control," 2012, 2nd Edition, John Wiley & Sons, New York.
2.	Lorenzo Sciavicco Bruno Siciliano , "Modelling and Control of Robot Manipulators", 2012, 1st Edition, Springer Science & Business Media, Berlin.
3.	Peter Corke, "Robotics, Vision and Control: Fundamental Algorithms in MATLAB", Reprint 2013, 1st Edition, Springer-Verlag Berlin Heidelberg.

Typical Projects

1. Pick and place robot
2. Ball throwing machine for cricket practice
3. Variable height vehicle
4. Wall plastering robot
5. Soil sample collecting robot
6. Object sorting robot
7. Automatic packing robot
8. Robotic goalkeeper

Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).

Recommended by Board of Studies :	13-02-2015		
Approved by Academic Council	No. 40	Date:	18-03-2016

Course code	Course title	L	T	P	J	C
ECE2018	Medical Informatics	3	0	0	0	3
Pre-requisite	Nil	Syllabus version				
		v1.0				

Course Objectives:

1. Introduce the basic concepts in Biomedical Informatics.
2. Understand the applications of an electronic medical record system and medical standards.
3. Acquaint the students to clinical decision support systems.
4. Introduce the basics of bioinformatics, resources in the field and explore the various databases.

Expected Course Outcomes:

1. Understand the basic concepts in Biomedical Informatics.
2. Comprehend the applications of an electronic medical record system.
3. Apply the various aspects of health informatics and medical standards.
4. Design and develop clinical decision support systems.
5. Understand the basics of bioinformatics and the resources in the field.
6. Explore and apply the various bioinformatics tools and databases available in NCBI.
7. Analyse and apply the standards in proper health care delivery.

Module:1	Introduction to Biomedical Informatics	7 hours

The Science and the Pragmatics - Biomedical Data - Their Acquisition, Storage, and Use - Computer Architectures for Health Care and Biomedicine - Overview of hospital information system - Patient history taking mechanisms - Patient data processing - Database Management - Communication of medical data across different hospital units - Networking and Integration of patient data.

Module:2	Computer Architectures and Software Engineering for Health Care and Biomedicine	6 hours

Data from patients - Patient Record, Coding and classification – Standards - Natural Language Processing - Biomedical Imaging Informatics - Biosignal Analysis - Electronic Health Record Systems - Patient-Centered Care Systems - Primary care - Clinical Departmental Systems - Nursing Information Systems.

Module:3	Electronic Patient Record and Standards	6 hours

Electronic Patient Record - Medical data formats – Medical Standards – HL7 – DICOM - LOINC - PACS - Medical Standards for Vocabulary - ICD 10 – DRG - MeSH, UMLS, SNOMED - Healthcare Standards - JCAHO, HIPAA.

Module:4	Biomedical Decision Making	6 hours

Probabilistic Clinical Reasoning - Medical Knowledge and Decision Support - Methods for decision support - Clinical decision-support systems - Strategies for medical knowledge acquisition - Predictive tools for clinical decision support.

Module:5	Bioinformatics	6 hours

Introduction to Bioinformatics- Biological information resources - Genome sequence acquisition and analysis - Retrieval of biological data - Data acquisition – databases - structure and annotation - Data

mining and data characteristics.		
Module:6	**Bioinformatics tools**	**6 hours**
NCBI - Human Genome Project – GenBank - Sequence alignment – BLAST – FASTA – CLUSTALW - Phylogenetic analyses.		
Module:7	**Methodology for Information Systems**	**6 hours**
Human-Computer interaction in health care - Costs and Benefits of information systems - Security in medical information systems - Standards in Health care informatics and Telematics - Project management.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book

1.	Edward H. Shortliffe and James J. Cimino, "Biomedical Informatics: Computer Applications in Health Care and Biomedicine (Health Informatics)", 2014, 4th edition, Springer, New York.

Reference Book

1.	Rastogi, "Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery", 2013, 1st edition, Prentice Hall, New Delhi.

Mode of Evaluation: Continuous Assessment Test, Quiz, Digital Assignment, Final Assessment Test, Additional Learning (MOOC / Conference, Journal Publications / Make a thon / Project competition and more)

Recommended by Board of Studies :	19-09-2019		
Approved by Academic Council	No. 56	Date	24-09-2019

Course Code	Course Title	L	T	P	J	C
ECE2025	PROBABILITY AND STATISTICAL THEORY OF COMMUNICATION	1	0	2	0	2
Pre-requisite	ECE1018 – Signal Analysis and Processing	Version : 1.1				

Course objectives (CoB):

The course is aimed at

1. Acquainting students with the basic concepts of random variable and random process.
2. Introducing the basics of information theory and channel capacity
3. Using statistical hypothesis and estimation theory for parameter estimation.

Course Outcomes (CO):

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

1. Comprehend the basics probability and random variables understand.
2. Understand the two-dimensional random variables.
3. comprehend the different types of random processes like stationary, Gaussian random process etc.
4. Compute information measure and channel capacity
5. Compute response of correlator in receiver and matched filter.
6. Use the various statistical hypothesis testing methods including LR test, Mim-Max test, Neyman Pearson test.
7. Comprehend the different estimation theory including MMSE, MAP, ML and CRB estimators.
8. Solve the problems using modern engineering tools

Module:1	**Probability and Random Variable**	**2 hours**	
Axioms of probability, Conditional probability, random variable, Probability Density Function, Moments, Standard distributions- Uniform, Normal, Exponential, Rayleigh.			
Module:2	**Two Dimensional Random Variables**	**2 hours**	
Joint distributions, Marginal and conditional distributions, Covariance, Correlation, Transformation of random variables, Central limit theorem			
Module:3	**Random Process**	**2 hours**	
Random Process- Stationarity, Independence, Gaussian Random Processes, Linear system Fundamentals-Random Signal Response of Linear Systems			
Module:4	**Information Measure**	**2 hours**	
Self-Information, Discrete and Continuous Entropy, Entropy of a binary source, Mutual Information, Channel capacity			
Module:5	**Optimum Linear Systems**	**2 hours**	
Digital Communication in presence of AWGN-Correlation receiver, Matched filter receiver			
Module:6	**Testing of statistical hypothesis**	**2 hours**	
Likelihood ratio test, Baye's test, Probability of error, Mini-Max test, Neyman Pearson Test			
Module:7	**Estimation theory**	**2 hours**	
Minimum mean square error estimator, Maximum a posteriori estimator, Maximum likelihood estimation, Cramer Rao bound (CRB) for parameter estimation			
Module:8	**Contemporary issues:**	**1 hours**	
Total Lecture: 15 hours			
Text Book(s)			

1. P.Z. Peebles, Probability, Random Variables and Random Signal Principles, 2012, 4th edition, Tata McGraw Hill, India **2.** John G. Proakis, Digital Communications, 2014, 5th Edition, Tata McGraw Hill, India.	
Reference Books: **1.** Simon Haykin, Communication Systems, 2012, 5th Edition, Wiley, India. **2.** Ranjan Bose, Information Theory, Coding and Cryptography, 2015, 18th Reprint, Tata McGraw Hill, India.	
Mode of Evaluation: Continues Assessment Test, Quiz, Digital Assignment, Challenging Experiments, Final Assessment Test	
List of Challenging Experiments(Indicative)	
Task I: Computation of Probability Mass (Density) Function (PMF or PDF) 1. Generate 1000 sample points of real numbers uniformly distributed between '0' and '1'. i) Let X be random variable(RV) taking values '0' &'1'. X=0 corresponds to the sample points whose values are less than 0.5. X=1 corresponds to the sample points whose values are between 0.5 and 1. Draw the probability mass function of the RV, X. ii) Repeat part (i) for RV 'Y' taking values 0, 1&2. 0 : sample values between 0&1/3 1: sample values between 1/3&2/3 2: sample values between 2/3 & 1.	3 hours
Task II : Computation of PDF and cumulative distribution function (CDF) 1. Draw the graph for the binomial density function for N=6 and p=0.4. Also compute and show it by graph, the binomial cumulative distribution function (CDF).	4 hours
Task III: Generation of Histogram of Uniform RV 1. Generate 1000 sample points of real numbers uniformly distributed between 0 & 1 using the Matlab function 'rand'. Compute the Histogram of the above sample points (Take 10 uniform steps between 0 & 1). Redraw the histogram when the sample points are increased to 2000. Also observe it when the steps are increased from 10 to 20. Compare your results with built in Matlab function.	3 hours
Task IV : Generation of Histogram of Gaussian RV Redo the steps Task III with Matlab function 'rand' replaced by 'randn'. Write a Matlab script to compute the mean, mean square, variance and standard deviation for the RVs given and display them on the command prompt. Compare your results with the built in functions. Generate 1000 samples of a uniform RV taking values between 0 & 2π . Generate the new RV, $Y = \sin\Theta$. Plot the p.d.f of Y. Compare this with the theoretical result.	4 hours
Task 5: Transformation of Uniform pdf to exponential and Rayleigh pdfs Generate 1000 sample points of uniform p.d.f,. Use appropriate transformation to convert uniform p.d.f to i) exponential p.d.f ii) Rayleigh p.d.f. Draw their corresponding p.d.f curves. Generate 1000 samples of a 'Gaussian' random variable X. Use the transformation $Y = X$ 2. Draw the p.d.f of Y and compare it with theoretical results	4 hours

