CURRICULUM DESIGN UNDER REGULATION 2016

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

SEMESTER I							
S.No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credits**	**Ext/Int**	**Category**
1	16EN001	Communication skills	2/0/2	4	3	40/60	HS
2	16MA101	Linear Algebra, Calculus and its application	3/2/0	5	4	60/40	BS
3	16PH103	Engineering Physics	3/0/2	5	4	40/60	BS
4	16EE301	Electron Devices	3/0/0	3	3	60/40	PC
5	16CS201	Problem Solving Techniques and C Programming	3/0/2	5	4	40/60	ES
6	16EE302	Measurements and Instrumentation	3/0/0	3	3	60/40	PC
7	16ME205	Engineering Graphics Laboratory	0/0/3	3	2	40/60	ES
			Total	**28**	**23**	**700**	

SEMESTER II							
S.No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
1	16EN002	Technical Communication Skills	2/0/2	4	3	40/60	HS
2	16MA102	Integral Calculus and Laplace Transforms	3/2/0	5	4	60/40	BS
3	16CH101	Engineering Chemistry	3/0/2	5	4	40/60	BS
4	16EE303	Electric Circuit Analysis	4/0/0	5	4	60/40	PC
5	16EE304	Electronic Circuits	3/0/0	3	3	60/40	PC
6	16EE305	Circuits and Devices Laboratory	0/0/3	3	2	40/60	PC
7	16ME204	Engineering Practices Laboratory	0/0/3	3	2	40/60	ES
8	16YY7XX	Mandatory Course-I	2/0/0	2	1	0/100	MC
			Total	**30**	**23**	**800**	

SEMESTER III							
S.No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
1	16MA104	Discrete Transforms and Fourier Analysis	3/1/0	5	4	60/40	BS
2	16EE306	Electrical Machines – I	4/0/0	4	4	60/40	PC
3	16EE307	Linear and Digital Integrated Circuits	4/0/0	4	4	60/40	PC
4	16EE308	Instrumentation Engineering	4/0/0	4	4	60/40	PC
5	16CS212	LINUX and Programming in C++	3/0/2	5	4	40/60	ES
6	16EE309	Electrical Machines – I Laboratory	0/0/3	3	2	40/60	PC
7	16EE310	Linear and Digital Integrated Circuits Laboratory	0/0/3	3	2	40/60	PC
8	16YY7XX	Mandatory Course-II	2/0/0	2	1	0/100	MC
			Total	**30**	**25**	**800**	

SEMESTER IV							
S.No	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
1	16MA109	Probability and Computational Methods	3/1/0	5	4	60/40	BS
2	16EE311	Electrical Machines – II	4/0/0	4	4	60/40	PC
3	16EE312	Control Systems	4/0/0	4	4	60/40	PC
4	16EE313	Generation, Transmission and Distribution	4/0/0	4	4	60/40	PC
5	16CS213	Data Structures and Algorithms	3/0/2	5	4	40/60	ES
6	16EE314	Electrical Machines - II Laboratory	0/0/3	3	2	40/60	PC
7	16EE315	Control and Instrumentation Laboratory	0/0/3	3	2	40/60	PC
8	16YY7XX	Mandatory Course-III	2/0/0	2	1	0/100	MC
9	16EE601	Mini Project-I	-	2	2	40/60	PW
		Total		**32**	**27**	**900**	

SEMESTER V							
S.No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
1	16EE316	Renewable Energy Systems	3/0/0	4	3	60/40	PC
2	16ES104	Virtual Instrumentation	3/0/2	5	4	40/60	ES
3	16EE317	Power Electronics	4/0/0	4	4	60/40	PC
4	16EE318	Microprocessors and controllers	4/0/0	4	4	60/40	PC
5	16EE4XX	Professional Elective-I	3/0/0	3	3	60/40	PE
6	16EE319	Power Electronics Laboratory	0/0/3	3	2	40/60	PC
7	16EE320	Microprocessors and controllers Laboratory	0/0/3	3	2	40/60	PC
8	16YY7XX	Mandatory Course-IV	2/0/0	2	1	0/100	MC
		Total		**28**	**23**	**800**	

SEMESTER VI							
S.No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
1	16EE321	Power System Analysis	4/0/0	5	4	60/40	PC
2	16EE322	Digital Signal Processing and its Applications	4/0/0	5	4	60/40	PC
3	16EE323	Principles of Embedded System	3/0/2	5	4	40/60	PC
4	16EE4XX	Professional Elective-II	3/0/0	3	3	60/40	PE
5	16EE4XX	Professional Elective-III	3/0/0	3	3	60/40	PE
6	16YY5XX	Open Elective-I	3/0/0	3	3	60/40	OE
7	16EE324	Simulation Laboratory - I	0/0/3	3	2	40/60	PC
9	16EE602	Mini Project-II	-	2	2	40/60	PW
		Total		**31**	**25**	**900**	

SEMESTER VII							
S.No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
1	16EE325	Power System Protection & Switchgear	3/0/0	4	3	60/40	PC
2	16EE326	Electric Drives and Control	3/0/2	5	4	40/60	PC
3	16EE4XX	Professional Elective-IV	3/0/0	3	3	60/40	PE
4	16EE4XX	Professional Elective-V	3/0/0	3	3	60/40	PE
5	16EE4XX	Professional Elective-VI	3/0/0	3	3	60/40	PE
6	16EE327	Prototype Module Laboratory	0/0/3	3	2	40/60	PC
7	16EE328	Simulation Laboratory-II	0/0/3	3	2	40/60	PC
		Total		**24**	**20**	**700**	

SEMESTER VIII							
S.No.	**Course Code**	**Course**	**L/T/P**	**Contact hrs/week**	**Credit**	**Ext/Int**	**Category**
1	16EE603	Project	0/0/24	24	12	100/100	PW
		Total		**24**	**12**	**200**	

SCHEME OF CREDIT DISTRIBUTION – SUMMARY

S. No.	**Stream**	**Credits/Semester**								**Credits**	**Courses**		**%**
		I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		**Theory**	**Lab**	
1.	Humanities (HS)	3	3	-	-	-	-	-	-	**6**	**2**	**-**	**3.33**
2.	Basic Sciences (BS)	8	8	4	4	-	-	-	-	**24**	**6**	**0**	**13.33**
3.	Engineering Sciences (ES)	6	2	4	4	4	-	-	-	**20**	**4**	**1**	**11.11**
4.	Professional Core (PC)	6	9	16	16	15	14	11	-	**87**	**18**	**11**	**48.33**
5.	Professional Electives (PE)	-	-	-	-	3	6	9	-	**18**	**6**	**-**	**10.00**
6.	Open Electives (OE)	-	-	-	-	-	3	-	-	**3**	**1**	**-**	**1.66**
7.	Project Work (PW)	-	-	-	2	-	2	-	12	**16**	**-**	**-**	**8.88**
8.	Mandatory Courses	-	1	1	1	1	0			**4**	**-**	**-**	**2.22**
9.	Employability Enhancement Skills									**2**	**-**	**-**	**1.11**
	Total	**23**	**23**	**25**	**27**	**23**	**25**	**20**	**12**	**180**	**37**	**12**	**100**

HUMANITIES SCIENCES (6 Credits)

S.No.	**Course Code**	**Course Title**	**L/T/P**	**Contact Hrs/Wk**	**Credits**	**Category**
1.	16EN001	Communication Skills	2/0/2	4	3	HS
2.	16EN002	Technical Communication Skills	2/0/2	4	3	HS

BASIC SCIENCES (24 Credits)

S.No.	**Course Code**	**Course Title**	**L/T/P**	**Contact Hrs/Wk**	**Credits**	**Category**
1.	16MA101	Linear Algebra, Calculus and its application	3/2/0	5	4	BS
2.	16MA102	Integral Calculus and Laplace Transform	3/2/0	5	4	BS

3.	16MA104	Discrete Transforms and Fourier Analysis	3/2/0	5	4	BS
4.	16MA109	Probability and Computational Methods	3/2/0	5	4	BS
5.	16PH103	Engineering Physics	3/0/2	5	4	BS
6.	16CH105	Engineering Chemistry	3/0/2	5	4	BS

ENGINEERING SCIENCES (20 Credits)

S.No.	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits	Category
1.	16CS201	Problem Solving Techniques and Computer Programming	3/0/2	5	4	ES
2.	16ME205	Engineering Graphics Laboratory	0/0/3	3	2	ES
3.	16ME204	Engineering Practices Laboratory	0/0/3	3	2	ES
4.	16CS212	LINUX and Programming in C++	3/0/2	5	4	ES
5.	16CS213	Data Structures and Algorithms	3/0/2	5	4	ES
6.	16ES104	Virtual instrumentation	3/0/2	5	4	ES

PROFESSIONAL CORE (87 credits)

S.No.	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits	Category
1.	16EE301	Electron Devices	3/0/0	3	3	PC
2.	16EE302	Measurements and Instrumentation	3/0/0	3	3	PC
3.	16EE303	Electric Circuit Analysis	4/0/0	5	4	PC
4.	16EE304	Electronic Circuits	3/0/0	3	3	PC
5.	16EE305	Circuits and Devices Laboratory	0/0/3	3	2	PC
6.	16EE306	Electrical Machines – I	4/0/0	5	4	PC
7.	16EE307	Linear and Digital Integrated Circuits	4/0/0	5	4	PC
8.	16EE308	Instrumentation Engineering	4/0/0	4	4	PC
9.	16EE309	Electrical Machines – I Laboratory	0/0/3	3	2	PC
10.	16EE310	Linear and Digital Integrated Circuits Laboratory	0/0/3	3	2	PC
11.	16EE311	Electrical Machines – II	4/0/0	4	4	PC
12.	16EE312	Control System	3/2/0	5	4	PC
13.	16EE313	Generation, Transmission and Distribution	4/0/0	4	4	PC
14.	16EE314	Electrical Machines - II Laboratory	0/0/3	3	2	PC
15.	16EE315	Control & Instrumentation Laboratory	0/0/3	3	2	PC
16.	16EE316	Renewable Energy Sources	3/0/0	4	3	PC
17.	16EE317	Power Electronics	4/0/0	4	4	PC
18.	16EE318	Microprocessors and controllers	4/0/0	4	4	PC
19.	16EE319	Power Electronics Laboratory	0/0/3	3	2	PC
20.	16EE320	Microprocessors and controllers Laboratory	0/0/3	3	2	PC
21.	16EE321	Power System Analysis	4/0/0	5	4	PC
22.	16EE322	Digital Signal Processing and its application	4/0/0	5	4	PC
23.	16EE323	Principals of Embedded System	3/0/2	5	4	PC
24.	16EE324	Simulation Laboratory - I	0/0/3	3	2	PC
25.	16EE325	Power System Protection & Switchgear	3/0/0	5	3	PC
26.	16EE326	Electric Drives and Control	3/0/2	5	4	PC
27.	16EE327	Prototype Module Laboratory	0/0/3	3	2	PC
28.	16EE328	Simulation Laboratory-II	0/0/3	3	2	PC

ELECTIVE/AUDIT COURSES (18 Credits)

S. No.	Course Code	Course Title	L/T/P	Contact Hrs/Wk	Credits	Category
PROFESSIONAL ELECTIVES (18 Credits)						
Elective Stream I - Power System (Prerequisite: Power Electronics and Power System)						
Group A						
1.	16EE401	Smart Grid Technology	3/0/0	3	3	PE
2.	16EE402	Energy Management	3/0/0	3	3	PE
3.	16EE403	Optimisation Technique	3/0/0	3	3	PE
Group B						
4.	16EE404	Power System Operation and Control	3/0/0	3	3	PE
5.	16EE405	Power Quality	3/0/0	3	3	PE
6.	16EE406	High Voltage Engineering	3/0/0	3	3	PE
Elective Stream II–Applied Electronics (Prerequisite: Microprocessor and Computing Systems)						
Group A						
1.	16EE407	Computer Networks	3/0/0	3	3	PE
2.	16EE408	Soft Computing Techniques	3/0/0	3	3	PE
3.	16EE409	VLSI Design	3/0/0	3	3	PE
Group B						
4.	16EE410	Wireless Sensor Networks	3/0/0	3	3	PE
5.	16EE411	ARM and Arduino Processor	3/0/0	3	3	PE
6.	16EE412	Automotive Electronics	3/0/0	3	3	PE
Elective Stream III–Power Electronics and Drives(Prerequisite: AC and DC Machines, Power Electronics)						
Group A						
1.	16EE413	Design of Electrical Machines	3/0/0	3	3	PE
2.	16EE414	Special Electrical Machines	3/0/0	3	3	PE
3.	16EE415	PLC and Automation	3/0/0	3	3	PE
Group B						
4.	16EE416	Servo Drives in Robotics	3/0/0	3	3	PE
5.	16EE417	Flexible AC Transmission Systems	3/0/0	3	3	PE
6.	16EE418	Modelling and Simulation of Power Electronic Circuits	2/0/1	3	3	PE
OPEN ELECTIVES(3 credits)						
1.	16EE501	Renewable Energy Sources	3/0/0	3	3	OE
2.	16EE502	Energy Auditing, Conservation and Management	3/0/0	3	3	OE
3.	16EE503	Smart Grid	3/0/0	3	3	OE
4.	16EE504	Servo and Robot Drives	3/0/0	3	3	OE

MANDATORY COURSES (4 credits)

S.No.	Course Code	Course Title	Credits	Category
1.	16CH701	Environmental Studies / E-waste Management	1	MC
2.	16EN701	Foreign Language / Spoken Hindi	1	MC
3.	16CE701	Professional Ethics/Human Values	1	MC
4.	16CS7XX	Soft skills (IOT/Big Data) / Data Base Management Systems	1	MC
5.	16EE701	Domain specific certification courses	1	MC

ONE CREDIT COURSES

S.No.	Course Code	Course Title	Credits
1.	16EE901	Electrical Testing and Safety Procedures	1
2.	16EE902	PLC and SCADA	1
3.	16EE903	Embedded System Design	1
4.	16EE904	Robotics	1
5.	16EE905	PCB design and Fabrication	1
6.	16EE906	MATLAB Programming for Electrical Engineering	1
7.	16EE907	Solar Panel Installation	1
8.	16EE908	Embedded Rashperi Pi	1
9.	16EE909	Wind Turbine Design	1
10.	16EE910	Industrial Electronics	1

EMPLOYABILITY ENHANCEMENT SKILLS (2 credits)

S.No.	Course Code	Name of the Course	L/T/P	Contact Hours/Wk	Credits
1.	16EE801	Industrial Practice	-	-	2

16EN001	COMMUNICATION SKILLS	2/0/2/3

PREREQUISITES: Language Skills

COURSE OBJECTIVES

1. To equip the students with the LSRW skills.
2. To develop communication skills and soft skills.
3. To facilitate the students to use the Language in practical mode.
4. To prepare the students for all competitive program like BEC/IELTS/TOEFL

COURSE OUTCOMES

Upon successful completion of the course, students shall have ability to

1. Gain comprehensive knowledge of LSRW Skills
2. Communicate effectively in Corporate Environment
3. Enhance fluency over language with self confidence
4. Use language with ease

Course Content:

GENERAL INTRODUCTION Getting to know people- Self introduction-Introducing others- Presenting about job - Presenting about working conditions- Presenting about company history and structure – Presenting about company activities- Instructions, Recommendations. **Focus on Skills**: Listening, Reading, Writing and Speaking. **Focus on Language**: Present simple, Adverb of frequency, Past Simple, Prepositions of time, Connectors of addition and contrast, Present Continuous, Parts of Speech, Gerunds and Infinitives. **WORD POWER** Vocabulary practice- Business Vocabulary- Telephonic Conversation and Etiquette - Requests and obligation-Describing trends- Presenting about company performance- Reasons and consequences through reading practices- Describing products Dimensions, Process description - Presenting about product development - Synonyms-Antonyms-Jumbled sentences. **Focus on Skills**: Listening, Reading, Writing and Speaking. **Focus on Language**: Compare and Contrast Adjectives and adverbs, Present perfect and past simple, Reasons and Consequences, Comparatives and superlatives, Question formation, Sequencing words, Present continuous, Articles, Prepositions. **ESP / ENGLISH FOR ENGINEERS** Presenting about business equipment- Letter Phrases- Writing Test Practice- Presenting about hotel facilities – Presenting about traffic and transport, Making Predictions – Report writing-Writing proposals. **Focus on Skills**: Listening, Reading, Writing and Speaking **Focus on Language**: Tenses- Present-Past-Future-Forms of verbs, Prefixes-Suffixes, Word Techniques- Formation.**PRESENTATION SKILLS AND EVENT MANAGEMENT PRESENTING** about conference arrangement- Presenting about a conference arrangement –Checking and confirming details-Presentation about a conference before, after, when, until, etc. Listening Test Practice- Presenting about production processes- Presenting about quality control - Itinerary- Paragraph Writing - Essay Writing- Check list **Focus on Skills**: Listening, Reading, Writing and Speaking **Focus on Language**: Passive forms and If- Conditionals**ENGLISH FOR CORPORATE** Language use in call centres, insurance and changes in working practices(Future possibility/ Probability- Presenting about banking- Speaking Test Practice- Presenting about delivery services - Presenting about trading - Presenting about recruitment -Presenting about job applications (Indirect questions)- Reading,Writing and Listening Test- Job Application Letter and Resume Writing **Focus on Skills**: Listening, Reading, Writing and Speaking **Focus on Language**: Prepositions of time, Tense review, indirect questions, Conditional 2 (hypothetical)

TOTAL HOURS:60

LABORATORY COMPONENTS

List of Experiments

1	Listening comprehension
2	Self-introduction
3	Oral presentation
4	Telephonic conversation
5	Conference arrangement

TEXT BOOKS:

1. Wood, Ian, Anne Williams with Anna Cowper Pass Cambridge BEC Preliminary, Cengage learning. Second Edition. 2014
2. Rizvi Ashraf M, "Efficient Technical Communication" ,McGraw Hill Education(India)Pvt.Ltd,2016
3. Dr Sumanth S, English for Engineers, Vijay Nicole Imprints Private Limited,2015

REFERENCE BOOKS:

1. Whitby, Norman. Cambridge University Press- Students Book. 2013.
2. Jawahar, Jewelcy, Rathna P, English Work book, VRB Publications Pvt Ltd, 2016.

