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

Curriculum and Syllabus

(***2019-20*** *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

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

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

PROGRAMME SPECIFIC OUTCOMES (PSOs)

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

PSO1. Design and develop systems for applications including Signal processing, Communication, Networking, Embedded systems, VLSI and Control systems.

PSO2. Use modern tools and techniques to solve contemporary problems in the field of Electronics and Communication Engineering.

PSO3: Analyze and understand deeper aspects of the problem and provide creative design solutions through high level thinking skills to attain the desired outcomes.

B. Tech Electronics and Communication Engineering

CREDIT STRUCTURE

Category-wise Credit distribution

Category	Credits
University core (UC)	**53**
Programme core (PC)	**59**
Programme elective (PE)	**36**
University elective (UE)	**12**
Bridge course (BC)	**-**
Total credits	**160**

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B. Tech Electronics and Communication Engineering

DETAILED CURRICULUM

University Core (UC): 53 Credits

No	Course Code	Course Title	L	T	P	J	C
1	CHY1701	Engineering Chemistry	3	0	2	0	4
2	CHY1002	Environmental Science	3	0	0	0	3* (0)
3	CSE1001	Problem solving and programming	0	0	6	0	3
4	CSE1002	Problem solving with Object Oriented Programming	0	0	6	0	3
5	ECE1901	Technical Answers for Real World Problems (TARP)	1	0	0	4	2
6	ECE1902	Industrial Internship	0	0	0	0	1
7	ECE1903	Comprehensive Examination	0	0	0	0	1
8	ECE1904	Co-op / Capstone Project	0	0	0	0	12
9	ENG1000	Foundation English-I	0	0	4	0	2* (0)
10	ENG2000	Foundation English-II	0	0	4	0	2* (0)
11	ENG1901/ ENG1902/ ENG1903	Technical English-I / Technical English-II / Advanced Technical English	0	0	4	0	2
12	EXC4097	Personality Development(extra & co -curricular activities)	0	0	0	0	1* (0)
13	FLC4097	Foreign Language Course basket	2	0	0	0	2
14	HUM1021	Ethics and Values	2	0	0	0	2
15	MAT1011	Calculus for Engineers	3	0	2	0	4
16	MAT2001	Statistics for Engineers	3	0	2	0	4
17	MGT1022	Lean Start-up Management	1	0	0	4	2
18	PHY1701	Engineering Physics	3	0	2	0	4
19	PHY1901	Introduction to Innovative Projects	1	0	0	0	1
20	STS4097	Soft Skills	0	0	0	0	6
		TOTAL					53

***Bridge Course (BC)**

B. Tech Electronics and Communication Engineering

Programme Core (PC): 59 Credits

No.	Course Code	Course Title	L	T	P	J	C	Pre-Requisite
1.	ECE1001	Fundamentals of Electrical Circuits	2	0	2	0	3	None
2.	ECE1002	Semiconductor Devices and Circuits	3	0	2	0	4	None
3.	ECE1003	Electromagnetic Field Theory	3	0	0	0	3	PHY1701
4.	ECE1004	Signals and Systems	2	0	0	4	3	MAT1011
5.	ECE1005	Sensors and Instrumentation	1	0	0	4	2	PHY1701
6.	ECE2001	Network Theory	3	0	0	0	3	ECE1001
7.	ECE2002	Analog Electronic Circuits	2	0	2	4	4	ECE1002
8.	ECE2003	Digital Logic Design	2	0	2	0	3	ECE1002
9	ECE2004	Transmission lines and Waveguides	3	0	0	0	3	ECE1003
10.	ECE2005	Probability Theory and Random Processes	3	0	0	0	3	ECE1004
11.	ECE2006	Digital Signal Processing	2	0	2	4	4	ECE1004
12.	ECE3001	Analog Communication Systems	3	0	2	0	4	ECE2002
13.	ECE3002	VLSI System Design	3	0	2	0	4	ECE2003
14.	ECE3003	Microcontroller and its applications	2	0	2	4	4	ECE2003
15.	ECE4001	Digital Communication Systems	3	0	2	0	4	ECE3001
16.	MAT2002	Applications of Differential and Difference Equations	3	0	2	0	4	MAT1011
17.	MAT3004	Applied Linear Algebra	3	1	0	0	4	MAT2002

B. Tech Electronics and Communication Engineering

Programme Elective (PE): 36 Credits

No.	Course Code	Course Title	L	T	P	J	C	Pre-Requisite
1	CSE2003	Data Structures and Algorithms	2	0	2	4	4	None
2	CSE2005	Operating Systems	2	0	2	4	4	None
3	ECE1006	Introduction to Nano Science and Nano Technology	2	0	0	4	3	PHY1701
4	ECE1007	Optoelectronics	3	0	0	0	3	PHY1701
5	ECE1008	Electronics Hardware Trouble Shooting	0	0	2	0	1	None
6	ECE2008	Robotics and Automation	2	0	0	4	3	ECE1005
7	ECE2010	Control Systems	3	0	0	4	4	ECE1004
8	ECE3004	Computer Organization and Architectures	3	0	0	0	3	ECE2003
9	ECE3005	Digital Image Processing	3	0	2	0	4	ECE2006
10	ECE3009	Neural Networks and Fuzzy Control	3	0	0	4	4	ECE2006
11	ECE3010	Antennas and wave propagation	3	0	0	0	3	ECE2004
12	ECE3011	Microwave Engineering	3	0	2	4	5	ECE2004
13	ECE3013	Linear Integrated Circuits	3	0	2	0	4	ECE2002
14	ECE4002	Advanced Microcontrollers	3	0	0	4	4	ECE3003
15	ECE4003	Embedded System Design	2	0	2	4	4	ECE3003
16	ECE4004	Embedded C and Linux	3	0	2	4	5	ECE3003
17	ECE4005	Optical Communication and Networks	2	0	2	4	4	ECE4001
18	ECE4007	Information Theory and Coding	3	0	0	4	4	ECE4001
19	ECE4008	Computer Communication	3	0	2	0	4	ECE4001
20	ECE4009	Wireless and Mobile communication	3	0	2	4	5	ECE4001
21	ECE4010	Satellite Communication	3	0	0	0	3	ECE4001
22	ECE4011	Wireless Sensor Networks	2	0	2	4	4	ECE4001
23	ECE4013	Cryptography and Network Security	3	0	0	0	3	ECE2005

No.	Course Code	Course Title	L	T	P	J	C	Pre-Requisite
24	MAT3005	Applied Numerical Methods	3	1	0	0	4	MAT2002
25	PHY1002	Material Science	3	0	2	0	4	PHY1701
26	ECE3046	Computer Vision and Pattern Recognition	3	0	0	0	3	ECE2006
27	ECE3047	Machine Learning Fundamentals	3	0	2	0	4	MAT3004
28	ECE3048	Deep Learning	3	0	0	0	3	MAT3004
29	ECE4033	IoT System Design and Applications	3	0	2	0	4	ECE3003
30	CSE3501	Information Security Analysis and Audit	2	0	2	4	4	NIL
31	CSE3502	Information Security Management	2	0	2	4	4	NIL
32	CSE3505	Foundations of Data Analytics	2	0	2	4	4	NIL
33	CSE3506	Essentials of Data Analytics	2	0	2	4	4	NIL
34	ECE3501	IoT Fundamentals	2	0	2	4	4	NIL
35	ECE3502	IoT Domain Analyst	2	0	2	4	4	NIL

B. Tech Electronics and Communication Engineering

University Elective (UE) Baskets: 12 Credits

Management Courses

Sl.No	Code	Title	L	T	P	J	C
1	MGT1001	Basic Accounting	3	0	0	0	3
2	MGT1002	Principles of Management	2	0	0	4	3
3	MGT1003	Economics for Engineers	2	0	0	4	3
4	MGT1004	Resource Management	2	0	0	4	3
5	MGT1005	Design, Systems and Society	2	0	0	4	3
6	MGT1006	Environmental and Sustainability Assessment	2	0	0	4	3
7	MGT1007	Gender, Culture and Technology	2	0	0	4	3
8	MGT1008	Impact of Information Systems on Society	2	0	0	4	3
9	MGT1009	Technological Change and Entrepreneurship	2	0	0	4	3
10	MGT1010	Total Quality Management	2	2	0	0	3
11	MGT1014	Supply Chain Management	3	0	0	0	3
12	MGT1015	Business Mathematics	3	0	0	0	3
13	MGT1016	Intellectual Property Rights	3	0	0	0	3
14	MGT1017	Business Regulatory Framework For Start-ups	3	0	0	0	3
15	MGT1018	Consumer Behaviour	3	0	0	0	3
16	MGT1019	Services Marketing	3	0	0	0	3
17	MGT1020	Marketing Analytics	2	0	2	0	3
18	MGT1021	Digital and Social Media Marketing	3	0	0	0	3
19	MGT1023	Fundamentals of Human Resource Management	3	0	0	4	4
20	MGT1024	Organizational Behaviour	3	0	0	4	4
21	MGT1025	Foundations of Management And Organizational Behaviour	3	0	0	4	4

Sl.No	Code	Title	L	T	P	J	C
22	MGT1026	Information Assurance and Auditing	2	0	0	4	3
23	MGT1028	Accounting and Financial Management	2	2	0	4	4
24	MGT1029	Financial Management	2	1	0	4	4
25	MGT1030	Entrepreneurship Development	3	0	0	4	4
26	MGT1031	International Business	3	0	0	4	4
27	MGT1032	Managing Asian Business	3	0	0	4	4
28	MGT1033	Research Methods in Management	2	1	0	4	4
29	MGT1034	Project Management	3	0	0	4	4
30	MGT1035	Operations Management	3	0	0	0	3
31	MGT1036	Principles of Marketing	3	0	0	4	4
32	MGT1037	Financial Accounting and Analysis	2	1	0	4	4
33	MGT1038	Financial Econometrics	2	0	0	4	3
34	MGT1039	Financial Markets and Institutions	2	0	0	4	3
35	MGT1040	Personal Financial Planning	2	0	0	4	3
36	MGT1041	Financial Derivatives	2	1	0	4	4
37	MGT1042	Investment Analysis and Portfolio Management	2	0	0	4	3
38	MGT1043	Applications in Neuro Marketing	3	0	0	4	4
39	MGT1044	Global Brand Marketing Strategies	3	0	0	4	4
40	MGT1045	Industrial Marketing	3	0	0	4	4
41	MGT1046	Sales and Distribution Management	3	0	0	4	4
42	MGT1047	Social Marketing	3	0	0	4	4
43	MGT1048	Political Economy of Globalization	3	0	0	4	4
44	MGT1049	Sustainable Business Models	3	0	0	4	4
45	MGT1050	Software Engineering Management	2	0	0	4	3
46	MGT1051	Business Analytics for Engineers	2	2	0	0	3
47	MGT1052	Bottom of the Pyramid Operations	3	0	0	0	3
48	MGT1053	Entrepreneurship Development, Business	1	0	2	0	2

Sl.No	Code	Title	L	T	P	J	C
		Communication and IPR					
49	MGT1054	Product Planning and Strategy	2	2	0	0	3
50	MGT1055	Design Management	2	2	0	0	3
51	MGT1056	Accounting and Financial Management	3	0	0	4	4
52	MGT6001	Organizational Behaviour	2	0	0	4	3

Humanities Courses

Sl.No	Code	Title	L	T	P	J	C
1	HUM1001	Fundamentals of Cyber Laws	3	0	0	0	3
2	HUM1002	Business Laws	3	0	0	0	3
3	HUM1003	Basic Taxation for Engineers	3	0	0	0	3
4	HUM1004	Corporate Law for Engineers	3	0	0	0	3
5	HUM1005	Cost Accounting for Engineers	3	0	0	0	3
6	HUM1006	Business Accounting for Engineers	3	0	0	0	3
7	HUM1007	Contemporary Legal Framework for Business	3	0	0	0	3
8	HUM1009	International Business	3	0	0	0	3
9	HUM1010	Foreign Trade Environment	3	0	0	0	3
10	HUM1011	Export Business	3	0	0	0	3
11	HUM1012	Introduction to Sociology	3	0	0	0	3
12	HUM1013	Population Studies	3	0	0	0	3
13	HUM1021	Ethics and Values	2	0	0	0	2
14	HUM1022	Psychology in Everyday Life	2	0	0	4	2
15	HUM1023	Indian Heritage and Culture	2	0	0	4	2
16	HUM1024	India and Contemporary World	2	0	0	4	2
17	HUM1025	Indian Classical Music	1	0	2	4	1
18	HUM1033	Micro Economics	3	0	0	0	3
19	HUM1034	Macro Economics	3	0	0	0	3

Sl.No	Code	Title	L	T	P	J	C
20	HUM1035	Introductory Econometrics	2	0	2	0	2
21	HUM1036	Engineering Economics and Decision Analysis	2	0	0	4	2
22	HUM1037	Applied Game Theory	2	0	0	4	2
23	HUM1038	International Economics	3	0	0	0	3
24	HUM1039	Community Development in India	2	0	0	4	2
25	HUM1040	Indian Social Problems	3	0	0	0	3
26	HUM1041	Indian Society Structure and Change	3	0	0	0	3
27	HUM1042	Industrial Relations and Labour Welfare in India	3	0	0	0	3
28	HUM1043	Mass Media and Society	2	0	0	4	2
29	HUM1044	Network Society	3	0	0	0	3
30	HUM1045	Introduction to Psychology	2	0	2	0	2
31	HUM1706	Business Accounting for Engineers	3	0	0	0	3

University Core (UC)

Course Code	Course Title	L	T	P	J	C
CHY1701	Engineering Chemistry (UC)	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. 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. AngÃ¨le Reinders, Pierre Verlinden, Wilfried van Sark, Alexandre Freundlich, Photovoltaic solar energy: From fundamentals to Applications, Wiley publishers, 2017.

Reference Books

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 ACM	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)

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

Reference Books

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

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, 2012, Fifth edition, Addison-Wesley.
2. Ali Bahrami, Object oriented Systems development, 1999, Tata McGraw - Hill Education.
3. Brian W. Kernighan, Dennis M. Ritchie, The C programming Language, 1988, 2nd edition, Prentice Hall Inc.

Reference Books

1. Bjarne stroustrup, The C++ programming Language, 2013, Addison Wesley, 4th edition.
2. Harvey M. Deitel and Paul J. Deitel, C++ How to Program, 2010, 7th edition, Prentice Hall.
3. Maureen Sprankle and Jim Hubbard, Problem solving and Programming concepts, 2014, 9th edition, Pearson Education.

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	15 hours

	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	
5.	**Selective Job Scheduling Problem** A server is a machine that waits for requests from other machines and 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	15 hours
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

Course Code	Course Title	L	T	P	J	C
ECE1901	Technical Answers for Real World Problems (TARP)	1	0	0	4	2
Pre-requisite	PHY1901 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
ECE1902	**Industrial Internship**	**0**	**0**	**0**	**0**	**1**
Pre-requisite	Completion of minimum of Two semesters					

Course Objectives:

The course is designed 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	Course Title	L	T	P	J	C
ECE1903	Comprehensive Examination	0	0	0	0	1
Prerequisite:	Minimum of 6th Semester Courses	Syllabus version				
		V:1.1				

Course Objectives:

1. Designed to test the students on the electronics and communication engineering concepts, and tools, and the process of identifying and solving engineering problems.

Expected Course Outcome:

The students will be able to

1. Apply knowledge of mathematics, science, and engineering
2. Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health care and safety, manufacturability, and sustainability.

Module:1 Networks, Signals and Systems

Network solution methods: nodal and mesh analysis; Network theorems: superposition, Thevenin and Norton's, maximum power transfer; Wye-Delta transformation; Steady state sinusoidal analysis using phasors; Time domain analysis of simple linear circuits; Solution of network equations using Laplace transform; Frequency domain analysis of RLC circuits; Linear 2-port network parameters: driving point and transfer functions; State equations for networks and Network Synthesis (RL,RC,LC and RLC Synthesis): Positive real functions, hurwitz polynomial, foster and cauer forms.

Continuous-time signals: LTI System & Properties,Fourier series and Fourier transform representations, sampling and aliasing concepts and applications; Discrete-time signals: discrete-time Fourier transform (DTFT), DFT, FFT, Z-transform. Interconnection of systems; Filter design concepts, phase and group delay concepts

Module:2 Electronic Devices and Analog Circuits

Energy bands in intrinsic and extrinsic silicon; Carrier transport: diffusion current, drift current, mobility and resistivity; Generation and recombination of carriers; Poisson and continuity equations; P-N junction, Zener diode, BJT, LED, photo diode and solar cell; MOS Transistor Theory: nMOS, pMOS Enhancement Transistor, ideal I-V characteristics, MOS capacitor, C-V characteristics, DC transfer Characteristics of CMOS inverter.

Small signal equivalent circuits of diodes, BJTs and MOSFETs; Simple diode circuits: clipping, clamping and rectifiers; Special diodes, Single-stage BJT and MOSFET amplifiers: biasing, bias stability, mid-frequency small signal analysis and frequency response; BJT and MOSFET amplifiers: multi-stage, differential, feedback, tuned amplifiers, power and operational; Simple op-amp circuits; Active filters; Sinusoidal oscillators: criterion for oscillation, single-transistor and op-amp configurations; Function generators, 555 timers, open and closed loop applications of Comparators, Voltage Regulators, regulator protection methods, noise analysis of electronic circuits, PLLs and Data converters.

Module:3 Digital Circuits

Number systems; Combinatorial circuits: Boolean algebra, minimization of functions using Boolean identities and Karnaugh map, logic gates and their static CMOS implementations, arithmetic circuits, code converters, multiplexers, decoders and PLAs; Sequential circuits: latches

and flip-flops, counters, shift-registers and finite state machines; Data converters: sample and hold circuits, ADCs and DACs; Semiconductor memories: ROM, SRAM, DRAM; 8-bit microcontroller (8051): architecture, programming, memory and I/O interfacing.
Module:4 Electromagnetics
Electrostatics; Maxwell's equations: differential and integral forms and their interpretation, boundary conditions, wave equation, Poynting vector; Plane waves and properties: reflection and refraction, polarization, phase and group velocity, propagation through various media, skin depth; Transmission lines: equations, characteristic impedance, impedance matching, S-parameters, Smith chart; Waveguides: modes, boundary conditions, cut-off frequencies, Rader range equvation,Friss formula; Antennas: antenna types, radiation pattern, gain and directivity, return loss, antenna arrays; **Wave Propagation**, **Antenna design considerations - Microstrip and Horn antennas.** Basics of radar; Properties and characteristics of light sources (Laser and LED) and detectors; Light propagation in optical fibers.
Module:5 Control Systems
Basic control system components; Feedback principle; Transfer function; Block diagram representation; Signal flow graph; Transient and steady-state analysis of LTI systems; Frequency response; Routh-Hurwitz and Nyquist stability criteria; Bode and root-locus plots; Closed loop control system design by Nichols plot , PID controller design, Lag, lead and lag-lead compensation, States space models, states space equations and solutions, states space methods for controller designs and non-linear control systems and its applications.
Module:6 Communications
Random processes: autocorrelation and power spectral density, properties of white noise, filtering of random signals through LTI systems; Analog communications: amplitude modulation and demodulation, angle modulation and demodulation, spectra of AM and FM, superheterodyne receivers, circuits for analog communications; Information theory: entropy, mutual information and channel capacity theorem. Digital communications: PCM, DPCM, digital modulation schemes, amplitude, phase and frequency shift keying (ASK, PSK, FSK), QAM, MAP and ML decoding, matched filter receiver, calculation of bandwidth, SNR and BER for digital modulation; Fundamentals of error correction, Hamming codes; inter-symbol interference and its mitigation; Wireless Communication: Structure of a Wireless Communication Link, Modulation Techniques: QPSK, MSK, GMSK. Basics of TDMA, FDMA and CDMA.
Mode of Evaluation: Computerized Multiple Choice Questions FAT Examination – 100%

Course Code	Course Title	L	T	P	J	C
ECE1904	Capstone Project	0	0	0	0	12
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. Synthesis 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
ENG1000	Foundation English - I	0	0	4	0	0
Pre-requisite	Less than 50% EPT score	Syllabus Version				
		1				

Course Objectives:

1. To equip learners with English grammar and its application.
2. To enable learners to comprehend simple text and train them to speak and write flawlessly.
3. To familiarize learners with MTI and ways to overcome them.

Expected Course Outcome:

1. Develop the skills to communicate clearly through effective grammar, pronunciation and writing.
2. Understand everyday conversations in English
3. Communicate and respond to simple questions about oneself.
4. Improve vocabulary and expressions.
5. Prevent MTI (Mother Tongue Influence) during usual conversation.

Module:1	Essentials of grammar	3 Hours
Understand basic grammar-Parts of Speech Activity: Grammar worksheets on parts of speech		
Module:2	**Vocabulary Building**	**3 Hours**
Vocabulary development; One word substitution Activity: Elementary vocabulary exercises		
Module:3	**Applied grammar and usage**	**4 Hours**
Types of sentences; Tenses Activity: Grammar worksheets on types of sentences; tenses		
Module:4	**Rectifying common errors in everyday conversation**	**4 Hours**
Detect and rectify common mistakes in everyday conversation Activity: Common errors in prepositions, tenses, punctuation, spelling and other parts of speech; Colloquialism		
Module :5	**Jumbled sentences**	**2 Hours**
Sentence structure; Jumbled words to form sentences; Jumbled sentences to form paragraph/ short story Activity: Unscramble a paragraph / short story		
Module:6	**Text-based Analysis**	**4 Hours**
Wings of Fire -Autobiography of APJ Abdul Kalam (Excerpts) Activity: Enrich vocabulary by reading and analyzing the text		
Module:7	**Correspondence**	**3 Hours**
Letter, Email, Application Writing Activity: Compose letters; Emails, Leave applications		
Module:8	**Listening for Understanding**	**4 Hours**
Listening to simple conversations & gap fill exercises Activity: Simple conversations in Received Pronunciation using audio-visual materials.		

Module:9	**Speaking to Convey**	**6 Hours**
Self-introduction; role-plays; Everyday conversations Activity**:** Identify and communicate characteristic attitudes, values, and talents; Working and interacting within groups		
Module:10	**Reading for developing pronunciation**	**6 Hours**
Loud reading with focus on pronunciation by watching relevant video materials Activity: Practice pronunciation by reading aloud simple texts; Detecting syllables; Visually connecting to the words shown in relevant videos		
Module:11	**Reading to Contemplate**	**4 Hours**
Reading short stories and passages Activity: Reading and analyzing the author's point of view; Identifying the central idea.		
Module:12	**Writing to Communicate**	**6 Hours**
Paragraph Writing; Essay Writing; Short Story Writing Activity: Writing paragraphs, essays and short- stories		
Module:13	**Interpreting Graphical Data**	**6 Hours**
Describing graphical illustrations; interpreting basic charts, tables, and formats Activity: Interpreting and presenting simple graphical representations/charts in the form of PPTs		
Module:14	**Overcoming Mother Tongue Influence (MTI) in Pronunciation**	**5 Hours**
Practicing common variants in pronunciation Activity: Identifying and overcoming mother tongue influence.		
	Total Laboratory Hours	**60 Hours**

Text Book / Workbook	
1.	Wren, P.C., & Martin, H. (2018).High School English Grammar & Composition N.D.V. PrasadaRao (Ed.). NewDelhi: S. Chand & Company Ltd.
2.	McCarthy, M. O'Dell, F.,& Bunting, J.D. (2010).Vocabulary in Use(High Intermediate students book with answers). Cambridge University Press
Reference Books	
1.	Watkins, P.(2018).Teaching and Developing Reading Skills: Cambridge Handbooks for Language teachers. Cambridge University Press.
2.	Mishra, S., &Muralikrishna, C. (2014).Communication Skills for Engineers. Pearson Education India
3	Lewis, N. (2011).Word Power Made Easy. Goyal Publisher
4	https:/americanliterature.com/short-short-stories
5	Tiwari, A., &Kalam, A. (1999).Wings of Fire - An Autobiography of Abdul Kalam. Universities Press (India) Private Limited.

Mode of Evaluation: Quizzes, Presentation, Discussion, Role Play, Assignments

List of Challenging Experiments (Indicative)		
1.	Rearranging scrambled sentences	**8 hours**
2.	Identifying errors in oral and written communication	**12 hours**

3.	Critically analyzing the text	**8 hours**
4.	Developing passages from hint words	**8 hours**
5.	Role-plays	**12 hours**
6.	Listening to a short story and analyzing it	**12 hours**
	Total Laboratory Hours	**60 hours**

Mode of Evaluation: Quizzes, Presentation, Discussion, Role Play, Assignments			
Recommended by Board of Studies	08-06-2019		
Approved by Academic Council	55	Date	13-06-2019

Course code	Course title	L	T	P	J	C
ENG2000	Foundation English - II	0	0	4	0	0
Pre-requisite	51% - 70% EPT Score / Foundation English I	Syllabus version				
		1				

Course Objectives:

1. To practice grammar and vocabulary effectively
2. To acquire proficiency levels in LSRW skills in diverse social situations.
3. To analyze information and converse effectively in technical communication.

Expected Course Outcome:

1. Accomplish a deliberate reading and writing process with proper grammar and vocabulary.
2. Comprehend sentence structures while Listening and Reading.
3. Communicate effectively and share ideas in formal and informal situations.
4. Understand specialized articles and technical instructions and write clear technical correspondence.
5. Critically think and analyze with verbal ability.

Module:1	Grammatical Aspects	4 hours
Sentence Pattern, Modal Verbs, Concord (SVA), Conditionals, Connectives Activity : Worksheets, Exercises		
Module:2	**Vocabulary Enrichment**	**4 hours**
Active & Passive Vocabulary, Prefix and Suffix, High Frequency Words Activity : Worksheets, Exercises		
Module:3	**Phonics in English**	**4 Hours**
Speech Sounds – Vowels and Consonants – Minimal Pairs- Consonant Clusters- Past Tense Marker and Plural Marker Activity : Worksheets, Exercises		
Module:4	**Syntactic and Semantic Errors**	**2 Hours**
Tenses /SVA/Articles/ Prepositions/ Punctuation & Right Choice of Vocabulary Activity : Worksheets, Exercises		
Module:5	**Stylistic errors**	**2 Hours**
Dangling Modifiers, Parallelism, Standard English, Ambiguity, Redundancy, Brevity Activity : Worksheets, Exercises		
Module:6	**Listening and Note making**	**6 Hours**
Intensive and Extensive Listening - Scenes from plays of Shakespeare (Eg: Court scene in *The Merchant of Venice*, Disguise Scene in *The Twelfth Night*, Death of Desdemona in *Othello*, Death scene in *Julius Caesar* and Balcony scene from *Romeo and Juliet*) Activity : Summarizing; Note-making and drawing inferences from Short videos		
Module:7	**Art of Public Speaking**	**6 Hours**
Impromptu, Importance of Non-verbal Communication, Technical Talks, Dynamics of Professional Presentations – Individual & Group Activity : Ice Breaking; Extempore speech; Structured technical talk and Group presentation		
Module:8	**Reading Comprehension Skills**	**4 Hours**
Skimming, scanning, comprehensive reading, guessing words from context, understanding text organization, recognizing argument and counter-argument; distinguishing between main information and supporting detail, fact and opinion, hypothesis versus evidence; summarizing and note-taking, Critical Reasoning Questions – Reading and Discussion		

Activity: Reading of Newspapers Articles and Worksheets on Critical Reasoning from web resources		
Module: 9	**Creative Writing**	**4 Hours**
Structure of an essay, Developing ideas on analytical/ abstract topics Activity: Movie Review, Essay Writing on suggested Topics, Picture Descriptions		
Module: 10	**Verbal Aptitude**	**6 hours**
Word Analogy, Sentence Completion using Appropriate words, Sentence Correction Activity: Practicing the use of appropriate words and sentences through web tools.		
Module: 11	**Business Correspondence**	**4 hours**
Formal Letters- Format and purpose: Business Letters - Sales and complaint letter Activity: Letter writing- request for Internship, Industrial Visit and Recommendation		
Module: 12	**Career Development**	**6 hours**
Telephone Etiquette, Resume Preparation, Video Profile Activity: Preparation of Video Profile		
Module: 13	**Art of Technical Writing - I**	**4 hours**
Technical Instructions, Process and Functional Description Activity: Writing Technical Instructions		
Module: 14	**Art of Technical Writing – II**	**4 hours**
Format of a Report and Proposal Activity: Technical Report Writing, Technical Proposal		
	Total Lecture hours:	**60 hours**

Text Book / Workbook	
1.	Sanjay Kumar & Pushp Lata, Communication Skills, 2nd Edition, OUP, 2015
2	Wren & Martin, High School English Grammar & Composition, Regular ed., ND: Blackie ELT Books, 2018
Reference Books	
1	Peter Watkins, Teaching and Developing Reading Skills: Cambridge Handbooks for Language Teachers, Cambridge, 2018
2	Aruna Koneru, Professional Speaking Skills, OUP, 2015.
3	J.C.Nesfield, English Grammar English Grammar Composition and Usage, Macmillan. 2019.
4	Richard Johnson-Sheehan, Technical Communication Today, 6th edition, ND: Pearson, 2017.
5	Balasubramaniam, Textbook of English Phonetics For Indian Students , 3rd Edition , S. Chand Publishers, 2013.