Task 6: Probability of error analysis			4 hours
Task 7: Baseband Transmission and Reception schemes			4 hours
Task 8: True parameter estimation schemes			4 hours
Total Laboratory Hours : 30 hours			
Mode of Evaluation: Continuous and Final Assessment test			
Recommended by Board of Studies :		26-02-2017	
Approved by Academic Council :	44	Date :	16-03-2017

Course code	Course title	L	T	P	J	C
ECE2027	EMC and EMI	2	0	0	4	3
Pre-requisite	ECE1017- Electro Magnetic Field Theory and Transmission Lines	Version: 1.2				

Course Objectives:

The course is aimed at
1. Imparting knowledge on the importance of EMC and EMC compliance.
2. Providing exposure to EMI sources, mitigation, and measurement techniques/standards to guarantee the correct working modalities.
3. Providing exposure to the guidelines for reduced EMI in PCB design.

Expected Course Outcome:

At the end of the course the student should be able to
1. Understand the concepts related to EMI and EMC, and differentiate between conducted and radiated emission.
2. Differentiate the types of EMI coupling mechanisms
3. Apply a proper EMI control technique for a specific identified EMI problem.
4. Design an EMC model for PCBs
5. Describe about various Radiated EMI Measurements techniques and chambers.
6. Understand the standards for EMI and EMC

Module:1	**EMI/EMC Concepts**	**3 hours**	

EMI/EMC definitions – Units - Sources of EMI: Classification, Lightning, ESD, NEMP - Conducted and radiated emission - Conducted and radiated susceptibility – Intra and inter system EMI - In band interference - Spectrum conservation - Radiation hazard - Specific Absorption Rate (SAR).

Module:2	**EMI Coupling Principles**	**3 hours**	

Conductive coupling: Common-mode, Differential-mode - Inductive coupling - Capacitive coupling - Radiative coupling

Module:3	**EMI Control Techniques -I**	**5 hours**	

Grounding: Earthing principle, system grounding - Shielding: Shielding theory and shielding effectiveness, Shielding integrity at discontinuities, Conductive coatings, Cable shielding, Bonding: Shape and material for bond strap - general guidelines for good bonds.

Module:4	**EMI Control Techniques -II**	**5 hours**	

EMI Filters: Characteristics of filters, Impedance mismatch effects, Lumped element filters, Power line filter design, Common mode filter, Differential mode filter - EMI suppression devices and components: EMI suppression cables, EMC connectors, EMC gaskets, Isolation transformers, Transient and surge suppression devices.

Module:5	**EMC Design of PCBs**	**5 hours**	

RF Sources in PCB - SMD / through hole components, Pins, Basic loops, Differential vs Common mode - Board layout: Grounds and Power, ground bounce, Power distribution for two-layer boards, Power supply decoupling, Board zoning, Signal traces, Cross talk, Trace routing - Cables and connectors.

Module:6	**EMI Measurements**	**4 hours**	

Radiated interference measurements: Open area test site measurement, anechoic chamber, TEM cell; Reverberating chamber - Conducted interference measurements: Characterization of conduction currents voltages, Conducted EM noise on power supply lines, Conducted EMI from equipment - Pulsed interference immunity: ESD/EFT, Electrical surge - Time domain EMI measurement

Module:7	**EMC Standards**	**3 hours**	

Military standards, IEEE/ ANSI Standards, CISPR/IEC, FCC standards, European Standards, VDE Standards, Other EMC Standards, Company Standards, EMC compliance for wireless devices, Radio Equipment Directive (RED).			
Module:8	**Contemporary issues:**	**2 hours**	
	Total Lecture hours:	**30 hours**	
Text Book(s)			
1. Henry W.Ott, Noise Reduction Techniques in Electronic Systems, 2011, 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey.			
Reference Books			
1. Clayton R.Paul, Introduction to Electromagnetic compatibility, 2010, 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey. **2.** Patrick G. André and Kenneth Wyatt, EMI Troubleshooting Cookbook for Product Designers 2014, 1st Edition, SciTech Publishing, UK. **3.** V.P. Kodali, Engineering EMC Principles, Measurements and Technologies, 2010,2nd Edition, IEEE Press, New York.			
Mode of Evaluation: Continues Assessment Test, Quiz, Digital Assignment, Challenging Experiments, Final Assessment Test			
List of Challenging Experiments (Indicative)			
Task1: Test and Analysis of RE/ RS Develop a test setup and study the performance of Radiated Emission, Radiation Susceptibility with respect to various standards.			7 hours
Task2: Test and Analysis of CE/ CS Develop a test setup and study the performance of Conducted Emission and Conducted Susceptibility with respect to various standards.			7 hours
Task 3: Comprehensive study and analysis of ESD / EFT / Surge Develop a test setup and analyze the radiated and conducted effects of Electrostatic Discharge/EFT and Surge			8 hours
Task 4:PCB Design Design a PCB for a circuit with a mixture of analog and digital parts, multiple power planes, and a single Ground plane split into analog and digital sections that have a common reference point using open source tool.			8 hours
Total Laboratory Hours			30 hours
Mode of Evaluation: Continuous and Final Assessment test			
Recommended by Board of Studies :		26-02-2017	
Approved by Academic Council :	44	Date :	16-03-2017

Course Code	Course Title	L	T	P	J	C
ECE3002	VLSI System Design	3	0	2	0	4
Prerequisite:	ECE2003 Digital Logic Design	V: 1.1				

Course Objectives:

1. To understand MOS device characteristics and to implement simple gates using CMOS logic style with delay and power constraints
2. To understand the CMOS fabrication process styles including layout design rules
3. To design combinational and sequential circuits using different logic styles
4. To use modern EDA tools to simulate and synthesize VLSI circuits

Expected Course Outcomes:

1. Clear understanding of fundamental concepts of MOS transistors
2. Able to design simple logic gates using CMOS logic style
3. Able to calculate power and delay of simple CMOS circuits
4. Understand fabrication processes and their impact on the circuit performance
5. Able to design and validate combinational and sequential circuits using different logic styles
6. Able to design VLSI circuits at sub-system abstraction level
7. Able to use modern EDA tools to design VLSI circuits

Module:1	**MOS Transistor Theory**	**5 hours**
I-V Characteristics, C-V Characteristics, Non ideal I-V effects of MOS Transistors		
Module:2	**CMOS Logic**	**5 hours**
Basic gates, Compound Gates, Transmission Gates based combinational and sequential logic design		
Module:3	**CMOS Circuit characterization and Performance Estimation**	**8 hours**
DC transfer Characteristics of CMOS inverter, Circuit characterization and performance estimation: Delay estimation, Logical effort and Transistor Sizing. Power Dissipation: Static & Dynamic Power Dissipation.		
Module:4	**CMOS Fabrication and Layout**	**5 hours**
CMOS Process Technology N-well, P-well process, Stick diagram for Boolean functions using Euler Theorem, Layout Design Rule		
Module:5	**CMOS Combinational Circuit Design**	**7 hours**
Static CMOS, Ratioed Logic, Cascode voltage Switch Logic, Dynamic circuits, Pass Transistor Circuits		
Module:6	**CMOS Sequential Circuit Design**	**7 hours**
Conventional CMOS Latches and Flip Flops, Pulsed Latches, Resettable and Enabled Latches and Flip Flops		
Module:7	**Sub System Design**	**6 hours**
Single bit Adder, Carry look ahead adder, Carry propagate Adder, Magnitude Comparator, Barrel Shifter, Signed and unsigned multiplier.		

