VIT®

Vellore Institute of Technology

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

SCHOOL OF ELECTRICAL ENGINEERING

B. Tech Electrical and Electronics Engineering

(B.Tech EEE)

Curriculum

(*2020-2021 admitted students*)

VISION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

Transforming life through excellence in education and research.

MISSION STATEMENT OF VELLORE INSTITUTE OF TECHNOLOGY

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

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

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

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

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

VISION STATEMENT OF THE SCHOOL OF ELECTRICAL ENGINEERING

To be a leader for academic excellence in the field of electrical, instrumentation and control engineering imparting high quality education and research leading to global competence for the societal and industrial developments.

MISSION STATEMENT OF THE SCHOOL OF ELECTRICAL ENGINEERING

M1: Impart high quality education and interdisciplinary research by providing conducive teaching learning environment and team spirit resulting in innovation and product development.

M2: Enhance the core competency of the students to cater to the needs of the industries and society by providing solutions in the field of electrical, electronics, instrumentation, and automation engineering.

M3: Develop interpersonal skills, leadership quality and societal responsibility through ethical value-added education.

B. Tech Electrical and Electronics Engineering

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The school of Electrical Engineering has established and sustained a well-defined set of educational objectives and preferred program outcomes. Educational objectives of the program satisfy to the requirements of the stakeholders such as students, parents, employers, alumni, faculty etc. The Program Educational Objectives (PEOs) are as follows.

PEO-1: Graduates will be engineering practitioners and leaders, who would help solve industry's technological problems in electrical engineering and allied disciplines.

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

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

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

PEO-5: Graduates will be successful in pursuing higher studies leading to careers in engineering, management, teaching, and research.

B. Tech Electrical and Electronics Engineering

PROGRAMME OUTCOMES (POs)

POs are statements that describe what students are expected to know and be able to do upon graduating from the program. These relate to the skills, knowledge, analytical ability attitude and behaviour that students acquire through the program.

NBA has defined the following twelve POs for an engineering graduate. These are in line with the Graduate Attributes as defined by the Washington Accord:

PO_01: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO_02: Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PO_03: Design / Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO_04: Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions for complex problems:

- that cannot be solved by straightforward application of knowledge, theories and techniques applicable to the engineering discipline as against problems given at the end of chapters in a typical text book that can be solved using simple engineering theories and techniques
- that may not have a unique solution. For example, a design problem can be solved in many ways and lead to multiple possible solutions

- that require consideration of appropriate constraints / requirements not explicitly given in the problem statement such as cost, power requirement, durability, product life, etc.
- which need to be defined (modelled) within appropriate mathematical framework
- that often require use of modern computational concepts and tools, for example, in the design of an antenna or a DSP filter.

PO_05: Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO_06: The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO_07: Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO_08: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO_09: Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO_10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO_11: Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO_12: Life-long Learning: Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

B. Tech Electrical and Electronics Engineering

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On completion of B. Tech. (Electrical and Electronics Engineering) programme, graduates will be able to

- PSO1: Analyze and design electrical and electronics systems for societal and industrial needs.

- PSO2: Design power systems network, power electronic circuits, electric drives and develop control strategies by considering economic and environmental constraints.

- PSO3: Apply and implement intelligent systems using modern tools for electrical engineering applications.

B. Tech Electrical and Electronics 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**
Total credits	**160**

B. Tech Electrical and Electronics Engineering

DETAILED CURRICULUM

University Core

S.No.	Course Code	Course Title	L	T	P	J	C	Remarks
1.	CHY1701	Engineering Chemistry	3	0	2	0	4	
2.	CHY1002	Environmental Sciences	3	0	0	0	3	Non Credit Course
3.	CSE1001	Problem Solving and Programming	0	0	6	0	3	
4.	CSE1002	Problem Solving and Object Oriented Programming	0	0	6	0	3	
5.	EEE1901	Technical Answers for Real World Problems (TARP)	1	0	0	4	2	
6.	EEE1902	Industrial Internship	0	0	0	0	1	
7.	EEE4098	Comprehensive Examination	0	0	0	0	1	
8.	EEE4099	Co-op /Capstone Project	0	0	0	0	12	
9.	ENG1901/ ENG1902/ ENG1903	Technical English I Technical English II Advanced Technical English	0/ 0/ 0	0/ 0/ 0	4/ 4/ 2	0/ 0/ 4	2	
10.	ENG1000/ ENG 2000	Foundation English I Foundation English II	0	0	4	0	2	Non Credit Course
11.	HUM1021	Ethics and Values	2	0	0	0	2	
12.	MAT1011	Calculus for Engineers	3	0	2	0	4	
13.	MAT2001	Statistics for Engineers	3	0	2	0	4	
14.	MGT1022	Lean Start-up Management	1	0	0	4	2	
15.	PHY1701	Engineering Physics	3	0	2	0	4	
16.	PHY1901	Introduction to Innovative Projects	1	0	0	0	1	
17.	EXC4097	Extra & Co- Curricular Activities	0	0	0	0	2	Non Credit Course
18.	FLC4097	Foreign Language Courses Basket	2	0	0	0	2	
19.	STS4097	Soft Skills	-	-	-	-	6	

B. Tech Electrical and Electronics Engineering

Programme Core

S. No.	Course Code	Course Title	L	T	P	J	C
1.	EEE1002	Electric Circuits	3	0	0	0	3
2.	EEE1003	Electrical Workshop	0	0	2	0	1
3.	EEE1004	Engineering Electromagnetics	3	0	2	0	4
4.	EEE1005	Signals and Systems	3	0	0	0	3
5.	EEE2001	Network Theory	3	0	0	0	3
6.	EEE2002	Semiconductor Devices and Circuits	2	0	2	4	4
7.	EEE2003	Electromechanical Energy Conversion	3	0	2	0	4
8.	EEE2004	Measurement and Instrumentation	2	0	0	4	3
9.	EEE2005	Digital Signal Processing	2	0	2	0	3
10.	EEE3001	Control Systems	3	0	2	0	4
11.	EEE3002	Analog and Digital Circuits	3	0	2	0	4
12.	EEE3003	Power System Engineering	3	0	2	0	4
13.	EEE3004	Power Electronics and Drives	3	0	2	0	4
14.	EEE4001	Microprocessor and Microcontroller	2	0	2	0	3
15.	MAT2002	Applications of Differential and Difference Equations	3	0	2	0	4
16.	MAT3003	Complex Variables and Partial Differential Equations	3	1	0	0	4
17.	MAT3005	Applied Numerical Methods	3	1	0	0	4

B. Tech Electrical and Electronics Engineering

Programme Elective

S. No.	Course Code	Course Title	L	T	P	J	C
1.	EEE1007	Neural Network and Fuzzy Control	2	0	0	4	3
2.	EEE1008	Bio-Medical Instrumentation	3	0	0	4	4
3.	EEE1011	Automated Test Engineering	2	0	2	0	3
4.	EEE1018	Nanotechnology Fundamentals and its Applications	3	0	0	0	3
5.	EEE1020	Engineering Optimization	2	1	0	4	4
6.	EEE2006	Communication Engineering	3	0	2	0	4
7.	EEE3005	Design of Electrical Apparatus	2	0	0	4	3
8.	EEE3006	Special Electrical Machines	3	0	0	0	3
9.	EEE3007	Finite Element analysis for Electrical Machines	2	0	0	4	3
10.	EEE4002	Power System Protection and Switchgear	3	0	2	0	4
11.	EEE4003	Generation and Utilization of Electrical Energy	2	0	0	4	3
12.	EEE4004	Distributed Generation and Microgrids	3	0	0	4	4
13.	EEE4005	Power System Operation and Control	2	0	0	4	3
14.	EEE4006	Restructured Power Systems	3	0	0	0	3
15.	EEE4007	Energy Management and SCADA	3	0	0	0	3
16.	EEE4008	High Voltage Engineering	3	0	0	0	3
17.	EEE4009	FACTS and HVDC	3	0	0	4	4
18.	EEE4010	Power Quality	2	0	0	4	3
19.	EEE4011	Energy Audit and Conservation	2	0	0	4	3
20.	EEE4012	Renewable Energy Sources	3	0	0	0	3
21.	EEE4013	Smart Grid	3	0	0	4	4
22.	EEE4016	Electric Vehicles	2	0	0	4	3
23.	EEE4017	Industrial Drives and Automation	3	0	0	4	4

24.	EEE4018	Advanced Control Theory	3	0	0	4	4
25.	EEE4019	Advanced Digital System Design With FPGAs	2	0	0	4	3
26.	EEE4020	Embedded System Design	2	0	0	4	3
27.	EEE4027	Robotics and Control	2	0	0	4	3
28.	EEE4028	VLSI Design	3	0	2	0	4
29.	EEE4037	Rapid prototyping with FPGAs	0	0	4	0	2
30.	EEE4038	Testing and Calibration Systems	0	0	2	0	1
31.	ECE3501	IoT Fundamentals	2	0	2	4	4
32.	ECE3502	IoT Domain Analyst	2	0	2	4	4
33.	MEE1006	Applied Mechanics and Thermal Engineering	2	0	2	0	3
34.	PHY1002	Materials Science	3	0	2	0	4

University Elective Baskets

Electrical courses

Sl.No	**Code**	**Title**	**L**	**T**	**P**	**J**	**C**
1	EEE1021	Electrical Safety	0	0	2	0	1
2	EEE1022	Fundamentals of Reliability Engineering	1	2	0	0	2
3	EEE1023	Industrial Drives	2	0	2	0	3
4	EEE4014	Switched Mode Power Conversion	2	0	0	4	3
5	EEE4015	Power Converters Analysis and Design	2	0	0	4	3

Management courses

Sl.No	**Code**	**Title**	**L**	**T**	**P**	**J**	**C**
1.	MGT1001	Basic Accounting	3	0	0	0	3
2.	MGT1002	Principles of Management	2	0	0	4	3
3.	MGT1003	Economics for Engineers	2	0	0	4	3
4.	MGT1004	Resource Management	2	0	0	4	3
5.	MGT1005	Design, Systems and Society	2	0	0	4	3
6.	MGT1006	Environmental and Sustainability Assessment	2	0	0	4	3

7.	MGT1007	Gender, Culture and Technology	2	0	0	4	3
8.	MGT1008	Impact of Information Systems on Society	2	0	0	4	3
9.	MGT1009	Technological Change and Entrepreneurship	2	0	0	4	3
10.	MGT1010	Total Quality Management	2	2	0	0	3
11.	MGT1014	Supply Chain Management	3	0	0	0	3
12.	MGT1015	Business Mathematics	3	0	0	0	3
13.	MGT1016	Intellectual Property Rights	3	0	0	0	3
14.	MGT1017	Business Regulatory Framework For Start-ups	3	0	0	0	3
15.	MGT1018	Consumer Behaviour	3	0	0	0	3
16.	MGT1019	Services Marketing	3	0	0	0	3
17.	MGT1020	Marketing Analytics	2	0	2	0	3
18.	MGT1021	Digital and Social Media Marketing	3	0	0	0	3
19.	MGT1022	Lean Start-up Management	1	0	0	4	2
20.	MGT1023	Fundamentals of Human Resource Management	3	0	0	4	4
21.	MGT1024	Organizational Behaviour	3	0	0	4	4
22.	MGT1025	Foundations of Management And Organizational Behaviour	3	0	0	4	4
23.	MGT1026	Information Assurance and Auditing	2	0	0	4	3
24.	MGT1028	Accounting and Financial Management	2	2	0	4	4
25.	MGT1029	Financial Management	2	1	0	4	4
26.	MGT1030	Entrepreneurship Development	3	0	0	4	4
27.	MGT1031	International Business	3	0	0	4	4
28.	MGT1032	Managing Asian Business	3	0	0	4	4
29.	MGT1033	Research Methods in Management	2	1	0	4	4
30.	MGT1034	Project Management	3	0	0	4	4
31.	MGT1035	Operations Management	3	0	0	0	3
32.	MGT1036	Principles of Marketing	3	0	0	4	4
33.	MGT1037	Financial Accounting and Analysis	2	1	0	4	4

34.	MGT1038	Financial Econometrics	2	0	0	4	3
35.	MGT1039	Financial Markets and Institutions	2	0	0	4	3
36.	MGT1040	Personal Financial Planning	2	0	0	4	3
37.	MGT1041	Financial Derivatives	2	1	0	4	4
38.	MGT1042	Investment Analysis and Portfolio Management	2	0	0	4	3
39.	MGT1043	Applications in Neuro Marketing	3	0	0	4	4
40.	MGT1044	Global Brand Marketing Strategies	3	0	0	4	4
41.	MGT1045	Industrial Marketing	3	0	0	4	4
42.	MGT1046	Sales and Distribution Management	3	0	0	4	4
43.	MGT1047	Social Marketing	3	0	0	4	4
44.	MGT1048	Political Economy of Globalization	3	0	0	4	4
45.	MGT1049	Sustainable Business Models	3	0	0	4	4
46.	MGT1050	Software Engineering Management	2	0	0	4	3
47.	MGT1051	Business Analytics for Engineers	2	2	0	0	3
48.	MGT1052	Bottom of the Pyramid Operations	3	0	0	0	3
49.	MGT1053	Entrepreneurship Development, Business Communication and IPR	1	0	2	0	2
50.	MGT1054	Product Planning and Strategy	2	2	0	0	3
51.	MGT1055	Design Management	2	2	0	0	3
52.	MGT1056	Accounting and Financial Management	3	0	0	4	4
53.	MGT6001	Organizational Behaviour	2	0	0	4	3

Humanities courses

Sl.No	**Code**	**Title**	**L**	**T**	**P**	**J**	**C**
1	HUM1001	Fundamentals of Cyber Laws	3	0	0	0	3
2	HUM1002	Business Laws	3	0	0	0	3
3	HUM1003	Basic Taxation for Engineers	3	0	0	0	3
4	HUM1004	Corporate Law for Engineers	3	0	0	0	3
5	HUM1005	Cost Accounting for Engineers	3	0	0	0	3

6	HUM1006	Business Accounting for Engineers	3	0	0	0	3
7	HUM1007	Contemporary Legal Framework for Business	3	0	0	0	3
8	HUM1009	International Business	3	0	0	0	3
9	HUM1010	Foreign Trade Environment	3	0	0	0	3
10	HUM1011	Export Business	3	0	0	0	3
11	HUM1012	Introduction to Sociology	3	0	0	0	3
12	HUM1013	Population Studies	3	0	0	0	3
13	HUM1021	Ethics and Values	2	0	0	0	2
14	HUM1022	Psychology in Everyday Life	2	0	0	4	2
15	HUM1023	Indian Heritage and Culture	2	0	0	4	2
16	HUM1024	India and Contemporary World	2	0	0	4	2
17	HUM1025	Indian Classical Music	1	0	2	4	1
18	HUM1033	Micro Economics	3	0	0	0	3
19	HUM1034	Macro Economics	3	0	0	0	3
20	HUM1035	Introductory Econometrics	2	0	2	0	2
21	HUM1036	Engineering Economics and Decision Analysis	2	0	0	4	2
22	HUM1037	Applied Game Theory	2	0	0	4	2
23	HUM1038	International Economics	3	0	0	0	3
24	HUM1039	Community Development in India	2	0	0	4	2
25	HUM1040	Indian Social Problems	3	0	0	0	3
26	HUM1041	Indian Society Structure and Change	3	0	0	0	3
27	HUM1042	Industrial Relations and Labour Welfare in India	3	0	0	0	3
28	HUM1043	Mass Media and Society	2	0	0	4	2
29	HUM1044	Network Society	3	0	0	0	3
30	HUM1045	Introduction to Psychology	2	0	2	0	2
31	HUM1706	Business Accounting for Engineers	3	0	0	0	3

CHY1002	Environmental Sciences	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**Chemistry of 12th standard or equivalent**	**Syllabus version**				
Anti-requisite	**Nil**	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	**46th AC**	Date	**24/08/2017**

CHY1701	Engineering Chemistry	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	Chemistry of 12th standard or equivalent	Syllabus version				
Anti-requisite	Nil	v.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: molding of plastics for Car parts, bottle caps (Injection molding), Pipes, Hoses (Extrusion molding), Mobile Phone Cases, Battery Trays, (Compression molding), Fiber reinforced polymers, Composites (Transfer molding), PET bottles (blow molding); 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. Angele 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	3 hours
2.	Water Quality Monitoring: Assessment of total dissolved oxygen in different water samples by Winkler's method	3 hours
3.	Estimation of sulphate/chloride in drinking water by conductivity method	3 hours
4/5	Material Analysis: Quantitative colorimetric determination of divalent metal ions of Ni/Fe/Cu using conventional and smart phone digital-imaging methods	6 hours
6.	Arduino microcontroller based sensor for monitoring pH/temperature/conductivity	3 hours

	in samples	
7.	Iron in carbon steel by potentiometry	3 hours
8.	Construction and working of an Zn-Cu electrochemical cell	3 hours
9.	Determination of viscosity-average molecular weight of different natural/synthetic polymers	6 hours
10.	Preparation/demonstration of a working model relevant to syllabus. Ex. 1. Construction and working of electrochemical energy system – students should demonstrate working of the system. 2. Model corrosion studies (buckling of Steel under applied load). 3. Demonstration of BOD/COD 4. Construction of dye sensitized solar cell and demonstration of its working 5. Calcium in food samples 6. Air quality analysis	Non-contact hours
	Total Laboratory Hours	**30 hours**

Mode of Evaluation: Viva-voce and Lab performance & FAT			
Recommended by Board of Studies	**31/05/2019**		
Approved by Academic Council	**55th AC**	Date	**13/06/2019**

CSE1001	Problem Solving and Programming	L	T	P	J	C
		0	0	6	0	3
Pre-requisite	**Nil**	**Syllabus version**				
Anti-requisite	**Nil**	v.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 Hours
4.	Operators and Expressions in Python	2 Hours
5.	Algorithmic Approach 1: Sequential	2 Hours
6.	Algorithmic Approach 2: Selection (if, elif, if.. else, nested if else	4 Hours
7.	Algorithmic Approach 3: Iteration (while and for)	2 Hours
8.	Strings and its Operations	2 Hours
9.	Regular Expressions	2 Hours
10.	List and its operations.	2 Hours
11.	Dictionaries: operations	2 Hours
12.	Tuples and its operations	2 Hours
13.	Set and its operations	2 Hours
14.	Functions, Recursions	2 Hours
15.	Sorting Techniques (Bubble/Selection/Insertion)	4 Hours

16.	Searching Techniques : Sequential Search and Binary Search	3 Hours
17.	Files and its Operations	4 Hours
	Total Lecture Hours	**45 hours**

Text Book(s)	
1.	John V. Guttag., 2016. Introduction to computation and programming using python: with applications to understanding data. PHI Publisher.
Reference Books	
1.	Charles Severance.2016.Python for everybody: exploring data in Python 3, Charles Severance.
2.	Charles Dierbach.2013.Introduction to computer science using python: a computational problem-solving focus. Wiley Publishers.

Mode of Evaluation: PAT / CAT / FAT			
Recommended by Board of Studies	**04/04/2014**		
Approved by Academic Council	**38th AC**	Date	**23/10/2015**

CSE1002	Problem Solving and Object Oriented Programming	L	T	P	J	C
		0	0	6	0	3
Pre-requisite	**Nil**	**Syllabus version**				
Anti-requisite	**Nil**	v.1.0				

Course Objectives:

1. To emphasize the benefits of object oriented concepts
2. To enable the 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. Recall 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. Propose 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

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.
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.
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.
4.	**Register Allocation Problem** A register is a component of a computer processor that can hold any type of data and can be accessed faster. As registers are faster to access, it is desirable to use them to the maximum so that the code execution is faster. For each code submitted to the processor, a register interference graph (RIG) is constructed. In a RIG, a node represents a temporary variable and

	an edge is added between two nodes (variables) t1 and t2 if they are live simultaneously at some point in the program. During register allocation, two temporaries can be allocated to the same register if there is no edge connecting them. Given a RIG representing the dependencies between variables in a code, implement an algorithm to determine the number of registers required to store the variables and speed up the code execution.
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.
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.
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.
	Total Laboratory Hours: 90 Hours
Text Book(s)	
1.	Stanley B Lippman, Josee Lajoie, Barbara E, Moo, "C++ primer", Fifth edition, Addison-Wesley, 2012.
2.	Ali Bahrami, Object oriented Systems development, Tata McGraw - Hill Education, 1999
3.	Brian W. Kernighan, Dennis M. Ritchie , The „C" programming Language, 2nd edition, Prentice Hall Inc., 1988.
Reference Books	
1.	Bjarne stroustrup, The C++ programming Language, Addison Wesley, 4th edition, 2013
2.	Harvey M. Deitel and Paul J. Deitel, C++ How to Program, 7th edition, Prentice Hall, 2010.
3.	Maureen Sprankle and Jim Hubbard, Problem solving and Programming concepts, 9th edition, Pearson Eduction, 2014
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

Recommended by Board of Studies	**29/10/2015**		
Approved by Academic Council	**39th AC**	Date	**17/12/2015**

EEE1901	Technical Answers for Real World Problems (TARP)	L	T	P	J	C
		1	0	0	4	2
Pre-requisite	**PHY1901 and 115 Credits Earned**	**Syllabus version**				
Anti-requisite	**Nil**	v. 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

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**

EEE1902	Industrial Internship	L	T	P	J	C
		0	0	0	0	1
Pre-requisite	Completion of minimum of Two semesters	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

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

Expected Course Outcome:

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

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

Contents	**4**	**Weeks**

Four weeks of work at industry site.

Supervised by an expert at the industry.

Mode of Evaluation: Internship Report, Presentation and Project Review

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

EEE4098	Comprehensive Examination	L	T	P	J	C
		0	0	0	0	1
Pre-requisite	As per the academic regulations	Syllabus version				
Anti-requisite	Nil	v.1.0				

Module:1	Electrical Circuits

Voltage and current sources: independent, dependent, ideal and practical; V-I relationships of resistor, inductor, mutual inductor and capacitor; transient analysis of RLC circuits with dc excitation. Kirchhoff's laws, mesh and nodal analysis, superposition, Thevenin's, Norton, maximum power transfer and reciprocity theorems. Peak, average and rms values of ac quantities; apparent, active and reactive powers; phasor analysis, impedance and admittance; series and parallel resonance, locus diagrams, realization of basic filters with R, L and C elements. One-port and two-port networks, driving point impedance and admittance, open-, and short circuit parameters

Module:2	Signals and Systems

Periodic, aperiodic and impulse signals; Laplace, Fourier and z-transforms; transfer function, frequency response of first and second order linear time invariant systems, impulse response of systems; convolution, correlation. Discrete time system: impulse response, frequency response, pulse transfer function; DFT and FFT; basics of IIR and FIR filters

Module:3	Control Systems

Mathematical modelling and representation of systems, Feedback principle, transfer function, Block diagrams and Signal flow graphs, Transient and Steady-state analysis of linear time invariant systems, Routh-Hurwitz and Nyquist criteria, Bode plots, Root loci, Stability analysis, Lag, Lead and Lead-Lag compensators; P, PI and PID controllers; State space model, State transition matrix

Module:4	Analog and Digital Circuits

Characteristics and applications of diode, Zener diode, BJT and MOSFET; small signal analysis of transistor circuits, feedback amplifiers. Characteristics of operational amplifiers; applications of opamps: difference amplifier, adder, sub tractor, integrator, differentiator, instrumentation amplifier, precision rectifier, active filters and other circuits. Oscillators, signal generators, voltage controlled oscillators and phase locked loop. Combinational logic circuits, minimization of Boolean functions. IC families: TTL and CMOS. Arithmetic circuits, comparators, Schmitt trigger, multi-vibrators, sequential circuits, flip-flops, shift registers, timers and counters; sample-and-hold circuit, multiplexer, analog-to-digital (successive approximation, integrating, flash and sigma-delta) and digital-to-analog converters (weighted R, R-2R ladder and current steering logic). Characteristics of ADC and DAC (resolution, quantization, significant bits, conversion/settling time); basics of number systems, microcontroller: applications, memory and input-output interfacing; basics of data acquisition systems.

Module:5	Electrical and Electronic Instrumentation

SI units, systematic and random errors in measurement, expression of uncertainty - accuracy and precision index, propagation of errors. PMMC, MI and dynamometer type instruments; dc potentiometer; bridges for measurement of R, L and C, Q-meter. Measurement of voltage, current and power in single and three phase circuits; ac and dc current probes; true rms meters, voltage and current scaling, instrument transformers, timer/counter, time, phase and frequency measurements, digital voltmeter, digital multimeter; oscilloscope, shielding and grounding

Module:6	**Industrial Instrumentation**		
Resistive-, capacitive-, inductive-, piezoelectric-, Hall effect sensors and associated signal conditioning circuits; transducers for industrial instrumentation: displacement (linear and angular), velocity, acceleration, force, torque, vibration, shock, pressure (including low pressure), flow (differential pressure, variable area, electromagnetic, ultrasonic, turbine and open channel flow meters) temperature (thermocouple, bolometer, RTD (3/4 wire), thermistor, pyrometer and semiconductor); liquid level, pH, conductivity and viscosity measurement			
Module:7	**Optoelectronic Instrumentation**		
Optical sources and detectors: LED, laser, photo-diode, light dependent resistor and their characteristics; interferometer: applications in metrology; basics of fiber optic sensing.			
Module:8	**Communication Engineering**		
Amplitude- and frequency modulation and demodulation; Shannon's sampling theorem, pulse code modulation; frequency and time division multiplexing, amplitude-, phase-, frequency-, pulse shift keying for digital modulation.			
Mode of Evaluation: Witten Exam			
Recommended by Board of Studies	**5/06/2015**		
Approved by Academic Council	**37th AC**	Date	**16/06/2015**

EEE4099	Capstone Project	L	T	P	J	C
		0	0	0	0	12
Pre-requisite	**As per the academic regulations**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

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

Expected Course Outcome:

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

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

Contents

1. Capstone Project may be a theoretical analysis, modeling & simulation, experimentation & analysis, prototype design, fabrication of new equipment, correlation and analysis of data, software development, applied research and any other related activities.
2. Project can be for one or two semesters based on the completion of required number of credits as per the academic regulations.
3. Can be individual work or a group project, with a maximum of 3 students.
4. In case of group projects, the individual project report of each student should specify the individual's contribution to the group project.
5. Carried out inside or outside the university, in any relevant industry or research institution.
6. Publications in the peer reviewed journals / International Conferences will be an added advantage

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

Recommended by Board of Studies	**5/06/2015**		
Approved by Academic Council	**37th AC**	Date	**16/06/2015**

ENG1901	Technical English - I	L	T	P	J	C
		0	0	4	0	2
Pre-requisite	Foundation English-II	Syllabus Version				
Anti-requisite	Nil	v.1.1				

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	**55th AC**	Date: **13/06/2019**

ENG 1902	Technical English - II	L	T	P	J	C
		0	0	4	0	2
Pre-requisite	71% to 90% EPT score	Syllabus Version				
Anti-requisite	Nil	v. 1.1				

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
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") /www.esl-lab.com/; www.bbc.co.uk/learningenglish/;

	/www.bbc.com/news; /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	**55th AC**	Date: **13/06/2019**

ENG1903	Advanced Technical English	L	T	P	J	C
		0	0	2	4	2
Pre-requisite	Greater than 90 % EPT score	Syllabus Version				
Anti-requisite	Nil	v. 1.1				

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	**55th AC**	Date: **13/06/2019**

ENG1000	Foundation English - I	L	T	P	J	C
		0	0	4	0	0
Pre-requisite	Less than 50% EPT score	Syllabus Version				
Anti-requisite	Nil	v. 1.1				

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	**55th AC**	Date	**13/06/2019**

ENG2000	Foundation English - II	L	T	P	J	C
		0	0	4	0	0

Pre-requisite	51% - 70% EPT Score / Foundation English I	Syllabus version
Anti-requisite	Nil	v.1.1

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	**55th AC**	Date	**13/06/2019**

HUM1021	Ethics and Values	L	T	P	J	C
		2	0	0	0	2
Pre-requisite	Nil	Syllabus version				
Anti-requisite	Nil	v. 1.2				

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

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. Pagliaro, L.A. and Pagliaro, A.M, "Handbook of Child and Adolescent Drug and Substance
3.	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	**46th AC**	Date	**24/08/2017**

MAT1011	Calculus for Engineers	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	Nil	Syllabus Version				
Anti-requisite	Nil	v.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 Outcome:

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

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

Module:1	Application of Single Variable Calculus	9 hours

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

Module:2	Laplace transforms	7 hours

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

Module:3	Multivariable Calculus	4 hours

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

Module:4	Application of Multivariable Calculus	5 hours

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

Module:5	**Multiple integrals**	**8 hours**
Evaluation of double integrals–change of order of integration–change of variables between Cartesian and polar co-ordinates - Evaluation of triple integrals-change of variables between Cartesian and cylindrical and spherical co-ordinates- evaluation of multiple integrals using gamma and beta functions.		
Module:6	**Vector Differentiation**	**5 hours**
Scalar and vector valued functions – gradient, tangent plane–directional derivative-divergence and curl–scalar and vector potentials–Statement of vector identities-Simple problems		
Module:7	**Vector Integration**	**5 hours**
line, surface and volume integrals - Statement of Green's, Stoke's and Gauss divergence theorems -verification and evaluation of vector integrals using them.		
Module:8	**Contemporary Issues:**	**2 hours**
Industry Expert Lecture		
	Total Lecture Hours	**45 hours**

Text Book(s)

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

Reference Books

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

Mode of Evaluation**:** Digital Assignments, Quiz, Continuous Assessments, Final Assessment Test

List of Challenging Experiments (Indicative)		
1.	Introduction to MATLAB through matrices, and general Syntax	2 hours
2	Plotting and visualizing curves and surfaces in MATLAB – Symbolic computations using MATLAB	2 hours
3.	Evaluating Extremum of a single variable function	2 hours
4.	Understanding integration as Area under the curve	2 hours
5.	Evaluation of Volume by Integrals (Solids of Revolution)	2 hours
6.	Evaluating maxima and minima of functions of several variables	2 hours
7.	Applying Lagrange multiplier optimization method	2 hours
8.	Evaluating Volume under surfaces	2 hours
9.	Evaluating triple integrals	2 hours

10.	Evaluating gradient, curl and divergence		2 hours
11.	Evaluating line integrals in vectors		2 hours
12.	Applying Green's theorem to real world problems		2 hours
	Total Laboratory Hours		**24 hours**
Mode of Evaluation**:** Weekly assessment, Final Assessment Test			
Recommended by Board of Studies	**12/06/2015**		
Approved by Academic Council	**37th AC**	Date	**16/06/2015**

MAT2001	Statistics for Engineers	L	T	P	J	C
		3	0	2	0	4
Prerequisites	MAT1011	Syllabus Version:				
Anti-requisite	Nil	v.1.0				

Course Objectives :

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

Expected Course Outcome:

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

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

Module: 1	Introduction to Statistics	6 hours

Introduction to statistics and data analysis-Measures of central tendency –Measures of variability-[Moments-Skewness-Kurtosis (Concepts only)].