WEB REFERENCES:

1. http://www.cambridgeindia.org
2. http://www.cambridgeenglish.org/exams/business-certificates/business-vantage

16MA101	LINEAR ALGEBRA, CALCULUS AND ITS APPLICATIONS	3/2/0/4

PREREQUISITES : Higher Secondary Mathematics

COURSE OBJECTIVES

- To develop the skill to use matrix algebra techniques that is needed by engineers for practical applications.
- To familiarize with functions of several variables which are needed in many branches of engineering.
- To find the solution of ordinary differential equations as most of the engineering problems are characterized in this form.
- To acquire sound knowledge of techniques in solving ordinary differential equations by numerical methods.

COURSE OUTCOMES

At the end of this course student would be able to

- Identify and solve algebraic Eigen value problems and find the extreme values of the given function.
- Apply the knowledge of differential equation in order to solve the engineering problems like electric circuits and bending of beams.
- Apply numerical method techniques to find the solution of ordinary differential equations.

COURSE CONTENTS

MATRICES Introduction with Applications- Characteristic equation – Eigen values and eigen vectors of a real matrix –Properties (excluding proof)–Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic form –Reduction of quadratic form to canonical form by orthogonal transformation. **FUNCTIONS OF SEVERAL VARIABLES** Total derivatives – Differentiation of implicit functions – Jacobians – Taylor series expansion- Maxima and Minima of functions of two variables – constrained Maxima and Minima- Method of Lagrangian multipliers. **ORDINARY DIFFERENTIAL EQUATIONS** Second and higher order linear differential equations with constant coefficients- Cauchy's linear differential equations –Transformation of differential equations with variable coefficients to constant coefficients - Legendre's linear differential equations - Method of variation of parameters. **APPLICATIONS OF SECOND ORDER DIFFERENTIAL EQUATIONS** Modelling - Free oscillations – Undamped system – Damped system - Solution of specified differential equations connected with electric circuits and bending of beams (Differential equations and associated conditions need to be given). **NUMERICAL SOLUTION TO FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS** Single step methods: Taylor series method - Euler's Method - Modified Euler's Method – Runge - Kutta Method of fourth order.

SELF STUDY: Multistep methods: Milne's Predictor and Corrector Method - Adam's Predictor and Corrector Method.

TOTAL : 60

TEXT BOOKS:

1. Kreyszig. E, “Advanced Engineering Mathematics” Tenth Edition, John Wiley and Sons (Asia) Limited, Singapore 2014.
2. Grewal. B.S, “Higher Engineering Mathematics”, 43rd edition, Khanna Publications, Delhi, 2014.

REFERENCE BOOKS:

1. Venkataraman. M.K, “Engineering Mathematics, Volume I Revised Enlarged, Fourth Edition”, The National Pub. Co., Chennai, Sep 2011.
2. Veerarajan. T, “Engineering Mathematics for first year”, 3rd edition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2011.
3. Kandasamy.P , Thilagavathy.K, Gunavathy.K, “ Numerical Methods” ,3rd edition, S Chand & Company Pvt. Ltd, 2013.

WEB REFERENCES:

1. http://www.nptel.ac.in/courses/111105035
2. http://www.nptel.ac.in/courses/122104017
3. http://nptel.ac.in/courses/122102009
4. http://nptel.ac.in/courses/111107063

16PH103	ENGINEERING PHYSICS	3/0/2/4

PREREQUISITES: Fundamental knowledge in Physics

COURSE OBJECTIVES

1. To gain knowledge on fundamental principles and applications of ultrasonic and LASER
2. To understand the concepts of optical fiber and fiber optic communication system.
3. To acquire knowledge about the basic concepts of quantum mechanics and the various types of microscopes.
4. To get exposure on vacuum pumps, gauges and nano science.

COURSE OUTCOMES

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

1. Demonstrate the uses of ultrasonic,laser and fiber optics in medicine and various engineering applications.
2. Gain knowledge about quantum mechanics.
3. Understand the concepts of nano science and vacuum systems.

UNIT 1	ULTRASONICS	9

Introduction – production methods –magnetostriction generator – piezoelectric generator – properties –Detection of ultrasonic waves – cavitation – velocity measurement – acoustic grating – Industrial applications – drilling, welding, soldering and cleaning –Non Destructive testing – pulse echo system through transmission –medical applications - sonogram, ultrasonic imaging

UNIT 2	LASERS	9

Introduction – principle of absorption and emission, population inversion – pumping mechanisms – Einstein's A and B coefficients. Types of laser –CO2, Nd-YAG, semiconductor laser. Industrial applications- heat treatment, welding, and cutting –medical applications. Holography –construction and reconstruction of hologram.

UNIT 3	FIBER OPTICS AND SENSORS	9

Principle and propagation of light through an optical fiber – numerical aperture, acceptance angle and fractional index change – classification of optical fibers based on material, mode of propagation and refractive index profile– fabrication technique: double crucible method – splicing- losses in optical fiber – fiber optic communication system (Block diagram) – light source for fiber optics(LED) – PIN detector – fiber optic sensors – temperature and displacement – Endoscope

UNIT 4	QUANTUM PHYSICS	9

Quantum theory – Introduction, de-Broglie concept on matter waves, uncertainty principle – Schrödinger's wave equation – time dependent and time independent equations – physical significance of wave function-applications of Schrödinger's equation-particle in a one dimensional potential box. Scanning electron microscope, transmission electron microscope, scanning transmission electron microscope – applications of microscope.

UNIT 5	VACUUM AND NANO SCIENCE	9

Introduction-concepts of vacuum-throughput, pumping speed, effective pumping speed. Types of pump- rotary pump, diffusion pump .Pressure gauges-Pirani gauge, Penning gauge

– working of vacuum system- applications. Introduction – top down and bottom up approach- Synthesis techniques-Chemical vapour decomposition, sol-gelmethod ,ball milling – properties and applications of nanomaterial.
TOTAL HOURS:45
Lab Component
1. Determination of Young's modulus of the material –Non- Uniform bending method
2. Determination of thickness of a thin wire – Air wedge method
3. Determination of Wavelength of Mercury Spectrum - Spectrometer Grating
4. Determination of Coefficient of viscosity of the given liquid(water) - Poiseuille's Method
5. Determination of laser parameters
a) Particle Size Determination using Diode Laser
b) Determination of Laser Parameter – Wavelength and angle of divergence
c) Determination of Acceptance angle and Numerical Aperture of an optical fiber.
6. Determination of Band Gap of a semiconducting material.
7. Determination of Specific Resistance of the given coil of wire using Carey Foster's Bridge.
8. Determination of Crystal Structure using XRD pattern
9. Determination of moment of inertia of disc and Rigidity modulus of a wire – Torsional Pendulum.
10. Determination of Thermal Conductivity of a bad conductor – Lee's Disc method
WEB REFERENCES: 1. http://nptel.ac.in 2. www.wikipedia.com 3. www.hyperphysics.com

16EE301	ELECTRON DEVICES	3	0	0	3

Course pre-requisite Engineering Physics

Course Objectives

1. To acquire the knowledge of semiconductor theory and PN junction.
2. To gain the knowledge of basic structure, operation and characteristics of junction transistors.
3. To understand the structure, operation and characteristics of field effect transistors.
4. To get exposed to special semiconductor devices and display devices.

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO1: Understand the semiconductor theory and characteristics of the PN junction diode.

CO2: Understand the construction, theory and characteristic of junction transistors.

CO3: Acquire knowledge about the construction, theory and characteristics of FET and MOSFET.

CO4: Get exposed to the special semiconductor devices and display devices.

Topics

UNIT I - SEMICONDUCTORS AND PN JUNCTION DIODE **9**

Atoms – Atomic Energy band – Classification of Solids based on Energy band theory (Insulators, Conductors and Semiconductors) Mobility and conductivity- Intrinsic Semiconductors – Extrinsic semiconductors – Donor and Acceptor impurities-Theory of PN junction – PN Junction Diode –Structure, Operation and V–I Characteristics Rectifiers – Half Wave and Full Wave Rectifiers(center tap and bridge type)–(Qualitative Analysis only)

UNIT II - BIPOLAR AND UNIPOLAR JUNCTION TRANSISTORS **9**

Bipolar Junction Transistors (BJT) – Types (NPN&PNP) – Structure and Operation- CE, CB, CC Configurations – Input and Output Characteristics- Transistor as a switch-Uni Junction Transistor (UJT) – Structure, Operation and V-I Characteristics.

UNIT III - FIELD EFFECT TRANSISTORS **9**

Junction Field Effect Transistors (JFET) – Types (N–Channel and P–Channel JFET) – Structure, Operation of N–Channel JFET- Drain and Transfer Characteristics of N–Channel JFET-FET as Variable Resistor- Metal Oxide Semiconductor Field Effect Transistor(MOSFET) – Enhancement and Depletion MOSFET(n-channel and p-channel) – Structure, Operation and V-I Characteristics of n-channel MOSFET.

UNIT IV - OTHER DEVICES **9**

Operation and V-I Characteristics of Zener diode– Structure, Operation of LED and LCD-Structure, Operation of Charge Coupled Display (CCD)- Structure, Operation and V-I Characteristics of Photo Diode ,Opto Coupler and LASER Diode

UNIT V - INTRODUCTION TO POWER ELECTRONIC DEVICES	**9**
Silicon Controlled Rectifier(SCR) – Structure, Operation and V-I Characteristics- TRIAC–DIAC– Structure, Operation and V-I Characteristics- IGBT– Structure, Operation and V-I Characteristics	
SELF STUDY: Applications of SCR,TRIAC, DIAC and IGBT	
TOTAL HOURS:45	

TEXT BOOKS:

1. Albert Malvino, "Electronic Principles", 8th edition, McGraw Hill education (India) Private Limited, 2010.
2. M.D. Singh, "Power Electronics", 2nd edition, McGraw Hill education (India) Private Limited, 2011.

REFERENCE BOOKS:

1. S.Salivahanan and N.Sureshkuma, "Electronic Devices and Circuits", 3rd edition, McGraw Hill education (India) Private Limited, 2015.
2. Robert L.Boylestad, Electronic Devices and Circuit theory, 10th edition., Pearson Education, Inc, New Delhi, 2010.
3. Jacob Millman, Christos.C.Halkias and Satyabrate Jit, Electronic Devices and Circuits, 4th edition, McGraw Hill education (India) Private Limited, 2010.

WEB REFERENCES:

1. https://onionesquereality.wordpress.com/.../more-video-lectures-iit-open
2. https://nptel.ac.in/courses/122106025/11

16CS201	PROBLEM SOLVING TECHNIQUES AND C PROGRAMMING	3/0/2/4

COURSE OBJECTIVES

1. To understand problem solving concepts .
2. To gain knowledge about the control structures in C
3. To use arrays and pointers in C Programs
4. To write functions in C .

COURSE OUTCOMES

Upon successful completion of the course, students shall have ability to

1. Apply problems solving techniques to real world problems.
2. Design programs using fundamental C constructs.
3. Use the concepts of pointers , arrays and structures in programs
4. Do modular programming with functions

UNIT 1	COMPUTATIONAL THINKING AND PROBLEM SOLVING TECHNIQUES	9

Computational Thinking: Introduction to Computational Thinking – From Abacus to machine –The First Software- First modern Computer-Information and Data-Converting information into data - Data Capacity.

Problem Solving Techniques: General problem Solving concepts-: Algorithm, Pseudo-code and Flowchart - Problem Solving with Sequential Logic Structure - Problem Solving with Decisions - Problem Solving with Loops. **Case Study:** Raptor and Scratch Tools

UNIT 2	INTRODUCTION TO C PROGRAMMING	9

C Character Set – Identifiers and Keywords– Data Types- Constants –Variables and Arrays-Declarations-Operators and Expressions – Data input and output-Preparing and running a Complete C Program

UNIT 3	CONTROL STRUCTURES	9

Branching: if-else-Looping: while-do while-for-nested control structures -switch-break-continue-comma-goto

UNIT 4	ARRAYS AND POINTERS	9

Arrays: Defining an array- Processing an array- Multi dimensional arrays – Strings: Defining a string-Null character-initialization of strings – reading and writing a string- processing the string – Pointers: fundamentals – Pointer Declaration & usage

UNIT 5	FUNCTIONS AND STRUCTURES	9

Defining a Function – Accessing a function – Function Prototypes – Passing arguments to a function - Recursion –Structures: Defining a structure – processing a structure.

SELF STUDY: Unions

TOTAL HOURS:45

LAB COMPONENTS:

1. Office Automation – Resume preparation , Spread sheet processing
2. Draw Flowchart using Raptor Tool
    a. Simple Flow Chart
    b. Decision Making
    c. Looping[Pre-test & Post-test]

3. Create Animation / Gaming /Application using Scratch Tool
4. Program to process data types, format input and output.

Program to evaluate an expression

5. Program using decision making statements
6. Program using looping statements
7. Program using single and two dimensional arrays
8. Program for string manipulation
9. Program using call by value and call by reference.

Program using recursion

10. Program using structures

TEXT BOOKS:

1. David Riley and Kenny Hunt, "Computational Thinking for the Modern Problem Solver", Chapman & Hall/CRC, 2014. [Unit I]
2. M. Sprankle, "Problem Solving and Programming Concepts", 9th Edition, Pearson Education, New Delhi, 2011. [Unit I]
3. Byron, S. Gottfreid, "Programming with C",3rd Edition, Tata McGraw Hill, Schaum's outlines2014. [Unit II- V]

REFERENCE BOOKS:

1. Herbert Schildt, "The Complete Reference C", 4th edition ,TMH,2015
2. S.Thamarai Selvi and R.Murugesan, "Programming in ANSI C", 6E, TMH, 2012.
3. K.R.Venugopal and Sudeep R.Prasad , "Mastering C", Second edition , TMH , 2015

WEB REFERENCES:

1. http://nptel.ac.in/courses/106105085/
2. http://nptel.ac.in/courses/106106127/
3. http://raptor.martincarlisle.com/
4. https://scratch.mit.edu/

16EE302	MEASUREMENTS AND INSTRUMENTATION	3	0	0	3

Course pre-requisite Engineering Physics

Course Objectives

1. To understand the basics of the measurements and instruments also its errors.
2. To understand the analog and digital techniques used to measure voltage, current, power & energy.
3. To study different methods available for measurement of passive elements like resistance, inductance & capacitance.

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO1: Understand the characteristics of an instrument and to know about how to calibrate the instruments.

CO2: Analyze the types of measuring instruments with respect to construction, working principle and torque equation to measure voltage, current, power and energy.

CO3: Understand and analyze various types of bridges.

Course Content:

Measurements: Significance & Methods of Measurements– Functions of Instruments & Measurements – Applications of Measurements – Characteristics: Static – Static error, Reproducibility, Drift, Accuracy, Sensitivity and Dead Zone - Dynamic – Speed of Response, Fidelity, Lag and Dynamic Error - Errors in measurement – Gross, Systematic and Random Errors. **MEASURING INSTRUMENTS** Types of Instruments - Working Principle, Construction, Torque equation, Advantages and Disadvantages: Moving coil – PMMC - Moving Iron – Attraction and Repulsion Instruments – Electrodynamometer type Instruments. **MEASUREMENT OF POWER** Instrument Transformers – Advantages – Characteristics: Current transformers and Potential Transformers – Construction: Electrodynamometer and Induction Type Wattmeter – Power Measurement: Three and Two wattmeter Method. **MEASUREMENT OF ENERGY AND PHASE** Single Phase Induction type Energy Meter – Construction – Two element meters – Power Factor meters – Construction: Single Phase Electrodynamometer type – Moving Iron type. **DC AND AC BRIDGE** Measurement of Resistance -Construction and Operation: Wheatstone bridge method – Kelvin Double Bridge - Megger - Measurement of Earth Resistance - AC Bridges - Measurement of Inductance: Maxwell's Inductance Bridge - Measurement of Capacitance: Schering's bridge. **SELF STUDY:** CRO, Function generators, Multimeters.

TOTAL HOURS:45

TEXT BOOKS:

1. Sawhney.A.K, “A course in Electrical and electronic Measurement and Instrumentation”, Dhanpat Rai & Sons, New Delhi, 2008.
2. Albert D Halfride& William D Cooper, “Modern Electronic instrumentation and measurement techniques”, Prentice Hall of India Pvt Ltd., 2007.
3. Golding. E. W, and Widdis F.C, “Electrical Measurements and Measuring Instruments”, 5th Edition, A.H.Wheeler&Company, 2003

REFERENCE BOOKS:

1. E.O. Doebelin, 'Measurement Systems – Application and Design', Tata McGraw Hill publishing company, 2003.
2. D.V.S. Moorthy, 'Transducers and Instrumentation', Prentice Hall of India Pvt Ltd, 2007.
3. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw Hill, II Edition 2004.

WEB REFERENCES:

1. http://nptel.ac.in/courses/108105064/
2. https://www.youtube.com/watch?v=moSUpIRCKMk
3. Module - Lecture 35, 36,37,38,39, 40,41

16ME205	ENGINEERING GRAPHICS LABORATORY	0/0/3/2

Nature of Course	:M (Practical application)
Co requisites	:Basic drawing and Computer Knowledge

Course Objectives:

1.	To know the method of constructing the conic curves used in Engineering Applications.
2.	To develop an understanding of Isometric to Orthographic Views and vice versa.
3.	To learn the basic projection of straight lines and plane surfaces.
4.	To develop the imagination of solids inclined to one reference planes.
5.	To know the sectioning of solids and development of surfaces used in various fields.