Module:8	**Contemproray Issues**	**2 hours**
	Total Lecture Hours:	**45 hours**

Text Books:

1.	Neil H.Weste, Harris, A. Banerjee, "CMOS VLSI Design, A circuits and System Perspective", 2014, Fourth Edition, Pearson Education, Noida, India.

Reference Books:

1.	Jan M. Rabaey, Anantha Chadrakasan, BorivojeNikolic, "Digital Integrated Circuits: A Design Perspective", 2014, Third Edition, Prentice Hall India, New Jersey, US.
2.	Yogesh Chauhan, Darsen Duane Lu, Vanugopalan Sriramkumar, Sourabh Khandelwal, Juan Duarte, NavidPayvadosi, Ai Niknejad, Chenming Hu, "FinFETModeling for IC Simulation and Design", 2015, Academic Press, Elsevier.

Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).

Sl.No.	**List of Challenging Experiemnts (Indicative):**	
1	i. Cadence EDA Tool Demo & Hands on - Schematic ii. Basic Cell structure (NMOS & PMOS) using conventional MOS iii. Verification with different corners iv.Design and Analysis of CMOS circuits (Analysis: Power, Delay, NM, PDP) (Design: Sizing)	8 hours
2	i. Cadence EDA Tool Demo & Hands on – Layout & Post Layout Simulation ii. Basic Cell layout (CMOS) iii. Fingering and folding iv. Standard cell design for different technology node	8 hours
3	i. Adder Design using conventional CMOS ii. Multiplier using conventional CMOS iii. Memory design (SRAM /DRAM /CAM). iv. Level converters (Optional)	8 hours
4	i. ALU Design using conventional CMOS ii. Simple Processor Design using conventional CMOS	6 hours
	Total Laboratory Hours:	**30 hours**

Mode of Evaluation: Continuous Assessment of Challenging experiments / Final Assessment Test (FAT).

Recommended by Board of Studies :		28-02-2016	
Approved by Academic Council:	47	Date:	05-10-2017

Course Code	Course Title	L	T	P	J	C
ECE 3039	CHEMICAL AND BIOSENSORS	3	0	0	0	3
Pre-requisite	ECE2023 - Principles of Sensors and Data Acquisition	Version : 1.1				

Course Objectives:

The course is aimed at making the students to
1. Study the basic principles of chemical sensors and its applications.
2. Familiarize with the technological advancements in the field of chemical sensors.
3. Understand the working principle of biosensors.
4. Know about the variety of sensing techniques for measurement and detection of bio-chemical to be rephrased processes.

Expected Course Outcome:

At the end of the course, the students will be able to
1. Gain knowledge about chemical sensors and their applications.
2. Gain the basic idea of biosensor, immobilization techniques and its applications.
3. Select a suitable chemical and biosensor for a given application.
4. Understand the sensors used for measuring analytical concentration of some components of the analyte gas or solution.
5. Know about the sensors used for quantification of biochemical processes.
6. Understand the working principle of sensors conduction and their characteristics.
7. Comprehend the working principle of mechanical sensors-based mass and heat for various applications.

Module:1	**Overview of Chemical Technology**	**6 hours**	
Galvanic Cells, Electrode – Electrolyte Interface, Fluid Electrolytes, Dissociation of Salt, Solubility Product, Ion Product, pH Value, Ionic Conductivity, Ionic Mobility, Phase Diagrams.			
Module:2	**Transduction Principles**	**7 hours**	
Transduction Elements- Ion-Selective Electrodes, Nernst Equation, voltammetry, amperometry, conductivity, FET, Modified electrodes, Thin-Film Electrodes and Screen-Printed electrodes			
Module:3	**Chemical Sensing Elements**	**7 hours**	
Ionic recognition, molecular recognition-chemical recognition agents, spectroscopic recognition, Biological recognition agents, Immobilization of biological components, performance factors of Urea biosensors, Amino acid biosensors, Glucose biosensors and Uric acid, Factors affecting the performance of sensors.			
Module:4	**Potentiometric Sensors**	**5 hours**	
Potentiometric- Ion selective electrodes- pH linked, Ammonia linked, CO_2 linked, Silver sulfide linked, Iodine selective, Lambda sensor, NOx sensor.			
Module:5	**Amperometric Sensors**	**5 hours**	
Amperometric-bio sensors (Glucose sensor) and gas sensors (C_2H_4, CH_4, O_2, NO_x, CO_2, NH_3).			
Module:6	**Conductometric Sensors**	**7 hours**	
Conductometric-chemirsistors-Biosensor based chemiresistors-Semiconducting oxide sensor, CHEMFETs, ISFETs, FET based Biosensors.			
Module:7	**Mass and Thermal Sensors**	**6 hours**	
Piezoelectric effect- Gas sensor applications, Biosensor applications- Quartz crystal microbalance, surface acoustic waves, Enzymatic mass sensor, Glucose thermistor, catalytic gas sensor, pellistors, Enzymethermistor.			
Module:8	**Contemporary issues:**	**2 hours**	

Total Lecture hours:		**45 hours**	
Text Book(s)			
1. Brian R Eggins, Chemical sensors and Biosensors, 2013, 1st ed., John Wiley sons Ltd, USA.			
Reference Books			
1. Loic J Blum and Coulet, Biosensor: Principle and applications, 2011, 2nd ed., CRC Press, USA. 2. Janata, Jiri, Principles of Chemical sensors, 2014, 2nd ed., Springer, USA. 3. Peter Grundler, Chemical Sensors: Introduction for Scientists and Engineers, 2011, 1st ed., Springer, USA. 4. R.G.Jackson, Novel sensors and Sensing, 2012, 1st ed., Philadelphia Institute of Physics, USA.			
Mode of Evaluation: Continuous Assessment Tests, Quiz, Digital Assignment, Final Assessment Test			
Recommended by Board of Studies :		26-02-2017	
Approved by Academic Council :	44	Date	16-03-2017

Course code	Course Title	L	T	P	J	C
ECE4005	Optical Communication and Networks	2	0	2	4	4
Pre-requisite	ECE4001: Digital Communication Systems	Syllabus version				
		1.0				

Course Objectives:

1. To discuss technology developments in Optical Communication system.
2. To provide an in-depth knowledge on various types of fibers and their transmission characteristics, the construction, working principle and characteristics of transmitters, receivers and various optical amplifiers used in long distance communication.
3. To describe the concepts of Wavelength Division Multiplexing technique, components used and the estimation of rise-time and power budget for digital transmission system.
4. To introduce SONET/SDH, OTN and PON Technologies.

Expected Course Outcomes:

1. Understand the concept of optical communication.
2. Select fiber and optoelectronic components to design, analyze an optical communication system and understand the basic concepts of optical transmitters, modulators and nonlinear effects.
3. Understand the concepts on photodetectors and receivers and various optical amplifiers.
4. Establish optical communication systems for multichannel systems using multiplexing techniques.
5. Understand the concepts of WDM system and their applications.
6. Understand and classify various types of optical Networks and their applications.
7. Design, analyze and evaluate optical communication systems.
8. Model and Simulate Optical Communication systems and networks.