Module: 2	Random variables	8 hours

Introduction -random variables-Probability mass Function, distribution and density functions - joint Probability distribution and joint density functions- Marginal, conditional distribution and density functions- Mathematical expectation, and its properties Covariance , moment generating function – characteristic function.

Module: 3	Correlation and regression	4 hours

Correlation and Regression – Rank Correlation- Partial and Multiple correlation- Multiple regression.

Module: 4	Probability Distributions	7 hours

Binomial and Poisson distributions – Normal distribution – Gamma distribution – Exponential distribution – Weibull distribution.

Module: 5	Hypothesis Testing I	4 hours

Testing of hypothesis – Introduction-Types of errors, critical region, procedure of testing hypothesis-Large sample tests- Z test for Single Proportion, Difference of Proportion, mean and difference of means.

Module: 6	Hypothesis Testing II	9 hours

Small sample tests- Student's t-test, F-test- chi-square test- goodness of fit - independence of attributes- Design of Experiments - Analysis of variance – one and two way classifications - CRD-RBD- LSD.

Module: 7	Reliability	5 hours

Basic concepts- Hazard function-Reliabilities of series and parallel systems- System Reliability - Maintainability-Preventive and repair maintenance- Availability.			
Module: 8	**Contemporary Issues**	**2 hours**	
Industry Expert Lecture			
	Total Lecture Hours	**45 hours**	
Text book(s)			
1.	Probability and Statistics for engineers and scientists, R.E.Walpole, R.H.Myers, S.L.Mayers and K.Ye, 9th Edition, Pearson Education (2012).		
2.	Applied Statistics and Probability for Engineers, Douglas C. Montgomery, George C. Runger, 6th Edition, John Wiley & Sons (2016).		
Reference books			
1.	Reliability Engineering, E.Balagurusamy, Tata McGraw Hill, Tenth reprint 2017.		
2.	Probability and Statistics, J.L.Devore, 8th Edition, Brooks/Cole, Cengage Learning (2012).		
3.	Probability and Statistics for Engineers, R.A.Johnson, Miller Freund's, 8th edition,		
4.	Prentice Hall India (2011).		
5.	Probability, Statistics and Reliability for Engineers and Scientists, Bilal M. Ayyub and Richard H. McCuen, 3rd edition, CRC press (2011).		
Mode of Evaluation**:** Digital Assignments, Continuous Assessment Tests, Quiz, Final Assessment Test.			
List of Experiments (Indicative)			
1.	Introduction: Understanding Data types; importing/exporting data.	2 hours	
2.	Computing Summary Statistics /plotting and visualizing data using Tabulation and Graphical Representations.	2 hours	
3.	Applying correlation and simple linear regression model to real dataset; computing and interpreting the coefficient of determination.	2 hours	
4.	Applying multiple linear regression model to real dataset; computing and interpreting the multiple coefficient of determination.	2 hours	
5.	Fitting the following probability distributions: Binomial distribution	2 hours	
6.	Normal distribution, Poisson distribution	2 hours	
7.	Testing of hypothesis for One sample mean and proportion from real-time problems.	2 hours	
8.	Testing of hypothesis for Two sample means and proportion from real-time problems	2 hours	
9.	Applying the t test for independent and dependent samples	2 hours	
10.	Applying Chi-square test for goodness of fit test and Contingency test to real dataset	2 hours	
11.	Performing ANOVA for real dataset for Completely randomized design, Randomized Block design ,Latin square Design	2 hours	
	Total Laboratory Hours	**22 hours**	
Mode of Evaluation**:** Weekly Assessment, Final Assessment Test			
Recommended by Board of Studies	**25/02/2017**		
Approved by Academic Council	**47th AC**	Date:	**05/10/2017**

MGT1022	Lean Start up Management	L	T	P	J	C
		1	0	0	4	2

Pre-requisite	Nil	Syllabus version
Anti-requisite	Nil	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 Hours	15 hours

Text Book(s)

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

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

Recommended by Board of Studies	**08/06/2015**		
Approved by Academic Council	**37th AC**	Date	**16/06/2015**

PHY1701	Engineering Physics	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	Nil	Syllabus version				
Anti-requisite	Nil	v.1.0				

Course Objectives:

1. Having an ability to apply mathematics and science in engineering applications
2. Having a clear understanding of the subject related concepts and of contemporary issues
3. Having Sense-Making Skills of creating unique insights in what is being seen or observed (Higher level thinking skills which cannot be codified)

Expected Course Outcome:

Students will acquire the necessary knowledge about modern physics and its applications in various engineering and technology disciplines.This course meets the following student outcomes

1. an ability to apply knowledge of physics in engineering problems
2. an ability to design and conduct experiments, as well as to analyze and interpret data
3. an ability to identify, formulate, and solve engineering problems

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	6 hours

Light propagation through fibers, Acceptance angle, Numerical Aperture, Types of fibers - step index, graded index, single mode & multimode, Attenuation, Dispersion-intermodal and intramodal.

Module:7	**Optoelectronic Devices & Applications of Optical fibers**	**9 hours**
Sources-LED & Laser Diode, Detectors-Photodetectors- PN & PIN - Applications of fiber optics in communication- Endoscopy. Special Theory of Relativity: Frame of reference, Galilean relativity, Postulate of special theory of relativity, Simultaneity, length contraction and time dilation.		
Module:8	**Contemporary issues:**	**2 hours**
Lecture by Industry Experts		
	Total Lecture Hours	**45 hours**

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

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

Mode of Evaluation**:** Quizzes , Digital Assignments, CAT-I and II and FAT

List of Challenging Experiments (Indicative)		
1.	Determination of Planck's constant using electroluminescence process (Module 1)	2 hours
2.	Electron diffraction (Module 1)	2 hours
3.	Determination of wavelength of laser source (He -Ne laser and diode lasers of different wavelengths) using diffraction technique (Module 4)	2 hours
4.	Dispersive power of prism (Module 6)	2 hours
5.	Optical Fiber communication (source + optical fiber + detector) (Modules 7+8)	2 hours

6.	Determination of size of fine particle using laser diffraction (Module 3)	2 hours
7.	Determination of the track width (periodicity) in a written CD (Module 4)	2 hours
8.	PIN diode characteristics (Module 8)	2 hours
9.	Black body Radiation (Module 1+2)	2 hours
10.	Optical Fiber communication (source + optical fiber + detector) (Modules 7 + 8)	2 hours
11.	Analysis of crystallite size and strain in a nano -crystalline film using X-ray diffraction (Module 3)	2 hours
12.	Numerical solutions of Schrödinger equation (e.g. particle in a box problem) (Module 2) (can be given as an assignment)	2 hours
13.	Laser coherence length measurement (Module 4)	2 hours
14.	Proof for transverse nature of E.M. waves (Module 6)	2 hours
15.	Quantum confinement and Heisenberg's uncertainty principle (Module 1 + 3)	2 hours
	Total Laboratory Hours	**30 hours**

Recommended by Board of Studies	**11/08/2017**		
Approved by Academic Council	**46th AC**	Date	**24/08/2017**

PHY1901	Introduction to Innovative Projects	L	T	P	J	C
		1	0	0	4	2
Pre-requisite	**Nil**	**Syllabus version**				
Anti-requisite	**Nil**	v.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. Understand the various types of thinking skills.
2. Enhance the innovative and creative ideas.
3. Find out a suitable solution for socially relevant issues- J component

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

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

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

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

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

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

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

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

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

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

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

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

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

25 brainstorming techniques and examples

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

Module:3	**Mind Mapping**	**1 hour**
Mind Mapping techniques and guidelines. Drawing a mind map **Project :** Using Mind Maps get another set of solutions forthe next 5 issues (issue 6 – 10) . **(4 non- contact hours)**		
Module:4 A	**Systems thinking**	**1 hour**
Systems Thinking essentials – examples – Counter Intuitive condemns **Project :** Select 1 issue / problem for which the possible solutions are available with you. Apply Systems Thinking process and pick up one solution [explanation should be given why the other possible solutions have been left out]. Go back to the customer and assess the acceptability and upload. . **(4 non- contact hours)**		
Module:4 B	**Design Thinking**	**1 hour**
Design thinking process – Human element of design thinking – case study **Project :** Apply design thinking to the selected solution, apply the engineering & scientific tinge to it. Participate in "design week" celebrations upload the weeks learning out come.		
Module:5 A	**Innovation**	**1 hour**
Difference between Creativity and Innovation – Examples of innovation –Being innovative. **Project:** A literature searches on prototyping of your solution finalized. Prepare a prototype model or process and upload. . **(4 non- contact hours)**		
Module:5 B	**Blocks for Innovation**	**1 hour**
Identify Blocks for creativity and innovation – overcoming obstacles – Case Study **Project :** Project presentation on problem identification, solution, innovations-expected results – Interim review with PPT presentation. . **(4 non- contact hours)**		
Module:5 C	**Innovation Process**	**1 hour**
Steps for Innovation – right climate for innovation **Project:** Refining the project, based on the review report and uploading the text. . **(4 non-contact hours)**		
Module:6 A	**Innovation in India**	**1 hour**
Stories of 10 Indian innovations **Project:** Making the project better with add ons. . **(4 non- contact hours)**		
Module:6 B	**JUGAAD Innovation**	**1 hour**
Frugal and flexible approach to innovation - doing more with less Indian Examples **Project:** Fine tuning the innovation project with JUGAAD principles and uploading (Credit for JUGAAD implementation) . **(4 non- contact hours)**		
Module:7 A	**Innovation Project Proposal Presentation**	**1 hour**
Project proposal contents, economic input, ROI – Template **Project:** Presentation of the innovative project proposal and upload . **(4 non- contact hours)**		
Module:8 A	Contemporary issue in Innovation	**1 hour**
Contemporary issue in Innovation		

Project: Final project Presentation , Viva voce Exam (**4 non- contact hours)**			
		Total Lecture Hours	**15 hours**
Text Book(s)			
1.	How to have Creative Ideas, Edward debone, Vermilon publication, UK, 2007		
2.	The Art of Innovation, Tom Kelley & Jonathan Littman, Profile Books Ltd, UK, 2008		
Reference Books			
1.	Creating Confidence, Meribeth Bonct, Kogan Page India Ltd, New Delhi, 2000		
2.	Lateral Thinking Skills, Paul Sloane, Keogan Page India Ltd, New Delhi, 2008		
3.	Indian Innovators, Akhat Agrawal, Jaico Books, Mumbai, 2015		
4.	JUGAAD Innovation, Navi Radjou, Jaideep Prabhu, Simone Ahuja Random house India, Noida, 2012.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar Three reviews with weightage of 25 : 25 : 50 along with reports			
Recommended by Board of Studies	**15/12/2015**		
Approved by Academic Council	**39th AC**	Date	**17/12/2015**

EEE1002	Electric circuits	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**Nil**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. Formulate the mathematical model of the electric circuits using basic laws
2. Apply various network theorems to solve the electric circuits
3. Compute and analyze the steady state and transient responses of DC and AC circuits

Expected Course Outcome:

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

1. Formulate the equations of the electric circuits using basic laws
2. Determine the response of DC circuits using basic analysis methods
3. Compute the response of DC circuits using network theorems
4. Analyze the transient behavior of electric circuits with different types of source
5. Describe the elements of AC circuits and the phasor concept
6. Design resonance circuits, and solve three phase ac circuits
7. Solve simple magnetic circuits

Module:1	**Fundamentals of Electric Circuits**	**5 Hours**

Introduction to Circuit Elements, Ohms Law and Kirchhoff's Laws. Voltage and Current Division, Star-Delta Transformation and Source Transformation.

Module:2	**Linear Circuit Analysis**	**5 Hours**

Nodal and Mesh Analysis of Linear Network with Independent and Dependent DC sources.

Module:3	**Network Theorems**	**7 Hours**

Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem and Superposition Theorem for circuits with independent and dependent sources.

Module:4	**Transient Circuit Analysis**	**7 Hours**

Dynamic Circuit Elements – L and C. Analysis of Source Free RC, RL and RLC Circuits, Singularity Functions, Step Response of RC, RL and RLC Circuits.

Module:5	**Introduction to Phasors**	**7 Hours**

Introduction to Sinusoids and Phasors, Impedance and Admittance with Phasors Representation. RMS and Average Values of Sinusoids, Instantaneous and Average Power, and Complex Power - Real Power, Reactive Power and Apparent Power Calculations and Power Factor.

Module:6	**AC Circuits and Resonance**	**7 Hours**

Sinusoidal Steady State Analysis for AC circuits with independent sources. Frequency Response of Circuits with R, L and C Combinations. Resonance in Series and Parallel RLC Circuits. Balanced Three Phase Circuits, Power in a Balanced System, Three Phase Power Measurement.

Module:7	**Magnetic Circuits**	**Hours 5**

Magnetically Coupled Circuits, Self and Mutual Inductance, Dot Convention, Energy in Coupled Circuits, Mesh Analysis of Magnetically Coupled Circuits.

Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture Hours	**45 Hours**

Text Book(s)

1.	Charles K Alexander, Mathew N O Sadiku, 'Fundamentals of Electric Circuits, Tata McGraw Hill, 2012.

Reference Books

1.	Allan R. Hambley, 'Electrical Engineering-Principles & Applications', Pearson Education Limited, 7/e, 2017.
2.	Robert L Boylestad, 'Introductory Circuit Analysis', Pearson Education Limited, 13/e, 2016.
3.	W. H. Hayt, J.E. Kemmerly and S. M. Durbin, 'Engineering Circuit Analysis', McGraw Hill, New York, 8/e, 2012.
4.	Abhijit Chakrabarti, 'Circuit Theory : Analysis and Synthesis', Dhanpat Rai & Co., New Delhi, 6/e, 2014
5.	Mahmood Nahvi; Joseph A Edminister, 'Electric Circuits', McGraw Hill Education, 6/e, 2015.

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

Recommended by Board of Studies	**29/05/2015**		
Approved by Academic Council	**37th AC**	Date	**16/06/2015**

EEE1003	Electrical Workshop	L	T	P	J	C
		0	0	2	0	1
Pre-requisite	**Nil**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. Apply the basic concepts of Electrical Engineering in the design and installation of Electrical Systems.

Expected Course Outcome:

On the completion of this course the student will be able to:
1.Design and Conduct experiments, as well as analyze and interpret data

List of Challenging Experiments (Indicative)

1	(a) Introduction (i) Conventional symbols for electrical installation, Wiring tools and Accessories, fuse, MCBs (ii) Electrical safety rules and Indian Electricity rules (iii) Multimeter and its testing of different components (iv) Single phase Energy meter (vi) Electrical appliances: kettle, fan, iron box, refrigerator, grinder, water heater (vi) UPS and its maintenance (b) Cable joints
2	Wiring circuit for a single lamp and a fan with regulator.
3	Staircase wiring circuit layout for multistorey buildings.
4	Hospital wiring circuit with buzzer and lamps.
5	Go down wiring circuit.
6	Fluorescent lamp connections.
7	Measurement of single phase power and energy consumed by a given AC load.
8	Study of earthing and measurement of Earth pit resistance.
9	PCB fabrication, soldering and testing of a rectifier circuit.
10	Electrical layout for a residential application using CAD software.
11	Series and parallel wiring circuit.
12	Measurement of three-phase power using two wattmeter method.
13	Measurement of grounding resistivity.
14	Practice to troubleshoot the electrical equipment.
	Total Laboratory Hours **30 hours**

Reference Books

1.	S.L. Uppal, Electrical Wiring Estimating and Costing, Khanna publishers, New Delhi, 2008.
2.	K. B. Raina and S. K. Bhattacharya, Electrical Design Estimating and Costing, Wiley Eastern Limited, 2010.
3.	Indian Electricity rules 1956, Law publishers, Allahabad.
4.	National Electrical Code 2011-IS-732-1983, Code of practice for electrical wiring installation, Indian standards.

Mode of Evaluation: Assignment / FAT

Recommended by Board of Studies	**29/05/2015**		
Approved by Academic Council	**37th AC**	Date	**16/06/2015**

EEE1004	Engineering Electromagnetics	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**MAT1011**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.1				

Course Objectives:

1. To convey the basic physical concepts that lie behind all electrical engineering, the interactions between charged particles, whether stationary or in motion.
2. To examine the electric and magnetic forces between stationary and steadily moving charged particles.
3. To study the various electric & magnetic field concepts both in static and time varying condition.

Expected Course Outcome:

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

1. Explore different coordinate systems related to magnetic fields.
2. Define the electric flux density, field intensity and different charge distributions.
3. Demonstrate the boundary conditions and method of images.
4. Compare the electric and magnetic boundary conditions, calculate the capacitance and inductance.
5. Analyze Maxwell equations.
6. Summarise the electric magnetic waves and wave propagation in different medium.
7. Apply the electric and magnetic field concepts
8. Design and Conduct experiments, as well as analyze and interpret data

Module:1	**Review of Scalar and Vector Fields**	**6 Hours**

Different Co-ordinate Systems: Cartesian, Cylindrical and Spherical –Differential elements in different coordinate systems – Del Operator: Divergence, Curl and Gradient, Divergence Theorem – Stoke's Theorem - Helmholtz's Decomposition.

Module:2	**Electrostatics: Charges**	**5 Hours**

Coulomb's law – Electric Field Intensity – Electric Flux – Gauss's Law – Potential due to Point, Line and Surface Charge Distributions.

Module:3	**Electric Fields in Dielectrics and Conductors**	**8 Hours**

Different current flow mechanisms – Continuity equation and relaxation time - Boundary conditions – Laplace and Poisson's equations - Solutions – Analytical Methods – Variables separable methods – Method of images – Numerical Techniques - Finite Difference Method – Electrostatic Energy – Capacitance Calculations

Module:4	**Magneto statics**	**8 Hours**

Magnetic Fields – Magnetic Flux – Biot Savart's Law – Ampere's Law – Magnetic Torque and Moment – Forces due to Magnetic Fields – Vector Potential – Magnetic Boundary Conditions – Inductors and Inductances – Calculations - Magnetic Energy

Module:5	**Electromagnetic Fields**	**8 Hours**

Faraday's law – Lenz's Law – Maxwell's equations – Displacement current – Maxwell's Equations in Final Forms – Time Varying Fields - Relation between field theory and circuit theory

Module:6	**Electromagnetic Waves Generation**	**8 Hours**
Propagation of waves in lossy dielectrics, conductors and free space – Skin effect – Complex Permittivity- Power and Poynting Vector.		
Module: 7	**Application**	**2 hours**
Sources, Effects and application of Electromagnetic fields		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**45 Hours**

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

List of Challenging Experiments (Indicative)		**1, 7**
1.	Electromagnetic concepts using Matlab tool functions	2 hours
2.	Vector Representation ,Coordinate Systems and conversion	2 hours
3.	Volume and surface integration (Vectorial)	2 hours
4.	Determining electric field distribution for an infinite sheet charges and line charge	2 hours
5.	Determining voltage due to line charge or surface or volume charge	2 hours
6.	Energy stored in a region due to electric field	2 hours
7.	Solving dielectric(□r1) - dielectric (□r2) boundary condition problem	2 hours
8.	Determination of electrical field and potential inside the parallel plate capacitor.	2 hours
9.	Determination of voltage and electric field distribution inside the co-axial cable. (Laplace equation).	2 hours
10.	Determining and plotting the magnetic field due to infinite sheet current	2 hours
11.	Determination of an inductance of a solenoid	2 hours
12.	Determination of the mutual inductance between an infinite line current and a rectangular coil	2 hours
13.	Electromagnetic wave propagation in good conductors.	2 hours
14.	Determination of Electric field and Voltage profile for a single core cable which is ruptured by the presents of a needle inclusion on the outer sheath.	2 hours
15.	Determination of static magnetic field induced by the stator windings in a two pole electric motor.	2 hours
	Total Laboratory Hours	**30 hours**

Mode of Evaluation: Assignment / FAT

Text Book(s)

1.	Matthew N. O. Sadiku & S. V. Kulkarni, 'Principles of Electromagnetics', Oxford University Press, New York, Sixth Edition, 2015.

Reference Books

1.	Hart Hayt, John A. Buck, 'Engineering Electromagnetics', McGraw-Hill, Eighth Edition, 2012.
2.	A. Edminister, 'Schaum's Outline of Electromagnetics', McGraw-Hill Professional, Fourth Edition, 2013.
3.	Karl E. Lonngren, Sava Savov, Randy J. Jost, 'Fundamental of Electomagnetic with MATLAB', 2007.

Recommended by Board of Studies	**30/11/2015**		
Approved by Academic Council	**39th AC**	Date	**17/12/2015**

EEE1005	Signals and systems	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**MAT2002**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. To understand the mathematical representations of signals and systems in continuous and discrete domain.
2. Analyse and perform various operations with the signals.
3. Analyse the response of linear time invariant (LTI) systems in continuous and discrete domain.
4. Understand sampling theorem and represent signals in the frequency domain.

Expected Course Outcome:

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

1. Define the term signals and systems, apply translation techniques and classify different types of systems based on their properties
2. Analyse LTI systems
3. Apply Fourier Series techniques for dealing with periodic continuous and discrete systems
4. Differentiate the behaviour of LTI systems as periodic and aperiodic signals using Fourier Transforms
5. Construct the original signal from samples.
6. Extend the analysis to unstable systems using the Laplace Transforms
7. Develop and formulate techniques of dealing with discrete systems using the z-transform.

Module:1	**Fundamentals of Signals**	**5 Hours**

Representation of Continuous and Discrete-time Signals, Unit Step, Unit Ramp, Unit Impulse, Sinusoidal and Complex Exponentials. Classification of signals – Periodic and Aperiodic Signal, Even and Odd Signal, Energy and Power Signal, Deterministic and Random signals. Transformation of Independent Variables –Time Shifting, Time Scaling and Time Reversal.

Module:2	**Fundamentals of Systems**	**5 Hours**

Representation of Continuous and Discrete Time Systems. Classification of systems - Static and Dynamic, Linear and Nonlinear, Time variant and Time Invariant, Causal and Non–Causal, Stable and unstable, Invertible and non- invertible systems. Block Diagram Representation and Interconnection of Systems

Module:3	**Analysis of LTI System**	**6 Hours**

Impulse Response of Continuous and Discrete Time LTI Systems. Convolution, Basic properties of systems using impulse response.

Module:4	**Fourier Representation of Periodic Signals and LTI Systems**	**6 Hours**

Fourier Series Representation of Continuous Time and Discrete-time periodic signals, Properties of Fourier Series, Parseval's relation, Response of LTI Systems to Complex Exponentials.

Module:5	**Fourier Representation of Aperiodic Signals and LTI Systems**	**7 Hours**
Continuous Time and Discrete Time Fourier Transforms, Properties of Fourier Transforms, Frequency response of LTI system. Applications: Modulation for communications, Filtering, Time–Frequency representation and uncertainty principle.		
Module:6	**Representation of Continuous time signals by its samples**	**5 Hours**
Sampling Theorem, Effects of Sampling and Aliasing. Sampling of Continuous Time Signals with Sample and Hold, Reconstruction of Signal from Samples – Interpolation.		
Module:7	**Analysis of Continuous and Discrete LTI Systems with Laplace Transform and Z-Transform**	**9 Hours**
Review of Laplace Transform, Region of Convergence, Characterization of LTI systems with Laplace Transforms, transfer functions. Mapping of s-plane to z-plane, Review of Z-Transform, Region of Convergence, Power series expansion, and partial fraction expansion. Characterization of LTI systems using Z -Transforms.		
Module:8	**Lecture by industry experts.**	**2 Hours**
	Total Lecture Hours	**45 Hours**

Text Book(s)	
1.	Signals and Systems by Alan V. Oppenhein, Alan S. Willsky and S. Hamid, Pearson 2016.
Reference Books	
1.	Signals and systems by Simon Haykin, John Wiley, 2016.
2.	Fundamentals of Signals and Systems Usin Web and MATLAB, Edward W Kamen, Bonnie S. Heck, Pearson, 2014.
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

Recommended by Board of Studies	**30/11/2015**		
Approved by Academic Council	**39th AC**	Date	**17/12/2015**

EEE2001	Network theory	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**EEE1002, MAT1011**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. Analyse the steady state response of circuits and discuss various theorems and their applications
2. Apply Laplace transform and Fourier transform techniques to circuits and obtain the complete response
3. Design passive filters and analyse its frequency response.

Expected Course Outcome:

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

1. Apply node voltage and mesh current methods to analyse circuits in steady state.
2. Apply Laplace transform techniques for solving problems and discuss the complete response of circuits.
3. Derive the transfer function and identify its poles and zeros
4. Analyse the harmonics in nonsinusoidal inputs to circuits using Fourier series.
5. Apply Fourier transform to circuits with nonsinusoidal inputs
6. Design passive filters and analyse the frequency response.
7. Evaluate and relate two-port network parameters.

Module:1	**Sinusoidal Steady State Analysis**	**6 Hours**

Review of Phasors. Nodal Analysis, Mesh Analysis, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem and Superposition Theorem for circuits with independent and dependent sinusoidal sources

Module:2	**Modeling of Network in s-Domain**	**6 Hours**

Circuit Models of R, L and C in s-Domain. Application of Laplace Transforms to integro-differential equations of RL, RC and RLC circuits. Transfer Function. Impulse Response of RL and RC Circuits and Response to any other sources using convolution integral.

Module:3	**Complete Response of Networks**	**6 Hours**

Circuit Analysis with zero and non zero initial conditions in s-domain. Pole-Zero Maps. Network Stability.

Module:4	**Networks with Periodic Non-Sinusoidal Excitation**	**7 Hours**

Trigonometric Fourier Series for Non-Sinusoidal Functions. Circuit Analysis. Average Power and RMS Values using Fourier Coefficients. Exponential Fourier Series.

Module:5	**Network Analysis using Fourier Transform**	**7 Hours**

Fourier Transform for commonly used periodic and aperiodic functions. Circuit Analysis in frequency domain. Energy in the signal using Parseval's Theorem.

Module:6	**Design of Filters**	**4 Hours**

Review of Frequency Response of RL, RC and RLC circuits. Passive Filters– Low Pass, High Pass, Band Pass and Band Stop. Magnitude and Frequency Scaling.

Module:7	**Two Port Networks**	**6 Hours**
Introduction to Two-Port Networks - Impedance and Admittance parameters, Transmission and Hybrid Parameters. Relationship between parameter, Interconnection of Networks.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture Hours	**45 Hours**

Text Book(s)	
1.	Charles K Alexander, Mathew N O Sadiku, "Fundamentals of Electric Circuits", Tata McGraw Hill, 2012.
Reference Books	
1.	Allan R. Hambley, 'Electrical Engineering-Principles & Applications' Pearson Education, First Impression, 6/e, 2013.
2.	Robert L Boylestad, 'Introductory Circuit Analysis' Pearson Education Ltd, 12th Edition, 2010.
3.	H. Hayt, J.E. Kemmerly and S. M. Durbin, 'Engineering Circuit Analysis', 6/e, Tata McGraw Hill, New Delhi, 2011.
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

Recommended by Board of Studies	**29/05/2015**		
Approved by Academic Council	**37th AC**	Date	**16/06/2015**

EEE2002	Semiconductor Devices and Circuits	L	T	P	J	C
		2	0	2	4	4
Pre-requisite	**EEE1002**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. To apply the knowledge of solid state devices principles to analyze electronic circuits.
2. To design amplifiers under different configurations and study their responses
3. To have hands on learning experience and software knowledge by doing practical exercises and projects.