Course Outcomes:

Upon completion of the course, students shall have ability to

C207.1	Recall the basic concepts of engineering drawing.	[R]
C207.2	Recall the basic syntax and commands of CAD software.	[R]
C207.3	Interpret the parameters of engineering drawing.	[U]
C207.4	Sketch the 2D geometries in the drafting software.	[AP]
C207.5	Examine the isometric projection and convert it into orthographic projection (Vice versa).	[A]

Course Contents:

1. Construction of Conic Curves (Ellipse, Parabola and Hyperbola)
2. Construction of Special Curves (Cycloid and Involutes)
3. Isometric to Orthographic projections – Manual sketches
4. Isometric to Orthographic projections – Software sketches
5. Projection of lines - Inclined to both HP and VP
6. Projection of Plane surfaces (Hexagon, Pentagon and circle) – Inclined to both HP and VP
7. Projection of Solids (Prism and Pyramid) – Inclined to HP
8. Projection of Solids (Cone and Cylinder) – Inclined to VP
9. Sectioning of Solids (Prism and Pyramid) with Section plane Inclined to HP
10. Sectioning of Solids (Cone and Cylinder) with Section plane Inclined to VP
11. Development of Surfaces (Prism,Pyramid,Cone and Cylinder)
12. Introduction to Perspective projection

Total Hours:	**45**

Reference Books:

1.	Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 50th Edition, 2014.
2.	Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2011.
3.	Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, 2013.

Web References:

1.	http://nptel.ac.in/courses/112102101/

Assessment Methods & Levels (based on Bloom'sTaxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	**Rubric based Continuous Assessment [60 marks] (in %)**	**End Semester Examination [40 marks] (in %)**
Remember	30	30
Understand	30	30
Apply	20	20
Analyse	20	20
Evaluate	0	0
Create	0	0

16EN002	TECHNICAL COMMUNICATION SKILLS	2/0/2/3

Nature of Course: D (Theory Application)

Pre Requisites: 16EN001 Communication Skills / BEC PRELIMINARY

Course Objectives:

1. To develop the prominence of listening and reading practices using authentic business vocabulary.
2. To instill analytical thinking and logical reasoning to enhance LSRW skills in Business related situations.
3. To urge the need of effective communication in corporate sector with Business English.
4. To prepare students for competitive program like BEC, IELTS, TOEFL.

Course Outcomes:

Upon successful completion of this course, the student will be able to:

C002.1	Understand and gain proficiency with business vocabulary	[U]
C002.2	Apply Task- Based activity to enhance an effective communication.	[AP]
C002.3	Remember LSRW skills and employ cross-cultural communication in business related situations.	[R]
C002.4	Analyse and apply Business English in working environment.	[A]
C002.5	Understand and Communicate effectively at managerial and professional level	[U]

Course Contents:

LISTENING Taking and Leaving Voice mail messages –Identifying the information before listening-Inferring ideas- Listening to short monologues -Longer listening tasks -Recognise functions. **SPEAKING** Expressing hypothetical Situations – Expressing obligation -Aspects of business – Giving examples- Giving reasons- Giving extra information- Presentation at a business meeting- Connecting ideas- Collaborative task – Short talk on a business topics- Film Reviews. **READING** Science texts- Terms related about science and scientists - Scanning for specific information- Understanding cohesive features - Skimming the reading comprehensions - Interpret opinions and ideas expressed – Collocations - Identifying dependent preposition - Identifying the extra words. **WRITING** Definitions, Extended Definitions -Letter writing (accepting and declining invitations)- Internal communication (notes/memo/E-mail writing to the head of the department, colleague, assistant , staff in the department etc) Report writing- Business proposal- circular- agenda and minutes- Appropriate linking words- Report Phrases - Asking for Information and Making Suggestions-Transcoding (Bar Chart, Flow Chart)- Letter for calling quotations, Replying for quotations- Placing an order and complaint letter. **PARTS OF SPEECH** Tenses - Adjectives - Adverbs - Articles- Modal verbs, Active and Passive, Impersonal Passive voice, Homophones- Homonyms- Acronyms- Abbreviations- British and American words- Comparatives and Superlatives- Gerunds- infinitives – Participles - Modal Verbs - Relative Pronouns- Reported Speech - Indirect Questions- Spotting errors.

LABORATORY COMPONENTS

EXP NO.	NAME OF THE EXPERIMENT	TEXT BOOK	PAGES	LAB HOURS
1	MINI PRESENTATION	T2	117-130	3
2	LOGICAL REASONING AND ETHICS IN A GIVEN SITUATION	T2	91-100	3
3	TECHNICAL PRESENTATION	T2	195-213	3
4	GROUP DISCUSSION	T2	165-187	3
5	EXTEMPORE	T2	117-130	3

Total Hours : 60

Text Books

1. Whitby, Norman. Cambridge University Press- Students Book. 2013.
2. Rizvi Ashraf M , “Effective Technical Communication”, McGraw Hill Education (India) Private Limited , 2016
3. Dr.Sumanth S, English for Engineers, Vijay Nicole Imprints Private Limited, 2015.

Reference Books:

1. Wood, Ian, Paul Sanderson, Anne Williams with Marjorie Rosenberg, Pass Cambridge BEC Vantage,

Cengage learning. Second Edition. 2014.
2. Gunasekaran S, 'A Text and Workbook of Technical English II", United Global Publishers, June 2010.
3. Lewis, Norman, Word Power Made Easy, Pocket Books, New York, 1979.

Web References:

1. http://www.cambridgeindia.org
2. http://www.cambridgeenglish.org/exams/business-certificates/business-vantage
3. *https://**steptest**.in*

Online Resources:

1.https://www.coursera.org/specializations/business-english
2. http://www.academiccourses.com/Courses/English/Business-English

Assessment Methods & Levels (based on Bloom's Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C002.1	Remember	Extempore	**5**
C002.2	Understand	Mini presentation	**5**
C002.3	Apply	Technical presentation	**5**
C002.4	Apply	Group Discussion	**5**

Blooms Taxonomy based Assessment Pattern:

Bloom's Category	**Continuous Assessment Tests**			**Semester End Examination**
	CIA1	**CIA2**	**Term Examination**	
Remember	30	20	20	20
Understand	30	30	30	30
Apply	40	50	50	50
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

16MA102	INTEGRAL CALCULUS AND LAPLACE TRANSFORMS	3/2/0/4
Nature of Course	J (Problem analytical)	
Pre requisites	Basics of integration	

Course Objectives:

1	To gain knowledge in improper integrals, Gamma and Beta functions which are needed in engineering applications
2	To develop logical thinking and analytical skills in evaluating multiple integrals
3	To acquaint with the concepts of vector calculus needed for problems in all engineering disciplines
4	To apply numerical methods to evaluate integrals when the function in the analytical form is too complicated or the huge amounts of data are given such as series of measurements, observations or some other empirical information
5	Solve the differential equations using Laplace transform technique

Course Outcomes:

Upon completion of the course, students shall have ability to

C102.1	Recall basic integration formulae, scalar and vector point function concepts	[R]
C102.2	Differentiate and integrate vector point functions	[U]
C102.3	Evaluate integrals using Beta and Gamma functions	[AP]
C102.4	Evaluate double integral and triple integral to compute area, volume for two dimensional and three dimensional solid structure	[AP]
C102.5	Find the gradient, divergence and curl of vector point functions and related theorems useful for evaluation of engineering problems	[AP]
C102.6	Apply the Laplace transform technique to solve ordinary differential equations	[AP]

Course Contents:

Definite integrals-Evaluation of definite integrals using Bernoulli's formula-Beta and Gamma Integrals- Relation between Beta and Gamma Functions-Evaluation of Integrals using Beta and Gamma Functions-**Multiple integrals** - Double integration in Cartesian coordinates – Area as double integral –Change the order of integration-Triple integration in Cartesian co-ordinates –Volume as triple integral-**Vector calculus** - Vector differential operator- Gradient of a scalar point function - Directional derivatives –Divergence and Curl of a vector point function – Irrotational and solenoidal vector fields –Simple problems– Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem(statements)– Simple applications involving cubes and rectangular parallelopipeds-**Numerical integration -** Trapezoidal rule – Simpson's 1/3 and 3/8 rules – Two and three point Gaussian Quadrature formulae –Trapezoidal rule and Simpson's rule to evaluate double integrals-**Laplace transform** –Conditions for existence – Transform of elementary functions – Basic properties (without proof) – Derivatives and integrals of Laplace transform -Transforms of derivatives and integrals - Periodic functions - **Inverse Laplace transform**-Partial fraction method - convolution theorem , Initial and Final value theorems (statements)– Problems - Solution of second order differential equations with constant coefficients.

Total Hours: 60

Text Books:

1	Kreyszig. E, "Advanced Engineering Mathematics" Tenth Edition, John Wiley and Sons (Asia) Limited, Singapore 2014

2	Grewal. B.S, "Higher Engineering Mathematics", 43rd edition, Khanna Publications, Delhi, 2014
3	N.P.Bali and Dr.Manish Goyal,"A Text book of Engineering Mathematics" 8th edition Laxmi publications ltd, 2011
Reference Books:	
1	Veerarajan. T, "Engineering Mathematics for first year", 3rdedition, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2011
2	Glyn James, —Advanced Modern Engineering Mathematics, Pearson Education, 4th edition, 2012
3	Jain M.K. Iyengar, K & Jain R.K., Numerical Methods for Scientific and Engineering Computation, New Age International (P) Ltd, Publishers 2013
Web References:	
1	http://nptel.ac.in/video.php?subjectId=122107037
2	http://nptel.ac.in/courses/122107036/
3	http://nptel.ac.in/video.php?subjectId=117102060
Online Resources:	
1	https://www.coursera.org/learn/pre-calculus
2	https://www.coursera.org/learn/linearalgebra1
3	https://alison.com/courses/Advanced-Mathematics-1
4	https://www.edx.org/course/algebra-lineal-mexicox-acf-0903-1x.
5	https://www.edx.org/course?search_query=laplace+transform

Assessment Methods & Levels (based on Blooms'Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C102.1	Remember	Classroom or Online Quiz	2
C102.2	Understand	Class Presentation/Power point presentation	4
C102.3, C102.4	Apply	Group Assignment	7
C102.5,C102.6	Apply	Group activities	7

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination
	CIA1	CIA2	Term End Assessment	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	50	50	50
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

16CH101	ENGINEERING CHEMISTRY	3 /0 /2 /4

Nature of Course	: E (Theory skill based)
Pre requisites	: NIL

Course Objectives:

1	To make the students conversant with boiler feed water requirements, water treatment techniques, the principles and applications of electrochemistry.
2	To understand the working principles of electrodes and the significances of various component analyzer.
3	To learn the effect of corrosion in materials and the methods for prevention of corrosion.
4	To acquire knowledge in applications of plastics and rubber in engineering field.
5	To understand the concepts of photophysical and photochemical processes in spectroscopy
6	To gain knowledge about non conventional the energy sources, fuel cells and storage Devices.

Course Outcomes:

Upon completion of the course, students shall have ability to

C101.1	Recall the requirements of boiler feed water, water treatment procedures for industries.	[R]
C101.2	Understand the working principle of Ion Selective Electrodes, pH electrodes and conductivity meters as an analyzer.	[U]
C101.3	Apply the various corrosion control techniques in real time industrial environments.	[A]
C101.4	Use the knowledge of polymers, various energy sources and storage devices in engineering field.	[U]
C101.5	Understand the principle and working of certain analytical techniques	[U]
C101.6	Solve theoretical problems based on the concepts acquired from the module in various engineering field.	[A]

Course Contents: Water Treatment-Boiler feed water–Requirements-disadvantages of hard water - demineralization process– desalination-reverse osmosis. Applied electrochemistry: Electrochemical cells – electrolytic cell-reversible and irreversible cells -electrode potential - single, standard - oxidation and reduction potentials - emf of a cell - emf series–significances-pH measurement, glass electrodes, hydrogen electrodes, reference electrodes. Corrosion and its control: Mechanism - types–galvanic corrosion–differential aeration–pitting corrosion – factors-Corrosion control–cathodic protection–corrosion inhibitors-protective coatings– electroplating -electroless plating. Engineering polymers: Polymerisation -free radical mechanism-Plastics- types-preparation, properties and uses of PTFE- Polyurethane - Poly Carbonate -Nylon 6,6 and Nylon 6 - Rubber-Vulcanization of rubber-synthetic rubber -Butyl rubber and SBR Spectrophotometry: Beer-Lambert law – UV Visible – IR Spectrophotometers – Flame emission photometers - Atomic absorption spectrophotometers. Energy Sources: Nuclear energy- reactor-breeder reactor- Photovoltaic cells-Wind energy -Fuel cells. Storage Devices: Batteries- alkaline -Lead acid, nickel cadmium and lithium-TiS_2 batteries.

Lab Component		
1	Water hardness	[E]
2	Alkalinity	[E]
3	Chloride content	[E]
4	Dissolved oxygen in water	[E]
5	pH meter	[E]
6	Conductivity meter	[E]
7	Potentiometer	[E]
8	Spectrophotometer	[E]
9	Electroplating of Nickel	[E]
10	Corrosion rate of a metal	[E]
	Total Hours:	**75**
Text Books:		
1	Dara S.S, Umare S.S, “Engineering Chemistry”, S. Chand & Company Ltd., New Delhi 2013.	
2	N.Krishna murthy,Vallinayagam D.,”Engineering Chemistry” PHI Learning Pvt Ltd.,2014	
3	R.V.Gadag, A.Nithyananda Shetty “Engineering Chemistry” 3rd edition PHI Learning Pvt Ltd.,2014	
Reference Books:		
1	Shikha Agarwal., “Engineering Chemistry and Applications”, Cambridge University press, 2016.	
2	Liliya.,Bazylak.I.,Gennady.E.,Zaikov.,Haghvi.A.K.,”Polymers and Polymeric Composites” CRC Press,2014.	
3	Lefrou.,Christine.,Fabry.,Pierre.,Poignet.,Jean-claude.,”Electrochemistry - The Basics, with examples” 2012 ., Springer.	
4	Zaki Ahmad, Digby Macdonald, “Principles of Corrosion Engineering and Corrosion Control”, Elsevier Science, 2nd Edition 2012.	
5	Perez, Nestor,”Electrochemistry and Corrosion Science”, Springer, 2016.	
6	Ghazi A.Karim. “Fuels, Energy and the Environment”, CRC Press, Taylor and Francis group, 2012.	
Web References:		
1	http://www.analyticalinstruments.in/home/index.html	
2	www.springer.com › Home › Chemistry › Electrochemistry	
3	https://www.kth.se/.../electrochem/welcome-to-the-division-of-applied-electrochemistry	
4	www.edx.org/	
5	https://www.ntnu.edu/studies/courses	
6	www.corrosionsource.com/	
Online Resources:		
1 2 3 4 5	nptel.ac.in/courses/105104102/hardness.htm https://ocw.mit.edu/courses/chemistry nptel.ac.in/courses/105106112/1_introduction/5_corrosion.pdf https://alison.com - Spectroscopic technique, Colorimetry https://ocw.mit.edu/courses/chemistry	

6	nptel.ac.in/courses/113108051

Assessment Methods & Levels (based on Blooms' Taxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment				End Semester Examination (Theory) [40 marks]
	Theory			Practical	
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	Rubric based CIA [40 Marks]	
Remember	30	30	30	10	20
Understand	60	50	40	20	50
Apply	10	20	30	40	30
Analyse	-	-	-	30	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

16EE304	ELECTRONIC CIRCUITS	3/0/0/3

Nature of Course:D (Theory application)

Pre Requisites:16PH103 Engineering Physics,16EE301 Electron Devices

Course Objectives:

1. To learn about biasing of BJT and FET
2. Toapply BJT and FET in amplifiers and oscillators.
3. To interpret feedback amplifiers and tuned amplifiers.
4. Todesign LC and RC oscillators, amplifiers, multivibrators and time base generators.

Course Outcomes

Upon completion of the course, students shall have ability to

C304.1	Remember the configurations and the methods of biasing for the transistors.	[R]
C304.2	Understand the differential amplifier and Darlington circuits.	[U]
C304.3	Understand the working principle of wave shaping circuits and Oscillators.	[U]
C304.4	Understand the feedback connections to be used in amplifiers.	[U]
C304.5	Apply BJT and FET as amplifiers and analyse its characteristics.	[AP]
C304.6	Apply resonance concepts in tuned amplifiers.	[AP]

Course Contents

BJT Amplifiers : DC Load line, operating point, Fixed and self biasing of BJT -Small signal Analysis of Common Emitter-AC Load line, Voltage swing limitations, Common collector and common base amplifiers – Differential amplifiers- CMRR- Darlington Amplifier- **FET Amplifiers:** Small signal analysis of JFET amplifiers-Common source amplifier, Source follower and Common Gate amplifiers. **Feedback Amplifiers and Tuned Amplifiers**: Concept of feedback, Classification of feedback amplifiers, General characteristics of negative feedback amplifiers, Effect of Feedback on Amplifier characteristics-Voltage series-Voltage shunt, Current series and Current shunt Feedback configurations, single tuned amplifiers, double tuned amplifier – effect of cascading single tuned and double tuned amplifiers on bandwidth. **Large Signal Amplifiers & Linear Wave shaping:** Class –A Power Amplifier, Maximum Value of Efficiency of Class-A Amplifier, Transformer coupled amplifier- Push Pull Amplifier-Complimentary Symmetry Circuits (Transformer Less Class B Power Amplifier)-RC wave shaping circuits – Diode clampers and clippers – Multivibrators – Astable, Monostable and Bistable – Schmitt triggers – UJT based saw tooth oscillators.

Oscillators: Conditions for oscillations. RC and LC type Oscillators- Crystal oscillators, Quartz, Hartley, and Colpitts Oscillators, RC-phase shift and Wien-bridge oscillators.

