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 Sensor and Wearable Technology

Curriculum

(*2018-2019 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 Sensor and Wearable Technology

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 Sensor and Wearable Technology

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 Sensor and Wearable Technology

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On the completion of B.Tech Electronics and Communication Engineering with Specialization with Specialization in Sensor and Wearable Technology,

Students will be able to

PSO1. Design and develop different classes of sensors, wearable devices and systems.

PSO2. Apply engineering tools to solve complex Electronics Engineering and interdisciplinary problems pertaining to wearable systems.

PSO3: Use skills and techniques to solve contemporary problems in the field of sensors and wearable technology.

B. Tech Electronics and Communication Engineering with Specialization in Sensor and Wearable Technology

CREDIT STRUCTURE

Category-wise Credit distribution

Category	Credits
University Core (UC)	70
University Elective(UE)	12
Program Core(PC)	69
Program Elective (PE)	29
Total Number of Credits	**180**

University Core – 70 Credits

Course Code	Course Title	L	T	P	J	C
CHY1002	Environmental Sciences	3	0	0	0	3
CSE1001	Problem Solving and Programming	0	0	6	0	3
CSE1002	Problem Solving and Object Oriented Programming	0	0	6	0	3
ECE3999	Technical Answers for Real World Problems (TARP)	1	0	0	8	3
ECE4098	Comprehensive Examination	0	0	0	0	2
ECE4099	Co-Op / Capstone Project	0	0	0	0	20
ENG1011	English for Engineers	0	0	4	0	2
HUM1021	Ethics and Values	2	0	0	0	2
MAT1011	Calculus for Engineers	3	0	2	0	4
MAT2001	Statistics for Engineers	2	2	2	0	4
MGT1022	Lean Start-up Management	1	0	0	4	2
PHY1001	Engineering Physics	3	0	2	0	4
PHY1999	Introduction to Innovative Projects	1	0	0	4	2
CBY4097	Chemistry / Biology	3	0	2	0	4
EXC4097	Co-Extra Curricular Basket	0	0	0	0	2
FLC4097	Foreign Language Course Basket	0	0	0	0	2
STS4097	Soft Skills	0	0	0	0	6
ECE3099	Industrial Internship	0	0	0	0	2

Program core -68 credits

S.No	Course Code	Course Title	L	T	P	J	C
1	CSE2003	Data Structures and Algorithms	2	0	2	4	4
2	ECE1017	Electromagnetic Field Theory and Transmission Lines	3	0	0	0	3
3	ECE1018	Signal Analysis and Processing	2	0	2	4	4
4	ECE1033	Basics of Sensors and Wearable Technology	2	0	2	0	3
5	ECE2010	Control Systems	3	0	0	4	4
6	ECE2024	Principles of Communication Engineering	2	0	0	0	2
7	ECE2026	Digital Circuit Design	2	0	2	4	4
8	ECE2028	Analog Circuits	2	0	2	4	4
9	ECE2032	Wearable Devices and Its Applications	2	0	2	4	4
10	ECE2033	Introduction to Data Analytics	2	0	2	0	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	ECE3037	Wireless sensor networks and IoT	2	0	0	4	3
16	ECE3042	Data Acquisition Techniques	3	0	0	4	4
17	ECE3044	Wearable Technology and IoT	2	0	0	4	3
18	EEE1001	Basic Electrical and Electronics Engineering	2	0	2	0	3
19	MAT2002	Applications of Differential and Difference Equations	3	0	2	0	4
20	MAT3004	Applied Linear Algebra	3	2	0	0	4

Program Electives – 30 Credits

S.No	Course Code	Course Title	L	T	P	J	C
1	CSE3019	Data Mining	2	0	2	4	4
2	CSE4033	Cloud Computing and Information Security	2	0	2	0	3
3	CSE4034	IoT Edge Nodes and its Applications	2	0	2	0	3
4	CSE4035	Mobile App Development for IoT	2	0	0	4	3
5	ECE2025	Probability and Statistical Theory of Communication	1	0	2	0	2
6	ECE2027	EMC and EMI	2	0	2	0	3
7	ECE2034	Flexible Electronics And Sensors	3	0	0	0	3
8	ECE3002	VLSI System Design	3	0	2	0	4
9	ECE3010	Antenna and Wave Propagation	3	0	0	0	3
10	ECE3011	Microwave Engineering	3	0	2	4	5
11	ECE3035	RFID and Flexible Sensors	3	0	0	0	3
12	ECE3036	Sensors for Structural Health Monitoring	2	0	0	4	3
13	ECE3038	MEMS and Nano Sensors	3	0	0	0	3
14	ECE3040	Wireless Technologies for IoT	3	0	0	0	3
15	ECE4002	Advanced Microcontrollers	3	0	0	4	4
16	ECE4005	Optical Communication and Networks	2	0	2	4	4
17	ECE4007	Information Theory and Coding	3	0	0	4	4
18	ECE4009	Wireless and Mobile Communication	3	0	2	4	5
19	ECE4025	Embedded Programming	2	0	2	0	3
20	ECE4026	M2M Communication	2	0	0	4	3
21	ECE4027	Embedded Sensing Technologies	2	0	0	4	3
22	ECE4030	Building Management System	1	0	0	0	1
23	ECE4031	Artificial Intelligence with Python	3	0	2	0	4
24	ECE4032	Neural Networks and Deep Learning	3	0	0	4	4
25	ITE1002	Web Technologies	2	0	2	0	3
26	MAT3005	Applied Numerical Methods	3	2	0	0	4
27	SWE4004	Geographical Information System	3	0	0	0	3

UNIVERSITY CORE

Course code	Course Title	L	T	P	J	C
CHY1701	Engineering Chemistry	3	0	2	0	4
Pre-requisite		Syllabus version				
		1.1				

Course Objectives:

1. To impart technological aspects of applied chemistry
2. To lay foundation for practical application of chemistry in engineering aspects

Expected Course Outcomes (CO): Students will be able to

1. **Recall** and **analyze** the issues related to impurities in water and their removal methods and **apply** recent methodologies in water treatment for domestic and industrial usage
2. **Evaluate** the causes of metallic corrosion and **apply** the methods for corrosion protection of metals
3. **Evaluate** the electrochemical energy storage systems such as lithium batteries, fuel cells and solar cells, and **design** for usage in electrical and electronic applications
4. **Assess** the quality of different fossil fuels and create an awareness to **develop** the alternative fuels
5. **Analyze** the properties of different polymers and distinguish the polymers which can be degraded and **demonstrate** their usefulness
6. **Apply** the theoretical aspects: (a) in **assessing** the water quality; (b) **understanding** the construction and working of electrochemical cells; (c) **analyzing** metals, alloys and soil using instrumental methods; (d) **evaluating** the viscosity and water absorbing properties of polymeric materials

Module:1	Water Technology	5 hours

Characteristics of hard water - hardness, DO, TDS in water and their determination – numerical problems in hardness determination by EDTA; Modern techniques of water analysis for industrial use - Disadvantages of hard water in industries.

Module:2	Water Treatment	8 hours

Water softening methods: - Lime-soda, Zeolite and ion exchange processes and their applications. Specifications of water for domestic use (ICMR and WHO); Unit processes involved in water treatment for municipal supply - Sedimentation with coagulant- Sand Filtration - chlorination; Domestic water purification – Candle filtration- activated carbon filtration; Disinfection methods- Ultrafiltration, UV treatment, Ozonolysis, Reverse Osmosis; Electro dialysis.

Module:3	Corrosion	6 hours

Dry and wet corrosion - detrimental effects to buildings, machines, devices & decorative art forms, emphasizing Differential aeration, Pitting, Galvanic and Stress corrosion cracking; Factors that enhance corrosion and choice of parameters to mitigate corrosion.

Module:4	Corrosion Control	4 hours

Corrosion protection - cathodic protection – sacrificial anodic and impressed current protection methods; Advanced protective coatings: electroplating and electroless plating, PVD and CVD.

Alloying for corrosion protection – Basic concepts of Eutectic composition and Eutectic mixtures - Selected examples – Ferrous and non-ferrous alloys.

Module:5	**Electrochemical Energy Systems**	**6 hours**
Brief introduction to conventional primary and secondary batteries; High energy electrochemical energy systems: Lithium batteries – Primary and secondary, its Chemistry, advantages and applications. Fuel cells – Polymer membrane fuel cells, Solid-oxide fuel cells- working principles, advantages, applications. Solar cells – Types – Importance of silicon single crystal, polycrystalline and amorphous silicon solar cells, dye sensitized solar cells - working principles, characteristics and applications.		
Module:6	**Fuels and Combustion**	**8 hours**
Calorific value - Definition of LCV, HCV. Measurement of calorific value using bomb calorimeter and Boy's calorimeter including numerical problems. Controlled combustion of fuels - Air fuel ratio – minimum quantity of air by volume and by weight- Numerical problems-three way catalytic converter- selective catalytic reduction of NO_X; Knocking in IC engines-Octane and Cetane number - Antiknocking agents.		
Module:7	**Polymers**	**6 hours**
Difference between thermoplastics and thermosetting plastics; Engineering application of plastics - ABS, PVC, PTFE and Bakelite; Compounding of plastics: moulding of plastics for Car parts, bottle caps (Injection moulding), Pipes, Hoses (Extrusion moulding), Mobile Phone Cases, Battery Trays, (Compression moulding), Fibre reinforced polymers, Composites (Transfer moulding), PET bottles (blow moulding); Conducting polymers- Polyacetylene- Mechanism of conduction – applications (polymers in sensors, self-cleaning windows)		
Module:8	**Contemporary issues:**	**2 hours**
Lecture by Industry Experts		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	1. Sashi Chawla, A Text book of Engineering Chemistry, Dhanpat Rai Publishing Co., Pvt. Ltd., Educational and Technical Publishers, New Delhi, 3rd Edition, 2015. 2. O.G. Palanna, McGraw Hill Education (India) Private Limited, 9th Reprint, 2015. 3. B. Sivasankar, Engineering Chemistry 1st Edition, Mc Graw Hill Education (India), 2008 4. "Photovoltaic solar energy : From fundamentals to Applications", AngÃ¨le Reinders, Pierre Verlinden, Wilfried van Sark, Alexandre Freundlich, Wiley publishers, 2017.
Reference Books	
2	1. O.V. Roussak and H.D. Gesser, ***Applied Chemistry-A Text Book for Engineers and Technologists***, Springer Science Business Media, New York, 2nd Edition, 2013. 2. S. S. Dara, ***A Text book of Engineering Chemistry,*** S. Chand & Co Ltd., New Delhi, 20th Edition, 2013.
Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & FAT	

List of Experiments

	Experiment title	Hours
1.	Water Purification: Estimation of water hardness by EDTA method and its removal by ion-exchange resin	1 h 30 min

2. 3.	Water Quality Monitoring: Assessment of total dissolved oxygen in different water samples by Winkler's method Estimation of sulphate/chloride in drinking water by conductivity method	3 h
4/5.	Material Analysis: Quantitative colorimetric determination of divalent metal ions of Ni/Fe/Cu using conventional and smart phone digital-imaging methods	3h
6.	Analysis of Iron in carbon steel by potentiometry	1 h 30 min
7.	Construction and working of an Zn-Cu electrochemical cell	1 h 30 min
8.	Determination of viscosity-average molecular weight of different natural/synthetic polymers	1 h 30 min
9.	Arduino microcontroller based sensor for monitoring pH/temperature/conductivity in samples.	1 h 30 min
	Total Laboratory Hours	17 hours

Mode of Evaluation: Viva-voce and Lab performance & FAT			
Recommended by Board of Studies	**31-05-2019**		
Approved by Academic Council	**54th**	**Date**	**13-06-2019**

Course code	Course Title	L	T	P	J	C
CHY1002	Environmental Sciences	3	0	0	0	3
Pre-requisite		Syllabus version				
		V:1.1				

Course Objectives:

1. To make students understand and appreciate the unity of life in all its forms, the implications of life style on the environment.
2. To understand the various causes for environmental degradation.
3. To understand individuals contribution in the environmental pollution.
4. To understand the impact of pollution at the global level and also in the local environment.

Expected Course Outcome: Students will be able to

1. Students will **recognize** the environmental issues in a problem oriented interdisciplinary perspectives
2. Students will **understand** the key environmental issues, the science behind those problems and potential solutions.
3. Students will **demonstrate** the significance of biodiversity and its preservation
4. Students will **identify** various environmental hazards
5. Students will **design** various methods for the conservation of resources
6. Students will **formulate** action plans for sustainable alternatives that incorporate science, humanity, and social aspects
7. Students will have foundational **knowledge** enabling them to make sound life decisions as well as enter a career in an environmental profession or higher education.

Module:1	Environment and Ecosystem	7 hours

Key environmental problems, their basic causes and sustainable solutions. IPAT equation. Ecosystem, earth – life support system and ecosystem components; Food chain, food web, Energy flow in ecosystem; Ecological succession- stages involved, Primary and secondary succession, Hydrarch, mesarch, xerarch; Nutrient, water, carbon, nitrogen, cycles; Effect of human activities on these cycles.

Module:2	Biodiversity	6 hours

Importance, types, mega-biodiversity; Species interaction - Extinct, endemic, endangered and rare species; Hot-spots; GM crops- Advantages and disadvantages; Terrestrial biodiversity and Aquatic biodiversity – Significance, Threats due to natural and anthropogenic activities and Conservation methods.

Module:3	Sustaining Natural Resources and Environmental Quality	7 hours

Environmental hazards – causes and solutions. Biological hazards – AIDS, Malaria, Chemical hazards- BPA, PCB, Phthalates, Mercury, Nuclear hazards- Risk and evaluation of hazards. Water footprint; virtual water, blue revolution. Water quality management and its conservation. Solid and hazardous waste – types and waste management methods.

Module:4	Energy Resources	6 hours

Renewable - Non renewable energy resources- Advantages and disadvantages - oil, Natural gas, Coal, Nuclear energy. Energy efficiency and renewable energy. Solar energy, Hydroelectric power, Ocean thermal energy, Wind and geothermal energy. Energy from biomass, solar- Hydrogen revolution.		
Module:5	**Environmental Impact Assessment**	**6 hours**
Introduction to environmental impact analysis. EIA guidelines, Notification of Government of India (Environmental Protection Act – Air, water, forest and wild life). Impact assessment methodologies. Public awareness. Environmental priorities in India.		
Module:6	**Human Population Change and Environment**	**6 hours**
Urban environmental problems; Consumerism and waste products; Promotion of economic development – Impact of population age structure – Women and child welfare, Women empowerment. Sustaining human societies: Economics, environment, policies and education.		
Module:7	**Global Climatic Change and Mitigation**	**5 hours**
Climate disruption, Green house effect, Ozone layer depletion and Acid rain. Kyoto protocol, Carbon credits, Carbon sequestration methods and Montreal Protocol. Role of Information technology in environment-Case Studies.		
Module:8	**Contemporary issues**	**2 hours**
Lecture by Industry Experts		
	Total Lecture hours:	**45 hours**

Text Books

1.	G. Tyler Miller and Scott E. Spoolman (2016), Environmental Science, 15th Edition, Cengage learning.
2.	George Tyler Miller, Jr. and Scott Spoolman (2012), Living in the Environment – Principles, Connections and Solutions, 17th Edition, Brooks/Cole, USA.

Reference Books

1.	David M.Hassenzahl, Mary Catherine Hager, Linda R.Berg (2011), Visualizing Environmental Science, 4thEdition, John Wiley & Sons, USA.

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & FAT			
Recommended by Board of Studies	12.08.2017		
Approved by Academic Council	No. 46	Date	24.08.2017

Course code	Course Title	L	T	P	J	C
CSE1001	PROBLEM SOLVING AND PROGRAMMING	0	0	6	0	3
Pre-requisite	NIL	Syllabus version				
		1.0				

Course Objectives:

1. To develop broad understanding of computers, programming languages and their generations
2. Introduce the essential skills for a logical thinking for problem solving
3. To gain expertise in essential skills in programming for problem solving using computer

Expected Course Outcome:

1. Understand the working principle of a computer and identify the purpose of a computer programming language.
2. Learn various problem solving approaches and ability to identify an appropriate approach to solve the problem
3. Differentiate the programming Language constructs appropriately to solve any problem
4. Solve various engineering problems using different data structures
5. Able to modulate the given problem using structural approach of programming
6. Efficiently handle data using flat files to process and store data for the given problem

List of Challenging Experiments (Indicative)

1.	Steps in Problem Solving Drawing flowchart using yEd tool/Raptor Tool	3 Hours
2.	Introduction to Python, Demo on IDE, Keywords, Identifiers, I/O Statements.	4 Hours
3.	Simple Program to display Hello world in Python.	
4.	Operators and Expressions in Python	4 Hours
5.	Algorithmic Approach 1: Sequential	2 Hours
6.	Algorithmic Approach 2: Selection (if, elif, if.. else, nested if else	2 Hours
7.	Algorithmic Approach 3: Iteration (while and for)	4 Hours
8.	Strings and its Operations	2 Hours
9.	Regular Expressions	2 Hours
10.	List and its operations.	2 Hours
11.	Dictionaries: operations	2 Hours
12.	Tuples and its operations	2 Hours
13.	Set and its operations	2 Hours
14.	Functions, Recursions	2 Hours
15.	Sorting Techniques (Bubble/Selection/Insertion)	4 Hours
16.	Searching Techniques : Sequential Search and Binary Search	3 Hours
17.	Files and its Operations	4 Hours
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	John V. Guttag., 2016. Introduction to computation and programming using python: with applications to understanding data. PHI Publisher.

Reference Books

1.	Charles Severance.2016.Python for everybody: exploring data in Python 3, Charles Severance.
2.	Charles Dierbach.2013.Introduction to computer science using python: a computational problem-solving focus. Wiley Publishers.

Mode of Evaluation: **PAT / CAT / FAT**			
Recommended by Board of Studies	04-04-2014		
Approved by Academic Council	No. 38	Date	23-10-2015

Course Code	Course Title	L	T	P	J	C
CSE1002	PROBLEM SOLVING AND OBJECT ORIENTED PROGRAMMING	0	0	6	0	3
Pre-requisite	Nil	Syllabus version				
		1.0				

Course Objectives:

1. To emphasize the benefits of object oriented concepts.
2.To enable students to solve the real time applications using object oriented programming features
3.To improve the skills of a logical thinking and to solve the problems using any processing elements

Expected Course Outcome:

1. Demonstrate the basics of procedural programming and to represent the real world entities as programming constructs.
2.Enumerate object oriented concepts and translate real-world applications into graphical representations.
3.Demonstrate the usage of classes and objects of the real world entities in applications.
4.Discriminate the reusability and multiple interfaces with same functionality based features to solve complex computing problems.
5.Illustrate possible error-handling constructs for unanticipated states/inputs and to use generic programming constructs to accommodate different datatypes.
6.Validate the program against file inputs towards solving the problem..

Module:1	Structured Programming	12 hours

Structured Programming conditional and looping statements - arrays - functions - pointers - dynamic memory allocation - structure

Module:2	Introduction to object oriented approach	10 hours

Introduction to object oriented approach: Why object oriented programming? - Characteristics of object oriented language: classes and objects - encapsulation - data abstraction - inheritance - polymorphism - Merits and Demerits of object oriented programming. UML - class diagram of OOP - Inline function default argument function - Exception handling (Standard) - reference: independent reference function returning reference pass by reference.

Module:3	Classes and objects	14 hours

Classes and objects: Definition of classes access specifier class versus structure constructor destructor copy constructor and its importance array of objects dynamic objects - friend function-friend class

Module:4	Polymorphism and Inheritance	26 hours

Polymorphism and Inheritance: Polymorphism - compile time polymorphism function over-loading operator overloading. Inheritance - types of inheritance - constructors and destructors in inheritance constraints of multiple inheritance - virtual base class - run time polymorphism-function overriding

Module:5	Exception handling and Templates	18 hours

Exception handling and Templates Exception handling(user-defined exception) - Function tem-plate , Class template Template with inheritance , STL Container, Algorithm, Iterator - vector, list, stack, map

Module:6	**IO Streams and Files**	**10 hours**
IOstreams and Files IOstreams, Manipulators - overloading Inserters( ) and Extractors( ), Sequential and Random files writing and reading objects into/from files		
Text Book(s)		
1.	Stanley B Lippman, Josee Lajoie, Barbara E, Moo, C++ primer, Fifth edition, Addison-Wesley, 2012.	
2	Ali Bahrami, Object oriented Systems development, Tata McGraw - Hill Education, 1999.	
3	Brian W. Kernighan, Dennis M. Ritchie , The C programming Language, 2nd edition, Prentice Hall Inc., 1988.	
Reference Books		
1.	Bjarne stroustrup, The C++ programming Language, Addison Wesley, 4th edition, 2013	
2.	Harvey M. Deitel and Paul J. Deitel, C++ How to Program, 7th edition, Prentice Hall, 2010	
3.	Maureen Sprankle and Jim Hubbard, Problem solving and Programming concepts, 9th edition, Pearson Eduction, 2014.	
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar		
List of Challenging Experiments (Indicative)		
1.	**Postman Problem** A postman needs to walk down every street in his area in order to deliver the mail. Assume that the distances between the streets along the roads are given. The postman starts at the post office and returns back to the post office after delivering all the mails. Implement an algorithm to help the post man to walk minimum distance for the purpose.	10 hours
2.	**Budget Allocation for Marketing Campaign** A mobile manufacturing company has got several marketing options such as Radio advertisement campaign, TV non peak hours campaign, City top paper network, Viral marketing campaign, Web advertising. From their previous experience, they have got a statistics about paybacks for each marketing option. Given the marketing budget (rupees in crores) for the current year and details of paybacks for each option, implement an algorithm to determine the amount that shall spent on each marketing option so that the company attains the maximum profit.	15 hours
3.	**Missionaries and Cannibals** Three missionaries and three cannibals are on one side of a river, along with a boat that can hold one or two people. Implement an algorithm to find a way to get everyone to the other side of the river, without ever leaving a group of missionaries in one place outnumbered by the cannibals in that place.	10 hours
4.	**Register Allocation Problem** A register is a component of a computer processor that can hold any type of data and can be accessed faster. As registers are faster to access, it is desirable to use them to the maximum so that the code execution is faster. For each code submitted to the processor, a register interference graph (RIG) is constructed. In a RIG, a node represents a temporary variable and an edge is added between two nodes (variables) t1 and t2 if they are live simultaneously at some point in the program. During register allocation, two temporaries can be allocated to the same register if there is no edge connecting them. Given a RIG representing the dependencies between variables in a code, implement an algorithm to determine the number of registers required to store the variables and speed up the code execution	15 hours

5.	**Selective Job Scheduling Problem** A server is a machine that waits for requests from other machines and	15 hours
	responds to them. The purpose of a server is to share hardware and software resources among clients. All the clients submit the jobs to the server for execution and the server may get multiple requests at a time. In such a situation, the server schedule the jobs submitted to it based on some criteria and logic. Each job contains two values namely time and memory required for execution. Assume that there are two servers that schedules jobs based on time and memory. The servers are named as Time Schedule Server and memory Schedule Server respectively. Design a OOP model and implement the time Schedule Server and memory Schedule Server. The Time Schedule Server arranges jobs based on time required for execution in ascending order whereas memory Schedule Server arranges jobs based on memory required for execution in ascending order	
6.	**Fragment Assembly in DNA Sequencing** DNA, or deoxyribonucleic acid, is the hereditary material in humans and almost all other organisms. The information in DNA is stored as a code made up of four chemical bases: adenine (A), guanine (G), cytosine (C), and thymine (T). In DNA sequencing, each DNA is sheared into millions of small fragments (reads) which assemble to form a single genomic sequence (superstring). Each read is a small string. In such a fragment assembly, given a set of reads, the objective is to determine the shortest superstring that contains all the reads. For example, given a set of strings, 000, 001, 010, 011, 100, 101, 110, 111 the shortest superstring is 0001110100. Given a set of reads, implement an algorithm to find the shortest superstring that contains all the given reads.	15 hours
7.	**House Wiring** An electrician is wiring a house which has many rooms. Each room has many power points in different locations. Given a set of power points and the distances between them, implement an algorithm to find the minimum cable required.	10 hours
	Total Laboratory Hours	90 hours
Mode of assessment: Project/Activity		
Recommended by Board of Studies	29-10-2015	
Approved by Academic Council	No. 39	Date 17-12-2015

ECE3099	Industrial Internship	L	T	P	J	C
		0	0	0	0	2
Pre-requisite	Completion of minimum of Two semesters					

Course Objectives:

The course is designed so as to expose the students to industry environment and to take up on-site assignment as trainees or interns.