Expected Course Outcome:

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

1. Understand the behavior of semiconductor devices
2. Analyze diode circuits
3. Relate the characteristics of various transistors with DC sources
4. Compare the various configurations of BJT
5. Understand the various configurations of MOSFET
6. Analyze the high speed response of semiconducting devices.
7. Compare and contrast the negative and positive feedback in amplifiers
8. Design and conduct experiments, as well as analyze and interpret data
9. Design a component or a product applying all the relevant standards with realistic constraints

Module:1	**Semiconductor Device Physics**	**2 Hours**

Semi-conductors, charge carriers, intrinsic and extrinsic semi-conductors, carrier generation, recombination, injection of carriers, Drift and diffusion, carrier mobility, conductivity.

Module:2	**Diode Circuit Analysis**	**4 Hours**

PN junction diode – Formation of Junction, Junction Capacitance, characteristics, Diode equations, Diode Circuits – Clipper and Clamper, rectifiers with and without filters, other multiple diode circuits, Regulated power supplies.

Module:3	**Transistor DC Analysis**	**5 Hours**

BJT Characteristics, current gains, h-parameters, MOSFET Characteristics, Load line and Operating point analysis, DC analysis and biasing of BJTs and MOSFETs.

Module:4	**BJT Amplifiers**	**5 Hours**

Small signal analysis of BJT amplifiers, Calculation of Gain, Input Impedance and Output Impedance. Basic BJT amplifier Configurations (CE, CC and CB). Power Amplifiers.

Module:5	**MOSFET Amplifiers**	**4 Hours**

Small signal analysis of MOSFET amplifiers. Calculation of Gain, Input Impedance and Output Impedance. Basic MOSFET amplifier configurations - (CS, CD and CG) amplifiers.

Module:6	**Frequency response**	**5 Hours**

Amplifier Frequency Response, System Transfer Functions, Frequency Response of Transistor Amplifier with Circuit Capacitors, Frequency Response of the FET, High-Frequency Response of

Transistor Circuits.		
Module:7	**Feedback Amplifiers and Oscillators**	**3 Hours**
Basic concepts of feedback-Negative feedback advantages and types. Voltage/Current Series/Shunt, Positive feedback, Stability, Conditions for Oscillations RC and LC oscillators.		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**30 Hours**

Text Book(s)	
1.	A.S.Sedra, K.C. Smith, "Microelectronic Circuits: Theory with Applications", 6Ed, Oxford University Press, 2013.
Reference Books	
1.	D.A. Neamen, Electronic Circuits – Analysis and Design, 3Ed, McGraw Hill, 2011.
2.	David A. Bell, "Electronic Devices and Circuits", 5ed, Oxford University Press, 2008.
3.	Behzad Razavi, Fundamentals of Microelectronics, 3Ed, Wiley, 2013.
4.	Ben Streetman, Sanjay Banerjee, Solid State Electronic Devices, 7ED, Pearson, 2014.

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

List of Challenging Experiments (Indicative)		
1.	Realization of logic gates using diodes	2 hours
2.	Design line and load voltage regulation circuits using Zener diode	2 hours
3.	Design a capacitor for a rectifier circuit	2 hours
4.	Design various clamping circuits using diode	2 hours
5.	Design various clipping circuits using diode	2 hours
6.	Design the circuit using BJT as a switch in an alarm system	2 hours
7.	Obtain the h-parameters for different configurations in BJT using input – output characteristics	2 hours
8.	Design the circuit for a verification of BJT as a switch and amplifier using Darlington pair	2 hours
9.	Design the circuit to perform DC analysis of a BJT	2 hours
10.	Switching characteristics of MOSFET	2 hours
11.	Design the circuit for verifying UJT as a triggering switch	2 hours
12.	Design a RC coupled amplifier	2 hours
13.	Design a common collector amplifier	2 hours
14.	Design a common source FET amplifier	2 hours
	Total Laboratory Hours	**30 hours**

Mode of Evaluation: Assignment /FAT

Recommended by Board of Studies	**29/05/2015**		
Approved by Academic Council	**37th AC**	Date	**16/06/2015**

EEE2003	Electromechanical Energy Conversion	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**EEE1002/EEE1001**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. To analyze the basic principles of DC Machines
2. To derive the various relations of electrical and mechanical parameters in AC Machines
3. Evaluate the characteristics and testing of AC Machines

Expected Course Outcome:

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

1. Illustrate the basic principles of electromechanical energy conversion
2. Comprehend the basic operation & characteristics of DC generator
3. Analyze the various starting technologies and performance characteristics of DC Motor
4. Apply magnetic circuit concepts and analyze performance of transformers
5. Solve the various torque equations and analyze the starting methods of Induction Motor
6. Design the equivalent circuit and circle diagram of Induction Motor
7. Analyze the effect of change in electrical and mechanical parameters of Synchronous Machine
8. Design and Conduct experiments, as well as analyze and interpret data

Module:1	**Principle of Electromechanical Energy Conversion**	**4 Hours**

Magnetic circuits - Singly excited systems - doubly excited systems - Force and Torque.

Module:2	**D.C. Generator**	**6 Hours**

Construction –Windings- Armature Reaction –Commutation-EMF Equation – Types of Generators- Magnetization and load characteristics - Voltage Regulation - Parallel operation - Applications.

Module:3	**D.C. Motor**	**5 Hours**

Methods of excitation - Equivalent circuit - Torque equation - Performance characteristics - Losses and efficiency - Speed control and starting techniques - Applications

.

Module:4	**Transformers**	**7 Hours**

Construction – types-EMF Equation-Transformer on No load and load-phasor diagram –Efficiency and Voltage Regulation –Transformer testing- Equivalent Circuit – predetermination of Efficiency and Voltage Regulation-Parallel Operation –3 Phase Transformers Applications.

Module:5	**Induction Motor**	**6 Hours**

3 phase induction motor: Construction Rotating Magnetic Field -Working principle-Power Transferred across air gap, Torque and Power output-Starting methods - Single phase induction motors - Applications.

Module:6	**Testing of Induction Machines**	**6 Hours**

Determination of Equivalent Circuit parameters – performance characteristics Circle Diagram –Speed Control –Induction Generator Applications.

Module:7	**Synchronous Machines**	**9 Hours**

Synchronous Generator (Alternator): Construction-Induced EMF - Synchronous reactance - Phasor Diagram and Voltage regulation - Parallel operation- - Synchronizing of alternator Effects of change in excitation and mechanical input. Synchronous Motor: Three-phase synchronous motor - Types - Principle of operation - Methods of starting - Hunting and Damper windings - synchronous condenser –

Applications.		
Module:8	**Contemporary issues**	**2 hours**
	Total Lecture Hours	**45 Hours**
Text Book(s)		
1.	I. J. Nagrath and D. P. Kothari, "Electric Machines" (Sigma Series), III edition, Tata McGraw Hill 2010.	
Reference Books		
1.	P. S. Bimbhra, "Electrical machinery", Seventh Edition, Khanna Publications, 2014.	
2.	P.C.Sen, “Principles of Electric Machines and Power Electronics”, Wiley, 2013.	
3.	Stephen J.Chapman, “Electric Machinery Fundamentals’, “McGraw Hill Intl. Edition, New Delhi, 6th Edition, 2012.	
4.	Arthur Egune Fitzgerald; Charles Kingsley; Stephen D Umans, “Electric machinery”, New York: McGraw-Hill, 7th Edition, 2014.	
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar		
List of Challenging Experiments (Indicative)		
1.	Speed control of DC shunt motor and predetermination of performance characteristics of DC shunt machine.	2 hours
2.	Performance characteristics of DC traction motor. 10. Voltage Regulation of a three phase induction generator.	2 hours
3.	Performance characteristics of DC motor used for rolling mills.	2 hours
4.	Magnetization and Load characteristics of DC shunt generator.	2 hours
5.	Performance test and connection assessment of a 3 phase transformer.	2 hours
6.	Open circuit and short circuit test on a 3 phase transformer.	2 hours
7.	Parallel operation of transformers.	2 hours
8.	Equivalent circuit and Performance evaluation of 3 phase industrial pump motor.	2 hours
9.	Load test on 3 phase motor used for lift applications.	2 hours
10.	Load test on single phase fan motor.	2 hours
11.	Voltage Regulation of a three phase induction generator.	2 hours
12.	Predetermination of Voltage Regulation in 3 phase alternator by EMF and MMF method.	2 hours
13.	Synchronization of a 3 phase alternator to the busbar.	2 hours
14.	V and inverted V curves of 3 phase synchronous motor.	2 hours
	Total Laboratory Hours	**30 hours**
Mode of Evaluation: Assignment /FAT		
Recommended by Board of Studies	**30/11/2015**	
Approved by Academic Council	**39th AC** Date	**17/12/2015**

EEE2004	Measurement and Instrumentation	L	T	P	J	C
		2	0	0	4	3
Pre-requisite	**EEE1002**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. To provide basic understanding of electrical and electronic measurement systems.
2. To give a thorough knowledge of varieties of measuring instruments, its operating principles, and limitations.
3. To provide basic understanding of data acquisition systems and virtual instrumentation

Expected Course Outcome:

On the completion of each module the student will be able to:

1. Explain the functions of instrumental elements and evaluate the errors in the process
2. Design a meter for measurement of electrical variables like voltage, current and power
3. Design DC bridges for measurement of various level of resistances,
4. Design AC bridges for measurement of various levels of Inductance, capacitance and frequencies
5. Analyze and apply various transducers for measurement process based on the applications
6. Outline the importance and working of digital instruments
7. Develop a Virtual Instrumentation system through LabVIEW software.
8. Design a component or a product applying all the relevant standards with realistic constraints.

Module:1	**Introduction**	**4 Hours**

Functional elements of an instrument, Static and dynamic characteristics of zero and first order instruments – sources of Errors in measurement, – Techniques for reducing error, – loading effect of instruments, Statistical evaluation of measurement data.

Module:2	**Electrical and Electronic Instruments**	**4 Hours**

Classification of instruments,– Working Principle of potentiometer, Design of analog voltmeter, ammeter using PMMC and MI and its loading effect. – Principle of working power factor meter – Single phase wattmeter, analog energy meter, Use of Instrument transformers.

Module:3	**D.C bridges**	**4 Hours**

Design of deflection bridges – Wheatstone bridge, Kelvin bridge, Kelvin double bridge and their merits and demerits.

Module:4	**A.C bridges**	**4 Hours**

Maxwell bridge, Anderson bridge, Schering Bridge, Wien Bridge and their Merits and Demerits.

Module:5	**Transducers and Display devices**	**4 Hours**

Classification of transducers – Selection of transducers – Resistive, capacitive & inductive transducers – Piezoelectric and digital transducers. Working principle and specifications of the Analog CRO and digital CRO, LED and LCD.

Module:6	**Digital Instruments:**	**4 Hours**

Comparison of analog and digital techniques – digital voltmeter – millimeter's – Energy meter - frequency counters – measurement of frequency and time interval – extension of frequency range – Automation in digital instruments, Automatic polarity indication, automatic ranging, automatic zeroing, fully automatic digital instruments, Computer controlled test systems, Virtual instruments.

Module:7	**Data acquisition using LabVIEW:**	**4 Hours**

Elements of digital data acquisition system– interfacing of transducers–multiplexing– data loggers – computer controlled instrumentation – IEEE 488 bus -DAQ cards and accessories, NI ELVIS, Data

Acquisition with LabVIEW-Interfacing a sensor to LabVIEW-Interfacing an actuator to LabVIEW.		
Module:8	**Lecture by industry experts.**	**2 hours**
	Total Lecture Hours	**30 Hours**

Text Book(s)	
1.	E.O. Doebelin, „Measurement Systems – Application and Design", 5th /e, Tata McGraw Hill Publishing, 2012.
Reference Books	
1.	D.V.S. Moorthy,„Transducers & Instrumentation",2nd/e, Prentice Hall of India Pvt Ltd, 2010.
2.	Gary W. Johnson, Richard Jenning, "LabVIEW Graphical Programming", 4th /e, Tata McGraw Hill, New York, 2006.
3.	Albert D. Helfrick and William D. Cooper - Modern Electronic Instrumentation and Measurement Techniques, Pearson / Prentice Hall of India, 2013
4.	Golding E.W and Widdis F.G., „Electrical Measurements and Measuring Instruments", Fifth Edition, AH Wheeler and Co., New Delhi, 2010.
5.	H.S. Kalsi, „Electronic Instrumentation", 3rd /e, Tata McGraw Hill, 2015.
6.	James W. Dally, William F. Riley, Kenneth G. McConnell, Instrumentation for Engineering Measurements, 2nd Edition, John Wiley, 2003.
7.	E.O. Doebelin, "Measurement Systems – Application and Design', Tata McGraw Hill publishing company, 2012.
8.	John G. Webstar, "The measurement Instrumentation and sensors handbook- Two volume set", CRC press, 2014.
9.	David A. Bell, Electronic Instrumentation and measurements, Prentice Hall of India Pvt Ltd, 2010.
10.	A.K. Shawney "A course in Electrical and Electronic measurements and instrumentation", Dhanpat Rai & Co 2001.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	**30/11/2015**		
Approved by Academic Council	**39th AC**	Date	**17/12/2015**

EEE2005	Digital Signal Processing	L	T	P	J	C
		2	0	2	0	3
Pre-requisite	**EEE1005**	**Syllabus version**				
Anti-requisite	**Nil**	v. 2.0				

Course Objectives:

1. To recognize Linear Time-Invariant (LTI) discrete-time systems
2. To design IIR filters using impulse invariance & bilinear transformation techniques
3. To design FIR filters using various window functions
4. To obtain knowledge and ability to use the appropriate tools like digital signal processors to build DSP systems for real time problems

Expected Course Outcome:

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

1. Understand the transform- domain signal and analyze the frequency response
2. Analyze and design analog filters
3. Design and implement IIR filtering operations with the real time constraints
4. Design a FIR filter for specific digital signal applications.
5. Compose and realize the structures of digital filters.
6. Estimate the adaptive filters for performance improvement.
7. Identify the techniques, skills and modern technical tools necessary for engineering practice to design and simulate a DSP system.
8. Design and Conduct experiments, as well as analyze and interpret data

Module:1	**Frequency Analysis of Signals and Systems**	**6 Hours**

Review of discrete -time signals and systems – Classification, Z- transform – ROC-stability/causality analysis, DTFT- Frequency domain sampling - DFT-Properties-Frequency analysis of signals using DFT-FFT Algorithm-Radix-2 FFT algorithms-Applications of FFT.

Module:2	**Theory and Design of Analog Filters**	**4 Hours**

Design techniques for analog low pass filter -Butterworth and Chebyshev approximations, frequency transformation, Properties.

Module:3	**Design of IIR Digital Filters**	**4 Hours**

IIR filter design - Bilinear and Impulse Invariant Transformation techniques - Spectral transformation of digital filters.

Module:4	**Design of FIR Digital Filters**	**4 Hours**

FIR Filter Design - Phase and group delay - Design characteristics of FIR filters with linear phase – Frequency response of linear phase FIR filters – Design of FIR filters using Rectangular, Hamming, Hanning, Bartlett and Blackmann window functions.

Module:5	**Realization of Digital Filters**	**4 Hours**

Direct Forms I and II, Cascade, Parallel and Lattice structures.

Module:6	**Filters for removal of artefacts and**	**4 Hours**

	interference	
Optimum Filter - The Wiener Filter, Adaptive filters and their applications.		
Module:7	**Digital Signal Processors**	**2 Hours**
General-purpose digital signal processors - Fixed point and floating point DSP - Finite word length effects - MAC, filter operation in different DSP architectures - typical implementation of DSP algorithms.		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**30 Hours**

Text Book(s)	
1.	John G. Proakis, D.G. Manolakis and D.Sharma, "Digital Signal Processing Principles, Algorithms and Applications", 4th edition, Pearson Education, 2012.
2.	Sanjit K. Mitra, Digital Signal Processing, 4th edition, TMH, 2013.
Reference Books	
1.	Sophocles J. Orfanidis, "Introduction to Signal Processing" 2nd edition, Prentice Hall, Inc, 2010
2.	Oppenhiem V.A.V and Schaffer R.W, "Discrete – time Signal Processing", 3rd edition, Pearson new international edition, 2014.
3.	Lawrence R Rabiner and Bernard Gold, "Theory and Application of Digital Signal Processing", Pearson India Education Services, 2016.
4.	Emmanuel C. Ifeachor, "Digital Signal Processing- A Practical Approach" 2nd edition, Prentice Hall, 2011.
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

List of Challenging Experiments (Indicative)		
1.	Analysis of continuous time and discrete time signals.	2 hours
2.	Consider a symmetric square wave with frequency 100 Hz. Plot the 4-term, 10-term and 25-term Fourier series approximations. Compare the FS approximations with the actual square wave. Observe the approximation behavior at the points of discontinuity.	2 hours
3.	Write a program to convolve two discrete time square pulse signals. Observe the effects of repeated convolution with a square pulse.	2 hours
4.	Study the effects of signal length and windowing on the spectrum of a signal computed with FFT.	2 hours
5.	Plot the frequency response and impulse response of an ideal discrete-time low-pass filter.	2 hours
6.	Analyze the effect of the following window functions on the magnitude of the frequency response: Rectangular, Hamming and Blackman.	2 hours
7.	Generate a sinusoidal signal which contains 50Hz, 70Hz, 100Hz and 120Hz frequencies. Analyse the frequency components present in the signal with and without AWGN for a SNR of 0.6. Obtain the plot and comment on the results.	2 hours
8.	Design an IIR filter to filter out noise from the sinusoidal signal for the	2 hours

	following specifications. Plot the spectra. Comment and infer your results. Type of filter: Butterworth Pass band frequency: 100 Hz; Stop band frequency: 150 Hz Pass band ripple: 0.1 dB; Stop band ripple: 40 dB	
9.	Design a FIR filter and estimate the filter coefficients for the following specifications. Plot, comment and infer your results. Type of filter: Band stop Order of the filter: 10 Pass band frequency: 200 Hz ; Stop band frequency: 300 Hz.	2 hours
10.	Design Chebyshev Type 1 and Type 2 high pass and band pass analog filters for the following specifications. Passband ripple =0.04dB ; Stopband attenuation= 30dB Passband frequency = 400Hz ; Stopband frequency = 800Hz Sampling frequency = 2000Hz Plot their magnitude and phase characteristics.	2 hours
11.	Signal processing methods for Music Signals using DSP Processor	2 hours
12.	Signal processing mechanisms for Bio-Signals using DSP processor	2 hours
	Total Laboratory Hours	**30 hours**

Mode of Evaluation: Assignment /FAT			
Recommended by Board of Studies	**05/03/2016**		
Approved by Academic Council	**40th AC**	Date	**18/03/2016**

EEE3001	Control Systems	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**EEE2001, MAT2002/EEE1001**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. To present a clear exposition of the classical methods of control engineering, physical system modelling, and basic principles of frequency and time domain design techniques.
2. To teach the practical control system design with realistic system specifications.
3. To provide knowledge of state variable models and fundamental notions of state feedback design

Expected Course Outcome:

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

1. Formulate the mathematical model and transfer function of physical systems
2. Analyze the system performance by applying various input signals
3. Determine the stability of linear systems in time domain
4. Perform frequency domain analysis using bode and polar plot
5. Analyze the stability of linear system in the frequency domain
6. Design compensators and controllers for the given specifications
7. Design and analyze state space model
8. Design and Conduct experiments, as well as analyze and interpret data

Module:1	**Systems and their Representations**	**6 hours**

Basic elements in control systems - open loop & closed loop - Transfer functions of mechanical, electrical and analogous systems. Block diagram reduction - signal flow graphs.

Module:2	**Time Response Analysis**	**6 hours**

Standard test signals, Time response of first and second order system, Time domain specifications, Steady state error, error constants, generalized error coefficient.

Module:3	**Stability Analysis and Root Locus**	**6 hours**

Stability - concept and definition, Characteristic equation – Location of poles – Routh Hurwitz criterion - Root locus techniques: construction, properties and applications.

Module:4	**Frequency Response Analysis**	**6 hours**

Bode plot - Polar plot - Correlation between frequency domain and time domain specifications

Module:5	**Stability in Frequency Domain**	**6 hours**

Relative stability, Gain margin, Phase margin, stability analysis using frequency response methods, Nyquist stability criterion.

Module:6	**Compensator and Controller**	**7 hours**

Realization of basic compensators, cascade compensation in time domain and frequency domain, feedback compensation - Design of lag, lead, lag-lead series compensator (using Bode plot), P, PI and PID controllers in frequency domain.

Module:7	**State Space Analysis**	**6 hours**
Concepts of state variable and state model, Solution of state equation, State space to transfer function conversion, Controllability, Observability, Pole placement control		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture Hours	**45 hours**

Text Book(s)	
1.	Norman S. Nise, "Control System Engineering", John Wiley & Sons, 6th Edition, 2011.
2.	Benjamin C Kuo "Automatic Control System" John Wiley & Sons, 8th Edition, 2007.
Reference Books	
1.	K. Ogata, "Modern Control Engineering", Pearson, 5th Edition, 2010.
2.	R.C. Dorf & R.H. Bishop, "Modern Control Systems", Pearson Education, 11th Edition, 2008.
3.	M. Gopal, "Control Systems-Principles And Design", Tata McGraw Hill –4th Edition, 2012.
4.	Graham C. Goodwin, Stefan F. Graebe, Mario E. Sagado, " Control System Design", Prentice Hall, 2003'
5.	J.Nagrath and M.Gopal," Control System Engineering", New Age International Publishers, 4th Edition, 2006.

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

List of Challenging Experiments (Indicative)		
1.	Block Diagram Reduction	2 hours
2.	Determination of Time Domain Specifications	2 hours
3.	Stability analysis of linear systems	2 hours
4.	PID Controller Design using Bode Plot	2 hours
5.	PID Controller Design using Root Locus	2 hours
6.	Compensator Design in Frequency and Time Domains	2 hours
7.	Transfer Function to State Space Conversion with Controllability and Observability Tests	2 hours
8.	Lag compensator design for linear servo motor for speed control application	2 hours
9.	Pole placement controller design for inverted pendulum	2 hours
10.	PD controller design for position control of servo plant	2 hours
11.	Cascade control design for ball and beam system	2 hours
12.	PID controller design for magnetic levitation system	2 hours
13.	Transfer function of Separately excited DC generator	2 hours
14.	Transfer function of Field Controlled DC Motor	2 hours
15.	Study of First and Second order systems	2 hours
	Total Laboratory Hours	**30 hours**

Mode of evaluation: CAM/ FAT			
Recommended by Board of Studies	**30/11/2015**		
Approved by Academic Council	**39th AC**	Date	**17/12/2015**

EEE3002	Analog and Digital Circuits	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**EEE2002**	**Syllabus version**				
Anti-requisite	**Nil**	v.2.0				

Course Objectives:

1. To introduce the functional building blocks, characteristics and applications of Analog ICs
2. To understand different methods for design and implementation of Digital circuits
3. To introduce the various applications of digital and analog ICs

Expected Course Outcome:

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

1. Analyze the performance characteristics of Op-Amp.
2. Design Op-Amp based circuits for engineering applications.
3. Identify the power supply requirements for electronic circuit applications.
4. Design a basic logic circuit for arithmetic operations in computers.
5. Design complex digital circuits for real time applications.
6. Design registers for memory applications in computers.
7. Apply analog/digital ICs for industrial control applications.
8. Design and Conduct experiments, as well as analyze and interpret data.

Module:1	**Operational Amplifier**	**6 Hours**

DC Performance - The operational amplifier, Input resistance, Output resistance, Open loop gain, Bias currents, Offset currents, Offset voltage, Common mode rejection ratio. Negative feedback Amplifier, closed loop gain, Differential amplifier.AC Performance - Frequency response, Transient response, Stability, Compensation, Poles and zeros cancelation

Module:2	**OPAMP Applications**	**7 Hours**

Linear applications of op-amp – summing, subtracting, averaging amplifier, voltage to current converter, current to voltage converter, differentiator and integrator. Nonlinear applications – comparator, Multivibrators, Schmitt Triggers, Precision Diode, Half wave and full wave rectifiers, Peak detector, Wave form generators and Active Filters.

Module:3	**Timer and Power Supplies**	**5 Hours**

555 Timer and its applications, monostable multivibrator, Astable multivibrator. Linear voltage regulator, 78XX and 79XX family, 723 IC voltage regulator, Switching regulators.

Module:4	**Digital Techniques**	**6 Hours**

Number systems - Binary, octal and hexadecimal numbers. Binary codes, Logic Gates, Boolean algebra - Conversion and operations. De Morgan's laws, Truth tables, Karnaugh's map, Min term, Max term, SOP, POS, Synthesis of Boolean functions, Quine Mccluskey method.

Module:5	**Combinational Circuit Design**	**6 Hours**

Arithmetic circuits, Parity generator, Seven-segment display, Analysis and Design Procedure - Multiplexer, Decoder, Encoder, Design using programmable logic Devices.

Module:6	**Synchronous Sequential Circuit Design**	**6 Hours**
Flip Flops - SR, D, T and JK Flip-flops, Master slave Flip Flops, Counters, Registers. Design using State machines-Moore and Mealy machines, Design Examples.		
Module:7	**Asynchronous Sequential Circuit Design**	**6 Hours**
Design Procedure- Asynchronous Sequential Circuits-State Diagram-State assignment-implication table-Design examples. **APPLICATIONS:** Temperature Indicator and Controller, Speed control of DC Motor using Analog/Digital ICs		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**45 Hours**

Text Book(s)	
1.	Op-Amps & Linear Integrated Circuits by Ramakant Gayakwad, Prentice Hall of India, New Delhi, 4th edition, 2002.
2.	Digital Design by M. Morris Mano and Mictael Ciletti, Pearson Education, 5th Edition, 2013.
Reference Books	
1.	Operation Amplifiers & Linear Integrated Circuits by Robert F. Coughlin and Frederick F. Driscoll, Prentice Hall of India, New Delhi, 6th Edition, 2009.
2.	Design with Operational Amplifiers & Analog Integrated Circuits by Sergio Franco, Tata McGraw Hill Education, 4rd Edition, 2015.
3.	Digital Fundamentals by Floyd, Madrid Pearson Education, 11th Edition, 2016.
4.	Digital System Design using Verilog by Charles Roth, Lizy John and Byeong Kil Lee, Cengage Learning, 1st Edition, 2016.
5.	Electronic Principles by Albert Malvino, David.J.Bates, Tata Mcgraw Hill Education, 8th Edition, 2016.
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

List of Challenging Experiments (Indicative)		
1.	Design and implementation of inverting and non-inverting amplifier	2 hours
2.	Design and implementation of precision rectifier using op-amp	2 hours
3.	Design and implementation of low pass and high pass filter	2 hours
4.	Design of implementation of integrator and differentiator using op-amp	2 hours
5.	Design and implementation of triangular wave generator using op-amp	2 hours
6.	Design and implementation of summing and difference amplifier	2 hours
7.	Design and implementation of astable multivibrator	2 hours
8.	Design and implementation of half and full adder circuit	2 hours
9.	Design and implementation of multiplexer	2 hours
10.	Design and implementation of magnitude comparator	2 hours
11.	Design and implementation of BCD to 7 segment display	2 hours
12.	Design and implementation of code converters	2 hours
13.	Design and implementation of J,K and D flip flops	2 hours
14.	Design and implementation of shift registers	2 hours

15.	Design and implementation of synchronous decade counter		2 hours
		Total Laboratory Hours	**30 hours**
Mode of Evaluation: Assignment /FAT			
Recommended by Board of Studies	**05/03/2016**		
Approved by Academic Council	**40th AC**	Date	**18/03/2016**

EEE3003	Power System Engineering	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**EEE2001**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.1				

Course Objectives:

1. To gain adequate knowledge on various aspects, issues related to power systems and identifying suitable solution methods.
2. To apply the concepts in solving practical power system problems.

Expected Course Outcome:

On completion of the course the student will be able to

1. Estimate the transmission line parameters.
2. Solve and calculate voltage regulation and efficiency of transmission line.
3. Categorize various components of transmission network and study the distribution system
4. Construct equivalent per unit model of three phase transmission line
5. Formulate various techniques to solve power flow problems.
6. Identify and classify various faults of power system network.
7. Analyze the impact of stability issues in power systems.
8. Design and Conduct experiments, as well as analyze and interpret data

Module:1	**Transmission Line parameters:**	**9 Hours**

Resistance, Inductance of transmission lines, Inductance of a single phase two wire line, Inductance of three phase lines with symmetrical and unsymmetrical spacing-Capacitance of a single phase two wire line-Capacitance of a three phase line with symmetrical and unsymmetrical spacing.