Web Resources

1. https://www.hitbullseye.com/Sentence-Correction-Practice.php
2. https://hitbullseye.com/Critical-Reasoning-Practice-Questions.php

Mode of Evaluation: Presentation, Discussion, Role Play, Assignments , FAT

List of Challenging Experiments (Indicative)		
1.	Reading and Analyzing Critical Reasoning questions	**8 hours**
2.	Listening and Interpretation of Videos	**12 hours**
3.	Letter to the Editor	**6 hours**
4.	Developing structured Technical Talk	**12 hours**
5.	Drafting SOP (Statement of Purpose)	**10 hours**

6.	Video Profile		**12 hours**
		Total Laboratory Hours	**60 hours**
Mode of Evaluation: Presentation, Discussion, Role Play, Assignments , FAT			
Recommended by Board of Studies	08.06.2019		
Approved by Academic Council	55	Date	13-06-2019

Course Code	Course Title	L	T	P	J	C
ENG1901	Technical English - I	0	0	4	0	2
Pre-requisite	Foundation English-II	Syllabus Version				
		1				

Course Objectives:

1. To enhance students' knowledge of grammar and vocabulary to read and write error-free language in real life situations.
2. To make the students' practice the most common areas of written and spoken communications skills.
3. To improve students' communicative competency through listening and speaking activities in the classroom.

Expected Course Outcome:

1. Develop a better understanding of advanced grammar rules and write grammatically correct sentences.
2. Acquire wide vocabulary and learn strategies for error-free communication.
3. Comprehend language and improve speaking skills in academic and social contexts.
4. Improve listening skills so as to understand complex business communication in a variety of global English accents through proper pronunciation.
5. Interpret texts, diagrams and improve both reading and writing skills which would help them in their academic as well as professional career.

Module:1	Advanced Grammar	4 hours

Articles, Tenses, Voice and Prepositions
Activity: Worksheets on Impersonal Passive Voice, Exercises from the prescribed text

Module:2	Vocabulary Building I	4 hours

Idioms and Phrases, Homonyms, Homophones and Homographs
Activity: Jigsaw Puzzles; Vocabulary Activities through Web tools

Module:3	Listening for Specific Purposes	4 hours

Gist, monologues, short conversations, announcements, briefings and discussions
Activity: Gap filling; Interpretations

Module:4	Speaking for Expression	6 hours

Introducing oneself and others, Making Requests & responses, Inviting and Accepting/Declining Invitations
Activity: Brief introductions; Role-Play; Skit.

Module:5	Reading for Information	4 hours

Reading Short Passages, News Articles, Technical Papers and Short Stories
Activity: Reading specific news paper articles; blogs

Module:6	Writing Strategies	4 hours

Joining the sentences, word order, sequencing the ideas, introduction and conclusion
Activity: Short Paragraphs; Describing familiar events; story writing

Module:7	**Vocabulary Building II**	**4 hours**
Enrich the domain specific vocabulary by describing Objects, Charts, Food, Sports and Employment. Activity: Describing Objects, Charts, Food, Sports and Employment		
Module:8	**Listening for Daily Life**	**4 hours**
Listening for statistical information, Short extracts, Radio broadcasts and TV interviews Activity: Taking notes and Summarizing		
Module:9	**Expressing Ideas and Opinions**	**6 hours**
Telephonic conversations, Interpretation of Visuals and describing products and processes. Activity: Role-Play (Telephonic); Describing Products and Processes		
Module: 10	**Comprehensive Reading**	**4 hours**
Reading Comprehension, Making inferences, Reading Graphics, Note-making, and Critical Reading. Activity: Sentence Completion; Cloze Tests		
Module: 11	**Narration**	**4 hours**
Writing narrative short story, Personal milestones, official letters and E-mails. Activity: Writing an E-mail; Improving vocabulary and writing skills.		
Module:12	**Pronunciation**	**4 hours**
Speech Sounds, Word Stress, Intonation, Various accents Activity: Practicing Pronunciation through web tools; Listening to various accents of English		
Module:13	**Editing**	**4 hours**
Simple, Complex & Compound Sentences, Direct & Indirect Speech, Correction of Errors, Punctuations. Activity: Practicing Grammar		
Module:14	**Short Story Analysis**	**4 hours**
"The Boundary" by Jhumpa Lahiri Activity: Reading and analyzing the theme of the short story.		
	Total Lecture hours	**60 hours**

Text Book / Workbook

1.	Wren, P.C.; Martin, H.; Prasada Rao, N.D.V. (1973–2010). *High School English Grammar & Composition*. New Delhi: Sultan Chand Publishers.
2	Kumar, Sanjay,; Pushp Latha. (2018) English Language and Communication Skills for Engineers, India: Oxford University Press.

Reference Books

1.	Guptha S C, (2012) *Practical English Grammar & Composition*, 1st Edition, India: Arihant Publishers
2.	Steven Brown, (2011) Dorolyn Smith**,** *Active Listening* ***3,*** 3rd Edition, UK: Cambridge University Press.

3.	Liz Hamp-Lyons, Ben Heasley, (2010) *Study Writing*, 2nd Edition, UK: Cambridge University Pres.
4.	Kenneth Anderson, Joan Maclean, (2013) Tony Lynch, *Study Speaking*, 2nd Edition, UK: Cambridge, University Press.
5.	Eric H. Glendinning, Beverly Holmstrom, (2012) *Study Reading*, 2nd Edition, UK: Cambridge University Press.
6.	Michael Swan, (2017) *Practical English Usage* (Practical English Usage), 4th edition, UK: Oxford University Press.
7.	Michael McCarthy, Felicity O'Dell, (2015) *English Vocabulary in Use Advanced* (South Asian Edition), UK: Cambridge University Press.
8.	Michael Swan, Catherine Walter, (2012) *Oxford English Grammar Course Advanced*, Feb, 4th Edition, UK: Oxford University Press.
9.	Watkins, Peter. (2018) *Teaching and Developing Reading Skills: Cambridge Handbooks for Language teachers*, UK: Cambridge University Press.
10.	(*The Boundary by Jhumpa Lahiri)* URL: https://www.newyorker.com/magazine/2018/01/29/the-boundary?intcid=inline_amp

Mode of evaluation: Quizzes, Presentation, Discussion, Role play, Assignments and FAT

List of Challenging Experiments (Indicative)		
1.	Self-Introduction	**12 hours**
2.	Sequencing Ideas and Writing a Paragraph	**12 hours**
3.	Reading and Analyzing Technical Articles	**8 hours**
4.	Listening for Specificity in Interviews (Content Specific)	**12 hours**
5.	Identifying Errors in a Sentence or Paragraph	**8 hours**
6.	Writing an E-mail by narrating life events	**8 hours**
	Total Laboratory Hours	**60 hours**

Mode of evaluation: Quizzes, Presentation, Discussion, Role play, Assignments and FAT

Recommended by Board of Studies	08.06.2019	
Approved by Academic Council	55	Date: 13-06-2019

Course Code	Course Title	L	T	P	J	C
ENG1902	Technical English - II	0	0	4	0	2
Pre-requisite	71% to 90% EPT score	Syllabus Version				
		1				

Course Objectives:

1. To acquire proficiency levels in LSRW skills on par with the requirements for placement interviews of high-end companies / competitive exams.
2. To evaluate complex arguments and to articulate their own positions on a range of technical and general topics.
3. To speak in grammatical and acceptable English with minimal MTI, as well as develop a vast and active vocabulary.

Expected Course Outcome:

1. Communicate proficiently in high-end interviews and exam situations and all social situations
2. Comprehend academic articles and draw inferences
3. Evaluate different perspectives on a topic
4. Write clearly and convincingly in academic as well as general contexts
5. Synthesize complex concepts and present them in speech and writing

Module:1	Listening for Clear Pronunciation	4 hours

Ice-breaking, Introduction to vowels, consonants, diphthongs.
Listening to formal conversations in British and American accents (BBC and CNN) as well as other 'native' accents
Activity: Factual and interpretive exercises; note-making in a variety of global English accents

Module:2	Introducing Oneself	4 hours

Speaking: Individual Presentations
Activity: Self-Introductions, Extempore speech

Module:3	Effective Writing	6 hours

Writing: Business letters and Emails, Minutes and Memos
Structure/ template of common business letters and emails: inquiry/ complaint/ placing an order; Formats of Minutes and Memos
Activity: Students write a business letter and Minutes/ Memo

Module:4	Comprehensive Reading	4 hours

Reading: Reading Comprehension Passages, Sentence Completion (Technical and General Interest), Vocabulary and Word Analogy
Activities: Cloze tests, Logical reasoning, Advanced grammar exercises

Module:5	Listening to Narratives	4 hours

Listening: Listening to audio files of short stories, News, TV Clips/ Documentaries, Motivational Speeches in UK/ US/ global English accents.
Activity: Note-making and Interpretive exercises

Module:6	Academic Writing and Editing	6 hours

Writing: Editing/ Proofreading symbols
Citation Formats
Structure of an Abstract and Research Paper
Activity: Writing Abstracts and research paper; Work with Editing/ Proofreading exercise

Module:7	Team Communication	4 hours

Speaking: Group Discussions and Debates on complex/ contemporary topics
Discussion evaluation parameters, using logic in debates

Activity: Group Discussions on general topics		
Module:8	**Career-oriented Writing**	**4 hours**
Writing: Resumes and Job Application Letters, SOP Activity: Writing resumes and SOPs		
Module:9	**Reading for Pleasure**	**4 hours**
Reading: Reading short stories Activity: Classroom discussion and note-making, critical appreciation of the short story		
Module: 10	**Creative Writing**	**4 hours**
Writing: Imaginative, narrative and descriptive prose Activity: Writing about personal experiences, unforgettable incidents, travelogues		
Module: 11	**Academic Listening**	**4 hours**
Listening: Listening in academic contexts Activity: Listening to lectures, Academic Discussions, Debates, Review Presentations, Research Talks, Project Review Meetings		
Module:12	**Reading Nature-based Narratives**	**4 hours**
Narratives on Climate Change, Nature and Environment Activity: Classroom discussions, student presentations		
Module:13	**Technical Proposals**	**4 hours**
Writing: Technical Proposals Activities: Writing a technical proposal		
Module:14	**Presentation Skills**	**4 hours**
Persuasive and Content-Specific Presentations Activity: Technical Presentations		
	Total Lecture hours:	**60 hours**

Text Book / Workbook	
1.	Oxenden, Clive and Christina Latham-Koenig. *New English File: Advanced Students Book*. Paperback. Oxford University Press, UK, 2017.
2	Rizvi, Ashraf. *Effective Technical Communication*. McGraw-Hill India, 2017.

Reference Books	
1.	Oxenden, Clive 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. Oxford University Press, UK, 2013.
2.	Balasubramanian, T. *English Phonetics for the Indian Students: A Workbook*. Laxmi Publications, 2016.
3.	Philip Seargeant and Bill Greenwell, *From Language to Creative Writing*. Bloomsbury Academic, 2013.
4.	Krishnaswamy, N. *Eco-English*. Bloomsbury India, 2015.
5.	Manto, Saadat Hasan. *Selected Short Stories*. Trans. Aatish Taseer. Random House India, 2012.
6.	Ghosh, Amitav. *The Hungry Tide*. Harper Collins, 2016.
7.	Ghosh, Amitav. *The Great Derangement: Climate Change and the Unthinkable*. Penguin Books, 2016.
8.	*The MLA Handbook for Writers of Research Papers*, 8th ed. 2016.
	Online Sources: https://americanliterature.com/short-short-stories. (75 *short* short stories) http://www.eco-ction.org/dt/thinking.html (Leopold, Aldo."Thinking like a Mountain")

	https://www.esl-lab.com/; http://www.bbc.co.uk/learningenglish/; https://www.bbc.com/news; https://learningenglish.voanews.com/a/using-voa-learning-english-to-improve-listening-skills/3815547.html

Mode of evaluation: Quizzes, Presentation, Discussion, Role play, Assignments and FAT

List of Challenging Experiments (Indicative)		
1.	Self-Introduction using SWOT	**12 hours**
2.	Writing minutes of meetings	**10 hours**
3.	Writing an abstract	**10 hours**
4.	Listening to motivational speeches and interpretation	**10 hours**
5.	Cloze Test	**6 hours**
6.	Writing a proposal	**12 hours**
	Total Laboratory Hours	**60 hours**

Mode of evaluation: Quizzes, Presentation, Discussion, Role play, Assignments and FAT

Recommended by Board of Studies	08.06.2019	
Approved by Academic Council	55	Date: 13-06-2019

Course Code	Course title	L	T	P	J	C
ENG1903	Advanced Technical English	0	0	2	4	2
Pre-requisite	Greater than 90 % EPT score	Syllabus Version				
		1				

Course Objectives:

1. To review literature in any form or any technical article
2. To infer content in social media and respond accordingly
3. To communicate with people across the globe overcoming trans-cultural barriers and negotiate successfully

Expected Course Outcome:

1. Analyze critically and write good reviews
2. Articulate research papers, project proposals and reports
3. Communicate effectively in a trans-cultural environment
4. Negotiate and lead teams towards success
5. Present ideas in an effective manner using web tools

Module:1	Negotiation and Decision Making Skills through Literary Analysis	5 hours

Concepts of Negotiation and Decision Making Skills
Activity: Analysis of excerpts from Shakespeare's "The Merchant of Venice" (court scene) and discussion on negotiation skills.
Critical evaluation of excerpts from Shakespeare's "Hamlet"(Monologue by Hamlet) and discussion on decision making skills

Module:2	Writing reviews and abstracts through movie interpretations	5 hours

Review writing and abstract writing with competency
Activity: Watching Charles Dickens "Great Expectations" and writing a movie review
Watching William F. Nolan's "Logan's Run" and analyzing it in tune with the present scenario of depletion of resources and writing an abstract

Module:3	Technical Writing	4 hours

Stimulate effective linguistics for writing: content and style
Activity: Proofreading
Statement of Purpose

Module:4	Trans-Cultural Communication	4 hours

Nuances of Trans-cultural communication
Activity:
Group discussion and case studies on trans-cultural communication.
Debate on trans-cultural communication.

Module:5	Report Writing and Content Writing	4 hours

Enhancing reportage on relevant audio-visuals
Activity:
Watch a documentary on social issues and draft a report
Identify a video on any social issue and interpret

Module:6	Drafting project proposals and article writing	4 hours

Dynamics of drafting project proposals and research articles
Activity:
Writing a project proposal.

Writing a research article.		
Module:7	**Technical Presentations**	**4 hours**
Build smart presentation skills and strategies Activity: Technical presentations using PPT and Web tools		
	Total Lecture hours	**30 hours**
Text Book / Workbook		
1.	Raman, Meenakshi & Sangeeta Sharma. *Technical Communication: Principles and Practice*, 3rd edition, Oxford University Press, 2015.	
Reference Books		
1	Basu B.N. *Technical Writing*, 2011 Kindle edition	
2	Arathoon, Anita. *Shakespeare's The Merchant of Venice* (Text with Paraphrase), Evergreen Publishers, 2015.	
3	Kumar, Sanjay and Pushp Lata. *English Language and Communication Skills for Engineers*, Oxford University Press, India, 2018.	
4	Frantisek, Burda. *On Transcultural Communication*, 2015, LAP Lambert Academic Publishing, UK.	
5	Geever, C. Jane. *The Foundation Center's Guide to Proposal Writing*, 5th Edition, 2007, Reprint 2012 The Foundation Center, USA.	
6	Young, Milena. *Hacking Your Statement of Purpose: A Concise Guide to Writing Your SOP*, 2014 Kindle Edition.	
7	Ray, Ratri, *William Shakespeare's Hamlet*, The Atlantic Publishers, 2011.	
8	C Muralikrishna & Sunitha Mishra, *Communication Skills for Engineers*, 2nd edition, NY: Pearson, 2011.	
Mode of Evaluation: Quizzes, Presentation, Discussion, Role Play, Assignments		
List of Challenging Experiments (Indicative)		
1.	Enacting a court scene - Speaking	**6 hours**
2.	Watching a movie and writing a review	**4 hours**
3.	Trans-cultural – case studies	**2 hours**
4.	Drafting a report on any social issue	**6 hours**
5.	Technical Presentation using web tools	**6 hours**
6.	Writing a research paper	**6 hours**
J- Component Sample Projects		
1.	Short Films	
2.	Field Visits and Reporting	
3.	Case studies	
4.	Writing blogs	
5.	Vlogging	
	Total Hours (J-Component)	**60 hours**
Mode of evaluation: Quizzes, Presentation, Discussion, Role play, Assignments and FAT		
Recommended by Board of Studies	08.06.2019	
Approved by Academic Council	55	Date: 13-06-2019

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
MAT1011	Calculus for Engineers	3	0	2	0	4
Pre-requisite	NIL	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, 2014, 13th edition, Pearson.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 2015, 10th Edition, Wiley India.

Reference Books

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

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

Reference books

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

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. Steve Blank, K & S Ranch, The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company, March 1, 2012, 1st edition.
2. Steve Blank, K&S Ranch, The Four Steps to the Epiphany, July 17, 2013, 2nd edition.
3. Eric Ries, The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create

	Radically Successful Businesses, 13 September 2011, Crown Business

Reference Books

1. Steve Blank, Holding a Cat by the Tail, August 14, 2014, K&S Ranch Publishing LLC.
2. Karal T Ulrich, SD Eppinger, Product Design and Development, McGraw Hill
3. Peter Thiel, Zero to One: Notes on Startups, or How to Build the Future, 2014, Crown Business
4. Alistair Croll & Benjamin Yoskovitz, O'Reilly Media, Lean Analytics: Use Data to Build a Better Startup Faster (Lean Series), March 21, 2013, 1st Edition.
5. Marty Cagan, Inspired: How To Create Products Customers Love, June 18, 2008, SVPG Press; 1st edition.

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			
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
2. Hill. 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 Learning Private Ltd.
5. S. Nagabhushana and B. Sathyanarayana, Lasers and Optical Instrumentation, 2010, I.K. International Publishing House Pvt. Ltd.,
6. R. Shevgaonkar, Electromagnetic Waves, 2005, 1st Edition, Tata McGraw Hill
7. Principles of Electromagnetics, Matthew N.O. Sadiku, 2010, Fourth Edition, Oxford.
8. 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 –	2 hrs

	Spectrometer	
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
PHY1901	Introduction to Innovative Projects	1	0	0	0	1
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. Edward debone, How to have Creative Ideas, 2007, Vermilon publication, UK. 2. Tom Kelley & Jonathan Littman, The Art of Innovation, 2008, Profile Books Ltd, UK.		
Reference Books		

1. Meribeth Bonct, Creating Confidence, 2000, Keogan Page India Ltd, New Delhi.
2. Paul Sloane, Lateral Thinking Skills, 2008, Keogan Page India Ltd, New Delhi.
3. Akhat Agrawal, Indian Innovators, 2015 Jaico Books, Mumbai.
4. Navi Radjou, Jaideep Prabhu, Simone Ahuja, JUGAAD Innovation, 2012. Random house India, Noida.

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:

- 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
6. 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**

Strengthening 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:

- 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
Maximizing 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, Bangalore.

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, Bangalore.
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 you 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:

- 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

10 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

Programme Core (PC)

Course Code	Course Title	L	T	P	J	C
ECE1001	Fundamentals of Electrical Circuits	2	0	2	0	3
Pre-requisite	None	Syllabus Version				
		1.0				

Course Objectives:

1. To develop an understanding of the fundamental laws, theorems, elements of electric circuits and to analyze dc and ac circuits.
2. To develop an ability to analyze magnetic circuits.
3. To understand transient response behaviour of electric circuits.
4. To simulate the circuits using software tools and compare their output with hard-wired circuitry.

Course Outcomes:

1. Comprehend and analyze dc and ac electric circuits using circuital laws.
2. Apply various network theorems to determine the response of the circuit.
3. Demonstrate a basic understanding of transient behavior of RL, RC and RLC circuits
4. Reflect the understanding of the sinusoidal steady state behavior of electric networks and determine power in these circuits.
5. Estimate complex power and understand resonance in ac circuits.
6. Compare electric and magnetic circuits and analyze the given magnetic circuit.
7. Demonstrate basic proficiency in building simple electrical circuits and operating fundamental electrical engineering equipment.

Module:1	DC Circuit Analysis	4 hours

Terminologies, Ohms law, Kirchhoff's laws, Series- parallel circuits, voltage & current division, star-delta conversion. Node voltage analysis, Mesh current analysis, special cases.

Module:2	Network Theorems	5 hours

Source transformation, Superposition theorem, Thevenin's& Norton's theorems, Reciprocity and Maximum power transfer theorem

Module:3	First-Order Transient Circuits	3 hours

Time response in inductance (L) and capacitance (C). Steady state response of circuits with RLC components. Response (forced & natural) of first order circuits (RL & RC): Series, parallel, source free, complex circuits with more than one resistance, power sources and switches.

Module:4	Second-Order Transient Circuits	3 hours

Response of second order circuit (RLC): Series, parallel and complex circuits.

Module:5	AC Circuit Analysis	5 hours

Wave form analysis: Average value, root mean square value, Phasor representation of alternating quantities, Concept of j-operator, Steady state AC circuit analysis for R, L, C, RL, RC & RLC series and parallel circuits.

Module:6	Complex Power and Resonance	4 hours

Concept of complex power and its calculation, Series and parallel resonance condition

Module:7	Magnetic Circuits	4 hours

Introduction to magnetic field, analogy between electrical & magnetic circuits. Analysis of magnetic circuits: Series, parallel; Magnetic materials, B-H curve. Electromagnetic induction Self & mutual inductance, Transformers

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

Text Book(s)	
1.	Charles K. Alexander, Matthew N. O. Sadiku, Fundamentals of Electric Circuits, 2017, Sixth Edition, Tata McGraw Hill Education Private Limited, India.
2.	Abhijit Chakrabarti, Circuit Theory Analysis and Synthesis, 2018, Seventh Edition, Dhanpat Rai and Co.
Reference Books	
1.	W.H.Hayt, J.E.Kemmerly & S.M.Durbin, Engineering Circuit Analysis, 2019, Ninth Edition, McGraw Hill Education, New Delhi, India.
2.	Allan R. Hambley, Electrical Engineering – Principles & Applications, 2017, Seventh Edition, Pearson Education, Noida, India.

Mode of Evaluation: Internal Assessment(CAT , Quizzes, Digital Assignments) & Final Assessment Test (FAT)

List of Challenging Experiments (Indicative)		
1.	Design a resistive circuit to derive the specified load voltage and load current from a DC power source.	2 hours
2.	Build and test the voltage across and the current through any element using appropriate circuit analysis techniques.	2 hours
3.	Build and test the voltage across and the current through any element driven by more than one source.	2 hours
4.	Build a circuit with appropriate number of nodes with a variable load and determine the voltage and current.	2 hours
5.	Design a circuit topology having star/delta connected network and determine the resistance at which the maximum brightness of the LED (Load device) occurs.	2 hours
6.	For a given time constant, design a RL/RC circuit. Determine its current/voltage response and analyse the step response and the source free response of your circuit with initial conditions.	4 hours
7.	Design a temporary power source using energy storage elements and determine the capacity of the power source.	2 hours
8.	For various damping conditions, design and build a system having second order RLC circuit and deduce the transient responses.	2 hours
9.	Design a phase shifter circuit for a given phase shift and validate its phasor diagram.	2 hours
10.	For a given reactive load (Inductive/Capacitive), determine the power factor of the load.	4 hours
11.	Design a radio tuner circuit which tunes to a given frequency using a toroid.	2 hours
12.	Construct and validate the step-up /step-down behavior of the transformer.	4 hours
	Total laboratory hours	**30 hours**

Mode of Assessment: Continuous Assessment & Final Assessment Test (FAT)

Recommended by Board of studies	13-12-2015		
Approved by Academic Council	No. 47	Date	05-10-2017

Course Code	Course Title	L	T	P	J	C
ECE1002	Semiconductor Devices and Circuits	3	0	2	0	4
Prerequisite:	None	Syllabus Version				
		2.1				

Course Objectives:

1. To give the students a solid background of solid-state devices.
2. To apply the inculcated knowledge for developing simple electronic circuits.
3. To use BJT and MOSFET in different configurations and study their parameters under various biasing schemes
4. To simulate the circuits using EDA tools and verify their theoretical output with hard-wired circuitry results

Course Outcomes:

1. Understand the semiconductor physics of the intrinsic and extrinsic materials
2. Comprehend the characteristics of the various P-N junction diode and special diodes.
3. Able to analyze the diode with different DC and AC models.
4. Construct electronic circuits using the PN junction diode for various applications.
5. Comprehend the impact of terminal voltages over the current using the BJT and MOSFET devices characteristics.
6. Design and analysis of BJT and MOSFET in different configurations and study their parameters with various biasing schemes for suitable applications.
7. Analyze the current–voltage characteristics of various semiconductor devices and their digital logic implementations.

Module:1	Semiconductor Fundamentals	8 hours

Formation of energy bands, Fermi level, energy- band models, direct and indirect band gap, electrons and holes, doping, intrinsic and extrinsic semiconductors, elemental and compound semiconductor, generation, recombination and injection of carriers, Drift and Diffusion of carriers, basic governing equations in semiconductors , Transport Equations

Module:2	PN Junction Diodes	6 hours

PN Junctions, Formation of Junction, Physical operation of diode, Contact potential and Space Charge phenomena, I - V Characteristics, Zener diode, Physical operation of special diodes (Tunnel diode, LED, OLED, Varactor diode and Photo Diode).

Module:3	Diode Circuits	3 hours

DC Analysis – Small Signals and Large signal models of PN junction diode and AC equivalent circuit.

Module:4	Diode Applications	4 hours

Rectifier circuits, Clipper and Clamper circuits, Photodiode and LED circuits.

Module:5	Transistors- Device Perspective	8 hours

Bipolar Junction Transistor: Device structure and physical operation, current – voltage characteristics.

Field Effect Transistor (FET): MOS Capacitor: Device Structure and mode of operation, C- V Characteristics, Threshold Voltage.

Module:6	Transistors- Circuits Perspective	8 hours

Bipolar Junction Transistor: DC Analysis of BJT Circuits, CB, CE and CC Configuration, Biasing BJT Circuits, Switch.

Field Effect Transistor (FET): DC Analysis of MOSFET Circuits, biasing circuits.

Module:7	**Applications of MOSFETs**	**6 hours**
CMOS device structure, characteristics, gates and inverters. MOSFET CS, CG and Source Follower Circuits.		
Module:8	**Contemporary Issues**	**2 hours**
	Total lecture hours:	**45 hours**

Text Books:

1.	Adel S. Sedra, Kenneth C. Smith & Arun N. Chandorkar, Microelectronic Theory and Applications, 2013, Fifth edition, Reprint, Oxford University press, New York, USA.
2.	B G.Streetman and S.Banerjee, Solid State Electronic Education, 2015, Seventh edition, New Delhi, India.

Reference Books:

1.	Jacob Millman, Christos C Halkias and Satyabrata Jit, Electronic devices and circuits, 2015, Fourth edition, Tata Mc Graw Hill, New delhi, India.