Expected Course Outcome:

At the end of this internship the student should be able to:

1. Have an exposure to industrial practices and to work in teams
2. Communicate effectively
3. Understand the impact of engineering solutions in a global, economic, environmental and societal context
4. Develop the ability to engage in research and to involve in life-long learning
5. Comprehend contemporary issues
6. Engage in establishing his/her digital footprint

Contents	**4**	**Weeks**

Four weeks of work at industry site.

Supervised by an expert at the industry.

Mode of Evaluation: Internship Report, Presentation and Project Review

Recommended by Board of Studies	05/03/2016		
Approved by Academic Council	40th AC	Date	18/03/2016

Course code	Technical Answers for Real World Problems (TARP)	L	T	P	J	C
ECE3999		1	0	0	8	3
Pre-requisite	PHY1999 and 115 Credits Earned	Syllabus version				
		1.0				

Course Objectives:

1. To help students to identify the need for developing newer technologies for industrial / societal needs
2. To train students to propose and implement relevant technology for the development of the prototypes / products
3. To make the students learn to the use the methodologies available to assess the developed prototypes / products

Expected Course Outcome:

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

1. Identify real life problems related to society
2. Apply appropriate technology(ies) to address the identified problems using engineering principles and arrive at innovative solutions

Module:1		15 hours

1. Identification of real life problems
2. Field visits can be arranged by the faculty concerned
3. 6 – 10 students can form a team (within the same / different discipline)
4. Minimum of eight hours on self-managed team activity
5. Appropriate scientific methodologies to be utilized to solve the identified issue
6. Solution should be in the form of fabrication/coding/modeling/product design/process design/relevant scientific methodology(ies)
7. Consolidated report to be submitted for assessment
8. Participation, involvement and contribution in group discussions during the contact hours will be used as the modalities for the continuous assessment of the theory component
9. Project outcome to be evaluated in terms of technical, economical, social, environmental, political and demographic feasibility
10. Contribution of each group member to be assessed
11. The project component to have three reviews with the weightage of 20:30:50

Mode of Evaluation: (No FAT) Continuous Assessment the project done – Mark weightage of 20:30:50 – project report to be submitted, presentation and project reviews

Recommended by Board of Studies	05/03/2016		
Approved by Academic Council	40th AC	Date	18/03/2016

Course Code	Course Title	L	T	P	J	C
ECE4099	Capstone Project	0	0	0	0	20
Pre-requisite	As per the academic regulations	Syllabus version				
		1.0				

Course Objectives:

To provide sufficient hands-on learning experience related to the design, development and analysis of suitable product / process so as to enhance the technical skill sets in the chosen field.

Expected Course Outcome:

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

1. Formulate specific problem statements for ill-defined real life problems with reasonable assumptions and constraints.
2. Perform literature search and / or patent search in the area of interest.
3. Conduct experiments / Design and Analysis / solution iterations and document the results.
4. Perform error analysis / benchmarking / costing
5. Synthesise the results and arrive at scientific conclusions / products / solution
6. Document the results in the form of technical report / presentation

Contents

1. Capstone Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.

2. Project can be for one or two semesters based on the completion of required number of credits as per the academic regulations.

3. Can be individual work or a group project, with a maximum of 3 students.

4. In case of group projects, the individual project report of each student should specify the individual's contribution to the group project.

5. Carried out inside or outside the university, in any relevant industry or research institution.

6. Publications in the peer reviewed journals / International Conferences will be an added advantage

Mode of Evaluation: Periodic reviews, Presentation, Final oral viva, Poster submission

Recommended by Board of Studies	10.06.2015		
Approved by Academic Council	37th AC	Date	16.06.2015

Course code	Course title	L	T	P	J	C
ENG1011	English for Engineers	0	0	4	0	2
Pre-requisite	Cleared EPT / Effective English	Syllabus version				
		v. 2.2				

Course Objectives:

1. To facilitate effective language skills for academic purposes and real-life situations.
2. To enhance students' language and communication with focus on placement skills development.
3. To aid students apply language and communication skills in professional reading and reporting.

Expected Course Outcome:

1. Apply language skills with ease in academic and real-life situations.
2. Build up a job winning digital foot print and learn to face interviews confidently.
3. Develop good interpreting and reporting skills to aid them in research.
4. Comprehend language and communication skills in academic and social contexts.
5. Acquire vocabulary and learn strategies for error-free communication.

Module:1	**Listening**	**4 hours**
Casual and Academic		
Module:2	**Speaking**	**4 hours**
Socializing Skills - Introducing Oneself- His / Her Goals & SWOT		
Module:3	**Reading**	**2 hours**
Skimming and Scanning		
Module:4	**Writing**	**2 hours**
Error-free sentences, Paragraphs		
Module:5	**Listening**	**4 hours**
News (Authentic Material): Analyzing General and Domain Specific Information		
Module:6	**Speaking**	**4 hours**
Group Discussion on factual, controversial and abstract issues		
Module:7	**Reading:**	**2 hours**
Extensive Reading		
Module:8	**Writing**	**2 hours**
Email Etiquette with focus on Content and Audience		
Module:9	**Listening**	**4 hours**
Speeches : General and Domain Specific Information		
Module:10	**Speaking**	**4 hours**
Developing Persuasive Skills - Turncoat and Debate		
Module:11	**Reading**	**2 hours**
Intensive Reading		
Module:12	**Writing**	**2 hours**

Data Transcoding		
Module:13	**Cross Cultural Communication**	**4 hours**
Understanding Inter and Cross-Cultural Communication Nuances		
Module:14	**Speaking**	**4 hours**
Public Speaking/Extempore /Monologues		
Module:15	**Reading for research**	**2 hours**
Reading Scientific/Technical Articles		
Module:16	**Writing**	**2 hours**
Creating a Digital/Online Profile – LinkedIn (Résumé/Video Profile)		
Module:17	**Speaking:**	**4 hours**
Mock Job/Placement Interviews		
Module:18	**Writing**	**2 hours**
Report Writing		
Module:19	**Speaking**	**4 hours**
Presentation using Digital Tools		
Module:20	**Vocabulary**	**2 hours**
Crossword Puzzles/Word games		
	Total Lecture hours:	**60 hours**

Text Book (s)	
1.	Clive Oxenden and Christina Latham-Koenig, New English File: Advanced: Teacher's Book
	with Test and Assessment CD-ROM: Six-level general English course for adults Paperback –
	Feb 2013, Oxford University Press, UK
2	
	Clive Oxenden and Christina Latham-Koenig,New English File: Advanced Students
	Book Paperback – Feb 2012, Oxford University Press, UK
3	Michael Vince,Language Practice for Advanced - Students Book, Feb. 2014,4th Edition, Macmillan Education, Oxford,UnitedKingdom
Reference Books	
1.	Steven Brown, Dorolyn Smith, Active Listening 3, 2011, 3rd Edition, Cambridge University Press,
	UK
2.	Tony Lynch, Study Listening, 2013, 2nd Edition, Cambridge University Press, UK
3.	Liz Hamp-Lyons, Ben Heasley, Study Writing, 2010, 2nd Edition, Cambridge University Press, UK
	Kenneth Anderson, Joan Maclean, Tony Lynch, Study Speaking, 2013, 2nd Edition, Cambridge

4.	University Press, UK
5.	Eric H. Glendinning, Beverly Holmstrom, Study Reading, 2012, 2nd Edition Cambridge University Press, UK
6.	Michael Swan, Practical English Usage (Practical English Usage), Jun 2017, 4th edition, Oxford
	University Press, UK
7.	Michael McCarthy, Felicity O'Dell, English Vocabulary in Use Advanced (South Asian Edition), May 2015, Cambridge University Press, UK
8.	Michael Swan, Catherine Walter, Oxford English Grammar Course Advanced, Feb 2012,
	4th Edition, Oxford University Press, UK
9.	Heather Silyn-Roberts, Writing for Science and Engineering: Papers, Presentations and Reports, Jun 2016, 2nd Edition, Butterworth-Heinemann, UK

Mode of Evaluation: Assignment and FAT- Mini Project, Flipped Class Room, Lecture, PPT's, Role play, Assignments Class/Virtual Presentations, Report and beyond the classroom activities

List of Challenging Experiments (Indicative)

1.	Create a Digital or Online Profile or a Digital Footprint	6 hours
2.	Prepare a video resume	8 hours
3.	Analyse a documentary critically	4 hours
4.	Turn Coat- Speaking for and against the topic / Activities through VIT Community Radio	6 hours
5	Present a topic using 'Prezi'	6 hours
6	Analyse a case on cross cultural communication critically	6 hours
7	Create a list of words relating to your domain	4 hours
8	Listen to a conversation of native speakers of English and answer the following questions	6 hours
9	Read an article and critically analyse the text in about 150 words	6 hours
10	Read an autobiography and role play the character in class by taking an excerpt from the book	8 hours
	Total Practical Hours	**60 hours**

Mode of evaluation: Mini Project, Flipped Class Room, Lecture, PPT's, Role play, Assignments Class/Virtual Presentations, Report and beyond the classroom activities

Recommended by Board of Studies	22-07-2017		
Approved by Academic Council	No. 47	Date	24.08.2017

Course code	Course title	L	T	P	J	C
HUM1021	ETHICS AND VALUES	2	0	0	0	2
Pre-requisite	Nil	Syllabus version				
		1.1				

Course Objectives:

1. To understand and appreciate the ethical issues faced by an individual in profession, society and polity
2. To understand the negative health impacts of certain unhealthy behaviors
3. To appreciate the need and importance of physical, emotional health and social health

Expected Course Outcome:

Students will be able to:

1. Follow sound morals and ethical values scrupulously to prove as good citizens
2. Understand various social problems and learn to act ethically
3. Understand the concept of addiction and how it will affect the physical and mental health
4. Identify ethical concerns in research and intellectual contexts, including academic integrity, use and citation of sources, the objective presentation of data, and the treatment of human subjects
5. Identify the main typologies, characteristics, activities, actors and forms of cybercrime

Module:1	**Being Good and Responsible**	**5 hours**

Gandhian values such as truth and non-violence – Comparative analysis on leaders of past and present – Society's interests versus self-interests - Personal Social Responsibility: Helping the needy, charity and serving the society

Module:2	**Social Issues 1**	**4 hours**

Harassment – Types - Prevention of harassment, Violence and Terrorism

Module:3	**Social Issues 2**	**4 hours**

Corruption: Ethical values, causes, impact, laws, prevention – Electoral malpractices;
White collar crimes - Tax evasions – Unfair trade practices

Module:4	**Addiction and Health**	**5 hours**

Peer pressure - Alcoholism: Ethical values, causes, impact, laws, prevention – Ill effects of smoking - Prevention of Suicides;
Sexual Health: Prevention and impact of pre-marital pregnancy and Sexually Transmitted Diseases

Module:5	**Drug Abuse**	**3 hours**

Abuse of different types of legal and illegal drugs: Ethical values, causes, impact, laws and prevention

Module:6	**Personal and Professional Ethics**	**4 hours**

Dishonesty - Stealing - Malpractices in Examinations – Plagiarism

Module:7	**Abuse of Technologies**	**3 hours**

Hacking and other cyber crimes, Addiction to mobile phone usage, Video games and Social networking websites

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

Guest lectures by Experts

	Total Lecture hours:	**30 hours**

Reference Books			
1.	Dhaliwal, K.K , "Gandhian Philosophy of Ethics: A Study of Relationship between his Presupposition and Precepts,2016, Writers Choice, New Delhi, India.		
2.	Vittal, N, "Ending Corruption? - How to Clean up India?", 2012, Penguin Publishers, UK.		
3.	Pagliaro, L.A. and Pagliaro, A.M, "Handbook of Child and Adolescent Drug and Substance Abuse: Pharmacological , Developmental and Clinical Considerations", 2012Wiley Publishers, U.S.A.		
4.	Pandey, P. K (2012), "Sexual Harassment and Law in India", 2012, Lambert Publishers, Germany.		
Mode of Evaluation: CAT, Assignment, Quiz, FAT and Seminar			
Recommended by Board of Studies	26-07-2017		
Approved by Academic Council	No. 46	Date	24-08-2017

Course Code	Course Title	L	T	P	J	C
MAT-1011	**Calculus for Engineers**	**3**	**0**	**2**	**0**	**4**
Pre-requisite	**MAT1001**	**Syllabus Version**				
		1.0				

Course Objectives :

1. To provide the requisite and relevant background necessary to understand the other important engineering mathematics courses offered for Engineers and Scientists.
2. To introduce important topics of applied mathematics, namely Single and Multivariable Calculus and Vector Calculus etc.
3. To impart the knowledge of Laplace transform, an important transform technique for Engineers which requires knowledge of integration

Expected Course Outcomes:

At the end of this course the students should be able to

1. apply single variable differentiation and integration to solve applied problems in engineering and find the maxima and minima of functions
2. understand basic concepts of Laplace Transforms and solve problems with periodic functions, step functions, impulse functions and convolution
3. evaluate partial derivatives, limits, total differentials, Jacobians, Taylor series and optimization problems involving several variables with or without constraints
4. evaluate multiple integrals in Cartesian, Polar, Cylindrical and Spherical coordinates.
5. understand gradient, directional derivatives, divergence, curl and Greens', Stokes, Gauss theorems
6. demonstrate MATLAB code for challenging problems in engineering

Module:1	**Application of Single Variable Calculus**	**9 hours**

Differentiation- Extrema on an Interval-Rolle's Theorem and the Mean Value Theorem-Increasing and Decreasing functions and First derivative test-Second derivative test-Maxima and Minima-Concavity. Integration-Average function value - Area between curves - Volumes of solids of revolution - Beta and Gamma functions–interrelation

Module:2	**Laplace transforms**	**7 hours**

Definition of Laplace transform-Properties-Laplace transform of periodic functions-Laplace transform of unit step function, Impulse function-Inverse Laplace transform-Convolution.

Module:3	**Multivariable Calculus**	**4 hours**

Functions of two variables-limits and continuity-partial derivatives –total differential-Jacobian and its properties.

Module:4	**Application of Multivariable Calculus**	**5 hours**

Taylor's expansion for two variables–maxima and minima–constrained maxima and minima-Lagrange's multiplier method.

Module:5	**Multiple integrals**	**8 hours**

Evaluation of double integrals–change of order of integration–change of variables between Cartesian and polar co-ordinates - Evaluation of triple integrals-change of variables between Cartesian and cylindrical and spherical co-ordinates- evaluation of multiple integrals using gamma and beta functions.

Module:6	**Vector Differentiation**	**5 hours**

Scalar and vector valued functions – gradient, tangent plane–directional derivative-divergence and curl–scalar and vector potentials–Statement of vector identities-Simple problems		
Module:7	**Vector Integration**	**5 hours**
line, surface and volume integrals - Statement of Green's, Stoke's and Gauss divergence theorems -verification and evaluation of vector integrals using them.		
Module:8	**Contemporary Issues:**	**2 hours**
Industry Expert Lecture		
	Total Lecture hours:	**45 hours**

Text Book(s)

[1] Thomas' Calculus, George B.Thomas, D.Weir and J. Hass, 13th edition, Pearson, 2014.
[2] Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edition, Wiley India, 2015.

Reference Books

1. Higher Engineering Mathematics, B.S. Grewal, 43rd Edition ,Khanna Publishers, 2015
2. Higher Engineering Mathematics, John Bird, 6th Edition, Elsevier Limited, 2017.
3. Calculus: Early Transcendentals, James Stewart, 8th edition, Cengage Learning, 2017.
4. Engineering Mathematics, K.A.Stroud and Dexter J. Booth, 7th Edition, Palgrave Macmillan (2013)

Mode of Evaluation

Digital Assignments, Quiz, Continuous Assessments, Final Assessment Test

List of Challenging Experiments (Indicative)		
1.	Introduction to MATLAB through matrices, and general Syntax	2 hours
2	Plotting and visualizing curves and surfaces in MATLAB – Symbolic computations using MATLAB	2 hours
3.	Evaluating Extremum of a single variable function	2 hours
4.	Understanding integration as Area under the curve	2 hours
5.	Evaluation of Volume by Integrals (Solids of Revolution)	2 hours
6.	Evaluating maxima and minima of functions of several variables	2 hours
7.	Applying Lagrange multiplier optimization method	2 hours
8.	Evaluating Volume under surfaces	2 hours
9.	Evaluating triple integrals	2 hours
10.	Evaluating gradient, curl and divergence	2 hours
11.	Evaluating line integrals in vectors	2 hours
12.	Applying Green's theorem to real world problems	2 hours
	Total Laboratory Hours	**24 hours**

Mode of Assessment:

Weekly assessment, Final Assessment Test

Recommended by Board of Studies	12-06-2015		
Approved by Academic Council	No. 37	Date	16-06-2015

Course Code	Course title	L	T	P	J	C
MAT2001	Statistics for Engineers	3	0	2	0	4
Prerequisites	MAT1011 – Calculus for Engineers	Syllabus Version				1.0

Course Objectives :

1. To provide students with a framework that will help them choose the appropriate descriptive methods in various data analysis situations.
2. To analyse distributions and relationship of real-time data.
3. To apply estimation and testing methods to make inference and modelling techniques for decision making.

Expected Course Outcome:

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

1. Compute and interpret descriptive statistics using numerical and graphical techniques.
2. Understand the basic concepts of random variables and find an appropriate distribution for analysing data specific to an experiment.
3. Apply statistical methods like correlation, regression analysis in analysing, interpreting experimental data.
4. Make appropriate decisions using statistical inference that is the central to experimental research.
5. Use statistical methodology and tools in reliability engineering problems.
6. demonstrate R programming for statistical data

Module: 1	**Introduction to Statistics**	**6 hours**
Introduction to statistics and data analysis-Measures of central tendency –Measures of variability-[Moments-Skewness-Kurtosis (Concepts only)].		
Module: 2	**Random variables**	**8 hours**
Introduction -random variables-Probability mass Function, distribution and density functions - joint Probability distribution and joint density functions- Marginal, conditional distribution and density functions- Mathematical expectation, and its properties Covariance , moment generating function – characteristic function.		
Module: 3	**Correlation and regression**	**4 hours**
Correlation and Regression – Rank Correlation- Partial and Multiple correlation- Multiple regression.		
Module: 4	**Probability Distributions**	**7 hours**
Binomial and Poisson distributions – Normal distribution – Gamma distribution – Exponential distribution – Weibull distribution.		
Module: 5	**Hypothesis Testing I**	**4 hours**
Testing of hypothesis – Introduction-Types of errors, critical region, procedure of testing hypothesis-Large sample tests- Z test for Single Proportion, Difference of Proportion, mean and difference of means.		
Module: 6	**Hypothesis Testing II**	**9 hours**
Small sample tests- Student's t-test, F-test- chi-square test- goodness of fit - independence of attributes- Design of Experiments - Analysis of variance – one and two way classifications - CRD-RBD- LSD.		
Module: 7	**Reliability**	**5 hours**
Basic concepts- Hazard function-Reliabilities of series and parallel systems- System Reliability - Maintainability-Preventive and repair maintenance- Availability.		
Module: 8	**Contemporary Issues**	**2 hours**
Industry Expert Lecture		
	Total Lecture hours	**45 hours**

Text book(s)

1. Probability and Statistics for engineers and scientists, R.E.Walpole, R.H.Myers, S.L.Mayers and K.Ye, 9th Edition, Pearson Education (2012).
2. Applied Statistics and Probability for Engineers, Douglas C. Montgomery, George C. Runger, 6th Edition, John Wiley & Sons (2016).

Reference books

1. Reliability Engineering, E.Balagurusamy, Tata McGraw Hill, Tenth reprint 2017.
2. Probability and Statistics, J.L.Devore, 8th Edition, Brooks/Cole, Cengage Learning (2012).
3. Probability and Statistics for Engineers, R.A.Johnson, Miller Freund's, 8th edition, Prentice Hall India (2011).
4. Probability, Statistics and Reliability for Engineers and Scientists, Bilal M. Ayyub and Richard H. McCuen, 3rd edition, CRC press (2011).

Mode of Evaluation

Digital Assignments, Continuous Assessment Tests, Quiz, Final Assessment Test.

List of Experiments (Indicative)		
1	Introduction: Understanding Data types; importing/exporting data.	2 hours
2	Computing Summary Statistics /plotting and visualizing data using Tabulation and Graphical Representations.	2 hours
3	Applying correlation and simple linear regression model to real dataset; computing and interpreting the coefficient of determination.	2 hours
4	Applying multiple linear regression model to real dataset; computing and interpreting the multiple coefficient of determination.	2 hours
5	Fitting the following probability distributions: Binomial distribution	2 hours
6	Normal distribution, Poisson distribution	2 hours
7	Testing of hypothesis for One sample mean and proportion from real-time problems.	2 hours
8	Testing of hypothesis for Two sample means and proportion from real-time problems	2 hours
9	Applying the t test for independent and dependent samples	2 hours
10	Applying Chi-square test for goodness of fit test and Contingency test to real dataset	2 hours
11	Performing ANOVA for real dataset for Completely randomized design, Randomized Block design ,Latin square Design	2 hours
	Total laboratory hours	**22 hours**

Mode of Evaluation

Weekly Assessment, Final Assessment Test

Recommended by Board of Studies	25-02-2017		
Approved by Academic Council	47	Date:	05-10-2017

Course code	Course title	L	T	P	J	C
MGT1022	Lean Start up Management	1	0	0	4	2
Pre-requisite	Nil	Syllabus version				
		v.1.0				

Course Objectives: To develop the ability to

1. Learn methods of company formation and management.
2. Gain practical skills in and experience of stating of business using pre-set collection of business ideas.
3. Learn basics of entrepreneurial skills.

Expected Course Outcome: On the completion of this course the student will be able to:

1. Understand developing business models and growth drivers
2. Use the business model canvas to map out key components of enterprise
3. Analyze market size, cost structure, revenue streams, and value chain
4. Understand build-measure-learn principles
   Foreseeing and quantifying business and financial risks

Module:1	**2 Hours**
Creativity and Design Thinking (identify the vertical for business opportunity, understand your customers, accurately assess market opportunity)	
Module:2	**3 Hours**
Minimum Viable Product (Value Proposition, Customer Segments, Build- measure-learn process)	
Module:3	**3 Hours**
Business Model Development(Channels and Partners, Revenue Model and streams, Key Resources, Activities and Costs, Customer Relationships and Customer Development Processes, Business model canvas –the lean model- templates)	
Module:4	**3 Hours**
Business Plan and Access to Funding(visioning your venture, taking the product/ service to market, Market plan including Digital & Viral Marketing, start-up finance - Costs/Profits & Losses/cash flow, Angel/VC,/Bank Loans and Key elements of raising money)	
Module:5	**3 Hours**
Legal, Regulatory, CSR, Standards, Taxes	
Module:6	**2 Hours**
Lectures by Entrepreneurs	
Total Lecture	**15 hours**

Text Book(s)

1.	The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company, Steve Blank, K & S Ranch; 1st edition (March 1, 2012)
2	The Four Steps to the Epiphany, Steve Blank, K&S Ranch; 2nd edition (July 17, 2013)

3	The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses, Eric Ries, Crown Business; (13 September 2011)
Reference Books	
1.	Holding a Cat by the Tail, Steve Blank, K&S Ranch Publishing LLC (August 14, 2014)
2	Product Design and Development, Karal T Ulrich, SD Eppinger, McGraw Hill
3	Zero to One: Notes on Startups, or How to Build the Future, Peter Thiel, Crown Business(2014)
4	Lean Analytics: Use Data to Build a Better Startup Faster (Lean Series), Alistair Croll& Benjamin Yoskovitz, O'Reilly Media; 1st Edition (March 21, 2013)
5	Inspired: How To Create Products Customers Love, Marty Cagan, SVPG Press; 1st edition (June 18, 2008)
6	**Website References:** 1. http://theleanstartup.com/ 2. https://www.kickstarter.com/projects/881308232/only-on-kickstarter-the-leaders-guide-by-eric-ries 3. http://businessmodelgeneration.com/ 4. https://www.leanstartupmachine.com/ 5. https://www.youtube.com/watch?v=fEvKo90qBns 6. http://thenextweb.com/entrepreneur/2015/07/05/whats-wrong-with-the-lean-startup-methodology/#gref 7. http://www.businessinsider.in/Whats-Lean-about-Lean-Startup/articleshow/53615661.cms 8. https://steveblank.com/tools-and-blogs-for-entrepreneurs/ 9. https://hbr.org/2013/05/why-the-lean-start-up-changes-everything 10. chventures.blogspot.in/ platformsandnetworks.blogspot.in/p/saas-model.html
Mode of Evaluation: Assignments; Field Trips, Case Studies; e-learning; Learning through research, TED Talks	
Project	
1.	Project	60 hours
	Total Project	**60 hours**

Recommended by Board of Studies	08-06-2015		
Approved by Academic Council	37	Date	16-06-2015

Course code	Course title	L	T	P	J	C
PHY1701	Engineering Physics	3	0	2	0	4
Pre-requisite	None	Syllabus version				
		V.2.1				

Course Objectives:

To enable the students to understand the basics of the latest advancements in Physics viz., Quantum Mechanics, Nanotechnology, Lasers, Electro Magnetic Theory and Fiber Optics.