Module:2	**Modelling of Transmission lines**:	**6 Hours**

Representation of lines-Short –Medium lines, Equivalent Circuits, Calculation of Voltage regulation and transmission efficiency- long transmission lines-Equivalent Circuit- Surge Impedance loading.

Module:3	**Insulators and Cables**:	**5 Hours**

Types, Potential distribution over a string of suspension insulators- Improvement of string efficiency-Underground Cables-Types- Grading in cables. **Distribution Systems:** A.C. distribution System-connection schemes-radial and ring main –Interconnected System.

Module:4	**Network Modelling**:	**7 Hours**

Need for system studies in planning and operation of power system-Per phase analysis of symmetrical three phase system-per unit representation-Bus Admittance Matrix-Equivalent circuit of transformer with off nominal tap ratio- Modeling of generator, load, shunt capacitor, transmission line, shunt reactor for power flow and short circuit studies.

Module:5	**Power Flow Studies**:	**7 Hours**

The power Flow Problem- Bus Classification-Derivation of Power Flow Equation, Newton Raphson and FDPF methods.

Module:6	**Fault Analysis**:	**6 Hours**

Approximations in Short Circuit Analysis, Calculation for radial networks-Symmetrical Short Circuit Analysis-Symmetrical Component Transformation- Zbus in phase frame and sequence frame-

Unsymmetrical Fault Analysis.		
Module:7	**Power System Stability**:	**3 Hours**
Introduction to different types of stability problems- The Swing Equation-Equal Area Criterion application to a single machine infinite bus system.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture Hours	**45 Hours**
Text Book(s)		
1.	John J. Grainger and William D.Stevenson Jr "Power System Analysis", Mcgraw Hill International Editions, 2013.	
2.	Hadi Saadat, “Power System Analysis", Tata McGraw Hill, 2015.	
Reference Books		
1.	D.P.Kothari and I.J. Nagrath, "Modern Power System Analysis", Tata McGraw Hill, Fourth Edition, New Delhi, 2011.	
2.	C.L.Wadhwa, "Electrical Power Systems", New Age International, Seventh Edition, 2016.	
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar		

List of Challenging Experiments (Indicative)		
1.	Determining the voltage profile of a transmission line	2 Hours
2.	Construction of power circle diagram	2 Hours
3.	Determination of compensator rating using power circle diagram	2 Hours
4.	Determination of Ybus with tap changing transformer	2 Hours
5.	Determination of String efficiency	2 Hours
6.	Determining the size of a graded cable	2 Hours
7.	Power flow solution with tap changing transformer using Gauss-Seidel method	2 Hours
8.	Voltage in ring main distribution system with interconnection	2 Hours
9.	Symmetrical fault analysis using Thevenin’s theorem	2 Hours
10.	Determining the critical clearing time using equal area criterion	2 Hours
	Total Laboratory Hours	**30 hours**
Mode of Evaluation: Assignment / FAT		

Recommended by Board of Studies	**05/03/2016**		
Approved by Academic Council	**40th AC**	Date	**18/03/5016**

EEE3004	Power Electronics and Drives	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**EEE2001,EEE2002**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. To explain basic concepts of Power semiconductor devices
2. To analyze converters its load and drive interaction
3. To analyze speed control concepts of ac and dc drives, speed reversal, regenerative braking aspects, design methodology

Expected Course Outcome:

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

1. Explain basic concepts of power semiconductor devices including operating characteristics, firing circuits and protection circuits.
2. Analyze and design DC-DC and AC-DC power converters and estimate its performance as per the requirements and constraints specified.
3. Analyze and design various DC-AC and AC-AC converters.
4. Determine the basic concepts of electric drives including electrical and mechanical parameters.
5. Design and analyze power converter fed Separately Excited DC Motor Drive.
6. Design and analyze power converter fed Induction Motor Drive.
7. Design and analyze power converter fed Synchronous Motor Drive.
8. Design and Conduct experiments, as well as analyze and interpret data

Module:1	Introduction to Power Semiconductor Devices:	6 Hours

Structure, and operating characteristics of power Diode SCR, power BJT, MOSFET and IGBT, SiC devices, Switching characteristics, Snubber designs, firing and protection circuits, basic concepts of PWM control and phase angle control.

Module:2	DC-DC & AC-DC Power Converter	7 Hours

2-pulse, 3-pulse and 6-pulse converters – performance parameters: harmonics, ripple, distortion, power factor – effect of source impedance and overlap- DC-DC chopper circuit using BJT and IGBT - problems, design and operation, control strategies.

Module:3	DC-AC & AC-AC Power Converter	6 Hours

Single phase, three phase Bridge inverters, Current source inverters, Multi-level inverter concepts, Single phase AC voltage controllers, AC chopper; single phase cyclo converters

Module:4	Fundamental concepts of Drives:	6 Hours

Fundamentals of Drive dynamics- Power and Torque - Efficiency and losses - Typical Operating Conditions - Reversing - Torque Control - Dynamic brake operation - Static brake operation - Motor Heating and Thermal monitoring -Rating of the Frequency Converters from Motor Specification - Overload Capacity - Control Range - Derating of Converters - Regenerative Energy - Motor Cables

Module:5	Separately Excited DC Motor Drive:	6 Hours

Single phase and three phase converter fed D.C motor drive. Chopper fed drives, input filter design. Braking and speed reversal of DC motor drives using choppers.

Module:6	Induction Motor Drives:	6 Hours

Speed Control Methods- variable voltage, V/f control, rotor resistance, pole changing, cascaded induction machines, slip power recovery - voltage source and current source inverter fed induction motor drives		
Module:7	**Synchronous Motor Drives:**	**6 Hours**
Synchronous motor control – analysis with electronic commutation – concept of self-control – stator current control and marginal angle control		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**45 Hours**

Text Book(s)	
1.	Muhammad H. Rashid, Power Electronics: Circuits, Devices & Applications, Pearson Education, 2013 .
2.	Ion Boldea and Syed A. Nasar, Electric Drives, Third Edition, CRC Press, 2016.
Reference Books	
1.	Ned mohan , Power electronics A first course , John Wiley & Sons Inc 2011
2.	Theodore Wildi, Electrical Machines, Drives and Power Systems 6th Edition, Pearson India 2014.
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

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

EEE4001	Microprocessor and Microcontroller	L	T	P	J	C
		2	0	2	0	3
Pre-requisite	**EEE3002**	**Syllabus version**				
Anti-requisite	**Nil**	v. 2.0				

Course Objectives:

1. To emphasis on the hardware functionality of Intel 8051 and ARM
2. To create the essential knowledge on operating modes of I/O ports ,Timers/Counters, control registers and various types of interrupts.
3. To analyse various interfacing techniques.

Expected Course Outcome:

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

1. Interpret the architecture of microprocessor and classify the different modes of ARM
2. Classify the instructions and differentiate the instruction under various categories
3. Solve real time problems using ARM
4. Develop a broad knowledge on the complete architecture of 8051 microcontroller
5. Analyse the instructions and write simple programs using 8051 microcontroller
6. Summarize various interrupts and write programs to handle interrupts
7. Design a microcontroller based embedded systems by interfacing external devices
8. Design and Conduct experiments, as well as analyze and interpret data

Module:1	**Introduction to ARM Processor**	**4 Hours**

Introduction to RISC processor – Comparison between CISC and RISC - Overview of ARM architecture – Different modes of ARM processor – Program status register

Module:2	**ARM Instruction Set**	**3 Hours**

Data transfer instruction – Arithmetic instruction - Logical Instruction – Multiply instruction – Branch instruction – Load/Store instruction – Swap instruction.

Module:3	**Programming using ARM Processor**	**2 Hours**

Solving an simple equation – generation of square wave form – Memory operations

Module:4	**8051 Microcontroller Architecture**	**4 Hours**

Architecture of 8051 Micro controller – Program Status Register – Structure of Random Access Memory – Special Function Registers - Pin diagram of 8051 Microcontroller – Ports of 8051 microcontroller.

Module:5	**Instruction set of 8051 microcontroller**	**3 Hours**

Data transfer Instructions – Arithmetic and Logical Instructions – Boolean Instructions – Control transfer Instructions – Programming using 8051 microcontroller – Demonstration of HEX file generation and program execution.

Module:6	**8051 Microcontroller Programming**	**5 Hours**

Programming I/O ports - Different modes of timer programs – Counters – Transferring data serially – Receive data serially - Interrupts and Interrupt Handling – Interrupt priority

Module:7	**Interfacing Techniques**	**7 Hours**
Interfacing of Analog to Digital Converter – Digital to Analog Converter – Sensor Interface – Keypad Interface.Display Interface: 7 segment interface – LCD.Communication Interface: GSM – Xbee – GPS – Bluetooth.		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**30 Hours**

Text Book(s)	
1.	Andrew N Sloss , Dominic Symes , Chris Wright, " ARM System Developer's Guide: Designing and Optimizing System Software ", Morgan Kaufmann Publishers, 1st edition, 2009.
2.	Mohammad Ali Mazidi, Janice Gillispie Mazidi, " The 8051 Microcontroller and Embedded Systems ", Pearson education, 2nd Edition, 2014.

Reference Books	
1.	Kenneth J.Ayla, “The 8051 Micro controller", Thomson learning, 3rd Edition, 2010.
2.	D Karuna Sagar, “Microcontroller 8051, Oxford : Alpha Science, 2011.
3.	P.V Guruprasad, “Arm Architecture System on Chip and More ", Apress, 2013.

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

List of Challenging Experiments (Indicative)

1.	to perform the arithmetic operations	2 hours
2.	Write a program to solve the given equation. D= (A.B.C2 + A2B + AB2 – A3B2)/ (A+B+C) Assume : A, B & C are 8 bit numbers.	2 hours
3.	Write a program to perform the following data transfer a. RAM to RAM b. ROM to RAM c. EXTERNAL to EXTERNAL d. RAM to EXTERNA	2 hours
4.	to solve the following Boolean expression	2 hours
5.	Write a program to perform the following tasks	2 hours

Option	0	1	2	3	9
Task	A + B	~B +1	A*B	AB + ~A~B	~A +1
Option	4	5	6	7	8
Task	A A to P1	55H to P1	A ^ B	~A	~B

6.	Write a program to generate the following wave forms. a. Generate 2 Hz square wave on P0.0. use Timer 1 in mode 1. Assume XTAL = 16MHz. b. Generate step wave form on P0.	2 hours
7.	Write a program to interface LED’s with 8051 microcontroller also generate any pattern using LED’s.	2 hours
8.	Write a program to generate 50 Hz square wave on P1.1 normally. When INT1 is pressed,generate 100 Hz square wave on P1.1. Use timer 0 in mode 1. Assume XTAL = 11.0592 MHz.	2 hours

9.	Write a program to display the following sequence in 7 segment display. 0 – 2 – 4 – 6 – 8	2 hours
10.	Write ARM processor program to solve the following expression. $Ab^2 + c^2d$ where, a,b,c,d are 16 bit numbers.	2hours
	Total Laboratory Hours	**30 hours**
Mode of Evaluation: Assignment / FAT		
Recommended by Board of Studies	**05/03/2016**	
Approved by Academic Council	**40th AC** Date **18/03/2016**	

MAT2002	Applications of Differential and Difference Equations	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**MAT1011**	**Syllabus Version**				
Anti-requisite	**Nil**	v.1.0				

Course Objectives

The course is aimed at

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

Expected Course Outcome

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

Mode of Evaluation		
Digital Assignments (Solutions by using soft skills), Continuous Assessment Tests, Quiz, Final Assessment Test		
1.	Solving Homogeneous differential equations arising in engineering problems	2 hours
2.	Solving non-homogeneous differential equations and Cauchy, Legendre equations	2 hours
3.	Applying the technique of Laplace transform to solve differential equations	2 hours
4.	Applications of Second order differential equations to Mass spring system (damped, undamped, Forced oscillations), LCR circuits etc.	2 hours
5.	Visualizing Eigen value and Eigen vectors	2 hours
6.	Solving system of differential equations arising in engineering applications	2 hours
7.	Applying the Power series method to solve differential equations arising in engineering applications	2 hours
8.	Applying the Frobenius method to solve differential equations arising in engineering applications	2 hours
9.	Visualising Bessel and Legendre polynomials	2 hours
10.	Evaluating Fourier series-Harmonic series	2 hours
11.	Applying Z-Transforms to functions encountered in engineering	2 hours
12.	Solving Difference equations arising in engineering applications	2 hours
	Total Laboratory Hours	**24 hours**
Mode of Evaluation: Weekly Assessment, Final Assessment Test		

Recommended by Board of Studies	**25/02/2017**		
Approved by Academic Council	**37th AC**	**Date**	**05/10/2017**

MAT3003	Complex Variables and Partial Differential Equation	L	T	P	J	C
		3	2	0	0	4
Pre-requisite	MAT2002	Syllabus version				
Anti-requisite	Nil	v.1.1				

Course Objectives :

The aim of this course is to present a comprehensive, compact and integrated treatment of two most important branches of applied mathematics for engineers and scientists namely the functions of complex variable and Partial differential equations in finite and infinite domains

Expected Course Outcome:

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

1. construct analytic functions and find complex potential of fluid flow and electric fields
2. find the image of straight lines by elementary transformations and
3. able to express analytic functions in power series
4. evaluate real integrals using techniques of contour integration
5. analyze partial differential equations, and its applications, design the boundary value problems (one dimensional heat and wave equations) and find Fourier series, Fourier transform techniques in their respective engineering problems.

Module:1	Analytic Functions	6 hours

Complex variable-Analytic functions and Cauchy – Riemann equations - Laplace equation and Harmonic functions - Construction of Harmonic conjugate and analytic functions - Applications of analytic functions to fluid-flow and Field problems.

Module:2	Conformal and Bilinear transformations	5 hours

Conformal mapping - Elementary transformations-translation, magnification, rotation, inversion. Exponential and Square transformations ($w = e^z$, z^2) - Bilinear transformation - Cross-ratio-Images of the regions bounded by straight lines under the above transformations.

Module:3	Power series	4 hours

Functions given by Power Series - Taylor and Laurent series -singularities - poles – Residues.

Module:4	Complex Integration	5 hours

Integration of a complex function along a contour - Cauchy-Goursat theorem- Cauchy's integral formula -Cauchy's residue theorem - Evaluation of real integrals - Indented contour integral.

Module:5	Partial Differential equations of first order	6 hours

Formation and solution of partial differential equation - General, Particular, Complete and Singular integrals - Partial Differential equations of first order of the forms: F(p,q)=0, F(z,p,q)=0, F(x,p)=G(y,q) and Clairaut's form - Lagrange's equation: Pp+Qq = R.

Module:6	**Applications of Partial Differential Equations**	**10 hours**
Linear partial differential equations of higher order with constant coefficients. Solution of a partial differential equation by separation of variables - Boundary Value Problems-one dimensional wave and heat equations- Fourier series solution.		
Module:7	**Fourier transforms**	**7 hours**
Complex Fourier transform and properties - Relation between Fourier and Laplace transforms - Fourier sine and cosine transforms – Convolution Theorem and Parseval's identity.		
Module:8	**Contemporary issues:**	**2 hours**
Industry Expert Lecture		
	Total Lecture Hours	**45 hours**
Tutorial	1. A minimum of 10 problems to be worked out by students inventory Tutorial Class 2. Another 5 problems per Tutorial Class to be given as home work	**30 hours**

Text Book(s)	
1.	Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edition, John Wiley & Sons (Wiley student Edison) (2015)
Reference Books	
1	Higher Engineering Mathematics, B. S. Grewal, 43rd Edition (2019), Khanna Publishers, New Delhi
2	A first course in complex analysis with applications, G.Dennis Zill, Patrick D. Shanahan, 3rd Edition, 2013, Jones and Bartlett Publishers Series in Mathematics:
3	Advanced Engineering Mathematics, Michael, D. Greenberg, 2nd Edition, Pearson Education (2006)
4	Advanced Engineering Mathematics, Peter V. O' Neil, 7th Edition, Cengage Learning (2012)
5	Complex Analysis for Mathematics and Engineers, JH Mathews, R. W. Howell, 5th Edition, Narosa Publishers (2013)

Mode of Evaluation:			
Digital Assignments, Quiz, Continuous Assessments, Final Assessment Test.			
Recommended by Board of Studies	**25/02/2017**		
Approved by Academic Council	**47th AC**	Date	**05/10/2017**

MAT3005	Applied Numerical Methods	L	T	P	J	C
		3	2	0	0	4
Pre-requisite	MAT2002	Syllabus Version				
Anti-requisite	Nil	v.1.1				

Course Objectives

The aim of this course is to

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

Expected Course 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	1. A minimum of 10 problems to be worked out by students in every Tutorial Class. 2. Another 5 problems per Tutorial Class to be given for practise.	**30 hours**

Text Book(s)	
1.	Numerical Methods for Scientific and Engineering, M. K. Jain, S. R. K. Iyengar and R. K. Jain, New Age International Ltd., 6th Edition, 2012.
2.	Applied Numerical Analysis, C. F. Gerald and P.V. Wheatley, Addition-Wesley, 7th Edition, 2004.
Reference Books	
1.	Introductory Methods of Numerical Analysis, S.S. Sastry, PHI Pvt. Ltd., 5th Edition, New Delhi, 2009.
2.	Applied Numerical Methods Using MATLAB, W.Y. Yang, W. Cao, T.S. Chung and
3.	J. Morris, Wiley India Edn., 2007.
4.	Numerical Methods for Engineers with Programming and Software Applications, Steven C. Chapra and Ra P. Canale, 7th Edition, Tata McGraw Hill, 2014.
5.	Numerical Analysis, R.L. Burden and J. D. Faires, 4th Edition, Brooks Cole, 2012.
6.	Numerical Methods: Principles, Analysis and Algorithms, Srimanta Pal, Oxford University Press India, 2009.

Mode of Evaluation**:** Digital Assignments, Continuous Assessment Tests, Final Assessment Test			
Recommended by Board of Studies	**25/02/2017**		
Approved by Academic Council	**47th AC**	Date	**05/10/2017**

EEE1007	Neural Networks and Fuzzy Control	L	T	P	J	C
		2	0	0	4	3
Pre-requisite	**MAT1011**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.1				

Course Objectives:

1. Apply the design concepts of feed forward and feedback neural networks for solving Engineering problems
2. Select appropriate weight and learning constant values for every learning
3. Formulate and analyze the real time system with the knowledge of fuzzy logic control

Expected Course Outcome:

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

1. Design the mathematical model for single and multi-layer Perceptron for real time systems.
2. Demonstrate the concepts of feed forward and re-current neural networks to find the optimal solution.
3. Explore the concepts of Recurrent and feedback networks in multilayer neurons.
4. Design the competitive learning neural networks for solving the engineering problems.
5. Estimate the performance of Self organizing networks.
6. Design of fuzzy systems for non-linear simulation with extension principle.
7. Apply membership functions with suitable Defuzzification method and apply neuro-fuzzy inference system concepts to modern controllers.
8. Design a component or a product applying all the relevant standards with realistic constraints

Module:1	Introduction to Artificial Neural Networks and Learning Laws	7 Hours

Artificial neural networks and their biological motivation – Terminology – Models of neuron – Topology – Characteristics of artificial neural networks – Types of activation functions.
Learning Laws: Learning methods – Error correction learning – Hebbian learning – Perceptron – XOR problem – Perceptron learning rule convergence theorem – Adaline – Madaline.

Module:2	Feed Forward Networks	4 Hours

Multilayer Perceptron – Delta Learning – Back Propagation learning algorithm – Universal function approximation – Associative memory: auto association and hetero association.

Module:3	Recurrent Neural Networks	2 Hours

Bi-directional associative memory – Hopfield neural network – Travelling Salesman Problem.

Module:4	Unsupervised Learning	3 Hours

Competitive learning neural networks – Max net – Maxican Hat – Hamming net.

Module:5	Self Organizing Networks	5 Hours

Kohonen Self organizing Feature Map – Counter propagation – Learning Vector Quantization – Adaptive Resonance Theory – Concept of support vector machines – Applications of neural networks in image processing, signal processing, modeling and control.

Module:6	Fuzzy Sets and Fuzzy Relations	5 Hours

Introduction – Classical sets and fuzzy sets – Classical relations and fuzzy relations – Membership functions – Fuzzy to Crisp conversion, Fuzzy Arithmetic, numbers, vectors and extension principle.

Module:7	**Fuzzy Decision Making**	**2 Hours**
Fuzzy rule based systems – Fuzzy nonlinear simulation – Fuzzy control systems and Defuzzification methods. **Neuro Fuzzy:** Mathematical formulation of adaptive Neuro – Fuzzy inference systems.		
Module:8	**Contemporary issues:**	**2 Hours**

Text Book(s)	
1.	Jacek. M. Zurada, "Introduction to Artificial Neural Systems", Jaico Publishing House, 2006.
2.	Simon Haykin, Neural Networks and learning Machines", Mac Millen College Pubco., New York, 2016.
Reference Books	
1.	Laurene Fausett, Fundamentals of Neural Networks – Architectures, algorithms and applications, Pearson Education Inc., 2004
2.	Timothy J.Ross, Fuzzy Logic with Engineering Applications, John Wiley and sons, 2017.
3.	J.S.R. Jang, C.T. Sun, E. Mizutani, "Neural Fuzzy and Soft Computing – A computational Approach to learning and Machine Intelligence", Pearson Education Inc., 2010.
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

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

EEE1008	Bio-Medical Instrumentation	L	T	P	J	C
		3	0	0	4	4
Pre-requisite	Nil	Syllabus version				
Anti-requisite	Nil	v. 2.0				

Course Objectives:

1. To give an understanding of the biological signals and signal acquisition
2. To provide the design concepts of bioelectric amplifiers
3. To learn the principle and operation of various biomedical systems

Expected Course Outcomes:

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

1. Evaluate and analyse the different physiological signals
2. Relate the knowledge to select appropriate medical instruments
3. Design the bio electric devices used for diagnostic equipment
4. Develop and analyse the therapeutic devices.
5. Understand the procedure for blood analysis in medical laboratory
6. Analyze the process involved in blood cell counters and sensors
7. Differentiate the advanced diagnostic techniques.
8. Design a component or a product applying all the relevant standards with realistic constraints

Module:1	Introduction to Biomedical Instrumentation and Measurement	8 Hours

Sources of bioelectric potentials, cardiovascular system, Central nervous system, Muscular System, linear/nonlinear analysis of different physiological signals (ECG, EEG, EMG), Electrode theory-mathematical analysis including Nernst equation, Goldman equation, Electrical conductivity of electrode, Electrodes for ECG, EEG &EMG.

Module:2	General Considerations of Medical Instruments	8 Hours

Operational Amplifiers, Bioelectric Amplifiers, Selection of biomedical amplifiers – Isolation amplifiers, Charge amplifiers and Chopper amplifier. Characteristics of biomedical recorder amplifiers, Physiological effects of electric currents, Electric shock hazards and leakage currents, Methods of accident prevention.

Module:3	Diagnostic Equipment	7 Hour

ECG Lead Configuration, Vector cardiograph, Phono-cardiograph, EEG and EMG Electrode system, Recorders, Measurement of various volumes/capacity of lungs, Spirometer. Measurement of cardiac output, blood flow and blood pressure.

Module:4	Therapeutic Equipment	6 Hours

Cardiac pacemakers, cardiac defibrillators, nerve & muscle stimulators, diathermy-types, ventilators, Dialyzer.

Module:5	Medical Laboratory Instrumentation	5 Hours

Analysis of Blood-Measurement of pH, pO2 and pCO2 value of blood using pH/gas analyzers

Module:6	Medical Laboratory Measurement	4 Hours

Photometers, Hematology, Blood cell counters, Electrophoresis- Serum detection and classification, Blood Glucose Sensors, GSR measurements.

Module:7	**Advanced Diagnostic Techniques**	**5 Hours**
2D, 3D Analysis and Visualization (X-Ray, MRI, CT), Biomedical Spectroscopy, Optical coherence tomography, Fluorescence based Bio-detection & Bio-imaging- Case study: Telemedicine based health care monitoring system.		
Module:8	**Contemporary issues:**	**2 hours**
	Total Lecture Hours	**45 hours**

Text Book(s)	
1.	Leslie Cromwell, Fred J, Weibell & Erich A and P Feiffer, 'Biomedical Instrumentation and Measurements', 2nd Edition, PHI, 2011.
2.	J.J. Carr & J.M. Brown, 'Introduction to biomedical Equipment Technology', Prentice Hall, 4th Edition, 2011.
Reference Books	
1.	R. S. Khandpur, 'Handbook of Biomedical Instrumentation', Tata Mc-Graw Hill, 2nd edition, 2014.
2.	John.E. Hall, Guyton and Hall, Textbook of Medical Physiology, Saunders; 13th Edition, 2015.
3.	Rangaraj M. Rangayyan, 'Biomedical Signal Analysis', A Case-Study Approach, Wiley, 2nd Edition, 2015.

Mode of Evaluation:	CAT I & II – 30%, DA I & II – 20%, Quiz – 10%, FAT – 40%		
Recommended by Board of Studies	**30/11/2015**		
Approved by Academic Council	**39th AC**	Date	**17/12/2015**

EEE1011	Automated Test Engineering	L	T	P	J	C
		2	0	2	0	3
Pre-requisite	**EEE3002**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. Aims to provide knowledge about the testing of IC's using automated Testing Equipment (ATE).
2. Providing hands-on in Simulation software's used to simulate the evaluation conditions.
3. Practical knowledge imparted on LabVIEW usage in PCBA testing for its full functional behaviour

Expected Course Outcome:

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

1. Discover the possible component faults that can occur in electronic manufacturing.
2. Classify the faults that occur in PCBs.
3. Analyze and develop practical skills involved in troubleshooting.
4. Test the Various parameters involved in ATE
5. Understand the board functional testing.
6. Design and analyze the board functional Testing.
7. Distinguish the Boundary Scan and Board Testing to understand the equipment used in automated testing.
8. Design and conduct the experiments, as well as analyze and interpret data

Module:1	**Introduction to PCB Assemblies:**	**3 Hours**

Printed Circuit Board (PCB)-types of PCB-multilayer PCBs-Plat Plated though Hole Technology - Surface Mount Technology (SMT) – Ball Grid Array (BGA) Technology – PCB Bare board manufacturing process – Bare board testing– PCB Inspection methods – Visual, Optical and X-ray Inspection systems– Electrical tests in PCBs

Module:2	**PCBA Troubleshoot Methods:**	**2 Hours**

PCB assembly troubleshoot – locating faults & Manual troubleshoot – Online & Offline troubleshoot – Fault types and causes in circuits – Tools and instruments for usage – DMM(Digital Multimeter) – CRO (Cathode Ray Oscilloscope) - Logic probes – Logic pulser – Logic Analyzer.

Module:3	**PCBA Troubleshoot Methods:**	**2 Hours**

Automated Testing of PCBs – Out-circuit & In-circuit test methods – VI Trace Technique – signature analysis – Board Functional Testing Techniques– Boundary Scan Test Strategy & methods – External Instrumentation in Automated Testing – PCB diagnostic testers – Diagnostic Testing technique.

Module:4	**Automated Test Techniques:**	**5 Hours**

Automated Test Techniques – Various parameters – AC – DC Parametric testing– QA testing– Identify and troubleshoot the failures of parameters– Environmental, Electrical Standards & Requirements for IC testing – In-circuit Testing methodologies – Back Driving – functional test– Digital, Analog and Mixed Signal ICs– Guarding Technique – VI Trace Technique of components – Boundary Scan Test for components on board – In-circuit measurement of passive components –

Kelvin measurement – Test Fixtures – Types of Test Fixtures – Bed of Nails Fixtures – Card Edge Test Fixtures – Reverse Engg to rebuild the Schematic Diagram using ATE and Software.

Module:5	**Board Functional Testing (BFT):**	**6 Hours**

Board Functional Test (BFT) techniques – Go-No-go Test – Cluster Test – Guided Probe Backtracking Technique – Simulators – Online and Offline Simulation - Fault Simulation– Comprehensiveness of Board program – Fault Dictionary– Analysis – BS and Non-BS device testing– BCSS– Interface adaptor or personality adaptor(Pod) - Sample board programming and testing – External Instrumentation used for board testing – PXI Instrumentation – Integration of PXI instruments.

Module:6	**DFT:**	**4 Hours**

Design for testability (DFT)- test issues – Fault Models — Boundary Scan Test– Self Test design – ATE for test.

Module:7	**DFM:**	**6 Hours**

Design for manufacturability (DFM) - Manufacturing phases in industry oriented Production process – strategies – new strategy for DFM – benefits of new strategies – ATE for manufacturing – Various applications.