Mode of Evaluation: : Internal Assessment(CAT , Quizzes, Digital Assignments) & Final Assessment Test (FAT)

Sl.No.	**List of Challenging Experiments (Indicative):**	
1	Design a circuit to measure the cut-in and reverse breakdown voltages of a diode.	2 hours
2	Design a circuit to measure the cut-in and regulation region voltages of a Zener diode.	2 hours
3	Construct a circuit to convert alternating voltage into unidirectional pulsating voltage using an uncontrolled single device diode.	2 hours
4	Construct a circuit to convert alternating voltage into unidirectional voltage using an uncontrolled two diodes. Also apply the capacitor filter to obtain the smoothened DC voltage.	4 hours
5	Construct a circuit to perform controlled clipping of positive half-cycle / negative half-cycle.	2 hours
6	Construct a circuit to perform controlled level shifting of positive half-cycle / negative half-cycle.	2 hours
7	Design a circuit to measure the operating regions of LED and Photodiode.	2 hours
8	Construct a circuit to measure and plot the input / output characteristics of a transistor for calculating h-parameters under CB / CE / CE configurations.	4 hours
9	Design a circuit to measure and plot the DC and AC Load-Line Analysis of a Transistor.	2 hours
10	Construct a circuit to amplify the low level signal using a Transistor as an Amplifier under CE configuration.	2 hours
11	Design a circuit to measure and plot the drain and transfer characteristics of a FET.	2 hours
12	Design a circuit to realize logic Gates using CMOS devices.	4 hours
	Total Laboratory Hours:	**30 hours**

Mode of Evaluation: Internal Assessment & Final Assessment Test (FAT)

Recommended by Board of Studies	28-02-2016		
Approved by Academic Council	No. 47	Date	05-10-2017

Course Code	Course Title	L	T	P	J	C
ECE1003	Electromagnetic Field Theory	3	0	0	0	3
Pre-requisite	PHY1701 – Engineering Physics	Syllabus Version				
		2.1				

Course Objectives:

1. To provide insight on vector and scalar analysis.
2. To analyze the electric field intensity and develop the boundary conditions between two different mediums in the electric field.
3. To analyze the magnetic field intensity and current, and develop the boundary conditions between two different mediums in the magnetic field.
4. To understand the Maxwell equations and uniform plane wave propagation for the time-varying electric and magnetic fields.

Course Outcomes:

1. Derive and convert the coordinate system in space.
2. Derive the electric flux density from the Gauss's law and define potential and potential gradient.
3. Describe the current and current density from Ohm's law.
4. Solve the capacitance problem using Poisson's equations and Laplace's equations and the boundary conditions between two different media of different dielectrics.
5. Solve different problems on forces and torques on a closed circuit.
6. Understand the time-varying electric and magnetic fields and plane wave propagation.

Module:1	Vector Analysis	5 hours

Cartesian, cylindrical, and spherical coordinate systems. Divergence, gradient, curl, Laplacian – Stokes' theorems.

Module:2	Electrostatics	8 hours

Coulomb's Law, Electric field intensity – Field due to the continuous line, surface, and volume charges - Electric flux density – Gauss Law – Energy expended in moving a charge in an electric field, Potential & potential gradient, Electric Dipole.

Module:3	Electrostatic boundary conditions	6 hours

Current and Current Density, Resistance. Dipole moment – Polarization - Properties & boundary conditions of metallic conductors, semiconductors and dielectrics, Laplace and Poisson's equations.

Module:4	Electrostatic boundary value problems	4 hours

Capacitance – Uniqueness Theorem- Method of images.

Module:5	Magnetostatics	8 hours

Biot-Savart's law, Magnetic field intensity, Ampere's circuital law, Magnetic flux and flux density. Magnetic scalar and vector potentials.

Module:6	Magnetostatic Force and boundary conditions	6 hours

Force on a moving charge (Lorentz force), force on a differential current element, and force between differential current elements, Boundary conditions - Inductance and mutual inductance.

Module:7	Time-varying Electromagnetic field	6 hours

Faraday's law, Lenz's law, Displacement current, Maxwell's equations in point and integral forms. Plane waves in free space, dielectrics, and conductors, Power and Poynting vector, Wave polarization: linear, elliptic, and circular polarizations

Module:8	**Contemporary issues**	**2 hours**
	Total lecture hours:	**45 hours**

Text Books	
1.	William Hayt and John Buck, Engineering Electromagnetics, 2012, Eighth edition, Tata McGraw Hill, New Delhi, India.
2.	Mathew O Sadiku, Elements of Electromagnetics, 2014, Sixth edition, Oxford University Press, New York, USA.
Reference Books	
1.	D K Cheng, Field and Wave Electromagnetics, 2013, Second edition revised, Pearson Education, Noida, India.
2.	David. J. Griffiths, Introduction to Electrodynamics, 2014, Fourth edition, Pearson Education, Noida, India.
3.	Constantine A. Balanis, Advanced Engineering Electromagnetics, 2012, Second edition, Wiley, New Jersey, USA.

Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)			
Recommended by Board of Studies	28-02-2016		
Approved by Academic Council	No. 47	Date	05-10-2017

Course Code	Course Title	L	T	P	J	C
ECE1004	Signals and Systems	2	0	0	4	3
Pre-requisite	MAT1011 - Calculus for Engineers	Syllabus version				
		2.0				

Course Objectives:

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

Course Outcomes:

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

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

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

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

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

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

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

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

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

Module:5	Convolution and Correlation	4 hours

Continuous-time convolution, Convolution sum, Correlation between signals, Cross correlation, Autocorrelation, Energy spectral density, Power spectral density

Module:6	System Analysis using Laplace transform	5 hours

Relation between Laplace and Fourier transforms, Properties, Inverse Laplace transform, Solution to differential equations using Laplace transform, Region of convergence, Stability analysis.

Module:7	System Analysis using z-Transform	5 hours

z-transform, Properties, s-plane to z-plane mapping, Inverse z-transform, Solution to difference

equations using z-transform, Region of convergence, Stability analysis.		
Module:8	**Contemporary Issues**	**2 hours**
	Total lecture hours:	**30 hours**

Text Book

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

Reference Books

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

Mode of Evaluation: Internal Assessment(CAT , Quizzes, Digital Assignments) & Final Assessment Test (FAT)

Typical Projects

1. a) Prove any five Fourier series properties for continuous time signals.
   b) Write a Matlab script to generate and plot the following discrete time signals for $-10 \le n \le 10$. Also compute their energies and display them on command prompt.
   a) i) $\delta(n)$ ii) $\delta(n-2)$ iii) $\delta(n+3)$
   b) i) $u(n)$ ii) $u(n-3)$ iii) $u(n+4)$
   c) i) $r(n)$ ii) $r(n-3)$ iii) $r(n+2)$
2. a) Analysis of Power spectral density for deterministic signals and random signal.
   b) Let $x(n) = \{1, 4, \underset{\uparrow}{3}, 5, 7, 6, 5, 4\}$. Write a Matlab script to determine and plot the following sequences. (select suitable time scale)
   i) $y(n) = 3x(n+2) - x(n-2)$
   ii) $y(n) = x(n)x(n-2)$
   iii) $y(n) = x(4-n) + x(n)x(n+2)$
3. a) Write a Matlab script to generate and plot the following discrete time signals for $-10 \le n \le 10$. Also compute their energies and display them on command prompt.
   i) $x(n) = (0.8)^{n-1}$
   ii) $x(n) = \exp((1+j)*n)$ (plot the magnitude, phase, real and imaginary parts on four different subplots)
   iii) $x(n) = 2\delta(n-2) - \delta(n+4)$
   iv) $x(n) = \dfrac{5\sin\left(\frac{\pi}{2}n\right)}{\pi n}$
   b) Prove any five Fourier series properties for discrete time signals.
4. a) Perceval's theorem for both Continuous and discrete time signals in Fourier transform.
   b) Let $x(n) = u(n) - u(n-10)$. Write a Matlab script to decompose $x(n)$ into even and odd components and plot them on two separate subplots.
5. a) Convolution for both Continuous and discrete time signals.
   b) Generate and plot the signal: $x(t) = \sin(2\pi t)$, for $0 \le t \le 2$ with an increment of 0.01. Find the scaled versions of $y_1(t) = x\left(\frac{t}{2}\right)$ & $y_2(t) = x\left(\frac{t}{16}\right)$ and plot them.

6. a) Correlation for both Continuous and discrete time signals.
   b) The sinusoidal Fourier series of any periodic continuous waveform with period 'T=1 sec' is given by.

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

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

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

7. a) Prove any five Fourier transforms properties for discrete time signals.
   b) The sinusoidal Fourier series of any periodic continuous waveform with period 'T=1 sec' is given by.

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

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

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

8. a) Analysis of system stability and causality issues in Z-Transform.
   b) The sinusoidal Fourier series of any periodic continuous waveform with period 'T=1 sec' is given by.

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

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

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

9. a)Consider the difference equation of a causal system: $y(n) - y(n-1) + 0.9y(n-2) = x(n)$ for all n
   I) Calculate and plot the impulse response $h(n)$ for $-20 \le n \le 100$
   II) Calculate and plot the unit step response $s(n)$ for $-20 \le n \le 100$
   III) Find out the stability of the system.
   b) Let $x(n) = u(n) - u(n-9)$ and $h(n) = (0.9)^n$. Write a Matlab script to find out the linear convolution of $y(n) = x(n) * h(n)$ and plot $x(n), h(n)$ and $y(n)$ in different subplots.

10. a) Evaluate the DTFT of $x(n) = (0.9)^n u(n)$, at 512 equidistant points between $[-\pi, \pi]$ and plot its magnitude, phase, real and imaginary parts on four different subplots. Extend the computation to 1024 equidistant points between $[\pi, 5\pi]$, and observe its periodicity and conjugate symmetry properties by plotting suitable plots.
    b) Study the characteristics of EEG signal.

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

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

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

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

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

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

(Half wave Rectified sine wave)

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

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

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

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

Mode of Evaluation: Review I, Review II and Review III			
Recommended by Board of Studies	28-02-2016		
Approved by Academic Council	No. 47	Date	05-10-2017

Course Code	Course Title	L	T	P	J	C
ECE1005	Sensors and Instrumentation	1	0	0	4	2
Pre-requisite	PHY1701 – Engineering Physics	Syllabus Version				
		2.0				

Course Objectives:

1. To provide basic understanding of measurement and instrumentation systems.
2. To gain knowledge about the variety of measuring instruments, their methods of measurement and the use of different sensors.
3. To analyse the concepts associated with multiple sensors and its sensing mechanism.
4. To apply the ideas towards the realization of various sensor applications.

Course Outcomes:

1. Differentiate between the types of sensors available
2. Characterize and mathematically model a sensor
3. Analyze different resistive sensors and utilize them for suitable applications
4. Analyze various inductive and capacitive sensors, and utilize them for suitable applications
5. Select a sensor for particular application
6. Recommend appropriate instrumentations for specific application
7. Apply the knowledge about the measuring instruments to use them more effectively.

Module:1	**Measurement Concepts and Classification of Sensors**	**1 hour**
General concepts and terminology of measurement systems, Sensors and transducers, Classification of sensors.		
Module:2	**Characteristics of Sensors**	**2 hours**
Static and dynamic characteristics, Mathematical model of sensor – Zero, I and II order.		
Module:3	**Variable Resistance Sensors**	**2 hours**
Resistive potentiometric, Strain gauge, Thermistor, Light dependent resistor.		
Module:4	**Variable Inductance and Variable Capacitance Sensors**	**2 hours**
Linear variable differential transformers (LVDT), Characteristics and applications of LVDT, Capacitive sensor.		
Module:5	**Special Purpose Sensors**	**2 hours**
Piezoelectric sensor, Ultrasonic sensor, Hall effect sensor.		
Module:6	**Introduction to Instrumentation**	**2 hours**
Fundamental concepts, Types of instruments, Calibration and standard.		
Module:7	**Electrical Measurement Instruments**	**2 hours**
Current and voltage measurement instruments – Moving coil, Moving iron, Rectifier type.		
Module:8	**Contemporary issues**	**2 hours**
	Total lecture hours:	**15 hours**

Text Books

1. A.K. Sawhney, Puneet Sawhney, A Course in Electrical and Electronic Measurements and Instrumentation, 2014, Dhanpat Rai and Co. (P) Ltd., New Delhi, India.
2. Ramon Pallas-Areny, John G. Webster, Sensors and Signal Conditioning, 2012, Wiley, India.

Reference Books	
1.	Albert D. Helfrick and William D. Cooper, Modern Electronic Instrumentation and Measurement Techniques, 2016, First Edition, Pearson Education, Noida, India.
2.	David A. Bell, Electronic Instrumentation and Measurements, 2013, Third Edition, Oxford University Press, New Delhi, India.
3.	Ernest O Doebelin and Dhanesh N. Manik, Measurement Systems, 2017, Sixth Edition, McGraw Hill Education, New delhi, India.
4.	H.S. Kalsi, Electronic Instrumentation, 2017, Third Edition, McGraw Hill Education, New delhi, India.
5.	Patranabis D, Sensors And Transducers, 2011, Second Edition (Reprint), Phi, New delhi, India.

Mode of Evaluation: Internal Assessment(CAT , Quizzes, Digital Assignments) & Final Assessment Test (FAT)

Typical Projects

1. Electronic Nose for IoT
2. Monitoring Room Temperature
3. Pressure Monitoring
4. Reverse Car Parking System for IoT
5. Water Tank Level Control for IoT
6. Humidity Measurement
7. Air Quality Measurement for IoT
8. Heart Beat Measurement
9. Fall Detection System

Mode of Evaluation: Review I, II and III.

Recommended by Board of Studies	13-12-2015		
Approved by Academic Council	No. 47	Date	05-10-2017

Course Code	Course Title	L	T	P	J	C
ECE2001	Network Theory	3	0	0	0	3
Pre-requisite	ECE1001 Fundamentals of Electrical Circuits	Syllabus Version				
		2.1				

Course Objectives:

1. To analyze the given electrical network using phasors and graph theory.
2. To introduce the basic knowledge of Laplace transform, Fourier Transform and Fourier series and to analyze the network using suitable technique
3. To analyze the two-port networks, passive filters, and attenuators

Course Outcomes:

1. Apply the knowledge of various circuit analysis techniques such as mesh analysis, nodal analysis, and network theorems to investigate the given network
2. Able to solve the networks using graphical approach
3. Able to analyze the given network by transforming from time domain to S domain
4. Express the periodic sources using Fourier series and simplify the analysis using phasor approach
5. Analyze the given network by transforming from time domain to frequency domain
6. Design and analyze two-port networks, passive filters and attenuators

Module:1	**Sinusoidal Steady -State Analysis**	**7 hours**
Review of steady state sinusoidal analysis using phasors. Node voltage and Mesh current analysis, special cases. Network theorems: Superposition, Thevenin, Norton and maximum power transfer theorems.		
Module:2	**Network Graphs**	**6 hours**
Definition of terms. Matrices associated with graphs: incidence, reduced incidence, fundamental cut-set and fundamental tie-set.		
Module:3	**Circuit Analysis in the S domain**	**6 hours**
Introduction to Laplace transform (LT), poles, zeros and transfer functions. Analysis of circuits subjected to periodic and aperiodic excitations using Laplace transforms.		
Module:4	**Application of Fourier series in Circuit Analysis**	**5 hours**
Trigonometric Fourier series, Symmetry conditions, Applications in circuit solving		
Module:5	**Application of Fourier transforms in Circuit Analysis**	**5 hours**
Fourier transforms. Properties, Applications in circuit solving, Comparisons of Fourier and Laplace transforms.		
Module:6	**Two-Port Networks**	**7 hours**
Significance and applications of one port and two port networks. Two port network analysis using Admittance (Y) parameters, Impedance (Z) parameters and Hybrid (h) parameters. Interconnection of Two port networks.		
Module:7	**Principles of Filters, Attenuators and equalizers**	**7 hours**
Concept of filtering. Filter types: Low pass, High pass, Band pass and Band stop and their Characteristics. Design of T-type, π-type, Lattice and Bridged-T attenuator, Equalizers.		
Module:8	**Contemporary Issues**	**2 hours**
	Total lecture hours:	**45 hours**

Text Book(s)

1. Charles K. Alexander, Matthew N. O. Sadiku, Fundamentals of Electric Circuits, 2013, Fifth Edition, Tata McGraw Hill Education Private Limited, New Delhi, India.

Reference Books			
1.	W.H.Hayt, J.E.Kemmerly & S.M.Durbin, Engineering Circuit Analysis, 2013, Eighth Edition, McGraw Hill Education, New Delhi, India.		
2.	Allan R. Hambley, Electrical Engineering – Principles & applications, 2016, Sixth Edition, Pearson Education, Noida, India.		
Mode of Evaluation: Internal Assessment(CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)			
Recommended by Board of Studies	28-02-2016		
Approved by Academic Council	No. 47	Date	05-10-2017

Course Code	Course Title	L	T	P	J	C
ECE2002	Analog Electronic Circuits	2	0	2	4	4
Prerequisite:	ECE1002 - Semiconductor Devices and Circuits	Syllabus Version				
		2.0				

Course Objectives:

1. To design BJT and FET amplifiers with parasitic, coupling and bypass capacitors and understand the effect of capacitances in its frequency response.
2. To understand the operation and design of various classes of power amplifier circuits
3. To introduce MOSFET active biasing and to design a MOSFET differential amplifier and analyze its frequency response.
4. To discuss the effects of negative feedback on amplifier circuits and study the different types of oscillator circuits.

Course Outcomes:

1. Design simple electronic circuits based on diodes.
2. Design a BJT and MOSFET amplifier for the given specifications and analyze the transient, frequency response.
3. Distinguish different classes of power amplifiers and employ it.
4. Classify the different current mirrors based on the biasing.
5. Illustrate MOSFET-based differential amplifiers with active biasing and its frequency response.
6. Construction of feedback amplifier and oscillator circuit for the given specifications.
7. Understand the contemporary issues related to analog electronic circuits.
8. Design, simulation, modeling and hardware implementation of analog circuits with discrete components.

Module:1	Diode Frequency Response:	3 hours

Diode Capacitance Low and High frequency Response of diode

Module:2	BJT Internal Capacitances & High Frequency Model:	4 hours

Diffusion capacitance, B-E junction capacitance, C-B junction capacitance, BJT high frequency hybrid- model, frequency response of a CE amplifier, the three frequency bands.

Module:3	MOSFET Internal Capacitances & High Frequency Model:	4 hours

MOS junction capacitances, high frequency model, unity gain frequency, frequency response of a CS amplifier, the three frequency bands.

Module:4	Power Amplifiers:	4 hours

Preview – Power Amplifiers, Power Transistors, Classes of Amplifiers, Class A Power Amplifiers, Class B, Class AB Push-Pull Complementary Output Stages

Module:5	MOSFET Active Biasing:	3 hours

Introduction to Current Mirror – Basic, Wilson and Cascode Current Mirror.

Module:6	MOS Differential Amplifiers:	5 hours

MOSFET Basic Differential Pair, Large Signal and Small Signal Analysis of Differential Amplifier, Differential Amplifier with Active Load, Differential Amplifier Frequency Response.

Module:7	**MOS Feedback Amplifiers and Oscillators:**	**5 hours**
Introduction to Feedback, Basic Feedback Concepts, Ideal Feedback Topologies - Series – Shunt ,Shunt - Series, Series - Series, Shunt - Shunt Amplifiers. Barkhausen Criterion, Hartley, Colpitt's, RC Phase Shift Oscillators.		
Module:8	**Contemporary Issues**	**2 hours**
	Total lecture hours:	**30 hours**

Text Books:	
1.	Adel S. Sedra, Kenneth C. Smith & Arun N. Chandorkar, Microelectronic Circuits: Theory and Applications, 2014, 7/e, Oxford University Press, New York.
2.	Donald A Neamen, Microelectronics: Circuit Analysis and Design, 2010, Edition 4.
Reference Books:	
1.	P. Malvino, D. J. Bates,Electronic Principles, 2017, 7/e, Tata McGraw-Hill.
2.	R. L. Boylestadad L. Nashelsky Electronic Devices and Circuit Theory, 2015, 11/e, Pearson Education.

Mode of evaluation: Internal Assessment(CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

List of Challenging Experiments (Indicative)

Simulation Tool used in Experiments : Multisim

Hardware components used in experiments : discrete R,L,C components, BJT, MOSFET, bread board, Signal Generator, Oscilloscope etc

Concepts studied in all the modules should have been used

1	Introduction to hardware workbench and multisim software simulation tool.	3 hours
2	Design of the Amplifiers for the given frequency Specifications and conduct frequency response analysis using BJT Single Stage Amplifier	3 hours
3	Design of the Amplifiers for the given frequency Specifications and conduct frequency response analysis using MOS Single Stage Amplifier	3 hours
4	Design of Power Amplifiers for the given Specifications using BJT Class B Power Amplifiers.	3 hours
5	Design of Power Amplifiers for the given Specifications using BJT Class AB Power Amplifiers.	3 hours
6	Design of the Amplifiers for the given frequency Specifications and conduct frequency response analysis using MOS Differential Amplifiers.	3 hours
7	Design of Feedback Amplifiers for the given Specifications- Shunt Series Feedback Amplifier.	3 hours
8	Design of Feedback Amplifiers for the given Specifications- Series Shunt Feedback Amplifier.	3 hours
9	Design of Oscillators for the given Specifications - RC Phase shift Oscillators.	3 hours
10	Design of Oscillators for the given Specifications - Colpitt's and Hartley Oscillator	3 hours
	Total laboratory hours	30 hours

Mode of assessment: Continuous Assessment & Final Assessment Test (FAT)

Typical Projects			
• Laser Based Transmitter And Receiver • FM Spy Audi Transmitter • DTMF Based Automation System • Cellphone Controlled Home Appliances Without Microcontroller • Bluetooth Controlled Car • DTMF Controlled Landrover • MOSFET Audio Equalizer Circuit • Mini UPS System • BJT Subwoofer Power Amplifier • Design of Low Power Emergency Light Circuit			
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
ECE2003	Digital Logic Design	2	0	2	0	3
Prerequisite:	ECE1002 – Semiconductor Devices and Circuits	Syllabus version 1.01				

Course Objectives:

1. To represent logical functions in canonical and standard forms
2. To design and analyse the combinational logic circuits
3. To design and analyse the sequential logic circuits
4. To implement combinational and sequential logic circuits using Verilog HDL

Course Outcome:

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

1. Understand the number systems and IC characteristics
2. Understand the Boolean algebra and its properties
3. Optimize the logic functions using K-map
4. Design and analyse the combinational logic circuits
5. Get grip on Verilog HDL syntax
6. Design and analyse the sequential logic circuits
7. Implement and simulate the combinational logic circuits using Verilog HDL

Module:1	Number systems and Logic Families:	3 hours

Brief review of Number Systems, Digital Logic Gates and its electrical characteristics, Review of RTL, DTL, TTL, ECL, CMOS families.

Module:2	Boolean algebra:	2 hours

Basic Definitions, Axiomatic Definition of Boolean Algebra, Basic Theorems and Properties of Boolean Algebra, Boolean Functions, Canonical and Standard Forms.

Module:3	Gate-Level Minimization:	3 hours

The Map Method - K-map, Product of Sums and Sum of Products Simplification, NAND and NOR Implementation

Module:4	Design of Combinational Logic Circuits:	5 hours

Design Procedure, Binary Adder-Subtractor, Parallel Adder, Binary Multiplier, Magnitude Comparator-4 bit, Decoders, Encoders, Multiplexers, De-multiplexer, Parity Generator and Checker. Application of Multiplexers and De-multiplexers.

Module:5	Verilog HDL Coding Style:	4 hours

Lexical Conventions, Ports and Modules, Gate Level Modelling, Operators, Data Flow Modelling, Behavioral level Modelling, Testbench.

Module:6	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:7	**Modelling of Logic Circuits:**	**5 hours**
Modelling of Combinational and Sequential Logic Circuits using Verilog HDL.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture Hours:	**30 hours**

Text Books:

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, India.

Reference Books:

1.	Charles H. Roth, Jr., Fundamentals of Logic Design, 2014, 7th Edition Reprint, Brooks/Cole, Pacific Grove, US.
2.	Michael D. Ciletti, Advanced Digital Design with the Verilog HDL, 2011, 2nd Edition, Pearson Pvt. Ltd, Noida, India.
3.	Stephen Brown and ZvonkoVranesic, Fundamentals of Digital Logic with Verilog Design, 2013, Third Edition, McGraw-Hill Higher Education, New Delhi, India.

Mode of evaluation: Internal Assessment(CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

Sl. No.	**List of Challenging Experiments (Indicative)**	
1	Characteristics of Digital ICs (Hardware)	4 hours
2	Implementation of Combinational Logic Design using MUX/Decoder ICs (Hardware)	4 hours
3	Design and Implementation of various data path elements Adders/Multipliers (Hardware)	4 hours
4	Design and Implementation of various data path elements like Adders/Multipliers and combinational Logic circuits like Multipliers (Mandatory: Verilog Modeling, Simulation and Synthesis. FPGA implementation (optional)	6 hours
5	Design and implementation of simple synchronous sequential circuits like Counters / Shift registers (Hardware)	2 hours
6	Complex state machine design (Simulation and Synthesis)	4 hours
7	Simple processor design (Simulation and Synthesis)	6 hours
	Total laboratory hours:	**30 hours**

Mode of assessment: Continuous Assessment & 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
ECE2004	Transmission Lines And Waveguides	3	0	0	0	3
Pre-requisite	ECE1003 - Electromagnetic Field Theory	Syllabus Version				
		1.0				

Course objectives:

1. To introduce the basic concepts of transmission lines and analyze the different parameters, namely SWR, reflection coefficient, return loss.
2. To have the basic knowledge of Smith chart for solving the transmission line problems and analyse the matching sections using stubs and LC network.
3. To teach different types of waveguide devices and understand the distribution of electromagnetic fields within waveguides using Maxwell's equations.

Course Outcomes:

1. Obtain solutions to transmission line equations with characteristic impedance, input impedance and propagation constant.
2. Able to solve the numerical problems of lossy, lossless and distortion less transmission line.
3. Distinguish between reflection coefficient plane and the impedance plane, location of SWR, voltage maxima and minima points and solve impedance and admittance calculations using Smith Chart.
4. Design and interpret the impedance matching transmission line sections using single stub, double stub and LC sections using Smith Chart.
5. Analyze the field components of different waveguides and planar transmission lines based on various modes of E and H field.
6. Understand the various interference techniques due to EM fields and the compatibility of the EM systems.

Module:1	Introduction	6 hours

Common types of transmission lines used in circuits, lumped circuit model for transmission line and formal solutions. Characteristic impedance, propagation constant, attenuation and phase constants, wavelength and phase velocity, Transmission line with mismatched load

Module:2	Lossy and Loss less Transmission line	7 hours

Reflection coefficient, standing wave ratio, return loss, transmission coefficient, insertion loss, standing wave pattern, input impedance. Low loss line, distortion less transmission lines, generator and load mismatch. Open circuited and short circuited lines. Transmission line resonator.

Module:3	Smith Chart	8 hours

Impedance and admittance chart, measurement of reflection coefficient, return loss, VSWR, impedance, admittance, insertion loss, standing wave ratio and attenuation.

Module:4	Impedance matching	5 hours

Lumped element matching, single and double stub matching, quarter wave transformer narrowband and broadband matching.

Module:5	**Waveguides**	**7 hours**
General solutions for TEM, TE and TM waves- parallel plate waveguide, rectangular waveguide, circular waveguide. Characteristics of wave guide- guide wavelength, cut off wave length, cut off frequency, wave impedance phase constant, phase velocity, group velocity, power and attenuation. Excitation of different modes in waveguides.		
Module:6	**Planar transmission lines**	**6 hours**
Introduction to planar transmission lines - strip lines, microstrip lines- coupled lines, slot line, coplanar wave guide (CPW). Microstrip lines - field distribution, design equations - Losses in microstrip lines. Coaxial transmission line (distributed parameters).		
Module:7	**Electromagnetic Interference (EMI)**	**4 hours**
Introduction to EMI and EMC, Electromagnetic noise sources, Coupling between transmission lines and external EM fields, Methods to suppress EMI- Grounding and shielding.		
Module:8	**Contemporary issues**	**2 hours**
	Total lecture hours:	**45 hours**

Text Book(s)

1. David M. Pozar, Microwave Engineering, 2012, 4th edition, Wiley, India.

Reference Books:

1. David K. Cheng, Field and Wave Electromagnetics, 2014, 2nd edition, Pearson, Noida, India.
2. Jordon and Balmain, Electromagnetic waves and Radiating systems, 2011, 2nd edition, PHI, New York, USA.

Mode of Evaluation: Internal Assessment(CAT, Quizzes, Digital Assignments) & 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
ECE2005	Probability Theory and Random Processes	3	0	0	0	3
Pre-requisite	ECE1004 – Signals and Systems	Syllabus Version				
		1.0				

Course Objectives

1. To familiarize the students with two and multi random variable theory
2. To enable the students to process the random signals in time and frequency domains
3. To make the students to understand the noise concepts and design a matched filter to increase the Signal to Noise Ratio(SNR)

Course Outcomes

The students will be able to

1. Extend the concept of single random variable to two and multi-random variables. Understand the probability density functions for multiple random variables
2. Perform transformation on multiple random variables and understand the concept of central limit theorem
3. Interpret the random processes in terms of stationarity, statistical independence and correlation
4. Compute the power spectral density of the random signals
5. Able to interpret the effect of random signals on LTI systems output both in time and frequency domain.
6. Able to design matched filter/Optimum filter for extracting signals in the presence of noise.