Expected Course Outcome: Students will be able to

1. Comprehend the dual nature of radiation and matter.
2. Compute Schrodinger's equations to solve finite and infinite potential problems.
3. Analyze quantum ideas at the nanoscale.
4. Apply quantum ideas for understanding the operation and working principle of optoelectronic devices.
5. Recall the Maxwell's equations in differential and integral form.
6. Design the various types of optical fibers for different Engineering applications.
7. Explain concept of Lorentz Transformation for Engineering applications.
8. Demonstrate the quantum mechanical ideas

Module:1	Introduction to Modern Physics	6 hours

Planck's concept (hypothesis), Compton Effect, Particle properties of wave: Matter Waves, Davisson Germer Experiment, Heisenberg Uncertainty Principle, Wave function, and Schrodinger equation (time dependent & independent).

Module:2	Applications of Quantum Physics	5 hours

Particle in a 1-D box (Eigen Value and Eigen Function), 3-D Analysis (Qualitative), Tunneling Effect (Qualitative) (AB 205), Scanning Tunneling Microscope (STM).

Module:3	Nanophysics	5 hours

Introduction to Nano-materials, Moore's law, Properties of Nano-materials, Quantum confinement, Quantum well, wire & dot, Carbon Nano-tubes (CNT), Applications of nanotechnology in industry.

Module:4	Laser Principles and Engineering Application	6 hours

Laser Characteristics, Spatial and Temporal Coherence, Einstein Coefficient & its significance, Population inversion, Two, three & four level systems, Pumping schemes, Threshold gain coefficient, Components of laser, Nd-YAG, He-Ne, CO2 and Dye laser and their engineering applications.

Module:5	Electromagnetic Theory and its application	6 hours

Physics of Divergence, Gradient and Curl, Qualitative understanding of surface and volume integral, Maxwell Equations (Qualitative), Wave Equation (Derivation), EM Waves, Phase velocity, Group velocity, Group index , Wave guide (Qualitative)

Module:6	Propagation of EM waves in Optical fibers and Optoelectronic Devices	10 hours

Light propagation through fibers, Acceptance angle, Numerical Aperture, Types of fibers - step index, graded index, single mode & multimode, Attenuation, Dispersion-intermodal and intramodal. Sources-LED & Laser Diode, Detectors-Photodetectors- PN & PIN - Applications of fiber optics in communication- Endoscopy.

Module:7	**Special Theory of Relativity**	**5 hours**

Frame of reference, Galilean relativity, Postulate of special theory of relativity, Simultaneity, length contraction and time dilation.

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

Lecture by Industry Experts

	Total Lecture hours:	**45 hours**

Text Book(s)

1. Arthur Beiser et al., Concepts of Modern Physics, 2013, Sixth Edition, Tata McGraw Hill.
2. William Silfvast, Laser Fundamentals, 2008, Cambridge University Press.
3. D. J. Griffith, Introduction to Electrodynamics, 2014, 4th Edition, Pearson.
4. Djafar K. Mynbaev and Lowell L.Scheiner, Fiber Optic Communication Technology, 2011, Pearson

Reference Books

1. Raymond A. Serway, Clement J. Mosses, Curt A. Moyer Modern Physics, 2010, 3rd Indian Edition Cengage learning.
2. John R. Taylor, Chris D. Zafiratos and Michael A. Dubson, Modern Physics for Scientists and Engineers, 2011, PHI Learning Private Ltd.
3. Kenneth Krane Modern Physics, 2010, Wiley Indian Edition.
4. Nityanand Choudhary and Richa Verma, Laser Systems and Applications, 2011, PHI
5. Learning Private Ltd.
   S. Nagabhushana and B. Sathyanarayana, Lasers and Optical Instrumentation, 2010, I.K.
6. International Publishing House Pvt. Ltd.,
7. R. Shevgaonkar, Electromagnetic Waves, 2005, 1st Edition, Tata McGraw Hill
8. Principles of Electromagnetics, Matthew N.O. Sadiku, 2010, Fourth Edition, Oxford.
   Ajoy Ghatak and K. Thyagarajan, Introduction to Fiber Optics, 2010, Cambridge University Press.

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

List of Experiments

1.	Determination of Planck's constant using electroluminescence process	2 hrs
2.	Electron diffraction	2 hrs
3.	Determination of wavelength of laser source (He -Ne laser and diode lasers of different wavelengths) using diffraction technique	2 hrs
4.	Determination of size of fine particle using laser diffraction	2 hrs
5.	Determination of the track width (periodicity) in a written CD	2 hrs
6.	Optical Fiber communication (source + optical fiber + detector)	2 hrs
7.	Analysis of crystallite size and strain in a nano -crystalline film using X-ray diffraction	2 hrs
8.	Numerical solutions of Schrödinger equation (e.g. particle in a box problem) (can be given as an assignment)	2 hrs
9.	Laser coherence length measurement	2 hrs
10.	Proof for transverse nature of E.M. waves	2 hrs
11.	Quantum confinement and Heisenberg's uncertainty principle	2 hrs
12.	Determination of angle of prism and refractive index for various colour – Spectrometer	2 hrs

13.	Determination of divergence of a laser beam			2 hrs
14.	Determination of crystalline size for nanomaterial (Computer simulation)			2 hrs
15.	Demonstration of phase velocity and group velocity (Computer simulation)			2 hrs
			Total Laboratory Hours	30 hrs
Mode of evaluation: CAT / FAT				
Recommended by Board of Studies	04-06-2019			
Approved by Academic Council	No. 55	Date	13-06-2019	

Course code	Course title	L	T	P	J	C
PHY1999	Introduction to Innovative Projects	1	0	0	4	2
Pre-requisite	None	Syllabus version				
		1.0				

Course Objectives:

This course is offered to the students in the 1st Year of B.Tech. in order to orient them towards independent, systemic thinking and be innovative.

1. To make students confident enough to handle the day to day issues.
2. To develop the "Thinking Skill" of the students, especially Creative Thinking Skills
3. To train the students to be innovative in all their activities
4. To prepare a project report on a socially relevant theme as a solution to the existing issues

Expected Course Outcome: Students will be able to

1. Comprehend the various types of thinking skills.
2. Explain the innovative and creative ideas.
3. Analyze a suitable solution for socially relevant issues

Module:1 A	**Self Confidence**	**1 hour**

Understanding self – Johari Window –SWOT Analysis – Self Esteem – Being a contributor – Case Study

Project : Exploring self, understanding surrounding, thinking about how s(he) can be a contributor for the society, Creating a big picture of being an innovator – writing a 1000 words imaginary autobiography of self – Topic "Mr X – the great innovator of 2015" and upload. **(4 non- contact hours)**

Module:1 B	**Thinking Skill**	**1 hour**

Thinking and Behaviour – Types of thinking– Concrete – Abstract, Convergent, Divergent, Creative, Analytical, Sequential and Holistic thinking – Chunking Triangle – Context Grid – Examples – Case Study.

Project : Meeting at least 50 people belonging to various strata of life and talk to them / make field visits to identify a min of100 society related issues, problems for which they need solutions and categories them and upload along with details of people met and lessons learnt. **(4 non-contact hours)**

Module:1 C	**Lateral Thinking Skill**	**1 hour**

Blooms Taxonomy – HOTS – Outof the box thinking – deBono lateral thinking model – Examples

Project : Last weeks - incomplete portion to be done and uploaded

Module:2 A	**Creativity**	**1 hour**

Creativity Models – Walla – Barrons – Koberg & Begnall – Examples

Project : Selecting 5 out of 100 issues identified for future work. Criteria based approach for prioritisation, use of statistical tools & upload . **(4 non- contact hours)**

Module:2 B	**Brainstorming**	**1 hour**

25 brainstorming techniques and examples

Project : Brainstorm and come out with as many solutions as possible for the top 5 issues identified & upload . **(4 non- contact hours)**

Module:3	**Mind Mapping**	**1 hour**

Mind Mapping techniques and guidelines. Drawing a mind map **Project :** Using Mind Maps get another set of solutions forthe next 5 issues (issue 6 – 10) . **(4 non- contact hours)**		
Module:4 A	**Systems thinking**	**1 hour**
Systems Thinking essentials – examples – Counter Intuitive condemns **Project :** Select 1 issue / problem for which the possible solutions are available with you. Apply Systems Thinking process and pick up one solution [explanation should be given why the other possible solutions have been left out]. Go back to the customer and assess the acceptability and upload. . **(4 non- contact hours)**		
Module:4 B	**Design Thinking**	**1 hour**
Design thinking process – Human element of design thinking – case study **Project :** Apply design thinking to the selected solution, apply the engineering & scientific tinge to it. Participate in "design week" celebrations upload the weeks learning out come.		
Module:5 A	**Innovation**	**1 hour**
Difference between Creativity and Innovation – Examples of innovation –Being innovative. **Project:** A literature searches on prototyping of your solution finalized. Prepare a prototype model or process and upload. . **(4 non- contact hours)**		
Module:5 B	**Blocks for Innovation**	**1 hour**
Identify Blocks for creativity and innovation – overcoming obstacles – Case Study **Project :** Project presentation on problem identification, solution, innovations-expected results – Interim review with PPT presentation. . **(4 non- contact hours)**		
Module:5 C	**Innovation Process**	**1 hour**
Steps for Innovation – right climate for innovation **Project:** Refining the project, based on the review report and uploading the text. . **(4 non-contact hours)**		
Module:6 A	**Innovation in India**	**1 hour**
Stories of 10 Indian innovations **Project:** Making the project better with add ons. . **(4 non- contact hours)**		
Module:6 B	**JUGAAD Innovation**	**1 hour**
Frugal and flexible approach to innovation - doing more with less Indian Examples **Project:** Fine tuning the innovation project with JUGAAD principles and uploading (Credit for JUGAAD implementation) . **(4 non- contact hours)**		
Module:7 A	**Innovation Project Proposal Presentation**	**1 hour**
Project proposal contents, economic input, ROI – Template **Project:** Presentation of the innovative project proposal and upload . **(4 non- contact hours)**		
Module:8 A	Contemporary issue in Innovation	**1 hour**
Contemporary issue in Innovation **Project:** Final project Presentation , Viva voce Exam (**4 non- contact hours)**		
	Total Lecture hours:	**15 hours**

Text Book(s)	
1.	How to have Creative Ideas, Edward debone, Vermilon publication, UK, 2007
2.	The Art of Innovation, Tom Kelley & Jonathan Littman, Profile Books Ltd, UK, 2008
Reference Books	
1.	Creating Confidence, Meribeth Bonct, Kogan Page India Ltd, New Delhi, 2000
2.	Lateral Thinking Skills, Paul Sloane, Keogan Page India Ltd, New Delhi, 2008
3.	Indian Innovators, Akhat Agrawal, Jaico Books, Mumbai, 2015
4.	JUGAAD Innovation, Navi Radjou, Jaideep Prabhu, Simone Ahuja Random house India, Noida, 2012.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar Three reviews with weightage of 25 : 25 : 50 along with reports			
Recommended by Board of Studies	15-12-2015		
Approved by Academic Council	No. 39	Date	17-12-2015

Course code	Course title	L	T	P	J	C
STS1001	Introduction to Soft skills	3	0	0	0	1
Pre-requisite	None	Syllabus version				
		1				

Course Objectives:

1. To enhance the ability to plan better and work as a team effectively
2. To boost the learning ability and to acquire analytical and research skills
3. To educate the habits required to achieve success

Expected Course Outcome:

- Enabling students to know themselves and interact better with self and environment

Module:1	Lessons on excellence	10 hours

Ethics and integrity : Importance of ethics in life, Intuitionism vs Consequentialism, Non-consequentialism, Virtue ethics vs situation ethics, Integrity - listen to conscience, Stand up for what is right. **Change management:** Who moved my cheese?, Tolerance of change and uncertainty, Joining the bandwagon, Adapting change for growth - overcoming inhibition
How to pick up skills faster?: Knowledge vs skill, Skill introspection, Skill acquisition, "10,000 hours rule" and the converse .**Habit formation:** Know your habits, How habits work? - The scientific approach, How habits work? - The psychological approach, Habits and professional success, "The Habit Loop", Domino effect, Unlearning a bad habit
Analytic and research skills: Focused and targeted information seeking, How to make Google work for you, Data assimilation

Module:2	Team skills	11 hours

Goal setting: SMART goals, Action plans, Obstacles -Failure management. **Motivation :** Rewards and other motivational factors, Maslow's hierarchy of needs, Internal and external motivation. **Facilitation:** Planning and sequencing, Challenge by choice, Full Value Contract (FVC), Experiential learning cycle, Facilitating the Debrief . **Introspection:** Identify your USP, Recognize your strengths and weakness, Nurture strengths, Fixing weakness, Overcoming your complex, Confidence building. **Trust and collaboration.** Virtual Team building, Flexibility, Delegating, Shouldering responsibilities

Module:3	Emotional Intelligence	12 hours

Transactional Analysis: Introduction**,** Contracting, Ego states**,** Life positions. **Brain storming:** Individual Brainstorming, Group Brainstorming, Stepladder Technique, Brain writing, Crawford's Slip writing approach, Reverse brainstorming, Star bursting, Charlette procedure, Round robin brainstorming. **Psychometric Analysis :**Skill Test, Personality Test . **Rebus Puzzles/Problem Solving:** More than one answer, Unique ways

Module:4	Adaptability	12 hours

Theatrix: Motion Picture, Drama, Role Play, Different kinds of expressions. **Creative expression** Writing, Graphic Arts, Music, Art and Dance ,**Flexibility of thought:** The 5'P' framework (Profiling, prioritizing, problem analysis, problem solving, planning). **Adapt to changes(tolerance of change and uncertainty):**Adaptability Curve , Survivor syndrome

	Total Lecture hours:	**45 hours**	

Text Book(s)			
1.	Chip Heath, How to Change Things When Change Is Hard (Hardcover),2010,First Edition,Crown Business.		
2.	Karen Kindrachuk, Introspection, 2010, 1st Edition.		
3.	Karen Hough, The Improvisation Edge: Secrets to Building Trust and Radical Collaboration at Work, 2011, Berrett-Koehler Publishers		
Reference Books			
1.	Gideon Mellenbergh, A Conceptual Introduction to Psychometrics: Development, Analysis and Application of Psychological and Educational Tests,2011, Boom Eleven International.		
2.	Phil Lapworth, An Introduction to Transactional Analysis, 2011, Sage Publications (CA)		
Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays,3 Assessments with Term End FAT (Computer Based Test)			
Recommended by Board of Studies	09/06/2017		
Approved by Academic Council	No. 45th AC	Date	15/06/2017

Course code	Course title	L	T	P	J	C
STS1002	Introduction to Business Communication	3	0	0	0	1
Pre-requisite	None	Syllabus version				
		2				

Course Objectives:

1. To provide an overview of Prerequisites to Business Communication
2. To enhance the problem solving skills and improve the basic mathematical skills
3. To organize the thoughts and develop effective writing skills

Expected Course Outcome:

1. Enabling students enhance knowledge of relevant topics and evaluate the information

Module:1	Study skills	10 hours

Memory techniques: Relation between memory and brain, Story line technique, Learning by mistake, Image-name association, Sharing knowledge, Visualization. **Concept map:**Mind Map, Algorithm Mapping, Top down and Bottom Up Approach. **Time management skills:** Prioritization - Time Busters, Procrastination, Scheduling, Multitasking, Monitoring Working under pressure and adhering to deadlines

Module:2	Emotional Intelligence (Self Esteem)	6 hours

Empathy: Affective Empathy and Cognitive Empathy . **Sympathy :** Level of sympathy (Spatial proximity, Social Proximity, Compassion fatigue)

Module:3	Business Etiquette	9 hours

Social and Cultural Etiquette: Value, Manners, Customs, Language, Tradition. **Writing Company Blogs :** Building a blog, Developing brand message, FAQs', Assessing Competition **Internal Communications:** Open and objective Communication, Two way dialogue, Understanding the audience. **Planning:** Identifying, Gathering Information, Analysis, Determining, Selecting plan, Progress check, Types of planning .**Writing press release and meeting notes:**Write a short, catchy headline, Get to the Point –summarize your subject in the first paragraph, Body – Make it relevant to your audience

Module:4	Quantitative Ability	4 hours

Numeracy concepts: Fractions, Decimals, Bodmas, Simplifications, HCF, LCM, Tests of divisibility. **Beginning to Think without Ink:** Problems solving using techniques such as: Percentage, Proportionality, Support of answer choices, Substitution of convenient values, Bottom-up approach etc. **Math Magic:** Puzzles and brain teasers involving mathematical concepts **Speed Calculations:** Square roots, Cube roots, Squaring numbers, Vedic maths techniques

Module:5	Reasoning Ability	3 hours

Interpreting Diagramming and sequencing information: Picture analogy, Odd picture, Picture sequence, Picture formation, Mirror image and water image. **Logical Links:** Logic based questions-based on numbers and alphabets

Module:6	Verbal Ability	3 hours

S**trengthening Grammar Fundamentals :** Parts of speech, Tenses, Verbs(Gerunds and infinitives): **Reinforcements of Grammar concepts :** Subject Verb Agreement, Active and Passive Voice, Reported Speech			
Module:7	**Communication and Attitude**		**10 hours**
Writing : Writing formal & informal letters, How to write a blog & knowing the format, Effective ways of writing a blog, How to write an articles & knowing the format, Effective ways of writing an articles, Designing a brochures, **Speaking skills:** How to present a JAM, Public speaking, **Self managing:** Concepts of self management and self motivation, Greet and Know, Choice of words, Giving feedback, Taking criticism			
	Total Lecture hours:	**45 hours**	

Text Book(s)	
1.	FACE, Aptipedia, Aptitude Encyclopedia, 2016, First Edition, Wiley Publications, Delhi.
2.	ETHNUS, Aptimithra, 2013, First Edition, McGraw-Hill Education Pvt. Ltd.
Reference Books	
1.	Alan Bond and Nancy Schuman, 300+ Successful Business Letters for All Occasions, 2010, Third Edition, Barron's Educational Series, New York.
2.	Josh Kaufman, The First 20 Hours: How to Learn Anything ... Fast , 2014, First Edition, Penguin Books, USA.
Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test)	

Recommended by Board of Studies	09/06/2017		
Approved by Academic Council	No. 45th AC	Date	15/06/2017

Course code	Course title	L	T	P	J	C
STS2001	Reasoning Skill Enhancement	3	0	0	0	1
Pre-requisite	None	Syllabus version				
		2				

Course Objectives:

1. To strengthen the social network by the effective use of social media and social interactions.
2. To identify own true potential and build a very good personal branding
3. To enhance the Analytical and reasoning skills.

Expected Course Outcome:

1. Understanding the various strategies of conflict resolution among peers and supervisors and respond appropriately

Module:1	Social Interaction and Social Media	6 hours

Effective use of social media: Types of social media, Moderating personal information, Social media for job/profession, Communicating diplomatically, **Networking on social media: m**aximizing network with social media, How to advertise on social media , **Event management:** Event management methods, Effective techniques for better event management, **Influencing:** How to win friends and influence people, Building relationships, Persistence and resilience, Tools for talking when stakes are high, **Conflict resolution:** Definition and strategies ,Styles of conflict resolution

Module:2	Non Verbal Communication	6 hours

Proximecs: Types of proximecs**,** Rapport building ,**Reports and Data Transcoding:** Types of reports, **Negotiation Skill :** Effective negotiation strategies, **Conflict Resolution:** Types of conflicts

Module:3	Interpersonal Skill	8 hours

Social Interaction : Interpersonal Communication,Peer Communication, Bonding,Types of social interaction, **Responsibility:** Types of responsibilities**,** Moral and personal responsibilities, **Networking :**Competition, Collaboration, Content sharing, **Personal Branding :**Image Building, Grooming, Using social media for branding, **Delegation and compliance:** Assignment and responsibility, Grant of authority, Creation of accountability

Module:4	Quantitative Ability	10 hours

Number properties: Number of factors, Factorials, Remainder Theorem, Unit digit position, Tens digit position, **Averages:** Averages, Weighted Average, **Progressions:** Arithmetic Progression, Geometric Progression, Harmonic Progression, **Percentages:** Increase & Decrease or successive increase , **Ratios :** Types of ratios and proportions

Module:5	Reasoning Ability	8 hours

Analytical Reasoning: Data Arrangement(Linear and circular & Cross Variable Relationship), Blood Relations, Ordering/ranking/grouping, Puzzletest, Selection Decision table

Module:6	Verbal Ability	7 hours
Vocabulary Building: Synonyms & Antonyms, One word substitutes, Word Pairs, Spellings, Idioms, Sentence completion, Analogies		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	FACE, Aptipedia Aptitude Encyclopedia, 2016, First Edition, Wiley Publications, Delhi.
2.	ETHNUS, Aptimithra, 2013, First Edition, McGraw-Hill Education Pvt.Ltd.
3.	Mark G. Frank, David Matsumoto, Hyi Sung Hwang, Nonverbal Communication: Science and Applications, 2012, 1st Edition, Sage Publications, New York.
Reference Books	
1.	Arun Sharma, Quantitative aptitude, 2016, 7th edition, Mcgraw Hill Education Pvt. Ltd.
2.	Kerry Patterson, Joseph Grenny, Ron McMillan, Al Switzler, Crucial Conversations: Tools for Talking When Stakes are High, 2001,1st edition McGraw Hill Contemporary, Bangalore.
3.	Dale Carnegie, How to Win Friends and Influence People, Latest Edition,2016. Gallery Books, New York.

Mode of evaluation: FAT, Assignments, Projects, Case studies, Role plays,
3 Assessments with Term End FAT (Computer Based Test)

Recommended by Board of Studies	09/06/2017		
Approved by Academic Council	No. 45th AC	Date	15/06/2017

Course code	Course title	L	T	P	J	C
STS2002	Introduction to Etiquette	3	0	0	0	1
Pre-requisite	None	Syllabus version				
		2				

Course Objectives:

1. To analyze social psychological phenomena in terms of impression management.
2. To control or influence other people's perceptions.
3. To enhance the problem solving skills

Expected Course Outcome:

Creating in the students an understanding of decision making models and generating alternatives using appropriate expressions.

Module:1	Impression Management	8 hours

Types and techniques

Importance of impression management, Types of impression management, Techniques and case studies, Making a good first impression in an interview (TEDOS technique) , How to recover from a bad impressions/experience, Making a good first impression online

Non-verbal communication and body language

Dressing, Appearance and Grooming, Facial expression and Gestures, Body language (Kinesics), Keywords to be used, Voice elements (tone, pitch and pace)

Module:2	Thinking Skills	4 hours

Introduction to problem solving process : Steps to solve the problem, Simplex process **, Introduction to decision making and decision making process :** Steps involved from identification to implementation**,** Decision making model

Module:3	Beyond Structure	4 hours

Art of questioning: How to frame questions, Blooms questioning pyramid, Purpose of questions, **Etiquette:** Business, Telephone etiquette, Cafeteria etiquette, Elevator etiquette, Email etiquette, Social media etiquette

Module:4	Quantitative Ability	9 hours

Profit and Loss : Cost Price & Selling Price, Margins & Markup, **Interest Calculations:** Simple Interest, Compound Interest, Recurring, **Mixtures and solutions :**Ratio & Averages, Proportions, **Time and Work:** Pipes & Cisterns, Man Day concept, Division Wages, **Time Speed and Distance:**Average speed, Relative speed, Boats and streams. **Proportions & Variations**		
Module:5	**Reasoning Ability**	**11 hours**
Logical Reasoning: Sequence and series, Coding and decoding, Directions **, Visual Reasoning :** Abstract Reasoning, Input Type Diagrammatic Reasoning, Spatial reasoning, Cubes **Data Analysis And Interpretation** DI-Tables/Charts/Text		
Module:6	**Verbal Ability**	**9 hours**
Grammar : Spot the Errors, Sentence Correction, Gap Filling Exercise, Sentence Improvisations, Misc. Grammar Exercise		
	Total Lecture hours: **45 hours**	

Text Book(s)

1.	Micheal Kallet, Think Smarter: Critical Thinking to Improve Problem-Solving and Decision-Making Skills, April 7, 2014, 1st Edition, Wiley, New Jersey.
2.	MK Sehgal, Business Communication, 2008, 1st Edition, Excel Books, India.
3.	FACE, Aptipedia Aptitude Encyclopedia, 2016, First Edition, Wiley Publications, Delhi.
4.	ETHNUS, Aptimithra, 2013, First edition, McGraw-Hill Education Pvt. Ltd, Banglore.