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

Text Book(s)

1.	S R Sabapathi, "Test Engineering for Electronic Hardware", Tata McGraw Hill, First Edition, 2011.

Reference Books

1.	Gordon Rogers and Yon Mayheq , "Engineering Thermodynamics", Pearson,2009
2.	Floyd , "The Fundamentals of Digital Semiconductor Testing", Pearson Education India, Sep-2005

List of Challenging Experiments (Indicative)		
1.	Functional Test Using Boundary Scan Tester	2hours
2.	Cluster Test Using Boundary Scan Tester	2 hours
3.	Out Circuit Functional Test	2 hours
4.	In Circuit Functional Test	2 hours
5.	QSMVI Signature Test	2 hours
6.	Scan Chain Test	2 hours
7.	Continuity Test Using Short Locater	2 hours
8.	Analog Test Using ATE	2 hours
9.	Parametric Testing DC and AC parameters	2 hours
10.	VLSI high speed Testing using ATE	2 hours
	Total Laboratory Hours	**20 hours**

Mode of Evaluation:	CAT I & II – 30%, DA I & II – 20%, Quiz – 10%, FAT – 40%		
Recommended by Board of Studies	**05/03/2016**		
Approved by Academic Council	**40th AC**	Date	**18/03/2016**

EEE1018	Nano Technology Fundamentals and its Applications	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**PHY1001/PHY1701**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. To understand the basic concepts involved in Nanoscience
2. To gain knowledge about various methods of synthesis, characterization and applications in Nanotechnology.

Expected Course Outcomes:

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

1. Understand the fundamental aspects of nanoscience
2. Identify various types of nanomaterials, their properties and applications
3. Compare the different nano fabrication processes
4. Synthesize and understand the properties & application of Carbon Nanotubes
5. Characterize nanoscale particles using various characterization techniques
6. Understand the limitations of current technology and advancements of nanoscale electronic devices
7. Apply nanotechnology in photonic devices

Module:1	**Basic Concepts**	**8 Hours**

Basic properties of Conductors, Insulators and Semiconductors; Band diagram concept of typical semiconductors; Basic Chemistry Concepts; Physical aspects, Bonding, Wave-particle duality, Heisenberg Uncertainty Principle, Schrödinger wave equation, Quantum confinement in 1-D, 2-D and 3-D; Effects of the nanometer length scale- Change in properties.

Module:2	**Nanomaterials**	**6 Hours**

Basic Types of Nanostructures- Quantum wells, Quantum Wires-Carbon Nanotubes, Nanowires; Quantum Dots, Nanoclusters; Nanoparticles- Colloidal nanoparticle crystals, Functionalized nanoparticles

Module:3	**Fabrication Methods**	**5 Hours**

Top-down processes, Bottom-up processes, Nanolithography techniques, Arc discharge method, Laser Ablaton method, Ion Implantation, Chemical Vapour deposition.

Module:4	**Carbon Nanotubes & its applications**	**6 Hours**

Synthesis of CNTs, Electronic properties, Mechanical properties; Applications- CNTs as interconnects, CNTFETs, CNTs for solar cell and energy storage applications

Module:5	**Characterization Techniques**	**8 Hours**

Classification of characterization methods, Different Microscopy techniques-Light Microscopy, Principle & Resolution, Electron Microscopy- Scanning Electron Microscopy (SEM), Principle & Resolution, Scanning Probe Microscopy- Scanning Tunneling Microscopy (STM) & Atomic Force Microscopy (AFM), Principle & Resolution.

Module:6	**Nanoelectronics**	**5 Hours**

Si Technology and its limitations, Nanoscale Devices, Single Electron Devices, Organic Field-effect transistors, Spintronics.

Module:7	**Nanophotonics**	**8 Hours**
Photonic Crystals and their applications**,** Plasmonics, Near field optics, Q-Dot Lasers		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**45 Hours**

Text Book(s)	
1	Jeremy J. Ramsden, Nanotechnology-An Introduction, Second Edition, Elseiver, 2016
2	Amretashis Sengupta**,** Chandan Kumar Sarkar (Eds.) "Introduction to Nano-Basics to Nanoscience and Nanotechnology", Springer, 2015
Reference Books	
1	Chris Binns , "Introduction to Nanoscience and Nanotechnology", Wiley, 2010
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

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

EEE1020	Engineering Optimization	L	T	P	J	C
		2	2	0	4	4
Pre-requisite	**Nil**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.1				

Course Objectives:

1. Exposure to and learning of engineering optimization concepts applied across the spectrum of courses in engineering curriculum

Expected Course Outcome:

On the completion of each module the student will be able to:

1. Understand the basic concepts of engineering optimization
2. Analyze the 1- D search methods in optimization
3. Design gradient based optimization method for various algorithms
4. Formulate and analyze systems using conjugate direction methods
5. Program and analyze dynamic optimization techniques
6. Apply mathematics and science in engineering applications
7. Understand genetic algorithm and PSO algorithm
8. Design a component or a product applying all the relevant standards with realistic constraints

Module:1	**Classical Optimization basics**	**7 Hours**

Taylor's series, Single-variable optimization, Multivariable optimization without and with equality and inequality constraints, Definitness of matrices, Sylvester's criterion, Convex programming problem.

Module:2	**1-D search methods**	**5 Hours**

Golden Section Search, Fibonacci Search, Inexact line search.

Module:3	**Gradient based optimization**	**7 Hours**

Gradient descent method, method of steepest descent, Newton's Method, Levenberg-Marquardt algorithm.

Module:4	**Conjugate Direction Methods:**	**7 Hours**

Conjugate directions and conjugate gradient method, Fletcher-Reeves formula. Convergence analysis of all algorithms.

Module:5	**Miscellaneous topics**	**6 Hours**

Dynamic programming. Dynamic optimization. Sample applications of gradient based and gradient free methods in engineering.

Module:6	**Application of optimization methods to neural networks**	**5 Hours**

NN basics, capabilities and limitations of single perceptron, multilayer perceptron. Training by gradient based and gradient free methods.

Module:7	**Gradient-free Optimization**	**6 Hours**

Direct and indirect methods, Limitations of gradient based methods, metaheuristic algorithms, Introduction to the genetic algorithm, particle swarm optimization. Simulated annealing.

Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**45 hours**

Text Book	
1.	Introduction to Optimization by Chong and Zak, John Wiley & Sons, Inc., IV Ed., 2013.
Reference Books	
1.	Engineering Optimization, Theory and Practice by S S Rao, John Wiley & Sons, Inc., IV Ed., 2009.
2.	Practical Methods of Optimization, by Fletcher, John Wiley & Sons, Inc., II Ed., 2006 Current literature.
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

Recommended by Board of Studies	**17/08/2017**		
Approved by Academic Council	**47th AC**	Date	**05/10/2017**

EEE2006	Communication Engineering	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**EEE1005**	**Syllabus version**				
Anti-requisite	**Nil**	v. 2.0				

Course Objectives:

1. To equip students with the knowledge of analog and digital communication engineering fundamentals.
2. To teach the students various communication systems and its analysis & applications
3. To provide basic understanding of appropriate tools and technologies to develop communication-engineering solutions.

Expected Course Outcome:

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

1. Demonstrate the need for modulation.
2. Examine the presence of noise in communication systems.
3. Analyze modulation techniques for analog and digital Signals.
4. Design transmitters and receivers for communication systems
5. Assess various shift keying techniques.
6. Demonstrate spread spectrum techniques and channel assignment strategies.
7. Analyze and design modern communication systems.
8. Design and Conduct experiments, as well as analyze and interpret data

Module:1	**Introduction to Communication System**	**6 Hours**

Communication systems: Introduction, need, importance, elements, block diagram and role of each block, types, frequency ranges – bandwidth– pre-emphasis and de-emphasis –modulation and its need– applications of electronic communications.

Module:2	**Noise in CW Modulation System**	**4 Hours**

Internal noise – external noise – noise voltage – signal-to-noise ratio– noise figure – noise temperature– noise in CW modulation systems.

Module:3	**Amplitude Modulation**	**8 Hours**

Representation and generation of analog modulation systems including AM, SSB, DSB,VSB – frequency spectrum, power relation– different types of modulators – AM transmitter: low level and high level modulation – SSB transmitter – AM demodulators: Square-law detector, envelope detector, rectifier detector, synchronous detector – characteristics of receivers – Super heterodyne principle – AM super heterodyne receiver – SSB receiver – comparison of different AM systems.

Module:4	**Phase Modulation:**	**10 Hours**

Representation and generation of frequency and phase modulation (FM and PM) – generation of NBFM and WBFM – FM transmitters – comparison of AM and FM – comparison of FM and PM – conversion of FM to PM and PM to FM – TRF Receivers – Choice of IF and oscillator frequencies – AVC – AFC – FM super heterodyne receiver– slope detectors – HF Communication Receiver – diversity reception.

Module:5	**Pulse Modulation Systems**	**5 Hours**

Pulse modulations– sampling theorem – pulse amplitude modulation– pulse width modulation – pulse position modulation – signal to noise ratio of pulse modulation systems – delta modulation –

pulse code modulation		
Module:6	**Digital modulation systems**	**5 Hours**
Amplitude shift keying – frequency shift keying – phase shift keying – advantages and disadvantages of digital communication systems.		
Module:7	**Cellular concept**	**5 Hours**
Channel assignment strategies – interference and system capacity – spread spectrum modulation – direct sequence spread spectrum – Frequency hop spread spectrum – code division multiplexing – OFDM for wireless communication – Broadband integrated services network.		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**45 Hours**

Text Book(s)

1.	Simon Haykin; Michael Moher, "An Introduction to Analog and Digital Communications.", Hoboken : Wiley Textbooks, 2012.
2.	Leon W Couch, " Digital and analog communication systems", Upper Saddle River, N.J, Prentice Hall, 2013
3.	Rappaport T.S., "Wireless Communications", Pearson Education, 2010.

Reference Books

1.	Herbert Taub; Donald L Schilling; Goutam Saha, "Principles of communication systems", New Delhi : McGrew Hill Education, 2013.
2.	Ramjee Prasad, "OFDM for wireless communications systems", Boston; London: Artech House, 2004.
3.	Wayne Tomasi, "Electronic Communication Systems – Fundamentals through advanced", 4th edition, Pearson Education, 2005.
4.	John G Proakis; Masoud Salehi, "Digital Communication", 5th edition, New York McGraw-Hill 2014.
5.	Kennedy and Davis, "Electronic Communication Systems", 4th edition, Tata McGraw Hill, 2008.

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

List of Challenging Experiments (Indicative)

1.	Amplitude Modulation	2 hours
2.	Pre-Emphasis and De-Emphasis	2 hours
3.	Pulse Amplitude Modulation	2 hours
4.	Pulse Width Modulation	2 hours
5.	Frequency Modulation/Mixer	2 hours
6.	Generation of Shift Keying Methods	2 hours
7.	DSB, SSB Modulation and Detection	2 hours
8.	FM and PM Modulation and Detection	2 hours
9.	Pulse Code Modulation and Delta Modulation	2 hours
10.	Generation and Detection of spread spectrum	2 hours
	Total Laboratory Hours	**30 hours**

Recommended by Board of Studies	**30/11/2015**		
Approved by Academic Council	**39th AC**	Date	**17/12/2015**

EEE3005	Design of Electrical Apparatus	L	T	P	J	C
		2	0	0	4	3
Pre-requisite	**EEE2003**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1.	Apply theoretical concepts in designing electrical machines.
2.	Select appropriate values for designing electrical machines.
3.	Estimate the machine performance based on the design outcome by data interpretation

Expected Course Outcome:

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

1. Determine electric and magnetic field strengths and their effects in and around electrical machinery, including effects of magnetic induction on moving parts.
2. Design stator and rotor parts of the d.c machines and predict the performance of DC machine using design values.
3. Design a transformer and estimates its performance as per the requirements and constraints specified.
4. Design the stator and cage rotor of an Induction machine.
5. Design the wound rotor of induction machine.
6. Calculate the main dimension and air gap length of Synchronous Machines.
7. Design the stator and cage rotor of Synchronous Machines.
8. Design a component or a product applying all the relevant standards with realistic constraints

Module:1	**Magnetic Circuits and Cooling of Electrical Machines:**	**4 Hours**

Concept of magnetic circuit – MMF calculation for various types of electrical machines – real and apparent flux density of rotating machines – leakage reactance calculation for transformers, induction and synchronous machine - thermal rating: continuous, short time and intermittent short time rating of electrical machines-direct and indirect cooling methods – cooling of turbo alternators

Module:2	**D.C. Machines**	**5 Hours**

Constructional details – output equation – main dimensions - choice of specific loadings – choice of number of poles – armature design – design of field poles and field coil – design of commutator and brushes – losses and efficiency calculations.

Module:3	**Transformers**	**5 Hours**

Constructional details of core and shell type transformers – output rating of single phase and three phase transformers –design of core, yoke and windings for core and shell type transformers – equivalent circuit parameter from designed data – losses and efficiency calculations – design of tank and cooling tubes of transformers.

Module:4	**Squirrel Cage Induction Motors**	**4 Hours**

Constructional details of squirrel cage motor – output equation – main dimensions – choice of specific loadings – design of stator – design of squirrel cage rotor – equivalent circuit parameters from designed data – losses and efficiency calculations.

Module:5	**Slip Ring Induction Motors**	**3 Hours**
Constructional details of slip ring motor – output equation – main dimensions – choice of specific loadings – design of stator – design of slip ring rotor – equivalent circuit parameters from designed data – losses and efficiency calculations. slip ring design - effect of skewing		
Module:6	**General Aspects of Synchronous Machines**	**4 Hours**
Constructional details of cylindrical pole and salient pole alternators – output equation – choice of specific loadings – main dimensions – short circuit ratio		
Module:7	**Design of Synchronous Machines**	**3 Hours**
Design of Synchronous Machines: of stator and rotor of cylindrical pole and salient pole machines - design of field coil - performance calculation from designed data - introduction to computer aided design.		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**30 Hours**

Text Book(s)	
1.	A.K. Sawhney, 'A Course in Electrical Machine Design', Dhanpat Rai and Sons, New Delhi, 2012.
2.	S.K. Sen, 'Principles of Electrical Machine Design with Computer Programmes', Oxford and IBH Publishing Co. Pvt Ltd., New Delhi, 2010.
Reference Books	
1.	R.K. Agarwal, 'Principles of Electrical Machine Design', S.K.Kataria and Sons, Delhi, 2012.
2.	V.N. Mittle and A. Mittle, 'Design of Electrical Machines', Standard Publications and Distributors, Delhi, 2010.
3.	M.V.Deshpande , "Design and Testing of Electrical Machines" Eastern Economy Edition, 2011.
4.	M.G.Say, "Performance and Design of Alternating Current Machines" CBS Publisher, 3rd Edition 2010.
5.	Clayton and Hancock, "Performance and Design of Direct Current Machines", 2010.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	**29/05/2015**		
Approved by Academic Council	**37th AC**	Date	**16/06/2015**

EEE3006	Special Electrical Machines	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**EEE2003**	**Syllabus version**				
Anti-requisite	**Nil**	v.1.0				

Course Objectives:

1. To impart knowledge on special type electrical machines and their importance.

Expected Course Outcome:

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

1. Understand the properties of permanent magnetic materials
2. Analyze the performance of stepper motor and design its controller
3. Distinguish switched reluctance motor from synchronous reluctance motor
4. Analyze square wave and sine wave permanent magnet brushless motor drives.
5. Comprehend various linear motors
6. Analyze the advanced synchronous motor
7. Select the appropriate drive for controlling the operations of special electrical machines

Module:1	**Stepper Motors:**	**6 Hours**

Constructional Features-principle of operation types and torque equations-modes of excitation, characteristics, driver circuits, and microprocessor control of stepper motors, concept of lead angle, applications.

Module:2	**Switched Reluctance Motors:**	**7 Hours**

Constructional feature – principle of operation – torque production –Power converters and their controllers – methods of rotor position sensing sensor less operation-characteristics- closed loop control applications.

Module:3	**Synchronous Reluctance Motors:**	**6 Hours**

Constructional feature -Axial and Radial flux motor- operating principles-voltage and torque equation – Phasor diagram --performance characteristics -applications.

Module:4	**Permanent Magnet Brushless DC Motors**:	**7 Hours**

Permanent Magnet materials-Magnet Characteristics-Permeance coefficient-Permanent magnet Vs. Electromagnet. Magnetic circuit analysis – EMF and torque equations – Commutation – Power Converter and their controllers – Characteristics – Applications.

Module:5	**Permanent Magnet Synchronous Motors:**	**7Hours**

Principle of operation-Ideal PMSM -EMF and Torque equations-Armature MMF--Synchronous reactance-sine wave motor with practical windings-phasor diagram-characteristics- power converter and their controllers-converter volt ampere requirements-applications.

Module:6	**Advanced Synchronous Machines:**	**4 Hours**

Flux switching motors-flux reversal motors-claw pole alternators-construction and working-characteristics-applications.

Module:7	**Linear Motors**:	**6 Hours**
Linear DC motors-Linear induction motor-linear synchronous motors-linear switched reluctance motors-constructions and working-applications. Line Start Synchronous Motors: Line start permanent magnet synchronous motor - line start synchronous reluctance motor - line start permanent magnet synchronous reluctance motor - applications.		
Module:8	**Lecture by industry experts.**	**2 Hours**
	Total Lecture Hours	**45 Hours**

Text Book(s)	
1.	T.J.E Miller, "Brushless Permanent Magnet and Reluctance Motor Drives", Clarendon Press, Oxford 1989.
2.	T. Kenjo, A. Sugawara, 'Stepping Motors and their Microprocessor Controls', Clarendon Press London, 1994.
3.	R. Krishnan, "Permanent Magnet and Brushless DC Motors Drives", CRC Press, New York, 2010.
4.	Ion Boldea, 'Linear Electric Machines, Drives, and MAGLEVs Handbook', CRC Press, London, 2013.
Reference Books	
1.	P. P. Acarnley, 'Stepping Motors – A Guide to Motor Theory and Practice', Fourth Edition, Peter Peregrinus, London, 2007.
2.	T. Kenjo and S. Nagamori, 'Permanent Magnet and Brushless DC Motors', Clarendon Press, London, 1988.
3.	R. Krishnan, 'Permanent Magnet and Brushless DC Motors Drives', CRC Press, New York, 2010.
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

Recommended by Board of Studies	**29/05/2015**		
Approved by Academic Council	**37th AC**	Date	**16/06/2015**

EEE3007	Finite Element Analysis for Electrical Machines	L	T	P	J	C
		2	0	0	4	3
Pre-requisite	**EEE2003**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. To expose the students to the concept of finite element analysis
2. To study the basic electromagnetic theory and its importance to electrical machines
3. To design any electro-magnetic devise
4. To perform electromagnetic analysis using finite element methods
5. To do electromagnetic coupled thermal analysis
6. To do electromagnetic coupled structural analysis

Expected Course Outcome:

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

1. Apply basic electromagnetic field equations to electrical machine design.
2. Learn the importance of finite element method through field equations.
3. Study the performance assessment and improvement in electrical machines.
4. Design various electro-mechanical devices
5. Analyze coupled field circuits
6. Use machine tools to find torque and errors
7. Optimize the air gap region to improve the performance of the electrical machine
8. Design a component or a product applying all the relevant standards with realistic constraints

Module:1	**Outline of Electromagnetic Fields:**	**4 Hours**
Vector Analysis - Electromagnetic Fields - Fundamental Equations.		
Module:2	**Principles of Finite Element Methods:**	**5 Hours**
Field Problems with Boundary Conditions - Classical Method for the Field Problem Solution - Classical Residual Method - Classical Variational Method - Finite Element Method.		
Module:3	**Computation of Losses:**	**2 Hours**
Computation of Eddy Current Loss - Losses in Winding.		
Module:4	**Computation of Resistance and Inductance:**	**4 Hours**
Inductance and Reactance - Poynting Vector - Nonlinear Problems.		
Module:5	**Analysis of Electrical Machines Using Finite Element Method -I:**	**4 Hours**
Ampere's Force Law - Boundary Conditions - Computation of the Solved Structure - Maxwell Stress Method - Virtual Work Method - Using Machine Models to find Torque - Errors in Force Computation - Convergence of Force.		
Module:6	**Analysis of Electrical Machines Using Finite Element Method:-II**	**5 Hours**
Using Machine Models to find Torque - Errors in Force Computation - Convergence of Force.		
Module:7	**Air-gap Elements for Electrical machines:**	**4 Hours**
Introduction - Description of the air gap element method - Finite Element Discretization - Analytical Solution - Coupling Scheme – Applications.		
Module:8	**Contemporary issues:**	**2 Hours**

	Total Lecture Hours		**30 Hours**
Text Book(s)			
1.	Nicola Bianchi, 'Electrical Machine Analysis Using Finite Elements', CRC Press, Taylor and Francis, 2015		
2.	P. P. Silvester, R. L. Ferrari, 'Finite Element Analysis and Design of Electromagnetic Devices', Cambridge University Press, Cambridge, England, Third Edition, 2006.		
3.	S. J. Salon, 'Finite Element Analysis of Electrical Machine', Kluwer Academic Publishers, Boston, MA, 2009.		
Reference Books			
1.	M.V. K. Chari, S. J. Salon. 'Numerical Methods in Electromagnetism', Academic Press, 2000.		
2.	J. P. A. Bastos, N. Sadowsky, 'Electromagnetic Modelling By Finite Element Methods', Marcel-Decker, 2003.		
3.	M. N. O. Sadiku, ' Numerical Techniques in Electromagnetics', CRC press, 2001.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar/ Mode of assessment			
Recommended by Board of Studies	**05/03/2016**		
Approved by Academic Council	**40th AC**	Date	**18/03/2016**

EEE4002	Power System Protection and Switchgear	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	EEE3003	Syllabus version				
Anti-requisite	Nil	v. 1.0				

Course Objectives:

1. Apply theoretical concepts in designing relays and circuit breakers.
2. identify appropriate switch gears for providing protection to power system components.
3. analyse the performance of the protection schemes during both pre-fault and post-fault conditions.

Expected Course Outcome:

On completion of the course the student will be able to

1. Apply the symmetrical components method for analyzing the different types of faults
2. Identify appropriate protection scheme to provide protection to different power system components.
3. Design relays used in the protection schemes
4. Analyze the types of relays based on their characteristics
5. Sketch the various types of circuit breakers
6. Discuss the various ratings of the circuit breakers
7. Identify an appropriate type of circuit breaker based on voltage and current ratings in the system
8. Design and Conduct experiments, as well as analyze and interpret data.

Module:1	Introduction to Faults and Protection:	6 Hours

Electrical faults – nature and causes of faults – types of faults – fault current calculation using symmetrical components – Principles and need for protective schemes – Equipment earthing and neutral grounding.

Module:2	Protective Relays	6 Hours

Basic properties of relay - Electromagnetic relays – Over current, directional - Static relays.

Module:3	Different Protection Schemes	5 Hours

Applications of instrument transformers in protection schemes, Differential protection, Distance protection – other schemes of protection- Under frequency relays and Negative sequence relays

Module:4	Protection of transformer, generator and motor:	6 Hours

Differential scheme for protection of transformer, generator, motor.

Module:5	Protection of bus bars, transmission lines:	6 Hours

Protection of bus bars-Application of differential scheme for bus bar protection, Transmission lines protection using distance scheme.

Module:6	Theory of Circuit Interruption :	6 Hours

Physics of arc phenomena and arc interruption. Restriking voltage & Recovery voltage, rate of rise of recovery voltage, resistance switching, current chopping and interruption of capacitive current – DC circuit breaking.

Module:7	Circuit Breakers :	8 Hours

Difference between circuit breakers and isolators– making and breaking capacity - Types of Circuit Breakers – Air blast, Air break, Oil, SF6 and Vacuum circuit breakers– comparative merits of different circuit breakers – Testing of circuit breakers. Earth leakage circuit breakers and

measurements.		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**45 Hours**

Text Book(s)	
1.	B. Ravindranath, and N. Chander, 'Power System Protection & Switchgear', New Age International., 2012.
2.	Badri Ram ,B.H. Vishwakarma, 'Power System Protection and Switchgear', New Age International Pvt Ltd Publishers, Second Edition 2011.
3.	Bhavesh Bhalja, R.P. Maheshwari, Nilesh G. Chotani,'Protection and Switchgear' Oxford University Press, 2011.
Reference Books	
1.	J B Gupta, "A Course in Electrical Power ", New Delhi, India : Kataria, 2014.
2.	C.L.Wadhwa, "Electrical Power Systems", New Academic Science, London, 2017.
3.	M.L. Soni, P.V. Gupta, V.S. Bhatnagar, A.Chakrabarti, "A Text Book on Power System Engineering", Dhanpat Rai & Co., 2013.
4.	Y.G.Paithankar and S.R.Bhide, " Fundamentals of Power System Protection", Prentice Hall of India Pvt., Ltd., 2014.

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

List of Challenging Experiments (Indicative)		
1.	(i) Performance characteristics of current transformers (ii) Earth leakage protection using core balance transformers	2 hours
2.	(i) Study of Zonal Protection Scheme (ii)Testing of breakdown voltage strength of the given sample of transformer oil using Transformer oil testing kit	2 hours
3.	Earth electrode resistance and soil resistivity measurements using Megger Earth Tester	2 hours
4.	(i)Earth fault protection for a 3-ϕ induction motor using Air circuit breakers (ii) Microcontroller based over and under voltage, IDMT/DMT relay.	2 hours
5.	Transformer protection using differential protection scheme.	2 hours
6.	Transformer protection using over current relay	2 hours
7.	Performance characteristics over current relay (IDMT Type)	2 hours
8.	Protection of three phase induction motor against earth fault using IDMT type Earth Fault Over current relay	2 hours
9.	Alternator Protection using (i) Reverse Power Relay (ii) Differential relay	2 hours
10.	Time graded protection for Radial Feeders	2 hours
11.	Fault analysis of 3- ϕ Alternator	2 hours
12.	Generator protection using numeric protective relays, over current, over voltage and under voltage relay.	2 hours
	Total Laboratory Hours	**30 hours**

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

EEE4003	Generation and Utilization of Electrical Energy	L	T	P	J	C
		2	0	0	4	3
Pre-requisite	EEE3003	Syllabus version				
Anti-requisite	Nil	v. 1.0				

Course Objectives:

1. Analyze the concepts and phenomenon of different sources of Power Generation.
2. Discuss the fundamental concepts in traction and comprehend different issues related to heating and welding.
3. Design the illumination and to discuss various Tariff methods for optimum utilization of electrical energy.

Expected Course Outcome:

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

1. Identify and critically evaluate the generation and demand scenario worldwide
2. Discuss various sources for the generation of electrical power
3. Design the different types of electric illumination for indoor and outdoor area.
4. Discuss various types of Electric Traction based on the motors used and mechanics of train movement.
5. Analyze energy consumption and tariff rates.
6. Evaluate the energy conservation and identify the economic choice of equipment.
7. Design the heating elements for various application and discuss about the process of welding.
8. Design a component or a product applying all the relevant standards with realistic constraints.

Module:1	Introduction:	2 Hours

Generation and demand-worldwide scenario- Types of Conventional and nonconventional sources, Energy sources and their availability in India, Introduction to the concept of distributed generation and effect on system operation.

Module:2	Generation from non-renewable sources:	3 Hours

Power generation from non-conventional sources -layout and working of steam, diesel, low and high head hydro power plants-pumped storage plants- nuclear plants.

Module:3	Generation from renewable sources:	5 Hours

Need for alternate energy sources– Power generation from tidal, wind, magneto hydro dynamics (MHD), geothermal and solar sources-solar thermal and solar photovoltaic, Fuel cells.

Module:4	Economic Generation and Utilization:	5 Hours

Comparison between AC and DC systems for transmission efficiency, Load and load duration curve, demand and diversity factors, Plant capacity and plant use factors, choice of type of generation, choice of size and number of unit cost of energy generated, Tariffs-KW demand constant and KVA demand constant. Introduction to Energy conservation –Economic choice of equipment-Tools for Energy auditing, Causes of low power factor-methods of improving power

factor, Case studies.		
Module:5	**Illumination:**	**5 Hours**
Nature of radiation, definition, laws, photometry, lighting calculations, design of illumination systems (for residential, industrial, commercial, health care, street lightings, sports, administrative complexes), types of lamps-energy efficiency comparison.		
Module:6	**Heating and Welding:**	**4 Hours**
Methods of heating, requirement of heating material, design of heating element, Types, Applications-furnaces, Ovens, , welding generator, welding transformer and its characteristics, welding types.		
Module:7	**Electric Traction:**	**4 Hours**
Introduction, requirements of an ideal traction system, supply systems for track electrification, types of traction system and comparison, mechanics of train movement, traction motors and control, multiple units, braking, current collection systems and recent trends in electric traction.		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**30 Hours**

Text Book(s)	
1.	S Sivanagaraju; M Balasubba Reddy; D Srilatha, "Generation and utilization of electrical energy", Noida, India: Pearson, 2010.
2.	J.B. Gupta, 'Utilization of Electric Power and Electric Traction', S.K.Kataria and Sons, second edition, 2012.
Reference Books	
1.	C.L. Wadhwa, 'Generation, Distribution and Utilization of Electrical Energy', 3rd/e, New Age International Pvt. Ltd, 2012.
2.	James L Kirtley, "Electric power principles: sources, conversion, distribution and use", Hoboken, N.J. : Wiley, 2013.
3.	Chakrabarti. A, Soni M I, Gupta P V, "Textbook on power system engineering", Dhanpat Rai & Co, 2008.