Total Hours	**45**

Text Books:

1. Sedra and Smith, “Micro Electronic Circuits”; Sixth Edition, Oxford University Press, 2011.
2. Donald .A. Neamen, Electronic Circuit Analysis and Design, 2nd Edition reprint,Tata Mc GrawHill, 2013.
3. Theodore F. Bogart, Jeffery S. Beasley and Guilermo Rico, ‘Electronic Devices and Circuits’, Pearson Education,6th edition, 2013.

Reference Books:

1. Robert Diffenderfer, 'Electronic Devices: Systems and Applications',Cengage Learning, 2010.
2. Jacob Millman, Christos.C.Halkias and SatyabrataJit, 'Electronic Devices and Circuits', Tata McGraw Hill, 2010.
3. David A. Bell, "Electronic Devices and Circuits", Oxford University Press, 5th Edition, 2010.

Web References:

1. https://nptel.ac.in/video.php?subjectId=117103063
2. https://onionesquereality.wordpress.com/.../more-video- lectures-iit-open
3. https://nptel.iitg.ernet.in/Elec_Comm_Engg/.../Video-ECE.pdf

Online Resources:

https://www.coursera.org/learn/electronics

Assessment Methods & Levels (based on Blooms'Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C304.1	Remember	Class room Quiz	**3**
C304.2	Understand	Online Quiz	**3**
C304.3	Understand	Class Presentation	**3**
C304.4	Understand	Class Presentation	**3**
C304.5	Apply	Group Assignment	**4**
C304.6	Apply	Group Assignment	**4**

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination
	CIA1	CIA2	Term End Assessment	
Remember	20	10	10	10
Understand	50	50	50	50
Apply	30	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

16EE303	ELECTRIC CIRCUIT ANALYSIS	4/0/0/4

Nature of Course: G (Theory analytical)

Pre Requisites:16PH103 Engineering Physics

Course Objectives:

1. To examine dc and ac circuits by applying mesh analysis, nodal analysis and network theorems.
2. To understand the transient response in RLC circuits.
3. To relate the concepts of resonance in tuned circuits.
4. To understand three phase circuit connection with balanced load.
5. To simulate electrical circuits using PSPICE.

Course Outcomes

Upon completion of the course, students shall have ability to

C303.1 Remember the circuit elements and the laws governing the electrical circuits. [R]

C303.2 Remember the ac circuit, resonance and three phase circuit concepts. [R]

C303.3 Remember the concepts of resonance in tuned circuits. [R]

C303.4 Understand mesh, nodal methods and network reduction techniques for dc circuit analysis. [U]

C303.5 Understand network theorems for both dc and ac circuit analysis. [U]

C303.6 Understand the transient response of RLC circuits. [U]

C303.7Apply PSPICE for dc and ac circuit analysis. (Internal Mode) [AP]

Course Contents

Circuit elements and parameters: Voltage, current, power and energy, resistance, inductance and capacitance, energy Sources, circuit- Ohm's Law, Kirchhoff's laws.Mesh current and node voltage method of analysis**.Network Reduction:** Series and parallel resistance, voltage division, current division, source transformation, star delta conversion. **AC circuits:** Voltage and current relations of sine wave–resistor, inductor and capacitor in AC circuits – Series RL, RC, RLC Circuits.**Network Theorems for DC and AC circuits:**Thevenin's and Norton's Theorem, Superposition Theorem, Maximum power transfer theorem and Reciprocity Theorem.**Transient Analysis:** Steady State and Transient response – DC response of RL, RC and RLC Circuits using Laplace transforms.AC Transients response of RL and RC Circuits.**Resonance:** Series Resonance – Bandwidth of an RLC circuit, Q factor, Magnification in Resonance. Parallel Resonance – Resonant frequency for a tank circuit factor of parallel resonance, magnification. **Tuned circuits:** Self and mutually induced emf, coefficient of coupling, dot convention rule, single and doubly tuned circuits.**Three phase circuits:** Three phase balanced voltage sources with 3 wire star and delta connected loads.**PSPICE**(elementary treatment only)- DC analysis and control statements-A.C analysis and control statements-Transient analysis.

Total Hours	60

Text Books:

1. Charles K.Alexander, Matthew N.O.Sadiku, 'Fundamentals of Electric circuits', McGraw-Hill Publications,5th edition,2013.
2. Sudhakar and Shyammohan S Pillai, 'Circuits and Networks', Tata McGraw Hill, New Delhi, 4th Edition, 2010.
3. William H. Hayt, Jack Kemmerly, Steven Durbin, 'Engineering Circuit Analysis', McGraw Hill, 8th Edition, 2012.

Reference Books:

1. Robins&Miller, 'Circuit analysis theory and practice', Delmar Publishers, 5th edition, 2012
2. M. E. Van Valkenburg, 'Network Analysis', Phi Learning, 3/E 3rd Edition, 2014.
3. MahmoodNahvi, Joseph Edminister, 'Schaum's Outline of Electric Circuits', McGraw Hill Education, 6th Edition, 2014.

Web References:

1. http://nptel.ac.in/courses/108102042
2. http://nptel.ac.in/courses/117106108
3. http://www.electrical4u.com/circuit-analysis.htm
4. http://www.allaboutcircuits.com

Online Resources:

1. https://www.edx.org/course/circuits-electronics-1-basic-circuit-mitx-6-002-1x-0.
2. Fundamentals of Electrical Engineering@coursera.
3. https://onlinecourses.nptel.ac.in/iitm_ec_1010.
4. MIT open courseware@MITOCW.

Assessment Methods & Levels (based on Blooms'Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C304.1	Remember	Class room Quiz	**2**
C304.2	Remember	Online Quiz	**2**
C304.3	Remember	Class Presentation	**3**
C304.4	Understand	Problem solving	**3**
C304.5	Understand	Problem solving	**3**
C304.6	Understand	Problem solving	**4**
C304.7	Apply	Group Assignment	**3**

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination
	CIA1	CIA2	Term End Assessment	
Remember	50	40	40	40
Understand	50	60	60	60
Apply	-	-	-	-
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

16EE305	CIRCUITS AND DEVICES LABORATORY	0/0/3/2

Nature of Course: M (Practical application)

Co Requisites: 16PH103 Engineering Physics

Course Objectives:

Design and construct simple electronic circuits to accomplish a specific function.

Course Outcomes

Upon completion of the course, students shall have ability to

C305.1 Examine the working and characteristics of transistors. [U]
C305.2 Experiment with the basic laws and theorems in electrical circuits. [U]
C305.3 Apply the diodes to build different types of rectifiers and filter circuits. [AP]
C305.4 Analyze the amplifier and Oscillator circuits. [A]
C305.5 Analyze the frequency response of series & parallel resonance circuits. [A]
C305.6 Evaluate electrical and electronic circuits using software [E]

Course Contents

1. Verification of Ohms Law and Kirchhoff's Law.(3)
2. Analyse the circuit by mesh and nodal Analysis.(3)
3. Analyse the circuit by Networks Theorems. (9)
4. Frequency Response of Series and Parallel resonance circuits.(3)
5. Characteristics of Transistor configurations.(3)
6. Analyze Differential amplifiers using BJT. (3)
7. Construct RC Phase shift oscillators and Colpitt's Oscillator.(6)
8. Design Schmitt trigger and UJT Oscillators.(6)
9. Simulation of Electrical Circuits.(3)
10. Simulation of rectifier circuits.(6)

Total Hours | **45**

Reference Books:

1. Jacob Millman, Christos.C.Halkias and SatyabrataJit, 'Electronic Devices and Circuits', Tata McGraw Hill, 2010.
2. Theodore F. Bogart, Jeffery S. Beasley and Guilermo Rico, 'Electronic Devices and Circuits', Pearson Education,6th edition, 2013.
3. Mahmood Nahvi, Joseph Edminister, "Schaum's Outline of Electric Circuits", McGraw Hill Education, 6th Edition, 2014.
4. William H. Hayt, Jack Kemmerly, Steven Durbin, "Engineering Circuit Analysis", McGraw Hill, 8th edition, 2012.

Web References:

1. https://nptel.ac.in/video.php?subjectId=117103063
2. https://www.nptelvideos.in/2012/.../basic-electronics- drchitralekh mahanta.html
3. http://www.electrical4u.com/circuit-analysis.htm
4. http://www.technologystudent.com
5. http://www.allaboutcircuits.com

Assessment Methods & Levels (based on Bloom'sTaxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Rubric based Continuous Assessment[60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	-	-
Understand	40	40
Apply	20	20
Analyse	30	30
Evaluate	10	10
Create	-	-

16ME204	ENGINEERING PRACTICES LAB	0/0/3/2

PREREQUISITES: Nil

COURSE OBJECTIVES

1. To gain hands on experience on Carpentry, Fitting, Sheet metal, Plumbing, Arc welding
2. To provide exposure to the students with hands on experience on various wiring system nd measurement system.
3. To provide exposure to the students with hands on experience on various Electronic omponents.

COURSE OUTCOMES

Upon successful completion of the course, students shall have ability to

1. Prepare simple components like try, cylinder funnel etc.
2. Prepare simple lap, butt and tee joints using arc welding equipments.
3. Prepare simple wooden joints using wood working tools.
4 To provide exposure to the students with hands on experience on various wiring system and measurement system.
5. To provide exposure to the students with hands on experience on various Electronic Components.

LIST OF EXPERIMENTS

Mechanical

1.Welding-butt,lap and tee point
2.Sheet metal-rectangular tray
3.Sheet metal –cylindrical container
4. Demonstration on turning and drilling practices, foundry operations and forging operations

Civil

1. Plumbing: basic pipe connections – mixed pipe material connection –pipe connections with different joining components.
2. Wood work, joints by sawing, planning and cutting.
3. Study of pipe connections requirements for pumps and turbines and joints in roofs, doors, windows and furniture. Demonstration of plumbing requirements of high –rise buildings.

Electrical

1. Identify different types of fuses, fuse carriers, mcb, elcb, mccb with ratings and usage f
2. Wiring of simple circuit for controlling light using switches, fuse and indicator.
3. Wiring of light circuit using two way switches (staircase wiring).
4. Measurement of unknown resistance using dc bridges.
5. Measurement of electrical parameters using transducers.
6. Identification of electronic components with specification.
7. Testing of cro and electronic components.
8. Generation of signals.
9. Soldering practice.
10. Single phase half wave and full wave rectifier using pn junction diode.

TOTAL LABORATORY HOURS:45

REFERENCES:

1. SeropeKalpakjian and Steven R. Schmid, "Manufacturing Engineering and Technology", Pearson Education, Inc. 2015 (Second Indian Reprint).
2. Suyambazhagan S, ‘Engineering practices’ PHI learning private limited, New Delhi, 2014.
3. Jeyapoovan T., Saravanapandian M. &Pranitha S., ‘Engineering Practices Lab Manual’, Vikas Publishing House Pvt.Ltd, 2014.

WEB REFERENCES:

1. https://www.youtube.com/results?search_query=electrical+engineering+practices
2. https://www.youtube.com/watch?v=rLUyP6g1VNI&list=PL425060D3C78350E1

16MA104	DISCRETE TRANSFORMS AND FOURIER ANALYSIS	3/1/0/4

Nature of Course	J (Problem analytical)
Pre requisites	16MA101-Linear Algebra ,Calculus and its Applications 16MA102-Integral Calculus and Laplace Transform

Course Objectives:

1	To acquaint the student with Fourier transform techniques which are used in variety of engineering fields
2	To understand the different possible forms of Fourier series and the frequently needed practical harmonic analysis that an engineer may have to make from discrete data
3	To study the concept of mathematical formulation of certain practical problems in terms of partial differential equations and solving for physical interpretation
4	To solve boundary value problems encountered in engineering practices using Fourier series
5	To solve difference equations using Z-transform technique

Course Outcomes:

Upon completion of the course, students shall have ability to

C104.1	Recall concepts of partial derivatives and summation of series	[R]
C104.2	Formulate and solve the partial differential equations	[U]
C104.3	Interpret Fourier series solutions to the engineering problems	[AP]
C104.4	Use Fourier transform techniques to evaluate the integrals	[AP]
C104.5	Apply the basics of Z transform techniques to solve difference equations	[AP]

Course Contents:

Fourier Transforms - Complex form of Fourier Transforms -Fourier sine and cosine transforms-Properties(excluding proof)-Transforms of simple functions-Convolution theorem and Parseval's Identity (Statement) – Evaluation of integrals using Parseval's Identity-**Fourier series** - Dirichlet's conditions- General Fourier Series – Odd and Even Functions- Half range sine series and cosine series –Parseval's Identity- Harmonic analysis- **Partial Differential Equations -** Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions- Lagrange's linear equations –Linear homogeneous partial differential equations of second and higher order with constant coefficients-**Applications of Partial Differential Equations -** One dimensional wave equation – One dimensional equation of heat conduction –Fourier series solutions in Cartesian coordinates-**Z- Transforms -** Definition - Z-transform of Standard functions-Properties (excluding proof)–**Inverse Z- transform-** Convolution theorem(Statement)- Formation of difference equations- Solution of difference equations using Z-transform Techniques

Total Hours: 60

Text Books:

1	Kreyszig. E, "Advanced Engineering Mathematics" Tenth Edition, John Wiley and Sons (Asia) Limited, Singapore 2014
2	Grewal. B.S, "Higher Engineering Mathematics", 43rd edition, Khanna Publications, Delhi, 2014

Reference Books:

1	Veerarajan. T, "Transforms and Partial differential equations", 2rd edition, Tata McGraw-Hill Publishing Company Ltd., reprint,2015
2	N.P.Bali and Dr.Manish Goyal,"A Text book of Engineering Mathematics Sem-III/IV" 4th edition Laxmi publications ltd, reprint 2012
3	Glyn James, —Advanced Modern Engineering Mathematics, Pearson Education, 4th edition, 2012

Web References:	
1	http://nptel.ac.in/video.php?subjectId=122107037
2	http://nptel.ac.in/courses/122107036/
3	http://nptel.ac.in/video.php?subjectId=117102060
Online Resources:	
1	https://www.edx.org/course/calculo-diferencial-galileox-cmath001rx
2	https://www.edx.org/course/pre-university-calculus-delftx-calc001x-1
3	https://www.edx.org/course/calculus-1a-differentiation-mitx-18-01-1x
4	https://alison.com/courses/Advanced-Mathematics-1
5	https://ocw.mit.edu/courses/.../18-335j-introduction-to-numerical-methods-fall-2010 /ocw.usu.edu › Electrical and Computer Engineering › Signals and Systems

Assessment Methods & Levels (based on Blooms' Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C104.1	Remember	Classroom or Online Quiz	2
C104.2	Understand	Class Presentation/Power point presentation	4
C104.3	Apply	Group Assignment	6
C104.4& C104.5	Apply	Group activities	8

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination
	CIA1	CIA2	Term End Assessment	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	50	50	50
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

16EE306	ELECTRICAL MACHINES-I	4/0/0/4

Nature of Course: G (Theory analytical)

Pre Requisites: 16EE303- Electric Circuit Analysis

Course Objectives:

1. This course aims to train the students with a basic understanding of field theory concepts,
2. Also aims to train the students with basic D.C. machines andTransformer fundamentals, machine parts and help to gain the skills for operating the D.C. machines and Transformers.
3. This course also trains the students with an ability to understand and analyse the equivalent circuits of D.C. machines and Transformers and solve basic problems related to field theory.

Course Outcomes

Upon completion of the course, students shall have ability to

CO306.1 Understand the basic concepts of field theory
CO306.2 Understand the constructional details and principle of operation of DC machines
CO306.3 Understand the constructional details and principle of operation of Transformers
CO306.4 Analyse the performance of the DC Machines under various operating Conditions using their various characteristics.
CO306.5 Evaluate the performance of Transformers using phasor diagrams and Equivalent circuits.
CO306.6 Select appropriate DC motor as well as to choose an appropriate method of Speed control for any industrial application.

Course Contents:

Basics of Field Theory –Coulomb's law, electric field intensity, electric flux density, Gauss' law, Electric potential – Biot - Savart's law, magnetic flux density, magnetic field intensity, Ampere's Law - Equation of continuity. **Principles of Energy conversion** – basic magnetic circuit analysis, Faraday's law of electromagnetic induction – singly and doubly excited magnetic field systems – torque production in rotating machines and general analysis of electro mechanical system. **D.C.Generator**– construction, principle of operation– emf equation– types, Characteristics, commutation – interpoles - armature reaction. **D.C. motor** – principle of operation – torque equation – types – electrical & mechanical characteristics–soft starters – Brushless D.C. motor concepts – D.C. servo motors - Permanent magnet D.C. motors - selection of D.C. motors for various industrial application aspects.**Transformers** – principle of operation – types – basic construction – equivalent circuit - regulation and efficiency – auto transformer - Star and Delta connections – all day efficiency – parallel operation of transformers – Concept of tap changing, on-load and off-load tap changers - Cooling methods of transformers – procedure for transformer erection in power stations.

Total Hours	60

Text Books:

1. D.P. Kothari and I.J. Nagrath, "Electric Machines', Tata McGraw Hill Publishing Company Ltd, 2010.
2. Fitzgerald. A.E., Charles KingselyJr, Stephen D.Umans, 'Electric Machinery', Sixth edition, Tata McGraw Hill Books Company, 2015.