Module:1	**Overview of optical fiber communication andNetworks**	**3 hours**
Motivation-Spectral bands-Key elements of optical fiber system-Modeling and simulation Tools		
Module:2	**Optical Fibers**	**4 hours**
Types - SM-SI; MM-SI, MM-GI; specialty fibers Geometrical-Optics Description, Wave Propagation, Chromatic Dispersion, Polarization Mode Dispersion, Dispersion-Induced Limitations, Fiber Losses, Nonlinear Optical Effects (SRS,SBS,SPM,CPM,FWM)		
Module:3	**Optical Transmitters and Receivers**	**6 hours**
Sources: LED, LASER, Modulators, Transmitter Design, Mach-Zehnder and Electro-absorption Modulators. Photodetector, Receiver Design, Receiver Noise, Bit Error rate, Receiver Sensitivity , Sensitivity Degradation, Receiver Performance.		
Module:4	**Optical Amplifiers**	**3 hours**
Semiconductor Optical Amplifiers , Raman Amplifiers , Erbium-Doped Fiber Amplifiers , System Applications		
Module:5	**Light-wave Transmission Systems**	**4 hours**
Intensity Modulation - Direct Detection Systems, Homodyne and heterodyne detection, Optical time division multiplexing (bit-interleaved, packet interleaved)Wavelength-division multiplexing, Sub carrier multiplexing, Polarization multiplexing. Digital links: Point-to-Point links-System consideration-Link power budget-Rise time budget, System performance		
Module:6	**Multichannel Systems**	**4 hours**
WDM Lightwave Systems and Components, Operational principles of WDM-Passive optical		

coupler:2x2 Fiber coupler-Wave guide coupler-Star couplers-MZI Multiplexers , Isolators and Circulators – Fiber Bragg Grating-FBG Applications, WDM System Performance Issues			
Module:7	**Optical Networks**		**4 hours**
Network concepts-Topologies SONET/SDH -The Optical Transport Network - Introduction - OTN Network Layers - FEC in OTN - OTN Frame Structure - OPU-k - ODU-k - OTU-k-The Optical Channel - Optical Channel Carrier and Optical Channel Group - Optical Networks Access(existing PON Technologies; CWDM-PON, TDM-PON,Hybrid TDM-WDM –PON) and Metro Networks Long-Haul Networks			
Module:8	**Contemporary Issues**		**2 hours**
	Total Lecture Hours:		**45 hours**
Text Book(s)			
1.	Gerd Keiser, “Optical Fiber Communications” McGraw Hill, 5th Edition, 2013.		
2.	J. M. Senior, “Optical Fiber Communications: Principles and Practice”, Pearson 2011.		
Reference Books			
1.	Cvijetic, M., Djordjevic. I. B.: Advanced Optical Communication Systems and Networks, Artech House 2012		
2.	R. Ramaswami & K.N. Sivarajan, Morgan Kaufmann, ”Optical Networks A practical perspective”,2nd Edition, Pearson Education, 2010.		
3.	G.P Agrawal, Fiber Optic Communication Systems, Wiley, 2nd Edition,2011		
4.	B.Mukerjee, Optical WDM Networks (Optical Networks), Springer edition; 2006		
5.	G. P. Agrawal, Nonlinear Fiber Optics, Academic Press, 2nd Edition,2008		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies :		13-12-2015	
Approved by Academic Council	No. 40	Date	18-03-2016

Course code	Course Title	L	T	P	J	C
ECE4007	Information Theory and Coding	3	0	0	4	4
Pre-requisite	ECE4001 : Digital Communication Systems					Syllabus version
						1.0

Course Objectives:

1. To acquaint students with the basics of probability, information and its properties
2. To familiarize students with different channel models and their capacity
3. To teach different types of source coding techniques
4. To explain various types of channel coding techniques

Expected Course Outcomes:

1. Comprehend and analyze the basics of probability, information and its properties
2. Examine different types of channels and determine their capacity
3. Understand the binary and non-binary source coding schemes
4. Analyze the dictionary-based coding schemes for image compression techniques
5. Understand the fundamentals of error control coding schemes
6. Construct, comprehend and analyze the advanced error control coding schemes
7. Evaluate the performance of source coding, channel coding techniques in image processing and wireless applications

Module:1	**Introduction**	**4 hours**
Review of Probability Theory, Introduction to information theory		
Module:2	**Entropy**	**6 hours**
Uncertainty, self-information, average information, mutual information and their properties - Entropy and information rate of Markov sources - Information measures of continuous random variables.		
Module:3	**Channel Models and Capacity**	**5 hours**
Importance and types of various channel models - Channel capacity calculation – Binary symmetric channel, binary erasure channel - Shannon's channel capacity and channel coding theorem - Shannon's limit.		
Module:4	**Source Coding I**	**6 hours**
Source coding theorem - Huffman coding - Non binary Huffman codes - Adaptive Huffman coding - Shannon Fano Elias coding - Non binary Shannon Fano codes		
Module:5	**Source Coding II**	**6 hours**
Arithmetic coding - Lempel-Ziv coding - Run-length encoding and rate distortion function - Overview of transform coding.		
Module:6	**Channel Coding I**	**8 hours**
Introduction to Error control codes - Block codes, linear block codes, cyclic codes and their properties, Encoder and Decoder design- serial and parallel concatenated block code, Convolution Codes-Properties, Encoder-Tree diagram, Trellis diagram, state diagram, transfer function of convolutional codes, Viterbi Decoding, Trellis coding, Reed Solomon codes.		
Module:7	**Channel Coding II**	**8 hours**
Serial and parallel concatenated convolutional codes, Block and convolutional interleaver, Turbo coder, Iterative Turbo decoder, Trellis coded modulation-set partitioning - LDPC Codes.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture Hours:	**45 hours**

Text Book(s)

1. Simon Haykin, "Communication Systems", 2012,4th Edition, Wiley India Pvt Ltd, India.

2	Ranjan Bose, "Information Theory, Coding and Cryptography", 2015, 1st Edition, McGraw Hill Education (India) Pvt. Ltd., India.
Reference Books	
1.	John G. Proakis, "Digital Communications", 2014, 5th Edition, McGraw-Hill, McGraw Hill Education (India) Pvt. Ltd., India.
2.	Bernard Sklar and Pabitra Kumar Ray "Digital Communications: Fundamentals and Applications", 2012, 1st Edition, Pearson Education, India.
3	Khalid Sayood, "Introduction to Data Compression", Reprint: 2015, 4th Edition, Elsevier, India.
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	
Typical Projects	

1. Efficient Image compression technique by using modified SPIHT algorithm
2. Develop the compression algorithms by using Discrete Wavelet Transform
3. Compress and decompress an Image using Modified Huffman coding
4. Apply Run length coding and Huffman encoding algorithm to compress an image.
5. Adaptive Huffman coding of 2D DCT coefficients for Image compression
6. Compress of an image by chaotic map and Arithmetic coding
7. Region of Interest based lossless medical image compression
8. Write a code to build the (3, 1, 3) repetition encoder. Map the encoder output to BPSK symbols. Transmit the symbols through AWGN channel. Investigate the error correction capability of the (3, 1, 3) repetition code by comparing its BER performance to that without using error correction code.
9. Write a code to compare the BER performance and error correction capability of (3, 1, 3) and (5, 1, 5) repetition codes. Assume BPSK modulation and AWGN channel. Also compare the simulated results with the theoretical results.
10. Write a code to compare the performance of hard decision and soft decision Viterbi decoding algorithms. Assume BPSK modulation and AWGN channel.
11. Write a code to build (8, 4, 3) block encoder and decoder. Compare the BER performance of (8, 4, 3) block coder with (3,1,3) repetition codes. Assume BPSK modulation and AWGN channel.
12. Consider the following Extended vehicular A channel power delay profile. Write a code to model the given profile. Also measure the channel capacity. Compare the obtained capacity to that without fading channel.

Delay (ns)	Power (dB)
30	-1.5
310	-3.6
710	-9.1
1730	-12

13. Performance analysis of various channels (BSC, BEC, Noiseless, Lossless) under AWGN.
14. FPGA implementation of linear block coding and syndrome decoding.