Reference Books

1.	**Andrew J. DuBrin, Impression Management in the Workplace: Research, Theory and Practice, 2010, 1st edition, Routledge.**
2.	Arun Sharma, Manorama Sharma, Quantitative aptitude, 2016, 7th edition, McGraw Hill Education Pvt. Ltd, Banglore.
3.	M. Neil Browne, Stuart M. Keeley, Asking the right questions, 2014, 11th Edition, Pearson, London.

Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays,
3 Assessments with Term End FAT (Computer Based Test)

Recommended by Board of Studies	09/06/2017		
Approved by Academic Council	No. 45th AC	Date	15/06/2017

Course code	Course title	L	T	P	J	C
STS3001	Preparedness for external opportunities	3	0	0	0	1
Pre-requisite	None	Syllabus version				
		2				

Course Objectives:

1. To effectively tackle the interview process, and leave a positive impression with your prospective employer by reinforcing your strength, experience and appropriateness for the job.
2. To check if candidates have the adequate writing skills that are needed in an organization.
3. To enhance the problem solving skills.

Expected Course Outcome:

1. Enabling students acquire skills for preparing for interviews, presentations and higher education

Module:1	Interview Skills	3 hours

Types of interview: Structured and unstructured interview orientation, Closed questions and hypothetical questions, Interviewers' perspective, Questions to ask/not ask during an interview
Techniques to face remote interviews: Video interview, Recorded feedback , Phone interview preparation
Mock Interview : Tips to customize preparation for personal interview, Practice rounds

Module:2	Resume Skills	2 hours

Resume Template : Structure of a standard resume**,** Content, color, font
Use of power verbs: Introduction to Power verbs and Write up
Types of resume: Quiz on types of resume
Customizing resume : Frequent mistakes in customizing resume, Layout - Understanding different company's requirement, Digitizing career portfolio

Module:3	Presentation Skills	6 hours

Preparing presentation : tips to prepare PowerPoint presentation**,** Outlining the content, Passing the Elevator Test
Organizing materials: Blue sky thinking, Introduction , body and conclusion, Use of Font, Use of Color, Strategic presentation
Maintaining and preparing visual aids: Importance and types of visual aids, Animation to captivate your audience, Design of posters
Dealing with questions: Setting out the ground rules, Dealing with interruptions, Staying in control of the questions, Handling difficult questions

Module:4	Quantative Ability	14 hours

Permutation-Combinations : Counting, Grouping, Linear Arrangement, Circular Arrangements
Probability: Conditional Probability, Independent and Dependent Events
Geometry and Mensuration: Properties of Polygon, 2D & 3D Figures, Area & Volumes
Trigonometry: Heights and distances, Simple trigonometric functions
Logarithms: Introduction, Basic rules
Functions: Introduction, Basic rules
Quadratic Equations: Understanding Quadratic Equations, Rules & probabilities of Quadratic Equations
Set Theory: Basic concepts of Venn Diagram

Module:5	**Reasoning Ability**	**7 hours**
Logical reasoning : Syllogisms, Binary logic, Sequential output tracing, Crypto arithmetic **Data Analysis and Interpretation:** Data Sufficiency Data interpretation-Advanced Interpretation tables, pie charts & bar chats		
Module:6	**Verbal Ability**	**8 hours**
Comprehension and Logic: Reading comprehension Para Jumbles Critical Reasoning : Premise and Conclusion, Assumption & Inference, Strengthening & Weakening an Argument		
Module:7	**Writing Skills**	**5 hours**
Note making What is note making, Different ways of note making **Report writing** What is report writing, How to write a report, Writing a report & work sheet **Product description** Designing a product, Understanding it's features, Writing a product description **Research paper** Research and its importance, Writing sample research paper		

	Total Lecture hours:	**45 hours**	

Text Book(s)	
1.	Michael Farra, Quick Resume & Cover letter Book, 2011, 1st Edition, JIST Editors, Saint Paul.
2.	Daniel Flage, An Introduction to Critical Thinking, 2002, 1st Edition, Pearson, London.
Reference Books	
1.	FACE, Aptipedia Aptitude Encyclopedia, 2016, 1st Edition, Wiley Publications, Delhi.
2.	ETHNUS, Aptimithra, 2013, 1st Edition, McGraw-Hill Education Pvt. Ltd.
Mode of Evaluation: FAT, Assignments, Projects, Case studies, Role plays, 3 Assessments with Term End FAT (Computer Based Test)	

Recommended by Board of Studies	09/06/2017		
Approved by Academic Council	No. 45th AC	Date	15/06/2017

Course code	Course title	L	T	P	J	C
STS3005	Code Mithra	3	0	0	0	1
Pre-requisite	None	Syllabus version				
		2				

Course Objectives:

1. To develop logics which will help them to create programs, applications in C.
2. To learn how to design a graphical user interface (GUI) with Java Swing.
3. To present an introduction to database management systems, with an emphasis on how to organize, maintain and retrieve - efficiently, and effectively.

Expected Course Outcome:

Enabling students to write coding in C,C++,Java and DBMS concepts

Module:1	**C Programming**	**15 hours**

Introduction to C, Execution and Structure of a C Program, Data Types and Operators, Control Statements, Looping, Arrays, Structure, Pointers, Memory Management in C, Functions.

Module:2	**C++ Programming**	**15 hours**

Introduction to C++, Need for OOP, Class & Objects, Create C++ & Java class and show the similarity Encapsulation, Access Specifiers, Relationship, Polymorphism, Exception Handling, Abstract Classes, Interfaces.

Module:3	**JAVA**	**10 hours**

Introduction to Java, Data Types and Operators, Control Statements, Looping, Arrays, Need for OOP, Class & Objects, Create C++ & Java class and show the similarity Encapsulation, Access Specifiers, Relationship, Polymorphism, Exception Handling, Abstract Classes, Interfaces.

Module:4	**Database**		**5 hours**

Introduction to database, DDL, Data Manipulation, SELECT, Joins.

	Total Lecture hours:	**45 hours**	

Reference Books

1.	Data Structures and Algorithms: https://ece.uwaterloo.ca/~dwharder/aads/Lecture_materials/
2.	C Programming: C Programming Absolute Beginner's Guide (3rd Edition) by Greg Perry, Dean Miller
3.	Java: Thinking in Java, 4th Edition
4.	**Websites: www.eguru.ooo**

Mode of Evaluation: FAT, Assignments, Projects 3 Assessments with Term End FAT (Computer Based Test)

Recommended by Board of Studies	09/06/2017		
Approved by Academic Council	No.45th AC	Date	15/06/2017

PROGRAM CORE

Course code	Course Title	L	T	P	J	C
CSE2003	DATA STRUCTURES AND ALGORITHMS	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
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 analyse 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 :	No: 43	Date :	12-12-2016

Course Code	Course Title	L	T	P	J	C
ECE1018	SIGNAL ANALYSIS AND PROCESSING	2	0	2	4	4
Pre-requisite	MAT1011 Calculus for Engineers					Version : 1

Course Objectives

The course is aimed at making the students to

1. Understanding the fundamental characteristics of signals and systems.
2. Characterizing the signals and systems both in time and transform domains to gain further insights into their analysis.
3. Acquire mathematical skills to solve problems involving convolution and sampling.

Expected Course Outcome:

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

1.Understand the various types of signals and systems, and study their properties.
2.Determine the system response of a Linear Time Invariant system.
3.Analyse system properties based on Impulse response and Fourier analysis.
4.Understand and use the concepts of correlation and convolution.
5.Apply Laplace Transform for analysis of CT signals and systems.
6.Apply Z-transform for analysis of DT signals and systems.
7.Apply the learnt mathematical tools in solving problems in a variety of signal processing applications with the aid of simulation software.

Module:1	**Introduction to Signals and systems**	**3 hours**	

Continuous-time and Discrete-time Signals**,** Transformation of independent variables- Shifting, Scaling. Exponential and sinusoidal signals, Unit impulse and Unit step functions. Basics of continuous and discrete time systems. Basic system properties. Sampling.

Module:2	**Linear Time-Invariant (LTI) Systems**	**3 hours**	

Discrete-time LTI systems: The convolution sum, Continuous-time LTI systems: The convolution integral, Properties of LTI systems- The commutative property, The distributive property, The associative property, The commutative property, Causality and stability for LTI systems

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

Orthogonal Function, Approximation using Orthogonal Function, Fourier series, Evaluation of Fourier coefficients, Gibbs Phenomenon, Continuous-time Fourier transform (CTFT), Properties, Parseval's theorem, Inverse Fourier transform

Module:4	**Frequency Domain Analysis of Discrete Time Signals**	**4 hours**	

Fourier series representation of discrete time periodic signals, Properties of discrete time Fourier series (DTFS), Representation of discrete time Fourier transform (DTFT), Properties of DTFT.

Module:5	**Concept of Convolution and Correlation**	**4 hours**	

Introduction to correlation, Relation between convolution and correlation. Correlation of energy signals, Properties of cross-correlation and auto correlation, Correlation of discrete-time periodic signals.

Module:6	**Laplace transform**	**5 hours**	

The Philosophy of Transform Methods, Differences between Laplace and Fourier transform, The Laplace Transform, Properties of Laplace Transform, Inverse Laplace transform, Uses of Laplace Transforms, Partial-Fraction Expansions, Region of convergence (ROC).

Module:7	**System Analysis using z-Transform**	**5 hours**	

Relation between DTFT and z-transform, z-transforms of unit impulse sequence, unit step sequence, unit ramp, sinusoidal and exponential sequence. ROC of finite duration sequences, Properties of z-transform, Inverse z-transform, Stability analysis.

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

Total Lecture hours:	**30 hours**	
Text Book(s).		
1	Alan. V. Oppenheim, Alan. S. Willsk, S. Hamid Nawab, Signals and systems, 2013, second edition, PHI learning Pvt. Ltd., New Delhi	
Reference Books		
1	Sanjit K. Mitra, Signals & Systems (The Oxford Series in Electrical and Computer Engineering), 2016, Edition-1, Oxford University Press, India	
2	Simon Haykin and Barry Van Veen, Signals & Systems, 2011, John Wiley and Sons Inc., New Delhi.	
3	P. Ramesh Babu, R. Anandanatarajan , Signals and systems,2011, fourth edition, Scitech. New Delhi.	
4	P. Rama Krishna Rao and Shankar Prakriya , Signals and Systems, 2013, second edition- - Mc-Graw Hill, India	
Mode of Evaluation: Continuous Assessment Test, Quiz, Digital Assignment, Final Assessment Test		
List of Challenging Experiments (Indicative)		
1.	Time domain representation of continuous time (CT) and Discrete time (DT) signals: Study the concept of basic signals and apply to generate the complex signals. For example: Asin(2*pi*t)+Bcos(4*pi/2*t), $x_1[n]=u[n]-u[n-4]$, $x_2[n]=\delta[n]+ 2\delta[n-1]+4\ \delta[n-2]-6\ \delta[n-3]$, $x_3[n]=r[n-2]$, $x_4[n]$=square wave with frequency 4Hz, duty cycle 50%, $x_5[n]$=Sawtooth wave with frequency 3Hz and peak is halfway through the period	4 hours
2.	Operation on CT and DT Signals: Generate arbitrary signals $x_1[n]$ & $x_2[n]$ and perform all the basic signal operations. For example: Addition/Subtraction, Time shifting, Time scaling, Amplitude Scaling, Odd/Even part of the signal etc.,	4 hours
3.	LTI System Analysis in time –domain: Detect the signal similarities and Find a signal of interest hidden in a long data record, measure delays between signals to synchronize them. Compute the response of to any input signal.	4 hours
4.	Frequency domain analysis of the signal: Analyze how the signal's energy is distributed over a range of frequencies. Magnitude/Phase spectrum, Apply FFT to filtering applications.	6 hours
5.	Frequency domain analysis of the system Analysis of LTI system through Pole-zero mapping and Z-transform, convolution/deconvolution, Transfer function and impulse response analysis	6 hours
6.	Signal processing in hardware to do projects with audio/speech signals	6 hours
	Total Laboratory Hours	30 hours
Mode of Evaluation: Challenging Tasks, Continuous Assessment Test, Final Assessment Test		
Typical Projects		

1. Consider an audio song with instrumental music and design a filter circuit to separate the voice signal and the instrumental
2. Design and implement an encryption and decryption algorithm for audio signals which can be used for secured communication.
3. Design a Hardware system to control a DC motor speed by using voice signal as an input and apply this concept for Robotics applications
4. Develop a Voice controlled Home automation system for controlling the Home appliances in terms of switch on, switch off and etc.
5. Develop a Speaker Verification system for biometric Security Applications. This project should be designed like fingerprint or Face recognition
6. Design the following modules for Analog to Digital conversion
    a. Sampling; b. Quantization; c. Encoding
7. Develop a system for noise cancellation. This system has to separate/filter the noise and the original signal.
8. Analyze an ECG signal for medical diagnosis applications.
9. Design and implement a DTMF signaling scheme for various controlling applications.
10. Design a motion detector circuit for intruder alarm, home automation system and etc.
11. Develop an algorithm for audio watermarking and implement the same in MATLAB
12. Develop an algorithm for speech signal Denoising and compression method for Communication.

Mode of Evaluation: Reviews, Project Competition / Make -a- thon			
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
ECE1033	Basics of Sensors and Wearable Technology	2	0	2	0	3
Pre-requisite	None	Syllabus Version				
		1.0				

Course Objectives:

1. To provide the basic understanding of measurement and instrumentation systems and the insight of the resistive sensors and its applications in real life.
2. To introduce the concept of the reactive sensors and self-generating sensors and its applications in real life.
3. To familiarize the characteristics, working principle and application of special purpose transducers.
4. To impart the importance of smart sensors, sensor interface standards for wearable device applications and to provide a brief overview of the wearable technology and its impact on social life.

Course Outcomes:

1. Gain the basic idea of measurements, characteristics and the errors associated with measurements.
2. Demonstrate the concept of resistive sensors which can be employed for real life applications
3. Realize the concept of reactive sensors employed for real life applications
4. Understand the working principle of special purpose sensors and the need for developing smart sensors.
5. Describe the taxonomy of the wearable devices and its design constraints for measuring physical and biological signals.
6. Able to design and perform experiments on the sensors and develop the projects based on the customer needs.

Module:1	Introduction to Measurements and Sensors	6 hours	

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, Units and standards, Calibration and errors . 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	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. Wearable applications: Strain sensor for monitoring Physiological signals, body movement.

Module:3	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. Wearable applications: Body/textile antennas for wireless data transmission.

Module:4	Self generating Sensors:	2 hours	

Thermoelectric sensors, piezoelectric sensors, pyroelectric sensors, photovoltaic sensors, electrochemical sensors, Wearable applications: temperature sensitive fabric, electrochemical sensors.			
Module:5	**Mechanical transducers:**	**4 hours**	
Accelerometers: Characteristics and working principle, Types- Capacitive, Piezoresistive, piezoelectric; Gyroscopes: Characteristics and working principle, Rotor Gyroscope; Diaphragm Pressure Sensor –resistive & capacitive type (micro press sensor). Wearable applications: Motion sensors for fall detection, hemiplegic and PD (Parkinson's disease) patients.			
Module:6	**Smart Sensors and Applications**	**4 hours**	
Integrated and Smart sensors, IEEE 1451 standard & Transducer Electronic Datasheets (TEDs), Overview of various smart sensors: Digital temperature sensor (DS1621, TMP36GZ), Humidity sensor (DHT11, DHT22, FC28), IR sensor (FC51), Gas sensor (MQ2,MQ8), Pressure sensors (BMP180), Accelerometers (ADXL335), etc; Structural health monitoring sensors, Introduction to MEMSand Flexible sensors.			
Module:7	**Scope of Wearable Devices**	**4 hours**	
Role of Wearables, Attributes of Wearables, The Meta Wearables – Textiles and clothing, Social Aspects: Interpretation of Aesthetics, Adoption of Innovation, On-Body Interaction; Case Study: Google Glass, health monitoring, Wearables: Challenges and Opportunities, Future and Research Roadmap.			
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		
2.	Jacob Fraden, "Hand Book of Modern Sensors: physics, Designs and Applications", 3rd ed., Springer, 2010.		
3.	Edward Sazonov, Michael R Neuman, "Wearable Sensors: Fundamentals, Implementation and Applications" Elsevier, 2014		
Reference Books:			
1.	A.K. Sawhney, "Electrical and Electronic Measurements and Instrumentation", DhanpatRai.		
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.		
5.	Subhas C. Mukhopadhyay, "Wearable Electronics Sensors-For Safe and Healthy Living", Springer International Publishing, 2015.		
List of Challenging Experiments (Indicative)			

1. Strain gauge sensors for measurement of normal strain. 2. Strain gauge sensors for measurement of Shear strain and Angle of twist. 3. Displacement measurement using LVDT 4. Displacement measurement using Hall effect sensor 5. Displacement measurement using LDR 6. Temperature measurement using RTD 7. Temperature measurement using Thermistor 8. Temperature measurement using Thermocouple 9. Static and Dynamic characteristics for Piezoelectric sensors			8 hours
Mode of evaluation : Continues Assessment Test, Quiz, Digital Assignment, Final Assessment Test			
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
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).			
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
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	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
ECE2032	Wearable Devices and its Applications	2	0	2	0	3
Pre-requisite	Basics of Sensors and Wearable Technology	Syllabus Version				
		1.0				

Course Objectives:

1. Identify the need for development of wearable devices and its implications on various sectors.
2. Comprehend the design and development of various wearable inertial sensors and wearable bio-electrode and physiological activity monitoring devices for use in healthcare applications.
3. Discuss the usage of various biochemical and gas sensors as wearable devices.
4. Acquaint various wearable locomotive sensors as assistive devices for tracking and navigation.

Course Outcome:

1. Identify and understand the need for development of wearable devices and its influence on various sectors.
2. Discus the applications of various wearable inertial sensors for biomedical applications.
3. Comprehend the design and development of various wearable bio-electrode and physiological activity monitoring devices for use in healthcare applications.
4. Discuss and analyze the usage of various biochemical and gas sensors as wearable devices.
5. Identify the use of various wearable locomotive tools for safety and security, navigation.
6. Acquaint the usage of wearable devices as assistive devices, diagnostic devices and other modern applications.
7. Design and develop various wearable devices for detection of biochemical and physiological body signals, environmental monitoring, safety and navigational assistive devices.

Module:1	Introduction to Wearable Devices	3 hours

Motivation for development of Wearable Devices, The emergence of wearable computing and wearable electronics, Types of wearable sensors:Invasive, Non-invasive;Intelligent clothing, Industry sectors' overview – sports, healthcare, Fashion and entertainment, military, environment monitoring, mining industry, public sector and safety.

Module:2	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, Quantitative Evaluation of Hemiplegic and Parkinson's Diseasepatients.Physical Activity monitoring: Human Kinetics, Cardiac Activity, Energy Expenditure measurement: Pedometers, Actigraphs.

Module:3	Wearable Devices for Healthcare-1	5 hours

Electrode – design, geometry,material; Fabrication of interdigitated (IDE) electrodes, choice of substrate, sensing film; Wearable Bioelectric impedance devices for Galvanic skin response;
Wearable ECGdevices: Basics of ECG and its design, Electrodes and the Electrode–Skin Interface; Wearable EEGdevices: 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:4	Wearable Devices for Healthcare-2	4 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: Intermittent and Continuous temperature monitoring, Detection principles – thermistor, infrared radiation, thermopile, Modality of measurement-wearable, adhesive/tattoo type. Conductive textile electrodes, Knitted PiezoresistiveFabric (KPF) sensors.

Module:5	**Wearable Biochemical and Gas Sensors**	**5 hours**

Wearable Biochemical Sensors: Parameters of interest, System Design –Textile based, Microneedle based; Types: Noninvasive Glucose Monitoring Devices, GlucoWatch® G2 Biographer, GlucoTrack™; Pulse oximeter, Portable Pulse Oximeters, wearable pulse oximeter; Wearable capnometer for monitoring of expired carbon dioxide.

Wearable gas sensors: Metal Oxide (MOS) type,electrochemicaltype, new materials-CNTs, graphene,Zeolites;Detection of atmospheric pollutants.

Module:6	**Wearable Cameras and Microphones for Navigation**	**3 hours**

Cameras in wearable devices, Applications in safety and security, navigation, Enhancing sports media, Automatic digital diary. Cameras in smart-watches; Use of Wearable Microphones: MEMS microphones, Bioacoustics, Microphones and AI for respiratory diagnostics and clinical trials.

Wearable Assistive Devices for the Blind - Hearing and Touch sensation, Assistive Devices for Fingers and Hands, Assistive Devices for wrist,forearmandfeet, vests and belts, head-mounted devices.

Module:7	**Other Wearable Devices**	**3 hours**

Wearable devices with Global Positioning System (GPS) integration for tracking and navigation.

Wearable Optical Sensors -chemical sensors, optical glucose sensors, UV exposure indicators, speech recognition using lasers; Photoplethysmography (PPG), 3D imaging and motion capture.

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

	Total Lecture hours:	**30hours**	

Text Book

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/ Research Articles

1. "Wearable Electronics Sensors - For Safe and Healthy Living", Subhas Chandra Mukhopadhyay, Springer 2015
2. "Environmental, Chemical and Medical Sensors", by Shantanu Bhattacharya, A K Agarwal, NripenChanda, Ashok Pandey and Ashis Kumar Sen, Springer Nature Singapore Pte Ltd. 2018
3. M. Mardonova and Y. Choi, "Review of Wearable Device Technology and Its Applications to the Mining Industry," Energies, vol. 11, p. 547, 2018.
4. N. Luo, W. Dai, C. Li, Z. Zhou, L. Lu, C. C. Y. Poon, et al., "Flexible Piezoresistive Sensor Patch Enabling Ultralow Power Cuffless Blood Pressure Measurement," Advanced Functional Materials, vol. 26, pp. 1178-1187, 2016.
5. S. Yang, Y.-C. Chen, L. Nicolini, P. Pasupathy, J. Sacks, B. Su, et al., "Cut-and-Paste" Manufacture of Multiparametric Epidermal Sensor Systems," Advanced Materials, vol. 27, pp. 6423-6430, 2015.

Experiments:			
1. Study of Textile based electrodes as temperature sensors&strain sensors. 2. Study of Wearable ECG electrodes: Design and measurement of electrical activity of heart. 3. Study of Wearable EEG electrodes: Design and measurement of electrical activity of brain. 4. Study of Wearable EMG electrodes: Design and measurement of electrical activity of muscle cells. 5. Study of Wearable motion sensors using textile based MEMS accelerometer. 6. Study of Wearable body temperature sensors. 7. Study of Wearable Galvanic Skin Response monitoring system. 8. Study of Wearable PPG and SPO2 monitoring system. 9. Kinematic monitoring using wearable FBG sensors.			
Mode of Evaluation: CAT, Digital Assignment, Quiz, LAB CAT and FAT			
Recommended by Board of Studies	05-09-2018		
Approved by Academic Council	53	Date	13-12-2018

Course Code	Course Title	L	T	P	J	C
ECE2033	INTRODUCTION TO DATA ANALYTICS	2	0	2	0	3
Pre-requisite	Signal Analysis and Processing			Version :2		

Course Objectives:

The course is aimed at

1. Introducing the methods and approaches of analyzing data and to convert information into useful knowledge.
2. Making the students to understand the establishment of mathematical basis of different approaches and discuss the advantages and drawbacks of different algorithms.
3. Familiarizing with a set of well-known supervised, semi-supervised and unsupervised learning algorithms.