Reference Books:

1. William H.Hayt, “Engineering Electromagnetics”,Tata McGraw Hill,8th Edition,2014.
2. J.B. Gupta, Theory and Performance of Electrical Machines‘, S.K.Kataria and Sons, 2015.
3. Stephen J.Chapman, “Electric Machinery Fundamentals”, Tata McGraw Hill International Edition, New Delhi, 5th Edition, 2011

Web References:

1. http://nptel.ac.in/course.php?disciplineId=108
2. https://ocw.mit.edu/courses/find-by topic/#cat=engineering&subcat=electricalengineering&spec=electricpower

Online Resources:

1. Electricity & Magnetism, Part 1- PHYS 102.1x (edx.in)
2. AP® Physics 2 - Part 2: Electricity and Magnetism (edx.in)

Blooms Taxonomy based Assessment Pattern:

Bloom’s Category	Continuous Assessment Tests			Semester End Examination
	CIA1	CIA2	Term Examination	
Remember (**R**)	50	30	30	30
Understand (**U**)	30	30	30	30
Apply (**Ap**)	20	40	40	40
Analyse (**A**)	0	0	0	0
Evaluate (**E**)	0	0	0	0
Create (**C**)	0	0	0	0

16EE307	LINEAR AND DIGITAL INTEGRATED CIRCUITS	4/0/0/4

Nature of Course: G (Theory analytical)

Pre Requisites: 16EE303 Electric Circuit Analysis,16EE301 Electron Devices

Course Objectives:

1. To study the IC Fabrication, OP-AMP characteristics and its applications
2. To simplify the expressions using Boolean functions and to design the Combinational Circuits
3. To study about Synchronous & Asynchronous Sequential circuits
4. To study about the various memories and Logic Families and programming digital systems.

Course Outcomes

Upon completion of the course, students shall have ability to

CO307.1 Understand the op-amp's basic construction, characteristics, parameter limitations and various configurations

CO307.2 Analyze and deign basic op-amp circuits, particularly various linear and non-linear circuits, active filters, signal generators, and data converters

CO307.3 Understand the functional blocks and application of 555 timer

CO307.4 Apply the learned concept to design signal conditioning units using operational amplifiers

CO307.5 Understand the operations of basic logic gates and use of Boolean algebra in optimizing the circuit complexity

CO307.6 Understand the concepts of basic combinational circuits and sequential circuits.

CO307.7 Understand the design procedure of designing synchronous and asynchronous sequential circuits for given specification

CO307.8 Understand the operation of memory devices and different types of digital logic Families

Course Contents with Course Outcomes/Blooms Taxonomy/Assessment Methods

Linear integrated circuits: IC fabrication -op amp characteristics-inverting, Non- inverting and voltage follower– applications of op-amp – summer, Difference amplifier, differentiator and integrator - Instrumentation amplifier - V/I and I/V converters – comparators - peak detectors - S/H circuits - D/A converter – R-2R ladder and weighted resistor types - A/D converter – Dual slope, successive approximation and flash types. Functional blocks and applications of ICs: 555 timer –Astable and Monostable operation Design of signal conditioning unit using operational amplifier.

Digital circuits- Number systems - Boolean algebra: De-Morgan's theorem, switching functions and simplification using K-maps and Quine Mc Cluskey method.

Combinational circuits – Design of Logic gates- Design of adder, subtractor, comparators, code converters, encoders, decoders, multiplexers and demultiplexers. **Flip flops** - SR, D, JK and T; shift register –types. Analysis of synchronous sequential circuits - Design of synchronous sequential circuits – Counters, state diagram, state reduction, state assignment. Design of asynchronous sequential circuits. **Memories:** RAM, ROM, PROM, EPROM - EEPROM, PLDs, FPGA - Digital Logic Families: TTL, CMOS.ECL.

Design of ALU, VHDL programming concepts.

Total Hours	60

Text Books:

1. A.Anand kumar, 'Fundamental of Digital Circuits', PHI Learning Private Ltd, 4th edition, 2014.

2. James M.Fiore, 'Opamps and Linear Integrated Circuits', Cengage Learning India Pvt Ltd, 1st edition, 2010.
3. M. **Morris** R. **Mano**, Michael D. Ciletti, 'Digital Logic Design', Prentice Hall,5th Edition,2013.

Reference Books:

1. Muhammed H.Rashid, 'Microelectronics circuit analysis and design', Cengage Learning India Pvt Ltd,, 2nd edition,2011 .
2. Floyd, 'Digital Fundamentals', Pearson education, 11th edition, 2015.
3. David A.Bell, 'Operational amplifiers and Linear ICs', Oxford University Press, 2nd edition, 2011

Web References:

1. http://nptel.ac.in/courses/117103064/
2. http://nptel.ac.in/courses/117106114/
3. http://nptel.ac.in/courses/108106069/
4. http://nptel.ac.in/courses/117106086/
5. http://nptel.ac.in/courses/108106068

Online Resources:

1.https://www.coursera.org/learn/electronics
2.http://electronics-course.com/
3.https://www.edx.org/course/circuits-electronics-3-applications-mitx-6-002-3x-0

Blooms Taxonomy based Assessment Pattern:

Bloom's Category	Continuous Assessment Tests			Semester End Examination
	CIA1	CIA2	Term Examination	
Remember	20	0	10	10
Understand	30	20	20	10
Apply	50	40	40	40
Analyse	0	40	30	40
Evaluate	0	0	0	0
Create	0	0	0	0

16EE308	INSTRUMENTATION ENGINEERING	4/0/0/4

Nature of Course: D (Theory Application)

Pre Requisites: Measurements and Instrumentation, Electronic circuits.

Course Objectives:

1. To stateabout instruments utilized in various disciplines in Industries.
2. To execute the different transducers in real time.
3. To expose recent developments in Instrumentation.

Course Outcomes

Upon completion of the course, students shall have ability to

CO308.1 Remember the basic concepts of analog instrumentation [R]

CO308.2 Understand the basic concepts of various instruments [U]

CO308.3 Apply knowledge and handle instruments for measurement using tranasducers and sensors [AP]

CO308.4 Apply knowledge and handle instruments for measurement of Electrical, Optical, Thermal and Mechanical quantities. [AP]

Course Contents :

Instruments for the measurement of Electrical Quantities: Components of Generalized measurement system, Introduction of Transducers/Sensors: Characteristics of Transducers, Requirement of Transducers, Classification of transducers, Selection Criteria of Transducers, Introduction to data acquisition system. CRO, DSO, Digital Multimeterss. **Instruments for the measurement of Mechanical Quantities:** Displacement, strain vibration and pressure: Potentiometers, Linear Variable Differential Transformer, Resistance Strain Gauges, Piezo resistive accelerometer, Piezo-capacitive accelerometer, Pressure gauge - Bourdon, Manometer. **Instruments for the measurement of thermal parameters:** Temperature measurement: RTD, Thermisters, Thermocouples, thermal conductivity, thermal diffusivity. **Optical Instrumentation:** Optical Source LED, laser, Photo-diode, and their characteristics, UV visible and IR spectrometry, Introduction to Interferometric technique. **Instruments for Biomedical application:** Clinical thermometer, Stethoscope, Sphygmomanometer, hemoglobinometer, urinalysis, Bio-potential based ECG, Pacemaker and its types, Incubator, Magnetic resonance imaging.

Total Hours	60

Text books:

1. Sawhney.A.K, “A course in Electrical and electronic Measurement and Instrumentation”, Dhanpat Rai & Sons, New Delhi, 19th Revised Edition 2011 Reprint 2014.
2. Albert D Halfride & William D Cooper, “Modern Electronic instrumentation and measurement techniques”, Prentice Hall of India Pvt. Ltd., latest edition, 2013.

Reference books:

1. Instrumentation: Theory and Applications Paperback by S Sheel, Narosa Publishing House, 2013.
2. H. Oliver and J. M. Cage, Electronic Measurement and Instrumentation, McGraw Hill, 6th edition, 2014.
3. J.J.Carr, Elements of Electronic Instrumentation and Control, Prentice Hall, 5th edition, 2014.
4. Electronic Instrumentation (Third Edition), H.S-Kalsi, Tata McGraw-Hill Education Pvt. Ltd. Publication, 2010.

5. M Arumugam, Biomedical Instrumentation, Anuradha Agencies. 2002.
6. R. Anandanatarajan Biomedical Instrumentation and measurements, PHI learning pvt 2011.
7. Daniel Malacara Optical Shop testing, 3 rd Edition, Wiley-interscience A John wiley & sons, inc publication

Web sources:

1. http://www.electrical4u.com
2. http://nptel.ac.in/courses
3. https://en.wikipedia.org

Online Resources:

1. http://kupce.ku.edu
2. http://www.shortcoursesportal.com
3. www.idc-online.com

Blooms Taxonomy based Assessment Pattern:

Bloom's Category	Continuous Assessment Tests			Semester End Examination
	CIA 1	CIA 2	Term Examination	
Remember	40	35	30	30
Understand	40	35	30	30
Apply	20	30	40	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

16CS212	LINUX AND PROGRAMMING IN C++	3/0/2/4
Nature of Course	: F (Theory Programming)	
Pre requisites	: 16CS201 PROBLEM SOLVING USING C PROGRAMMING	

Course Objectives:

1	To introduce basic Linux concepts.
2	To understand Object Oriented Programming concepts like data abstraction and encapsulation.
3	To analyse different kinds of constructors, inheritance and polymorphism.
4	To understand and apply streams and file concepts.

Course Outcomes:
Upon completion of the course, students shall have ability to

CO.1	Remember the basic commands of Linux.	[R]
CO.2	Understand the basic Linux Commands and file system hierarchy	[U]
CO.3	Construct and apply C++ program to solve the given problems using basic programming constructs.	[AP]
CO.4	Apply the concepts of friend function and virtual functions.	[AP]
CO.5	Apply the concepts of polymorphism.	[AP]
CO.6	Make use of I/O functionality to code basic file operations and experiment with templates.	[AP]

Course Contents:

Introduction to Linux-Linux basic Commands- File System Hierarchy-Users, groups and permissions. Programming paradigms - Basic concepts and benefits of Object Oriented Programming, An overview of C++, datatypes, Selection statements, Functions, Arrays, Function overloading . Classes and objects, Default constructor, operator overloading, Friend functions - virtual functions. Templates, Exception handling. Derived classes- Inheritance, Virtual Base Class, Abstract class, Polymorphism and Virtual Functions-Virtual Base class. Console Input /output operation, File Handling. Error handling.

Lab Component

1	Linux Commands	[E]
2	Shell Programming	[E]
3	Simple Classes for understanding objects, member functions and constructors	[E]
4	Compile time polymorphism	[E]
5	Run time polymorphism	[E]
	Total Hours:	**75**

Text Books:

1	Christopher Negus, Christine Bresnahan, “Linux Bible”, Willey Publishing Inc., 2012.
2	Herbert Shildt , “ The Complete Reference C++” , Fourth Edition, TMH, 2003.

Reference Books:

1	K.R.Venugopal, Rajkumar Buyya, T.Ravishankar, “Mastering C++”, TMH, 2003.
2	Bjarne Stroustrup, "The C++ programming language" Addison Wesley, fourth edition.

3	Richard Blum, Christine , " Linux Command Line and Shell Scripting Bible" , 2nd Edition, Wiley Publishing Inc. 2011.
Web References:	
1	http://nptel.ac.in/courses/117106113/
2	http://nptel.ac.in/syllabus/syllabus.php?subjectId=106106111
Online Resources:	
1	www.edx.org/course/introduction-linux-linuxfoundationx-lfs101x-0
2	https://www.coursera.org/learn/c-plus-plus-a

Assessment Methods & Levels (based on Blooms' Taxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment				End Semester Examination (Theory) [40 marks]
	Theory			Practical	
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	Rubric based CIA [40 Marks]	
Remember	30	30	30	-	20
Understand	30	40	40	20	40
Apply	40	30	30	30	30
Analyse	-	-	-	30	10
Evaluate	-	-	-	20	-
Create	-	-	-	-	-

16EE309	Electrical Machines – I Laboratory	0/0/3/2

Nature of Course: M (Practical application)

Co Requisites: 16EE303 Electric Circuit Analysis

Course Objectives:

1. To obtain the performance characteristics of DC machines by using Virtual Labs, MATLAB and experimental methods.
2. To obtain the performance characteristics of transformers based on various tests under no load, loading conditions, Open circuit and short circuit conditions
3. To analyse the equivalent circuit parameters of transformers using Virtual Labs.

Course Outcomes

Upon completion of the course, students shall have ability to

CO309.1 Analyze the no load and load characteristics of DC shunt generator.
CO309.2 Analyze the performance characteristics of Series and Compound generator.
CO309.3 Determine the mechanical and electrical characteristics of Shunt ,Series and Compound motor
CO309.4 Determine the electrical characteristics of Single phase Transformers.
CO309.5 Understand the different types of single and three phase transformer connections

Course Contents

1. To determine the effective efficiency and speed characteristic of DC shunt motor (3)
2. To determine the effective efficiency and speed characteristic of DC series motor(3).
3. To determine the effective efficiency and speed characteristic of DC Compound motor(3).
4. To determine the OCC characteristics of self excited DC shunt generator using Simulation software. (3).
5. To determine the no load characteristics of the separately excited DC generator.(3)
6. Determination of efficiency of DC machine through Hopkinson s Test (3).
7. Determination of the equivalent circuit parameters of a single phase transformer (3).
8. Sumpners Test on Transformers (6).
9. Swinburne's test and speed control of DC Shunt motor(9)
10. a)Scott Connection of Two Single phase Transformers (3) .b)Three phase Transformer connections(6)

Total Hours	**45**

Reference Books:

1. D.P. Kothari and I.J. Nagrath, “Electric Machines‘, Tata McGraw Hill Publishing Company Ltd, 2010.
2. Fitzgerald. A.E., Charles KingselyJr, Stephen D.Umans, ‘Electric Machinery’, Sixth edition, Tata McGraw Hill Books Company, 2015.
3. J.B. Gupta, Theory and Performance of Electrical Machines‘, S.K.Kataria and Sons, 2015.

Web References:

1. http://www.electrical4u.com/characteristic-of-separately-excited-dc-generator/
2. http://www.academia.edu

Online Resources:

http://iitg.vlab.co.in/?sub=61&brch=168

Blooms Taxonomy based Assessment Pattern:

Bloom’s Category	Continuous Assessment Tests		Semester End Examination
	Mid Sem Review	Term Review	
Remember	10	10	10
Understand	30	30	30
Apply	30	30	30
Analyse	20	20	20
Evaluate	10	10	10
Create	0	0	0

16EE310	LINEAR AND DIGITAL INTEGRATED CIRCUITS LABORATORY	0/0/3/2

Nature of Course: M (Practical application)

Co Requisites: 16EE303 Electric Circuit Analysis, 16EE301 Electron Devices

Course Objectives:

1. To verify the expressions using Boolean functions and to verify the Combinational circuits
2. To design and verify the output of Synchronous Sequential circuits
3. To design and verify the output of Asynchronous Sequential circuits
4. To implement the basic circuits using OP-AMP and to implement the timer IC application

Course Outcomes

Upon completion of the course, students shall have ability to

C310.1 Verify the expressions using Boolean functions and to verify the Combinational circuits

C310.2 Design and verify the output of Synchronous Sequential circuits

C310.3 Design and verify the output of Asynchronous Sequential circuits

C310.4 Implement the basic circuits using OP-AMP and the timer IC application.

Course Contents

1. Implementation of Inverting and Non inverting Amplifier.(3)
2. Comparator, Integrator and Differentiator using Op-amp. (3)
3. Astable and monostable multivibrators using 555 timers.(3)
4. Implementation of Boolean Functions, Adder, Subtractor circuits. (3)
5. Design of Code convertors , parity generator and checker.(6)
6. Design of Encoders and Decoders using logic gates. (6)
7. Design of Multiplexer and Demultiplexer using logic gates.(6)
8. Design and implementation of synchronous and asynchronous counters and shift registers using flipflops. (6)
9. VHDL programming of simple combinational and sequential circuits.(3)
10. Realization of A/D and D/A converters simulation software.(3)
11. Realization of flipflops using simulation software.(3)
12. Precision Half and Full Wave rectifier using OP-AMP

Total Hours | **45**

Reference Books:

1.A.Anandkumar, 'Fundamental of Digital Circuits', PHI Learning Private Ltd, edition, 2014.

2.James M.Fiore, 'Opamps and Linear Integrated Circuits', Cengage Learning India Pvt Ltd, 1st edition, 2010.

Web References:

1. http://www.electrical4u.com/digital-electronics.htm
2. http://www.technologystudent.com/elec1/dig1.htm

Online Resources:

http://www.digital.iitkgp.ernet.in/dec/index.php

Blooms Taxonomy based Assessment Pattern:

Bloom's Category	Continuous Assessment Tests		Semester End Examination
	Mid Sem Review	Term Review	
Remember	10	10	10
Understand	30	30	30
Apply	30	30	30
Analyse	20	30	20
Evaluate	10	10	20
Create	0	0	0

16MA109	PROBABILITY AND COMPUTATIONAL METHODS	3/1/0/4
Nature of Course	J(Problem analytical)	
Pre requisites	16MA101-Linear Algebra , Calculus and its Applications 16MA102-Integral Calculus and Laplace Transform	

Course Objectives:

1	To find the roots of nonlinear (algebraic and transcendental) equations, solutions of large system of linear equations and eigen values of a matrix
2	To study the concept of fitting a curve of best fit to the given numerical data and to calculate the deviation of the expected value from the observed value
3	To apply analytic function techniques to transform irregular geometry to regular geometry
4	To study the basic probability concepts
5	To acquire skills in handling situations involving more than one random variable
6	To understand and have a well – founded knowledge of standard distributions which can be used to describe real life phenomena

Course Outcomes:

Upon completion of the course, students shall have ability to

C109.1	Recall the concepts of basic probability	[R]
C109.2	Fit a polynomial or special function curve for the given data	[U]
C109.3	Apply numerical methods to solve algebraic, transcendental and simultaneous equations	[AP]
C1O9.4	Find the derivatives of the complex valued functions and to evaluate complex valued integrals	[AP]
C109.5	Apply the probability concept in solving engineering problems	[AP]
C109.6	Use distribution in cluster analysis of similar binary variables	[AP]

Course Contents:

Numerical solution to algebraic and transcendental equations - Regula-Falsi method - Newton-Raphson method –Gauss Elimination method -Gauss Jordan method –Gauss Jacobi method - Gauss Seidel method – Inverse of a matrix by Gauss Jordan method –Eigen value of a matrix by power method- **Curve Fitting** - Empirical laws – Linear law – Method of group averages – Principle of Least squares – Fitting straight line, parabola and exponential curve - **Complex integration**-Analytic function (definition)-Cauchy's integral theorem(statement)-Laurent's series-zeros and singularities-Residues-Cauchy's residue theorem(statement)-Contour integration(excluding poles on the real axis)- **Probability** - Probability concepts-Addition and Multiplication law of probability – Conditional probability - Total probability theorem, Bayes theorem(statement) – Problems - **Random Variables**- One dimensional random variable - Probability mass function - Probability density function – Discrete and continuous random variables – **Standard distributions**-Discrete distributions - Binomial – Poisson – Geometric – Continuous distributions - Uniform – Exponential - Normal distributions – MGF- Simple problems

Total Hours: 60

Text Books:

1	Grewal B.S., Numerical methods in Engineering and Science. 10th edition, Khanna Publishers, 2014.
2	Grewal B.S, —Higher Engineering Mathematics, 43rd edition, Khanna Publications, Delhi, 2014.