Module:1	Multiple Random Variables	6 hours

Introduction to Random Variables – Vector Random Variables- Joint Distribution and its Properties-Joint Density and its Properties – Conditional Distribution and Density - Statistical Independence –Distribution and Density of a Sum of a Random Variables – Central Limit Theorem.

Module:2	Operations on Multiple Random Variables	7 hours

Joint Moments – Joint Central Moments – Joint Characteristics Function – Jointly Gaussian Random Variables – Transformations of Multiple Random Variables – Linear Transformation of Gaussian Random Variables – Complex Random Variables

Module:3	Random Processes – Temporal Characteristics	7 hours

Random Process - Stationarity - Independence-Correlation Functions and its Properties - Measurement of Correlation functions-Gaussian Random Processes- Poisson Random Processes-Complex Random Processes

Module:4	Random Processes – Spectral Characteristics	7 hours

Power Density Spectrum and its Properties-Cross PSD and its properties, Relationship between Correlation and Power Spectrum-Power Spectrum for Discrete Time Processes and Sequences Power Spectrum of Complex Processes.

Module:5	Linear Systems with Random Inputs	4 hours

Linear system Fundamentals-Random Signal Response of Linear Systems-Product Device

response to a Random Signal- Spectral Characteristic of System Response.		
Module:6	**Noise**	**4 hours**
Definitions-System Evaluation using Random noise-Spectral Characteristic of System Response for Noise-Noise Bandwidth – Band pass – Band limited – Narrow Band Processes		
Module:7	**Modelling of Noise Sources**	**8 hours**
Resistive Noise Sources – Arbitrary Noise Sources – Effective Noise Sources-Noise Temperature-Noise Figure-Incremental Modelling of Noisy Networks- Modelling of Practical Noisy Networks Signal to Noise Ratio – Mean Square Error- Optimization by Parameter Selection- Matched Filter for Colored Noise- Matched Filter for White Noise-Practical Applications		
Module:8	**Contemporary issues**	**2 hours**
	Total lecture hours:	**45 hours**

Text Book(s)	
1.	P.Z. Peebles, Probability, Random Variables and Random Signal Principles, 2017, 4th edition, McGraw Hill, New Delhi, India.
Reference Books	
1.	Papoulis and S.U. Pillai, Probability, Random variables and stochastic processes, 2017, 4th edition, McGraw Hill, New Delhi, India.
2.	Hwei Hsu, Probability, Random variables, Random Processes, 2017, Schaum's outline series, McGraw Hill, New Delhi, India.
3.	Robert M. Gray, Lee D. Davisson, An Introduction to Statistical Signal Processing, 2011, Cambridge University Press, India.
4.	H. Stark and J.W. Woods, Probability and Random Processes with Applications to Signal processing, 2012, International Edition, Pearson Education, 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
ECE2006	Digital Signal Processing	2	0	2	4	4
Pre-requisite	ECE1004 – Signals and Systems	Syllabus Version				
		1.0				

Course Objectives:

1. To summarize and analyze the concepts of signals, systems in time and frequency domain with corresponding transformations.
2. To instruct the students to design the analog and digital IIR, FIR filters.
3. To introduce the students the diverse structures for realizing digital filters.
4. To teach students the usage of appropriate tools for realizing signal processing modules

Course Outcomes:

1. Comprehend, classify and analyze the signals and systems, also, transform the time domain signals to frequency domain for analyzing system response
2. Able to simplify Fourier transform computations using fast algorithms
3. Comprehend the various analog filter design techniques and their digitization.
4. Able to design digital filters.
5. Able to realize digital filters using delay elements, summer, etc.
6. Able to realize lattice filters using delay elements, ladders, summers, etc.
7. Able to analyze and exploit the real-time signal processing applications
8. Design and implement systems using the imbibed signal processing concepts

Module:1	Frequency Analysis of Signals and Systems-I	2 hours

Review of Discrete -Time Signals and Systems – Classification, Convolution- z- transform: ROC-stability/causality analysis, DTFT: Frequency response-System analysis.

Module:2	Frequency Analysis of Signals and Systems-II	5 hours

Frequency domain sampling- Sampling rate conversion - Aperiodic correlation estimation-Cepstrum processing- Band limited discrete time signals- Phase and group delay- DFT-Properties. Frequency analysis of signals using DFT-FFT Algorithm-Radix-2 FFT algorithms-Applications of FFT

Module:3	Theory and Design of Analog Filters	5 hours

Design techniques for analog low pass filter -Butterworth and Chebyshev approximations, frequency transformation, Properties -Constant group delay and zero phase filters

Module:4	Design of IIR Digital Filters	4 hours

IIR filter design: Bilinear and Impulse Invariant Techniques- Spectral transformation of Digital filters.

Module:5	Design of FIR Digital Filters	5 hours

FIR Filter Design: Design characteristics of FIR filters with linear- phase – Frequency response of linear phase FIR filters – Design of FIR filters using window functions (Rectangular, Hamming, Hann, Blackmann, and Kaiser).

Module:6	Realization of Digital Filters	3 hours

Direct, Cascade, Parallel, State space representations, Basic FIR and IIR digital filter structures

Module:7	**Realization of Lattice filter structures**	**4 hours**
All pass filters, IIR tapped cascaded lattice structures, FIR cascaded lattice structures, Parallel all pass realization of IIR transfer function.		
Module:8	**Contemporary issues**	**2 hours**
	Total lecture hours:	**30 hours**

Text Book(s)

1. J. G. Proakis, D.G. Manolakis and D.Sharma, Digital Signal Processing Principles, Algorithms and Applications, 2012, 4th edition, Pearson Education, Noida, India.
2. S.K.Mitra, Digital Signal Processing, 2013, 4th edition, TMH, New Delhi, India.

Reference Books

1. Richard G Lyons and D.Lee Fugal, The Essential Guide to Digital Signal Processing, 2014, Prentice Hall, New Jersey, US.
2. Oppenhiem V.A.V and Schaffer R.W, Discrete – time Signal Processing, 2013, 3rd edition, Prentice Hall, New Jersey, US.
3. Lyons, Understanding Digital Signal Processing, 2013, Pearson Edition, Noida, India.
4. Emmanuel C. Ifeachor, Digital Signal Processing A Practical Approach, 2011, 2nd edition reprint, Prentice Hall, New Jersey, US.

Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

List of Challenging Experiments (Indicative)		
1	Introduction to MATLAB 2015A, Code Composer Studio and Digital Signal Processor.	6 hours
2	Basics of Digital Signal processing: Time domain and Frequency domain signal analysis for standard signals- Convolution, Correlation, Stability analysis, Spectral Estimation through DTFT and DFT, Radix-N- Algorithms.	6 hours
3	Signal Processing Techniques for Speech Applications-simulation, optimization and implementation.	6 hours
4	Signal processing methods for Music Signals- simulation, optimization and implementation.	6 hours
5	Signal processing mechanisms for Bio-Signals - simulation, optimization and implementation.	6 hours
	Total laboratory hours	30 hours

Mode of evaluation: Continuous Assessment & Final Assessment Test (FAT)

Typical Projects

1. Voice biometric speaker recognition
2. Hearing aid system
3. Identification of Musical Instruments
4. Simulation of cochlear implant in MATLAB
5. Speaker recognition system based on MFCC
6. Voice conversion
7. Disease detection based on ECG
8. Implementation of 5-Band Audio Equalizer in Matlab
9. Watermarking in audio signal

10. Musical tone generator using Matlab 11. Hearing aid system for impaired People using Matlab 12. Noise Cancellation using adaptive filters. 13. Implementation of speech recognition system 14. Disease detection based on Speech signal 15. Disease detection based on EEG.			
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
ECE3001	Analog Communication Systems	3	0	2	0	4
Pre-requisite	ECE2002 – Analog Electronics Circuits	Syllabus version				
		1.0				

Course Objectives:

1. To impart students the need, design, analysis and applications of Linear AM modulators and demodulators.
2. To introduce Angle Modulation, demodulation and the concept of pre-emphasis and de-emphasis.
3. To elaborate the super-heterodyne receiver and the Figure of Merit in DSB-SC, SSB, AM and FM receivers
4. To describe the sampling, pulse modulation schemes-PAM, PWM and PPM and the multiplexing techniques FDM and TDM.

Course Outcomes:

1. Able to comprehend the elements of electronic communication system
2. Ability to design AM, DSB-SC and SSB-SC modulation and demodulation, and to calculate the power of AM, DSB-SC and SSB-SC schemes.
3. Able to design DSB-SC and SSB-SC modulator and demodulator.
4. Comprehend and compare the FM and PM generation and design, distinguish Wideband and Narrowband FM signals.
5. Comprehend and compare different angle demodulators.
6. Able to design radio receivers, identify role of AGC, and compute noise voltage, signal-to-noise ratio, noise figure, noise temperature and figure of merit.
7. Determine the Nyquist sampling rate of a given signal, explain aliasing effect, Comprehend and compare the different pulse modulation techniques

Module:1	Introduction to Communication Systems	4 hours

Need and Importance of Communication, Elements of a Communication System, Types of communication systems - Electromagnetic Spectrum used in communication, concept of bandwidth and power, Receiver characteristics, Need for modulation

Module:2	Linear Modulation	8 hours

Amplitude modulation – 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:3	Bandwidth and Power Efficient AM Systems	5 hours

DSB-SC modulation, Power saving in DSB-SC, Synchronous detection, Quadrature null effect, SSB-SC, VSB generation and demodulation. Comparison of linear modulation systems with respect to power, bandwidth and receiver complexity, Low level and high level AM transmitters

Module:4	Angle Modulation	7 hours

Principle of frequency and phase modulation – Relation between FM and PM waves – Frequency deviation, Bandwidth of FM – Narrow band and wide band FM, FM transmitter, Bessel functions and Carson's rule – Generation of FM and PM wave- Comparison of AM and FM.

Module:5	**Demodulation of Angle Modulated Signals**	**8 hours**
FM detectors – slope detectors – Phase discriminators – Ratio detectors. Feedback Demodulators - The Phase Locked Loop-Frequency Compressive Feedback Demodulator. Pre-emphasis and de-emphasis.		
Module:6	**Receivers and Noise in Communication Systems**	**7 hours**
Tuned Radio Frequency (TRF), Super-heterodyne receiver (AM and FM) - Choice of IF and Oscillator frequencies – Tracking – alignment – AGC, AFC Noise and its types. Noise voltage - Signal-to-noise ratio - Noise figure - Noise temperature - Noise figure, Figure of Merit in DSB-SC, SSB, AM and FM receivers		
Module:7	**Pulse Modulation Systems**	**4 hours**
Sampling theorem, Types of Sampling. Pulse modulation schemes – PAM, PPM and PWM generation and detection-Pulse code modulation. Conversion of PWM to PPM. Multiplexing Techniques - FDM and TDM - problems related to FDM and TDM.		
Module:8	**Contemporary issues:**	**2 hours**
	Total lecture hours:	**45 hours**

Text Books

1.	Simon Haykin, Communication Systems,5th Edition ISBN: 978-0-471-69790-9 ,Wiley
2.	Roddy and Coolen, Electronic Communication, 2014, 4th Edition, Pearson Education, Noida, India.

Reference Books

1.	HweiKsu and Debjani Mitra, Analog and Digital Communication: Schaum's Outline Series, 2017, 3rd Edition, McGraw Hill Education, New Delhi, India.
2.	Herbert Taub and Donald Schilling, Principles of Communication Systems, 4th edition, 2017,Mc Graw Hill
3.	Wayne Tomasi, Advanced Electronic Communications Systems, 2014, 6th Edition, Pearson New International Edition, Noida, India.

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & 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
ECE3002	VLSI System Design	3	0	2	0	4
Prerequisite:	ECE2003 Digital Logic Design	Syllabus version				
		1.2				

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

Course Outcomes:

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

Module:1	MOS Transistor Theory	5 hours

I-V Characteristics, C-V Characteristics, Non ideal I-V effects of MOS Transistors

Module:2	CMOS Logic	5 hours

Basic gates, Compound Gates, Transmission Gates based combinational and sequential logic design

Module:3	CMOS Circuit characterization and Performance Estimation	8 hours

DC transfer Characteristics of CMOS inverter, Circuit characterization and performance estimation: Delay estimation, Logical effort and Transistor Sizing. Power Dissipation: Static & Dynamic Power Dissipation.

Module:4	CMOS Fabrication and Layout	5 hours

CMOS Process Technology N-well, P-well process, Stick diagram for Boolean functions using Euler Theorem, Layout Design Rule

Module:5	CMOS Combinational Circuit Design	7 hours

Static CMOS, Ratioed Logic, Cascode voltage Switch Logic, Dynamic circuits, Pass Transistor Circuits

Module:6	CMOS Sequential Circuit Design	7 hours

Conventional CMOS Latches and Flip Flops, Pulsed Latches, Resettable and Enabled Latches and Flip Flops

Module:7	Sub System Design	6 hours

Single bit Adder, Carry look ahead adder, Carry propagate Adder, Magnitude Comparator, Barrel Shifter, Signed and unsigned multiplier.

Module:8	**Contemporary 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: Internal Assessment (CAT, Quizzes, Digital Assignments) & 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 & 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
ECE3003	Microcontroller and its Applications	2	0	2	4	4
Pre-requisite	ECE2003 - Digital Logic Design	Syllabus version				
		1.01				

Course Objectives:

1. To introduce the architectures of microprocessors, microcontroller and ARM processors
2. To familiarize the students with assembly language programming in 8051 microcontroller
3. To design the interfacing of peripherals interfacing with the 8051 microcontroller
4. To introduce code converters and sensors interfacing with 8051 microcontroller

Course Outcomes:

1. Comprehend and analyze architectures of microprocessors, microcontroller and ARM7 processor
2. Comprehend the evaluations of the Intel (i3, i5, i7) series processors
3. Comprehend the memory organization of 8051 microcontroller
4. Showcase the skill, knowledge and ability of programming using instruction set
5. Work with microcontroller and interfaces including general purpose input/ output and timers
6. Comprehend and use peripheral serial communication and the concepts of interrupts in 8051 microcontroller
7. Interface 8051 microcontroller with the input and output devices such as LEDs, LCDs, 7-segment display and keypad
8. Design 8051 microcontroller based system with analog-to-digital converters and digital-to-analog converters within realistic constraints like user specification, availability of components etc.

Module:1	Introduction to Processors:	4 hours

Introduction to Microprocessors and Microcontrollers, 8-bit/16-bit Microprocessor Architectures [8085, 8086], Introduction to ARM7, Intel I (i3, i5, i7) Series Processors

Module:2	8051 Architecture:	4 hours

8051 - Organization and Architecture, RAM-ROM Organization, Machine Cycle

Module:3	8051 Instruction Set:	6 hours

Data Processing - Stack, Arithmetic, Logical; Branching – Unconditional and Conditional

Module:4	8051 Peripherals: Ports and Timers	3 hours

Peripherals: I/O Ports, Timers-Counters

Module:5	8051 Peripherals: Serial Communication and Interrupt	3 hours

Peripherals: Serial Communication, Interrupts

Module:6	Peripheral Interfacing:	4 hours

Interfaces: LCD, LED, Keypad

Module:7	Peripheral Interfacing:	4 hours

Interfaces: Analog-to-Digital Convertors, Digital-to-Analog Convertors, Sensor with Signal

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

Text Book(s)

1.	Mohammad Ali Mazidi, Janice G. Mazidi, Rolin D. McKinlay, The 8051 Microcontroller and Embedded Systems, 2014, Pearson, India.

Reference Books

1.	Muhammad Ali Mazidi, Rolin D. McKinlay, Janice G. Mazidi, The 8051 Microcontroller: A Systems Approach, 2012, First Edition, Pearson, India.
2.	A. Nagoor Kani, 8086 Microprocessors and its Applications, 2012, Second Edition, Tata McGraw-Hill Education Pvt. Ltd., New Delhi, India.
3.	Joseph Yiu, The Definitive Guide to ARM® Cortex®-M0 and Cortex-M0+ Processors, 2015, 2nd Edition, Elsevier Science & Technology, UK

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

List of Challenging Experiments (Indicative)		
1	Keil Simulator tool Introduction.	2 hours
2	I/O ports programming.	4 hours
3	LCD Interfacing.	2 hours
4	Keypad Interfacing.	2 hours
5	Timer programming.	4 hours
6	Interrupt Programming.	4 hours
7	Motor Interfacing.	2 hours
8	ADC/DAC Interfacing.	4 hours
9	Sensors Interfacing.	4 hours
10	Serial port programming.	2 hours
	Total laboratory hours	**30 hours**

Mode of evaluation: Continuous Assessment & Final Assessment Test (FAT)

Typical Projects:

1. Electronic code locker
2. Water level Indicator alarm
3. Remote Room Temperature Monitoring
4. Digital countdown timer
5. Fire detection
6. Digital voltmeter
7. Car parking system
8. Vehicle tracking system
9. TV Remote control
10. Intelligent Traffic control
11. Smartphone home appliance control
12. Automated toll collection system
13. Sun tracking system
14. Street light intensity control

15. Rash driving alert 16. Flood monitoring 17. Automatic irrigation system 18. GSM based energy monitoring system 19. Gas leakage detection 20. Electronic Voting Machine 21. Automatic College Bell 22. Finger print based Electronic Voting Machine 23. Line Following Robot Microcontroller based Intelligent Digital Volume Controller with Timers			
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
ECE4001	Digital Communication Systems	3	0	2	0	4
Pre-requisite	ECE3001 – Analog Communication Systems	Syllabus version				
		1.1				

Course Objectives:

1. To interpret the transmitter and receiver blocks of various waveform coding techniques.
2. To analyze various line coding techniques in time and frequency domains.
3. To identify the role of baseband and bandpass formats for effective transmission of signals, combat ISI and to increase the reliability of transmission.
4. To understand the principles and importance of spread spectrum and multiple access in the context of communication.

Course Outcomes:

1. Comprehend the sampling process of analog signal and recover the original signal without any distortion.
2. Apply the knowledge of signal theory and evaluate the performance of various waveform coding techniques.
3. Characterize various line coding techniques in time and frequency domains.
4. Design the baseband pulse for ISI free transmission over finite bandwidth channels.
5. Describe the mathematical model of a digital modulation technique, characterize the effect of AWGN channel and determine its bit error rate performance.
6. Describe and analyze the digital communication system with spread spectrum modulation.
7. Design as well as conduct experiments, analyze and interpret the results to provide valid conclusions for digital modulators and demodulators using hardware components and MATLAB tool.

Module:1	Sampling and Quantization	4 hours

Model of digital communication system – Review of sampling – Quantization – Uniform & non-uniform quantization.

Module:2	Waveform Coding Techniques	5 hours

Pulse Code Modulation (PCM) – Quantization noise and signal to quantization noise ratio – Companding (A law and μ law) – Differential pulse code modulation-Delta modulation.

Module:3	Line Codes	6 hours

Representation of line codes – Properties and applications of line codes – Power spectral density of NRZ unipolar, NRZ polar, NRZ bipolar and Manchester.

Module:4	Baseband System	7 hours

Inter Symbol Interference (ISI) – Nyquist criterion for distortion less transmission – Raised cosine spectrum – Correlative coding – Eye pattern – Equalization.

Module:5	Bandpass System-I	8 hours

Gram-Schmidt orthogonalization procedure – Correlation receiver – QAM- Generation and detection of coherent system (BASK, BFSK, BPSK, QPSK, MSK) – Error performance.

Module:6	Bandpass System-II	6 hours

Matched filter – Generation and detection of non-coherent system –DPSK, FSK and its error performance.

Module:7	**Spread Spectrum Techniques and Multiple Access Techniques**	**7 hours**
Generation of PN sequence and its properties – Direct sequence spread spectrum – Processing gain – Probability of error – Anti-jam characteristics – Frequency hopped spread spectrum – Slow and fast frequency hopping – Multiple access techniques - TDMA, FDMA, CDMA		
Module:8	**Contemporary issues**	**2 hours**
	Total lecture hours:	**45 hours**

Text Book(s)

1. Simon Haykin, Digital Communications, 2014, 1st edition, John Wiley, India.

Reference Books

1. John.G. Proakis, Digital Communication, 2014, 5th edition, Pearson Education, Noida, India.
2. Herbert Taub and Donald L Schilling, Principles of Communication Systems, 2012, edition, Tata McGraw Hill, New Delhi.
3. Bernard Sklar, Digital Communications: Fundamentals and Applications, 2016, 2nd edition, Prentice Hall, New Jersey, US.

Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

List of Challenging Experiments (Indicative)

SOFTWARE BASED TASKS

1	**Simple digital communication system** Simulate a simple communication system which transmits a text message from the source to the destination. Also, observe signals at different points of this communication system.	2 hours
2	**Coding for analog sources** Consider the given analog audio signal. Convert the analog input signal into binary sequence using i. Pulse code modulation (PCM) ii. Differential pulse code modulation (DPCM) iii. Delta Modulation (DM) iv. Adaptive delta modulation (ADM) Also, construct the stair-case approximated signal from the received binary sequence using above mentioned decoding schemes. In DM, analyse the impact of step size and sampling period on the stair case reconstruction.	4 hours
3	**Line coding** Write a code which uses the below mentioned line coding techniques to generate the baseband signal for the given text message. Also, transmit the generated base band signal through AWGN channel. Analyse the effect of channel noise on the reconstructed signal. i. Unipolar ii. Polar iii. Bipolar iv. Differential coding (Mark and Space)	4 hours
4	**Band-pass Modulation** Write a code which uses below mentioned band pass modulation	4 hours

	techniques to generate the modulated signal for the given text message. Transmit the modulated signal through AWGN channel. Detect transmitted message using the suitable rules. Plot the necessary graphs. i. BASK ii. BPSK iii. BFSK iv. DPSK	
5	**Probability of error analysis** i. Consider the bit sequence of length 10,000. Modulate it with BPSK, BASK, BFSK. Transmit the signal through AWGN channel. Vary the SNR. Compare the theoretical and simulated probability of error. ii. Consider the bit sequence of length 10,000. Modulate it with BPSK, QPSK and 8-PSK. Transmit the signal through AWGN channel. Vary the SNR. Compare the theoretical and simulated probability of error.	2 hours
6	**Spread spectrum** Write a code to complete the following task: i. For the given connection logic and the number of flip-flops, generate the pseudo-noise (PN) sequence. Check whether the given connection logic is primitive or not using periodicity property. ii. For the generated PN sequence, verify a) Balance property b) Run property c) Auto-correlation property iii. Use the generated PN sequence to get direct sequence spread spectrum (DSSS) (Assume BPSK modulation). Construct a simple transceiver chain. iv. Use the generated PN sequence to get slow and fast frequency hopped signals (Assume M-FSK modulation). Construct a simple transceiver chain.	4 hours
	Multiple Access Consider 4 users with different data. Use the following multiple access schemes to generate the composite signal. Use the orthogonality property to get back the proper data at the receiver end. Multiple access schemes: i. TDMA (Hint: Use GSM burst format) ii. CDMA (Hint: Use Hadamard codes) iii. OFDMA (Hint: Use IEEE 802.11a specifications)	4 hours
HARDWARE BASED TASKS		
8	**Generation and detection of ASK,FSK and PSK** Build the transceiver circuit for ASK,FSK and PSK scheme	2 hours
9	**Implementation of QPSK modulation** Build the transceiver chain for the QPSK scheme. Observe signals at different points of communication system.	2 hours

10	**Adaptive linear Equalizer** Build the transceiver chain for adaptive linear equalizer and discuss the RRC pulse generation and LMS rule.	2 hours
	Total laboratory hours	30 hours

Mode of evaluation: Continuous assessment & FAT			
Recommended by Board of Studies	28-02-2016		
Approved by Academic Council	No. 47	Date	05-10-2017

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

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 $(X' = AX + G)$ and $X'' = AX$		
Module:5	**Strum Liouville's problems and power series Solutions:**	**6 hours**
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.	Erwin Kreyszig, Advanced Engineering Mathematics, 2015, 10th Edition, John Wiley India.

Reference Books

1.	B. S. Grewal, Higher Engineering Mathematics, 2015, 43rd Edition, Khanna Publishers, India.
2.	Michael D. Greenberg, Advanced Engineering Mathematics , 2006, 2nd Edition, Pearson Education, Indian edition.

Mode of Evaluation: Digital Assignments (Solutions by using soft skills), Continuous Assessment Tests, Quiz, Final Assessment Test

List of Challenging Experiments (Indicative)		
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	4 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	4 hours
8.	Applying the Frobenius method to solve differential equations	2 hours

	arising in engineering applications	
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	4 hours
	Total laboratory hours	**30 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
PHY17	Applied Linear Algebra	3	1	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

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

Reference Books

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

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

Programme Elective (PE)

Course Code	Course Title	L	T	P	J	C
CSE2003	Data Structures And Algorithms	2	0	2	4	4
Pre-requisite	NIL	Syllabus version				
		1.0				

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.

Course Outcomes:

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, 2009, Third edition, MIT Press.
Reference Books	
1.	Sanjoy Dasgupta, C.Papadimitriou and U.Vazirani, Algorithms, 2008, Tata McGraw-Hill.
2.	A. V. Aho, J.E. Hopcroft and J. D. Ullman, Data Strucures and Algorithms, 2002, Pearson India, 1st Edition.
3.	A. V. Aho, J.E. Hopcroft and J. D. Ullman, The Design and Analysis of Computer Algorithms, 2006, 1st edition, Pearson.
4.	Sara Baase, Allen Van Gelder, Computer Algorithms, Introduction to Design and Analysis, 1999, 3rd edition, Wesley Longman Publishing.

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

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	4 hours
12.	Minimum Spanning Tree	4 hours
	Total laboratory hours	30 hours

Mode of evaluation: Continuous Assessment & Final Assessment Test (FAT)

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
CSE2005	Operating Systems	2	0	2	4	4
Pre-requisite	NIL	Syllabus version				
		1.0				

Course Objectives:

1. To introduce the concept of Operating system concepts and designs and provide the skills required to implement the services.
2. To describe the trade-offs between conflicting objectives in large scale system design.
3. To develop the knowledge for application of the various design issues and services.

Course Outcomes:

1. Interpret the evolution of OS functionality, structures and layers.
2. Apply various types of system calls and to find the stages of various process states.
3. Design a model scheduling algorithm to compute various scheduling criteria.
4. Apply and analyze communication between inter process and synchronization techniques.
5. Implement page replacement algorithms, memory management problems and segmentation.
6. Differentiate the file systems for applying different allocation and access techniques.
7. Representing virtualization and Demonstrating the various Operating system tasks and the principle algorithms for enumerating those tasks.

Module:1	Introduction	2 hours

Introduction to OS: - Functionality of OS - OS Design issues - Structuring methods (monolithic, layered, modular, micro-kernel models) - Abstractions, processes, and resources - influence of security, networking, multimedia.

Module:2	OS Principles	3 hours

System Calls System/Application Call Interface - Protection User/Kernel modes - Interrupts Processes and Threads - Structures (Process Control Block, Ready List etc).

Module:3	Scheduling	5 hours

Processes Scheduling - CPU Scheduling - Pre-emptive non-pre-emptive - Resource allocation and management - Deadlocks Deadlock Handling Mechanisms.

Module:4	Concurrency	4 hours

Inter-process communication Synchronization - Implementing Synchronization Primitives Semaphores - Monitors - Multiprocessors and Locking - Scalable Locks - Lock-free Coordination.

Module:5	Memory management	5 hours

Main Memory management Memory allocation strategies Caching -Virtual Memory Hardware TLB - Virtual Memory OS techniques Paging Segmentation Page Faults Page Replacement Thrashing Working Set.

Module:6	Virtualization	4 hours

Virtual Machines Virtualization (Hardware/Software, Server, Service, Network) Hypervisors -OS - Container Virtualization - Cost of virtualization.

Module:7	File systems	3 hours

File system interface - file system implementation File system recovery Journaling - Soft updates

LFS - Distributed file system.		
Module:8	**Security Protection and trends**	**4 hours**
Security and Protection - Mechanism Vs Policies Access and authentication - models of protection Memory Protection Disk Scheduling - OS performance, Scaling OS - Mobile OS: Recent Trends: - Future directions in Mobile OS / Multi-core Optimization /Power efficient Scheduling		
	Total lecture hours:	**30 hours**

Text Book(s)

1.	Abraham Silberschatz, Peter B. Galvin, Greg Gagne, Operating System Concepts, 2012, Wiley.

Reference Books

1.	Ramez Elmasri, A Carrick, David Levine, Operating Systems, A Spiral Approach, 2009, McGrawHill Science Engineering Math.
2.	Remzi H. Arpaci-Dusseau, Andrea C. Arpaci-Dusseau, Operating Systems, Three Easy Pieces, 2015, Arpaci-Dusseau Books, Inc.