Expected Course Outcome:

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

1. Understand state- of-the art big data platforms and data analytic techniques
2. Analyse data using statistical techniques.
3. Understand about the techniques of data pre-processing and visualization.
4. Identify real world applications that can be tackled with techniques from machine learning and Neural Networks.
5. Perform Time-series data analysis using recurrent model, autoregressive models
6. Use different optimization techniques, predominantly used in data analytics.
7. Design and implement efficient data analytic solutions for real world applications.

Module:1	**Introduction**	**2 hours**	
Wearables and big data- potential challenges, intelligent data analysis, analytic processes and tools, analysis Vs reporting;			
Module:2	**Statistical concepts**	**4 hours**	
properties of an attribute: Mean, Median, Mode; Range, Variance, Standard Deviation; Expectation and Variance, probability distributions, sampling distributions, measures of similarity and dissimilarity, multi-dimensional vector spaces			
Module:3	**Data pre-processing and visualisation**	**4 hours**	
Data pre-processing: types of error and error handling, filtering, data transformation, data merging; Data Visualization: - plots and projection methods- 2D and 3D scatter diagram, principle component analysis, histogram, spectral analysis-amplitude, phase spectra, cosine and sine transform			
Module:4	**Introduction to Machine Learning**	**5 hours**	
Differentiating algorithmic and model based frameworks, Regression-least squares, Ridge regression, Lasso regression, K Nearest Neighbor regression and classification Linear Discriminant Analysis, logistic regression			
Module:5	**Supervised and Unsupervised Techniques**	**6 hours**	
Classification-Naïve Bayesian classifier, Back propagation neural network, decision trees, support vector machine, fuzzy decision trees; Clustering- K Nearest Neighbor, K-Means, Fuzzy C Means, Deep learning concepts			
Module:6	**Time-series data analysis**	**4 hours**	
Auto-covariance and autocorrelation, finite state machines, recurrent model, autoregressive models			
Module:7	**Optimization methods**	**3 hours**	
Search by gradient descent, simulated annealing, Genetic algorithms			
Module:8	**Contemporary issues:**	**2 hours**	
	Total Lecture hours:	**30 hours**	

Text Book(s)

<table>
<tr><td colspan="4">1. Thomas A Runkler, Data Analytics: Models and Algorithms for Intelligent Data Analysis, Springer, 2012</td></tr>
<tr><td colspan="4">Reference Books</td></tr>
<tr><td colspan="4">1. Montgomery, Douglas C., and George C. Runger. Applied Statistics and Probability for Engineers. John Wiley & Sons, 2010
2. Kevin P. Murphy & Francis Bach, Machine Learning: A probabilistic perspective , MIT Press, 2012
3. Trevor Hastie, Robert Tibshirani & Jerome Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer, 2017
4. Shai Shalev-Shwartz, Shai Ben-David, Understanding Machine Learning: From Theory to Algorithms, Cambridge University Press, 2014</td></tr>
<tr><td colspan="4">Mode of Evaluation :Continuous assessment test, Digital Assignment, Quiz and Final Assessment Test</td></tr>
<tr><td colspan="2">List of Experiments (indicative)</td><td>8 hours</td><td></td></tr>
<tr><td colspan="4">Programming with Data analytic tools: WEKA, R Tool, python and SPSS
1. Using R for Introductory Statistics
2. Creating and customizing applications to analyse data.
3. Exploring the data and pre-processing the data using WEKA tool
4. Data Visualization
5. Apply Regression and different classification techniques for classifying the given data:
i) Linear regression, ii) Logistic regression, iii) Neural networks,
iv) SVM, v) Decision tree, vi) Naïve Bayes
6. Apply various clustering techniques to cluster the data:
i) K Nearest Neighbour, ii) K-Means
iii) Fuzzy C Means, iv) Self-organizing map
7. Apply various associative rule mining algorithms
8. Apply Deep learning for extracting complex patterns from big data.
Framework and application of ARIMA model- Build the model and make prediction in the future time points</td></tr>
<tr><td colspan="2">Recommended by Board of Studies:</td><td colspan="2">31-08-2018</td></tr>
<tr><td>Approved by Academic Council :</td><td>53rd</td><td>Date :</td><td>13-12-2018</td></tr>
</table>

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
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	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 call. Get the Data From Port P1 and Send it to Port P2,Note:P1 as input Port and P2 as Output Port	4 hours
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	4 hours
	(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.	
		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
ECE3032	SENSOR TECHNOLOGY	2	0	2	0	3
Pre-requisite	ECE2023 - Principles of Sensors and Data Acquisition	Version : 1				

Course Objectives:

The course is aimed at making the students to

1. Introduce various developments in sensor technology.
2. Familiarize with the basics of optimal system layout, partitioning and device scaling.
3. Know various thick film and thin film techniques used for sensor development.
4. Study the various sensor technologies for the measurement of Force, Pressure, acceleration, vibration and Torque.

Course Outcomes (CO):

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

1. Study the basics of sensor technology and the various sensors.
2. Understand the basics of optimal system layout, partitioning and device scaling.
3. Acquaint with various thick and thin film techniques used in sensor development.
4. Know about various sensor technologies for flow and level measurement.
5. Recognize various sensor technologies for Force, Pressure and Torque measurement.
6. Identify the sensor for acceleration, vibration and shock measurement.
7. Familiarize with the fabrication techniques for packaging of sensors.
8. Apply an integrated knowledge on the sensors, work with and interpret the data obtained from various sensor applications.

Module:1	**Developments in Sensor Technology**	**4 hours**	
Semiconductor sensors, smart sensors, micro sensors, fiber optic sensors, chemical sensors, bio sensors, TEDs.			
Module:2	**Sensor Design and Packaging**	**4 hours**	
Partitioning, Layout, technology constraints, scaling, compatibility study.			
Module:3	**Thick film Technology**	**4 hours**	
Thick-film processing-screen printing, Lasering of substrates, curing, low temperature co-fired ceramic processing, wire bonding. Micro machining, IOC (Integrated Optical circuit) fabrication process.			
Module:4	**Thin Film Technology**	**4 hours**	
Thin film formation and characterization- sol-gel method, chemical vapour deposition, physical vapour deposition, sputtering, plasma/Ion beam deposition, structural and physical properties, Applications- Thin films for microelelctronics, MEMS, optical coatings, photodetectors, smart sensors.			
Module:5	**Sensor Technologies for Flow and Level Measurement**	**4 hours**	
Differential pressure- primary element options, mechanical and electronic flowmeters- design, installation and maintenance, selection and sizing, recent developments. Level probe design, materials, characteristics, installation considerations, applications and manufacturers.			
Module:6	**Sensor Technologies for Force, Pressure and Torque Measurement**	**4 hours**	
Load cell- bending beam, column and shear-web, elastic diaphragm, torsion bar- materials, characteristics, design considerations and mounting procedures, applications and manufacturers.			
Module:7	**Sensor Technologies for Acceleration, Vibration and Shock Measurement**	**4 hours**	
Mass-Spring system, sensing technologies, selecting and specifying accelerometers, applicable standards, interfacing and design, applications and manufacturers.			

Module:8	**Contemporary issues:**	**2 hours**	
Total Lecture Hours :30			
Text Book(s) **1.** Jon S Wilson, Sensor Technology Handbook, 2005, Elsevier Inc., USA.			
Reference Books 1. B C Nakra& K K Choudhry, Instrumentation Measurement and Analysis, 2010, 3rd ed., Tata McGrawHill, India. 2. Jacob Fraden, Hand Book of Modern Sensors: Physics, Designs and Applications, 2010, 3rd ed., Springer, USA. 3. John G Webster, Measurement, Instrumentation and sensor Handbook, 2014, CRC Press, USA. 4. A Stephen, The Science and Engineering of Microelectronic Fabrication, 2001, Second Edition,, Oxford University Press, 198, Madison Avenue, New York.			
Mode of Evaluation : Continues Assessment Test, Quiz, Digital Assignment, Challenging Experiments, Final Assessment Test			
List of Challenging Experiments (Indicative)			
1.	Design a force measurement system using a cantilever beam with full bridge strain gage configuration. Deform the beam by placing known weights on the free end, thus deflecting the beam and creating strain. The force exerted by the weights is proportional to the strain along the beam. Measure this strain using strain gauges in a Wheatstone bridge configuration. Use a strain gage having nominal resistance 350Ω with the cantilever beam sensitivity 400με/kg. Calibrate the output of the strain gages as a function of the applied force. Use the least squares method (also known as linear regression) to obtain the best first-order relationship between the Force/Voltage Data.	8 hours	
2.	In the transfer of mechanical power from one point to another, the twisting moment transmitted by a shaft without damage to the material is of primary importance. Given the hollow aluminium shaft measure its dimensions and fix it in the set up for measuring twisting moment. Apply a load of 100g in the weighing pan. Due to loading the shaft is twisted. Figure out how pure torsion is applied to the shaft. Using mirror and telescope arrangement note down the scale readings. Figure out how to find the angle of twist from these readings. Evaluate the shear modulus of the shaft material. Devise a method for measuring the shear strain of the shaft using 350Ω strain gages bonded to the shaft material in full bridge configuration	8 hours	
3.	Study the process involved in screen printing technology (thick film) and construct a miniaturized Interdigitated comb type electrodes (1 mm line width & 1 mm inter electrode gap) which can be used for sensing applications. After developing the electrodes, measure the actual electrode conductivity. The overall printing surface of the electrodes on the substrate can be restricted to one square inch.	7 hours	
4.	Understand the dip coating / spin coating methods (thin film technology) how are being used for developing thin films for sensing applications. After the study, deposit a thin film layer of Tin oxide on the screen printed IDT electrodes. Measure the conductivity of the coated thin film using suitable electronic circuit. Based on the observation, propose how it can be used for a chemical sensing applications.	7 hours	
Total Laboratory hours : 30 hours			
Mode of Evaluation: Continuous Assessment 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
ECE 3037	Wireless Sensor Networks and IoT	2	0	0	4	3
Pre-requisite	ECE 3026 IoT for System Architecture			Version:1.1		

Course Objectives:

The course is aimed at
1. Understanding the implementation, challenges and design constraints of WSN.
2. Knowing about the MAC layer and routing protocols in WSN
3. Modeling of WSN for interfacing with IoT platform.

Expected Course Outcome:

At the end of the course, the student should be able to
1. Describe the applications, challenges, and constraints of WSN.
2. Relate sensing, Processor and Communication subsystems.
3. Understand Medium Access Control and Network Layers.
4. Gain knowledge about Power Management of WSNs.
5. Integrate WSN to Cloud Services for IoT
6.Understand the network architecture for WSNs and understand the design strategies of sensor layer.
7. Design an efficient routing protocol in WSN for IoT based real time applications.

Module:1	**Motivation for a Network of Wireless Sensor Nodes**	**5 hours**	
Definitions and Background - Challenges and Constraints: Energy, Self-Management, Wireless Networking, Decentralized Management, Design Constraints, Security - Applications : Structural Health Monitoring, Traffic Control, Health Care, Pipeline Monitoring, Precision Agriculture, Active Volcano, Underground Mining			
Module:2	**Node Architecture**	**3 hours**	
The Sensing Subsystem, The Processor Subsystem, Communication Interfaces, Prototypes			
Module:3	**Medium Access Control**	**5 hours**	
Characteristics of MAC Protocols in Sensor Networks, Contention-Free MAC Protocols, Contention-Based MAC Protocols, Hybrid MAC Protocols			
Module:4	**Network Layer**	**5 hours**	
Routing Metrics, Flooding and Gossiping, Data-Centric Routing, Proactive Routing, On-Demand Routing, Hierarchical Routing, Location-Based Routing, QoS-Based Routing Protocols			
Module:5	**Power Management**	**3 hours**	
Local Power Management Aspects, Dynamic Power Management, Conceptual Architecture			
Module:6	**Integration of WSN to IoT**	**3 hours**	
Integration approaches – stack based approaches, topology based approaches - SCADA network architecture - Security Challenges			
Module:7	**Integration of WSN to Cloud Services for IoT**	**4 hours**	
Network Architecture, Sensor Layer Design, Coordination layer design: 6LoWPAN Gateway, Supervision layer, Lightweight Secure constrained application protocol			
Module:8	**Contemporary issues:**	**2 hours**	
	Total Lecture hours:	**30 hours**	

Text Book(s)

1. W. Dargie and C. Poellabauer, Fundamentals of Wireless Sensor Networks, 2010, Wiley, USA.
2. Holger Karl and Andreas Willig, Protocols and Architectures for Wireless Sensor Networks, 2011, Wiley, USA.

Reference Books

<table>
<tr><td colspan="4">1. Ian F. Akyildiz, and Mehmet Can Vuran, Wireless Sensor Networks, 2010, Wiley, USA.
2. IBM Bluemix: The Cloud Platform for Creating and Delivering Applications, http://www.redbooks.ibm.com/redpapers/pdfs/redp5242.pdf</td></tr>
<tr><td colspan="4">Mode of Evaluation: Continuous Assessment Test, Digital Assignment, Quiz, Final Assessment Test</td></tr>
<tr><td colspan="3">Typical Projects</td><td></td></tr>
<tr><td colspan="4">1. Analysis of link quality between sender and receiver (Different types of nodes)
2. Impact of dynamic channel selection by pan coordinator on the network by restarting the pan coordinator
3. Performance analysis of MAC based routing (mbr) and level based routing (lbr) in multi hop network.
4. Performance analysis of WLAN gateway based wireless interface for connectivity between WSN and IoT
5. QoS analysis in routing protocol.</td></tr>
<tr><td colspan="4">Mode of Evaluation: Continuous Assessment Reviews</td></tr>
<tr><td colspan="2">Recommended by Board of Studies :</td><td colspan="2">26-02-2017</td></tr>
<tr><td>Approved by Academic Council :</td><td>44</td><td>Date :</td><td>16-03-2017</td></tr>
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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 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.	4 hours
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
ECE3044	WEARABLE TECHNOLOGY AND IOT	2	0	0	4	3
Pre-requisite	ECE3031-Microcontroller and Embedded Systems	Syllabus Version				
		1.0				

Course Objectives:

1. To provide a basic understanding of evolution of IoT and its functional modules.
2. To develop skillset to implement IoT systems for wearable applications.

Expected Course Outcome:

The students will be able to

1. Design and develop IoT end points for wearable applications.
2. To identify the real world problem and give IoT solutions.
3. To analyse and select appropriate protocols, wireless techniques for the problem.

Module:1	**Role of IoT in wearable devices**	**5 hours**

Smart connectivity and Big picture of IoT-smart devices, networks, Wireless technologies and need for data analysis.

Evolution of wearable technology, Wearable IoT use cases- Smart watches , Android wear, Smart glasses, fitness trackers, health care devices, cameras, smart clothing etc

Module:2	**IoT supported technologies: Internet/Web and networking basics**	**4 hours**

OSI model, data transfer referred with OSI model, IP Addressing, point to point data transfer, point to multi point data transfer & network topologies, sub-nets, network topologies referred with web, introduction to web servers and cloud computing

Module:3	**IoT supported technologies: Hardware platforms:**	**4 hours**

Overview of single board computers (Raspberry pi/Beagle bone black), ARM Cortex Processors, Arduino. Network Fundamentals: Overview and working principle of wired and wireless networking equipment's – router, switches, access points, and hubs. Networking configurations in Linux accessing hardware & device files interactions.

Module:4	**Wireless communication standards:**	**3 hours**

Bluetooth - IEEE 802.15.1, Wireless LAN- IEEE 802.11(WiFi) , Near Field communication, WiMax- IEEE 802.16, LR-WPAN- IEEE 802.15.4 (Zigbee), 6LoWPAN, mobile network, GPS

Module:5	**IOT architecture:**	**4 hours**

IoT functional requirements, building blocks, IoT architecture layers, cloud and fog based architecture, M2M – Machine to Machine architecture, Web of Things, physical layer, MAC layer, 6LoWPAN security aspects in IoT

Module:6	**IOT Application Development:**	**4 hours**

Application Protocols: MQTT, REST/HTTP, CoAP, MySQL Back-end Application Designing: Apache for handling HTTP Requests, PHP & MySQL for data processing, MongoDB Object type Database, HTML, CSS &jQuery for UI Designing, JSON lib for data processing, Security & Privacy during development, Application Development for mobile Platforms: Overview of Android / IOS App Development tools

Module:7	**Wearable IoT**	**4 hours**

Case studies – Health care, fitness and sports, industrial, defence and security, home automation, gaming, fashion and apparel.			
Module:8	**Contemporary issues:**		**2 hours**
	Total Lecture hours:	**30 hours**	

Text Book(s)	
1.	Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, Stefan Meissner, "Enabling things to talk – Designing IoT solutions with the IoT Architecture Reference Model", Springer Open, 2013
Reference Books	
1.	The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World 1st Edition
2.	
3.	Jan Holler, VlasiosTsiatsis, Catherine Mulligan, StamatisKarnouskos, Stefan Avesand, David Boyle, "From Machine to Machine to Internet of Things", Elsevier Publications, 2014.
4	IEEE Standards Association Working Group for an Architectural Framework for the Internet of Things (IoT) (P2413) - http://grouper.ieee.org/groups/2413/
5	Internet of Things – Architecture – Final Architectural Reference Model for the IoT v3.0, http://www.iot-a.eu/public

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

Typical Projects

Development of IoT enabled
Smart watch
Cameras
Smart cloths
Gloves
Diagnostic jacket
Fitness meter
Patient monitoring systems

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
EEE1001	Basic Electrical and Electronics Engineering	2	0	2	0	3
Pre-requisite	NIL	Syllabus version				
		v. 1.0				

Course Objectives:

1. To understand the various laws and theorems applied to solve electric circuits and networks
2. To provide the students with an overview of the most important concepts in Electrical and Electronics Engineering which is the basic need for every engineer

Expected Course Outcome:

1. Solve basic electrical circuit problems using various laws and theorems
2. Analyze AC power circuits and networks, its measurement and safety concerns
3. Classify and compare various types of electrical machines
4. Design and implement various digital circuits
5. Analyze the characteristics of semiconductor devices and comprehend the various modulation techniques in communication engineering
6. Design and conduct experiments to analyze and interpret data

Module:1	**DC circuits**	**5 hours**

Basic circuit elements and sources, Ohms law, Kirchhoff's laws, series and parallel connection of circuit elements, Node voltage analysis, Mesh current analysis, Thevenin's and Maximum power transfer theorem

Module:2	**AC circuits**	**6 hours**

Alternating voltages and currents, AC values, Single Phase RL, RC, RLC Series circuits, Power in AC circuits-Power Factor- Three Phase Systems – Star and Delta Connection- Three Phase Power Measurement – Electrical Safety –Fuses and Earthing, Residential wiring

Module:3	**Electrical Machines**	**7 hours**

Construction, Working Principle and applications of DC Machines, Transformers, Single phase and Three-phase Induction motors, Special Machines-Stepper motor, Servo Motor and BLDC motor

Module:4	**Digital Systems**	**5 hours**

Basic logic circuit concepts, Representation of Numerical Data in Binary Form- Combinational logic circuits, Synthesis of logic circuits

Module:5	**Semiconductor devices and Circuits**	**7 hours**

Conduction in Semiconductor materials, PN junction diodes, Zener diodes, BJTs, MOSFETs, Rectifiers, Feedback Amplifiers using transistors. Communication Engineering: Modulation and Demodulation - Amplitude and Frequency Modulation

	Total Lecture hours:	**30 hours**	

Text Book(s)

1. 1. John Bird, 'Electrical circuit theory and technology ', Newnes publications, 4 t h Edition, 2010.

Reference Books

1. Allan R. Hambley, 'Electrical Engineering -Principles & Applications' Pearson Education,

	First Impression, 6/e, 2013			
2.	Simon Haykin, 'Communication Systems', John Wiley & Sons, 5 t h Edition, 2009.			
3.	Charles K Alexander, Mathew N O Sadiku, 'Fundamentals of Electric Circuits', Tata McGraw Hill, 2012.			
4.	Batarseh, 'Power Electronics Circuits', Wiley, 2003			
5.	H. Hayt, J.E. Kemmerly and S. M. Durbin, 'Engineering Circuit Analysis', 6/e, Tata McGraw Hill, New Delhi, 2011.			
7.	Fitzgerald, Higgabogan, Grabel, 'Basic Electrical Engineering', 5t h edn, McGraw Hill, 2009.			
8.	S.L.Uppal, 'Electrical Wiring Estimating and Costing ', Khanna publishers, NewDelhi, 2008.			
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar				
List of Challenging Experiments (Indicative)				
1.	Thevenin's and Maximum Power Transfer Theorems – Impedance matching of source and load			2 hours
2.	Sinusoidal steady state Response of RLC circuits			2 hours
3.	Three phase power measurement for ac loads			2 hours
4.	Staircase wiring circuit layout for multi storey building			2 hours
5.	Fabricate and test a PCB layout for a rectifier circuit			2 hours
6.	Half and full adder circuits.			2 hours
7.	Full wave Rectifier circuits used in DC power supplies. Study the characteristics of the semiconductor device used			2 hours
8.	Regulated power supply using zener diode. Study the characteristics of the Zener diode used			2 hours
9.	Lamp dimmer circuit (Darlington pair circuit using transistors) used in cars. Study the characteristics of the transistor used			2 hours
10.	Characteristics of MOSFET			2 hours
			Total Laboratory Hours	20 hours
Mode of assessment: Assignment / FAT				
Recommended by Board of Studies	**29-05-2015**			
Approved by Academic Council	**37**	Date	**16-06-2015**	

Course code	Course title	L	T	P	J	C
MAT2002	Applications of Differential and Difference Equations	3	0	2	0	4
Pre-requisite	MAT1011 - Calculus for Engineers	Syllabus Version				
		1.0				

Course Objectives:

The course is aimed at

1. Presenting the elementary notions of Fourier series, which is vital in practical harmonic analysis
2. Imparting the knowledge of eigenvalues and eigen vectors of matrices and the transform techniques to solve linear systems, that arise in sciences and engineering 3. Enriching the skills in solving initial and boundary value problems
4. Impart the knowledge and application of difference equations and the Z-transform in discrete systems, that are inherent in natural and physical processes

Expected Course Outcomes:

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

1. Employ the tools of Fourier series to find harmonics of periodic functions from the tabulated values
2. Apply the concepts of eigenvalues, eigen vectors and diagonalisation in linear systems
3. Know the techniques of solving differential equations
4. understand the series solution of differential equations and finding eigen values, eigen functions of Strum-Liouville's problem
5. Know the Z-transform and its application in population dynamics and digital signal processing
6. demonstrate MATLAB programming for engineering problems

Module:1	Fourier series	6 hours

Fourier series - Euler's formulae - Dirichlet's conditions - Change of interval - Half range series – RMS value – Parseval's identity – Computation of harmonics

Module:2	Matrices	6 hours

Eigenvalues and Eigen vectors - Properties of eigenvalues and eigen vectors – Cayley-Hamilton theorem - Similarity of transformation - Orthogonal transformation and nature of quadratic form

Module:3	Solution of ordinary differential equations	6 hours

Linear second order ordinary differential equation with constant coefficients – Solutions of homogenous and non-homogenous equations - Method of undetermined coefficients – method of variation of parameters – Solutions of Cauchy-Euler and Cauchy-Legendre differential equations

Module:4	Solution of differential equations through Laplace transform and matrix method	8 hours

Solution of ODE's - Nonhomogeneous terms involving Heaviside function, Impulse function - Solving nonhomogeneous system using Laplace transform – Reduction of *n*th order differential equation to first order system - Solving nonhomogeneous system of first order differential equations and $(X' = AX + G)$

Module:5	Strum Liouville's problems and power $X'' = AX$	6 hours

	series Solutions	
The Strum-Liouville's Problem - Orthogonality of Eigen functions - Series solutions of differential equations about ordinary and regular singular points - Legendre differential equation - Bessel's differential equation		
Module:6	**Z-Transform**	**6 hours**
Z-transform -transforms of standard functions - Inverse Z-transform: by partial fractions and convolution method		
Module:7	**Difference equations**	**5 hours**
Difference equation - First and second order difference equations with constant coefficients - Fibonacci sequence - Solution of difference equations - Complementary function - Particular integral by the method of undetermined coefficients - Solution of simple difference equations using Z-transform		
Module:8	**Contemporary Issues**	**2 hours**
Industry Expert Lecture		
	Total Lecture hours:	**45 hours**

Text Book(s)	
1.	Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edition, John Wiley India, 2015
Reference Books	
1.	Higher Engineering Mathematics, B. S. Grewal, 43rd Edition, Khanna Publishers, India, 2015
2.	Advanced Engineering Mathematics by Michael D. Greenberg, 2nd Edition, Pearson Education, Indian edition, 2006

Mode of Evaluation		
Digital Assignments (Solutions by using soft skills), Continuous Assessment Tests, Quiz, Final Assessment Test		
1.	Solving Homogeneous differential equations arising in engineering problems	2 hours
2.	Solving non-homogeneous differential equations and Cauchy, Legendre equations	2 hours
3.	Applying the technique of Laplace transform to solve differential equations	2 hours
4.	Applications of Second order differential equations to Mass spring system (damped, undamped, Forced oscillations), LCR circuits etc.	2 hours
5.	Visualizing Eigen value and Eigen vectors	2 hours
6.	Solving system of differential equations arising in engineering applications	2 hours
7.	Applying the Power series method to solve differential equations arising in engineering applications	2 hours
8.	Applying the Frobenius method to solve differential equations arising in engineering applications	2 hours
9.	Visualising Bessel and Legendre polynomials	2 hours
10.	Evaluating Fourier series-Harmonic series	2 hours
11.	Applying Z-Transforms to functions encountered in engineering	2 hours

12.	Solving Difference equations arising in engineering applications			2 hours
			Total Laboratory Hours	**24 hours**
Mode of Evaluation: Weekly Assessment, 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
MAT-3004	**Applied Linear Algebra**	3	2	0	0	4
Pre-requisite	**MAT2002 Applications of Differential and Difference Equations**	**Syllabus Version**				
		1.0				

Course Objectives

1. understanding basic concepts of linear algebra to illustrate its power and utility through applications to computer science and Engineering.
2. apply the concepts of vector spaces, linear transformations, matrices and inner product spaces in engineering.
3. solve problems in cryptography, computer graphics and wavelet transforms

Expected Course Outcomes

At the end of this course the students are expected to learn

1. the abstract concepts of matrices and system of linear equations using decomposition methods
2. the basic notion of vector spaces and subspaces
3. apply the concept of vector spaces using linear transforms which is used in computer graphics and inner product spaces
4. applications of inner product spaces in cryptography
5. Use of wavelet in image processing.