3	Kreyszig. E, —Advanced Engineering Mathematics, tenth Edition, John Wiley and Sons (Asia) Limited, Singapore, 2014.
4	Gupta, S.C., & Kapoor, V.K., Fundamentals of Mathematical Statistics, Sultan Chand & sons, 2000,Reprint 2014.
5	Palaniammal.S.,-Probability and Random Processes, Prentice hall of India, New Delhi, 2014,Reprint 2015
Reference Books:	
1	Glyn James, —Advanced Modern Engineering Mathematics, Pearson Education, 4th edition, 2012.
2	Jain M.K. Iyengar, K & Jain R.K., Numerical Methods for Scientific and Engineering Computation, New Age International (P) Ltd, Publishers 2013.
3	Kandasamy.P,Thilagavathy,K,P.Gunavathy,"Numerical Methods",3rd edition, S.Chand and company Pvt.Ltd.,2013
4	Peebles Jr.P.Z.,-Probability Random Variables and Random signals principles , Tata McGraw- Hill Publishers, Fourth edition , New Delhi , 2002.
Web References:	
1	http://nptel.ac.in/syllabus/syllabus.php?subjectId=111999935
2	http://nptel.ac.in/courses/112106064/
3	http://nptel.ac.in/courses/111103070/
Online Resources:	
1	https://ocw.mit.edu/courses/.../18-335j-introduction-to-numerical-methods
2	https://www.coursera.org/learn/complex-analysis
3	www.edx.org/Probability
4	https://ocw.mit.edu/courses/.../18-440-probability-and-random-variables-spring-2014/

Assessment Methods & Levels (based on Bloom'sTaxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C109.1	Remember	Class room Quiz	**2**
C109.2	Understand	Class presentation / Powerpoint presentation	**6**
C109.3 , C109.4	Apply	Group activity	**7**
C109.5 C109.6	Apply	Group Assignment	**7**

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	50	50	50
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

16EE311 ELECTRICAL MACHINES - II 4/0/0/4

Nature of Course : G (Theory analytical)
Pre requisites : 16EE306 Electrical Machines I

Course Objectives:

1 To study the single phase Induction motor and special machines
2 To acquire the knowledge about starting and speed control of poly phase Induction motor
3 To acquire the knowledge about three phase Induction motor and Synchronous machines

Course Outcomes:

Upon completion of the course, students shall have ability to

C311.1	Remember the basic fundamentals and working principles of rotating machines.	[R]
C311.2	Understand the constructional details and principle of operation of Synchronous Machines.	[U]
C311.3	Understand and appraise the principle of operation and performance of PMBLDC Machines.	[U]
C311.4	Understand the performance of the AC Induction Machine using the phasor diagrams and equivalent circuits.	[U]
C311.5	Apply the performance of the Synchronous Machine using the phasor diagrams and equivalent circuits.	[AP]
C311.6	Select appropriate AC and special machine for any application and appraise its significance	[AP]

Course Contents:

Alternators: Construction, principle and types, armature reaction, load characteristics, voltage regulation, two-reaction theory, synchronization and synchronizing power, Parallel operation and load sharing, operation on infinite bus-bar typical applications, Alternator grounding in power stations. **Synchronous motors:** Synchronous machines on infinite bus bars, phasor diagram, V and inverted-V curves, Hunting and its suppression, starting methods, Working of synchronous motor as a condenser. **Poly-phase Induction motors:** Construction, principle and types, no load and blocked rotor test, equivalent circuit, circle diagram, Starting and speed control methods, Braking methods. Induction generators - types, principle of operation, equivalent circuit and applications – Induction generator in windmill power plant – Linear induction motor. **Single-phase Induction motors** - Construction, principle and types, double revolving field theory, equivalent circuit, Permanent magnet brushless motors: Construction, principle and types, torque equation, application aspects related to vehicle and house hold. **Special Purpose Machines:** Construction and principle of operation of Stepper motors, Linear Induction motors, A.C. servo motors and their Applications. **Energy Efficient A.C. Machines:** Construction, Basic Concepts, losses minimization and efficiency calculations. Super Conducting A.C. Machines: Construction, Principle of operation and basic concepts.

Total Hours: 60

Text Books:

1 D.P.Kothari, Electrical Machines, 4th edition, Tata McGraw-Hill, New Delhi 2010.
2 P.S.Bimbhra, Electrical Machinery, Khaana Publishers, 2011.

Reference Books:

1 Fitzgerald A.E. Kingsly C., Umans S.D., Electrical Machinery, 7th edition, McGraw Hill International Edition, New York, 2013.
2 Stephen J.Chapman, Electric Machinery Fundamentals, Tata McGraw Hill, New Delhi, 5th Edition, 2011.
3 B.L. Theraja and A.K. Theraja, Electrical Technology, S. Chand Publishing, 2010.

Web References:

1 http://nptel.ac.in/syllabus/syllabus.php?subjectId=108105018
2 http://freevideolectures.com/Course/2335/Basic-Electrical-Technology/23

Online Resources:

1 https://www.youtube.com/watch?v=b24jORRoxEc

Assessment Methods & Levels (based on Bloom's Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C311.1	Remember	Quiz	**4**
C311.2	Understand	Writing Skills	**4**
C311.3	Understand	Class Presentation	**4**
C311.4	Understand	Group Assignment	**2**
C311.5	Apply	Class Presentation	**4**
C311.6	Apply	Group Assignment	**2**

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	20	20	20	20
Understand	80	80	40	40
Apply	-	-	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

16EE312 **CONTROL SYSTEMS** **4/0/0/4**

Nature of Course :G (Theory analytical)
Pre requisites :16EE301 -Electric Circuit Analysis

Course Objectives:

1. To understand the methods of representation of systems and to desire their transfer function models.
2. To provide adequate knowledge in time response of systems and steady state error analysis.
3. To accord basic knowledge in obtaining the open loop and closed loop frequency responses of systems.
4. To understand the concept of stability and methods of stability analysis.
5. To allow the students to design controllers and compensators for stability control.

Course Outcomes:

Upon completion of the course, students shall have ability to

C312.1	Develop the theoretical aspects of Control systems and to translate variousControl systems into mathematical models.	[R]
C312.2	Compute transfer function of control systems using Block diagram reduction technique and Mason's gain formula.	[U]
C312.3	Understand the transient and steady state response of first order and second order Control systems.	[U]
C312.4	Understand the generalized error coefficient and steady state error for various types and order of the system.	[U]
C312.5	Accord basic knowledge in obtaining the open loop frequency responses of systems using Bode Plot and Polar plot.	[AP]
C312.6	Appraise the stability of the control systems using Root locus and Routh-Hurwitz Criteria.	[AP]
C312.7	Design and realize the controllers and compensation techniques that can be used to stabilize the control systems using bode plot.	[AN]
C312.8	Modelling electromechanical applications in Simulation software.	[E]

Course Contents:

Control System Modeling: Basic elements in Control Systems – Open loop and Closed loop systems – Overview of Laplace Transform, Mathematical modeling of Mechanical and Electrical systems: Translational, Rotational – Block diagram reduction using Signal flow graph. **Time response analysis**: Time domain specifications - Types of test signals – First and Second Order System response – Steady state error – Generalized error coefficients. **Frequency response analysis**: Frequency domain specifications – Correlation between frequency and time domain specifications – Bode plot – Polar plot. **Stability of control system**: Characteristics equation – Location of roots in S plane for stability – Routh Hurwitz criterion – Root Locus techniques – Illustration of the effect of adding zero and a pole – Nyquist stability criterion – Gain margin and Phase margin – Analysis using simulation software. **Controllers and Compensators Design**: Design of P, PI and PID controllers – Performance criteria – Lag, lead and lag – lead networks – Lag Compensator design using Bode plot - Analysis using simulation software tool**; Case studies:** Analysis of two tank liquid level system.

Total Hours: 60

Text Books:

1 I.J. Nagrath and M. Gopal, 'Control Systems Engineering', 5th Edition, New Age International, 2013.
2 K. Ogata, 'Modern Control Engineering', 5th edition, Prentice Hall India, New Delhi, 2011.
3. Benjamin C. Kuo, 'Automatic Control systems',8th Edition, Pearson Education, New Delhi, 2012.

Reference Books:

1 Norman S. Nise, 'Control Systems Engineering', 7th Edition, John Wiley, New Delhi, 2015.
2 Richard Poley, 'Control Theory Fundamentals', 2nd Edison, Createspace, 2014.
3 Richard C. Dorf, Robert H.Bishop, 'Modern Control Engineering', 13th Edition, Pearson Education, New Delhi, 2016.

Web References:

1. http://www.nptel.ac.in/courses/108101037/
2. http://www.nptel.ac.in/courses/108102043/
3. http://www.ijaiem.org/Volume4Issue5/IJAIEM-2015-05-03-4.pdf

Online Resources:

1. https://ocw.mit.edu/courses/mechanical-engineering/2-04a systems-and-controls-spring-2013/
2. https://www.edx.org/course/introduction-control-system-design- first- mitx-6-302-0x

Assessment Methods & Levels (based on Bloom'sTaxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C312.1	Remember	Online Quiz	**2**
C312.2	Understand	Writing Skill	**2**
C312.3	Understand	Technical Presentation	**3**
C312.4	Understand	Simulation Exercise	**3**
C312.5	Apply	Simulation Exercise	**3**
C312.6	Apply	Problem Solving	**2**
C312.7	Analyse	Simulation Exercise	**3**
C312.8	Evaluate	Group Assignment	**2**

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment**			**End Semester Examination [60 marks]**
	CIA-I [6 marks]	**CIA-II [6 marks]**	**Term End Examination [8 marks]**	
Remember	20	20	10	10
Understand	80	40	40	40
Apply	-	40	30	30
Analyse	-	-	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

16EE313 GENERATION, TRANSMISSION AND DISTRIBUTION 4/0/0/4

Nature of Course : G (Theory analytical)

Pre requisites : 16EE303 - Electric Circuit Analysis

Course Objectives:

1. To introduce the Generation, Transmission and Distribution sector of power system.
2. To enable the students to understand the calculation of transmission line parameter for different conductors.
3. To analyse the concepts of modelling, corona loss and efficiency of transmission line.
4. To learn selection of cables and insulators in power system network.
5. To realise substation, distribution system and tariff calculation.

Course Outcomes:

Upon completion of the course, students shall have ability to

C313.1	Remember the operation of conventional generating stations and renewable sources of electrical power.	[R]
C313.2	Understand overhead line insulator and underground cables and corona.	[U]
C313.3	Apply the concepts of modelling, corona loss and efficiency of transmission line.	[AP]
C313.4	Apply knowledge in substations, their types and distribution systems.	[AP]
C313.5	Evaluate the electrical circuit parameters of transmission lines.	[AN]
C313.6	Analyse various economic power tariff methods.	[AN]

Course Contents:

Generation of electric power:Typical Layout of an Electrical Power System, Hydro station, Steam Power Plant, Nuclear Power Plant, Pelamis – Wave Energy, wind Energy, and Solar Energy.**Transmission line parameters calculation:**Overview of Differentiation and Integration, Resistance, inductance, capacitance of single phase and three phase lines with symmetrical and unsymmetrical spacing of solid and bundled conductors, effect of earth on capacitance.**Modelling and performance of transmission lines:**Modelling and simulation of Medium & long transmission lines, efficiency and regulation, power circle diagram, surge impedance loading Ferranti effect and corona loss, Mechanical design of transmission lines. **Overhead line insulators:** Selection of Insulators,different types, string efficiency. **Underground cables:**Selection of cables, rating of cables, constructional details of various types of cables, oil and gas-filled cables, XLPE cable , capacitance grading, sheath loss, thermal ratings. **Substation and distribution system**: Substation layout, radial and ring systems, selection of feeders and distributors, economic aspects and tariff calculations.

Total Hours: 60

Text Books:

1. Leonard.L. Grigsby, Electric Power Generation, Transmission and distribution, Third Edition, CRC Press, 2012.
2. C.L. Wadhwa, Generation, Distribution and Utilization of Electrical Energy, ThirdEdition, New Age International, 2015.

Reference Books:

1. B. R. Gupta, Generation of Electrical Energy, 4e,S. Chand Publication, 2013.
2. A. S. Pabla, Electric Power Distribution, McGrawHill International Edition, 2012.
3. S.N. Singh, Electric Power Generation, Transmission and Distribution, Twelflh Printing (Second Edition) Published by Asoke K. Ghosh, Prentice-Hall of India Private Limited, New Delhi, 2011.

Web References:

1. http://nptel.ac.in/video.php?subjectId=108102047
2. http://textofvideo.nptel.iitm.ac.in/108102047/lec20.pdf

Online Resources:

1 https://www.edx.org/course/smart-grids-electricity-future-ieeex-smartgrid-x-0

Assessment Methods & Levels (based on Blooms'Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C313.1	Remember	Quiz	**2**
C313.2	Understand	Class presentation	**4**
C313.3	Apply	Group Assignment	**4**
C313.4	Apply	Poster presentation	**2**
C313.5	Analyse	Simulation Exercise	**4**
C313.6	Analyse	Case study	**4**

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment**			**End Semester Examination [60 marks]**
	CIA1 [6 marks]	**CIA2 [6 marks]**	**Term End Examination [8 marks]**	
Remember	30	20	20	20
Understand	60	30	30	30
Apply	-	30	30	30
Analyse	10	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

16CS213 **DATA STRUCTURES AND ALGORITHMS (Common to ECE/EEE)** **3/0/2/4**

Nature of Course :K (Problem Programming)

Pre requisites : 16CS201 PROBLEM SOLVING USING C PROGRAMMING

Course Objectives:

1. To stress the importance of Algorithms and Data structures in becoming a more productive programmer.
2. To understand the Algorithms and Data structures used for solving a problem are much more important than knowing the exact code for it in some programming language.
3. To provide an insight into the intrinsic nature of the problem as well as possible solution techniques, independent of programming language, programming paradigms, computer hardware or any other implementation technique.

Course Outcomes:

Upon completion of the course, students shall have ability to

CO1	Identify the suitable data structure for a real world problem	[R]
CO2	Select an appropriate design paradigm that solves the given problem efficiently	[U]
CO3	Write efficient algorithms	[AP]
CO4	Analyze the complexities of algorithms	[AN]
CO5	Compare the complexities of the algorithms	[E]
CO6	Develop efficient algorithms for different applications	[C]

Course Contents:

Introduction to Data structures and Algorithms: Importance of algorithms and data structures, Stages of algorithm development for solving a problem: Describing the problem, Identifying a suitable technique, Design of an Algorithm, Proof of Correctness of the Algorithm, Computing the time complexity of the Algorithm. **Analysis of Algorithms:** Overview of Mathematical preliminaries Asymptotic notations and their significance, Running time of an algorithm, Time-complexity of an algorithm, Performance analysis of an algorithm, Analysis of iterative and recursive algorithms. Master theorem**. Data Structures:** Importance of data structures, Arrays, Stacks, Queues, Linked list, Trees, Hashing table, Binary Search Tree, AVL trees, Red Black trees, splay trees, Heaps. **Graph Algorithms:** Breadth First Search (BFS), Depth First Search (DFS), Minimum Spanning Tree (MST), Single Source Shortest Paths**.Advanced Data Structures:** Bi-connected components, Cut vertices, Matching, Network flow, Data Mining, Data Fusion, Web Data structures, Real Time application**.**

Total Hours: 75

Lab Component

1. Array, Loops
2. Stacks and Queues
3. Searching and Sorting
4. Linked List
5. Brute force technique
6. Greedy Technique
7. Backtracking
8. Dynamic Programming
9. Tree
10. BFS and DFS
11. Minimum Spanning Tree

12. Dijsktra's Shortest path algorithm
13. Domain Specific Algorithms

Text Books:

1 Thomas H. Cormen, C.E. Leiserson, R L.Rivest and C. Stein, Introduction to Algorithms , Paper Back 2010, Third edition, MIT Press, 2010(Reprint)

Reference Books:

1 SanjoyDasgupta, C.Papadimitriou and U.Vazirani , Algorithms , Tata McGraw-Hill, 2006.
2 V. Aho, J.E. Hopcroft and J. D. Ullman, Data Strucures and Algorithms, Pearson India, Ist Edition, 2002.
3 V. Aho, J.E. Hopcroft and J. D. Ullman, Design and Analysis of Computer Algorithms, Pearson, 1st edition, 2011.
4 Sara Baase , Allen Van Gelder, Computer Algorithms, Introduction to Design and Analysis, 3rd edition, Wesley Longman Publishing, 2000.
5 Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd edition, Pearson Education, 2007

Web References:

1 http://www.amazon.in/Data-Structures-Algorithms-Made Easy/dp/0615459811/ref=sr_1_1?ie=UTF8&qid=1474906913&sr=8-1&keywords=karumanchi-C++edition
2 http://www.amazon.in/Data-Structures-Algorithms-Made-Easy/dp/1466304162/ref=sr_1_2?ie=UTF8&qid=1474906913&sr=8-2&keywords=karumanchi-java edition
3 http://nptel.ac.in/courses//106103069/
4 http://web.stanford.edu/class/cs97si/