15. Performance of linear block codes under single error and burst error. 16 .Performance of analysis of convolution codes under single error and burst error 17. Implementation of VITERBI decoding in FPGA. 18. Efficiency checking of different interleaver for turbo encoder. 19. Implementation of trellis code modulator in FPGA. 20. Developing the Compression algorithms for Wireless multimedia sensor networks.			
Mode of evaluation: Review I, Review II and Review III			
Recommended by Board of Studies :		13-12-2015	
Approved by Academic Council	No. 40	Date	18-03-2016

Course Code	Course Title	L	T	P	J	C
ECE4009	Wireless and Mobile Communications	3	0	2	4	5
Pre-requisite	ECE4001 : Digital Communication Systems	Syllabus version				
		1.0				

Course Objectives:

1. To familiarize the concepts related to cellular communication and its capacity.
2. To acquaint students with different generations of mobile networks.
3. To teach students the fundamentals of multipath fading and propagation models.
4. To describe the modulation and diversity schemes as applied in mobile communication.

Expected Course Outcomes:

1. Understand and solve telecommunication design issues using cellular and trunking theory.
2. Interpret the functions of the building blocks of cellular network architecture.
3. Perform practical link budget analysis for next generation cellular networks.
4. Analyze the effect of multipath channels and suggest a suitable model for indoor or outdoor applications.
5. Demonstrate the implications of multipath parameters in mobile communication.
6. Differentiate the digital modulation schemes available and select appropriate method to improve the performance of wireless communication.
7. Appraise a suitable diversity technique to combat the multipath fading effects.
8. Design a wireless mobile communication system by formulating the apt techniques and selecting the supporting software/ hardware components.

Module:1	Cellular Concept	6 hours

Cellular concept – Frequency reuse – Channel assignment strategies – Handoff strategies – Interference & system capacity – Trunking & grade of service – Improving coverage and capacity in cellular system.

Module:2	Cellular Networks	5 hours

GSM architecture – CDMA architecture – GPRS architecture – UMTS architecture

Module:3	Introduction to Mobile Radio Propagation	5 hours

Free space propagation model – Three basic propagation mechanism – Reflection, diffraction and scattering – Two ray ground reflection model

Module:4	Mobile Radio Propagation: Large Scale Path Loss	6 hours

Link budget design using path loss model – Outdoor and indoor propagation models

Module:5	Mobile Radio Propagation : Small Scale Fading and Multipath	6 hours

Small scale multipath propagation – Parameters of mobile multipath channels – Types of small scale fading – Fading effects due to multipath time delay spread and doppler spread – Rayleigh and Rician fading.

Module:6	Modulation Techniques for Mobile Radio	9 hours

Overview of linear modulation techniques: QPSK, MSK, QAM – GMSK- OFDM and its principle, transceiver implementation, cyclic prefix, inter carrier interference, windowing, PAPR and its

reduction techniques.		
Module:7	**Diversity Techniques**	**6 hours**
Diversity – Types of diversity – Diversity combining techniques: Selection, Feedback, Maximal Ratio Combining and Equal Gain Combining – Rake receiver		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Rappaport, T.S., "Wireless communications", 2012 (Reprint), 2nd edition, Pearson Education, Noida, India.
Reference Books	
1.	T L Singal, "Wireless Communications", 2014 (Reprint), Tata McGraw Hill Education, 1st edition, New Delhi, India.
2.	Keith Q T Zhang, "Wireless Communications: Principles, Theory and Methodology", 2016, 1st edition, John Wiley & Sons, West Sussex, UK.
3.	Andreas.F. Molisch, "Wireless Communications", 2012, 2nd edition, John Wiley & Sons, West Sussex, UK.
4.	Gottapu Sasibhushana Rao, "Mobile Cellular Communications", 2013, 1st edition, Pearson Education, Noida, India.
5.	Y. S. Cho, J. Kim, W.Y. Yang, C. G. Kang, "MIMO-OFDM Wireless Communications with Matlab", 2014 (Reprint), 1st edition, John Wiley & Sons, Singapore.
Mode of Evaluation: Continuous Assessment Test –I (CAT-I), Continuous Assessment Test –II (CAT-II), Digital Assignments/ Quiz / Completion of MOOC, Final Assessment Test (FAT).	

List of Challenging Experiments (Indicative)		
1.	To study the effect of various fading channels such as Rayleigh, Ricean and various noise channel such as AWGN and Laplacian noise	3 hours
2.	Simulate to compute the pathloss of urban, suburban and rural environment for LTE/WiMAX/WLAN system using free space, Ericsson, COST 231, ECC, Hata and SUI model	3 hours
3.	Evaluate Signal to Interference Noise Ratio (SINR) distribution for the following scenarios a. Effect of changing transmit power b. Effect of common vertical tilt of antennas c. Effect of changing percentage of users who are indoor and outdoor d. Different Terrains	6 hours
4.	Simulate link level Bit Error Rate (BER) performance a. Link level BER Performance without FEC b. Link level BER Performance with various CQI indices c. Link level BER Performance with various transmission mode	6 hours
5.	Study of relative interference levels in homogeneous networks	3 hours
6.	Evaluate SINR distribution for heterogeneous scenarios with Picos a. Effect of Pico locations and number of Picos b. Effect of power levels of Picos c. Effect of Pico bias	5 hours
7.	Study of CQI variation a. CQI variations for different users b. CQI variations in different sub bands	4 hours

		Total Laboratory hours	**30 hours**
Mode of evaluation: Continuous Assessment of Challenging experiments / Final Assessment Test (FAT)			
Typical Projects			
1. Energy-and cost-efficient mobile communication using multi-cell MIMO and relaying techniques 2. Inter-cell interference mitigation for mobile communication system 3. Improving capacity / resource allocation for soft handoff performance in wireless mobile communication 4. Security in mobile communication 5. Call admission and control schemes for QoS in cellular networks 6. Analysis of different traffic models in mobile communication 7. Dynamic channel assignment in wireless mobile communication 8. Performance analysis of macrocell / microcell hierarchical cellular systems 9. Performance analysis of propagation models 10. Performance analysis of modulation schemes			
Mode of evaluation: Review I, II and III.			
Recommended by Board of Studies :		13-12-2015	
Approved by Academic Council	No. 40	Date	18-03-2016

Course Code	Course Title	L	T	P	J	C
ECE 4025	EMBEDDED PROGRAMMING	2	0	2	0	3
Pre-requisite	ECE 3031 Microcontroller and Embedded System	Version:1				

Course Objectives:

The course is aimed at
1. Expressing to Embedded C and Linux and the range of applications to which they are suited.
2. Developing skills in the Embedded C, SHELL programming and Linux
3. Familiarizing the students with data structures

Expected Course Outcome:

At the end of the course, the student should be able to
1.Understand and write simple Embedded pseudo codes.
2.Comprehend the fundamentals of C
3.Comprehend the Data structures
4.Comprehend the basics of OS Concepts and Linux
5.Showcase the skill, knowledge and ability of SHELL programming.
6.Exhibit the working knowledge of basic Embedded Linux
7.Have hands on experience in using state-of- art hardware and software tools

Module:1	**Basics of Embedded Programming**	**3 hours**	
Basic concepts of C, Embedded C Vs. C, Embedded programming aspects with respect to firmware and OS Functions, Data Types, Data Type Conversions - Operators - Conditional Controls – Loop Controls- Input / Output Operations.			
Module:2	**C Programming Concepts**	**3 hours**	
Functions, Arrays, pointers, structures and Inputs/Outputs			
Module:3	**Data Structures**	**3 hours**	
Linked list, Single linked list, Double linked list, Stack and Queues			
Module:4	**OS Concepts**	**3 hours**	
Operating system structures, Process Management, Process Synchronization, CPU Scheduling			
Module:5	**Basics of Linux**	**6 hours**	
Command prompt, X windows basics, Navigating file system, finding files, working with folders, reading files text editing in Linux, Compression and archiving tools, Basic shell commands, File Management, I/O Handling, File Locking			
Module:6	**Shell Programming**	**5 hours**	
Processes, giving more than one command at a time, prioritizing and killing processes, Scheduling Commands, pipes and redirection, regular expression, pattern matching, Scripting using for while, if and other commands			
Module:7	**Linux Programming Concepts**	**5 hours**	
File Management , I/O Handling, File Locking, Process Management , Memory Management, Message Queues , Shared Memory, Semaphores			
Module:8	**Contemporary issues:**	**2 hours**	
Total Lecture hours:		**30 hours**	

Text Book(s)

1. Neil Mathew, Richard stones, Beginning Linux Programming, 2012 reprint, Wrox –Wiley Publishing, USA.
2. Eric Foster Johnson, John C. Welch, Micah Anderson, Beginning shell scripting, 2012, Reprint ,Wrox – Wiley Publishing, USA.