Module:1	**System of Linear Equations**:	**6 hours**

Gaussian elimination and Gauss Jordan methods - Elementary matrices- permutation matrix - inverse matrices - System of linear equations - - LU factorizations.

Module:2	**Vector Spaces**	**6 hours**

The Euclidean space and vector space- subspace –linear combination-span-linearly dependent-independent- bases - dimensions-finite dimensional vector space.

Module:3	**Subspace Properties**:	**6 hours**

Row and column spaces -Rank and nullity – Bases for subspace – invertibility- Application in interpolation.

Module:4	**Linear Transformations and applications**	**7 hours**

Linear transformations – Basic properties-invertible linear transformation - matrices of linear transformations - vector space of linear transformations – change of bases – similarity

Module:5	**Inner Product Spaces:**	**6 hours**

Dot products and inner products – the lengths and angles of vectors – matrix representations of inner products- Gram-Schmidt orthogonalisation

Module:6	**Applications of Inner Product Spaces**:	**6 hours**

QR factorization- Projection - orthogonal projections – relations of fundamental subspaces – Least Square solutions in Computer Codes

Module:7	**Applications of Linear equations** :	**6 hours**

An Introduction to coding - Classical Cryptosystems –Plain Text, Cipher Text, Encryption,		
Decryption and Introduction to Wavelets (only approx. of Wavelet from Raw data)		
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.	**30 hours**

Text Book(s)

1. Linear Algebra, Jin Ho Kwak and Sungpyo Hong, Second edition Springer(2004). (Topics in the Chapters 1,3,4 &5)
2. Introductory Linear Algebra- An applied first course, Bernard Kolman and David, R. Hill, 9th Edition Pearson Education, 2011.

Reference Books

1. Elementary Linear Algebra, Stephen Andrilli and David Hecker, 5th Edition, Academic Press(2016)
2. Applied Abstract Algebra, Rudolf Lidl, Guter Pilz, 2nd Edition, Springer 2004.
3. Contemporary linear algebra, Howard Anton, Robert C Busby, Wiley 2003
4. Introduction to Linear Algebra, Gilbert Strang, 5th Edition, Cengage Learning (2015).

Mode of Evaluation

Digital Assignments, Continuous Assessments, Final Assessment Test

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

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PROGRAM ELECTIVE

Course code	Course title	L	T	P	J	C
CSE3019	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
CSE4033	Cloud Computing and Security	2	0	2	0	3
Pre-requisite	ECE 3026 IoT System Architecture				Version:01	

Course Objectives:

The course is aimed at making the students to

1. Evaluate industry-leading systems and technologies for public and private cloud infrastructure.
2. Understand cloud orchestration to support elasticity and availability.
3. Implement cloud features to secure and harden the cloud infrastructure

Course Outcomes (CO):

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

1. Study the basics of cloud computing, cloud models and its applications.
2. Understand cloud technologies, its services and platforms.
3. Learn how to use Public Cloud Services and to build applications.
4. Design cloud applications and analyse the design considerations and methodologies.
5. Familiar with the division of responsibility in Cloud environment and managing risks in the Cloud architecture.
6. Know about the security concepts and ability to design a resilient cloud architecture.
7. Acquainted with the concepts of Operating System and Network Security.
8. Analyse platform-specific tools and management consoles to configure and manage cloud infrastructure.

Module:1	**Introduction to cloud computing**	**4 Hours**	

Characteristics of Cloud computing – Cloud Models – Cloud Services – IaaS, PaaS, SaaS, DaaS– Cloud based services and applications,

Module:2	**Technologies, Services and Platforms**	**4 Hours**	

Virtualization, Load Balancing, Scalability, Elasticity, Deployment, Replication, Monitoring, Software defined Networking, Network function Virtualization, Mapreduce, Access management and Service level agreements

Module:3	**Cloud Services and Platforms**	**4 Hours**	

Compute Services, Storgae Services, Database services, Application Services, Content Delivery Services, Analutics Services, Deployment and Management Services, identity and Access management services : Amazon Web Services, Google Cloud Platform, Windows Azure

Module:4	**Cloud Application Design**	**4 Hours**	

Design considerations – Reference Architectures – Design Methodologies – Sata Storage Approaches

Module:5	**Risk Analysis and Division of Responsibility**	**4 Hours**	

Managing Risks in the Cloud. Dividing Operational Responsibility and Visibility. Retaining Information Security Accountability. Managing User Authentication and Authorization. Negotiating Security Requirements with Vendors. Identifying Needed Security Measures. Establishing a Service Level Agreement (SLA). Ensuring SLAs Meet Security Requirements.

Module:6	**Securing the Cloud Infrastructure**.	**4 Hours**	

Securing the Platform. Restricting Network Access through Security Groups. Configuring Platform-Specific User Access Control. Integrating Cloud Authentication/Authorization Systems. Compartmentalizing Access To Protect Data Confidentiality and Availability. Securing Data in Motion and Data at Rest. Identifying Your Security Perimeter. Cloud Access Control and Key Management. Cloud Computing Architecture and Security Concepts. Secure Cloud Architecture. Designing Resilient Cloud Architectures.

Module:7	**Operating System and Network Security**	**4 Hours**	

Locking Down Cloud Servers**.** Scanning for and Patching Vulnerabilities. Controlling and Verifying Configuration Management. Leveraging Provider-Specific Security Options. Defining Security Groups To Control Access. Filtering Traffic by Port Number. Benefiting from the			
Provider's Built-In Security. Protecting Archived Data			
Module:3	**Contemporary Issues**	**2 Hours**	
			Total Lecture Hours :30

Text Book(s):

1. Arshdeep Bahga, Vijay Madisetti, "Cloud Computing: A Hands-On Approach", A HANDSON APPROACH Text Book series, 2013.

Reference Books:

1. John R. Vacca, "Cloud Computing Security: Foundations and Challenges", CRC Press, 2016.
2. Pearson, Siani, Yee, George, "Privacy and Security for Cloud Computing", Springer, 2013.
3. Nick Antonopoulos, Lee Gillam, Cloud Computing: Principles, Systems and Applications, Springer, 2010
4. Toby Velte, Anthony Velte, Robert Elsenpeter , Cloud Computing, A Practical Approach, McGraw Hill, 2010

List of Challenging Experiments:

1. Case study: Google Cloud
2. Virtualization Tools – KVM, Virtual Box, Xen
3. Case study: Windows Azure
4. Case study: Amazon Web services
5. Case Study: IBM Bluemix
6. Cuckoo Sandobox – open source cloud security tool(malware analysis)
7. SLA – Use Cases
8. Deplpyment of end to end IoT Application
9. Build a mobile messaging Application
10. Interfacing to Raspberry Pi or Intel Galileo

Recommended by Board of Studies :		31-08-2018	
Approved by Academic Council :	53	Date :	13-12-2018

Course Code	Course Title	L	T	P	J	C
CSE4034	IoT Edge Nodes and its Applications	2	0	2	0	3
Pre-requisite	ECE3026 - IoT System Architecture	Version : 1				

Course Objectives:

The course is aimed at

1. Introducing the basic concepts of Physical & Logical design of IoT and analyses of Machine to Machine Concepts
2. Exposing students to the usage of Protocol Standardization for IoT with IoT Edge and Gateway Network with Communication protocols
3. Preparing the students to know the basics of protocol stacks for the edge devices and design challenges.
4. Providing IoT Solutions with sensor based application through embedded system platform

Course Outcomes (CO):

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

1. Comprehend and analysis concepts of Physical design and Logical design of IoT
2. Compute response analysis of Machine to Machine Concepts of IoT.
3. Comprehend the Protocol Standardization for IoT with Efforts of M2M and WSN Protocols
4. Comprehend the operation of IoT Edge and Gateway Network with Communication protocols
5. Understand the issues on Development challenges and Security challenges in IoT.
6. Comprehend the ideas of Developing IoT Solutions
7. Provide suitable solution for domain specific applications of IoT
8. Use tools to practice IoT enabling Technologies.

Module:1	**Introduction to IoT**	**4 Hours**	
Defining IoT; Characteristics of IoT; Physical design of IoT; Logical design of IoT; Functional blocks of IoT; Communication models & API's Actuators; Controllers and Sensors.			
Module:2	**IoT PROTOCOLS**	**4 Hours**	
Protocol Standardization for IoT; Efforts of M2M and WSN Protocols; SCADA and RFID Protocols; Unified Data Standards; Protocols – IEEE 802.15.4; Network layer; 6LowPAN;MQTT; COAP			
Module:4	**IoT Edge and Gateway Network**	**6 Hours**	
IoT Edge basic introduction; What and where is the "edge"; Edge /Fog computing Value of keeping data local; An edge-first approach; The power of edge to cloud; IoT Edge cloud interface; Communication protocols and protocol stacks for the edge devices Overview of Edge Networks in IoT; Implementation of IoT Edge Gateway; Edge Architecture **:** CloudPath; A Multi-Tier Cloud Computing Framework Femto Clouds; Leveraging Mobile Devices to Provide Cloud Service at the Edge Fast; Scalable and Secure Onloading of Edge Functions Using Air Box			
Module:5	**Challenges in IoT**	**3 Hours**	
Design challenges; Development challenges; Security challenges; Other challenges.			
Module:6	**Developing IoT Solutions**	**4 Hours**	
Introduction to IoT tools; Developing applications through IoT tools; Developing sensor based application through embedded system platform; Edge Analytics, Edge Security and Artificial Intelligence(AI).			
Module:7	**Domain specific applications of IoT**	**3 Hours**	
Home automation; Industry applications; Surveillance applications; Other IoT applications.			
Module:8	**Contemporary Issues**	**2 Hours**	
			Total Lecture hours: 30 Hours

Text Books:

1.Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, 2015.

2.Ovidiu Vermesan, Peter Friess, “Internet of Things – From research and innovation to market deployment”, 2014, River Publishers Series in Communication, USA.
3. David Boswarthick, “M2M Communications – A Systems Approach”, 2012, Wiley, USA.
4..Waltenegus Dargie,Christian Poellabauer, “Fundamentals of Wireless Sensor Networks:Theory and Practice” Wiley Publications 2010

Reference Books:

1. Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Dr. Ovidiu Vermesan, Dr. Peter Friess, River Publishers 2013.
2. Interconnecting Smart Objects with IP: The Next Internet, Jean-Philippe Vasseur, Adam Dunkels, Morgan Kuffmann , Elsevier, 2010.
3. 6LoWPAN: The Wireless Embedded Internet, Zach Shelby, Carsten Bormann, Wiley Publications 2010
4. Ian F. Akyildiz, and Mehmet Can Vuran, Wireless Sensor Networks, 2010, Wiley, USA
IBM Bluemix: The Cloud Platform for Creating and Delivering Applications, 2010 John Wiley & Sons Ltd.

Mode of Evaluation: Continuous Assessment Test + Digital Assignment +Quiz + Final Assessment Test

List of Challenging Experiments (Indicative):

1.LoWPAN for IoT gateway functions to send Ipv6 packets over IEEE802.15.4 based networks.
2.Implementation of edge nodes & edge gateways
3.Edge Analytics with (WISE3) IoT Platform
4.Design and analyse the data transmission between zigbee nodes with no path loss and analyse the throughput based on IEEE 802.15.4
5. Implementation of clustered based wireless sensor network and analysis on Residual energy and throughput.
5. To develop a case study for IoT based systems.
6. Implement Sample Edge Gateway based IoT Solution

Mode of Evaluation: Continuous Assessment Task + Final Assessment Test

Recommended by Board of Studies :		31-08-2018	
Approved by Academic Council :	53	Date :	13-12-2018

Course Code	Course Title	L	T	P	J	C
CSE4035	Mobile App Development for IoT	2	0	0	4	3
Pre-requisite	ECE3026 - IoT System Architecture	Version :1				

Course objectives (CoB):

The course is aimed at

1. Acquainting students with the basic concepts in web app creation
2. Introducing students to key concepts of multimedia in android system
3. Teaching the students optimization techniques and scheduling approaches

Course Outcomes (CO):

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

1. Discuss about mobile interfaces and applications.
2. Design multimedia application in android platform.
3. Comprehend the various scheduling techniques and memory mapping techniques for embedded android system.
4. Implement the different models and optimization techniquesusing SQLite, data storage.
5. Achieve the Power Optimizations with Loop Scheduling.
6. Comprehend the basic concepts of Mobile Cloud Computing
7. Work with Big Data Processing techniques
8. Develop a Mobile App for IoT applications.

Module:1	**Overview of Mobile App and Mobile Interface**	**2 Hours**	
Mobile System – Mobile Interface and Applications – Mobile Cloud			
Module:2	**Introduction of Key Concepts and 2D Graphics and Multimedia in Android of Android**	**5 Hours**	
APP Components – APP Resources – APP Mainfest – Introduction of 2D Graphics Techniques – Advanced UI Design – Audio implementations in Android – Executing Video in Android			
Module:3	**Mobile Embedded System Architecture**	**4 Hours**	
Scheduling Algorithms – Memory Technology – Mobile Embedded Systems – Messaging and Communication Mechanisms			
Module:4	**Data Storage and SQLite Operations and Mobile Optimization by Dynamic Programming**	**5 Hours**	
Local Data – Sqlite Database – Content Provider – Fixed Time Model – Probabilistic Time Model – Nondeterministic Polynomial Time Problems			
Module:5	**Mobile Optimizations by Loop Scheduling**	**4 Hours**	
Introduction – Basic Graph Models and Techniques – Fundamental Timing Optimizations – Time and Power Optimizations with Loop Scheduling			
Module:6	**Mobile Cloud Computing in Mobile Applications Deployment**	**4 Hours**	
Introduction – Concepts of Mobile Cloud Computing – Main Techniques of Mobile Cloud Computing – Mobile Cloud Computing Architecture			
Module:7	**Efficient Data Synchronization on Mobile Devices in Big Data**	**4 Hours**	
Overview of Big Data – Big Data Processing – Mobile Big Data Storage			
Module:8	**Contemporary issues:**	**2 Hours**	
Total Lecture hours: 30 hours			
Text Book:			

<table>
<tr><td colspan="5">1. Meikang Qiu, Wenyun Dai, and Keke Gai, “Mobile Applications Development With Android Technologies and Algorithms”, Chapman and Hall/CRC Publication, 2016</td></tr>
<tr><td colspan="5">References:
2. Jon Duckett, Gilles Ruppert, and Jack Moore, “JavaScript and Jquery: Interactive Front-End Web Development”, CreateSpace Independent Publishing Platform, 2017
3. Jeff McWherter and Scott Gowell, “Professional Mobile Application Development”, John Wiley & Sons, 2012
4. Nishith Pathak, Anurag Bhandari, “IoT, AI, and Blockchain for .NET: Building a Next-Generation Application from the Ground Up”, Apress, 2018</td></tr>
<tr><td colspan="5">Mode of Evaluation: Continuous Assessment Tests, Quiz, Digital Assignment, Final Assessment Test</td></tr>
<tr><td colspan="4">Typical Projects for J component</td><td></td></tr>
<tr><td>1.</td><td colspan="4">Develop an application that uses GUI components, Font and Colors.</td></tr>
<tr><td>2.</td><td colspan="4">Develop an application that uses Layout Managers and event listeners.</td></tr>
<tr><td>3.</td><td colspan="4">Develop a native calculator application.</td></tr>
<tr><td>4.</td><td colspan="4">Write an application that draws basic graphical primitives on the screen.</td></tr>
<tr><td>5.</td><td colspan="4">Develop an application that makes use of database.</td></tr>
<tr><td>6.</td><td colspan="4">Develop an application that makes use of RSS Feed.</td></tr>
<tr><td>7.</td><td colspan="4">Implement an application that implements Multi threading.</td></tr>
<tr><td>8.</td><td colspan="4">Develop a native application that uses GPS location information.</td></tr>
<tr><td colspan="5">Mode of evaluation: Continuous Assessment Reviews</td></tr>
<tr><td colspan="3">Recommended by Board of Studies :</td><td colspan="2">31-08-2018</td></tr>
<tr><td colspan="2">Approved by Academic Council :</td><td>53</td><td>Date :</td><td>13-12-2018</td></tr>
</table>

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 orPDF) 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 andp=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 1. Redo the steps Task III with Matlab function 'rand' replaced by'randn'. 2. 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. 3. 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 1. Generate 1000 sample points of uniform p.d.f,. Use appropriatetransformation to convert uniform p.d.f to i) exponential p.d.f ii) Rayleigh p.d.f. Draw their corresponding p.d.f curves. 2. Generate 1000 samples of a 'Gaussian' random variable X. Usethe 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	Program Elective	L	T	P	J	C
ECE2034	Flexible Electronics and Sensors	3	0	0	0	3
Pre-requisite	Basics of Sensor and Wearable Technology	Syllabus Version				
		1				

Course Objectives: (COB)

1. Provide an overview of flexible electronics technology.
2. Understand the materials and methods used for fabrication of flexible electronics.
3. Application of flexible electronics as sensors

Course Outcomes: (CO)

The student will be able to

1. Understand the trends and technologies of flexible electronics and its road map
2. Identify the materials for flexible electronics application.
3. Understand the various thin film deposition methods
4. To provide the insight of TFT device structures and its characteristics
5. Fabricate the foil type flexible electronics using solution based patterning methods.
6. Develop wearable sensors for healthcare, wellness and environmental applications

Module:1	Introduction to Flexible Electronics	5 hours

Background and history, trends, emerging technologies, general applications, areas of research.

Module:2	Thin-film Deposition and Processing Methods for Flexible Devices	7 hours

CVD, PECVD, PVD, etching, photolithography, low-temperature process integration

Module:3	Materials for Flexible Electronics	6 hours

Nanowire and nanoparticle synthesis, transition metal oxides, amorphous thin films, polymeric semiconductors, structure and property relationships, paper-based electronics, textile substrates, barrier materials.

Module:4	Thin Film Transistors: device structure and performance	6 hours

Fundamental issues for low-temperature processing, Low-temperature thin-film transistor Devices, Device structures and materials processing, Low-temperature a-Si:Hand a-IGZO thin-film transistor device performance, I-V characteristics, device stability.

Module:5	Solution-based Patterning Processes	6 hours

Ink-jet printing, gravure, imprint lithography, spray pyrolysis, surface energy effects, multilayer patterning, design rule considerations.

Module:6	Flexible Electronics Applications	6 hours

Displays, sensor arrays, memory devices, MEMS, lab-on-a-chip, and flexible solar panels.

Module:7	Flexible Sensors	7 hours

Wearable Sensors: Flex sensor, pulse oximeter, glucose sensor, ECG sensor, Inertial sensor, dehydration sensor, pH sensor, heart rate sensor, gas sensor, haptic glove, fitness tracker.

Module:8	Contemporary issues	2 hours

	Total Lecture:	**45 hours**
Text Book(s)		
1	William S. Wong, Alberto Salleo, **Flexible Electronics: Materials and Applications**, 2011, 1st Edition, Springer, New York.	
2	Guozhen Shen, Zhiyong Fan, "**Flexible Electronics: From Materials to Devices**", 2015, 1st Edition, World Scientific Publishing Co, Singapore	
Reference Books		
1	Edward Sazonov, Michael R. Newman, "**Wearable Sensors: Fundamentals, Implementation and Applications**", 2014, 1st Edition, Academic Press, Cambridge.	
2	Kate Hartman, "**Make: Wearable Electronics: Design, prototype, and wear your own interactive garments**", 2014, 1st Edition, Marker Media, Netherlands.	
3	Yugang Sun, John A. Rogers, "**Semiconductor Nanomaterials for Flexible Technologies: From Photovoltaics and Electronics to Sensors and Energy Storage (Micro and Nano Technologies**)", 2011, 1st Edition, William Andrew, New York.	
Mode of Evaluation: CAT, Digital Assignments, Quiz, Online course, Paper publication, Projects, Hackathon/Makeathon and FAT		
Approved by Academic Council	54	Date	14-03-2019

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

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

2. Having a clear understanding of the subject related concepts and of contemporary issues
5. Having design thinking capability
14. Having an ability to design and conduct experiments, as well as to analyze and interpret data

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 3010	ANTENNA AND WAVE PROPAGATION	3	0	0	0	3
Pre-requisite	ECE2004 – Transmission Lines and Waveguides	Syllabus version				
		1.1				

Course Objectives:

1. To introduce and discuss the mechanism and models for radio-wave propagation, antenna radiating principles and fundamental characteristics and parameters of antennas.
2. To understand operating principles and design concepts of antenna arrays, HF and VHF antennas.
3. To design & analyze microwave frequency antennas and also to bring awareness of antenna applications in various types of communication.

Expected Course Outcomes:

1. Identify the type of radio-wave propagation for different communication
2. Comprehend the radiation mechanism of wired antennas and dipoles.
3. Identify basic antenna parameters and contrast radiation patterns of different antennas.
4. Design and analyze antenna arrays and wire antennas
5. Design and analyze aperture antennas and patch antennas
6. Appropriate identification of an antenna for a specific application.

Module:1	Wave Propagation	8 hours

Propagation Mechanism - Reflection, refraction, transmission, Scattering and diffraction. Propagation Model- Path Loss, Free space loss - Plane earth Loss - Modes of propagation - Ground wave Propagation, Space wave propagation- tropospheric Propagation-Sky wave Propagation- Ionospheric Propagation - Structure of ionosphere, Skip distance, wave bending mechanism, Virtual height, Critical frequency, MUF.

Module: 2	EM Radiation	6 hours

Radiation mechanism-single wire, two wire, dipole and current distribution on thin wire. Radiation integrals and auxiliary potential functions, Radiated field components - Hertzian dipole, half wave dipole, monopole antenna

Module: 3	Antenna Parameters and Measurements	6 hours

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 formula, Radar range equation. Measurements - radiation pattern- gain- directivity and impedance measurements.