Online Resources:

1 https://www.coursera.org/learn/data-structures
2 https://www.coursera.org/specializations/data-structures- algorithms
3 http://nptel.ac.in/courses//data-structures

Assessment Methods & Levels (based on Blooms' Taxonomy)					
Summative assessment based on Continuous and End Semester Examination					
Bloom's Level	**Continuous Assessment**				**End Semester Examination (Theory) [40 marks]**
	Theory			**Practical**	
	CIA1 [6 marks]	**CIA2 [6 marks]**	**Term End Assessment [8 marks]**	**Rubric based CIA [40 Marks]**	
Remember	10	10	10	-	-
Understand	20	20	20	-	-
Apply	50	40	40	20	20
Analyse	-	30	30	30	30
Evaluate	-	-	-	20	20
Create	-	-	-	30	30

16EE314 Electrical Machines - II Laboratory 0/0/3/2

Nature of Course : M (Practical application)
Co requisites : 16EE306 Electrical Machines – I

Course Objectives:

1. To obtain the performance of induction motor, synchronous motor, Alternators and excitation characteristics of induction generator based on various tests and also using Virtual Labs.
2. To obtain the DC resistance of the stator in induction motor using Virtual Labs

Course Outcomes:

Upon completion of the course, students shall have ability to

C314.1	Measure the regulation of three phase alternator and verify Synchronization of Alternator	[AP]
C314.2	Determine the performance characteristics of single and three phase induction motors	[AN]
C314.3	Understand the Performance characteristics of Three-Phase Induction Motor from Circle diagram	[AN]
C314.4	Understand the self excitation characteristics of an induction generator	[AN]
C314.5	Analyse the performance of synchronous machine	[AN]

Course Contents:

1. Equivalent circuit parameters of a single and three phase squirrel cage induction motors. (6)
2. V and Inverted V curves of Synchronous Machine. (3)
3. Regulation of Alternator.(6)
4. Separation of No load losses of three phase induction motor.(6)
5. Performance characteristics of alternator.(6)
6. Performance characteristics of single phase and three phase induction motors using Virtual Labs.(6)
7. Characteristics of Induction generator using simulation.(6)
8. Speed control of three phase induction motor using simulation.(6)

Total Hours : 45

Reference Books:

1 Fitzgerald A.E. Kingsly C., UmansS.D., 'Electrical Machinery' 7th edition, McGrawHill International Edition, New York, 2013.
2 Stephen J. Chapman, 'Electric Machinery Fundamentals', Tata McGraw Hill International Edition, New Delhi, 5th Edition, 2011.
3 D.P.Kothari, 'Electrical Machines.' 4th edition, Tata McGraw-Hill, NewDelhi 2010.

Web References:

1 http://www.electrical4u.com/characteristic-of-separately-excited-dc-generator/
2 http://www.academia.edu

Online Resources:

1 http://iitg.vlab.co.in/?sub=61&brch=168

Assessment Methods & Levels (based on Bloom'sTaxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	**Rubric based Continuous Assessment[60 marks] (in %)**	**End Semester Examination [40 marks] (in %)**
Remember	10	10
Understand	20	20
Apply	30	30
Analyse	40	40
Evaluate	0	0
Create	0	0

16EE315 CONTROL AND INSTRUMENTATION LABORATORY 0/0/3/2

Nature of Course :M (Practical application)
Co requisites :16EE308 Instrumentation Engineering
16EE312 Control Systems

Course Objectives:

1.To train the students to understand the Measuring Instruments

2. To identify the hardware and software that is needed in a basic control system.

3. To construct circuits, observe and analyse the behaviour of control system for various elementary applications.

Course Outcomes:

Upon completion of the course, students shall have ability to

C315.1	Remember the measurement of Power and Energy	[R]
C315.2	Understand the knowledge of Amplifiers, Converters and Measuring Instruments	[U]
C315.3	Determine the transfer function of DC Motor and DC Generator	[AP]
C315.4	Analyze the analog response of Type 0 and Type 1 Systems	[AN]
C315.5	Understand simulation software and its application in Control System	[E]

Course Contents:

1. Power and Energy Measurement (6)
2. Instrumentation amplifiers and A/D converters (6)
3. Transfer function of DC Machines (6)
4. Simulation of Type - 0 and Type – 1 system and controllers using simulation software tool (6)
5. DC and AC position control systems (3)
6. Simulation of Block diagram reduction techniques, first and Second order system for different test inputs (6)
7. Design of compensators using simulation software(6)
8. Speed control of Servo and Stepper motors using simulation software. (6)

Total Hours: 45

Reference Books:

1. Sawhney.A.K, "A course in Electrical and electronic Measurement and Instrumentation", Dhanpat Rai & Sons, New Delhi, 2008.
2. K. Ogata, 'Modern Control Engineering', 5th edition, PHI, New Delhi, 2011.
3. Norman S. Nise, 'Control Systems Engineering', 5th Edition, John Wiley, New Delhi, 2015.
4. I.J.Nagrath & M.Gopal, Control Systems Engineering', 5th Edition New Age International Publishers, 2013.

Web References:

1 http://nptel.ac.in/courses/108105064/
2 http://www.nptel.ac.in/courses/108101037/
3 http://www.iitk.ac.in/ee/data/Teaching_labs/Control_System/EE380_lab.pdf

Online Resources:

1 http://vlab.co.in/institute_detail.php?ins=003

Assessment Methods & Levels (based on Bloom'sTaxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	**Rubric based Continuous Assessment[60 marks] (in %)**	**End Semester Examination [40 marks] (in %)**
Remember	10	10
Understand	20	20
Apply	30	30
Analyse	30	20
Evaluate	10	20
Create	0	0

16EE316	RENEWABLE ENERGY SYSTEMS	3/0/0/3

Nature of Course: D (Theory Application)

Pre Requisites: 16PH101 Engineering Physics

Course Objectives:

1. To understand different non-conventional energy systems and its applications.
2. To advance student's knowledge and assimilate new technologies.
3. To perform simple techno-economical case studies of renewable energy systems.

Course Outcomes:

Upon completion of the course, students shall have ability to

CO316.1 Remember the concepts of Kyoto Protocol

CO316.2 Understand the energy scenario in India and Integrated Resource Plan

CO316.3 Understand the operation and application of Solar energy, Biomass, Wind energy and Tidal energy

CO316.4 Understand the operation and application of Geothermal energy and fuel cells

CO316.5 Understand the concepts of different energy storage methods

CO316.6 Apply ideas to perform case studies on renewable energy systems

Course Contents with Course Outcomes/Blooms Taxonomy/Assessment Methods

Energy Scenario: Energy scenario in India, Kyoto protocol, concept of clean development mechanism and prototype carbon funds, integrated resource plan **Solar Energy:** Solar thermal, solar photovoltaic, applications, maximum power point tracking**,** grid interactive solar PV systems **Wind Energy:** Site selection, wind energy conversion system, applications, maximum power operation, grid connected operations **Other Energy Sources:** Biomass energy, tidal energy, geothermal energy, fuel cells, applications. **Energy Storage and Case studies:** Storage methods of mechanical, chemical, electromagnetic, electrostatic and thermal energy, case studies on solar PV system, wind energy system and hybrid electric vehicles**.**

Total Hours	**45**

Text Books:

1. John Twidwell and Tony Weir, “Renewable Energy Resources”, 3rd Edition, Routledge, 2015.
2. Rai, G.D, “Non Conventional Energy Sources”, Khanna Publishers, 2010.

Reference Books:

1. Aldo Vieira Da Rosa, “Fundamentals of Renewable Energy Processes”, Academia Press, 2012.
2. B.H. Khan, “Non-Conventional Energy Resources”, 2nd Edition, Tata McGraw Hill, New Delhi, 2010.
3. G.N. Tiwari, “Solar Energy”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.

Web References:

1. http://nptel.ac.in/courses/108108078/
2. http://www.homepower.com/
3. http://unfccc.int/kyoto_protocol/items/2830.php
4. https://wbcarbonfinance.org/Router.cfm?Page=PCF&FID=9707&
5. http://www.pacificorp.com/es/irp.html
6. https://www.ashden.org/files/SKG%20full.pdf

Online Resources:

1. https://www.edx.org/course/sustainable-energy-design-renewable-delftx-energyx
2. https://www.coursera.org/learn/wind-energy
3. https://www.edx.org/course/solar-energy-delftx-et3034x-0

Assessment Methods & Levels (based on Blooms'Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C316.1	Remember	Quiz	**2**
C316.2	Understand	Class presentation	**4**
C316.3	Understand	Group Assignment	**4**
C316.4	Understand	Quiz	**4**
C316.5	Understand	Group Assignment	**2**
C316.6	Apply	Case study	**4**

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA1 [6 marks]	CIA2 [6 marks]	Term End Examination [8 marks]	
Remember	30	20	20	20
Understand	70	80	80	80
Apply	-	-	-	-
Analyse				
Evaluate	-	-	-	-
Create	-	-	-	-

16ES104	VIRTUAL INSTRUMENTATION	3/0/2/4

Nature of Course	: D (Theory and Laboratory application)
Pre requisites	: 16EE308-Instrumentation Engineering

Course Objectives:

1. To understand the Virtual instrumentation and to realize the architecture of VI.
2. To familiarize with the VI software and learn programming in VI.
3. To study various Instrument Interfacing and data acquisition methods.
4. To understand various analysis tools and develop programs for various applications.

Course Outcomes:

Upon completion of the course, students shall have ability to

Upon completion of the course, students shall have ability to

C104.1 Understand the Architecture and features of virtual Instrument.	[U]
C104.2 Understand the Mathematical operation available in LabVIEW.	[AP]
C104.3 Apply the application of Loops and Charts with Respect to LabVIEW application	[AP]
C104.4 Understand the working principle of PC based data Acquisition System.	[U]
C104.5 Understand the working principle of Communication Protocols	[U]
C104.6 Analyse the toolkits in LabVIEW and develop programs for various applications	[A]

Course Contents

Review of Virtual Instrumentation: Historical perspective – Need of VI – Advantages of VI – Define VI – Block diagram & Architecture of VI – Data flow techniques – Graphical programming in data flow – Comparison with conventional programming. **Programming Techniques:** VI's and sub-VI's – Loops and charts – Arrays – Clusters – Graphs – Case & sequence structures – Formula nodes – Local and global variable – String & file input**. Data Acquisition Basics**: Concept of PC based data acquisition – Typical on board DAQ card – Resolution and sampling frequency - Analog inputs and outputs – Use of timer-counter – Grounding: Differential and Single Ended. **Instrument Interfaces and Protocols**: Serial Communication Protocols: RS232, RS 422, RS 485 and USB standards - Parallel Communication Protocols: IEEE 488 standard – Introduction to bus protocols of MOD bus and CAN bus **Use of Analysis Tools and Application of VI:** Image acquisition cards - Control System Design Toolbox- PID controller Toolbox– Temperature data acquisition system – Web Publishing Tools

Lab Component

1	Verification of Arithmetic Operations, Half adder and Full adder	[U]
2	Implementation of For loop, While loop, Array and Cluster functions.	[A]
3	Implementation of Case, Sequence Structure and Formula Nodes	[E]
4	Program for controlling the speed of a DC motor using PID tool box	[E]
5	Program to control Temperature by using Thermocouple and DAQ	[E]
	Total Hours:	**75**

Text Books:

1. Jovitha Jerome, 'Virtual Instrumentation using LabVIEW', Prentice Hall, 2010.
2. Gary W. Johnson, Richard Jennings, "Lab-view Graphical Programming", Tata McGraw Hill Professional Publishing, IV Edition, 2006.

Reference Books:

1. Peter W. Gofton, 'Understanding Serial Communications', Sybex International ,1994 .
2. Gupta. S, Gupta. J.P, "PC Interfacing for Data Acquisition and Process Control", ISA, 1994.
3. Kevin James, 'PC Interfacing and Data Acquisition: Techniques for Measurement Instrumentation and Control', Newness, 2000.

Web References:

1. www.ni.com/academic/students/learn_labview
2. www.ni.com/academic/students/learn_ daq

Online Resources:

http://www.ni.com/webcast/2898/en/

Assessment Methods & Levels (based on Blooms' Taxonomy)					
Summative assessment based on Continuous and End Semester Examination					
Bloom's Level	**Continuous Assessment**				**End Semester Examination (Theory) [40 marks]**
	Theory			**Practical**	
	CIA-I [6 marks]	**CIA-II [6 marks]**	**Term End Examination [8 marks]**	**Rubric based CIA [40 Marks]**	
Remember	20	20	10	-	10
Understand	80	20	20	20	30
Apply	-	30	30	-	30
Analyse	-	30	40	30	30
Evaluate	-	-	-	50	-
Create	-	-	-	-	-

16EE317	POWER ELECTRONICS	4/0/0/4

Nature of Course:

Pre Requisites: 16EE301 Electron Devices

Course Objectives:

1. To learn about the characteristics of Power devices
2. To use power devices in rectifier circuits.
3. To study the operation of DC choppers.
4. To learn the PWM inverters
5. To study the operation of cycloconverter.

Course Outcomes

Upon completion of the course, students shall have ability to

C317.1	Remember the characteristics and the turn on methods of power devices.	[R]
C317.2	Understand the operation of rectifier circuits.	[U]
C317.3	Understand the working principle of DC choppers.	[U]
C317.4	Understand the operation of inverter circuits.	[U]
C317.5	Understand the working principle of AC-AC Converter.	[U]
C317.6	Apply the power devices in drives.	[AP]

Course Contents

Power Devices Static Characteristics and switching behaviour of different solid- state devices namely Power Diode, SCR, TRIAC, GTO, IGBT, MOSFET and IGCT. **Firing and Protection Circuit** firing circuit of SCR using UJT, Gate driver circuit of MOSFET & IGBT, Protection of SCR, Thermal analysis of MOSFET & IGBT. Two - transistor analogy of SCR, Series and Parallel operation of SCR. **Rectifiers** Classification of Rectifiers, Phase controlled rectifiers: Single phase half controlled rectifiers, Single phase half wave and full converter. Three phase half controlled rectifiers and full converter .Effect of source impedance on the performance of single phase controlled rectifiers. Dual Converters. **Choppers** Principles, classification, Time ratio control and current limit control, use. Resonant converter. **Inverters** Single phase and three phase inverters, constant voltage source and constant current source inverters, PWM inverters. **AC-AC Converters** Characteristics of DIAC & TRIAC, Frequency conversion: Single phase cycloconverter circuit, AC-AC Voltage Controller.

Application : D.C. and A.C. drives, S.M.P.S., Resonant converters, A.C. Line Filters, ratio, interference suppression.

Total Hours	**60**

Text Books:

1. M.H. Rashid, “Power Electronics circuits, devices and applications”, Pearson Education, Inc. Edition 2009.
2. M.D. Singh and K.B. Khanchandani, “Power Electronics” Tata McGraw-Hill, Edition 2008.
3. Ned Mohan, Tore M. Undeland & William P. Robbins, “Power Electronics – Converters, Applications and Design”, John Wiley & Sons edition 2009.
4. Vedam Subrahmanyam, “Power Electronics” John Wiley edition 2000.

Reference Books:

1. P.S. Bhimbra, “Power Electronics”, Khanna Publishers edition 2009.
5. P.C. Sen, “Power Electronics”, Tata McGraw-Hill, edition 2008.
2. Bimal K. Bose, “Modern Power Electronics & AC Drives”, Prentice Hall, edition 2002.

Web References:

1. http://nptel.ac.in/courses/108101038
2. http://freevideolectures.com/Course/2351/Power-Electronics

3. https://www.mooc-list.com/course/introduction-power-electronics-coursera
Online Resources: https://www.coursera.org/learn/power-electronics

Assessment Methods & Levels (based on Blooms'Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C317.1	Remember	Class room Quiz	**3**
C317.2	Understand	Online Quiz	**3**
C317.3	Understand	Class Presentation	**3**
C317.4	Understand	Class Presentation	**3**
C317.5	Understand	Group Assignment	**4**
C317.6	Apply	Group Assignment	**4**

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment**			**End Semester Examination**
	CIA1	**CIA2**	**Term End Assessment**	
Remember	20	10	10	10
Understand	50	50	50	50
Apply	30	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

16EE318	MICROPROCESSOR AND CONTROLLERS	4/0/0/4

Nature of Course: G (Theory)

Pre Requisites: 16EE307 Linear and digital integrated circuits

Course Objectives:

1. To create a strong foundation by studying the basics of Microprocessors and interfacing to various peripherals
2. To study Architecture of microcontroller like Intel 8051,PIC microcontroller and ARM.
3. To develop skill in simple applications development with programming 8085 & 8051
4. To introduce commonly used peripheral / interfacing

Course Outcomes

Upon completion of the course, students shall have ability to

C318.1 To understand and design Microprocessor based systems.

C318.2 To understand assembly language programming in Microprocessor and controllers

C318.3 To learn and understand concept of interfacing of peripheral devices and their applications

C318.4 To learn the microcontroller architecture and usages of the instruction set of the representative microcontrollers.

C318.5 To learn about PIC microcontroller and its architecture

Course Contents

MICROPROCESSOR: Basic functions of the microprocessor. **8086:**Introduction to 8086 – Microprocessor architecture – Addressing modes - Instruction set and assembler directives – Assembly language programming-Interrupt structure **INTERFACING:** Study on need, Architecture, configuration and interfacing with ICs: 8255, 8259, 8254, 8237, 8251, 8279 interfacing with 8086. **MICROCONTROLLER 8051:** Hardware Architecture, pinouts – Functional Building Blocks of Processor – Memory organization – I/O ports and data transfer concepts– Timing Diagram – Interrupts.-Applications Introduction to ARM processor and its features. **PIC MICROCONTROLLER:** CPU Architecture – Instruction set – Addressing modes - interrupts- Timers- I2C Interfacing – UART- A/D Converter –PWM and introduction to C-Compilers.