Reference Books

1. Robert Love, Linux System Programming: Talking directly to the kernel and C library: and C

Library, 2013, 2nd Edition, O'Reilly Publication, USA. 2. Paul J. Deitel, C How to Program, 2016, 1st Edition, Pearson Education, India. 3. William Stallings, Operating System, 2014, 8th Edition, Prentice Hall of India.		
Mode of Evaluation: Continues Assessment Test, Quiz, Digital Assignment, Final Assessment Test		
List of Challenging Experiments (Indicative)		
1.	Task 1: C programming Create a child process by calling fork system call and display the current process ID and parent process ID for the following conditions. (i) Process ID and parent process ID for process and childprocess (ii) Process ID and parent process ID for process and childprocess while sleep in theparent. (iii) Process ID and parent process ID for process and childprocess while sleep in achild.	5 hours
2.	Task 2: C programming Create a pipe system call to communicate between the parent process and child process. Create a fifo system call and communicate between two different process.	5 hours
3.	Task 3: Implementation of data structure for an application Write a SortedMerge() function that takes two lists, each of which is sorted in increasing order, and merges the two together into one list which is in increasing order. SortedMerge() should return the new list. The new list should be made by splicing together the nodes of the first two lists.	6 hours
4.	Task 4: Shell Programming Development of inventory management system using Shell scripting with the following features. User may add/update/delete inventory. • User may add/update inventory details. • Details include cost, quantity and description. • Includes forms for inventory inwards and outwards. • User may create sub-inventories. • An interactive user interface	6 hours
5.	Task 5: Inter Process Communication Write an implementation of Message queue, shared memory and semaphore inter process communications	6 hours
Total Laboratory Hours		30 hours
Mode of Evaluation: Challenging Experiments, Final Assessment Test		
Recommended by Board of Studies :	26-02-2017	
Approved by Academic Council : 44	Date : 16-03-2017	

Course Code	Course Title	L	T	P	J	C
ECE4026	M2M COMMUNICATIONS	2	0	0	4	3
Pre-requisite	ECE3030 - Principles of Computer Communications	Version : 1.2				

Course objectives (CoB):

The course is aimed at

1. Introducing students with the basic concepts of M2M communication
2. Acquainting with M2M architecture, protocols and its security
3. Knowing the significance of M2M interfaces and services

Course Outcomes (CO):

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

1. G et acquainted with the basics of M2M Communication
2. Understand the operation of M2M protocols and architecture
3. Possess an ability to optimize the M2M in public mobile networks
4. Know about IP in M2M
5. distinguish between different types of M2M security methods
6. Comprehend the operation and, characteristics of M2M terminals and interfaces
7. Familiarise with the basics of M2M services
8. Analyse the traffic models, routing protocols and different services using modern engineering tools.

Module:1	**Introduction M2M**	**4 hours**	
What is M2M, Business of M2M, Accelerating M2M maturity, High level M2M framework, Policies, M2M Standards, M2M Value Chain, MVNO Led Model, Optimization in M2M Deployments.			
Module:2	**M2M Architecture and Protocols**	**4 hours**	
Use-Case driven approach in M2M architecture, ETSI-M2M work on use cases, Smart Metering Approach in ETSI M2M, Typical Smart Metering Deployment Scenario, Traffic models, M2M market applications			
Module:3	**M2M Optimization in Public Mobile Networks**	**5 hours**	
M2M over a Telecommunications Network, M2M Communication Scenarios, Data Connections for M2M Applications, 3GPP Standardization of Network Improvements for Machine Type			

Communications, Numbering, Identifiers, and Addressing, Triggering Optimizations, Overload and Congestion Control			
Module:4	**IP in M2M**	**3 hours**	
Neighbor Discovery Protocol, IPv6 for M2M, 6LoWPAN: Framework, Header Compression, Routing Protocol for Low-Power and Lossy Networks (RPL), RPL Topology, CoRE, REST Architecture.			
Module:5	**M2M Security**	**5 hours**	
Security Characteristics of Cellular M2M, Security Requirements, Access Network Provider, M2M Service Provider perspectives, Approaches Against Hijacking, Public Key Solutions, Smart card based solutions, Methods Based on Pre-Provisioned Symmetric Keys, Bootstrapping and identity based encryption, Security for Groups of M2M Devices, ETSI M2M Security.			
Module:6	**M2M Terminals and Interfaces**	**3hours**	
Access technologies, Physical form factors, Hardware interfaces, UICC (Universal Integrated Circuit Card) Interface, GPIO (General-Purpose Input/Output Port) Interface, SPI (Serial Peripheral Interface) Interface, Analog Audio Interfaces. Durability test.			
Module:7	**M2M Services**	**4 hours**	
Application Execution Environment, Connectivity Services, Management services, Software services, AT Commands, SDK commands, Cellular identification, MNO Identification.			
Module:8	**Contemporary issues:**	**2 hours**	
Total Lecture hours:30 hours			

Text Book(s)

1. David Boswarthick, M2M Communications – A Systems Approach, 2012, Wiley, USA.

Reference Books

1. Vojislav B. Misic, JelenaMisic, Machine to Machine Communications: Architecture, Technologies, Standards and Applications, October 18, 2017, CRC Press, USA.
2. Carles Anton-Haro, Mischa Dohler, Machine to Machine Communications: Architecture, Performance and Applications, 2015, Elsevier, Amsterdam, Netherlands.

Mode of Evaluation: Continuous Assessment Tests, Quiz, Digital Assignment, Final Assessment Test

Typical Projects

1. Design and implement a Telemedicine application using M2M Communications.
2. Design and implement Telemetry applications using M2M
3. Design and implement a Building management using M2M
4. Design and implement M2M Applications using GGSN
5. Design and implement M2M Applications using PDSN
6. Design and implement Healthcare applications using M2M
7. Design and implement Power sector control using M2M
8. Design and implement Transport and logistics using M2M

Design and implement Smart metering applications

Mode of Evaluation: Continuous Assessment Reviews

Recommended by Board of Studies :		26-02-2017	
Approved by Academic Council :	44	Date :	16-03-2017

Course code	Course Title	L	T	P	J	C
ITE1002	Web Technologies	2	0	2	0	3
Pre-requisite	CSE1001	Syllabus version				
		1.10				

Course Objectives:

1. To understand the web architecture and web languages.
2. To program for web client and web server objects.
3. To understand web development environment and methodology

Expected Course Outcome:

1. Implement interactive and responsive web pages using HTML and CSS.
2. Use Java script language to transfer data and add interactive components to web pages.
3. Develop a sophisticated web application that appropriately employs the MVC architecture
4. Demonstrate a client server application using HTTP protocol and access web services for dynamic content using AJAX.
5. Exhibit the working of server-side scripts.
6. Understand the fundamental working of data using open source databases
7. Develop advanced web frameworks by combining multiple web technologies
8. Implement Client side and Server side programming.