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

List of Challenging Experiments (Indicative)

1.	Write a boot loader - to load a particular OS say TinyOS/ KolibriOS image - code to access from BIOS to loading the OS - involves little assembly code may use QEMU/virtual machines for emulation of hardware.	4 hours
2.	Allocate/free memory to processes in whole pages, find max allocatable pages, incorporate address translation into the program.	2 hours
3.	Create an interrupt to handle a system call and continue the previously running process after servicing the interrupt.	4 hours
4.	Write a Disk driver for the SATA interface. Take care to check readiness of the controller, locked buffer cache, accept interrupts from OS during the period, interrupting the OS again once done and clearing buffers.	2 hours
5.	Demonstrate the use of locks in conjunction with the IDE driver.	4 hours
6.	Run an experiment to determine the context switch time from one process to another and one kernel thread to another. Compare the findings.	2 hours
7.	Determine the latency of individual integer access times in main memory, L1 Cache and L2 Cache. Plot the results in log of memory accessed vs average latency.	4 hours
8.	Compare the overhead of a system call with a procedure call. What is the cost of a minimal system call?	2 hours
9.	Compare the task creation times. Execute a process and kernel thread, determine the time taken to create and run the threads.	4 hours
10.	Determine the file read time for sequential and random access based of varying sizes of the files. Take care not to read from cached data - used the raw device interface. Draw a graph log/log plot of size of file vs average per-block time.	2 hours
	Total laboratory hours	**30 hours**

Mode of evaluation: Continuous Assessment & Final Assessment Test (FAT)

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
ECE1006	Introduction to Nano Science and Nanotechnology	2	0	0	4	3
Pre-requisite	PHY1701–Engineering Physics	Syllabus Version				
		2.0				

Course Objectives:

1. To understand the basic concepts involved in the field of Nanoscience and Nanotechnology.
2. To introduce the fundamental concepts of statistical mechanics, to compare different distribution functions and to enable them to understand the various degrees of quantization.
3. To analyze the concepts of quantum mechanics and its applications.
4. To gain knowledge about various synthesis routes of nanostructured materials and to introduce students about the basic characterization concepts and nanometrology tools.

Course Outcomes:

1. Understand and appreciate the novel concepts in the field of nanoscience and nanotechnology. Also to comprehend and compare various particles based on their distribution functions and the degrees of quantization.
2. Understand the basic concepts of quantum mechanics.
3. Understand about the change in properties at nanoscale.
4. Know the types of nanostructures and few important nanomaterials including carbon nanotubes.
5. Gain knowledge about bottom-up and top-down approaches for producing nanomaterials.
6. Be aware of various morphological characterization techniques and selecting the appropriate tool for their future research.
7. Be aware of various spectroscopic characterization techniques and work on futuristic applications of nanomaterials.

Module:1	Introduction	4 hours

Band theory of Solids - Basic properties of Conductors, Insulators, and Semiconductors. Band theory of typical semiconductors, Statistical mechanics – Fundamental concepts of classical statics (Maxwell-Boltzmann) and Quantum statistics (Bose-Einstein, Fermi-Dirac statistics). Fermi distribution function and Fermi level.

Module:2	Quantum Mechanics	4 hours

Basics in Quantum Mechanics, Schrödinger wave equation and its applications. Quantum confinement and density of states in 0-D, 1-D and 2-D. Quantum mechanical tunneling process.

Module:3	Change in material properties at Nano scale	2 hours

Effects of the nanometre length scale- Change in physical, chemical, mechanical, magnetic, electronic and optical properties at Nano scale.

Module:4	Important Nano materials	4 hours

Engineering Nano materials, Basic Types of Nanostructures- Fundamental concepts on semiconductor hetero structure (super lattice and quantum wells), Carbon Nanotubes, Nanowires, and Quantum Dots.

Module:5	**Fabrication methods for nanomaterials**	**5 hours**
Top-down processes- Ball milling, Optical lithography, E-Beam lithography, Micro machining, Bottom-up processes- Physical vapour deposition, Chemical vapour deposition, Self-assembly, Molecular beam epitaxy.		
Module:6	**Characterization Technique - Microscopy**	**5 hours**
Classification of characterization methods, Principles of Electron Microscopy - Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM). Principle of probe microscopy –Scanning Tunneling Microscopy (STM) & Atomic Force Microscopy (AFM).		
Module:7	**Characterization Technique – Spectroscopy**	**4 hours**
Principle and operation of UV-vis-NIR Spectroscopy and photoluminescence spectroscopy, EELS (Electron Energy Loss Spectroscopy).		
Module:8	**Contemporary issues**	**2 hours**
	Total lecture hours:	**30 hours**

Text Books

1.	B.S. Murty, P. Shankar, Baldev Raj, B B Rath, James Murday, Textbook of Nanoscience and Nanotechnology, 2013, 1st edition, Springer-Verla Berlin, Heidelberg
2.	Arthur Besier, S. Rai Choudhury, Shobhit Mahajan, Concepts of Modern Physics, Arthur Beiser, 2015, 7th edition, Mcgraw Hill Education, India

Reference Books:

1.	Gregory L. Timp, Nanotechnology, 2012, 3rd edition, Springer, New York
2.	Guozhong Cao, Ying Wang, Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, 2011, 2nd edition, World Scientific, Singapore
3.	T. Pradeep, A Textbook of Nanoscience and Nanotechnology, 2012, 2nd edition, Tata McGraw-Hill Education, New Delhi
3.	Marius Grundmann, Nanooptoelectronics: Concepts, physics and devices, 2012, 2nd edition, Springer-Verla Berlin, Heidelberg
4.	Narendra Kumar, Sunita Kumbhat, Essentials in Nanoscience and Nanotechnology, 2016, 1st edition, John Wiley & Sons, Inc, New Jersey

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

List of Challenging Projects:

1. Chemical composition study of metallic nanomaterials using Fourier transform infrared spectroscopy (FTIR) 2. Synthesis of Anti Corrosive paints using Nanomaterials (Sol-Gel) 3. Synthesis of nano particles to make anti fading fabric (Sol-Gel) 4. Bandages impregnated with nanosilver to kill germs 5. Synthesis of nano particles to make nanosocks which keeps the feet from smelling bad (Sol-Gel) 6. Effectiveness of different kinds of sunscreen- With and without nanoparticles 7. Synthesis of nano coating materials to make Hydro phobic clothes (Sol-Gel) 8. Property optimization of multi wall carbon nano tubes (MWNT) and single wall nano tubes (SWNT) 9. Construction of a wire, Inverter, Majority gate using Quantum Cellular Automata using QCA Designer.
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
ECE1007	Optoelectronics	3	0	0	0	3
Pre-requisite	PHY1701 – Engineering Physics	Syllabus Version				
		1.1				

Course Objectives:

1. To introduce the fundamentals of the basic physics behind optoelectronic devices.
2. To impart the applied aspects of optoelectronic device physics and its usage in the design and operation of laser diodes, light-emitting diodes, photodetectors and light modulators.
3. To provide applications of optoelectronic systems in telecommunication engineering

Course Outcomes:

1. Understand the band structures of various types of semiconductors and choice of materials for optical process in semiconductors.
2. Understand the basic concepts of optical absorption and recombination process in semiconductors.
3. Understand the various types of optical sources, characteristics and their applications.
4. Apply, analyze and design circuits using optoelectronic components for various applications and analyze their performance.
5. Understand the various types of optical detectors and modulators, characteristics and their applications.
6. Exploit the way to improve the use of optoelectronic components in engineering, modern application systems and their longevity.

Module:1	Elemental and Compound semiconductors	4 hours

Band structure, Direct band gap and indirect semiconductors, Transmission media and choice of materials

Module:2	Absorption in semiconductors	7 hours

Indirect intrinsic transitions, Donor-Acceptor and Impurity band absorption, Impurity band absorption, Intraband transition and free carrier absorption, Franz –Keldysh effect and quantum confined stark effect

Module:3	Recombination in semiconductors	7 hours

Relation between absorption and emission spectra, Stokes shift in optical transitions, Band to band recombination, Donor acceptor and impurity band transitions, Deep level transitions, Auger recombination

Module:4	Light emitting diodes (LED) Sources	7 hours

Double heterojunction LED, Surface emitter LED, Edge emitter LED, Superluminescent LED, LED power and efficiency, LED characteristics-output power, output spectrum, modulation bandwidth, reliability.

Module:5	LASER Sources	8 hours

Absorption and emission of radiation, Einstein relations, Population inversion, Optical feedback and oscillation, Threshold condition for laser oscillation, Broad area DH injection laser, Stripe geometry DH injection laser, Single mode operation, Distributed feedback laser, Distributed Braggs reflector laser, VCSEL, Temperature effects.

Module:6	**Optical Detectors**	**7 hours**
PN, PIN, Avalanche and Heterojunction photodiodes, Photo transistors, Avalanche multiplication process in APDs, Quantum efficiency, Responsivity.		
Module:7	**Optoelectronic Modulators**	**3 hours**
Basic principle, Birefringence, Optical Activity, Electro –Optic modulators, Acousto-Optic modulators, Magneto-Optic modulators.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. Pallab Bhattacharya, Semiconductor Optoelectronic Devices, 2017, 2nd Edition, Pearson Education, India.
2. John M Senior, Optical Fiber Communication – principle and practices, 2014, 3rd Edition, PHI, India.

Reference Books

1. A K Ghatak and K Thyagarajan, Optical Electronics, 2017, 1st Edition, Cambridge University Press, India.
2. Safa O. Kasap, Optoelectronics and Photonics-Principles and Practices, 2012, 2nd Edition, Pearson Prentice Hall, India.

Mode of assessment: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

Recommended by Board of Studies	28-02-2016		
Approved by Academic Council	No. 47	Date	05-10-2017

Course Code	Course Title	L	T	P	J	C
ECE1008	Electronics Hardware Troubleshooting	0	0	2	0	1
Prerequisite:	Nil	Syllabus Version				
		1.0				

Course Objectives:

1. To understand the process of identification and testing of various electronic components and instruments.
2. To introduce the troubleshooting methods of electronic circuits.
3. To understand the process of PCB layout and implementation of various circuits on it.

Course Outcomes:

1. Perform testing and identification of various electronic components and instruments.
2. Perform trouble shooting of simple electronic circuits
3. Perform soldering, basic operations of hardware trouble shooting on a PCB.
4. Construct and Implement basic application oriented circuits on PCB.

 # List of possible experiments:

1. Study of Measuring, Testing, Power Supply Instruments and Breadboard.
2. Testing and Trouble shooting of Diodes and Transistors.
3. Trouble shooting of Clamper and Clipper Circuits.
4. Trouble shooting and testing of power supply.
5. Use of C.R.O to find Mid-band Voltage gain and Frequency Response of Amplifiers.
6. Trouble shooting and Testing of NMOS Inverter, NMOS NOR and NAND Logic with Pull-Up resistor
7. Trouble shooting and Testing of NMOS and Diode connected with Pull-Up resistor for A specific logic.
8. PCB layout and hardware troubleshooting of simple audio amplifier.
9. Trouble shooting and testing of power Inverter.
10. Trouble shooting and testing of multi-meter.
11. Trouble shooting and testing of equalizer circuits.
12. Trouble shooting and testing of emergency light.

1. THE STUDY OF MEASURING INSTRUMENTS, TESTING INSTRUMENTS AND POWER SUPPLY. Short description:- The objective of this experiment is to gain some hand on experience with the tools that is used in the electronic testing and measuring equipment's. A breadboard has a construction base for prototyping of electronic circuits. Solderless breadboard does not required soldering, it is reusable. In general breadboard consist of power rail, DIP support and terminal strips.	**2 Hours**
2. TESTING AND TROUBLE SHOOTING OF DIODES AND TRANSISTORS. Short description: In diodes faults are determined using multi-meter by checking forward and reverse bias resistances. In digital multi-meter diode is tested by connecting diode test function. In Transistors upper and lower 3dB frequencies, bandwidth & gain frequency are determined by using CRO. Phase difference is determined by applying two signals on channel 1 and channel 2	**2 Hours**

3. TROUBLE SHOOTING OF CLAMPER AND CLIPPER CIRCUITS. Short description: - Trouble shooting the problems related to clipper and clamper circuits. Study of nonlinearities in diode and analysis of charging and discharging time of capacitors**.**	**2 Hours**
4. USE OF C.R.O TO FIND MID-BAND VOLTAGE GAIN AND FREQUENCY RESPONSE OF BASIC AMPLIFIERS. Short description: Outputs and input of amplifier is connected to channel 1 and channel 2. Output amplitude of amplifier is independent of the input frequency variation which gives mid-band gain of the amplifier. By adjusting tuning knob of function generator 3-dB frequency can be determined.	**2 Hours**
5. TROUBLE SHOOTING AND TESTING OF POWER SUPPLY. Short description: -A regulated power supply expected to have constant output voltage or current despite variation in load current or input supply. Conversely, output of an unregulated power supply changes significantly when its input voltage or load current changes. Power supply should be ripple free and concerning filter circuits are designed carefully.	**2 Hours**
6. TROUBLE SHOOTING AND TESTING OF NMOS INVERTER, NMOS NOR AND NAND LOGIC WITH PULL-UP RESISTOR. Short description: - All logic circuit is consists of an N-channel MOSFET and pull-up resistor. Strong zeroes and strong ones are to be expected at the outputs. To elevate back-gate effects Bulk is to be biased properly. Small device lengths are preferred which reduces both static and dynamic power dissipation.	**2 Hours**
7. TROUBLE SHOOTING AND TESTING OF NMOS DIODE CONNECTED WITH PULL-UP RESISTOR FOR A SPECIFIC LOGIC. Short description: - When input voltage is high and greater than V_T, NMOS is ON. The input Supply voltage is applied to the gate and output is applied to the LED. By this arrangement a unique logic is implemented other than basic logic gates.	**2 Hours**
8. PCB LAYOUT AND HARDWARE TROUBLESHOOTING OF SIMPLE AUDIO AMPLIFIER. Short description: - study of audio amplifier is an electronics amplifier that amplify low poweraudio signal (signal composed primarily of frequencies ranges between 20 to 20KHz) to a levelsuitable for driving loudspeakers is implemented on PCB and issues related to amplifier layout on PCB are rectified.	**3 Hours**
9. TROUBLE SHOOTING AND TESTING OF POWER INVERTER. Short description: - Study of issues related to input-output power of the inverter and fuseof the inverter. Study of performance parameters related to the changing of DC to AC which is dependent on input voltage, output voltage, frequency and overall power handling.	**3 Hours**
10. TROUBLE SHOOTING AND TESTING OF ELECTRONIC COMPONENTS USING MULTI-METER.	**3 Hours**

Short description: -Troubleshooting the electronics devices and components to check whether they are working properly. Before testing components proper mode should be selected and pins of components should be inserted in their respective slots.	
11.TROUBLE SHOOTING AND TESTING OF EQUALIZER. Short description: -Trouble shooting the circuit for correction of frequency dependent distortion in telecommunication. Study of signal which is send to bank of filter and the signal which is passed as a portion of the signal present in its own frequency range.	**3 Hours**
12.TROUBLE SHOOTING AND TESTING OF EMERGENCY LIGHT. Short description: - Study and controlling of charging currents in battery. Study of minimizing the switching delays. When battery is fully charged power should cut-off and leakages of battery charge should be minimized when not in use.	**3 Hours**
Total laboratory hours:	**30 hours**

Text Books:

1.	D. A. Neamen, Electronic Circuit Analysis and Design, 2007, 3/e, Tata McGraw-Hill, New Delhi.

Reference Books:

1.	Jacob Millman, Christos C Halkias and Satyabrata Jit, 2007, Electronic devices and circuits, Tata McGraw Hill 2nd Edition.

Mode of evaluation: Continuous Assessment & 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
ECE2008	Robotics and Automation	2	0	0	4	3
Prerequisite:	ECE1005 - Sensors and Instrumentation	Syllabus version				
		2.0				

Course Objectives :

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

Course Outcomes:

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

Module:1	Introduction to Robotics	2 hours

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

Module:2	Drives for Robotics	3 hours

Drives: Electric, hydraulic and pneumatic drives.

Module:3	Sensors for Robots	4 hours

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

Module:4	Robot Kinematics and Dynamics	7 hours

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

Module:5	Path Planning	5 hours

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

Module:6	Programming of Robots	3 hours

Robot programming: languages and software packages-MATLAB/Simulink, OpenRDK, Adams.

Module:7	Application of Robots	4 hours

Industrial robots used for welding, painting and assembly, remote controlled robots, robots for nuclear, thermal and chemical plants, industrial automation, typical examples of automated industries.

Module:8	**Contemporary Issues**	**2 hours**
	Total lecture hours:	**30 hours**

Text Books:	
1.	Mikell P. Groover, Industrial Robotics: Technology, Programming and Applications, 2012, 2nd Edition, McGraw-Hill Publishers.
2.	John J. Craig, Introduction to Robotics, Mechanics and Control, 2010, 3rd Edition, Pearson Education.
Reference Books:	
1.	M.W. Spong and M. Vidyasagar, Robot Dynamics and Control, 2012, 2nd Edition, John Wiley & Sons, New York.
2.	Lorenzo Sciavicco Bruno Siciliano, Modelling and Control of Robot Manipulators, 2012, 1st Edition, Springer Science & Business Media, Berlin.
3.	Peter Corke, Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Reprint 2013, 1st Edition, Springer-Verlag Berlin Heidelberg.

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

Typical Projects

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

Mode of evaluation: Review I,II and III

Recommended by Board of Studies	13-12-2015		
Approved by Academic Council	No. 40	Date:	18-03-2019

Course Code	Course Title	L	T	P	J	C
ECE2010	Control Systems	3	0	0	4	4
Pre-requisite	ECE1004 -Signals and Systems	Syllabus version				
		2.1				

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

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: Internal Assessment (CAT, Quizzes, Digital Assignments) & 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
ECE3004	Computer Organization and Architecture	3	0	0	0	3
Pre-requisite	ECE2003 - Digital Logic Design	Syllabus version				
		1.0				

Course Objectives:

1. To discuss about architecture, bus interconnection, data processing units and control unit operations.
2. To elucidate memory systems, mapping techniques and various I/O interfacing methods.
3. To introduce parallelism and pipelining concepts, Flynn taxonomy and multi-processor architectures.

Course Outcomes:

1. Understand the functional components of a computer, different types of bus architectures and differentiate between Von-Neumann, Harvard architectures.
2. Understand how basic arithmetic operations are implemented in computer architecture and how signed multiplication and divisions are carried out using Booth multiplier and divider in processor architectures.
3. Compare the differences between CISC and RISC architectures, understand and design hardwired, micro programmed control units.
4. Gain knowledge between the levels of memory subsystems like Cache memory and Virtual memory, understand memory mapping schemes used in computer architectures
5. Classify types of I/O schemes and their operations choose the scheme based on the requirements.
6. Comprehend the methods of performance enhancement techniques such as pipelining and their hazards, Scalar and Vector processing architectures, Multiprocessing techniques like SMP.

Module:1	Introduction to Computing Systems	5 hours

Organization vs. Architecture, Function and structure of a computer, Functional components of a computer, Interconnection of components – Simple Bus Interconnect. Evolution of Computers, Moore's law, Von-Neumann vs. Harvard architectures.

Module:2	Processing Unit – Data Path	6 hours

Register organization, Arithmetic and Logic Unit – signed addition/subtraction, Multiplier Architecture – signed/unsigned multiplication – Booth multiplier, array multipliers, restoring and non-restoring division

Module:3	Processing Unit – Control Path	6 hours

Machine instructions, Operands, Addressing modes, Instruction formats, Instruction set architectures - CISC and RISC architectures. Instruction Cycle – Fetch-Decode-Execute, Control Unit- Organization of a control unit - Operations of a control unit, Hardwired control unit, Micro-programmed control unit.

Module:4	Memory Subsystem	8 hours

Semiconductor memories, Memory cells - SRAM and DRAM cells, Internal Organization of a memory chip, Organization of a memory unit, Cache memory unit - Concept of cache memory, Mapping methods, Organization of a cache memory unit, Fetch and write mechanisms, Memory management unit - Concept of virtual memory, Address translation.

Module:5	**I/O Subsystem**	**8 hours**
Access of I/O devices, I/O ports, I/O control mechanisms - Program controlled I/O, Interrupt controlled I/O, and DMA controlled I/O, I/O interfaces - Serial port, Parallel port, PCI bus, SCSI bus, USB bus.		
Module:6	**Instruction Level Parallelism**	**5 hours**
Instruction level parallelism - overview, Design issues, Super Scalar Processors, VLIW processors, Performance Evaluation, Pipelining and Pipeline hazards.		
Module:7	**Multiprocessors**	**5 hours**
Processor level parallelism - Dependency, Flynn taxonomy, Memory organization for Multiprocessors system, Symmetric Multiprocessor, Cache Coherence and The MESI Protocol		
Module:8	**Contemporary issues:**	**2 hours**
	Total lecture hours:	**45 hours**

Text Book(s)	
1.	David A. Patterson, John L. Hennessy, Computer Organization and Design-The hardware/software interface, 2013, 5th edition, Morgan Kaufmann Publishers, USA
Reference Books	
1	Carl Hamacher, ZvonkoVranesic, Safwat Zaky and Naraig Manjikian, Computer Organization and Embedded Systems, 2012, 6th edition McGraw Hill, USA.
2	William Stallings, Computer Organization and Architecture, 2016, 10th edition, Pearson / PHI, USA

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

Recommended by Board of Studies	28-02-2016		
Approved by Academic Council	No. 47	Date	05-10-2017

Course Code	Course Title	L	T	P	J	C
ECE3005	Digital Image Processing	3	0	2	0	4
Pre-requisite	ECE2006 - Digital Signal Processing	Syllabus version				
		1.1				

Course Objectives:

1. To introduce the fundamentals of digital image processing, the concept of two dimensional transformation on spatial images.
2. To apply various filtering methods for image enhancement.
3. To understand the concepts of color image processing and different image compression techniques.
4. To study various image segmentation algorithms and introduce descriptors for boundary representation of images.

Course Outcomes:

1. Perform histogram processing and apply spatial filter on images.
2. Apply 2D-FFT, DWT and KL transform on images.
3. Perform filtering in frequency domain for image enhancement.
4. Process the color image in three dimensions for enhancement.
5. Design various standard image compression techniques and interpret their effects in terms of data reduction.
6. Apply various image segmentation algorithms and also, represent the same using boundary, region descriptors
7. Design and implement algorithms using the imbibed image processing concepts

Module:1	Basics of Digital Image Processing	6 hours

Introduction, Fundamental steps in DIP – Elements of visual perception -Image sensing and Acquisition – Image Sampling and Quantization – Imaging geometry, discrete image mathematical characterization- Basic relationship between pixels. Basic Gray level Transformations – Histogram Processing – Smoothing spatial filters- Sharpening spatial filters.

Module:2	Image Transforms	8 hours

Two dimensional Fourier Transform- Properties – Fast Fourier Transform – Inverse FFT- Discrete cosine transform and KL transform-Discrete Short time Fourier Transform. Discrete Wavelet Transform- the Haar wavelet family – Multiresolution analysis: shifting and the scaling functions- Implementation using filters.

Module:3	Image Enhancement in Frequency domain	6 hours

Smoothing frequency domain filters- Sharpening frequency domain filters- Homomorphic filtering, Restoration filters

Module:4	Color Image Processing	5 hours

Color models-Pseudo color image processing- Color transformations

Module:5	Image Compression	6 hours

Overview of Image Compression Techniques- Quantization- Entropy Encoding-JPEG and MPEG standards

Module:6	**Image Segmentation**	**7 hours**
Detection of discontinuities – Edge linking and boundary detection- Thresholding -Edge based segmentation-Region based segmentation- Matching-Morphological segmentation- Watershed algorithm		
Module:7	**Representation and Description**	**5 hours**
Boundary descriptions-Region descriptors- Use of Principal Components and Description, Texture description.		
Module:8	**Contemporary issues**	**2 hours**
	Total lecture hours:	**45 hours**

Text Book(s)

1.	Anil K. Jain, Fundamentals of Digital Image Processing, 2015, 1st edition, Pearson India, India
2.	Rafael C. Gonzalez & Richard E. Woods, Digital Image Processing, 2017, 4th edition, Pearson Education, USA

Reference Books

1.	Mark Nixon & Alberto Aguado, Feature Extraction, and Image Processing, 2012, 3rd edition, Elsevier's Science & Technology Publications, Woborn MA, Great Britain.
2.	Scott E. Umbaugh, Digital Image Processing and Analysis: Human and Computer Vision Applications with CVIP tools, 2011, 2nd edition, CRC press, Boca Raton, FL, USA.

Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

List of Challenging Experiments (Indicative)

1	Perform point to point operation on the given image and compute the following and interpret changes in image • Image Negative • Power law transformation • Log transform	2 hours
2	Perform histogram equalization for the given image and analyze the enhanced quality of the image. • Read the input Image of size 256 × 256 and perform up sampling and down sampling by a factor of 2. Show the effect of image shrinking and zooming. • Read the input image of size 256 × 256 and show the effect of gray level variation for L = 32, 4, 2. • Perform contrast stretching for the given poor contrast image.	2 hours
3	Extract all 8-bit planes from given image and comment on the number of visually significant bits in each image.	1 hour
4	To detect moving objects in an image sequence using background subtraction algorithm.	2 hours
5	For the given 512×512 image (lena.jpg), implement the following spatial domain filtering techniques • Low Pass Filtering • High Pass Filtering	2 hours

	• Order Statistics (Median) Filtering	
6	To perform DFT for the given image and obtain its Fourier spectrum. Verify the symmetric property of DFT and compare the result with Discrete Cosine Transform.	2 hours
7	Removal of fine details in an image by frequency domain processing and analysis of information loss.	2 hours
8	Identifying objects in an image based on their boundaries	1 hour
9	Compute the Fourier Transform of the given images and add them using blend. Take the inverse Fourier Transform of the sum. Explain the result.	2 hours
10	Perform logical operations on the given images.	2 hours
11	Perform image enhancement, feature extraction studies and compression using DFT.	4 hours
12	Perform image enhancement, feature extraction studies and compression using DCT.	4 hours
13	Perform image enhancement, feature extraction studies and compression using DWT.	4 hours
	Total laboratory hours	**30 hours**

Mode of evaluation: Continuous Assessment & Final Assessment Test (FAT)			
Recommended by Board of Studies		28-02-2016	
Approved by Academic Council	No. 47	Date	05-10-2017

Course Code	Course Title	L	T	P	J	C
ECE3009	Neural Networks and Fuzzy Control	3	0	0	4	4
Pre-requisite	ECE2006 - Digital Signal Processing	Syllabus version				
		1.0				

Course Objectives:

1. To summarize basic learning laws and architectures of neural networks.
2. To describe supervised and unsupervised learning laws of Neural Networks.
3. To introduce Fuzzy Logic, Fuzzy relations and Fuzzy mathematics for designing a Fuzzy logic controller.
4. To discuss neuro fuzzy approaches like ANFIS and CANFIS.

Course Outcomes:

1. To translate biological motivations into various characteristics of artificial neural networks
2. To comprehend and analyze basic learning laws of neural networks and activation functions
3. To interpret associative memories for storing and recalling the input patterns
4. To learn and implement supervised and unsupervised learning algorithms for various applications.
5. To learn fuzzification and de-fuzzification methods for developing Fuzzy inference systems
6. To apply and integrate various neuro-fuzzy techniques for designing intelligent systems using ANFIS and CANFIS.
7. To design a model using neural networks and fuzzy logic for various applications.

Module:1	Introduction to Artificial Neural Networks	3 hours

Artificial neural networks and their biological motivation, terminology, models of neuron, topology, characteristics of artificial neural networks, and types of activation functions.

Module:2	Learning methods	7 hours

Error correction learning, Hebbian learning, perceptron – XOR problem– perceptron learning rule convergence theorem – adaline.

Module:3	Supervised Learning	9 hours

Introduction to ANN architecture, multilayer perceptron, back propagation learning algorithm, momentum factor, radial basis function network. Associative memory: Auto association, hetero association, recall and cross talk. Recurrent neural networks - Hopfield neural network.

Module:4	Unsupervised Learning	9 hours

Introduction, competitive learning neural networks, max net, Mexican hat, hamming net, Kohonen self organizing feature map, counter propagation, learning vector quantization, adaptive resonance theory, performance of SOM.

Module:5	Fuzzy Sets and Fuzzy Relations	4 hours

Introduction, classical sets and fuzzy sets, classical relations and fuzzy relations, membership function.