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

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

EEE4004	Distributed Generation and Microgrid	L	T	P	J	C
		3	0	0	4	4
Pre-requisite	**EEE3004**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.1				

Course Objectives:

1. Obtain knowledge of different distributed generations, energy storage devices and Microgrid system.
2. Understanding the concepts of system development and relevant issues.

Expected Course Outcome:

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

1. Understand the need for DG's and various types
2. Understand the synchronization of distributed resources such as energy storage and fuel cell
3. Comprehend the issues of interfacing DG's in regulatory market
4. Understand the types of microgrid and its configuration
5. Apply power electronic equipment's in Microgrid and acquire the knowledge of multifunction grid connected converters
6. Analyze the various types of control in micro grid in islanded and grid connected mode
7. Apply energy management concept in grid connected and islanded microgrid
8. Design a component or a product applying all the relevant standards with realistic constraints

Module:1	**Introduction to Distributed Generation**	**7 Hours**

DG Units - Micro turbines, reciprocating engines, wind generators, photovoltaic generators, fuel cells, biomass, and tidal sources - Need for Distributed generation, renewable sources in distributed generation, current scenario in Distributed Generation, Planning of DGs – Siting and sizing of DGs – optimal placement of DG sources in distribution systems.

Module:2	**Grid integration of DGs**	**6 Hours**

Synchronization - Different types of interfaces - Inverter based DGs and rotating machine based interfaces - Aggregation of multiple DG units - Distributed resources to electric power systems: IEEE 1547. Energy storage elements: Batteries, ultra-capacitors, flywheels.

Module:3	**Economics and Regulatory Aspects of DGs**	**6 Hours**

Selection of sources, regulatory standards/ framework, Standards for interconnecting DG installation classes, security issues in DG implementations. Economic and control aspects of DGs –Market facts, issues and challenges - Limitations of DGs.

Module:4	**Introduction to Microgrid**	**5 Hours**

Microgrid Configurations – CERTS Microgrid Test Bed – DC Microgrid- HFAC Microgrid –LFAC Microgrid – Hybrid DC- and AC- Coupled Microgrid

Module:5	**Power Electronics in Microgrid**	**6 Hours**
Power Electronics based Microgrid - Grid Connected Mode – Islanded mode – Battery Charging mode – design of parallel inverters – Microgrid application - Brick Busses Software Frame work.		
Module:6	**Control in Microgrid**	**7 Hours**
Impact of load characteristics – Local control – Centralized Control- Decentralized Control- Microgrid control for islanded operation – PQ Control - Droop control methods – Frequency/Voltage Control – Control of Inverter Output Impedance.		
Module:7	**Microgrid Energy Management Systems**	**6 Hours**
Introduction - Load Sharing and Power Management Strategy in Microgrid - Stand-alone – Grid connected – energy storage - Voltage Control and Active Power Management.		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**45 Hours**

Text Book(s)

1.	N. Jenkins, J.B.Ekanayake and G.Strbac, 'Distributed Generation', IET Press, 2010
2.	Nikos Hatziargyiou, "Microgrids: Architectures and Control", Wiley-IEEE Press December 2013

Reference Books

1.	Suleiman M. Sharkh, Mohammad A. Abu-Sara, Georgios I. Orfanoudakis, Babar Hussai, "Power Electronic Converters for Microgrid" , Wiley-IEEE Press, 2014
2.	S.Chowhury, S.P.Chowdury and Peter Crossley," Microgrids and Active Distribution Networks" ISBN978-1-84919-014-5, IET renewable Energy series, 2009

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

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

EEE4005	Power System Operation and Control	L	T	P	J	C
		2	0	0	4	3
Pre-requisite	**EEE 3003**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. This course will provide the student with power generation systems, their operation in an economic mode and their control.
2. Introduce students to the important terminal characteristics for hydroelectric and thermal power generation systems.
3. Introduce current topics in the system development and methods are used in modern control systems for power system network.

Expected Course Outcome:

On successful completion of the module, students will be able to:

1. Analyze the basic structure of power system and the effect of load characteristics on system operation
2. Analyze key managerial issues in operating states of the power system
3. Model AGC and ALFC mathematically
4. Analyze the relationship between voltage and reactive power.
5. Explain the constraints in unit commitment problem and issues to be addressed in the solution of unit commitment problem.
6. Formulate the model for operating cost of fossil-fuel plants and solve the economic dispatch problems
7. Understand Energy Management System
8. Design a component or a product applying all the relevant standards with realistic constraints

Module:1	**Power System Performance**	**2 Hours**

System load characteristics, load curves, load-duration curve, load factor, diversity factor. Reserve requirements: Installed reserves, spinning reserves, cold reserves, hot reserves.

Module:2	**Power System Operation**	**4 Hours**

Load forecasting, unit commitment, load dispatching. Governor control, LFC, EDC, AVR, system voltage control, security control.

Module:3	**Automatic Generation Control**	**7 Hours**

Speed-load characteristics, Load sharing concept of control area, LFC control of a single-area system: Static and dynamic analysis of uncontrolled and controlled cases, Economic Dispatch Control, Multi-area systems modeling, static analysis, uncontrolled case and tie line with frequency bias control of state variable model

Module:4	**Automatic voltage control**	**7 Hours**

Typical excitation system, modeling, static and dynamic analysis, stability compensation, generation and absorption of reactive power, Relation between voltage, power and reactive power; Injection of

reactive power and MVAR injection of switched capacitors-maintain voltage profile - minimize transmission loss,		
Module:5	**Unit Commitment(UC)**	**3 Hours**
Unit Commitment (UC) constraints in UC, spinning reserve, thermal, hydro, fuel and other constraints, UC solution methods, Priority-list methods, forward dynamic programming approach, numerical problems.		
Module:6	**Economic Dispatch (ED)**	**2 Hours**
Incremental cost curve, co-ordination equations without loss and with loss, solution by direct method and λ-iteration method, Base point and participation factors and Economic dispatch controller with LFC control		
Module:7	**Energy Management System**	**3 Hours**
Energy control, Monitoring, data acquisition and control, System hardware configuration, SCADA and EMS functions, Network topology determination, state estimation, security analysis and control, Various operating states: Normal, alert, emergency, in extremis and restorative, State transition diagram showing various state transitions and control strategies		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**30 Hours**

Text Book(s)	
1.	D P Kothari, I J Nagrath, "Modern Power System Analysis", Publisher Name, 3rd Edition, 2011
2.	Allen.J.Wood and Bruce F.Wollenberg, 'Power Generation, Operation and Control', 3rd/e, John Wiley & Sons, Inc., 2013.
Reference Books	
1.	P S R Murthy, 'Operation and Control in Power Systems', BS Publications ; Leiden : CRC Press, cop. 2011.
2.	L.L. Grigsby, 'The Electric Power Engineering Hand Book', 3rd/e, CRC Press &IEEE Press, 2012.
3.	Leonard L Grigsby, 'Power System Stability & Control', Third edition, Boca Raton, Fla. : CRC Press, 2012

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

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

EEE4006	Restructured Power Systems	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**EEE 3003**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. This course will provide the student with an overview of the restructuring and different restructuring models.
2. Explain the students to stranded costs, market operations, and transmission pricing and congestion management.
3. Introduce the various restructuring models of power systems
4. Introduce the restructuring process taken place in international scenario with pricing concepts.
5. Introduce the current scenario of deregulation in Indian Power sector.

Expected Course Outcome:

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

1. Identify the need of restructuring / deregulation in power system network.
2. Explain the technical and Non-technical issues in deregulated power exchange market.
3. Explain and specify the various pricing mechanisms in electrical power sector
4. Analyze the congestion management, stability aspects, and power quality issues in deregulated environment.
5. Design the market architecture and power market aspects
6. Develop effective and efficient market pricing schemes followed in Indian power sector.

Module:1	**Power System Restructuring**	**3 Hours**

Typical Structure of a deregulated electricity system ,Comparison with Vertically integrated electric utility, Motivaton for restructuring of power system-Different entities-Benefits from a competitive environment.

Module:2	**Operations in Power Market**	**5 Hours**

Restructuring Models-poolco, bilateral, hybrid models-ISO, Role of ISO, Power exchange-Market Clearing Price-Single Auction and Double Auction Power Pool.

Module:3	**Transmission and Congestion Pricing**	**6 Hours**

Transmission Pricing, Transmission cost allocation methods: Postage stamp rate method, contract path method, MW Mile method with examples, Congestion Pricing, Congestion pricing methods, Transmission rights.

Module:4	**Congestion Management**	**6 Hours**

Management of Inter-zonal and intra- zonal congestion, solution procedure, Formulation of Inter-zonal congestion sub problem with examples, Formulation of Intra-zonal congestion sub problem

with examples		
Module:5	**Available Transfer Capability (ATC)**	**5 Hours**
Definitions, OASIS, Methods of ATC Determination, ATC calculation using MATLAB/PWS.		
Module:6	**Ancillary service Management**	**9 Hours**
Classification of Ancillary services as per NERC – Load generation balancing related services services – Voltage control and reactive power support devices – Black start capability service- NERC standards CPS1 and CPS2 –Case studies.		
Module:7	**Reforms in Indian Power Sector**	**9 Hours**
Introduction – Framework of Indian power sector – Reform initiatives - Availability based tariff – Electricity act 2003 – players in the Indian power system, Open access issues – Power exchange – Reforms in the near future		
Module:8	**Lecture by industry experts.**	**2 Hours**
	Total Lecture Hours	**45 Hours**

Text Book(s)

1.	Mohammad Shahidepour Mueaffaq Alomoush, Marcel Dekker, "Restructured Electrical power systems Operation, Trading and Volatility ", CRC Press; 1st edition, 2001.
2.	Kankar Bhattacharya, Math H.J. Boolen, Jaap E. Daadler, " Operation of restructured power systems ", Kluwer Academic publishers, 2012.

Reference Books

1.	Loi Lei Lai ,John, " Power System Restructuring and deregulation Trading, Performance and information Technology ", John Wiley &Sons Ltd ,England ,2001.
2.	Marija Illic, Francisco Galiana and Lester fink, "Power System Restructuring Engineering and Economics ", Kluwer Academic publishers, USA 2013.
3.	P.Venkatesh, B.V.Manikantan, S.Charles raja, "Electrical Power systems Analysis, security and deregulation ", PHI Learning private limited, New Delhi 2012.

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

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

EEE4007	Energy Management Systems and SCADA	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	**EEE3003**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. The course aims to make the students familiar with the preparatory work necessary for meeting the next day's operation and the various automatic control actions to be implemented on the system to meet the Minute-to-minute variation of system load in power systems.

Expected Course Outcome:

On completion of the course the student will be able to

1. Outline the function of Energy Management System (EMS) and load flow methods
2. Diagnose the factors influencing fuel scheduling.
3. Solve hydro thermal coordination and load scheduling
4. Analyze the techniques for power/energy interchange and apply the wheeling concept in deregulated Environment.
5. Apply state estimation techniques in power system prediction/analysis.
6. Discuss the SCADA architecture and functional requirements
7. Apply the SCADA concept in power system automation.

Module:1	**Overview of Load Flow Methods**	**6 Hours**

Energy Management Centres and their functions – Recent Developments.

Module:2	**Economic Dispatch**	**6 Hours**

Take or pay Fuel supply contract – Composite Generation and solution – Fuel scheduling Problems.

Module:3	**Hydrothermal Coordination**	**7 Hours**

Short term hydro scheduling – Pumped storage hydro plant. Unit Commitment – Solutions techniques of unit commitment.

Module:4	**Interchange of power and energy**	**6 Hours**

Interchange of power and energy, Economic aspects, Energy Interchange with unit commitment, Power Pool, Transmission effects and Issues, Wheeling, Transaction involving non-utility Parties.

Module:5	**State Estimation**	**7 Hours**

Need for State estimation, Power System State Estimation, Maximum likely hood concept, Weight list Square state estimation (WLS), WLS by DC Analysis, Concept of observability, problems.

Module:6	**Supervisory Control and Data Acquisition**	**6 Hours**

Introduction to Supervisory Control and Data Acquisition – SCADA Functional requirements and Components – Structure of a SCADA communication Protocol - General features, Functions and Applications, Benefits.

Module:7	**Power Systems SCADA**	**5 Hours**
Introduction to Power Systems SCADA and SCADA in Power System Automation.		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**45 Hours**

Text Book(s)	
1.	Wood, A. J and Wollenberg, B. F, "Power Generation Operation and Control", 2nd Edition John Wiley and Sons, 2013.
2.	Mini S.Thomos & John D.Mcdonald, "Power system SCADA and smart grids", CRC press, 2015.
Reference Books	
1.	Stuart A.Boyer, "SCADA: Supervisory Control and Data Acquisition", by ISA; 4th Revised Edition 2010.
2.	Turner, W. C, "Energy Management Handbook**",** Vol. 2, 8th Edition, 2010.
3.	Green, J. N, Wilson, R, "Control and Automation of Electric Power Distribution Systems", Taylor and Francis, 2007.
4.	Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", by Gordon R.Clarke, Deon Reynder & Edwin wright - Elsevier, Newness Publications 2004.
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

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

EEE4008	High Voltage Engineering	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	EEE3003	Syllabus version				
Anti-requisite	Nil	v. 1.0				

Course Objectives:

1. Discuss and analyze the various breakdown mechanisms in gaseous, liquid and solid dielectrics
2. Design high voltage, high current and impulse generators
3. Analyze the various methodologies for high voltage, high current and impulse voltage measurement
4. Explain the various types of over-voltages in power system and methods for insulation coordination of power apparatus

Expected Course Outcome:

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

1. Discuss and analyze various types of electrical stress control techniques in gas and vacuum insulation systems
2. Derive and analyze the expression of current growth and breakdown voltage
3. Derive and analyze the various mechanisms of breakdown in liquid and solid dielectrics breakdown
4. Identify the various methodologies for high voltage and high current generation
5. Design high voltage direct current, alternating current and impulse generators
6. Analyze the various types of high voltage and high current measurement techniques
7. Evaluate the impact of various insulation tests of electrical power apparatus

Module:1	**High voltages in electrical systems and electric stress**:	6 Hours

Levels of High voltage – Electrical insulation and Dielectrics – importance of electric field intensity in the dielectrics – Electric field stresses – gas / vaccum as insulator - estimation and control of electric stress – Surge voltage their distribution and control.

Module:2	**Conduction and breakdown in gases**	6 Hours

Gases as insulating media - Collision Processes – Ionization Processes – Townsend's current growth equation – Current growth in the presence of secondary processes - Townsend's criterion for breakdown - the experimental determination of coefficients α and γ – breakdown in electro negative gases – time lags for breakdown – streamer theory of breakdown in gases – paschen' law – breakdown in non-uniform field and corona discharges.

Module:3	**Conduction and breakdown in Liquid, solid dielectrics**	6 Hours

Liquids as insulator – conduction and breakdown in pure liquids – conduction and breakdown in commercial liquids – testing of insulating oils – breakdown in solid dielectrics – intrinsic, electromechanical and thermal - breakdown in composite dielectrics.

Module:4	**Generations of high voltages and currents**	6 Hours

Generations of high direct current and alternating voltages – generation of impulse voltages and currents – tripping and control of impulse generators.

Module:5	**Measurement of high voltages and currents**	**6 Hours**
Measurement of high direct current voltages - Measurement of high ac and impulse voltages - Measurement of high current – direct, alternating and impulse – cathode ray oscillographs for impulse voltage and current measurements – measurement of direct current resistivity - measurement of dielectric constant and loss factor - partial discharge measurement.		
Module:6	**High voltage testing of electrical apparatus**	**7 Hours**
Testing of insulators and bushings - Testing of isolators and circuit breakers - Testing of cables - Testing of transformers - Testing of surge arrestors – radio interference measurements.		
Module:7	**Over voltage and insulation coordination in electric power system:**	**6 Hours**
Natural causes for over voltages – lightning switching and temporary over voltage – Protection against over voltage – bewley's lattice diagram – principles of insulation coordination on high voltage and extra high voltage power system.		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**45 Hours**

Text Book(s)	
1.	High Voltage Engineering by M.S.Naidu and V. Kamaraju – TMH Publications, 5rd Edition,2013.
2.	High Voltage Engineering: Fundamentals by E.Kuffel, W.S.Zaengl, J.Kuffel by Elsevier, 2nd Edition, 2000.
Reference Books	
1.	Extra High Voltage AC Transmission Engineering , Rakosh Das Begamudre, New Age International (P) Ltd., New Delhi – 2007.
2.	High Voltage Engineering by C.L.Wadhwa, New Age Internationals (P) Limited, 2010.
3.	High Voltage Engineering:, E. Kuffel, W. S. Zaengl, J. Kuffel, Cbs Publishers New Delhi, 2nd Edition, 2005.
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

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

EEE4009	FACTS and HVDC	L	T	P	J	C
		3	0	0	4	4
Pre-requisite	**EEE3003, EEE 3004**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. Understand the importance of controllable parameters and benefits of FACTS controllers.
2. Identify the significance of HVDC over HVAC transmission systems, types, control and application of HVDC links in practical power systems.

Expected Course Outcome:

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

1. Study the applications of FACTS Controllers in power flow
2. Sort out the significance of shunt, series compensation and role of FACTS devices on system control.
3. Analyze the functional operation and design the controller of GCSC, TSSC, TCSC and SSSC.
4. Discuss the principles, operation and control of UPFC and IPFC.
5. Describe the SSR theory and its mitigation methods using FACTS controllers.
6. Explain the HVDC concepts and application of HVDC systems in bulk power transmission.
7. Classify the DC links and describe the operation of various MTDC systems.
8. Design a component or a product applying all the relevant standards with realistic constraints

Module:1	**Introduction**	**6 Hours**
Control of power flow in transmission lines, Application and classification of FACTS controllers. Introduction to HVDC transmission- Comparison between HVDC and HVAC systems		
Module:2	**Shunt connected Devices**	**6 Hours**
Objectives of shunt compensation , Methods of controllable VAR generation, Static Var Compensator, STATCOM		
Module:3	**Series connected devices**	**7 Hours**
Objectives of series compensation , GCSC, TSSC, TCSC and SSSC		
Module:4	**Combined controllers**	**6 Hours**
Unified Power Flow Controller, Interline Power Flow Controller and Generalized Unified Power Flow Controller		
Module:5	**Sub synchronous Resonance**	**5 Hours**
SSR Theory and Mitigation using FACTS controllers		
Module:6	**HVDC Transmission**	**7 Hours**
Introduction to CSI and VSI based HVDC Controllers. Converter control, Configuration of HVDC system Recent Trends in HVDC transmission, HVDC systems in India. Case study		
Module:7	**Dc Links**	**6 Hours**
Types of DC links, Back to back HVDC connections. Multi-terminal HVDC systems		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**45 Hours**

Text Book(s)			
1.	Narain Hingorani & Lazzlo Gyugi "Understanding FACTS. Concepts & Technology of FACTS", Standard publishers & distributors, 2001.		
2.	K.R.Padiyar,"HVDC Power Transmission Systems " New Academic Science , 2017		
Reference Books			
1.	R.MohanMathur, Rajiv.K.Varma, "Thyristor Based FACTS Controllers for Electrical Transmission systems" John Wiley and Sons, 2011.		
2.	Jos Arrillaga, Y. H. Liu, Neville R. Watson " Flexible Power Transmission: The HVDC Options", Wiley 2007.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	**05/03/2016**		
Approved by Academic Council	**40th AC**	Date	**18/03/2016**

EEE4010	Power Quality	L	T	P	J	C
		2	0	0	4	3
Pre-requisite	**EEE3004**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.1				

Course Objectives:

1. To describe power quality characteristics as per IEEE/IEC standards
2. To simulate and analyze overvoltage and transients in power systems
3. To evaluate SAIDI/SAIFI and THD at customer site using PQ analyzer
4. To conduct power quality survey at an Industrial/Datacentre/Hospital site

Expected Course Outcome:

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

1. Define and Describe power quality characteristics as per IEEE/IEC standards
2. Analyze voltage sag and interruption
3. Differentiate over voltages and enumerate the methods to reduce over voltages
4. Analyze harmonics & Design of filters for harmonic reduction
5. Apply IEEE/IEC power quality standards for measurements and analysis
6. Evaluate power quality at an Industry/Data centre/Hospital and Develop solution
7. Design a model to Evaluate power quality in grid integration of Microgrid
8. Design a component or a product applying all the relevant standards with realistic constraints

Module:1	**Introduction To Power Quality**	**4 Hours**

Terms and definitions: Overloading - under voltage - over voltage. Concepts of transients - short duration variations such as interruption - long duration variation such as sustained interruption. Sags and swells - voltage sag - voltage swell - voltage imbalance - voltage fluctuation - power frequency variations. International standards of power quality. Computer Business Equipment Manufacturers Associations (CBEMA) curve.

Module:2	**Voltage Sags And Interruptions**	**4 Hours**

Sources of sags and interruptions - Estimating Voltage Sag Performance -Fundamental Principles of Protection -Solutions at the End-User Level-Evaluating the Economics of Different Ride-Through Alternatives -Motor-Starting Sags ,Utility System Fault-Clearing Issues

Module:3	**Overvoltages**	**4 Hours**

Sources of over voltages - Capacitor switching – lightning - ferro resonance. Mitigation of voltage swells - surge arresters - low pass filters - power conditioners. Lightning protection – shielding - line arresters - protection of transformers and cables

Module:4	**Harmonics**	**4 Hours**

Harmonic sources from commercial and industrial loads, locating harmonic sources. Power system response characteristics - Harmonics Vs transients. Effect of harmonics - harmonic distortion - voltage and current distortion - harmonic indices - inter harmonics – 2-9kHz harmonics – Infraction harmonics

Module:5	**Power Quality Standards And Regulations**	**4 Hours**
Standards - IEEE, IEC, ANSI, EN, UL, Limits and regulations on power quality in transmission and distribution network		
Module:6	**Power Quality Monitoring And Survey**	**4 Hours**
Monitoring Considerations - Historical Perspective of Power Quality Measuring Instruments-Power Quality Measurement Equipment-Assessment of Power Quality Measurement Data-Application of Intelligent Systems-Power Quality Monitoring Standards		
Module:7	**Harmonic Analysis Tools And Case Study**	**4 Hours**
VLT® Motion Control Tool MCT 31, Harmonic Calculation Software (HCS), PQ Box – Case Studies and Reports on effect of diesel generators and renewables on power quality parameters in a electrical network grid		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**30 Hours**

Text Book(s)

1.	Roger C. Dugan, Mark F. McGranaghan, Surya Santoso "Electrical Power System Quality", Tata Mcgraw-hill, New Delhi, 2012.
2.	Adreas Eberhard, Power Quality, , InTech, 2011.

Reference Books

1.	Mohammad A.S Masoum, Ewald F.Fuchs, Power Quality in Power Systems and Electrical Machines", Academic Press, Elsevier, 2015.
2.	Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, "Power Quality: Problems and Mitigation Techniques", John Wiley & sons Ltd, 2015

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

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

EEE4011	Energy Audit and Conservation	L	T	P	J	C
		2	0	0	4	3
Pre-requisite	**EEE3003**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. To understand the energy audit and energy saving concept in electrical system
2. To understand the energy scenario and Electricity Acts
3. To understand the effect of over exploitation of energy resources

Expected Course Outcome:

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

1. Understand Indian Energy Policy and Electricity ACT.
2. Discuss the impact of Climatic change on Environment and Energy resources.
3. Explain needs of energy management through energy audit.
4. Solve energy management problem using modern tools.
5. Estimate the energy consumption and derive energy saving opportunities
6. Design energy ratings for components.
7. Interpret ECBC for various Buildings & Support firms with HVAC specifications.
8. Design a component or a product applying all the relevant standards with realistic constraints.

Module:1	**Energy Scenario and Energy Conservation Act 2001 and related policies**	**5 Hours**

Types of Energy resources, final energy consumption, Indian energy scenario and consumption, energy needs of growing economy, energy intensity, long term energy scenario, energy pricing, energy security, energy conservation and its importance, energy strategy for the future. Energy conservation Act 2001 and its features, Electricity Act 2003, Integrated energy policy, National action plan on climate change

Module:2	**Energy, Environment and Climate change**	**3 Hours**

Energy and environment, air pollution, climate change United Nations Framework Convention on Climate Change (UNFCC), sustainable development, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), CDM Procedures case of CDM – Bachat Lamp Yojna and industry; Prototype Carbon Fund (PCF).

Module:3	**Energy Management & Audit**	**3 Hours**

Energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, energy audit instruments and metering, precautions, thermography, smart metering

Module:4	**Energy Monitoring and Targeting**	**3 Hours**

Defining monitoring & targeting, elements of monitoring & targeting, data and information-analysis, techniques - energy consumption, production, cumulative sum of differences (CUSUM). Energy

Management Information Systems (EMIS)		
Module:5	**Electrical system**	**5 Hours**
Electricity billing, electrical load management and maximum demand control, power factor improvement, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Star labelled distribution transformers, Demand side management, Assessment of transmission and distribution efficiency, losses due to harmonics and voltage unbalance, Maximum demand controllers, automatic power factor controllers, energy efficient transformers.		
Module:6	**Electric motors**	**3 Hours**
Factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors. Star labeled energy efficient motors, motor history sheet (new, Ist rewind, 2nd rewind), Star operation, voltage unbalance, energy efficient motors, soft starters with energy saver, variable speed drives.		
Module:7	**Energy conservation in Buildings and Energy Conservation Building Codes (ECBC)**	**5 Hours**
Energy Conservation Building Codes (ECBC), building envelope, insulation, lighting, Heating, ventilation, air conditioning (HVAC), fenestrations, water pumping, inverter and energy storage/captive generation, elevators and escalators, star labeling for existing buildings, Energy Service Companies based case studies		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**30 Hours**

Text Book(s)

1.	Wayne C. Turner, Steve Doty, "Energy Management Handbook", The Fairmont Press, Inc., 2013.
2.	Course Material for Energy Audit and Managers Exam, Vol. 1-4 Energy Audit Manual the Practitioner's Guide Jointly published by EMC and NPC, 2017.

Reference Books

1.	Barney L. Capehart, Wayne C. Turner, William J. Kennedy , " Guide to Energy Management", The Fairmont Press, Inc, 2016.
2.	Albert Thumann, Terry Niehus, William Younger, " Handbook of Energy Audits" The Fairmont Press, Inc, 2013.

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

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

EEE4012	Renewable Energy Sources	L	T	P	J	C
		3	0	0	0	3
Pre-requisite	EEE3003	Syllabus version				
Anti-requisite	Nil	v. 1.0				

Course Objectives:

1. To impart in depth knowledge of various types of renewable energy sources.
2. To develop a micro grids using different renewable energy sources.
3. To understand the basic principles of operation of the various renewable energy sources.

Expected Course Outcome:

On completion of the course the student will be able to

1. Gain knowledge on different types of renewable energy sources.
2. Understand and design different type's thermal collectors and PV cells.
3. Comprehend the types and analyse the performance of wind mills.
4. Understand the basic operating principles of tidal and wave energy to design an Ocean Thermal Energy Conversion (OTEC) plant.
5. Identify geothermal energy sources and its application.
6. Utilization of biomass energy conversion techniques for conversion of waste into useful energy.
7. Understand the fuel cells types, working principles and its related applications.

Module:1	Introduction to Energy Sources	4 Hours

Energy sources on earth – Energy utilisation – Global energy problems and role of renewable energy – Introduction to alternate energy sources.

Module:2	Solar Energy and Applications	8 Hours

Solar radiation - Solar radiation geometry – Solar radiation measurements – Principles, Characteristics and efficiency of different types of collectors-Solar cell-Solar cell array. Solar energy applications: water heaters, air heaters, solar cooling, solar cooking, solar pumping, and solar drying – Solar electric power generation: Solar tower concept (solar pond) and Solar photo-voltaic.

Module:3	Wind Energy	7 Hours

Energy from the wind - Types and General theory of wind mills - Performance of wind machines-wind power efficiency - wind electric generation schemes -Applications of wind Energy - stand-alone and grid connected systems.

Module:4	Tidal and Wave Energy	7 Hours

Energy from tides and waves - Tidal Barrage -working principles and operation of different types tidal and wave power generation- Design of 5 MW OTEC pro-commercial plant. Economics and Environmental impacts of OTEC.

Module:5	Geothermal Energy	6 Hours

Estimation of geothermal power – Geothermal sources - principle of working and operation of different types of geothermal power generation- Future of geothermal energy.

Module:6	Bio-Energy	6 Hours

Biomass conversion techniques: Biogas generation, classification and types of biogas plants, Energy from biomass: Industrial wastes, municipal waste, burning plants and agricultural wastes.