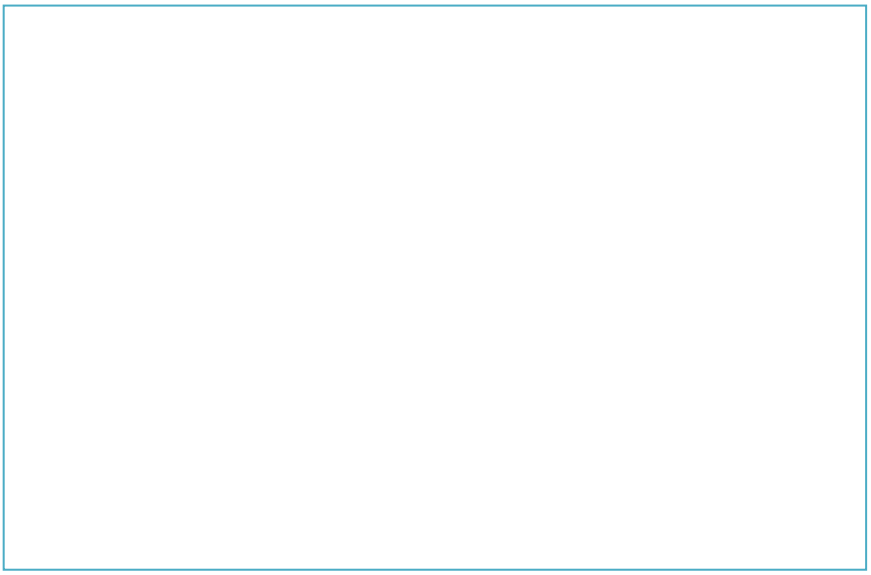
Module:1	**Web Essentials**	**4 hours**
Evolution of Web – Web architecture – HTML –XHTML- CSS		
Module:2	**Client-Side Scripting**	**5 hours**
Javascript Basics –Arrays- Functions - Javascript objects – HTML DOM - DOM methods – Events- Regular Expressions – Form Validation-JSON-Jquery		
Module:3	**Web Applications**	**5 hours**
Web applications- Web Application Frameworks-MVC framework-Angular JS – Single Page Applications-Responsive Web Design		
Module:4	**Client/Server Communication**	**4 hours**
HTTP- Request/Response Model- HTTP Methods- RESTful APIs-AJAX-AJAX with JSON		
Module:5	**Web Servers**	**5 hours**
Node.js-NPM- Callbacks -Events- Express framework-Cookies-Sessions-Scaling		
Module:6	**Storage**	**3 hours**
MongoDB-Manipulating and Accessing MongoDB Documents from Node js		
Module:7	**Reactive frameworks**	**2 hours**
Meteor JS framework – Templates – Events – Sessions – Publish & Subscribe –Accounts		
Module:8	**Contemporary issues:**	**2 hours**

	Total Lecture hours:	**30 hours**	

Text Book(s)	
1.	Brad Dayley, Node.js, MongoDB, and AngularJS Web Development, Addison Wesley, 2014
2.	Morris Mano, Digital logic and Computer design, 4th Edition, Pearson, 2008.
Reference Books	
1.	Jon Duckett,HTML & CSSDesign and Build Websites,Wiley, 2011
2.	Jon Duckett,JavaScript and JQuery: Interactive Front-End Web Development,Wiley,2014
3.	Holdener, Ajax: The Definitive Guide,Oreilly,2010

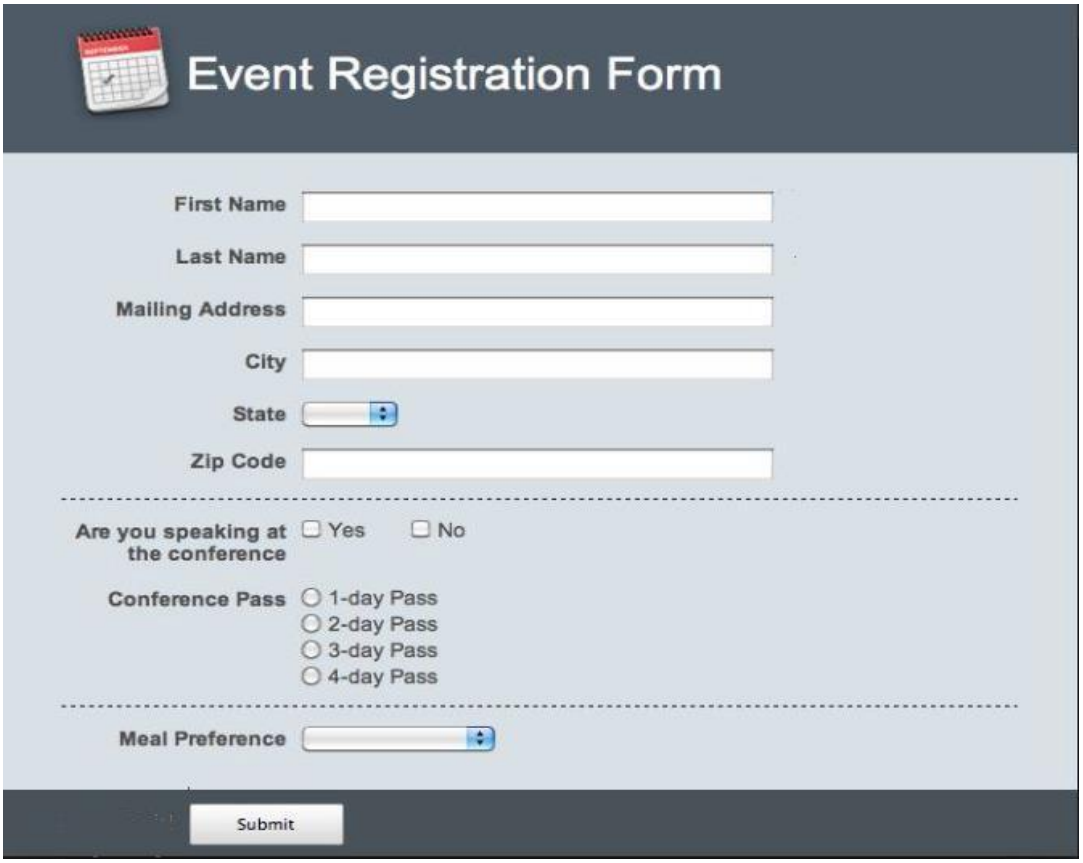
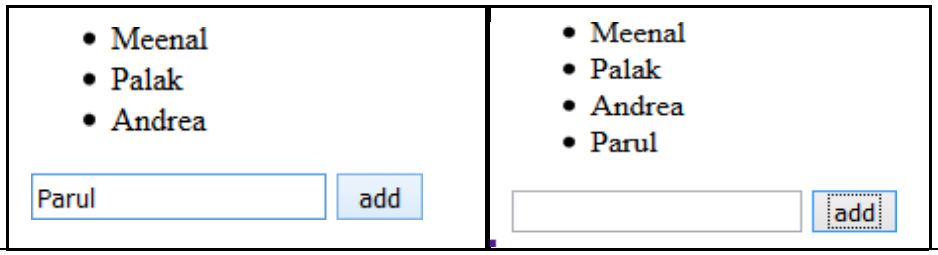
List of Challenging Experiments (Indicative)

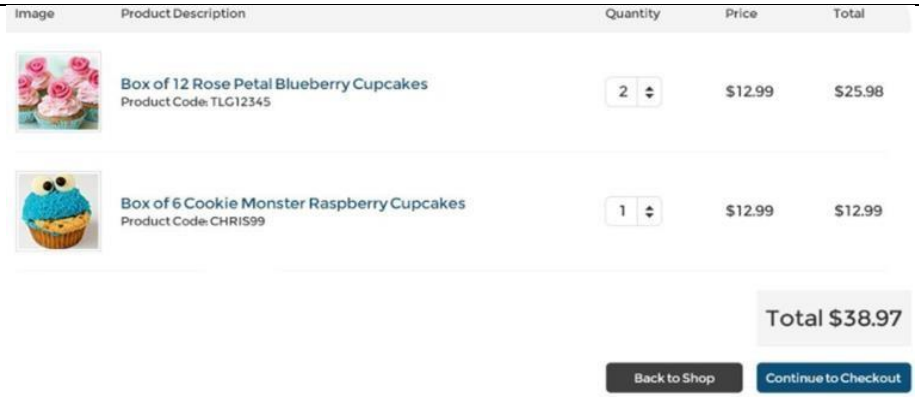
1. Use DHTML to perform the following**.**
   a) Design the spotlight section of VIT home page. Use Box properties of CSS.



   b) To create a web page which includes a map and display the related information when a hot spot is clicked in the map
   c) Create a web page which displays an image "ganesha.jpg" and the text "This is image of Lord Ganesh". Place three buttons in the web page which performs the following on clicking them
      - To right align the image.
      - To change the height, width and border of the image to 250, 350 and 3 pixels respectively
      - To change the source and alternate text of the image to "vinayaga.jpg" and "The image cannot be loaded" respectively.
        1. Design a web page with image gallery and sliding menu for movie reviews
2. Design the following using JavaScript and DOM
   a) Given an array of words, write a javascript code to count the number of vowels and number of consonants in each word. Use Regular Expressions.
   b) Include Image Slide Show Digital clock, Survey Poll to make your webpage
      i) Dynamic.