Module:6	Fuzzy Inference Systems	6 hours

Fuzzification, fuzzy arithmetic, numbers, extension principle, fuzzy inference system, defuzzification, fuzzy rule based systems, fuzzy nonlinear simulation, fuzzy decision making, fuzzy

optimization.		
Module:7	**Neuro-Fuzzy Systems**	**5 hours**
Introduction, ANFIS, ANFIS as universal approximator, CANFIS.		
Module:8	**Contemporary issues**	**2 hours**
	Total lecture hours:	**45 hours**

Text Book(s)

1.	J.S.R. Jang, C.T. Sun, E. Mizutani, Neuro Fuzzy and Soft Computing - A computational Approach to Learning and Machine Intelligence, 2012, 1st edition, PHI learning Private Limited, New Delhi.
2.	Timothy J. Ross, Fuzzy Logic with Engineering Applications, 2016, 4th edition, John Wiley and sons, USA

Reference Books

1.	Jacek. M. Zurada, Introduction to Artificial Neural Systems, 2014, 11th edition, Jaico Publishing House, Mumbai.
2.	Simon Haykin, Neural Networks and Learning Machines, 2016, 3rd edition, Pearson Education Inc. India
3.	Samir Roy, Udit Chakraborthy, Introduction to Soft Computing Neuro - Fuzzy and Genetic Algorithms, 2013, 1st edition, Pearson education, Noida.

Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

Typical Projects

1. Adaptive filtering for Medical (ECG) signals.
2. Adaptive Neuro Fuzzy Inference System
3. Automation of Traffic signal using Raspberry Pi
4. Cardiac Image Diagnostic System
5. Cryptographic System using Neural Networks
6. Design and Development of Biometric Recognition and Matching System
7. Digital Audio Watermark Embedding System
8. Electrical load forecasting using Neural Networks
9. Electronic Music System using ANN
10. Face Identification System using ANN
11. Feature Extraction of EEG Signals
12. Image Decryption using Neural Networks
13. Internal Fault identification using Artificial Neural Network
14. Signature Forgery and Handwriting Detection System
15. Smart Driver Assist System using Raspberry Pi
16. Speaker Recognition using Soft Computing
17. Speech Separation Using ICA Based Neural 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
ECE3010	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, models for radio-wave propagation, antenna radiating principles and fundamental characteristics, 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:5	HF and VHF Antennas	5 hours

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: Internal Assessment (CAT, Quizzes, Digital Assignments) & 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.

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: Internal Assessment (CAT, Quizzes, Digital Assignments) & 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**

Typical Projects

1. Design and development of miniaturized power dividers
   - 2 way power divider
   - 4 way power divider
2. Design and development of miniaturized power dividers
   - 90^0 hybrid coupler
   - Coupled line coupler
   - 180^0 hybrid coupler
3. Design and development of microwave filters
   - Low pass filter
   - Band pass filter
   - High pass filter
4. Design and development of microwave amplifiers
   - Low noise amplifier
   - Power amplifier
   - Maximum gain and specific gain

5. Design and development of transmission line matching network
    - Pi network
    - T-network
6. Design and development of waveguide based
    - E-plane Tee
    - H-plane Tee
    - Magic Tee
7. Design and development of compact coupled-line balun with complex impedances transformation.
8. Analysis and design of non-planar antenna for wireless communication system.
9. Design of antennas for wireless applications
    - Planar dipole
    - Planar monopole
    - RFID antenna
    - Inverted F antenna
    - Dual polarized antenna
    - MIMO antenna
10. Design and development of polarization microstrip array antenna for satellite communication system
    - Frequency polarization
    - Radiation pattern polarization

Mode of evaluation: Continuous Assessment & 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
ECE3013	Linear Integrated Circuits	3	0	2	0	4
Pre-requisite	ECE2002 – Analog Electronic Circuits	Syllabus version				
		1.1				

Course Objectives :

1. To understand the characteristics of Operational Amplifier.
2. To design various linear and non-linear circuits using operational amplifiers.
3. To acquaint and demonstrate the concepts on waveform generators, filter configurations, PLL, Timer, ADC and DAC.

Course Outcomes :

1. Comprehend the ideal and practical characteristics of op-amps and design fundamental circuits based on op-amps.
2. Design the negative feedback configuration of operational amplifier for various mathematical operations.
3. Design and analyze different waveform generator circuits using operational amplifiers.
4. Design and analyze various filter circuits using operational amplifiers.
5. Realize circuits containing PLL and IC 555
6. Comprehend various converter circuits.
7. Design and analyze the circuits for inverting and non-inverting amplifiers, differential amplifiers, simple amplifiers and comparators experimentally using IC LM741.

Module:1	Operational amplifier Characteristics	4 hours

Operational amplifier.equivalent circuits, ideal Operational amplifier, DC characteristics and AC characteristics, non-ideal characteristics.

Module:2	Linear Operational amplifier Circuits	8 hours

DC and AC amplifiers, summing, scaling, and averaging amplifiers, Instrumentation amplifiers, I/V and V/I converter, Integrator, Differentiator, Differential amplifiers. Operational amplifier with negative feedback: Voltage Series, Voltage Shunt feedback amplifier.

Module:3	Operational amplifier applications using Diodes	4 hours

Logarithmic amplifiers, Rectifiers, Peak detection and Voltage regulation

Module:4	Comparators and Waveform Generators	7 hours

Comparator and its applications, Schmitt trigger, Free-running, One-shot Multivibrators, Barkhausen Criterion, Sinewave generators, Phase-shift, Wein-bridge oscillators, Square, Triangular and Saw-tooth wave function generator.

Module:5	Active filters	7 hours

Filter classifications, frequency and impedance scaling, First and second order Low-pass and High pass filter designs, Band-pass filter, Notch filter.

Module:6	PLL and Timers	7 hours

PLL-Phase detector, comparator, VCO, Low-pass filter, PLL applications, 555 timer IC, Astable and Monostable operations and applications.

Module:7	**A/D and D/A Converters**	**6 hours**
Sample-and-hold circuits, DAC characteristics, D/A conversion techniques, A/D characteristics, A/D conversion techniques-integrating, successive approximation, flash converters.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1. J D. Roy Choudhury, Linear integrated Circuits, 2017, 5th Edition, New-Age International Publishers, Chennai.

Reference Books

1. Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, 2015, 4th Edition, Pearson Education, Bangalore.
2. Robert F. Coughlin and Frederick F. Driscoll, Operational Amplifiers and Linear Integrated Circuits, 2015, 6th Edition, Pearson Education, Bangalore.

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

List of Challenging Experiments (Indicative)

1	Study of internal structure of operational amplifier	2 hours
2	Design of Inverting, Non Inverting amplifiers and Voltage follower	2 hours
3	Mathematical operations using operational amplifier	2 hours
4	Design of Instrumentation amplifier	2 hours
5	Design and testing of Precision Rectifier.	2 hours
6	Design of Comparator and Schmitt trigger circuits	2 hours
7	Design of Square wave generator for a specified frequency and duty cycle, using operational amplifier IC741	2 hours
8	Design of Triangular wave generator from Square wave generator	2 hours
9	Design of a Sinusoidal oscillator for specified frequency-Wien bridge and RC phase shift oscillators using IC741	2 hours
10	Design of Audio Q Multiplier using IC741	2 hours
11	Design and testing of Active filters -LPF and HPF for specified frequency	2 hours
12	Design of Astable and Monostable Multivibrators using IC 555	2 hours
13	Design of A/D and D/A convertors	2 hours
14	Implementation of Analog Arithmetic Logic Unit (AALU)	2 hours
15	Design of Frequency multiplier using IC 565	2 hours
	Total laboratory hours	**30 hours**

Mode of evaluation: Continuous assessment & Final Assessment Test (FAT).

Recommended by Board of Studies	28-02-2016		
Approved by Academic Council	No. 47	Date	05-10-2017

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.

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, 2013, Pearson.
2.	Andrew N Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide, 2010, Morgan Kaufmann Publishers.

Reference Books:

1.	Joseph Liu, The Definitive guide to ARM Cortex M0, 2012, Newnes.
2.	Simon Monk, Programming Arduino Next Steps: Going further with sketches, 2014, McGraw Hill.

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

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: 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
ECE4003	Embedded System Design	2	0	2	4	4
Pre-requisite	ECE3003 - Microcontroller and its applications	Syllabus version				
		1.0				

Course Objectives:

1. To explain the definition, characteristics, challenges and design lifecycle of Embedded Systems. Also, highlight the principles of processor technologies, IC technologies, general-purpose processors and processor selection strategies.
2. To impart the fundamental knowhow of I/O interfacing, serial communication protocols, wireless technologies, design using UML and Petri Net models.
3. To introduce the concepts and features of Real-time operating systems, task scheduling, memory management, resource synchronization and inter-task communication.
4. To introduce various programming tools, modeling and simulation packages to program, design, simulate and build Embedded Systems

Course Outcomes:

1. Comprehend the applications, examples, characteristics, design challenges related to Embedded Systems. Able to design any application based on the given specifications by keeping in mind different design metrics.
2. Understand general-purpose processing and its principles; select a microprocessor/ microcontroller for a particular application.
3. Understand the process of interfacing basic peripherals.
4. Differentiate the pros and cons of various serial communication and wireless protocols and analyze UML diagrams and petri net models for a given application.
5. Differentiate the features of RTOS and GPOS and understand the concepts such as priority inversion, pre-emption, deadlocks, race conditions, inter-process communication and real-time task scheduling.
6. Model the working of ES using FSMs and UML designs apart from programming embedded software using suitable IDEs and free RTOS.
7. Design and implement algorithms for embedded systems.
8. Develop real-time working prototypes of different small-scale and medium-scale embedded Systems.

Module:1	Embedded system product development	4 hours

Characteristics of embedded systems, general purpose, customized, application specific processors, Embedded product development cycle.

Module:2	System design using general purpose processor	4 hours

Microcontroller architectures (RISC, CISC), Embedded Memory, Strategic selection of processor and memory.

Module:3	Programming the peripherals of microcontrollers	4 hours

Programming ADC, DAC, switches, keyboards, Timers / Counters, PWM generation, LED, LCD.

Module:4	Emerging bus standards and communication	4 hours

USB, PCI,UART, SPI, I2C, CAN, Bluetooth, Zigbee

Module:5	**Modeling embedded systems**	**4 hours**
Unified model language, examples, Petrinet model.		
Module:6	**Embedded Operating Systems**	**4 hours**
Process Management and Inter Process Communication, Memory Management, I/O sub- system & Embedded File Systems, POSIX Thread Programming, POSIX Semaphores, Mutexes, Message Queues, Debugging and Testing of Multi-Threaded Applications.		
Module:7	**Introduction to Real-Time Concepts**	**4 hours**
RTOS Internals & Real Time Scheduling, Performance Metrics of RTOS, Task Specifications, Schedulability Analysis, Application Programming on RTOS.		
Module:8	**Contemporary issues**	**2 hours**
	Total lecture hours:	**30 hours**

Text Book(s)

1.	Wayne Wolf, Computers as components: Principles of Embedded Computing System Design, 2013, 3rd edition, The Morgan Kaufmann Series in Computer Architecture and Design, United States

Reference Books

1.	Raj Kamal, Embedded systems Architecture, Programming and Design, 2017, 3rd edition, reprint, McGraw Hill Education, India.
2.	Steve Heath, Embedded Systems Design, 2013, 3rd edition, EDN Series, United States.
3.	Jane W. S. Liu, Real time systems, 2013, reprint, Pearson Education, UK

Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

List of Challenging Experiments (Indicative)

1	Device Control via Bluetooth • Sub Task 1: Interfacing devices with microcontroller via driver circuits. • Sub Task 2: Interfacing Bluetooth with microcontroller for data transfer. • Sub Task 3: Creating Android APK for controlling devices.	6 hours
2	Parameter Monitoring via CAN protocol • Sub Task 1: Interfacing sensors with Microcontroller. • Sub Task 2: Interfacing display unit/actuators with microcontroller. (can be implemented by I2C protocol) • Sub Task 3: CAN Bus communication between controller	8 hours
3	RTOS Based Parameter Monitoring and Controlling System. • Sub Task 1: collecting the data from sensor interfaced with microcontroller. • Sub Task 2: interfacing display devices/actuators with microcontroller. • Sub Task 3: inter task/process communication between task/process.	8 hours
4	RTOS Based Data transfer between microcontrollers using Communication	8 hours

	Protocol. • Sub Task 1: Creating tasks for interfacing sensors with microcontroller. • Sub Task 2: Creating tasks for interfacing display unit/actuators with microcontroller. (can be implemented by I2C protocol) • Sub Task3: CAN Bus communication between controller	
	Total laboratory hours	**30 hours**

Mode of evaluation: Continuous Assessment & Final Assessment Test (FAT)

Typical Projects

1. Develop a Micro controller-based precision agriculture which includes accessing real-time data about the conditions of the crops, soil and ambient air. Sensors in fields measure the moisture content and temperature of the soil and surrounding air.
2. Design a Microcontroller based automated patient monitoring system which continuously measures the patient parameters such as heart rate and rhythm, respiratory rate, blood pressure and many other parameters has become a common feature the care of critically ill patients. When accurate and immediate decision-making is crucial for effective patient care, electronic monitors frequently are used to collect and display physiological data.
3. Develop a Microcontroller based waste management system, where the sensors are placed in the common garbage bins placed at the public places. When the garbage reaches the level of the sensor, then that indication will be given to Microcontroller. The controller will give indication to the driver of garbage collection truck as to which garbage bin is completely filled and needs urgent attention. The controller will give indication by sending SMS using GSM technology.
4. Implement a Digital Clock and Alarm using microcontroller that needs a keypad to be interfaced with the following requirement. Key 1 to turn on alarm, Key 2 to enable alarm settings, Key 3 to enable time settings, Key 4 to change hour's settings, Key 5 to change minute settings, Key 6 to increment the time, Key 7 to decrement the time. The normal time and alarm time should be displayed using 2 X 16 LCD and a buzzer should be triggered once the normal time equal to alarm time.
5. Design face recognition based Authenticated Door Opening System using FPGA. Database consisting of authorized persons faces should be created and the same should be compared with the real time camera input faces such that if face matching happens the door actuator needs to be triggered to open the door.

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
ECE4004	Embedded C and Linux	3	0	2	4	5
Pre-requisite	ECE3003 - Microcontroller and its applications	Syllabus version				
		1.0				

Course Objectives:

1. To develop awareness about Embedded C and Linux and the range of applications to which they are suited.
2. To develop API (Application Peripheral Interface) in C for 8051
3. To develop Shell programming
4. To develop awareness about Process management

Expected Course Outcomes:

1. Program Embedded Systems in C language
2. Handle Interfacing issues of 8051 microcontroller
3. Do shell programming in Linux
4. Do Resource management for Embedded Systems
5. Do Inter Process Communication for Embedded Systems
6. Write simple device drivers for embedding intelligence in embedded systems.
7. Develop Microcontroller-based application
8. Know Embedded C and Linux and the range of applications to which they are suited.

Module:1	Introduction to C programming	7 hours

Basic concepts of C, Embedded C vs C, programming aspects with respect to firmware and OS, functions, arrays, Pointers, File I/O and bit level operations.

Module:2	Embedded C	7 hours

Modular programming-Multiple file programs, Extern and static declaration (for variable and for functions)-how executable file are created-the compiler-the linker-project structure- Object libraries-Advanced use of Pointers-void pointers, pointers to functions-Pointers to structures.

Module:3	Interfacing issues of 8051 microcontroller	6 hours

The external interface of the Standard 8051-Reset requirements- Clock frequency and performance-Memory issues- I/O pins-Timers-Interrupts-Serial interface-Power consumption.

Module:4	Programming Embedded Systems in C	6 hours

Embedded world-Reading switches-Adding Structure to the code–object oriented programming with C-Meeting real time constraints-using the serial interface.

Module:5	Basics of Linux	6 hours

Command prompt –Navigating file system –finding files – working with folders – reading files text editing in Linux – Compression and archiving tools.

Module:6	Linux Programming Concepts	6 hours

Shell programming - File Management – I/O Handling – File Locking.

Module:7	Resource management and Inter Process Communication	5 hours

Process Management – Memory Management – Message Queues – Shared Memory – Semaphores.

Module:8	**Contemporary issues**	**2 hours**
	Total lecture hours	**45 hours**

Text Book(s)

1. Michael J. Pont, Embedded C, 2015, 1st edition reprint, Pearson Education India.
2. Neil Mathew, Richard stones, Beginning Linux Programming, 2011, 4th edition, Wrox – Wiley Publishing, USA.

Reference Books

1. Brian W. Kernighan, The C programming language, 2015, 2nd edition, Prentice Hall PTR, USA.

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

List of Challenging Experiments (Indicative)

1	**Task-1: Development of API (Application Peripheral Interface) in C for 8051 to control the speed of motor.** • Sub task-1: use timer and generate an exact time delay for T_{ON} and T_{OFF} • Sub task-2: use timer interrupt in generating the waveform • Sub tast-3: controlling speed of a DC motor using Timer	6 hours
2	**Task-2: Microcontroller based application** • Sub task-1: Interface Zigbee with 8051 • Sub task-2: Interface keypad with 8051 • Sub task-3: Interface GSM with 8051 • Sub task-4: based on KEY pressed in keypad, transmit the key info via Zigbee and make a motor to rotate, which is interfaced with 8051. Using GSM module send the status of motor[run/stop] to the user.	6 hours
3	**Task–3:** Development of API (Application Peripheral Interface) in C for 8051 LCD (Liquid Crystal Display), Keypad, buzzer and implementation of Musical Keypad System. **Task Calculator Application** • Sub task 1: make the LCD interfaced to 8051 • Sub task 2: get input from switch which is interfaced to 8051 and display it on LCD • Sub task 3: Based on switch input, perform basic operation of a calculator	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

	• A flexible inventory management system	
5	**Task-5 : Process Management** • Sub Task 1: 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 child process (ii) Process ID and parent process ID for process and child process while sleep in the parent. (iii) Process ID and parent process ID for process and child process while sleep in a child. • Sub task 2: Create a pipe system call to communicate between the parent process and child process. • Sub Task 3: Write an implementation of Message queue, shared memory and semaphore inter process communications	6 hours
	Total laboratory hours	**30 hours**

Mode of evaluation: Continuous Assessment & Final Assessment Test (FAT)

Typical Projects

1. Design a 8051 based automated patient monitoring system which continuously measures the patient parameters such as heart rate and rhythm, respiratory rate, blood pressure and many other parameters has become a common feature of the care of critically ill patients. When accurate and immediate decision-making is crucial for effective patient care, electronic monitors frequently are used to collect and display physiological data.
2. A busy highway is intersected by a little used farm road. Detectors C sense the presence of cars waiting on the farm road. With no car on farm road, light remains green in highway direction. If vehicle on farm road, highway lights go from Green to Yellow to Red, allowing the farm road lights to become green. These stay green only as long as a farm road car is detected but never longer than a set interval. When these are met, farm lights transition from Green to Yellow to Red, allowing highway to return to green. Even if farm road vehicles are waiting, highway gets at least a set interval as green.
3. Assume you have an interval timer that generates a short time pulse (TS) and a long time pulse (TL) in response to a set (ST) signal. TS is to be used for timing yellow lights and TL for green lights.
4. Development of employee database management system using C Programming with the following features.
   - Company master module
   - Employee module
   - Leave module
   - Loan module
   - Salary module
   - Reports module
   - Help module
   - Exit module
5. 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. • A flexible inventory management system			
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
ECE4005	Optical Communication and Networks	2	0	2	4	4
Pre-requisite	ECE4001: Digital Communication Systems	Syllabus version				
		1.0				

Course Objectives:

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

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:	**30 hours**

Text Book(s)	
1.	Gerd Keiser, Optical Fiber Communications, 2013, McGraw Hill, 5th Edition.
2.	J. M. Senior, Optical Fiber Communications: Principles and Practice, 2011, Pearson..
Reference Books	
1.	Cvijetic, M., Djordjevic. I. B.: Advanced Optical Communication Systems and Networks, 2012, Artech House.
2.	R. Ramaswami & K.N. Sivarajan, Morgan Kaufmann, Optical Networks A practical perspective, 2010, 2nd Edition, Pearson Education.
3.	G.P Agrawal, Fiber Optic Communication Systems, Wiley, 2011, 2nd Edition.
4.	B.Mukerjee, Optical WDM Networks (Optical Networks), 2006, Springer edition
5.	G. P. Agrawal, Nonlinear Fiber Optics, 2008, 2nd Edition, Academic Press.

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

Typical Projects

1. Design of a DWDM link(50 Ghz grid)with multiple backward pumped Raman amplification
2. Chromatic dispersion and its effects on data transmission
3. EDFA wavelength division multiplexing
4. Penalties due to fiber induced loss
5. Topology schematic for the signal channel
6. Compensation of dispersion with fiber bragg grating component and DCF
7. Single mode fiber design
8. Analysis of fiber nonlinearity.
9. Simulated assisted design of free space optical transmission system
10. Design of Optical Fiber Transmitter And Receiver

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				
		1.1				

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

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: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

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)
0	0
30	-1.5
150	-1.4
310	-3.6
370	-0.6
710	-9.1
1090	-7
1730	-12
2510	-16.9

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
ECE4008	Computer Communication	3	0	2	0	4
Pre-requisite	ECE4001 - Digital Communication Systems	Syllabus version				
		1.0				

Course Objectives:

1. To familiarize with the basic terminologies and concepts of OSI, TCP/IP reference model and functions of various layers.
2. To understand the ARQ protocols, design and performance issues associated with the functioning of LANs and WLANs.
3. To introduce IP addressing and basics of transport layer protocol.

Course Outcomes:

1. List and explain the functions of the OSI, TCP/IP reference models and differentiate between various switching techniques and internetworking devices.
2. Able to analyze the network topologies and interconnecting devices using Transparent and Source Routing bridges.
3. Able to analyze the different topologies, error detection techniques and ARQ protocol.
4. Comprehend the various types of LAN and WAN technologies.
5. Describe routing techniques and design subnets.
6. Explain and demonstrate the functioning of TCP and UDP.
7. Comprehend the basics of DNS, FTP, SMTP and HTTP.
8. Analyze the performance of internetworking devices, various LAN, WLAN and routing protocols using simulation tools.

Module:1	**Layered Network Architecture**	**5 hours**
Evolution of data networks – Switching techniques – Categories of networks - ISO/OSI Reference model – TCP/IP model		
Module:2	**Network Topologies and Internetworking devices**	**6 hours**
Network topologies - Repeaters – Hubs – Switches – Bridges - Transparent and source routing– Routers.		
Module:3	**Data Link Layer**	**8 hours**
Logical link control – Error detection techniques – ARQ protocols – Framing – HDLC –Point to point protocol - Medium access control – Random access protocols – Scheduling approaches to MAC.		
Module:4	**Local Area Networks& Wide Area Networks**	**6 hours**
Ethernet- Token bus/ring - FDDI – Virtual LAN - WAN Technologies – Frame Relay - ATM - Wireless LAN		
Module:5	**Network Layer**	**8 hours**
Internetworking – IP addressing – Subnetting – IPv4 and IPv6 – Routing – Distance vector and link state routing – Routing protocols.		
Module:6	**Transport Layer**	**6 hours**
Connection oriented and connectionless service – User Datagram Protocol (UDP) – Transmission Control Protocol (TCP) – Congestion control – QoS parameters.		
Module:7	**Application Layer**	**4 hours**
Domain Name System (DNS) – Simple Mail Transfer Protocol (SMTP) – File Transfer Protocol (FTP) – Hypertext Transfer Protocol (HTTP) - World Wide Web (WWW)		
Module:8	**Contemporary Issues**	**2 hours**

	Total lecture hours:	**45 hours**
Text Book(s)		
1.	Alberto Leon-Garcia, Communication Networks, 2013, 2nd edition, Tata McGraw-Hill, USA.	
Reference Books		
1.	Robert Gallager, Data Networks, 2013, 2nd edition, Prentice Hall, USA.	
2.	W. Stallings, Data and Computer Communications, 2013, 8th edition, Pearson Prentice Hall, USA.	
3.	Behrouz A Forouzan, Data Communications and Networking, 2012, 5th edition, Tata McGraw-Hill, USA.	
Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)		
List of Challenging Experiments (Indicative)		
1	1. Create a simple network model with multiple scenarios, collect statistics on network performance through the use of simulation tools, analyze statistics and draw conclusions on network performance. 2. Performance analysis of layer 1 and layer 2 (physical and data link layer) devices in LAN. 3. Compare the throughput and delay of a Local Area Network interconnected by a switch by creating a switched LAN with __4_____ nodes. Assume voice traffic and use the voice codec standards G.711, G.723 and G.729. Also analyze the voice custom traffic for the throughput of 200 kbps and 64 kbps	6 hours
2	Analyse the spanning tree algorithm by varying the priority among the switches: 1. Observe and explain the default behavior of spanning tree protocol (STP, 802.1D) 2. Observe the response to a change in the spanning tree topology	4 hours
3	Analyze IPV4 using Class A, B & Class C.	4 hours
4	An ISP is granted a block of addresses starting with 190.100.0.0/24 (65,536 addresses). The ISP needs to distribute these addresses to three groups of customers as follows: 1. The first group has 64 customers; each needs 256 addresses. 2. The second group has 128 customers; each needs 128 addresses. 3. The third group has 128 customers; each needs 64 addresses. Design the subnetting of sub blocks and find out how many addresses are still available after these allocations.	4 hours
5	Examine the network and 1. Identify connectivity problems- Use the ping command to test network connectivity. 2. Troubleshoot network connections 3. Begin troubleshooting at the host connected to the router. 4. Examine the router to find possible configuration errors. 5. Use the necessary commands to correct the router configuration. 6. Verify the logical configuration.	4 hours
6	Configure, apply real-time routing protocols (RIP/OSPF) in a simple network topology and analyze the routing tables and check the network connectivity	4 hours

7	Recommend suitable Queuing mechanism among the following 1.First - In - First - out 2.Priority Queuing 3.Weighted Fair Queuing for Voice, Video & Custom traffic by creating a network using nodes, switches & routers using NETSIM Tool.	4 hours
	Total laboratory hours	**30 hours**

Mode of evaluation: Continuous Assessment & Final Assessment Test (FAT)			
Recommended by Board of Studies	28-02-2016		
Approved by Academic Council	No. 47	Date	05-10-2017

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 with different generations of mobile networks.
3. To teach the fundamentals of multipath fading and propagation models.
4. To describe the modulation and diversity schemes as applied in mobile communication.

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: Internal Assessment (CAT, Quizzes, Digital Assignments) & 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	4 hours

	b. CQI variations in different sub bands	
	Total laboratory hours	**30 hours**
Mode of evaluation: Continuous Assessment & 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
ECE4010	Satellite Communication	3	0	0	0	3
Pre-requisite	ECE4001 - Digital Communication Systems	Syllabus version				
		1.0				

Course Objectives:

1. To have a conceptual knowledge of communication through satellites.
2. To have a detailed understanding of navigation - both inertial and by navigation satellites.
3. To analyze typical challenges of satellite based systems.

Course Outcomes:

1. Understand the concept of orbits, launch vehicles and satellites
2. Comprehend the design of satellite subsystems
3. Imbibe the basics of digital transmission related to satellite communication
4. Have an in-depth knowledge of navigation satellite services.
5. Understand the impact of diverse parameters on satellite link design
6. Appreciate the applications of satellite systems

Module:1	Elements of Orbital Mechanics	6 hours

Overview of satellite communication - Orbital mechanics - Equations of the orbit - Kepler's laws of planetary motion - Orbital elements - Look angle determination - Orbital perturbation and determination.

Module:2	Orbital Launchers	3 hours

Launches and launch vehicles- Launch vehicle selection factors - Satellite positioning into geostationary orbit - Orbital effects in communication systems performance - Doppler shift - Range variations - Solar eclipse and sun transit outage.

Module:3	Elements of Communication Satellite Design	5 hours

Satellite subsystems - Attitude and orbit control electronics - Telemetry and tracking - Power subsystems - Communication subsystems - Satellite antennas - Reliability and redundancy- Frequency modulation techniques.

Module:4	Digital Transmission Basics	4 hours

Multiple access techniques – FDMA, TDMA, CDMA, SDMA, ALOHA and its types – Onboard processing- Satellite switched TDMA – Spread spectrum transmission and reception for satellite networks.

Module:5	Satellite Link Design	9 hours

Basic transmission theory – System noise temperature and G/T Ratio- Noise figure and noise temperature- Calculation of system noise temperature – G/T ratio for earth stations - Link budgets - Uplink and downlink budget calculations - Error control for digital satellite links - Prediction of rain attenuation and propagation impairment counter measures.

Module:6	VSAT Systems	9 hours

Overview of VSAT systems - Network architectures – One way implementation – Split IP implementation – Two way implementation – Access control protocols – Delay considerations - VSAT earth station engineering - System design procedure and calculation of link margins for VSAT network.