Module: 4	Linear and Planar Arrays	8 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:	HF and VHF Antennas	5 hours

5		
Wire Antennas - long wire, V-Antenna, rhombic antenna, loop antenna-helical antenna, Yagi-Uda antenna		
Module: 6	**UHF and Microwave Antennas**	**7 hours**
Frequency independent antennas - spiral and log periodic antenna- Aperture antennas – Horn antenna, Parabolic reflector antenna- Microstrip antenna.		
Module: 7	**Antennas for Modern Wireless Communications**	**3 hours**
Antennas for Terrestrial mobile communication - mobile handsets and base station. Antennas for Satellite Communication, Radar systems, RFID. Ultra wideband antenna, Wearable antenna, MEMS antenna, MIMO antenna.		
Module: 8	**Contemporary issues**	**2 hours**
	Total Lecture hours	**45 hours**

Text Book(s)	
1.	C.A. Balanis, "Antenna Theory - Analysis and Design", 2016, 3rd edition, Wiley & Sons, New York, USA.
Reference Books	
1.	Warren L. Stutzman and Gary A. Thiele, "Antenna theory and Design", 2013, 3rd edition, Wiley & Sons, New York, USA.
2.	J. D. Krauss, R. J. Marhefka and A. S. Khan, "Antenna and Wave Propagation", 2012, 4th edition, Tata McGraw-Hill, New Delhi, India.
3.	Albert Sabban, "Wideband RF Technologies and Antennas in Microwave Frequencies", 2016, Wiley, New York USA.

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 :	13.12.2015		
Approved by Academic Council	No. 40	Date:	18.03.2016

Course Code	Course Title	L	T	P	J	C
ECE3011	Microwave Engineering	3	0	2	4	5
Pre-requisite	ECE2004 – Transmission Lines and Waveguides	Syllabus version				
		1.0				

Course Objectives:

1. To understand the importance of microwave circuits and applications.
2. To comprehend operational principles of microwave sources and to characterize microwave networks.
3. To design and analyze various passive and active microwave circuits.

Expected Course Outcomes:

1. Identify various applications and measurement schemes for microwave circuits.
2. Comprehend the performance of different microwave sources and ferrite devices.
3. Analyze microwave circuits using scattering parameters.
4. Design and analyze power dividers and couplers at microwave frequencies.
5. Design and analyze low pass filters at microwave frequencies.
6. Understand the importance of high frequency transistors to design microwave amplifiers.
7. Measure the performance of microwave passive devices using test bench setup and also simulate and analyze microstrip passive and active circuits.
8. Design the microwave circuits to suit the needs of industry.

Module:1	Microwave measurements and applications	4 hours

Microwave frequencies (IEEE Standards), microwave measurements - guide wavelength VSWR, frequency and impedance, practical perspective of microwaves: Microwave oven, Radar, wireless applications.

Module:2	Microwave Sources	8 hours

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

Module:3	Microwave Network Analysis	6 hours

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

Module:4	Power dividers	9 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).

Module:5	Microwave Ferrite devices	4 hours

Properties of ferromagnetic materials, principle of faraday rotation, isolator, circulator and phase Shifter.

Module:6	MW Filters (Microstrip line)	6 hours

Filter design by insertion loss method. Low pass filter implementation (Butterworth and Chebyshev) - Richards transformation, Kuroda's identity - Stepped impedance.

Module:7	**Microwave Amplifiers**	**6 hours**
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 hours:	**45 hours**

Text Book(s)	
1.	D. M. Pozar, "Microwave engineering", 2012, 4th edition, John Wiley & Sons, USA
Reference Books	
1.	Robert, E. Collin, "Foundations of Microwave Engineering", 2014 (Reprint), 2nd edition, John Wiley & Sons, USA
2.	Annapurna Das and S.K. Das, "Microwave Engineering", 2017, 3rd edition, Tata McGraw-Hill, India.
3.	Samuel Y. Liao, "Microwave Devices and Circuits", 2015 (Reprint), 3rd edition, Pearson Education, UK.

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.	Analysis of S-Parameters for the waveguide components using microwave test bench	6 hours
2.	Perform the circuit analysis and electromagnetic simulation of equal and unequal Wilkinson power divider.	6 hours
3.	Design and perform the electromagnetic simulation of branch line coupler and Rat-race coupler.	6 hours
4.	Perform the circuit and electromagnetic simulation for low pass filter using steeped impedance method and Richard's transform method.	6 hours
5.	Using maximum gain and specific gain method design and perform the electromagnetic simulation for microwave filters in S and L bands.	6 hours
	Total Laboratory hours	30 hours

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

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
ECE3035	RFID AND FLEXIBLE SENSORS	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. Gain basic knowledge of different types of materials and methods used for fabrication of flexible electronics.
2. Understand and designing Radio frequency identification (RFID) systems, middleware architectures for real-world applications.
3. Determine road map for transformation of flexible electronics from foils to textiles
4. Understand the principle and applications of flexible sensors.

Course Outcome:

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

1. Have a clear understanding of the RFID related components, concepts and contemporary issues.
2. Design a RF component or a product applying all the relevant standards and with realistic constraints at a rudimentary level.
3. Possess knowledge for use of RF technology for a wide range of applications.
4. Have a lucid picture of the material related concepts and fabrication techniques for flexible electronics
5. Know about the recent trends in wearable technology.
6. Apply the knowledge of wearable technology for use in biological, chemical and mechanical processes.
7. Acquire knowledge on sensors in electronic textile domain.

Module:1	Overview of RFID Technology	7 hours	

Introduction- Core components of RFID systems-RFID Tags- RFID Interrogators- RFID Controllers- Frequency- selection criteria for RFID systems- Automatic identification and data capture systems- Smart Tags vs. Barcodes- RFID technology in supply chain management.

Module:2	RFID Middleware and Information Technology Integration	6 hours	

RFID Middleware- Recent focus on middleware- Core functions of RFID middleware- Middle ware as part of an RFID system-The EPC architecture- Present state of middleware development.

Module:3	Applications of RFID Technology	6 hours	

Short range RFID applications: Access control-Transportation Ticketing- Personnel identification-Vehicle identification- Production line monitoring, Long range RFID applications: Supply chain management- Mail and shipping-Clothing tags-Food production control

Module:4	Materials and Novel patterning methods for flexible electronics	6 hours	

Introduction, Inorganic semiconductors and dielectrics, organic semiconductors and dielectrics, conductors - Print processing options for device fabrication: Overview, control of feature sizes of jet printed liquids, jet printing for etch mask patterning, methods for minimizing feature size, printing of active materials.

Module:5	Wearable Haptics	6 hours	

World of wearables - Attributes of wearables - Textiles and clothing: The meta wearable - Challenges and opportunities - Future of wearables - Need for wearable haptic devices - Categories of wearable haptic.

Module:6	Wearable Bio, Chemical and Inertial sensors	6 hours	

Introduction-Systems design - Challenges in chemical and biochemical sensing - Application areas -Wearable inertial sensors - obtained parameters from inertial sensors - Applications for wearable motion sensors - Practical considerations for wearable inertial sensor - Application in clinical

practice and future scope.			
Module:7	**Knitted electronic textiles**	**6 hours**	
From fibers to textile sensors - Interlaced network -Textile sensors for physiological state monitoring - Biomechanical sensing - Noninvasive sweat monitoring by textile sensors and other applications.			
Module:8	**Contemporary issues:**	**2 hours**	
			Total Lecture hours: 45 hours

Text Book(s)

1. Amin Rida and Manos M. Tentzeris, RFID-Enabled Sensor Design and Applications (Artech House Integrated Microsystems), 2011, 1st edition, Artech House Publishers, UK.

Reference Books

1. Min-Chen, and Shigang Chen, RFID Technologies for Internet of Things (Wireless Network), 2016, 1st edition, Springer, USA
2. Miodrag Bolic, David Simplot-Ryl, and Ivan Stojmenovic, RFID Systems: Research Trends and Challenges, 2011, 1st ed., Wiley, USA
3. William S. Wong, Alberto Salleo, Flexible Electronics: Materials and Applications, 2011, 1st ed., Springer, USA
4. Guozhen Shen, Zhiyong Fan, Flexible Electronics: From Materials to Devices, 2015, 1st Edition, World Scientific Publishing Co, USA
5. Yugang Sun, John A. Rogers, Semiconductor Nanomaterials for Flexible Technologies: From Photovoltaics and Electronics to Sensors and Energy Storage (Micro and Nano Technologies), 2010, 1st Edition, William Andrew, Elsevier, 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
ECE 3036	SENSORS FOR STRUCTURAL HEALTH MONITORING	2	0	0	4	3
Pre-requisite	ECE2023 Principles of Sensors and Data Acquisition				Version:1	

Course Objectives:

The course is aimed

1. To give an overview of sensors their principles and applications in structural health monitoring.
2. To bring an awareness of a variety of challenges that structural health monitoring environment presents to the sensor designer.
3. To understand the future technologies in the structural health monitoring.

Expected Course Outcome:

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

1. Aware structural health monitoring applications and technical challenges
2. Gain knowledge on Vibration based Techniques for SHM
3. Understand about SHM using Piezoelectric Sensors, Fiber Optic Sensors and Electrical resistance
4. Relate Low Frequency Electromagnetic Techniques for SHM
5. Relate Capacitive Methods for SHM in Civil Engineering
6. Develop a novel prototype models for health monitoring of various structure.
7. Understand abot fiber optic sensors for phase modulation and wavelength based sensor

Module:1	**Introduction**	**4 hours**	
Need for structural health monitoring, technical challenges, potential applications in civil, naval, aerospace & manufacture engineering. definition of damage, structural measurands, overview of smart materials			
Module:2	**Vibration based Techniques for SHM**	**3 hours**	
Basic vibration and modal analysis- Frequency domain methods, time domain methods, mode shape methods. Limitations of vibration based damage detection techniques.			
Module:3	**SHM using Piezoelectric Sensors**	**5 hours**	
Lamb wave structure interrogation, sensor technology, localized damage with guided waves in composite materials, electro-mechanical impedance in defect detection in metallic and composite parts.			
Module:4	**SHM using Electrical Resistance**	**4 hours**	
Composite damage, electrical resistance of unloaded composite, influence of temperature, composite strain and damage monitoring-piezoresistivity and strain sensing, damage localization, Corrosion sensors.			
Module:5	**Low Frequency Electromagnetic Techniques**	**5 hours**	
Maxwell's equation, dipole radiation, surface impedance, diffraction, eddy current, polarization of dielectrics. Applications to NDE/NDT domain- Application to SHM domain: magnetic method, electric method, hybrid method.			
Module:6	**Capacitive Methods for SHM in Civil Engineering**	**3 hours**	
Principle, capacitance probe for cover concrete, applications for external post-tensioned cable, capacitance probe for moisture monitoring in historic buildings.			
Module:7	**Fiber Optic Sensors**	**4 hours**	
Intensity based, phased modulated or interferometers, wavelength based or Fiber Bragg gratings. FBG as strain and temperature sensor, FBGs as damage sensors for composites, applications in aeronautics and civil engineering.			
Module:8	**Contemporary issues:**	**2 hours**	
	Total Lecture hours:	**30 hours**	

Text Book(s)			
1. Daniel Balageas, Claus-Peter Fritzen and Alfredo Güemes, Structural Health Monitoring, 2010,John Wiley & sons, USA			
Reference Books			
1. Victor Giurgiutiu, Structural Health Monitoring with Piezoelectric wafer Active Sensors, 2014, 2nd edition, Academic Press, USA 2. Branko Glisic, Daniele Inaudi, Fiber Optic Methods for Structural Health Monitoring, 2008, Wiley, USA 3. D Huston, Structural Sensing, Health Monitoring and Performance Evaluation, 2010, CRC Press, USA			
Mode of Evaluation: Continuous Assessment Tests, Quiz, Digital Assignment, Final Assessment Test			
Typical Projects: 1. Design and develop a structural load measurement system using strain gages 2. Implement a Health monitoring system using fiber optic sensors in suspended structures 3. Develop a Wireless acoustic emission sensor system for bridge monitoring 4. Structural deformation detection using wireless sensor network 5. Detection of internal corrosion caused by water seepage 6. Health monitoring of submersible navy composites 7. Develop a Damage detection system in aerospace structure			
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
ECE3038	MEMS AND NANOSENSORS	3	0	0	0	3
Pre-requisite	ECE 2023 - Principles of Sensors and Data Acquisition	Version : 1.1				

Course Objectives:

The course is aimed at

1. Introducing and discuss the historical background of evolution of MEMS and Microsystems and their applications as miniaturized sensors and actuators
2. Educating on the rudiments of various materials used in MEMS fabrication and discuss scaling effects in miniaturizing devices.
3. Comprehendingvarious modern Micro-Nano fabrication techniques, device integration, packaging and bonding and highlight the applications of MEMS and Nano sensors to disciplines beyond Electrical and Mechanical engineering.

Expected Course Outcome:

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

1. Understand the historical background of evolution of MEMS and Microsystems to the students.
2. Comprehend the various micro sensing and actuating units were provided to the students.
3. Discuss about scaling effects in different Physical domains on miniaturizing devices was done with the students.
4. Rudiments of silicon and various polymer materials for MEMS fabrication was discussed with students.
5. Explore latest micromachining techniques for complete device integration, packaging and bonding.
6. Acquaint the students with Basics of Nanotechnology and its approaches towards nano-device realization.

Module:1	Introduction to Microsystems	7 hours	

Overview of microelectronics and Microsystems technology, Microsystems and Miniaturization, The multi disciplinary nature of MEMS, Smart materials, Structures and Systems, RF MEMS, MOEMS, BioMEMS, Applications of MEMS in various industries.

Module:2	Micro Sensors and Actuators	6 hours	

Working principle of Microsystems - micro actuation techniques - micro sensors – types – Micro actuators – types – micropump –Electrohydrodynamics- micromotors – micro – valves – micro grippers – micro accelerometers.

Module:3	Scaling Laws in Miniaturization	6 hours	

Introduction to scaling, Scaling in Mechanical Domain, Electrostatic Domain, Magnetic Domain and Thermal Domain

Module:4	Materials for Mems and Microsystems	6 hours	

Substrates and wafers, Silicon and Silicon compounds, Gallium Arsenide, Piezoelectric materials, Polymers

Module:5	Fabrication Process	6 hours	

Photolithography – Ion implantation – Diffusion – Oxidation – Chemical Vapour Deposition (CVD) - Physical vapor deposition - Deposition epitaxy - etching process.

Module:6	Micro System Manufacturing	6 hours	

Etching – isotropic and anisotrophic, Wet and Dry Etching of Silicon – Plasma Etching – Deep Reaction Ion Etching (DRIE), Bulk Micro manufacturing - surface micro machining – LIGA – SLIGA - Micro system packaging materials - die level - device level - system level - packaging techniques – die preparation – surface bonding - wire bonding - sealing.

Module:7	Nano Sensors	6 hours	

Introduction to nanotechnology, Future requirements and opportunities of nanotechnology in

sensing, CNT based sensors, Nano electronics and nano photonics.			
Module:8	**Contemporary issues:**	**2 hours**	
	Total Lecture hours:	**45 hours**	
Text Book(s)			
1.Tai-Ran Hsu,MEMS and Microsystems Design and Manufacture, 2017, 1st edition, Tata McGraw-Hill Publishing Company Ltd., India.			
Reference Books			
1. Chang Liu, Foundation of MEMS, 2011, 2nd ed., Pearson Education India. 2. Rai Choudhury, MEMS and MOEMS Technology and Applications, 2013, PHI Learning Private Limited, India. 3. Zheng Cui, Nanofabrication, Principles, Capabilities and Limits,2016, 2nd ed., Springer(India) Pvt. Ltd., India			
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
ECE3040	WIRELESS TECHNOLOGIES FOR IoT	3	0	0	0	3
Pre-requisite	ECE3026 - IoT System Architecture	Version : 1.1				

Course Objectives:

The course is aimed at making the students to

1. Understand the different types of fading and diversity, and signal propagation mechanism.
2. Understand the different wireless standards (WLAN, WPAN and WMAN) and its security
3. Understand the basics of 6LoWPAN and Bluetooth Low Energy (BLE) technology

Course Outcome:

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

1. Study different types of fading and diversity.
2. Analyse different types of signal propagation mechanism and multiple access techniques.
3. Know the characteristics of WLAN and their security issues.
4. Know the characteristics of WPAN and their security issues.
5. Study various types of wireless MAN standards
6. Comprehend the architecture and protocol stack of 6LoWPAN.
7. Comprehend basics of Bluetooth Low Energy (BLE) technology.

Module:1	Fading Channels and Diversity Technique	6 hours	

Wireless channels –overview of fading channels – Diversity techniques – Multiple antennas in wireless communication

Module:2	Radio Communication Basics	6 hours	

RF Spectrum- Wireless Multiplexing and Multiple Access Techniques-RF signal propagation and reception-Ultra Wideband Radio-MIMO.

Module:3	Wireless LAN	7 hours	

IEEE 802.11 WLAN standards- IEEE 802.11 MAC Layer –IEEE 802.11 PHY Layer-IEEE 802.11 Enhancement –WLAN Security- Other WLAN Standards

Module:4	Wireless PAN	6 hours	

Introduction – Bluetooth-Wireless USB-ZigBee-IrDA-Wireless PAN Security

Module:5	Wireless MAN	6 hours	

IEEE 802.16 Wireless MAN Standard-Metropolitan Area- Mesh Network-Start-up phase and operating phase

Module:6	6LoWPAN	6 hours	

Introduction – Architecture –Protocol stack of 6LoWPAN Architecture – Neighbor discovery – Challenges in 6LoWPAN

Module:7	Bluetooth SMART/Bluetooth Low Energy(BLE)	6 hours	

Introduction – Network topology – BLE frequency channels – Message exchange – BLE protocol stack- Application.

Module:8	Contemporary issues:	2 hours	

Total Lecture hours: 45 hours

Text Book(s)

1. Steve Rackley, Wireless Networking Technology - From principles to successful implementation, 2007, First Edition, Elsevier, Science Direct
2. Jochen Schiller, Mobile Communication, 2010, Second Edition (Reprint), Pearson Education

Reference Books

1. O. Hersent, The Internet of Things: Key Applications and Protocols,2013, First Editon,Wiley.
2. Akiba and Robert Davidson, Getting Started with Bluetooth Low Energy-Tools and

Techniques of Low power networking, 2016, First Edition, O'Reilly Media			
Mode of Evaluation: Continuous Assessment Test + Digital Assignment, Quiz, Final Assessment Test			
Recommended by Board of Studies :		26-02-2017	
Approved by Academic Council :	44th	Date :	16-03-2017

Course Code	Course title	L	T	P	J	C
ECE4002	Advanced Microcontrollers	3	0	0	4	4
Prerequisite:	ECE3003 – Microcontrollers and Applications	Syllabus version				
		1.0				

Course Objectives:

1. To understand advanced architectures.
2. To develop Programs both in C and assembly for advanced architectures.
3. To understand the advanced features like memory management unit, exception handling.
4. To build real-time system using ARM/AVR controllers.

Expected Course Outcomes:

1. Comprehend the architecture and instruction set of AVR controllers
2. Develop efficient C codes for AVR architecture and program AVR peripherals like timers, interrupts and serial port.
3. Design AVR controller based system within realistic constraint like user specification, availability of components
4. Understand the design philosophy of ARM controllers.
5. Comprehend the instruction and assembly language program.
6. Develop efficient C codes for ARM architecture and its interfaces.
7. Design application for various social relevant and real time issues

Module:1	AVR architecture and Assembly language Programming:	5 hours

AVR Register File, Special Addressing registers, Addressing modes, Stack pointer, Program status register, Pipelines, Clock, Arithmetic and logical Instructions, Jump and branch Instructions, Move, Load store Instructions, Load and store Program memory, Push and pop Instruction, Bit Instructions, I/O Port.

Module:2	AVR (C Programming):	5 hours

Data types, Time delays, I/O Programming, Logic Operations, Data Conversion, Data Serialization, Memory Allocation.

Module:3	AVR Peripherals (C programming):	4 hours

Timers, Interrupts, Serial Port

Module:4	Communication with real world (C programming):	8 hours

SPI, I2C, ADC & DAC, PWM, Relay, stepper motor, LCD, keyboard

Module:5	ARM Architecture:	5 hours

ARM Design Philosophy, Overview of ARM architecture States [ARM, Thumb, Jazelle], Registers, modes, Conditional Execution, Pipelining, Vector Tables, Exception handling.

Module:6	ARM & Thumb Instructions and Assembly language Programming:	8 hours

ARM Instruction- data processing instructions, branch instructions, load store instructions, SWI instruction, Loading instructions, conditional Execution, Assembly Programming. Thumb Instruction-Thumb Registers, ARM Thumb interworking, branch instruction, data processing instruction, single/multiple load store instruction, Stack instruction, SWI instruction.

Module:7	ARM Microcontroller (C Programming):	8 hours

ARM Cortex M Microcontroller- Ports, Timer, UART, ADC, I2C.		
Module:8	**Contemporary Issues**	**2 hours**
Total Lecture:		**45 hours**

Text Books:	
1.	Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi, "AVR Microcontroller and Embedded Systems Using Assembly and C", Pearson, 2013.
2.	Andrew N Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide" Morgan Kaufmann Publishers, 2010.
Reference Books:	
1.	Joseph Liu, "The Definitive guide to ARM Cortex M0", Newnes, 2012.
2.	Simon Monk, "Programming Arduino Next Steps: Going further with sketches", McGraw Hill, 2014.

Typical Projects:

1. Home Automation
2. Smart precision irrigation system
3. Building Secure Home Automation
4. Green computing
5. Gesture controlled home automation for disabled
6. Patient monitoring system
7. Health monitoring system for old aged
8. Pollution monitoring and control system
9. Waste management
10. Smart Lighting
11. Forest Fire detection

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	Optical Communication and Networks	L	T	P	J	C
ECE4005		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 of 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 and Networks	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
ECE4027	EMBEDDED SENSING TECHNOLOGIES	2	0	0	4	3
Pre-requisite	ECE3031 Microcontroller and Embedded Systems				Version:1	

Course Objectives:

The course is aimed at

1. Introducing fundamentals of sensing and exploration of various sensors widely used for real life application.
2. Making a shift towards advanced microcontrollers for interfacing sensors.

Expected Course Outcome:

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

1. Understand the working principle and behavior of sensors
2. Relate and realize the importance automotive sensors and bio medical senosrs
3. Differentiate and associate the architecture, instruction set, interrupts of MSP430 and ARM Cortex M4.
4. Know the ARM peripherals programming and interfacing with advanced cortex MX microcontroller
5. Design and interface sensors with embedded controllers

Module:1	**Fundamentals of Sensors**	**5 hours**	
Principles of sensing- capacitance- magnetic and electromagnetic induction – resistance - piezoelectric effect – heat transfer-light. Physical sensors, Optical Detectors and Sensors			
Module:2	**Automotive Sensors**	**4 hours**	
Pressure, Engine temperature, Airflow, Combustion, Torque, Accelerometers, Gas composition sensors – Liquid level sensors			
Module:3	**Bio-medical sensors**	**3 hours**	
Electrical Potentials and Propagation of Nerve Signals, Electrodes, EMG, ECG, EEG, Blood pressure.			
Module:4	**Low Power Microcontroller**	**4 hours**	
MSP430: Architecture, Memory, Addressing modes, Instruction set, Clock system, Exceptions: Interrupts and resets - Low power mode.			
Module:5	**ARM Cortex MX Processor**	**4 hours**	
ARM Cortex M4: Assembly language basics, Thumb-2 Technology, ARM Instruction set, Cortex M4 architecture, advantages, peripherals, instruction set, floating point operations.			
Module:6	**ARM Peripherals Programming and Interfacing**	**4 hours**	
Principle of data acquisition, ADC, DAC ,Sensor interface, single channel, multichannel Digital input/output, LCD Displays, Watchdog timers, timers, SPI, I2C, UART, Zigbee controller			
Module:7	**Advanced Cortex MX Microcontroller**	**4 hours**	
Core, Architecture, on chip wifi, configuring WLAN, on CHIP 6LoWPAN and configuration.			
Module:8	**Contemporary issues:**	**2 hours**	
	Total Lecture hours:	**30 hours**	

Text Book(s)

1. Jacob Fraden, Handbook of Modern Sensors: Physics, Design and Applications, 2016, 5th Edition, Springer, USA
2. John H. Davies, MSP430 Microcontroller Basics, Newones, 2011, second edition, Elsevier, USA.