Module:7	**Fuel Cells Energy**	**5 Hours**
Fuel cells – Principle of operation, classification and types of fuel cells – Applications- Limitations and future prospect.		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**45 Hours**

Text Book(s)	
1.	Frank Kreith, Susan Krumdeick, Principles of Sustainable Energy Systems, CRC press, Taylor and Francis group, Second Edition, 2014
2.	G.D. Rai, Non-Conventional Energy Sources, Khanna Publishers, 2004.
Reference Books	
1.	John Twidell and Tony Weir, Renewable Energy Resources, Second edition, Taylor & Francis, 2006.
2.	S.P. Sukhatme, Solar Energy, Principles of Thermal Collection and Storage, Tata McGraw Hill Publishers, Fourth Print, February 2015.
3.	G.D. Rai, Solar Energy Utilizations, Khanna Publishers, Second Revised Edition, 2004.
4.	Ronald Shaw, Wave Energy: A Design Challenge, Eills Horwood Ltd. Publishers, First Edition 1982.
5.	Putnam, Energy from the Wind, Prentice Hall of India.2004.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	**05/03/2016**		
Approved by Academic Council	**40th AC**	Date	**18/03/2016**

EEE4013	Smart Grid	L	T	P	J	C
		3	0	0	4	4
Pre-requisite	**EEE3003, EEE3004**	**Syllabus version**				
Anti-requisite	**Nil**	v. 2.0				

Course Objectives:

1. Architecture designs
2. Measurement and Communications Technologies
3. To familiarize the transmission and distribution automation using smart Grid.
4. Integration of vehicles with rechargeable batteries in to distribution networks.

Expected Course Outcome:

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

1. Describe the necessity and evolution of smart grid with policies
2. Identify the appropriate measurement techniques for smart grid implementation
3. Apply theoretical concepts for analyzing the performance of the grid
4. Identify the appropriate choice for data transaction in a secure manner
5. Understand various power transmission automation techniques
6. Explain the working of distribution automation and the two way power flow of distribution system
7. Design the concept of V2G & G2V using Electric vehicle & Batteries
8. Design a component or a product applying all the relevant standards with realistic constraints

Module:1	**Smart Grid Architectural Designs**	**7 Hours**

Introduction. Evolution of electric Grid, Need for smart grid, difference between Conventional grid and smart grid, General View of the Smart Grid Market Drivers, Functions of Smart Grid Components, present development and international policies in smart grid.

Module:2	**Smart Grid Communications And Measurement Technology**	**8 Hours**

Communication and Measurement , Monitoring, PMU, Smart Meters, and Measurements Technologies ,Wide Area Monitoring Systems (WAMS), Phasor Measurement Units (PMU) , Smart Meters , Smart Appliances, Advanced Metering Infrastructure (AMI),, GIS and Google Mapping Tools Multi agent Systems (MAS) Technology ,Multi agent Systems for Smart Grid Implementation , Micro grid and Smart Grid Comparison

Module:3	**Performance Analysis Tools For Smart Grid Design**	**6 Hours**

Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Flow Methods ,types ,Load Flow State of the Art: Classical, Extended Formulations, and Algorithms , Congestion Management Effect , Load Flow for Smart Grid Design , Cases for the Development of Stochastic Dynamic optimal Power Flow (DSOPF), Application to the Smart Grid, Static Security Assessment (SSA) and Contingencies, Contingency Studies for the Smart Grid

Module:4	**Information Security And Communication Technology For Smart Grid**	**6 Hours**

Data communication, switching techniques, communication channels,HAN,NAN,WAN, Bluetooth, Zigbee, GPS, Wi-Fibased communication, Wireless mesh network, Basic of cloud computing and cyber security for smart grid, Broadband over power line(BPL)

Module:5	**Transmission Automation:**	**7 Hours**
Introduction, Transmission Infrastructure functionality, Transmission technology , Energy Management System , Map Board Automatic Generation Control (AGC) ,Supervisory Control , Contingency Reserve Management ,Interchange Scheduling , SCADA Master Terminal Unit , Transmission Substations, Synchrony phasor as IEDs , Relays as IEDs ,Programmable Logic Controllers as IEDs ,RTUs as IEDs, Smart Transmission Cyber Security.		
Module:6	**Distribution Automation:**	**6 Hours**
Introduction , Distribution System Architecture, Distribution automation, working of Distribution Automation, ,role of Smart Grid Function of Distribution Automation, Importance of the Distribution System and Its Security Challenges ,Securing the Distribution System, Distribution Management Systems ,Standards, Inoperability, and Cyber Security		
Module:7	**Integration Of Vehicles With Rechargeable Batteries Into Distribution Networks**	**3 Hours**
The revolution of individual electrical transport, consequences on the electrical network. Demand management and vehicle-to-grid, Vehicles as “active loads” Energetic services,. Frequency regulation.		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**45 Hour**

Text Book(s)	
1.	James momoh, "Smart grid fundamentals of design and analysis, "IEEE Press, a john wiley & sons, inc., publication, 2012.
2.	Bernd M. Buchholz, Zbigniew Styczynski ,"Smart grid fundamentals and Technologies in Electricity Networks", Springer ,Heidelberg New York Dordrecht London, 2014.
Reference Books	
1.	Janaka Ekanayake, Nick Jenkis, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smard grid technology and applications,: Wiley, 2012.
2.	Stuart Borlase " Smart grid: Infrastructure, Technology and solutions, "CRC Press 2012.

Mode of Evaluation:	CAT I & II – 30%, DA I & II – 20%, Quiz – 10%, FAT – 40%		
Recommended by Board of Studies	**05/03/2016**		
Approved by Academic Council	**40th AC**	Date	**18/03/2016**

EEE4016	Electric Vehicles	L	T	P	J	C
		2	0	0	4	3
Pre-requisite	EEE3004	Syllabus version				
Anti-requisite	Nil	v. 1.0				

Course Objectives:

1. This course introduces the fundamental concepts, principles, analysis and design of hybrid electric vehicles.

Expected Course Outcome:

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

1. Comprehend the performance of conventional vehicles.
2. Infer the hybrid electric vehicles and its impact on environment
3. Analyze the various hybrid vehicle configurations and its performance.
4. Interpret the electric components used in hybrid and electric vehicles
5. Design the sizing of drive systems for electric vehicles.
6. Choose proper energy storage systems for vehicle applications
7. Identify various communication protocols and technologies used in vehicle networks
8. Design a component or a product applying all the relevant standards with realistic constraints.

Module:1	Introduction to Conventional Vehicles:	3 Hours

Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance

Module:2	Introduction to Electrical Vehicles:	3 Hours

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, future of electric vehicles, comparison with IC engine drive vehicles

Module:3	Electric Vehicle Drive Train:	4 Hours

Transmission configuration, Components, gears, differential, clutch, brakes, regenerative braking, motor sizing. Basic concept of electric traction, Introduction to various drive train topologies, power flow control in electric drive topologies, fuel efficiency analysis

Module:4	Electric Propulsion Unit:	4 Hours

Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Introduction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Module:5	Sizing the drive system:	3 Hours

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

Module:6	Energy Storage:	4 Hours

Introduction to energy storage requirements in hybrid and Electric vehicles, Battery based energy storage and its analysis, fuel cell based and super capacitor based energy storage and its analysis. Hybridization of different energy storage devices

Module:7	**Energy management strategies and Case Studies:**	**7 Hours**
Introduction to energy management strategies used in hybrid and electric vehicle, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy strategies - Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**30 Hours**

Text Book(s)	
1.	Iqbal Hussain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press, Second Edition, 2011.
2.	Mehrdad Ehsani, Yimin Gao, and Ali Emadi, "Modern Electric, Hybrid and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010.
Reference Books	
1.	Chris Mi, MA Masrur, and D W Gao, "Hybrid Electric Vehicles- Principles and Applications with Practical Perspectives", Wiley, 2011.
2.	Davide Andrea, "Battery management Systems for Large Lithium-Ion Battery Packs", Artech House, 2010.

Mode of Evaluation:	CAT I & II – 30%, DA I & II – 20%, Quiz – 10%, FAT – 40%		
Recommended by Board of Studies	**05/03/2016**		
Approved by Academic Council	**40th AC**	Date	**18/03/2016**

EEE4017	Industrial Drives and Automation	L	T	P	J	C
		3	0	0	4	4
Pre-requisite	**EEE3004, EEE3001**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. To explore the various DC, AC and special machine drives for industrial applications
2. To study the various open loop and closed loop control schemes for drives.
3. To introduce the hardware implementation of the basic controllers using PLC.

Expected Course Outcome:

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

1. Discuss the basic components of the drive system from automation perspective.
2. Analyze the various converter and chopper fed DC drive with appropriate control.
3. Explain the various scalar and vector control methodologies for induction motor drive.
4. Classify the synchronous motor drive with relevant control techniques.
5. Identify the various special machines and its control.
6. Understand the basic logics of PLC
7. Apply the PLC programming to control drives.
8. Design a component or a product applying all the relevant standards with realistic constraints.

Module:1	**Introduction**	**5 Hours**

Introduction to Electric Drives – Need of electric drives, basic parts, present scenario of electric drives, Mechanical Dynamics in an Electric Drive – Understand the concept of Industrial Automation and exposure on its components. Identify the Scope.

Module:2	**DC Motor Drive**	**6 Hours**

Four quadrant chopper circuit –steady state analysis of chopper controlled DC motor drives – DC motor drive using half controlled and fully controlled single phase and three phase rectifiers, continuous and discontinuous conduction modes of operation, 4-quadrant operation using dual converter- Braking. Analysis of Closed Loop Control of DC Motor.

Module:3	**Induction Motor Drive**	**6 Hours**

Induction motor with variable voltage operation -Variable frequency operation- constant v/f operation –constant torque and field weakening regions-Vector control strategies-Direct torque control scheme-Slip power recovery scheme- analysis-Applications

Module:4	**Synchronous motor Drive**	**5 Hours**

Synchronous motor Drive with voltage source inverter, load commutated thyristor inverter and Cyclo-converter - Control strategies – Constant torque angle control –Unity power factor control – Constant mutual flux linkage control.

Module:5	**Special Machine Drives**	**7 Hours**

Permanent magnet synchronous motor - Field oriented control - Direct torque control – Sensor-less control. Brushless Direct current (BLDC) machine control strategies, Voltage Source Inverter fed BLDC-Torque ripple minimization – Application.

Module:6	**Introduction to Programmable Logic Controllers**	**7 Hours**
PLC architecture, Input Output modules, PLC interfacing with plant, memory structure of PLC. PLC programming methodologies: ladder diagram, STL, functional block diagram, creating ladder diagram from process control descriptions, introduction to IEC61131 international standard for PLC.		
Module:7	**PLC based Control**	**5 Hours**
Bit logic instructions, ladder diagram examples, interlocking, latching, inter dependency and logical functions, PLC Timer & Counter functions, Control components, sensors, actuators and valves, PID configuration, various network topologies and communication protocols like Profibus, Foundation field bus, Devicenet, HART		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**45 Hours**

Text Book(s)

1.	Vedam Subramanyam, "Electric Drives – Concepts and Applications", Tata McGraw Hill, 2011.
2.	Richard Shell, Handbook of Industrial Automation, CRC Press, 2000.

Reference Books

1.	John Webb: Programmable Logic Controllers principles & Applications, PHI, 2009.
2.	A K Gupta, Industrial Automation and Robotics, Firewall Media, 2013.
3.	Bimal K Bose, "Modern Power Electronics and AC Drives", Pearson Education Asia, 2012.
4.	R. Krishnan, „Permanent Magnet Synchronous and Brushless DC Motor Drives", Taylor and Francis, 2010
5.	Haitham Abu-Rub, Atif Iqbal, Jaroslaw Guzinski, "High Performance Control of AC Drives with Matlab/Simulink Models", John Wiley & Sons, 2012.

Mode of Evaluation:	CAT I & II – 30%, DA I & II – 20%, Quiz – 10%, FAT – 40%		
Recommended by Board of Studies	**05/03/2016**		
Approved by Academic Council	**40th AC**	Date	**18/03/2016**

EEE4018	Advanced Control Theory	L	T	P	J	C
		3	0	0	4	4
Pre-requisite	**EEE 3001**	**Syllabus version**				
Anti-requisite	**Nil**	v. 2.0				

Course Objectives:

1. To impart in-depth knowledge in the field of control theory, analysis and design of MIMO systems in state space
2. Basic understanding on features of linear and nonlinear systems
3. To analyze the features of linear and nonlinear systems using phase plane analysis and describing function analysis
4. To analyze the stability of linear and nonlinear systems using stability concepts

Expected Course Outcome:

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

1. Model physical systems using state variable approach
2. Analyze MIMO systems by state space approach
3. Design state feedback controller and observer for simple and practical dynamic systems
4. Identify and classify the nonlinearities in the physical systems
5. Analyze the features and stability of nonlinear systems using phase portraits
6. Analyze the systems with common nonlinearities using describing function
7. Analyze stability of linear and non – linear systems
8. Design a component or a product applying all the relevant standards with realistic constraints

Module:1	**State Variable Representation**	**6 Hours**

Introduction, Concept of State Equation for Dynamic Systems, Non Uniqueness of State model, State Diagrams, Physical Systems and State Assignments - State space representation of multivariable systems

Module:2	**Solution Of State Equations**	**6 Hours**

State transition matrix – Properties and Computation. Controllability and Observability, Stabilizability and Detectability.

Module:3	**Design In State Space**	**7 Hours**

State Feedback, Output Feedback, Design Methods, Pole Assignment, Full Order and Reduced Order Observers. Introduction to Linear Quadratic problems.

Module:4	**Introduction To Non Linear Sytems**	**5 Hours**

Introduction, Features of Linear and Non Linear Systems, Types of non-linearity, Common nonlinearities in control systems, Typical Examples , Concept of phase portraits – Singular points – Limit cycles

Module:5	**PHASE PLANE ANALYSIS**	**7 Hours**

Construction of phase portrait, Concepts of phase plane analysis Phase plane analysis of linear system and nonlinear system, Existence of limit cycles.

Module:6	**Describing Function Analysis**	**6 Hours**

Describing function fundamentals, Describing functions of common nonlinearities, Describing function analysis of nonlinear systems, Limit cycles , Stability of Oscillations

Module:7	**Stability Analysis**	**6 Hours**

Stability Concepts, Equilibrium Points, BIBO and Asymptotic Stability, Lyapunov theory, Lyapunov's Direct method, Variable gradient method Frequency Domain Stability Criteria, Popov's

Method & its Extension.			
Module:8	**Contemporary issues:**		**2 Hours**
	Total Lecture Hours		**45 Hours**
Text Book(s)			
1.	Katsuhiko Ogata, "Modern Control Engineering ", PHI Learning Pvt Ltd, 5th Edition, 2010.		
2.	Hassan K Khalil, "Nonlinear Control ", Pearson Prentice Hall, 1st Edition, 2014.		
Reference Books			
1.	M. Gopal, "Modern Control Systems Theory", New Age Publishers, 3rd Edition, 2014.		
2.	Richard C. Dorf, Robert H. Bishop, "Modern Control Systems", Prentice Hall, 12th Edition, 2010.		
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	**05/03/2016**		
Approved by Academic Council	**40th AC**	Date	**18/03/2016**

EEE4019	Advanced Digital Design with FPGAs	L	T	P	J	C
		2	0	0	4	3
Pre-requisite	EEE3002	Syllabus version				
Anti-requisite	Nil	v. 1.0				

Course Objectives:

1. To learn complex digital systems using Hardware Description Language.
2. To learn field programmable gate array (FPGA) technologies and utilize associated computer aided design (CAD) tools to synthesize and analyze digital systems.

Expected Course Outcome:

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

1. Design and recognize the trade-offs involved in digital design flows for system
2. Compile and synthesize Verilog HDL.
3. Analyze and synthesize digital modules and circuits for a wide application range.
4. Design state machines to control complex systems.
5. Verify Verilog test bench to test Verilog modules.
6. Build a synchronous DSP system in Verilog and verify its performance.
7. Design a floating point arithmetic using the IEEE-754 Standard.
8. Design a component or a product applying all the relevant standards with realistic constraints

Module:1	Introduction to FPGAs	3 Hours

Basic Programmable Logic architectures, Complex Programmable Logic Devices (CPLDs), Field Programmable Gate Arrays (FPGAs), Design Flow, Design Tools.

Module:2	Introduction to Verilog HDL	5 Hours

Review of Verilog HDL, Modeling styles: Behavioral, Dataflow, and Structural Modeling, gate delays, switch-level Modeling, Hierarchal structural modeling.

Module:3	Implementing Logic using MSI Combinational Logic Blocks	4 Hours

Multiplexer, DeMultiplexer, Encoder, Decoder, ROM, PAL, PLA.

Module:4	Verilog Modelling of Sequential Circuits	4 Hours

Flip-Flops, Shift Registers, Counters, Finite State Machine Modelling.

Module:5	Verification	3 Hours

Functional verification, simulation types, Test Bench design, value change dump (VCD) files.

Module:6	Design	6 Hours

Adders and Substractors, Multiplication Digital Signal Processing modules: FIR and IIR Filters, Bus structures, Synchronous & Asynchronous data transfer, UART baud rate generator, A simple CPU design.

Module:7	Floating point arithmetic circuits	3 Hours

Adders, Subtractors, Multipliers		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**30 Hours**

Text Book(s)	
1.	Michael D Ciletti, "Advanced Digital Design with the Verilog HDL" Prentice Hall, 2nd Edition, 2011.
2.	Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis" Pearson, Second Edition, 2009.
Reference Books	
1.	Stephen Brown & Zvonko Vranesic, "Fundamentals of digital Logic with Verilog Design" TATA Mc Graw Hill Ltd. 3rd Edition 2014.
2.	Ming-Bo Lin., Digital System Designs and Practices Using Verilog HDL and FPGAs. Wiley, 2008.
3.	Woods, R., McAllister, J., Yi, Y. and Lightbody, G. FPGA-based implementation of signal processing systems. John Wiley & Sons, 2017.
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar	

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

EEE4020	Embedded System Design	L	T	P	J	C
		2	0	0	4	3
Pre-requisite	EEE4001	Syllabus version				
Anti-requisite	Nil	v. 1.0				

Course Objectives:

1. To give an emphasis on the characteristics and hardware architecture of embedded system and real time operating systems.
2. To provide essential knowledge on various communication protocols and understanding of Mealy and Moore machines.
3. To provide the essential knowledge in the embedded modeling and design of finite state machines.

Expected Course Outcome:

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

1. Understand the characteristics and concepts of embedded system.
2. Understand the architecture of hardware embedded system
3. Compare the concepts of RTOS with general purpose OS.
4. Design hardware components/architecture for embedded system applications.
5. Interpret the wired and wireless communication protocols.
6. Design state space model using Moore and Mealy technique
7. Analyze the embedded system modelling with state transition and FSM.
8. Design a component or a product applying all the relevant standards with realistic constraints

Module:1	Introduction to Embedded systems:	3 Hours

Embedded system- Definition, Categories, Requirements. Challenges and issues in embedded software development, Trends in embedded software development, Applications of embedded systems.

Module:2	Hardware architecture of embedded system:	4 Hours

Processor, Memory, Memory models, Latches and Buffers, crystal, Timers, reset circuit, Watchdog timer, chip select logic circuit, ADC and DAC, Display units, Communication interfaces, Introduction to emulators.

Module:3	Real time operating system (RTOS) with Kernel:	4 Hours

RTOS vs General purpose OS, Kernel Architecture and Functionalities - Task management, Process Scheduling, Resource management (Semaphores and Mutex), Task Synchronization. Embedded software development Life cycle.

Module:4	Serial Bus for embedded systems:	5 Hours

I2C- Features, Arbitration, Bit Transfer Waveform and exceptions. CAN- Layered Architecture of CAN, properties, Data Rates, Frame types. USB- Physical interface, Enumeration process in USB, Types of packets, Types of transfers.

Module:5	Wireless Applications:	4 Hours

Introduction to wireless networking –Basics. Bluetooth – Overview, power levels, Device communication, Base band, Packet format, packet heading, packet types and packet timing. Overview of IEEE 802.15.4 standard feature, Device types and Frame format. ZigBee – Architecture objectives, Network model, ZigBee stack block diagram, Network layer. ZigBee Vs

Bluetooth.		
Module:6	**Introduction to Moore and Mealy models**	**4 Hours**
Design of a Level to Pulse converter implementing Moore and Mealy FSM- Block diagram, definition of the state, building state transition diagram to state table, Relative trade-offs. State space models of sequential machines- Introduction.		
Module:7	**Embedded System Modelling:**	**4 Hours**
Finite State Machine (FSM) - Rules for designing FSM, Design examples implementing state and state transition diagram for vending machine, ATM, digital lock.		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**30 Hours**

Text Book(s)	
1.	David.E. Simon, "An Embedded Software primer", Pearson Education Inc., 2012.
2.	Tammy Noergaard, "Embedded systems architecture: a comprehensive guide for engineers and programmers" Berlin: Elsevier, 2014.
Reference Books	
1.	Xiacong Fan, "Real-time embedded systems: Design principles and engineering practices", Amsterdam [Netherlands]: Newnes, 2015.
2.	Frank Vahid and Tony Givargis, "Embedded System Design: A Unified Hardware/Software Approach", Wiley; Student edition, 2010.

Mode of Evaluation: CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	**05/03/2016**		
Approved by Academic Council	**40th AC**	Date	**18/03/2016**

EEE4027	Robotics And Control	L	T	P	J	C
		2	0	0	4	3
Pre-requisite	EEE3001	Syllabus version				
Anti-requisite	Nil	v. 1.0				

Course Objectives:

1. To develop the student's knowledge in various robot structures and their workspace.
2. To develop student's skills in performing spatial transformations associated with rigid body motions & some knowledge and analysis skills associated with trajectory planning.
3. To develop student's skills in performing kinematic analysis of robotic systems and some knowledge and skills associated with robot control

Expected Course Outcome:

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

1. Select different types of sensors and actuators for robotic systems
2. Apply spatial transformation to obtain the forward kinematic equation of robot manipulators.
3. Analyse forward and inverse kinematics for simple robot manipulators.
4. Derive Jacobian matrix and identify singularities.
5. Identify the dynamics of the robotic manipulator using Euler Lagrangian approach
6. Generate joint trajectories for motion planning.
7. Implement the multivariable controller for setpoint tracking and disturbance rejection
8. Design a component or a product applying all the relevant standards with realistic constraints

Module:1	Introduction	2 Hours

Brief History, Types of robots, Degrees of freedom of robots, Robot configurations and concept of workspace, End effectors and Different types of grippers, vacuum and other methods of gripping. Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots.

Module:2	Rigid Motion and Homogeneous transformation	5 Hours

Position definitions. Coordinate frames. Different orientation descriptions. Free vectors. Translations rotations and relative motion, Composition of rotation, rotation with respect to fixed frame and current frame, parameterisation of rotation, Euler Angele, roll, pitch, yaw, axis/angle representation, Homogeneous transformation

Module:3	Forward Kinematics	4 Hours

Link coordinate frames. Denavit-Hartenberg convention. Assignment, of coordinate frame, Joint and end effector Cartesian space. Calculation of DH parameters and forward kinematic equation of different configuration of manipulator, Planner elbow manipulator, Cylindrical three link, SCARA, Spherical Wrist and other configuration.

Module:4	Velocity Kinematics:	4 Hours

Forward kinematics transformations of position Translational and rotational velocities. Velocity Transformations. Singularity, The Manipulator Jacobian.

Module:5	Robot Dynamics	4 Hours

Lagrangian formulation, general expression for kinetic and potential energy of n-link manipulator, Newton-Euler equations of motion. Derivation of equations of motion for simple cases: two-link manipulators.

Module:6	**Trajectory Planning& Programming**	**5 Hours**
Trajectory planning and avoidance of obstacles.Trajectory for point to point motion,Cubic polynomial trajectory,Quintic polynomial, LSPB(Linear segment with parabolic blend)Minimum time trajectory, Trajectories for Paths Specified by Via Points. Robot languages, computer control and Robot software		
Module:7	**Independent Joint Control:**	**4 Hours**
Actuator dynamics, Set point tracking Feed forward control, Drive Train dynamics. Introduction to force control and multivariable control.		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**30 Hours**

Text Book(s)

1.	M.W. Spong, S. Hutchinson, and M. Vidyasagar, Robot Modeling and Control, Wiley, 2nd revise edition, 2012
2.	J.J. Craig, Introduction to Robotics: Mechanics and Control, Pearson Education, 4th Edition, 2017
3.	M.P. Groover, et.al., Industrial Robots: Technology, Programming and applications, McGraw Hill, 2nd indian edition, 2012.

Reference Books

1.	Robot Manipulators : Modeling, Performance Analysis and Control. by Etienne Dombre; Wisama Khalil, Somerset : Wiley, 2013.
2.	M O Tokhi, A K M Azad,Flexible robot manipulator :modelling,simulation and control 2nd edition, 2017.
3.	Ashitava Ghosal.Robotic fundamental Concept and Analysis,Oxford University Press 11th impression 2015.

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

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

EEE4028	VLSI Design	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	**EEE3002**	**Syllabus version**				
Anti-requisite	**Nil**	v. 2.0				

Course Objectives:

1. To provide an understanding of the digital VLSI concepts, circuit design, principles.
2. To provide introduction to architecture and design concepts underlying modern complex VLSI.
3. To provide students with the background needed to design, develop, and test digital circuits using VHSIC Hardware Description Language (VHDL) and Verilog HDL.
4. To provide the students to design the digital circuits using transistors for complex systems.

Expected Course Outcome:

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

1. Analyze and identify the methodologies for fabricating the ICs.
2. Synthesize and design arithmetic circuits using HDL.
3. Design logic circuits using CMOS and its equivalent layout for fabrication.
4. Analyze the characteristics of CMOS to reduce the delay and power dissipation in logic circuits.
5. Identify transistor configurations for better performance in logic circuits.
6. Design memory devices using transistors.
7. Identify and design arithmetic circuits for various applications.
8. Design and Conduct experiments, as well as analyze and interpret data

Module:1	**Overview of VLSI Design Methodology**	**4 Hours**

The VLSI design process, Architectural design, logical design, Physical design, layout styles, Full custom, Semi custom approaches.

Module:2	**Introduction to Verilog HDL**	**6 Hours**

Introduction Verilog HDL, Gate level, data flow, behavioral modeling, Data types and Operators, Blocking and non-blocking assignment statements. Test benches.

Module:3	**Introduction to MOS Devices**	**6 Hours**

Introduction to MOS Transistor Theory: nMOS, pMOS Enhancement Transistor, MOSFET as a Switch, Threshold voltage, MOS Device Design Equations, Body effect, Second order effects. MOS Transistor Circuit Model. Stick Diagram, Layout Design Rules.

Module:4	**Circuit Characterization And Performance Estimation**	**6 Hours**

DC Characteristics of CMOS Inverter, Switching Characteristics of CMOS Inverter, Transistor Sizing Analytical Delay model- Rise Time, Fall Time. Gate Delays, RC Delay Models, Logical Effort. Power Dissipation: Static- Dynamic-Short Circuit Power Dissipation

Module:5	**Combinational logic Circuits**	**6 Hours**

Introduction, Static CMOS Design- Complex Logic Gates, Ratioed Logic, Pass-Transistor Logic, Transmission gate Logic, Dynamic CMOS Logic Design: Dynamic Logic Design Considerations. Speed and Power Dissipation of Dynamic logic, Signal integrity issues, Cascading Dynamic gates.

Module:6	**Sequential Logic Circuits**	**6 Hours**
Static and Dynamic Latches and Registers, Timing issues, pipelining		
Module:7	**Designing arithmetic circuits**	**9 Hours**
Adders-Ripple carry, Carry-Look ahead, Multiplier using Array based-Ripple carry adder, Carry-Save adder, Multiplier using Tree based-Wallace Tree, Dadda Tree, Booth Multiplier, Squarer. Modeling of arithmetic circuits using HDL: Pipelined Multiplier and Accumulator, FIR filter design. Verilog Coding for arithmetic circuits.		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**45 Hours**
List of Challenging Experiments (Indicative)		**2,5,9**

1.	Four bit adder using different approaches for delay and Area reduction	2 Hours
2.	Four Bit Wallace tree multiplier	2 Hours
3.	Four bit dada tree multiplier	2 Hours
4.	Four bit squarer design	2 Hours
5.	Multiplier and Accumulator design	2 Hours
6.	FIR filter design	2 Hours
7.	CMOS switch level implementation of Complex Boolean functions	2 Hours
8.	CMOS switch level implementation of adder and subtractor	2 Hours
9.	Implementation of Boolean function using various transistors	2 Hours
10.	Positive and negative edge triggered register design	2 Hours
	Total Laboratory Hours	**30 hours**

Text Book(s)

1.	Jan Rabaey, Anantha Chandrakasan, B.Nikolic, “Digital Integrated circuits: A design perspective”. Second Edition, Prentice Hall of India, 2013.
2.	Neil H.E.Weste, David Money Harris, “CMOS VLSI DESIGN: a circuits and systems perspective”, Fourth edition, Pearson 2015.