Module:7	Direct Broadcast Satellite Television systems and GPS	7 hours

DBS TV system design - Direct broadcast satellite television transmitters and receivers - DBS TV link budget - Radio and satellite navigation –GPS position location principles – GPS navigation messages and signal levels - GPS receivers design – Role of satellites in future networks –

Advanced error control codes for satellite systems.		
Module:8	**Contemporary Issues**	**2 hours**
	Total lecture hours:	**45 hours**

Text Book(s)	
1.	T. Pratt, C.W. Boastian and Jeremy Allnutt Satellite Communication, 2013, 2nd edition, John Wiley and Sons, Bangalore, India.
Reference Books	
1.	Madhavendra Richharia, Mobile Satellite Communications: Principles and Trends, 2014, 2nd edition, John Wiley and Sons, United Kingdom.
2.	D.Roddy, Satellite Communications, 2011, 4th edition (sixth reprint), Tata McGraw Hill, New York.
3.	W.L. Pritchard and H.G Suyderhoud, Satellite Communication Systems Engineering, 2011, 2nd edition, Pearson Education, India.
4.	Teresa M. Braun, Satellite Communications Payload and System, 2012, 1st edition, John Wiley and Sons, USA
5.	ichael Olorunfunmi Kolawole, Satellite Communication Engineering, 2013, 2nd edition, CRC Press, India.
6.	Daniel Minoli, Innovations in Satellite Communication and Satellite Technology, 2015, 1st edition, Wiley. New Delhi, India.

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

Recommended by Board of Studies	13-02-2016		
Approved by Academic Council	No.47	Date	05-10-2017

Course Code	Course Title	L	T	P	J	C
ECE4011	Wireless Sensor Networks	2	0	2	4	4
Pre-requisite	ECE4008: Computer Communication	Syllabus version				
		1.1				

Course Objectives:

1. To introduce the state-of-the-art in wireless sensor networks and to provide knowledge about architectures related to wireless sensor networks.
2. To study the applications of wireless sensor networks
3. To understand and analyze the basic WSN technology and supporting protocols.
4. To acquaint with various sensor network simulation tools and provide hands on training in programming.

Course Outcomes:

1. Understand the concepts of sensor network architecture, challenges and applications of wireless sensor networks
2. Understand and analyze the sensor node architecture, protocol design and Gateway concepts
3. Understand the design constraints and requirements of Physical Layer in Sensor Network Stack
4. Acquire an overview of the various network level protocols for MAC, routing, time synchronization and data aggregation in wireless sensor networks
5. Analyze the higher-level decision making that directs network packets from their source towards their destination through intermediate network nodes by specific packet forwarding mechanisms
6. Analyze the low power communication standards and IP addressing mechanism
7. Analyze the various hardware, software platforms that exist for sensor networks, realize them through simulation
8. Build and deploy a wireless sensor system for real world application for various use cases

Module:1	Introduction	4 hours

Ad hoc Networks - Applications of Ad Hoc Wireless Networks - Issues in Ad Hoc Wireless Networks – Sensor versus Ad Hoc Networks - Technical Challenges and design principles of Wireless Sensor Networks – Sensor Network Applications

Module:2	Sensor Node and Architecture	4 hours

Single Node Architecture and protocol stack – Hardware Components – Energy Consumption of Sensor Nodes, Sensor Network Scenarios, Gateway Concepts

Module:3	Physical Layer	2 hours

Design Constraints and Requirements - Physical Layer and Transceiver Design

Module:4	Data Link Layer	5 hours

Link layer fundamentals and requirements – Link management - MAC Protocols — S-MAC , Low Duty Cycle and Wakeup concepts – Contention Based – Schedule Based, IEEE 802.15.4 Standard – PHY/MAC Slotted - Unslotted CSMA/CA- GTS Mechanism

Module:5	Network Layer	5 hours

Need for routing protocol- Energy aware routing- Location based routing : GF, GAF, GEAR,

GPSR, Attribute based routing – Directed diffusion, Rumor routing, Geographic hash tables		
Module:6	**Wireless Personal Area Network**	**3 hours**
Zigbee and 6LoWPAN Network Layer Design		
Module:7	**WSN Tools, Platforms and Applications**	**5 hours**
Programming Challenges; Node-Level Platforms; Node-Level Simulator; Home Control, Building Automation, Industrial Automation, Medical Applications		
Module:8	**Contemporary Issues**	**2 hours**
	Total lecture hours:	**30 hours**

Text Book(s)	
1.	Holger Karl and Andreas Wiilig, Protocols and Architectures for Wireless Sensor Networks, 2017, 1st Edition, John Wiley and Sons Limited, New Delhi, India.
2.	Kazem Sohraby, Daniel Minoli, & Taieb Znati, Wireless Sensor Networks-Technology, Protocols, and Applications, 2016, 1st Edition, John Wiley and Sons Limited, New Delhi, India.
Reference Books	
1.	Jun Zheng and Abbas Jamalipour, Wireless Sensor Networks- A Networking Perspective, 2014, 1st Edition, John Wiley and Sons Limited, New Delhi, India.
2.	Feng Zhao & Leonidas J. Guibas, Wireless Sensor Networks- An Information Processing Approach, 2014, 1st Edition, Elsevier, India.

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

List of Challenging Experiments (Indicative)

Simulation Tools/ Software used in Experiments : NetSim/Qualnet

Hardware experiments : Sensor Motes

1	Simulation analysis of range based localization techniques	3 hours
2	Analyze the effect of variable sensing rates and data transmission rate on the power consumption of a sensor node	3 hours
3	Performance analysis of CSMA/ CA (slotted, un-slotted) MAC protocol.	3 hours
4	Analysis of various real world sensors (temperature, humidity, light intensity, rain gauge etc.) and to demonstrate data acquisition from a sensor node.	3 hours
5	Evaluate different topologies recommended for a wireless sensor network.	3 hours
6	Simulation analysis of multi-hop communication vs. direct transmission	3 hours
7	Study and analyze WSN algorithms for clustering of sensor nodes.	3 hours
8	Evaluate static clustering technique with respect to WSN life time and throughput.	3 hours
9	Study and demonstrate the role of gateways (forwarding nodes) in inter cluster / cluster to sink data transmissions.	3 hours
10	Design and analyze the performance of any two routing techniques prescribed for WSN architecture (Energy aware routing- Location	3 hours

	based routing : GF, GAF, GEAR, GPSR, Attribute based routing – Directed diffusion, Rumor routing, Geographic hash tables)	
	Total laboratory hours	**30 hours**

Mode of evaluation: Continuous Assessment & Final Assessment Test (FAT)

Typical Projects

i. Investigate and research on many challenging problems in wireless sensor networks:
   a. Data aggregation/collection
   b. Tasking and control
   c. Routing
   d. Topology control

ii. Implement and build real-world wireless sensor systems:
   a. Temperature sensor networks
   b. RFID inventory management
   c. People management
   d. Monitoring Mechanisms for Wireless Sensor Network
   e. Medical Applications Based on Wireless Sensor Networks
   f. Wireless Sensors Based System for Home Energy Consumption
   g. Zigbee Based Remote Health Monitoring

ii. Research on wireless sensor network management framework.
   a. To come out with a general architecture that supports many different types of sensor network management like static, mobile wireless sensor networks

Mode of evaluation: Review I, II and III.

Recommended by Board of Studies	13-12-2015		
Approved by Academic Council	No. 40	Date	18-03-2015

Course Code	Course Title	L	T	P	J	C
ECE4013	Cryptography and Network Security	3	0	0	0	3
Pre-requisite	ECE2005 Probability Theory and Random Process	Syllabus version				
		1.2				

Course Objectives:

1. To introduce the basic concepts in security mechanism, classical and traditional Encryption techniques.
2. To understand the significance of message authentication and digital signature in cryptography.
3. To acquaint the different types of network security and its significance.

Course Outcomes:

1. Comprehend and analyze OSI Security Architecture and Symmetric Key Encryption.
2. Comprehend the various mathematical techniques in cryptography, including number theory, Finite Field, Modulo operator and Discrete Logarithm.
3. Able to analyse block ciphers, Data Encryption Standard (DES), Advanced Encryption Standard (AES) and public key cryptography.
4. Able to analyse Diffie-Hellman key exchange, ElGamal Cryptosystem in asymmetric key cryptosystem.
5. Comprehend the various types of data integrity and authentication schemes.
6. Comprehend the various network security mechanism

Module:1	**Classical Encryption Techniques:**	**5 hours**
Introduction, Security Services and Mechanisms, Classical Encryption Techniques		
Module:2	**Mathematical Foundations:**	**6 hours**
Number Theory and Finite Fields, Principles of Pseudorandom Number Generation, Fermat's and Euler's Theorems, The Chinese Remainder Theorem, Discrete Logarithms, Elliptic Curve Arithmetic		
Module:3	**Symmetric Ciphers:**	**8 hours**
Block Ciphers and encryption standards - DES, AES, Pseudorandom Number Generation, Stream Ciphers, Public-Key Cryptography – RSA		
Module:4	**Asymmetric Ciphers:**	**6 hours**
Diffie-Hellman Key Exchange, ElGamal Cryptosystem, Elliptic Curve Cryptography, Pseudorandom Number Generation Based on an Asymmetric Cipher		
Module:5	**Data Integrity:**	**6 hours**
Cryptographic Hash Functions, Message Authentication Codes		
Module:6	**Mutual Trust:**	**6 hours**
Digital Signatures, Key Management and Distribution, User Authentication Protocols		
Module:7	**Network Security:**	**6 hours**
Transport-Level Security, WLAN Security – Firewalls, Web Security, Software Security, IoT threats, Security issue in Cognitive Networks, constraints and challenges		
Module:8	**Contemporary Issues**	**2 hours**
	Total lecture hours:	**45 hours**

Text Book(s)

1. William Stallings, Cryptography and Network security: Principles and Practice, 2014, 5th Edition, Pearson Education, India.

Reference Books			
1.	Christof Paar and Jan Pelzl, Understanding Cryptography – A Textbook for Students and Practitioners, 2014, Springer.		
2.	Behrouz A.Forouzan: Cryptography & Network Security, 2010, The McGraw Hill Company.		
Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)			
Recommended by Board of Studies	28-02-2016		
Approved by Academic Council	No.47	Date	05-10-2017

Course Code	Course Title	L	T	P	J	C
MAT3005	Applied Numerical Methods	3	1	0	0	4
Pre-requisite	MAT2002 – Applications of Differential and Difference Equations	Syllabus Version				
		1.0				

Course Objectives

The aim of this course is to

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

Course Outcome

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

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

Module:1	Algebraic and Transcendental Equations	5 hours

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

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

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

Module:3	Interpolation	6 hours

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

Module:4	Numerical Differentiation and Integration	6 hours

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

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

Text Book(s)

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

Reference Books

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

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

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
PHY1002	Materials Science	3	0	2	0	4
Pre-requisite	PHY1701-Engineering Physics	Syllabus version				
		1.0				

Course Objectives:

To enable the students to understand the nature of different types of materials namely Conducting, Semi conducting, Dielectrics, Magnetic and Superconducting materials.

Course Outcome: Students will be able to

1. Understand the fundamentals of physics for conducting materials and how it is pertinent for engineering related applications
2. Describe the basic classification of semiconducting materials and how to develop an engineering related devices
3. Describe the fundamental polarization mechanism involved in dielectrics and how it is responsible with different frequency of radiation including how stress and strain plays a major role in piezoelectric.
4. Learn the basic magnetization concepts in detail and study different properties of magnetic materials, including the analysis of various magnetic properties and its applications.
5. Describe the phenomenon of super conduction and explain how superconductors behave in magnetic fields including some engineering applications of superconductors.
6. Gain the basic phenomenon behind the mechanism between materials and light and how a material blacking, absorbing and enhancing the light including the complete idea of negative index and negative materials by understanding the universal parameters of permeability and permittivity.
7. Gain an introduction to nanomaterials and in depth knowledge about synthesis and properties of bulk and nanostructured materials, including their applications.
8. Demonstrate electrical, thermal, dielectric, semiconducting and magnetic properties of materials – LAB

Module:1	Conducting Materials	6 hours

Drude-Lorentz Classical free electron theory of metals, electrical conductivity, relaxation time, drift velocity, Matthiessen's rule, thermal conductivity Wiedemann-Franz law, drawbacks of classical theory, Kronig-Penny Model, Quantum theory (derivation) and its success, Band theory of solids.

Module:2	Semiconducting Materials	7 hours

Band theory of solids – Kronig-Penney Model & its success; P and N type – direct and indirect semiconductor; Density of energy state; Variation of Fermi level with respect to temperature and carrier concent rat ion in intrinsic and extrinsic semiconductors; Hall effect – theory – experimental proof; Hall Sensors, Problems.

Module:3	Dielectric Materials	7 hours

Introduction, Clausius-Mosotti relation; Polarization mechanisms, electronic, ionic and orientation, Temperature dependence of dielectric constant, Frequency dependence of dielectric constant, Dielectric loss, dielectric breakdown types, dielectric materials as electrical insulators - examples, Problems, Ferroelectric and Piezoelectric materials

Module:4	Magnetic Materials	6 hours

Magnetic parameters and their relations - Origin of magnetization– orbital magnetic, moment, spin magnetic moment, Bohr magneton, Properties of dia, para, ferro, antiferro and ferromagnetic

materials - Domain theory of ferromagnetism, Hysteresis, soft and hard magnetic materials, Application-computer hard disk		
Module:5	**Superconducting Materials**	**6 hours**
Superconductors, types, properties, Meissner Effect, BCS theory, High Tc Superconductors (YBCO). Applications- Josephson Effect-SQUID-Cryotron; Problems.		
Module:6	**Metamaterials**	**6 hours**
Introduction, Natural and Artificial Materials, Photonic Bandgap Materials, Equivalent plasma frequency of a wire medium, Resonant elements for metamaterials, Polarizability of a current - carrying resonant loop, Effective permeability, Effect of negative materials constants.		
Module:7	**Material Synthesis**	**6 hours**
Material synthesis processes, PVD sputtering, Chemical Vapor deposition (CVD), Examples: preparation of thin films, bulk and nanomaterials (any one material).		
Module:8	**Contemporary issues:**	**2 hours**
Guest lecture by industry experts		
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	C.M. Srivasta and Srinivasan, Science of Engineering Materials, 2003, Tata McGraw Hill Publications.
2.	M S Vijaya & G Rangarajan, Materials Science, 2003, Tata McGraw – Hill Publishing Company Ltd.
3.	M. Ali Omar, Elementary Solid State Physics, 1975, Pearson Education India.
4.	L. Solymar and D. Walsh, Electrical Properties of Materials (eighth edition, 2010), Oxford university Press.

Reference Books

1.	Pillai S O, Solid State Physics, 2007, revised sixth edition, New Age International (P) Ltd.
2.	S.O. Kasap, Principles of Electronic Materials and devices, 2002, Second edition, Tata McGraw – Hill Publishing Company Ltd.
3.	Van Vlack L, Materials Science for Engineers, 1995, Addison Wesley.
4.	Raghavan V, Materials Science and Engineering, 1998, Prentice – Hall of India, New Delhi.
5.	M S Vijaya & G Rangarajan, Materials Science, 2003, Tata McGraw – Hill Publishing Company Ltd.
6.	Donald A. Neamen, Semiconductor Physics & Devices, Tata McGraw Hill Publication.
7.	Milton Ohring, Materials Science of Thin Films, 2002, Academic Press.
8.	P.Bhattacharya, Semiconductor Optoelectronic Devices, 1994, Prentice Hall.

Mode of Evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

List of Challenging Experiments (Indicative)

1.	Thermal and Electrical Conductivity of a Good Conductor	2 hours
2.	Dielectric study - dielectric behavior of a ferroelectric ceramic material at various temperature and determine the curie temperature	2 hours
3.	Hall Effect - Determine the Hall coefficient of a given Germanium (Semiconductor) crystal	2 hours
4.	Solar Cell - Draw I-V characteristic of a solar cell and determine the maximum power generated from solar cell, fill factor and efficiency.	2 hours

5.	Magnetic Susceptibility - by Quinke's Method	2 hours
6.	Band Gap - using four probe method	2 hours
7.	Schering bridge: To find unknown capacitance and reactance of the circuit	2 hours
8.	B-H curve of magnetic materials	2 hours
9.	Determination of the electron spin g-factor (Lande g-factor) of a given sample by ESR spectrometer	2 hours
	Total laboratory hours	**30 hours**

Mode of evaluation: Continuous Assessment & Final Assessment Test (FAT)			
Recommended by Board of Studies	05-03-2016		
Approved by Academic Council	No. 40	Date	18-03-2016

Course Code	Course Title	L	T	P	J	C
ECE3046	Computer Vision and Pattern Recognition	3	0	0	0	3
Pre-requisite	ECE2006 – Digital signal Processing	Syllabus version				
		1.0				

Course Objectives :

1. To develop algorithms and techniques for analyzing and interpreting the real world scenarios.
2. To introduce the concepts related to multi-dimensional signal processing, feature extraction, pattern analysis.
3. To explore and contribute to research and further developments in the field of computer vision.
4. To investigate and develop object recognition algorithms supporting real-world scenarios.

Course Outcomes :

1. Able to understand digital image formation and low-level processing.
2. Able to perceive the diverse perspectives of digital imaging
3. Able to interpret, analyze and apply the different feature extraction methods.
4. Able to recognize various motion patterns, analyze and classify the same
5. Able to recognize and detect objects
6. Able to identify and recognize human faces
7. Able to identify and recognize instances

Module:1	Introduction	7 hours

Introduction to computer vision, Image Formation – Digital Camera and optics –Light and color properties – Sampling and quantization - Enhancement Techniques – Spatial, frequency Domain.

Module:2	Morphology representation and segmentation	5 hours

Morphological operators, Boundary descriptor, Regional descriptors, Segmentation – Thresholding techniques, Edge , Region based segmentation

Module:3	Feature detection and Matching	8 hours

Interest points and corners, Local image features, Model fitting, Detectors and Key point Descriptors, SIFT, RANSAC and transformations.

Module:4	**Multiple views and motion**	**4 hours**
Stereo introduction and camera calibration, epipolar geometry and structure from motion, Stereo correspondence and optical flow, Geometric alignment.		
Module:5	**Supervised Recognition**	**6 hours**
Patterns and pattern classes – template matching – Active appearance and 3D shape models Introduction to classification – Decision theoretic methods – Bayesian classifier- Support vector Machine-ANN		
Module:6	**Unsupervised Recognition**	**8 hours**
Clustering techniques – K – Means algorithm – Hierarchical clustering- Cluster evaluation methods – similarity measures.		
Module:7	**Applications**	**5 hours**
Data Base and Test Set, Object Detection, Pedestrian detection, Face recognition, Instance recognition, Medical diagnosis, Deep Learning concepts & Transfer learning: CV applications.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Richard Szeliski , Computer Vision: Algorithms and Applications, Springer, 2011.

Reference Books

1.	E.R. Davies -Computer and Machine Vision : Theory , Algorithms, Practicalities – Elsevier Publication, 2012
2.	David A.Forsyth and Jean Ponce, Computer Vision – A Modern approach, Pearson education inc,2012
3.	Goodfellow, I., Bengio,Y., and Courville, A., Deep Learning, MIT Press, 2016.
4.	Richard O. Duda, Peter E. Hart and David G. Stork, “Pattern Classification”, John Wiley & Sons, Second edition, 2007.

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final

Assessment Test (FAT)			
Recommended by Board of Studies	05-02-2020		
Approved by Academic Council	No. 58	Date	26-02-2020

Course Code	Course Title	L	T	P	J	C
ECE3047	Machine Learning Fundamentals	3	0	2	0	4
Pre-requisite	MAT3004-Applied Linear Algebra	Syllabus version				
		1.0				

Course Objectives :

1. To understand the importance and significance of Machine Learning
2. To get acquainted with different types of regression
3. To understand the diverse methods of data classification
4. To preface the essentials of mathematical optimization

Course Outcomes :

1. To comprehend different types of learning
2. To identify data discrepancies and eliminate anomalies
3. To predict the outcome based on regression
4. To compute optimal hyperplane and support vectors for data classification
5. To solve numericals based on Baye's classifier
6. To appreciate clustering as an unsupervised learning methods
7. To realize the usage of optimization in solving real-world engineering problems

Module:1	Introduction	4 hours

Common definitions – Applications – Types of Learning – Supervised, Unsupervised, Reinforcement. Performance measure

Module:2	Data Preprocessing	6 hours

Basics of Vectors & Matrices – Overview : Data cleaning, Integration , Transformation & Reduction

Module:3	Regression	7 hours

Linear – Multi Linear Regression(MLR) – Logistic –Model Estimation – Evaluation

Module:4	Classification	7 hours

Introduction – Hyperplane – Radial Basis Function (RBF) –Support Vector Machine (SVM) – Support Vector Regression (SVR)- Random Forest (RF)- Case Study.

Bayes' theorem – Parameter Estimation – Distribution - Classifier – Networks – K-Nearest Neighbors- Case Study.

Module:5	**Clustering**	**7 hours**
Introduction - Mixture Densities - Types – Partitioning, Hierarchical – Supervised Learning after Clustering- Choosing number of Clusters- Applications.		
Module:6	**Optimization**	**7 hours**
Introduction - Classification – Derivative-based, Derivative-free.		
Module:7	**Reinforcement Learning**	**5 hours**
Introduction to RL, Immediate RL, Bandit Algorithm, Montecarlo methods.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Alpaydin Ethem, Introduction to Machine Learning, 3rd Edition, PHI learning private limited, 2019.

Reference Books

1.	Deisenroth, Marc Peter, A. Aldo Faisal, and Cheng Soon Ong. Mathematics for machine learning. Cambridge: Cambridge University Press, 2019.
2.	Marsland, Stephen. Machine learning: an algorithmic perspective. Chapman and Hall/CRC, 2014.
3.	Anuradha Srinivasaraghavan and Vincy Joseph. Machine Learning, Wiley Publisher, 2019.

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

List of Challenging Experiments (Indicative)

Software: Python, Numpy, Tensorflow, Keras, Pandas, OpenCV

Appropriate datasets from the following repository (suggestive) can be utilised

1. https://archive.ics.uci.edu/ml/datasets.html
2. http://sci2s.ugr.es/keel/datasets.php#sub1

List of experiments:

Algorithms to be practised include,

1. Linear & Multi-Linear Regression
2. Naive Bayes classifier
3. Decision trees
4. Logistic regression
5. Support Vector Machines – Linear & Non-linear
6. Single & Multilayer Perceptrons
7. K-NN, K-Means & K-mode clustering
8. Random – forest
9. Self – Organizing maps

	Total laboratory hours	**30 hours**

Mode of evaluation: Continuous assessment & Final Assessment Test (FAT).

Recommended by Board of Studies	05-02-2020		
Approved by Academic Council	No. 58	Date	26-02-2020

Course Code	Course Title	L	T	P	J	C
ECE3048	Deep Learning	3	0	0	0	3
Pre-requisite	MAT3004 - Applied Linear Algebra	Syllabus version				
		1.0				

Course Objectives :

1. To understand the importance of Deep Learning
2. To get familiarized with deep feedforward neural networks
3. To get acquainted with diverse regularization strategies
4. To understand the role of optimization on deep learning models

Course Outcomes :

1. To analyze different learning techniques using regularization parameters
2. To build a deep feedforward network
3. To focus on regularization strategies for building deep models
4. To optimize the performance of deep learning
5. To analyze the impact of Convolution on simple neural networks
6. To process sequential data using recurrent neural networks
7. To apply deep learning algorithms for solving real-world engineering problems

Module:1	Machine Learning Basics	4 hours

Review of Machine Learning techniques – Capacity, Overfitting & Underfitting – Hyperparameters & Validation sets – Estimators, Bias and Variance - Supervised and Un-supervised learning algorithms, Stochastic Gradient Descent. Artificial Neural networks - Concepts.

Module:2	Deep Feedforward Networks	6 hours

Learning XOR – Gradient Based learning – Hidden Units – Architecture Design - , Back propagation and other differentiation algorithms.

Module:3	Regularization	9 hours

Norm penalties – Constrained & Under-constrained problems-Dataset augmentation- Early Stopping –Sparse representations-Ensemble methods – Dropout.

Module:4	Optimization for training deep models	7 hours

Learning & Optimization - Challenges in Optimization – Basic algorithms – Algorithms with adaptive learning rate - Approximate Second-Order Methods, Optimization Strategies and Meta-Algorithms.		
Module:5	**Convolutional Neural Networks**	**7 hours**
Convolution operation – Pooling – Efficient convolution algorithms		
Module:6	**Sequence Modelling**	**7 hours**
Recurrent Neural Networks (RNN) – Bi-directional RNN – Long Short-term Memory (LSTM) - Gated Recurrent Unit (GRU) – Deep Recurrent Networks		
Module:7	**Applications**	**3 hours**
Computer vision – Speech recognition – Natural Language Processing		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Goodfellow, Ian, Yoshua Bengio, and Aaron Courville, "Deep Learning", MIT press, 2016.

Reference Books

1.	Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani, An Introduction to Statistical Learning with Applications in R, Springer, New York, 2013.
2.	S.N. Deepa, S.N. Sivanandam, "Principles of Soft Computing", Wiley India Pvt. Ltd., 2011.
3.	Buduma, Nikhil, and Nicholas Locascio. Fundamentals of deep learning: Designing next-generation machine intelligence algorithms. "O'Reilly Media, Inc.", 2017.
4.	Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017.
5.	Umberto Michelucci "Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks" Apress, 2018.

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

Recommended by Board of Studies	05-02-2020		
Approved by Academic Council	No. 58	Date	26-02-2020

Course Code	Course Title	L	T	P	J	C
ECE4033	IoT System Design and Applications	3	0	2	0	4
Pre-requisite	ECE3003 - Microcontroller and Applications	Syllabus version				
		1.0				

Course Objectives :

1. To teach students the fundamental design concepts of Internet of Things (IoT).
2. To acquaint the students with the hardware components, various networking protocols and software platforms used to build an end-to-end IoT system.
3. To familiarize students with the data analytics, machine learning algorithms used in IoT systems.
4. To apprise the students about the choices of sensors, boards and cloud services in designing a typical IoT application.

Course Outcomes :

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

1. Identify the different components of an IoT system and their purpose.
2. Select suitable sensors and embedded board to fit into a specified IoT application.
3. Choose appropriate protocols to interpret the data from an IoT system.
4. Evaluate the various data analytics tool and machine learning algorithms and employ suitable techniques.
5. Design and develop an IoT system architecture using appropriate hardware/ software components for the given use case.
6. Explore Edge and Cloud computing platforms for IoT
7. Case studies of IoT in different verticals.

Module:1	Hardware subsystem of IoT	7 hours

IoT system Architecture and Design approaches, IoT Standards, Ubiquitous computing and Internet of Things. IoT communication Requirements: IoT Network design fundamentals, Low power design considerations for IoT Sensors. Sensor interfacing, Actuator Interfacing, Wireless MCU/MPU – Architecture.

Module:2	Networking Subsystem for IoT	6 hours

Ethernet – ESP shield, Wi-Fi, IEEE 802.15.4, ZigBee, Bluetooth, LoRa, 4G & 5G networking paradigms.

Module:3	Programming IoT Devices- Peripheral Interfacing	6 hours

Programming the IoT devices using C/C++/Python – Digital and Analog I/O units, SPI & I2C

protocol.		
Module:4	**Programming IoT devices – Networking to cloud**	**12 hours**
Networking – SSH, Sockets, Network libraries and web services. Retrieving data from real world sensors. Working with cloud – Publishing data, setting up IoT analytics at cloud.		
Module:5	**IoT Edge to cloud protocols**	**7 hours**
MQTT, MQTT – SN, CoAP, HTTP, RestFul API, AMQP. Significance of gateway design, characteristics, protocol bridging, implementations. Edge analytics at devices and gateways.		
Module:6	**Data Analytics and Machine learning in the Cloud and Edge**	**6 hours**
Data analytics in IoT – Azure/Watson/AWS. Data Ingestion & complex Event processing. Streaming Analytics. Training and inference for IoT - Cloud rendering of training data - Model training and packaging - Deployment and delivery of new models - Execution of the trained model on an edge device.		
Module:7	**Case studies for IoT**	**3 hours**
IoT for Home automation, Smart Cities, Smart Agriculture. IoT for predictive analytics and maintenance. Smart Medical data sensing and applications in Healthcare.		
Module:8	**Contemporary Issues**	**2 hours**
	Total Lecture hours:	**45 hours**

Text Book(s)

1.	Perry Lea, “Internet of Things for Architects”, 1st edition, Packt Publishing, 2018.
2.	Subhas Chandra Mukhopadhyay, “Internet of Things Challenges and opportunities”, Springer, 2015.
3.	Daniel Minoli “Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications”, Wiley, 2015.