   Develop a web application to implement online quiz system. The application includes only client side script
3. Create a popup Login form using jQuery which appears at the center of screen on loading the page after a specified time interval. Include Captcha text in the login page.
4. a) Validate the Event Registration Form given below using Jquery for the following conditions.

	• All fields are mandatory • Zip code should be exactly five digits • Email validation  b) Create a JSON file for a list of cities. Provide autocomplete option for city field using the JSON file as source.
5.	Using Angular JS, add names that are entered in textbox to the list and clear the textbox once the name is added to list. 
6.	Design a shopping cart application using AngularJS. Your shopping webpage should have the provisions for selecting the list of items from different category, Once the items are selected on clicking the submit button the items in the cart with its price should be displayed. Sample design is given below.

	
7.	Create a MongoDB collection of "books" with the following details: ***Title, ISBN(unique id), Authors, Publication ,Year of Publication and Price.*** Write commands for the following: a) Insert a new document with multiple authors. b) Update a document with change in price c) Remove documents with year of publication lesser than 1990.
8.	d) A MongoDB collection of words has the document structure as: *{* *word:<word>,* *first:<first_letter>,* *last:<last_letter>,* *size: <character_count>* *}* Perform the following operations on those documents using Nodejs. • Find the set of words which starts with letters 'a','b' or 'c'. • Find the set of words which exactly has 12 letters. • Count the number of words that starts and ends with a vowel. • Find the first ten words that end with the letter 'e' and display it in descending order.
9.	e) Develop an Online banking Web application over MEAN stack with the following scenarios. • Initially the login page should contain only user id field. On entering the user id, if only the user id exists, password field should be displayed. • On successful login, display the account summary with the following details retrieved from the database: Account no, Account type and Available Balance. • On the left side top of the page display the Current date, Last Login date and UserName and User Id. • The session should expire on logout or if the page is idle for more than 2 minutes.
10.	f) Create an application in node.js for employee management. The application should manage the following details of an employee: ID, name, surname, cadre and salary. Name and surname are strings, while ID, cadre and Salary are integers. The application should have the following functionalities: • To search an employee using his/her ID If the employee exists, it will show his/her data in a form, otherwise an pop message should be displayed stating the employees does not exist. • To delete an employee, by specifying his/her ID. • To insert a new employee using a form. By default, the form is hidden, by pressing a

	button the form should appear. If the same button is clicked the form should disappear. Every time the form is shown, it should be empty. The form should allow to specify all data of an employee. If the ID field is left empty, the system will assign the next available ID. If the ID is already associated to an employee, the employee data are overwritten. If the ID is not associated to any employee, the employee is created. All the other fields cannot be empty.			
11.	. Design an online book store using ExpressJS which has the following features (use the MongoDB database created in Question.No.9): a) Search option based on Title , Author or ISBN b) On retrieving the results , display the book details in table format with the Price field in sorted order using AngularJS			
12.	Design a student registration form which takes student name, register number, DOB, program, email id, temporary address, permanent address, phone number. Validate the following using jquery: a. Mobile number should be exactly 10 digits b. Register number should have alphabets and numbers only c. Name should not exceed 30 characters and can be only alphabets. d. Email validation e. Provide a checkbox saying "Permanent address is same as temporary address". If checked, the value of permanent address should be added automatically from temp address. And should be in disabled mode.			
Total Laboratory Hours				30 hours
Recommended by Board of Studies	12-08-2017			
Approved by Academic Council	No. 47	Date	05-10-2017	

Course Code	Course title	L	T	P	J	C
MAT-3005	Applied Numerical Methods	3	2	0	0	4
Pre-requisite	MAT2002 – Applications of Differential and Difference Equations	Syllabus Version				
		1.0				

Course Objectives

The aim of this course is to

1. cover certain basic, important computer oriented numerical methods for analyzing problems that arise in engineering and physical sciences.
2. use MATLAB as the primary computer language to obtain solutions to a few problems that arise in their respective engineering courses.
3. impart skills to analyse problems connected with data analysis,
4.solve ordinary and partial differential equations numerically

Expected Course Outcomes

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

1. Observe the difference between exact solution and approximate solution.
2. Use the numerical techniques to find the solution of algebraic equations and system of equations.
3 . Fit the data using interpolation technique and spline methods.
4. Find the solution of ordinary differential equations, Heat and Wave equation numerically.
5. Apply calculus of variation techniques to extremize the functional and also find approximate series solution to ordinary differential equations

Module:1	Algebraic and Transcendental Equations	5 hours

General iterative method- rates of convergence- Secant method - Newton – Raphson method-System of non-linear equations by Newton's method.

Module:2	System of Linear Equations and Eigen Value Problems	6 hours

Gauss –Seidel iteration method. Convergence analysis of iterative methods-LU Decomposition -Tri diagonal system of equations-Thomas algorithm- Eigen values of a matrix by Power and Jacobi methods.

Module:3	Interpolation	6 hours

Finite difference operators- Newton's forward-Newton's Backward- Central differences-Stirling's interpolation - Lagrange's interpolation - Inverse Interpolation-Newton's divided difference-Interpolation with cubic splines.

Module:4	Numerical Differentiation and Integration	6 hours

Numerical differentiation with interpolation polynomials-maxima and minima for tabulated values-Trapezoidal rule, Simpsons $1/3^{rd}$ and $3/8^{th}$ rules. –Romberg's method. Two and Three point Gaussian quadrature formula.

Module:5	Numerical Solution of Ordinary Differential Equations	8 hours

First and second order differential equations - Fourth order Runge – Kutta method. Adams-Bashforth-Moulton predictor-corrector methods. Finite difference solution for the second order ordinary

differential equations.		
Module:6	**Numerical Solution of Partial Differential Equations**	**6 hours**
Classification of second order linear partial differential equations-Laplace equation –Gauss-Seidal method-One dimensional heat equation- Schmidt explicit method-Crank-Nicolson implicit method.-One dimensional wave equation–Explicit method.		
Module:7	**Variational Methods**	**6 hours**
Introduction - functional –variational problems- extremals of functional of a single dependent variable and its first derivative- functional involving higher order derivatives- Isoperimetric problems-Galerkins- Rayleigh Ritz methods.		
Module:8	**Contemporary Issues**	**2 hours**
Industry Expert Lecture		
	Total Lecture hours:	**45 hours**
Tutorial	• A minimum of 10 problems to be worked out by students in every Tutorial Class. • Another 5 problems per Tutorial Class to be given for practise.	**30 hours**

Text Book(s)

1. Numerical Methods for Scientific and Engineering, M. K. Jain, S. R. K. Iyengar and R. K. Jain, New Age International Ltd., 6th Edition, 2012.
2. Applied Numerical Analysis, C. F. Gerald and P.V. Wheatley, Addition-Wesley, 7th Edition, 2004.

Reference Books

1. Introductory Methods of Numerical Analysis, S.S. Sastry, PHI Pvt. Ltd., 5th Edition, New Delhi, 2009.
2. Applied Numerical Methods Using MATLAB, W.Y. Yang, W. Cao, T.S. Chung and J. Morris, Wiley India Edn., 2007.
3. Numerical Methods for Engineers with Programming and Software Applications, Steven C. Chapra and Ra P. Canale, 7th Edition, Tata McGraw Hill, 2014.
4. Numerical Analysis, R.L. Burden and J. D. Faires, 4th Edition, Brooks Cole, 2012.
5. Numerical Methods: Principles, Analysis and Algorithms, Srimanta Pal, Oxford University Press India, 2009.

Mode of Evaluation:

Digital Assignments, Continuous Assessment Tests, Final Assessment Test

Recommended by Board of Studies	25-02-2017		
Approved by Academic Council	No.47	Date	05-10-2017