Reference Books

1. John Turner, Automotive Sensors, 2012, Momentum Press, USA.
2. J. G. Webster, Medical Instrumentation; Application and Design, 2010, 4th Edition, John Wiley, USA.
3. John G Webster, Measurement, Instrumentation and sensors Handbook, 2014, CRC Press,

USA.

4. Jonathan W Valvano, Embedded Systems: Introduction to ARM Cortex -M Microcontrollers, 2017, 5th edition, University of Texas, USA

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

Typical Projects

1. Remote monitoring of soil parameters - deploy sensors in a land to measure the parameters like moisture, temperature, humidity etc.
2. Power optimization in home: Using human activity defectors appropriate appliances should be activated for a home application
3. Design and development of a prototype to demonstrate the structure health monitoring using strain gauge, accelerometer, ultra sonic sensor etc.
4. Design a gesture based controller to operate appropriate motors remotely.
5. Design an intelligent wearable device like watch, cap to sense the physical condition of human and to log the data for further analysis.
6. Design and develop an embedded bed monitoring system capable of sensing patient's temperature, pressure, pulse rate, ECG etc and decide necessary actuations

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
ECE4030	Building Management Systems	1	0	0	0	1
Pre-requisite	NONE	Version : 1				

Course Objectives:

The Course is aimed at

1. Acquainting the student with the basic concepts of Building Management Systems and comfort parameters.
2. Describing the students how HVAC, security Engineering, fire Engineering, and intrusion systems works.
3. Making the students to insight into Compressor performance.

Course Outcome:

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

1. Describe the basic concepts of BMS
2. Explain the working of HVAC
3. Outline the various performance parameters of a compressor
4. Recognize / relate various "concept parameters" in building management systems
5. Understand the need and operation of security engineering
6. Study the various intrusion systems (FAT)
7. Understand the working of fire Engineering systems (FAT)

Module:1	**Introduction**	**2 hours**	
Importance of BMS and intelligent buildings, energy efficiency, architecture of BMS, introduction to OSI layers, protocols used in BMS.			
Module:2	**Heating, Ventilation & Air-Conditioning (HVAC)**	**2 hours**	
Concepts of heating, ventilation & air-conditioning, concept of air-handling system, air handling unit, types, advantages and disadvantages of AHU, different equipment's in AHU, different control strategies			
Module:3	**Compressor**	**1 Hour**	
Concepts of compressor, heat recovery system, humidification, de-humidification, energy conservation in AHU			
Module:4	**Comfort Parameters Measurement in BMS System**	**2 Hours**	
Introduction, temperature sensors, humidity and the Psychrometric chart moisture sensors, pressure sensors, flow sensors and meters			
Module:5	**Security Engineering**	**2 Hours**	
Introduction, different controllers used for the security, access control system			
Module:6	**Intrusion Systems**	**2 Hours**	
Components of video surveillance system, CCTV & video surveillance systems, components of intrusion alarm system.			
Module:7	**Fire Engineering**	**2 Hours**	
Concept of fire, cold fire, concept of smoke, fire detection system, fundamental of fire alarm system, smoke detection system, fire alarm control panel, smoke detector, flame or fire detectors.			
Module:8	**Contemporary Issues**	**2 Hours**	
		Total Lecture hours: 15 hours	

Text Book(s)

1. "Building Management Systems-Course Material" by Johnson controls of India

Reference Books

1. Building Energy Management Systems: An Application to Heating, Natural Ventilation, Lighting and Occupant Satisfaction by Geoff Levermore , 2nd Edition, Routledge, 2000

2. Automation Systems In Smart and Green Buildings by V.K. Jain, Khanna Publishers; First edition, 2009			
Mode of Evaluation: Continuous Assessment Test + Digital Assignment +Quiz + Final Assessment Test			
Recommended by Board of Studies :		31-08-2018	
Approved by Academic Council :	53	Date :	13-12-2018

Course Code	Course title	L	T	P	J	C
ECE4031	Artificial Intelligence with python	3	0	2	0	4
Pre-requisite	NONE	Version : 1				

Course Objectives:

The course is aimed at

1. Providing exposure to the advancements in the Artificial Intelligence (AI) and facilitate in depth discussions on chosen topics.
2. Presenting the mathematical and computational challenges of Classification, Regression using supervised learning and Predictive Analytics with Ensemble Learning.
3. Providing exposure to various Artificial Intelligence techniques using Python.

Expected Course Outcome:

AT the end of this course, the students will be able to

1. Understand primary concepts of AI and Python.
2. Understand the mathematical and computational models of Classification, Regression using supervised learning and Predictive Analytics with Ensemble Learning
3. Carry out Pattern detection using Unsupervised Learning
4 .Have an overview of Building Recommender and Logic Programming.
5. Identify suitable applications of AI, solution of which can be rendered using Python.
6.Implement the learnt artificial intelligence concepts in solving the real world problems, at a basic level.

Module:1	**Primer Concepts**	**6 Hours**	
Basics of Artificial intelligence (AI) – Necessity of learning AI – Applications of AI – Branches of AI – Intelligence - Agent and Environment – python for AI – Features of python – script from the command line – IDE			
Module:2	**Classification and Regression using Supervised learning**	**7 Hours**	
Supervised and unsupervised learning – classification – preprocessing data – label encoding – logistic Regression Classifier – Naïve Bayes Classifier – Confusion matrix – Support vector machines - Classifying income data using Support Vector Machines – Regression - Building a single variable regressor - Building a multivariable regressor- Estimating housing prices using a Support Vector Regressor			
Module:3	**Predictive Analytics with Ensemble Learning**	**6 Hours**	
Ensemble Learning - Decision Trees - Random Forests and Extremely Random Forests - Dealing with class imbalance- Finding optimal training parameters using grid search - Computing relative feature importance - Predicting traffic using Extremely Random Forest regressor			
Module:4	**Detecting Patterns with Unsupervised Learning**	**6 Hours**	
Unsupervised learning - Clustering data with K-Means algorithm - Estimating the number of clusters with Mean Shift algorithm - Estimating the quality of clustering with silhouette scores - Gaussian Mixture Models - Building a classifier based on Gaussian Mixture Models - Finding subgroups in stock market using Affinity Propagation model- Segmenting the market based on shopping patterns			
Module:5	**Building Recommender**	**5 Hours**	
Creating a training pipeline - Extracting the nearest neighbors - Building a K-Nearest Neighbors classifier - Computing similarity scores - Finding similar users using collaborative filtering - Building a movie recommendation system			
Module:6	**Logic Programming**	**5 Hours**	

Basics of logic programming - Understanding the building blocks of logic programming - Solving problems using logic programming - Installing Python packages - Matching mathematical expressions			
- Validating primes - Parsing a family tree - Analyzing geography - Building a puzzle solver			
Module:7	**Applications of AI with python**	**8 Hours**	
Heuristic Search Techniques - Genetic Algorithms - Building Games With Artificial Intelligence - Building A Speech Recognizer - Object Detection and Tracking			
Module:8	**Contemporary Issues**	**2 Hours**	
Total Lecture hours:		**45 Hours**	

Text Book(s)

1. Artificial intelligence with python, Prateek Joshi, Packt publishing Ltd, UK, ISBN 978-1-78646-439-2, 2017.
2. Python code for Artificial Intelligence: Foundations of Computationa l Agents, David L. Poole and Alan K. Mackworth, Cambridge University Press, 2017.
3. Artificial Intelligence: A Modern Approach 3rd Edition, Stuart. J Russell, Peter Norvig, Pearson Publications, ISBN: 9789332543515, 2015.
4. A First Course in Artificial Intelligence, Deepak Khemani, McGraw Hill Education (India), 2013.
5. Introduction to Artificial Intelligence, Philip C. Jackson, Second Enlarged Edition, Dover Publications, 1985.

Mode of Evaluation: Continuous Assessment Test + Digital Assignment +Quiz + Final Assessment Test

Lab Exercise:

1. **Searching for Solutions:** To define a structure of graph. Use depth first branch and bound algorithm for identifying occurrence of element or not in the given graph.
2. **Reasoning with Constraints:** Use stochastic local search, in particular a probabilistic mix of the variable with the most conflicts, any - conflict and a random variable, to solve Constraint Satisfactions Problems. It only maintains the data structures needed for the a lgorithm.
3. **Propositions and Inference:** Use Horn clauses for assumable, including consistency-based diagnosis.
4. **Learning with Uncertainty :** Implementation of k- means and Expectation– maximization algorithm (*EM*) for unsupervised learning
5. **Multiagent Systems:** Implementation of Two player zero-sum games and mini- max with alpha-beta pruning.
6. **Reinforcement Learning:** Q- learner, Model- based reinforcement learner, Feature- based reinforcement learner and implementing simple games

Recommended by Board of Studies :		31-08-2018	
Approved by Academic Council:	53	Date :	13-12-2018

Course Code	Course title	L	T	P	J	C
ECE4032	Neural Networks and Deep Learning	3	0	0	4	4
Pre-requisite	NONE	Version : 1				

Course Objectives:

The course is aimed at making the students to

1. Expose to neural networks advances and facilitate in depth discussions on deep learning
2. Understand about the mathematical, statistical and computational challenges of building stable representations for high-dimensional data, such as images, text and data.
3. Understand the convolutional architectures, invariance learning, unsupervised learning and non-convex optimization.

Expected Course Outcome:

The Students will be able to

1. Understand the types of network architectures, learning processes, and fundamental issues & challenges in deep learning.
2. Comprehend the architectures of Deep feed forward Networks and Convolutional networks.
3. Understand the usage of Recurrent Neural Networks and Auto Encoders
4. Model the Deep Generative Network - Boltzmann Machine for a problem at hand
5. Explore Artificial Intelligence based solutions
6. Implementation of deep learning algorithms for the real world applications.

Module 1	**Introduction to Neural Networks**	**3 Hours**	
Definition - McCulloch-Pitts's Neuron - Types of activation function - Types of network architectures - Learning processes - Advantages and disadvantages			
Module:2	**A Brief Introduction to Deep Learning**	**4 Hours**	
Historical Trends in Deep Learning; Applied Math and Machine Learning Basics: Linear Algebra; Probability and Information Theory; Numerical Computation; Machine Learning Basics			
Module:3	**Deep Feed forward Networks and Convolutional Networks**	**10 Hours**	
Example Learning XOR; Hidden Units; Architecture Design; Backpropagation; Regularization for Deep Learning; Optimization for Training Deep Models; The convolution operation; Motivation; Pooling; Variants of basic Convolution Function; Efficient Convolution Algorithms; Generative Adversarial Networks			
Module:4	**Sequence Models:**	**6 Hours**	
Recurrent Neural Networks; Bi directional RNNs; Deep Recurrent Networks; Leaky units; Long Short Term Memory and Other Gated RNNs			
Module:5	**Auto Encoders:**	**7 Hours**	
Under-complete Auto-encoders; Regularized Auto-encoders; Representational Power, Layer Size and Depth; Stochastic Encoders and Decoders; De-noising Auto-encoders; Learning Manifolds with Auto-encoders; Contractive Auto-encoders; Predictive Sparse Decomposition; Applications of Auto-encoders			
Module:6	**Deep Generative Models:**	**7 Hours**	
Boltzmann Machines; Restricted Boltzmann Machines; Deep Belief Networks; Deep Boltzmann Machines; Boltzmann Machines for Real-Valued Data; Convolutional Boltzmann Machines; Boltzmann Machines for Structured or Sequential Outputs Other Boltzmann Machines			
Module:7	**Practical Applications and Road to Artificial Intelligence:**	**6 Hours**	
Large Scale Deep Learning; Computer Vision; Speech Recognition; Natural Language Processing; Other Applications			
Module:8	**Contemporary Issues**	**2 Hours**	
Total Lecture hours:		45 Hours	

Text Book:			
1) Deep Learning, Ian Goodfellow, Yoshua Bengio and Aaron Courville, MIT Press, ISBN: 9780262035613, 2016. 2) Neural Networks & Deep Learning, Pat Nakamoto, Kindle Edition, 2016. 3) Neural Network and Deep Learning, Michael Nielsen, Online Book, 2016			
Mode of Evaluation: Continuous Assessment Test + Digital Assignment +Quiz + Final Assessment Test			
List of Projects (J) (Indicative			
1) Sleep Prediction Using Consumer Wearable Devices 2) Unsupervised Face Recognition in Television News Media 3) Finding Sarcasm in Reddit Postings: A Deep Learning Approach 4) Fake News Detection 5) Predicting Diabetes Re-admittance 6) Deep Imitation Learning for Playing Real Time Strategy Games 7) Time Series Sales Forecasting 8) A neural network approach for predicting urban building energy consumption 9) Weather-driven predictions of solar energy 10) Real-time Image Style Transfer 11) Deep Learning Approach to Accent Recognition 12) Voice Commands Recognition with Convolution Neural Network 13) Detecting Thoracic Diseases from Chest X-Ray Images 14) Supervised Learning for Autonomous Driving 15) Real-time Emotion Recognition From Facial Expressions			
Recommended by Board of Studies:		31-08-2018	
Approved by Academic Council:	53	Date :	13-12-2018

Course code	Web Technologies	L	T	P	J	C
ITE1002		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

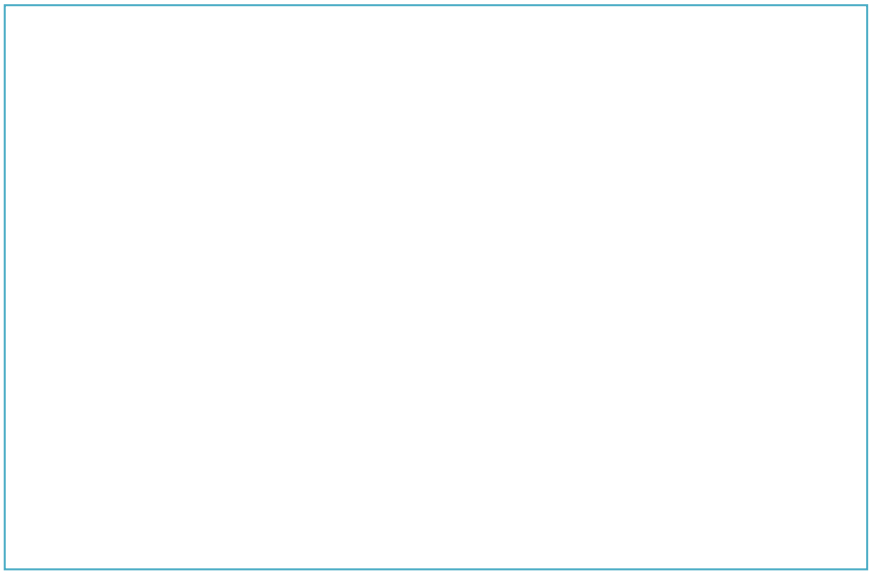
Module:8	**Contemporary issues:**	**2 hours**

	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

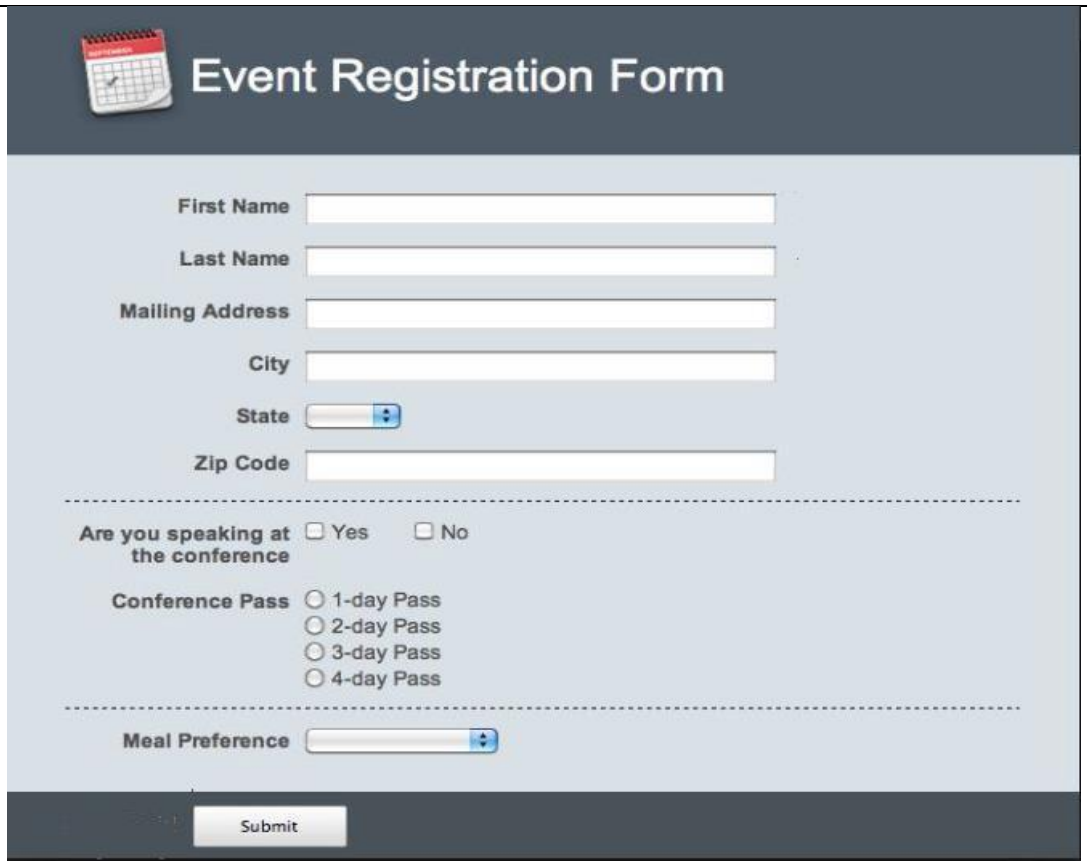
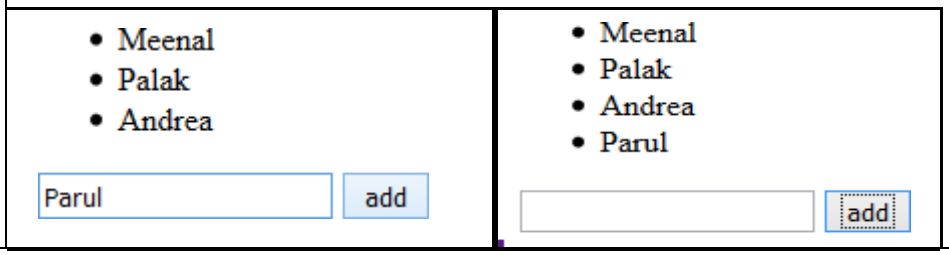
List of Challenging Experiments (Indicative)

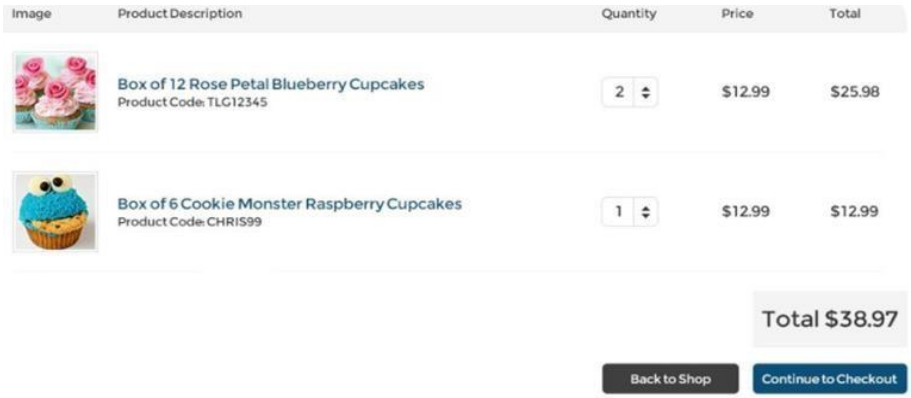
1. Use DHTML to perform the following**.**
   a) Design the spotlight section of VIT home page. Use Box properties of CSS.



   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.	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.	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.	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
MAT3005	Applied Numerical Methods	3	2	0	0	4
Pre-requisite	MAT2002 – Applications of Differential and Difference Equations	Syllabus Version				
		1.0				

Course Objectives (CoB): 1,2,3,4

The aim of this course

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

Course Outcome (CO): 1,2,3,4,5

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 (algorithms) to find the solution (approximate) 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; 978-0195693751, 2009.

Mode of Evaluation

Digital Assignments (Solutions by using soft skills), Continuous Assessment Tests, Final Assessment Test

Recommended by Board of Studies	03-06-2019		
Approved by Academic Council	No. 55	Date	13-06-2019

Course code	Geographic information system	L	T	P	J	C
SWE4004		3	0	0	4	4
Pre-requisite	SWE3002	Syllabus version				
		v. 1.0				

Course Objectives:

- Demonstrate an understanding of guidelines, principles, and theories influencing Geographic Information System.
- To know about the GIS automation and decision making using GIS
- Use the information sources available, and be aware of the methodologies and technologies supporting the advances in GIS.

Expected Course Outcome:

Upon Completion of the course, the students will be able to

1. Have a clear understanding of the subject related concepts and of contemporary issues
2. Gain knowledge in Map projections
3. Understand spatial data models
4. Understand the data input errors
5. Have design thinking capability
6. Understand analytical modelling in GIS
7. Use techniques, skills to develop new GIS application

Module:1	Introduction	3 hours	

Overview of Geographic Information Systems:- Definition of a GIS, features and functions; why GIS is important; how GIS is applied; GIS as an Information System; Components of GIS.

Module:2	Maps	7 hours	

Map Projections and Coordinate Systems:-Characteristics of Maps: Map Scale – Classification of Maps; Plane and Geographic Coordinates: Plane Rectangular Coordinate System - Plane Polar Coordinate System – Geographic Coordinate System of Earth; Map Projections: Types of Map Projections – Common Map Projections -Properties - Major uses; Map Projections: Classification -Aspects – Viewpoints; Georeferencing framework – Geodetic and Vertical Datums; Relationship between coordinate system and Map Projections.

Module:3	Cartography and Spatial data modeling	7 hours	

Cartography:- GIS and cartography - Difference between CAD and GIS - Introduction to Remote Sensing-Spatial Data Modelling: Introduction – Entity Definition – Spatial Data Models – Spatial Data Structures: Raster data structures – vector data structure

Module:4	Data Input and Editing	5 hours	

Methods of data input: keyboard entry-manual digitizing-automatic digitizing - Electronic data transfer - Data editing: Detecting and correcting errors – common errors in spatial data – Re-projection, transformation and generalization – Geocoding address data – Updating and maintaining spatial database Case study: Ordnance Survey(OS) data collection. - satellite imagery-satellite image resolution and scaling.

Module:5	Data analysis	7 hours	

Measurements in GIS – lengths, perimeters and areas – Queries – Reclassification - Buffering and neighborhood functions- Integrating data – map overlay - Spatial interpolation- Analysis of surfaces - Network analysis.			
Module:6	**Analytical modelling in GIS**	**7 hours**	
Introduction- Process models- Modelling physical and environmental processes - Modelling human processes- Modelling the decision-making process-Problems with using GIS to model spatial processes.			
Module:7	**Data Automation, Database and Data Quality**	**7 hours**	
Data Sources: Internet resources for GIS - Data Resources - Product Information - locating and evaluating data - data formats – ArcGIS software; Database- PostGIS database / ArcGIS supported Databases(Ex. PostgreSQL); Data Quality Issues – Introduction, Describing data quality and errors – Sources of error in GIS – Finding and modeling errors in GIS – Managing GIS error.			
Module:8	**Contemporary issues:** Applications of Geographic information systems in Industry-Case Studies.	**2 hours**	**-**
	Total Lecture hours:	**45 hours**	

Text Book(s)

1.	Ian Heywood, Introduction to Geographical Information Systems, Pearson Education, fourth edition, 2012
2.	C.P.LO, Albert K. W. Yeung, Concepts and Techniques of Geographic Information Systems, Publisher: PHI, 2nd Edition, 2012.

Reference Books

1.	Jatin Pandey, Darshana Pathak , Geographic Information System, The Energy and Resources Institute, TERI , 2013
2.	Kang-Tsung Chang, Introduction to Geographic Information Systems, McGraw-Hill Higher Education, 6 edition, 2011
3.	Basudeb Bhatta, Remote Sensing and GIS, Oxford; Second edition, 2011.

Recommended by Board of Studies		05-03-2016	
Approved by Academic Council	No. 40	Date	18-03-2016