Reference Books

1.	Gatson. C Hiller, "Internet of Things with Python", Packt Publishing, 2016.
2.	Samuel Greengard, "The Internet of Things (Essential Knowledge)", MIT Press, 2015.
3.	Rajkumar Buyya and Satish Narayanan Srirama, "Fog and Edge computing – Principles and Paradigms", Wiley, 2019.
4.	Amita Kapoor, "Hands-on Artificial Intelligence for IoT", Packt Publishing, 2019.

Mode of evaluation: Internal Assessment (CAT, Quizzes, Digital Assignments) & Final Assessment Test (FAT)

List of Challenging Experiments (Indicative)

List of experiments:

1. Porting Yocto Linux in Intel Edison - Board Bringup
2. Porting Rasbian Linux in R Pi3 – Board Bringup
3. Controlling GPIO using MQTT
4. Controlling LED's using RESTful API
5. Using MQTT with Mosquito and Eclipse Paho
6. Measuring ambient Temperature from sensors and publishing using MQTT/RESTful API's
7. Setting Up Intelligent Gateway.
8. Deploying IoT analytics at cloud suing Azure/Watson/AWS for temperature prediction
9. Waste Management / Smart light in Smart City
10. Predicting tomorrow's temperature with past and present data
11. Predicting monthly current/power consumption
12. Predictive analytics – Implementation in pacemaker
13. LoRaWAN based smart city implementation

	Total laboratory hours	**30 hours**

Mode of evaluation: Continuous assessment & Final Assessment Test (FAT).

Recommended by Board of Studies	05-02-2020		
Approved by Academic Council	No. 58	Date	26-02-2020

Course Code	Information Security Analysis and Audit	L	T	P	J	C
CSE3501	Job Role: SSC/Q0901	2	0	2	4	4
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Objective of the course

1. To introduce system security related incidents and insight on potential defenses, counter measures against common threat/vulnerabilities.
2. To provide the knowledge of installation, configuration and troubleshooting of information security devices.
3. To make students familiarize on the tools and common processes in information security audits and analysis of compromised systems.

Expected Outcome

After successfully completing the course the student should be able to

1. Contribute to managing information security
2. Co-ordinate responses to information security incidents
3. Contribute to information security audits
4. Support teams to prepare for and undergo information security audits
5. Maintain a healthy, safe and secure working environment
6. Provide data/information in standard formats
7. Develop knowledge, skills and competence in information security

Module: 1	Information Security Fundamentals	7 hours

Definitions & challenges of security, Attacks & services, Security policies, Security Controls, Access control structures, Cryptography, Deception, Ethical Hacking, Firewalls, Identify and Access Management (IdAM).

Module: 2	System Security	6 hours

System Vulnerabilities, Network Security Systems, System Security, System Security Tools, Web Security, Application Security, Intrusion Detection Systems.

Module: 3	Information Security Management	3 hours

Monitor systems and apply controls, security assessment using automated tools, backups of security devices, Performance Analysis, Root cause analysis and Resolution, Information Security Policies, Procedures, Standards and Guidelines.

Module: 4	Incident Management	5 hours

Security requirements, Risk Management, Risk Assessment, Security incident management, third party security management, Incident Components, Roles.

Module: 5	Incident Response	4 hours

Incident Response Lifecycle, Record, classify and prioritize information security incidents using standard templates and tools, Responses to information security incidents, Vulnerability Assessment, Incident Analysis.

Module: 6	Conducting Security Audits	3 hours

Common issues in audit tasks and how to deal with these, Different systems and structures that may need

information security audits and how they operate, including: servers and storage devices, infrastructure and networks , application hosting and content management, communication routes such as messaging, Features, configuration and specifications of information security systems and devices and associated processes and architecture, Common audit techniques, Record and report audit tasks, Methods and techniques for testing compliance.		
Module: 7	**Information Security Audit Preparation**	2 hours
Establish the nature and scope of information security audits, Roles and responsibilities, Identify the procedures/guidelines/checklists, Identify the requirements of information security, audits and prepare for audits in advance, Liaise with appropriate people to gather data/information required for information security audits.		
Module: 8	**Self and Work Management**	2 hours
Establish and agree work requirements with appropriate people, Keep the immediate work area clean and tidy, utilize time effectively, Use resources correctly and efficiently, Treat confidential information correctly, Work in line with organization's policies and procedures, Work within the limits of their job role.		
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	William Stallings, Lawrie Brown, Computer Security: Principles and Practice, 3rd edition, 2014.
2.	Nina Godbole, Information Systems Security: Security Management, Metrics, Frameworks and Best Practices, Wiley, 2017
3.	Nina Godbole, Sunit Belapure, Cyber Security- Understanding cyber-crimes, computer forensics and legal perspectives, Wiley Publications, 2016
4.	Andrew Vladimirov Michajlowski, Konstantin, Andrew A. Vladimirov, Konstantin V. Gavrilenko, Assessing Information Security: Strategies, Tactics, Logic and Framework, IT Governance Ltd, O'Reilly, 2010

Reference Books

1.	Charles P. Pfleeger, Security in Computing, 4th Edition, Pearson, 2009.
2.	Christopher J. Alberts, Audrey J. Dorofee , Managing Information Security Risks, Addison-Wesley Professional, 2004
3.	Peter Zor, The Art of Computer Virus Research and Defense, Pearson Education Ltd, 2005
4.	Lee Allen, Kevin Cardwell, Advanced Penetration Testing for Highly-Secured Environments - Second Edition, PACKT Publishers, 2016
5.	Chuck Easttom , System Forensics Investigation and Response, Second Edition, Jones & Bartlett Learning, 2014
6.	David Kennedy, Jim O'Gorman, Devon Kearns, and Mati Aharoni, Metasploit The Penetration
7	Tester's Guide, No Starch Press, 2014
8.	Practical Malware Analysis by Michael Sikorski and Andrew Honig, No Starch Press, 2015
9.	Ref Links: https://www.iso.org/isoiec-27001-information-security.html https://csrc.nist.gov/publications/detail/sp/800-55/rev-1/final https://www.sans.org/reading-room/whitepapers/threats/paper/34180 https://www.sscnasscom.com/qualification-pack/SSC/Q0901/

List of Experiments (Indicative)		
	• Install and configure information security devices • Security assessment of information security systems using automated tools. • Vulnerability Identification and Prioritization • Working with Exploits • Password Cracking • Web Application Security Configuration • Patch Management • Bypassing Antivirus Software • Static Malware Analysis • Dynamic Malware Analysis • Penetration Testing • MySQL SQL Injection • Risk Assessment • Information security incident Management • Exhibit Security Analyst Role	
	Total Laboratory Hours	**30 hours**

Recommended by Board of Studies	08-02-2020		
Approved by Academic Council	No.58	Date	26-02-2020

Course Code	Information Security Management	L	T	P	J	C
CSE3502	Job Role: SSC/Q0901	2	0	2	4	4
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Objective of the course

1. To introduce system security related incidents and insight on potential defenses, counter measures against common threat/vulnerabilities.
2. To provide the knowledge of installation, configuration and troubleshooting of information security devices.
3. To make students familiarize on the tools and common processes in information security audits and analysis of compromised systems.

Expected Outcome

After successfully completing the course the student should be able to

1. Contribute to managing information security
2. Co-ordinate responses to information security incidents
3. Contribute to information security audits
4. Support teams to prepare for and undergo information security audits
5. Maintain a healthy, safe and secure working environment
6. Provide data/information in standard formats
7. Develop knowledge, skills and competence in information security

Module:1	Information Security Devices	5 hours

Identify And Access Management (IdAM), Networks (Wired And Wireless) Devices, Endpoints/Edge Devices, Storage Devices, Servers, Infrastructure Devices (e.g. Routers, Firewall Services) , Computer Assets, Servers And Storage Networks, Content management, IDS/IPS.

Module:2	Security Device Management	6 hours

Different types of information security devices and their functions,
Technical and configuration specifications, architecture concepts and design patterns and how these contribute to the security of design and devices.

Module: 3	Device Configuration	5 hours

Common issues in installing or configuring information security devices, Methods to resolve these issues, Methods of testing installed/configured information security devices.

Module: 4	Information Security Audit Preparation	5 hours

Establish the nature and scope of information security audits, Roles and responsibilities, Identify the procedures/guidelines/checklists, Identify the requirements of information security, audits and prepare for audits in advance, Liaise with appropriate people to gather data/information required for information security audits. **Security Audit Review -**
Organize data/information required for information security audits using standard templates and tools, Audit tasks, Reviews, Comply with the organization's policies, standards, procedures, guidelines and checklists, Disaster Recovery Plan

Module: 5	Team Work and Communication	2 hours

Communicate with colleagues clearly, concisely and accurately , Work with colleagues to integrate their work effectively, Pass on essential information to colleagues in line with organizational requirements, Identify any problems they have working with colleagues and take the initiative to solve these problems, Follow the organization's policies and procedures for working with colleagues.		
Module: 6	**Managing Health and Safety**	2 hours
Comply with organization's current health, safety and security policies and procedures, Report any identified breaches in health, safety, and Security policies and procedures, Identify, report and correct any hazards, Organization's emergency procedures, Identify and recommend opportunities for improving health, safety, and security.		
Module: 7	**Data and Information Management**	3 hours
Fetching the data/information from reliable sources, Checking that the data/information is accurate, complete and up-to-date, Rule-based analysis of the data/information, Insert the data/information into the agreed formats, Reporting unresolved anomalies in the data/information.		
Module: 8	**Learning and Self Development**	2 hours
Identify accurately the knowledge and skills needed, Current level of knowledge, skills and competence and any learning and development needs, Plan of learning and development activities to address learning needs, Feedback from appropriate people, Review of knowledge, skills and competence regularly and appropriate action taken		

	Total Lecture hours:	**30 hours**

Text Book(s)

1.	Information Systems Security: Security Management, Metrics, Frameworks and Best Practices, Nina Godbole, Wiley, 2017
2.	Rhodes-Ousley, Mark. Information Security: The Complete Reference, Second Edition, . Information Security Management: Concepts and Practice. New York, McGraw-Hill, 2013.
3.	Christopher J. Alberts, Audrey J. Dorofee , Managing Information Security Risks, Addison-Wesley Professional, 2004

Reference Books

1.	Andrew Vladimirov Michajlowski, Konstantin, Andrew A. Vladimirov, Konstantin V. Gavrilenko, Assessing Information Security: Strategies, Tactics, Logic and Framework, IT Governance Ltd, O'Reilly 2010
2.	Christopher J. Alberts, Audrey J. Dorofee , Managing Information Security Risks, Addison-Wesley Professional, 2004
3.	Chuck Easttom , System Forensics Investigation and Response, Second Edition, Jones & Bartlett Learning, 2014
4.	David Kennedy, Jim O'Gorman, Devon Kearns, and Mati Aharoni, Metasploit The Penetration
5.	Tester's Guide, No Starch Press, 2014 Ref Links: https://www.iso.org/isoiec-27001-information-security.html https://www.sans.org/reading-room/whitepapers/threats/paper/34180 https://csrc.nist.gov/publications/detail/sp/800-40/version-20/archive/2005-11-16 https://www.sscnasscom.com/qualification-pack/SSC/Q0901/

List of Experiments (Indicative)		
1.	• Install and configure information security devices • Penetration Testing • MySQL SQL Injection • Information security incident Management • Intrusion Detection/Prevention • Port Redirection and Tunneling • Exploring the Metasploit Framework • Working with Commercial Tools like HP Web Inspect and IBM AppScan etc., • Explore Open Source tools like sqlmap, Nessus, Nmap etc • Documentation with Security Templates from ITIL • Carry out backups of security devices and applications in line with information security policies, procedures and guidelines • Information security audit Tasks - Procedures/guidelines/checklists for the audit tasks.	
	Total Laboratory Hours	**30 hours**

Recommended by Board of Studies	08-02-2020		
Approved by Academic Council	No.58	Date	26-02-2020

Course Code	Foundations of Data Analytics	L	T	P	J	C
CSE3505	Job Role: SSC/Q2101	2	0	2	4	4
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. To establish clearly the objectives and scope of the predictive analysis
2. Use R programming language to identify suitable data sources to agree the methodological approach
3. Validate and review data accurately and identify anomalies
4. To appreciate the current trends in data analysis procedure
5. Carry out rule-based analysis of the data in line with the analysis plan
6. Apply statistical models to perform Regression Analysis, Clustering and Classification
7. Present the results and inferences from your analysis using R tool
8. To improve document management and team work

Expected Course Outcome:

Students will be able to:

1. Understand R with Business Intelligence, Business Analytics, Data and Information
2. Contextually integrate and correlate information automatically to gain faster insights
3. Implement statistical analysis techniques for solving practical problems.
4. Graphically interpret data and Find a meaningful pattern in data
5. Perform statistical analysis on variety of data.

Module:1	Introduction to Analytics	4 hours

Analytics life cycle - Business analytics - lending analytics- recommendation analytics- Healthcare Analytics- financial analytics - sports analytics

Module:2	R programming Basics	5 hours

Introduction to R, R Studio (GUI): R Windows Environment, introduction to various data types, Numeric, Character, date, data frame, array, matrix etc.,

Module:3	Working with datasets and files:	6 hours

Reading Datasets, Working with different file types .txt,.csv , R studio, Files, Datasets, Extracting Datasets, Preparing datasets. Data Cleaning, Data imputation, Data conversion Analysis

Module:4	Introduction to statistical learning and R-Programming	6 hours

Basic statistics: mean, median, standard deviation, variance, correlation, covariance - Outliers, Combining Datasets in R, Functions and loops. Summary Statistics - Summarizing data with R - Correlation and Regression

Module:5	Document Creation and Knowledge Sharing:	3 hours

Access existing documents, language standards, templates and documentation tools from their

organization's knowledge base. Confirm the content and structure of the documents with appropriate people, Create documents using standard templates and agreed language standards. Review documents with appropriate people and incorporate their inputs		
Module:6	**Self and work Management:**	**3 hours**
Establish and agree their work requirements with appropriate people - Keep their immediate work area clean and tidy - utilize their time effectively - Use resources correctly and efficiently - Treat confidential information correctly - Work in line with organization's policies and procedures - Work within the limits of their job role		
Module:7	**Team Work and Communication**	**3 hours**
Communicate with colleagues clearly, concisely and accurately - Work with colleagues to integrate their work effectively with them - Pass on essential information to colleagues in line with organizational requirements - Work in ways that show respect for colleagues - carry out commitments they have made to colleagues - Let colleagues know in good time if they cannot carry out their commitments, explaining the reasons - Identify any problems they have working with colleagues and take the initiative to solve these problems		
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	Trevor Hastie and Rob Tibshirani, "An Introduction to Statistical Learning with Applications in R", Springer, 2017.
2.	Mark van der Loo, Edwin de Jonge, "Learning R Studio for R Statistical Computing", Packt Publishing, 2012.
3.	Jure Leskovek, Anand Rajaraman and Jeffrey Ullman. "Mining of Massive Datasets". Cambridge University Press. 2014.

Reference Books

1.	Hadley Wickham and Garrett Grolemund, "R for Data Science: Import, Tidy, Transform, Visualize, and Model Data", O'Reilly, 2017.
2.	Grolemund, Garrett. "Hands-on programming with R", O' Reilly Media, Inc., 2014.
3.	Christopher D. Manning, Prabhakar Raghavan, Hinrich Schutze, "Introduction to Information Retrieval", Cambridge University Press, First South Asian Edition, 2008.
4.	Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer, Second Edition, 2011.
5.	https://www.sscnasscom.com/qualification-pack/SSC/Q2101/

List of Challenging Experiments (Indicative)

1.	Understanding of R System and installation and configuration of R-Environment and R-Studio, Understanding R Packages, their installation and management	
2.	Understanding of nuts and bolts of R: a. R program Structure b. R Data Type, Command Syntax and Control Structures c. File Operations in R	
3.	Dataframes and lists	

4.	Excel and R integration with R connector.	
5.	Preparing Data in R a. Data Cleaning b. Data imputation c. Data conversion	
6.	Manipulating Matrices in R	
7.	Outliers detection using R	
8.	Correlation and N-Fold cross validation in R	
9.	Debugging and Program Efficiency in R	
10.	Visualizing data using R with different type of graphs and charts	
	Total Laboratory Hours	**30 hours**

Recommended by Board of Studies	08-02-2020		
Approved by Academic Council	No.58	Date	26-02-2020

Course Code	Essentials of Data Analytics	L	T	P	J	C
CSE3506		2	0	2	4	4
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. To understand the concepts of analytics using various machine learning models.
2. To appreciate supervised and unsupervised learning for predictive analysis
3. To understand data analytics as the next wave for businesses looking for competitive advantage
4. Carry out rule-based analysis of the data in line with the analysis plan
5. Validate the results of their analysis according to statistical guidelines
6. Validate and review data accurately and identify anomalies
7. To learn aspects of computational learning theory
8. Apply statistical models to perform Regression Analysis, Clustering and Classification

Expected Course Outcome:

1. Use a tool to implement typical clustering algorithms for different types of applications
2. Identify applications suitable for different types of machine learning with suitable
3. justification
4. Apply machine learning techniques to text classification and clustering which is used for efficient Information Retrieval
5. Implement statistical analysis techniques for solving practical problems.
6. Ability to apply and implement learned algorithm design techniques and models to solve problems.

Module:1	Regression Analysis	6 hours

Linear regression: simple linear regression - Regression Modelling - Correlation, ANOVA, Forecasting, Autocorrelation

Module:2	Classification	6 hours

Logistic Regression, Decision Trees, Naïve Bayes-conditional probability - Random Forest - SVM Classifier

Module:3	Clustering	4 hours

K-means, K-medoids, Hierarchical clustering

Module:4	Optimization	3 hours

Gradient descent - Variants of gradient descent - Momentum - Adagrad - RMSprop - Adam - AMSGrad

Module:5	Managing Health and Safety	4 hours

Comply with organization's current health, safety and security policies and procedures - Report any identified breaches in health, safety, and security policies and procedures to the designated person - Identify and correct any hazards that they can deal with safely, competently and within

the limits of their authority - Report any hazards that they are not competent to deal with to the relevant person in line with organizational procedures and warn other people who may be affected.		
Module:6	**Data and Information Management**	**4 hours**
Establish and agree with appropriate people the data/information they need to provide, the formats in which they need to provide it, and when they need to provide it - Obtain the data/information from reliable sources - Check that the data/information is accurate, complete and up-to-date		
Module:7	**Data and Information Management**	**3 hours**
Obtain advice and guidance from appropriate people to develop their knowledge, skills and competence - Identify accurately the knowledge and skills they need for their job role - Identify accurately their current level of knowledge, skills and competence and any learning and development needs - Agree with appropriate people a plan of learning and development activities to address their learning needs		
	Total Lecture hours:	**30 hours**

Text Book(s)

1.	Cathy O'Neil and Rachel Schutt. "Doing Data Science, Straight talk from the Frontline", O'Reilly. 2014.
2.	Dan Toomey, "R for Data Science", Packt Publishing, 2014.
3.	Trevor Hastie, Robert Tibshirani and Jerome Friedman. "Elements of Statistical Learning", Springer , Second Edition. 2009.
4.	Kevin P. Murphy. "Machine Learning: A Probabilistic Perspective", MIT Press; 1st Edition, 2012.

Reference Books

1.	Glenn J. Myatt, "Making Sense of Data : A Practical Guide to Exploratory Data Analysis and Data Mining", John Wiley & Sons, Second Edition, 2014.
2.	G. K. Gupta, ―Introduction to Data Mining with Case Studies", Easter Economy Edition, Prentice Hall of India, 2006.
3.	Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.
4.	Colleen Mccue, "Data Mining and Predictive Analysis: Intelligence Gathering and Crime Analysis", Elsevier, 2007.
5.	R N Prasad, Seema Acharya, "Fundamentals of Business Analytics", Wiley; Second edition, 2016.
6.	https://www.sscnasscom.com/qualification-pack/SSC/Q2101/

List of Experiments (Indicative)

1.	Linear regression analysis	
2.	Forecasting - weather dataset using R	
3.	Gradient descend implementation using R	
4.	Text Analytics – Sentiment Analysis using R, Word cloud analysis using	

	R	
5.	Time Series Components(Trend, Seasonality, Cyclicity and Level)	
6.	Banking Sector: Understand customer spend & repayment behavior, along with evaluating areas of bankruptcy, fraud, and collections. Also, respond to customer requests for help with proactive offers and service.	
7.	Retail Case Study: A retail store requires analyzing the day-to-day transactions and keeping a track of its customers spread across various locations and their purchases/returns across various categories. The objective of the case study is to understand customer behavior in-terms of purchase and returns through various Data Manipulation steps in R.	
8	Movie Recommendation System: To understand the functioning of how a recommendation system works. Develop an Item Based Collaborative Filter using Netflix dataset	
9.	Case study on Stock Market Analysis and applications. Stock data can be obtained from Yahoo! Finance, Google Finance. A team of students can apply statistical modeling on the stock data to uncover hidden patterns. R provides tools for moving averages, auto regression and time-series analysis which forms the crux of financial applications.	
10.	Detect credit card fraudulent transactions - The dataset can be obtained from Kaggle. The team will use a variety of machine learning algorithms that will be able to discern fraudulent from non-fraudulent one.	
	Total Laboratory Hours	**30 hours**

Recommended by Board of Studies	08-02-2020		
Approved by Academic Council	No.58	Date	26-02-2020

Course Code	IoT Fundamentals	L	T	P	J	C
ECE3501	Job Role: SSC/Q8210	2	0	2	4	4
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. To impart knowledge on the infrastructure, sensor technologies and networking technologies of IoT.
2. To analyse, design and develop IoT solutions.
3. To explore the entrepreneurial aspect of the Internet of Things
4. To apply the concept of Internet of Things in the real world scenarios

Expected Course Outcome:

After successfully completing the course the student should be able to

1. Identify the main component of IoT
2. Program the controller and sensor as part of IoT
3. Assess different Internet of Things technologies and their applications

Module:1	Introduction:	2 hour

IT-ITeS/BPM Industry – An Introduction, the relevance of the IT-ITeS sector, **Future Skills – An Introduction,** General overview of the Future Skills sub-sector

Module:2	Internet of Things - An Introduction:	3 hours

Evolution of IoT and the trends, Impact of IoT on businesses and society, Existing IoT use cases and applications across industries.

Module:3	IoT Security and Privacy:	6 hours

Security and privacy risks, analyze security risks, Technologies and methods that mitigate security, Privacy standards and regulations, Social and privacy impacts

Module:4	IoT Solutions	6 hours

IoT use case development, Need and Goals for IoT solution, Adoption of IoT solutions, Planning for IoT Solution: Evaluate costs, competition, technology challenges and internal resource considerations, Need for stakeholder buy-in

Module:5	Prototyping the Pilot execution:	5 hours

Prototype developing Stages, deploy real-time UI/UX visualizations, Methods and metrics to analyze and convey business outcomes, feedback and data obtained from execution.

Module:6	Scalability of IoT Solutions:	5 hours

Roadmap for developing complete IoT solutions, Strategies for implementation, key Milestone, Scalability of IoT Solutions, Methods, platforms and tools. Web and Mobile Interfaces

Module:7	Build and Maintain Relationships at the Workplace,	3 hours

	Team Empowerment	
	Total Lecture hours:	**30 hours**

Text Book(s)

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A hands-on Approach", University Press, 2015.
2. Adrian McEwen & Hakim Cassimally, "Designing the Internet of Things", Wiley,Nov 2013, (1 st edition)
3. Claire Rowland, Elizabeth Goodman, Martin Charlier, Ann Light, Algred Lui," Designing Connected Products: UX for the consumer internet of things", O'Reilly, (1 st edition),2015.

Reference Books

1. Rethinking the Internet of things: A Scalable Approach to Connecting Everything by Francis daCosta, Apress, 2014
2. Learning Internet of Things by Peter Waher, Packt Publishing, 2015
3. Designing the Internet of Things, by Adrian Mcewen, Hakin Cassimally , Wiley India Private Limited
4. Cloud Computing, Thomas Erl, Pearson Education, 2014
5. Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud, William Stallings, Addison-Wesley Professional; 1 edition
6. https://nsdcindia.org/sites/default/files/MC_SSCQ8210_V1.0_IoT-Domain%20Specialist_09.04.2019.pdf

List of Experiments

1. Measure the light intensity in the room and output data to the web API.
2. Control your home power outlet from anywhere using raspberry pi.
3. Build a web based application to automate door that unlocks itself using facial recognition.
4. Drinking water monitoring and analytics, consists of IoT device, cloud, and mobile and web app.
5. Smart Parking System
6. IoT based Healthcare application
7. Real-time environmental monitoring and weather prediction
8. Traffic pattern prediction
9. Smart Street light
10. Plant health monitoring

Total Laboratory Hours	30 hours

Recommended by Board of Studies	08-02-2020		
Approved by Academic Council	No.58	Date	26-02-2020

Course Code	IoT Domain Analyst	L	T	P	J	C
ECE3502	Job Role: SSC/Q8210	2	0	2	4	4
Pre-requisite	NIL	Syllabus version				
		v.1.0				

Course Objectives:

1. To impart knowledge on the infrastructure, sensor technologies and networking technologies of IoT.
2. To analyse, design and develop IoT solutions.
3. To explore the entrepreneurial aspect of the Internet of Things
4. To apply the concept of Internet of Things in the real world scenarios

Expected Course Outcome:

After successfully completing the course the student should be able to

1. Identify the main component of IoT
2. Program the controller and sensor as part of IoT
3. Assess different Internet of Things technologies and their applications

Module:1	IoT Solution Models:	3 hour

Models applied in IoT solutions, Semantic models for data models, Application of semantic models, information models, information models to structure data, relationships between data categories.

Module:2	Data Models :	3 hours

Tags to organize data, tag data to pre-process large datasets, predictive models for forecasting, Application of predictive models.

Module:3	Simulation Scenarios:	4 hours

Models to simulate real-world scenarios, Application of the models, stages of data lifecycle, reuse existing IoT solutions, reusability plan.

Module:4	Use Case Development	4 hours

Approaches to gather business requirements, defining problem statements, business requirements for use case development, Assets for development of IoT solutions.

Module:5	Value engineering and Analysis:	4 hours

Principles and phases of Value Engineering and Analysis, Frameworks for Value Engineering in IoT solutions, cost-function analysis of IoT solution components, action plans to incorporate Value Engineering, Data modelling requirements, Development models: Waterfall, Agile, Spiral, V models, monetization models for IoT use cases - 'Outcomes As A Service' model.

Module:6	Data Analytics for IoT Solutions:	6 hours

Data generation, Data gathering, Data Pre-processing, data analyzation, application of analytics, vertical-specific algorithms, Exploratory Data Analysis.

Module:7	Deployment of Analytics Solutions	6 hours

Anomaly Detection and Data Clustering, Predictive Analytics and Streaming Analytics, cloud/edge methods, integrating analytics models, performance of analytical models, Templates for data insights, deriving insights.

	Total Lecture hours:	**30 hours**

Text Book(s)

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A hands-on Approach", University Press, 2015.
2. Adrian McEwen & Hakim Cassimally, "Designing the Internet of Things", Wiley,Nov 2013, (1 st edition)
3. Claire Rowland, Elizabeth Goodman, Martin Charlier, Ann Light, Algred Lui," Designing Connected Products: UX for the consumer internet of things", O'Reilly, (1 st edition),2015

Reference Books

1. Rethinking the Internet of things: A Scalable Approach to Connecting Everything by Francis daCosta, Apress, 2014
2. Learning Internet of Things by Peter Waher, Packt Publishing, 2015
3. Designing the Internet of Things, by Adrian Mcewen, Hakin Cassimally , Wiley India Private Limited
4. Cloud Computing, Thomas Erl, Pearson Education, 2014
5. Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud, William Stallings, Addison-Wesley Professional; 1 edition
6. https://nsdcindia.org/sites/default/files/MC_SSCQ8210_V1.0_IoT-Domain%20Specialist_09.04.2019.pdf

List of Experiments

1. Measure the light intensity in the room and output data to the web API.
2. Control your home power outlet from anywhere using raspberry pi.
3. Build a web based application to automate door that unlocks itself using facial recognition.
4. Drinking water monitoring and analytics, consists of IoT device, cloud, and mobile and web app.
5. Smart Parking System
6. IoT based Healthcare application
7. Real-time environmental monitoring and weather prediction
8. Traffic pattern prediction
9. Smart Street light
10. Plant health monitoring

Total Laboratory Hours	30 hours

Recommended by Board of Studies	08-02-2020		
Approved by Academic Council	No.58	Date	26-02-2020