Reference Books

1.	Samir Palnitkar, “Verilog HDL”, Prentice Hall, 2010.
2.	Sung-Ma Kong, Yusuf Leblebici and Chulwoo Kim, "CMOS digital integrated circuits: analysis and design", 4th edition, McGraw-Hill Education, 2015.

Mode of Evaluation:	CAT I & II – 30%, DA I & II – 20%, Quiz – 10%, FAT – 40%		
Recommended by Board of Studies	**05/03/2016**		
Approved by Academic Council	**40th AC**	Date	**18/03/2016**

EEE4037	Rapid Prototyping with FPGAs	L	T	P	J	C
		0	0	4	0	2
Pre-requisite	**Nil**	**Syllabus version**				
Anti-requisite	**Nil**	v.1.0				

Course Objectives:

1. This course exposes students to hands-on experience in the design and test of a wide variety of prototype electric and electronic systems hardware
2. Engineering design by applying a combination of human creativity and modern computational tools to the synthesis of a simple component or system.

Expected Course Outcome:

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

1. Design and Conduct experiments, as well as analyze and interpret data

List of Experiments

1	Accumulator design in Verilog	4 Hours
2	MAC design in Verilog	4 Hours
3	HDL programming- Adder, Subtractor,Multplexer, Demultiplexer	4 Hours
4	Code converter	4 Hours
5	Shift register/Universal shift register	4 Hours
6	Upcounter / Downcounters	4 Hours
7	FIR filter	4 Hours
8	Array multiplier	4 Hours
9	Rapid Prototyping of Power Electronics Converters for Photovoltaic System Application Using Xilinx System Generator	4 Hours
10	Design Principles for Rapid Prototyping Forces Sensors Using 3-D Printing	6 Hours
11	Rapid Control Prototyping of Active Vibration Control Systems in Automotive Applications	6 Hours
12	Rapid Prototyping of a Low-Cost Solar Array Simulator Using an Off-the-Shelf DC Power Supply	6 Hours
13	Rapid Prototyping of Miniature Capsule Robots	6 Hours
	Total Laboratory Hours :	**60 Hours**

Reference Books

1. Chee Kai Chua, Kah Fai Leong, Chu Sing Lim Rapid Prototyping: Principles and Applications ,3rd Edition, Kindle Edition
2. Miltiadis Boboulas, CAD-CAM & Rapid prototyping Application Evaluation, Bookboon
3. R. C. Cofer Benjamin Harding , Rapid System Prototyping with FPGAs

Recommended by Board of Studies	**13/10/2018**		
Approved by Academic Council	**53rd AC**	Date	**13/12/2018**

EEE4038	Testing and Calibration Systems	L	T	P	J	C
		0	0	2	0	1
Pre-requisite	**EEE4021/EEE2004**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. To explore the basic concepts and terminology of testing and calibration systems.

Expected Course Outcome:

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

1. Design and Conduct experiments, as well as analyze and interpret data

List of Experiments

1	Perform a comparative experimental study on Calibration of a Pressure Gauge Using a Dead Weight Pressure Gauge Calibrator and the Digital Pressure Calibrator.	3 Hours
2	Evaluate the errors and estimate the uncertainties during pressure measurement. Perform an experimental study on calibration of pressure gauge to overcome the same.	3 Hours
3	Perform an experimental study on calibration of rotameter. Evaluate the same by estimation of uncertainties during flow measurement.	3 Hours
4	Perform uncertainty calculations for the given Voltmeter and ammeter and calibrate the same using multifunctional calibrator system. Validate the meters for a given electrical circuit.	3 Hours
5	Conduct a verification and validation of a three-phase wattmeter and a single-phase wattmeter. Perform uncertainty calculations for the same	3 Hours
6	Configure and calibrate the given K-type thermocouple for measuring temperature of a kettle between 25°C to 250°C. Perform uncertainty analysis.	3 Hours
7	Perform a calibration and uncertainty analysis for a given thermistor for measuring temperature of a system between 25°C to 150°C.	3 Hours
8	Conduct a verification and validation of a hygrometer for measuring humidity. Perform measurement uncertainty for the same.	3 Hours
9	Perform an experiment for RTD and Thermocouple probe calibration.	3 Hours
10	Conduct an experiment for torque transducer calibration and check the errors	3 Hours
	Total Laboratory Hours:	**30 Hours**

Reference Books

1. Calibration Handbook of Measuring Instruments by Alessandro Brunelli ,Ist Edition,ISA.
2. ction to Measuration and Calibration by Paul.D.Q. Campbell Industrial Press Inc
3. Sensors and Signal Conditioning by Ramon Pallas-Areny/John.G.Webster , Second Edition, Wiley India.

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

Recommended by Board of Studies	**13/10/2018**		
Approved by Academic Council	**53rd AC**	Date	**13/12/2018**

ECE3501	IoT Fundamentals	L	T	P	J	C
	Job Role: SSC/Q8210	2	0	2	4	4
Pre-requisite	Nil	Syllabus version				
Anti-requisite	Nil	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, Team Empowerment**	**3 hours**
	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 % 20 Specialist_09.04.2019.pdf

List of Experiments	**1,2,14**
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			
Approved by Academic Council		Date	

ECE3502	IoT Domain Analyst	L	T	P	J	C
	Job Role: SSC/Q8210	2	0	2	4	4
Pre-requisite	Nil	Syllabus version				
Anti-requisite	Nil	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, (1st edition)
3.	Claire Rowland, Elizabeth Goodman, Martin Charlier, Ann Light, Algred Lui,” DesigningConnected 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 da Costa, 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 Ltd
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 % 20 Specialist_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			
Approved by Academic Council		Date	

MEE1006	Applied Mechanics and Thermal Engineering	L	T	P	J	C
		2	0	2	0	3
Pre-requisite	**Nil**	**`Syllabus version**				
Anti-requisite	**Nil**	v.2.1				

Course Objectives:

1. To make the students to understand the principles of solid mechanics.
2. To make the students to understand the basic concepts of mechanical vibrations.
3. To familiarize the students with the properties of fluids and the applications of fluid mechanics.
4. To make the students to understand the principles of thermodynamics and to get broad knowledge in its applications.
5. To provide the students a gist of the theory behind the refrigeration and air conditioning system.
6. To make the students to understand the principles of heat transfer.

Expected Course Outcome:

Student will be able to

1. Evaluate the allowable loads and associated allowable stresses before mechanical failure in different types of structures.
2. Assess the vibrations associated with various mechanical systems.
3. Apply the fundamental laws of thermodynamics for the analysis of wide range of thermodynamic systems.
4. Explain basic concepts of fluid mechanics and their applications.
5. Demonstrate and analyze various refrigeration and air conditioning systems.
6. Evaluate heat transfer through different modes.

Module 1	**Solid Mechanics**	**5 hours**

Concept of stress and strain-Normal and shear stress -relationship between stress and strain-Elasticity- poisson's ratio-shear force and bending moment diagrams for simply supported, cantilever and overhanging beams - Analysis of forces in truss members

Module 2	**Mechanical Vibrations**	**5 hours**

Single degree of freedom systems- Un-damped and damped- Natural frequency- transverse vibration of shafts- critical speed by Rayleigh's and Dunkerley's method.Forced vibration-Harmonic excitation-Magnification factor- Vibration isolation-Torsional vibration-Holzer's analysis.

Module 3	**Fluid Mechanics**	**4 hours**

Properties of fluid- Uniform and steady flow- Euler's and Bernoulli's Equations- pressure losses along the flow. Flow measurement- Venturi meter and Orifice meters, Pipes in series and parallel. Introduction to Turbines and pumps - classification of turbines - specific speed and speed governance. Classification of pumps- characteristics and efficiency.

Module 4	**Thermodynamic systems**	**3 hours**

Basic concepts of Thermodynamics - First law of thermodynamics– Second law of thermodynamics - applications. Working Principle of four stroke and two stroke engines - Open and closed cycle gas turbines

Module 5	**Steam Boilers and Turbines**	**3 hours**
Formation of steam – Thermal power plant – Boilers -Modern features of high-pressure boilers - Mountings and accessories - Steam turbines: Impulse and reaction principle.		
Module 6	**Compressors, Refrigeration and Air conditioning**	**5 hours**
Air Compressors- Principle of operation of reciprocating, centrifugal and axial flow compressors - Basic functions of refrigeration- Vapour Compression and Vapour absorption systems-Principle of air conditioning system- Types and comparison.		
Module 7	**Heat Transfer**	**3 hours**
Fundamentals of heat transfer-conduction, convection and radiation - Free convection and forced convection - Applications like cooling of electronic components, electric motor and transformers		
Module 8	**Contemporary Discussion**	**2 hours**
	Total Lecture hours	**30 hours**

Mode: Flipped Class Room, [Lecture to be videotaped], Use of physical cut section models to lecture, Visit to Industry, Min of 2 lectures by industry experts.

Practical Experiments

1. Evaluation of Engineering Stress / Strain Diagram on Steel rod, Thin and Twisted Bars under tension.
2. Compression test on Bricks, Concrete blocks.
3. Natural frequency of longitudinal vibration of spring mass system.
4. Determination of torsional vibration frequency of a single rotor system
5. Undamped free vibration of equivalent spring mass system
6. Damped vibration of equivalent spring mass system
7. Flow through Venturimeter
8. Flow through Orifice Meter
9. Verification of Bernoulli's Apparatus
10. Performance test on air-conditioning system
11. Performance test on vapour compression refrigeration system
12. Heat transfer in natural/forced convection
13. Heat transfer through a composite wall.

Mode of Evaluation: Continuous Assessment includes CAT I, CAT II, Assignments/Quizzes, FAT

Text Book(s)

1. R.K. Rajput, (2010), Thermal Engineering, Lakshmi Publications

Reference Books

1. Rogers and Mayhew, 'Engineering Thermodynamics – Work and Heat Transfer', Addision Wesley, New Delhi, 1999.
2. B.K. Sarkar, 'Thermal Enginerring', Tata McGraw Hill, New Delhi, 1998.
3. Ahmadal Ameen 'Refrigeration and Airconditioning' Prentice Hall of India Ltd, 2006.
4. P.K. Nag, 'Heat Transfer', Tata McGraw Hill 2002.

5.	R.K. Rajput, (2006), Strength of materials (Mechanics of solids), S. Chand & Company Ltd.			
6.	P.K. Nag, 'Basic and Applied Engineering Thermodynamics', Tata McGraw Hill, New Delhi,2010.			
7.	B.K. Sachdeva, 'Fundamentals of Engineering Heat and Mass Transfer (SI Units)', New Age International (P) Limited (2009).			
8.	C.P. Arora 'Refrigeration and Air Conditioning', Tata McGraw Hill (2001).			
	Recommended by Board of Studies		**17/08/2017**	
	Approved by Academic Council No.	**47th AC**	Date	**05/10/2017**

PHY 1002	Materials Science	L	T	P	J	C
		3	0	2	0	4
Pre-requisite	Nil	Syllabus version				
Anti-requisite	Nil	v. 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.

Expected Course Outcome:

1. Students will be able to understand the fundamentals of physics for conducting materials and how it is pertinent for engineering related applications
2. Students can understand how to describe the basic classification of semiconducting materials and how to develop an engineering related devices
3. Students will be able to 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 basic magnetization concepts in detail and study different properties of magnetic materials, including the analysis of various magnetic properties and its applications.
5. Students will be able to describe the phenomenon of superconduction 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. Gain knowledge by demonstrating to understand 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”, Tata McGraw Hill Publications, 2003.
2.	M S Vijaya & G Rangarajan, “Materials Science”, Tata McGraw – Hill Publishing Company Ltd., 2003.
3.	Elementary Solid State Physics by M. Ali Omar, Pearson Education India, 1975
4.	Electrical Properties of Materials (eighth edition, 2010), L. Solymar and D. Walsh (Oxford university Press).
Reference Books	
1.	Pillai S O, “Solid State Physics”, revised sixth edition, New Age International (P) Ltd, 2007.
2.	S.O. Kasap, “Principles of Electronic Materials and devices”, Second edition, Tata McGraw – Hill Publishing Company Ltd., 2002.
3.	Van Vlack L, “Materials Science for Engineers”, Addison Wesley, 1995.
4.	Raghavan V, “Materials Science and Engineering”, Prentice – Hall of India, New Delhi, 1998.
5.	M S Vijaya & G Rangarajan, “Materials Science”, Tata McGraw – Hill Publishing Company Ltd., 2003.
6.	Donald A. Neamen , “Semiconductor Physics & Devices” , Tata McGraw Hill Publication.
7.	Materials Science of Thin Films, Milton Ohring, Academic Press, 2002.

8.	P.Bhattacharya, "Semiconductor Optoelectronic Devices", Prentice Hall, 1994.	
Mode of Evaluation: CAT / Assignment / Quiz / FAT / Seminar		
List of Challenging Experiments (Indicative)		
1.	Thermal and Electrical Conductivity of a Good Conductor	4 hours
2.	Dielectric study - dielectric behavior of a ferroelectric ceramic material at various temperature and determine the curie temperature	4 hours
3.	Hall Effect - Determine the Hall coefficient of a given Germanium (Semiconductor) crystal	4 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.	3 hours
5.	Magnetic Susceptibility - by Quinke's Method	3 hours
6.	Band Gap - using four probe method	3 hours
7.	Schering bridge: To find unknown capacitance and reactance of the circuit	3 hours
8.	B-H curve of magnetic materials	3 hours
9.	Determination of the electron spin g-factor (Lande g-factor) of a given sample by ESR spectrometer	3 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	**40th AC** Date **18/03/2016**	

EEE1021	Electrical Safety	L	T	P	J	C
		0	0	2	0	1
Pre-requisite	**Nil**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. Apply standard safety procedures in an industrial environment.
2. Understand the purpose and scope of the Standards and Electrical Codes to be followed.
3. Recognize the standard workplace hazards, warning signs and labels.

Expected Course Outcome:

1. Design and Conduct experiments, as well as analyze and interpret data

List of Experiments

1	Study of Various types of protection devices a. Fuses b. MCB c. ELCB	2 hours
2	Study of Various types of Earthing a. Sizing of Earth stripping for Earthing arrangement b. Sizing of pipe Earthing and plate Earthing as per IS 3043 standard for Earthing arrangement	2 hours
3	Introduction of Electrical safety precautions a. Rubber Mat b. Electrical Gloves specification	2 hours
4	Verification of operation of power supply tester.	2 hours
5	Sizing of Neutral Link.	2 hours
6	Insulation resistance for Motors	2 hours
7	Insulation resistance for Cables	2 hours
8	Measurement of Earth resistance	2 hours
9	Earth continuity test	3 hours
10	Sensitivity test for ELCB	3 hours
11	Types, Procedure for operation, maintenance and application of fire extinguishers	3 hours
12	Acceptance criteria for ohmic value of Earthing for various purpose a. Industry b. Domestic c. Commercial d. Laboratories	3 hours
	Total Lecture Hours	**30 Hours**

Text Book(s)	
1.	S. Rao, and H.L. Saluja : Electrical Safety, Fire Engineering and Safety Management, Khanna Publishers, Delhi.
Reference Books	
1.	H. Cotton : Electrical Technology, Wheeler Publishing Company.
2.	S.L. Uppal : A Textbook of Electrical Engineering, Khanna Publishers, Delhi..
3.	NSC, Chicago : Accident Prevention Manual for Industrial Operations
4.	M.G. Say : Electrical Earthing and Accident prevention, Newnes, London, 1954.
5.	John V Grimaldi and Rollin H Simonds., Safety Management Indian Electricity Act & Rules
6.	Komamoto and Henley, Probabilistic Risk Assessment for Engineering and Scientists, IEEE Press, 1995.
7.	Heinrich et al., Industrial Accident Prevention, McGraw Hill, 1980.
8.	Petersen D, Techniques for safety management - A systems approach, ASSE 1998.

Mode of assessment: Assignments/FAT			
Recommended by Board of Studies	**10/05/2017**		
Approved by Academic Council	**53rd AC**	Date	**13/12/2018**

EEE1022	Fundamentals of Reliability Engineering	L	T	P	J	C
		1	2	0	0	2
Pre-requisite	**MAT2001/MAT2002**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. Apply the principles & methods of reliability and safety engineering tools and techniques for Design problems
2. Understand the importance of reliability and its relationship with quality and safety
3. Identify the factors influencing the reliability of a system

Expected Course Outcome:

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

1. Summarize the requirements of system reliability and its role.
2. Develop models to analyze and predict reliability performance using block diagrams.
3. Design to meet the reliability and safety objectives of the components.
4. Examine the various reliability test strategies and select the best strategy to assess
5. Analyze reliability in manufacturing and maintenance engineering
6. Understand the influence of variability in production on system reliability
7. Develop the reliability predictive models using software tools

Module:1	Reliability Fundamentals	2 Hours

Terms and Definitions - RAMS, Benefits of Reliability Engineering, Bathtub Curve, Interrelationship Between Rams and Quality, Product Life Cycle - Phases and Applicable RAMS Activities, Reliability Engineer- role and responsibilities in product life cycle, Ethics in reliability engineering.

Module:2	Probability And Statistics For Reliability	2 Hours

Basics of Statistics and Probability Concepts, Probability Distributions, Probability Functions, Sampling Plans for Statistics and Reliability Testing, Confidence Intervals, Introduction to Weibull Analysis.

Module:3	Reliability And Safety In Design - I	3 Hours

Reliability Requirements - Allocation, Reliability Modelling, Life Estimation, Part And Assembly Reliability Considerations, Introduction to Reliability Analysis Techniques - FMEA, Fault Tree Analysis, Worst Case Analysis, Durability Analysis

Module:4	Reliability And Safety In Design - Ii	3 Hours

Finite Element Analysis, Safety Analysis, Thermal Analysis, Electromagnetic Analysis, Maintainability and Testability Analysis, Common Mode Failure Analysis, Risk Matrix, Stress and Strength Analysis, Physics of Failure and Failure Mechanisms.

Module:5	Reliability Testing	4 Hours

Reliability Testing Strategies Introduction, Design of Experiments, Combinatorial Testing, HALT, RGT, ALT, Fracas And Root Cause Analysis. Sample Size and Test Duration – Guidelines

Module:6	**Reliability In Manufacturing, In-Service Reliability And Maintenance Engineering**	**4 Hours**
Statistical Process Control And Six Sigma, Process FMEA, Reliability Screening, ORT, PRAT, In-Service Reliability Tracking, Warranty Cost Analysis, Maintenance Engineering - Introduction and Different types of maintenance.		
Module:7	**Tutorials**	**12 Hours**
Reliability Prediction - PTC Windchill Prediction, Reliability, Maintainability And Availability Modelling - Reliasoft Blocksim, Reliability Data Analysis - Reliasoft Weibull++		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**30 Hours**

Text Book(s)

1.	C. Ebeling, "An Introduction to Reliability and Maintainability Engineering", 2nd edition, Waveland Press, Inc., 2010

Reference Books

1.	V. Sankar, "System Reliability Concepts", Himalaya Publishing House, 2015.
2.	Roy Billinton and Ronald N. Allan, "Reliability Evaluation of Engineering Systems", Reprinted in India B. S. Publications, 2007.
3.	E. Balagurusamy, "Reliability Engineering", Tata McGraw Hill, 2003.
4.	Charles E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill, 2000.
5.	Patric D. T. O connor, "Practical Reliability Engineering", 4th Edition, John Wesley & Sons, 2003.

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

Recommended by Board of Studies	**13/05/2018**		
Approved by Academic Council	**53rd AC**	Date	**13/12/2018**

EEE1023	Industrial Drives	L	T	P	J	C
		2	0	2	0	3
Pre-requisite	**EEE2001,EEE2002**	**Syllabus version**				
Anti-requisite	**EEE3004**	v. 1.0				

Course Objectives:

1. To understand the fundamental concepts and principles of Industrial Electric Drives
2. To analyze various controlling methods in drives
3. To analyze the challenges in industrial drives

Expected Course Outcome:

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

1. Illustrate different types of loads and drives
2. Describe the different components of electric drives
3. Apply various controlling methods to electric drives
4. Analyze the power converter requirements of various drives
5. Illustrate various selection criteria for drives
6. Describe the types of issues with electric drives
7. Remember the selection criteria of motors for different applications
8. Design and Conduct experiments, as well as analyze and interpret data

Module:1	**Introduction**	**5 Hours**

Motion Concepts – Types of Load - Types of Variable Speed Drives- Dynamics of motor/load – steady state stability

Module:2	**Electric Motors**	**7 Hours**

Torque Production – Different type of motors –Characteristics of Electric Motors – power stages in electric motor – advantages of electric motor

Module:3	**Selection of industrial drives**	**7 Hours**

Components of electric drive – power rating of motors and converters - Load Requirements – General Application Considerations

Module:4	**Automotive industrial drives**	**6 Hours**

Criteria for selection – different components- control methods – dc drive – bldc drive

Module:5	**Process control and manufacturing industrial drives**	**6 Hours**

Criteria for selection – different components- control methods – induction motor drive – synchronous motor drive

Module:6	**Robotic control**	**6 Hours**

Criteria for selection – different components- servo drives – stepper motor drive

Module:7	**Challenges in industrial drives**	**6 Hours**

EMI/EMC – Vibration – Noise – Protection – standards		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**45 Hours**

Text Book(s)	
1.	G. K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House Second Edition, 2015
2.	Bimal K Bose, "Modern Power Electronics and AC Drives", Pearson Education Asia, 2005
Reference Books	
1.	R. Krishnan, "Electric Motor Drives: Modeling, Analysis, and Control", Prentice Hall, 2001
2.	Austin Hughes , "Electric Motors and Drives: Fundamentals, Types and Applications", Elsevier, 2005
3.	Malcolm Barnes, "Practical Variable Speed Drives and Power Electronics", Newnes 2003

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

List of Challenging Experiments (Indicative)		
1.	FC 302 Drives Operating Instructions	3 hours
2.	Speed Up & Down of FC 302 drive using MCT 10 Software.	3 hours
3.	Start/Stop Command with reversing and preset by FC 302 drive using MCT 10 software.	3 hours
4.	Speed control of Induction Motor Drive using V/F Control	3 hours
5.	Speed control of Induction Motor Drive using VVC+	3 hours
6.	Speed control of Induction Motor Drive using Flux Sensor less Control	3 hours
7.	AC Drive Load test using coupled motor-generator setup	3 hours
8.	Speed Control of Switched Reluctance Motor (SRM) Drive	3 hours
9.	Speed Control of Permanent Magnet Synchronous Motor Drive (PMSM)	2 hours
10.	Speed Control of Synchronous motor drive using V/F control	2 hours
11.	Speed Control of Synchronous motor drive using flux sensor less control	2 hours
12.	Speed Control of synchronous drive using PI/PID Controller	2 hours
	Total Laboratory Hours	**30 hours**

Mode of Evaluation: Assignments/FAT

Recommended by Board of Studies	**13/10/2018**		
Approved by Academic Council	**53rd AC**	Date	**13/12/2018**

EEE4014	Switched Mode Power Conversion	L	T	P	J	C
		2	0	0	4	3
Pre-requisite	**EEE3004**	**Syllabus version**				
Anti-requisite	**Nil**	v. 1.0				

Course Objectives:

1. To provide knowledge on switch mode power conversion concepts and applications
2. Design and analysis of appropriate switched mode power supplies for particular application

Expected Course Outcome:

After completion of this course, the student will be able to:

1. Understand the concepts of switched mode power conversion
2. Analyse different non isolated DC-DC converters under steady-state condition.
3. Perform circuit analysis for different dc –dc converters under different operating conditions
4. Compare isolated and non-isolated dc-dc converters
5. Design magnetic components of dc-dc converters
6. Apply EMI filtering techniques for suppression of EMI generated by different switched mode converters.
7. Know the applications of switched mode power converters for different domains
8. Design a component or a product applying all the relevant standards with realistic constraints

Module:1	**Introduction**	**6 Hours**

Linear converters Vs switching converters. Basic principles of switch-mode power conversion- Concept of steady state in switching converters, volt-second and ampere-second balance equations- Steady state analysis of (CCM) Buck Converter, Boost Converter, and Buck - Boost converter

Module:2	**Discontinuous conduction Mode analyses (DCM)**	**3 Hours**

buck, and boost converter. Losses and efficiency

Module:3	**Non-Ideal converter analysis**	**4 Hours**

buck, boost and buck converters. Losses and efficiency

Module:4	**Introduction to Isolated DC-DC converters**	**4 Hours**

Steady state analysis of isolated dc-dc converters including forward, flyback, half bridge and full bridge topologies

Module:5	**Magnetic Design**	**4 Hours**

Selection of energy storage inductor, Design of high frequency Inductor and high frequency transformer

Module:6	**EMI Suppression in SMPS**	**4 Hours**

EMI filter components, Conducted EMI suppression, and grounding. Non-linear phenomena in switched mode power converters: Chaos.

Module:7	**Applications**	**3 Hours**

High-Frequency Power Sources for Fluorescent Lamps and Low-Input-Voltage Regulators for Laptop Computers and Portable Electronics

Module:8	**Lecture by industry experts.**	**2 Hours**

	Total Lecture Hours	**30 Hours**
Text Book(s)		
1.	Robert W. Erickson and Dragan Maksimovic, "Fundamentals of Power Electronics", Springer, reprint of the original 2nd edition (2012).	
2.	Simon Ang, Alejandro Oliva, "Power-Switching Converters ", CRC Press, Vol. No., third Edition, 2010.	
Reference Books		
1.	Philip T Krein, "Elements of Power Electronics ", Oxford University Press, 2nd Edition, 2012.	
2.	Ned Mohan, Undeland and Robbin, "Power Electronics: converters, Application and design" John Wiley & sons. 2013 (reprint).	
Mode of Evaluation**:** CAT / Assignment / Quiz / FAT / Project / Seminar		

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

EEE4015	Power Converters Analysis and Design	L	T	P	J	C
		2	0	0	4	3
Pre-requisite	EEE3004	Syllabus version				
Anti-requisite	Nil	v. 1.0				

Course Objectives:

1. To give a systematic approach for design of all power electronic converters
2. To analyze the power electronic converters with active and passive loads
3. To introduce the basics of Multilevel inverters

Expected Course Outcome:

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

1. Describe the various AC to DC converters
2. Identify the various three phase rectifiers
3. Analyze the various DC to DC converters with commutation circuits
4. Discuss the basic inverter types with modulation techniques
5. Explain the AC to AC converters with different loads
6. Present the various types of Pulse Width Modulation Techniques for power converters
7. Outline the recent Multilevel Inverters with their advantages
8. Design a component or a product applying all the relevant standards with realistic constraints

Module:1	SINGLE PHASE AC-DC CONVERTERS	3 Hours

Single Phase Semi converters- Fully Controlled Converters

Module:2	THREE PHASE AC-DC CONVERTERS	3 Hours

Three Phase Semi converters- Fully Controlled Converters

Module:3	DC-DC CONVERTERS	5 Hours

Analysis and design of DC to DC converters- Control of DC-DC converters- Buck converters-Boost converters- Buck-Boost converters- Cuk converters – Chopper and commutation circuits.

Module:4	DC-AC CONVERTERS	4 Hours

Single phase and Three phase inverters - Voltage source and Current source inverters-120° and 180° mode operation of 3 phase inverter – PWM Techniques – Harmonic elimination techniques.

Module:5	AC-AC CONVERTERS	5 Hours

AC to AC power conversion using voltage controllers. Single phase and Three Phase AC-AC controllers – single phase step up, step down cycloconverters – three phase to single phase and three phase to three phase cycloconverters

Module:6	PWM TECHNIQUES FOR INVERTERS	4 Hours

Single Pulse Modulation- Multiple Pulse Width Modulation- SPWM- Space Vector Modulation- Harmonic Elimination Techniques

Module:7	**ADVANCED POWER CONVERTERS**	**4 Hours**
Multilevel concept – diode clamped – flying capacitor – cascade type multilevel inverters - Matrix converters		
Module:8	**Contemporary issues:**	**2 Hours**
	Total Lecture Hours	**30 Hours**

Text Book(s)	
1.	Rashid M.H., 'Power Electronics-Circuits, Devices and Applications', Prentice Hall India, New Delhi, 2013.
2.	Ned Mohan, Undeland and Robbin, 'Power Electronics: converters, Application and design', John Wiley and sons. Inc, Newyork, 2007
3.	P.C Sen., 'Modern Power Electronics', Wheeler publishing Company, 1st Edition, New Delhi, 2005
Reference Books	
1.	R. Krishnan, 'Electric motor drives: modeling, analysis, and control',Prentice Hall PTR, 2001
2.	P.C Sen., 'Principles of electric machines and power electronics', John Wiley & Sons, 2013
3.	Joseph Vithayathil, 'Power Electronics Principles and Applications', Tata McGraw-Hill edition, 2010.
4.	Bin Wu, 'High-Power Converters and AC Drives', John Wiley & Sons, 2006.

Mode of Evaluation**:** CAT / Assignment / Quiz / FAT / Project / Seminar			
Recommended by Board of Studies	**05/03/2016**		
Approved by Academic Council	**40th AC**	Date	**18/03/2016**