Total Hours	**60**

Text Books:

1. 1. Krishna Kant, “Microprocessor and Microcontrollers”, Eastern Company Edition, Prentice Hall of India, New Delhi , 2007.
2. 2. R.S. Gaonkar, ‘Microprocessor Architecture Programming and Application’, with 8085, Wiley Eastern Ltd., New Delhi, 2013.

Reference Books:

1. Soumitra Kumar Mandal, Microprocessor & Microcontroller Architecture, Programming & Interfacing using 8085,8086,8051,McGraw Hill Edu,2013.
2. Steve Furber, ‘’ ARM System –On –Chip architecture “Addision Wesley , 2000.
3. John .B.Peatman , “ Design with PIC Microcontroller , Prentice hall, 1997
4. Muhammad Ali Mazidi & Janice Gilli Mazidi, R.D.Kinely ‘The 8051 Micro Controller and Embedded Systems’, PHI Pearson Education, 5th Indian reprint, 2003.

Web References:

1. http://www.electrical4u.com/
2. http://www.technologystudent.com/

Assessment Methods & Levels (based on Blooms'Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C318.1	Remember	Class room Quiz	**3**
C318.2	Understand	Technical Quiz	**2**
C318.3	Understand	Class Presentation	**5**
C318.4	Understand	Group Assignment	**5**
C318.5	Apply	Group Assignment	**5**

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment**			**End Semester Examination**
	CIA1	**CIA2**	**Term End Assessment**	
Remember	20	0	10	10
Understand	30	20	20	10
Apply	50	40	40	40
Analyse	0	40	30	40
Evaluate	-	-	-	-
Create	-	-	-	-

16EE319	POWER ELECTRONICS LABORATORY	0/0/3/2

Nature of Course: M (Practical application)

Co Requisites:16EE301 Electron Devices and Circuits

Course Objectives:

To provide an opportunity to under the operation, function and interaction between various components and to impart the knowledge in design, modelling and simulation of Power Electronic Converter based systems

Course Outcomes

Upon completion of the course, students shall have ability to

C319.1 Examine the working and characteristics of transistor & thyristor. [U]
C319.2 Study the working operation of single phase converter. [U]
C319.3 Examine the working of Chopper. [U]
C319.4 Observe the working operation of Three phase AC voltage controller. [U]
C319.5 Study of single phase Cyclo-converter. [U]
C319.6 Evaluate power electronic circuits using software. [E]

Course Contents

1. VI characteristics of SCR & TRIAC.
2. VI characteristics of POWER MOSFET & IGBT.
3. Switching characteristics of SCR and IGBT.
4. Single-phase half and fully controlled Rectifiers.
5. A) Design a buck converter & boost converter circuit using power MOSFET.

   B) Single & Four quadrant chopper.
6. Single phase IGBT based Inverter.
7. ZVS and ZCS converter.
8. Three-phase AC voltage controllers.
9. Single-phase cycloconverter.
10. Simulation of Power Electronic circuits.

Total Hours	45

Reference Books:

1. M.H. Rashid, “Power Electronics circuits, devices and applications”, Pearson Education, Inc. Edition 2009.
2. M.D. Singh and K.B. Khanchandani, “Power Electronics” Tata McGraw-Hill, Edition 2008.
3. Ned Mohan, Tore M. Undeland & William P. Robbins, “Power Electronics – Converters, Applications and Design”, John Wiley & Sons edition 2009.
4. Vedam Subrahmanyam, “Power Electronics” John Wiley edition 2000.
5. P.S. Bhimbra, “Power Electronics”, Khanna Publishers edition 2009.
6. P.C. Sen, “Power Electronics”, Tata McGraw-Hill, edition 2008.
7. Bimal K. Bose, “Modern Power Electronics & AC Drives”, Prentice Hall, edition

Web References:

1. http://nptel.ac.in/courses/108101038
2. http://freevideolectures.com/Course/2351/Power-Electronics

Online Resources:

https://www.coursera.org/learn/power-electronics

Assessment Methods & Levels (based on Bloom'sTaxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	**Rubric based Continuous Assessment[60 marks] (in %)**	**End Semester Examination [40 marks] (in %)**
Remember	-	-
Understand	40	40
Apply	20	20
Analyse	30	30
Evaluate	10	10
Create	-	-

16EE320	MICROPROCESSOR AND CONTROLLERS LABORATORY	0/0/3/2

PREREQUISITES: 16EE310 Linear and Digital integrated circuits laboratory

1.To provide solid foundation on interfacing the external devices to the processor according to the user requirements to create novel products and solutions for the real time problems.

COURSE OUTCOMES

Upon successful completion of the course, students shall have ability to

C320.1 To Learn an ALP in 8086 and its interfacing circuits.

C320.2 To Write an ALP in 8051 for parallel ports and timers.

C320.3 To Develop an ability in designing a microprocessor and microcontroller s ystems

C320.4 To familiarize with the assembly level programming

LIST OF EXPERIMENTS

1. Simple arithmetic operations: addition / subtraction / multiplication / division using 8086
2. Programming with control instructions using 8086
   (i) Ascending / Descending order, Maximum / Minimum of numbers (ii) Programs using Rotate instructions (iii) Hex / ASCII / BCD code conversions.
3. Interface Experiments using 8086 A/D Interfacing and D/A Interfacing.
4. Interface Experiments using 8086/8051
   Simple experiments using 8251, 8279, 8254.
5. Demonstration of basic instructions with 8051 Micro controller execution, including:
   Conditional jumps, looping, Calling subroutines, Stack parameter testing
6. Parallel port programming with 8051 using port 1 facility:
   Stepper motor interfacing
7. Simple arithmetic operations like addition, subtraction, multiplication and division using PIC Microcontroller.
8. Interfacing experiments with PIC microcontroller
9. Mini project development with processors.
10. Programming Practices with Simulators/Emulators/open source

REFERENCES BOOKS

1.Soumitra Kumar Mandal, Microprocessor & Microcontroller Architecture, Programming& Interfacing using 8085,8086,8051,McGraw Hill Edu,2013.

2. Steve Furber, '' ARM System –On –Chip architecture "Addision Wesley , 2000.

3. John .B.Peatman , " Design with PIC Microcontroller , Prentice hall, 1997

WEB REFERENCE.

1. http://www.electrical4u.com/
2. http://www.technologystudent.com/

Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	**Rubric based Continuous Assessment[60 marks] (in %)**	**End Semester Examination [40 marks] (in %)**
Remember	-	-
Understand	40	40
Apply	20	20
Analyse	30	30
Evaluate	10	10
Create	-	-

16EE 321	POWER SYTEM ANALYSIS	4/0/0/4
Nature of Course	G (Theory analytical)	
Pre requisites	Generation, Transmission and Distribution	

Course Objectives:

1	To Understand the Power system concepts and its components.
2	To model and Use numerical methods to analyse a power system in steady state and on fault conditions.
3	To study and analyse the stability concepts of power systems.

Course Outcomes:
Upon completion of the course, students shall have ability to

C321.1	Understand basic components in a power system and perform a per phase analysis of generator and transformer model.	[U]
C321.2	Form the bus admittance and impedance matrix.	[AP]
C321.3	Perform load flow computations and analyze the load flow results.	[A]
C321.4	Analyze both symmetrical and unsymmetrical conditions in power systems	[A]
C321.5	Understand power system stability concepts.	[U]

Course Contents:

System Representation: Single line representation, review of per unit calculations. **Formation of Network Matrices:** Formation of admittance matrix with and without mutual impedances, Zbus building algorithm without mutual impedances and Zbus building algorithm with mutual impedances. **Load Flow Analysis:** Formation of static load flow equations, solution of load flow problem by Gauss-Seidel, Newton-Raphson(polar and rectangular) and fast decoupled techniques Computational issues in large scale power systems. **Short Circuit Analysis:** Review of symmetrical components, sequence networks, fault calculations for balanced fault using ZBUS and unbalanced faults. **Power System Stability:** Swing equation, power angle equation, synchronizing power coefficient, basic concepts of steady state, dynamic and transient stability, equal area criterion, solution of the swing equation, multi-machine, Basic Concepts of voltage Stability Analysis.

Total Hours:	**60**

Text Books:

1	J.J. Grainger & W.D.Stevenson, “Power system analysis ”, McGraw Hill ,2012
2	Kothari D. P. and Nagrath I. J., “Modern Power System Analysis”,3rdEd., Tata McGraw-Hill Publishing Company Limited.2011
3	Pai M. A., “Computer Techniques in Power System Analysis”, 2nd Ed., Tata McGraw-Hill Publishing Company Limited. 2010

Reference Books:

1	Hadi Sadaat,”Power System Analysis”, Tata Mcgraw -hill Education 2012
2	Prabha Kundur.,“Power System Stability and Control”5th Ed., Tata McGraw-Hill Publishing Company Limited 2010

Web References:

1	http://nptel.ac.in/courses/108105067/
2	https://cosmolearning.org/courses/power-system-analysis-304/video-lectures/

Assessment Methods & Levels (based on Blooms 'Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C321.1	Understand	Quiz	**5**
C321.2	Apply	Assignment	**3**
C321.3	Analyse	Group Assignment	**3**
C321.4	Analyse	Simulation Exercise	**5**
C321.5	Understand	Case study	**4**

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	**Continuous Assessment**			**End Semester Examination [60 marks]**
	CIA1 [6 marks]	**CIA2 [6 marks]**	**Term End Examination [8 marks]**	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	40	30	30	30
Analyse	10	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

16EE322	Digital Signal Processing and its Application	4/0/0/4

Nature of Course	: G (Theory Analytical)
Course Pre-requisites	Transforms and Fourier Analysis

Course Objectives:

1	To study and analyze various signals & systems and their mathematical operations.
2	To analyze discrete time and continuous time systems.
3	To design analog and digital filters for signal processing applications.
4	To learn about programmable digital signal processor and multirate signal processing.

Course Outcomes:

Upon completion of the course, students shall have ability to

C322.1	Understand various concepts of Signals and Systems	[U]
C322.2	Analyze the mathematical operations on signals and systems	[A]
C322.3	Apply various Transform techniques	[AP]
C322.4	Analyze Discrete Fourier Transforms and its applications	[A]
C322.5	Design IIR and FIR filter for filtering applications	[AP]
C322.6	Understand programmable digital signal processor and multi-rate signal processing	[U]

Course Contents:

Signals & Systems: Signals & systems, LTI System, Convolution and correlation, Basic block diagram of DSP, Applications of DSP. **Transformation Techniques:** Z Transform – properties, ROC, Inverse z transforms, Discrete Fourier Transforms- properties - Circular Convolution – Fast Fourier Transform algorithms – Decimation In Time Algorithm & Decimation In Frequency Algorithm, Relation between DFT and DTFT. **Design of Digital Filters and Architecture of DSP:** Finite Impulse Response filter – Linear Phase FIR filters – design of FIR filters using windowing technique – Rectangular, Hamming, Hanning windows, Frequency sampling technique, IIR design: Analog filter design - Butterworth and Chebyshev approximations; digital design using impulse invariant and bilinear transformation - **Architecture of DSP** - Von Neumann and Harvard architecture- Architecture and features of TMS 320C55xx DSP processor- Introduction to multi-rate Signal Processing.

Total Hours:	**60**

Text Books:

1	J.G. Proakis and D.G. Manolakis, 'Digital Signal Processing Principles, Algorithms and Applications', Pearson Education, New Delhi, 4th edition, 2007.
2	A.Nagoorkanni, 'Digital Signal Processing', Tata McGraw Hill, New Delhi,2012
3	S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill, 2011.

Reference Books:

1	A.V. Oppenheim and R. W. Schafer, "Discrete Time Signal Processing", Prentice Hall, 2011
2	Salivahanan, A. Vallavaraj, C. Gnanapriya, 'Digital Signal Processing', Tata McGraw Hill,New Delhi, 2011.

3	Vinay K. Ingle and J.G. Proakis, 'Digital Signal Processing Using MATLAB', 3rd Edition', Pearson Education ,2010.
Web References:	
1	http://nptel.ac.in/courses/117102060/
2	http://nptel.ac.in/courses/108105055/
3	https://www.tutorialspoint.com/digital_signal_processing/
4	https://www.dspguide.com/ch28/3.htm
5	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-341-discrete-time-signal-processing-fall-2005/

Assessment Methods & Levels (based on Blooms'Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C322.1	Understand	Online Quiz	**2**
C322.2	Analyse	Problem solving Assignment	**4**
C322.3	Apply	Online Group Assignment	**4**
C322.4	Analyse	Class presentation	**4**
C322.5	Apply	Online Quiz	**2**
C322.6	Understand	Case study	**4**

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA1 [6 marks]	CIA2 [6 marks]	Term End Examination [8 marks]	
Remember	20	20	20	20
Understand	70	30	30	30
Apply	-	30	30	30
Analyse	10	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

16EE323	PRINCIPLES OF EMBEDDED SYSTEMS	3/0/2/4
Nature of Course	D (Theory application)	
Pre requisites	Microprocessor and controllers	

Course Objectives:

1	Introduce the students to functional building blocks of embedded systems.
2	To provide sufficient knowledge to understand the embedded systems design and interfacing between processors & peripheral device.
3	To enable coding of effective Embedded C programs on any dedicated processor.
4	Familiarize with the concepts of Real time operating systems and choice for specific application.
5	To make the students understand how real-world embedded devices integrate hardware and software.

Course Outcomes:
Upon completion of the course, students shall have ability to

C323.1	Understand the basics of embedded system building blocks, Processor and memory Organization	[U]
C323.2	Comprehend the selection of Processors and various techniques of memory Organization.	[U]
C323.3	Analyse the architecture and functioning of network devices, I/O Programming and Schedule Mechanism.	[A]
C323.4	Apply the RTOS concepts in suitable applications.	[AP]
C323.5	Code and simulate programs for peripheral interface experiments.	[C]

Course Contents:

INTRODUCTION TO EMBEDDED SYSTEM : Introduction to functional building blocks of embedded systems – Register, memory devices, ports, timer, interrupt controllers using block diagram representation for each categories. **PROCESSOR AND MEMORY ORGANIZATION :** Structural units in a processor; selection of processor & memory devices; shared memory; DMA; interfacing processor, memory and I/O units; memory management – Cache mapping techniques, dynamic allocation - Fragmentation. Case study**:** Required Memory devices for a Digital Camera and Voice recorder. **DEVICES & BUSES FOR DEVICES NETWORK** : I/O devices; timer & counting devices; serial communication using I^2C,SPI, CAN, USB buses; parallel communication using ISA, PCI, PCI/X buses, arm bus; interfacing with devices/ports, Introduction to device drivers in a system. **I/O PROGRAMMING AND SCHEDULE MECHANISM :** Intel I/O instruction – Transfer rate, latency; interrupt driven I/O - Non-maskable interrupts; software interrupts, writing interrupt service routine in C & assembly languages; preventing interrupt overrun; disability interrupts. Case study**:** Automatic Washing machine, Chocolate vending machine. **REAL TIME OPERATING SYSTEM (RTOS)**: Introduction to basic concepts of RTOS, Interrupt handling in RTOS, Scheduling – Tasks and Threads. Multi threaded programming – premature & non-premature multitasking, context switching, Scheduling Algorithms - round robin scheduling, priority based scheduling, assigning priorities, Rate monotonic algorithm - earliest deadline algorithm –Allocation and scheduling, semaphores, deadlock, watch dog timers. Embedded system design issues in system development process – Action plan ,use of target system, emulator, use of software tools. Design Example: Elevator Controller. Introduction to IDE. Selection of operating systems for commercial applications-LINUX

List of Experiments

1. Study of RIDE using 8051
2. LED Blinking and switch using 8051
3. Interfacing LCD with 8051
4. Seven Segment Display using 8051

5. Interfacing ADC with 8051
6. Interfacing DAC with 8051
7. Elevator Interfacing using 8051
8. Temperature Sensing using 8051
9. Real time Clock monitoring using 8051
10. Study of KEIL using 8051

Total Hours:	**75**

Text Books:

1	P. Rajkamal, 'Embedded System – Architecture, Programming, Design', Tata McGraw Hill, 2014.
2	Daniel W. Lewis, 'Fundamentals of Embedded Software', Prentice Hall of India, 2013.
3	Wayne Wolf, "Computers as Components: Principles of Embedded Computer System Design", Elsevier, 2011

Reference Books:

1	David E. Simon, 'An Embedded Software Primer', Pearson Education, 2004.
2	Frank Vahid, 'Embedded System Design–A Unified Hardware & Software Introduction', John Wiley, 2002.
3	Sriram V. Iyer, Pankaj Gupta, 'Embedded Real Time Systems Programming', Tata McGraw Hill, 2004.

Web References:

1	https://www.embedded.com
2	https://www.ni.com/EmbeddedSystems/Reduce_Cost
3	https://www.nptelvideos.in/2012/11/embedded-systems.htm
	https://www.coursera.org/learn/embedded-operating-system

Assessment Methods & Levels (based on Blooms 'Taxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	**Continuous Assessment**				**End Semester Examination (Theory) [40 marks]**
	Theory			**Practical**	
	CIA1 [6 marks]	**CIA2 [6 marks]**	**Term End Assessment [8 marks]**	**Rubric based CIA [40 Marks]**	
Remember	20	10	10	-	20
Understand	50	50	50	40	30
Apply	30	40	40	30	30
Analyse	0	0	0	30	20
Evaluate	0	0	0	0	0
Create	0	0	0	0	0

16EE324	Simulation Laboratory - I	0/0/3/2
Nature of Course	M (Practical application)	
Co requisites	Power System Analysis	
Course Objectives:		
	To simulate and to analyze the power system network	
Course Outcomes: **Upon completion of the course, students shall have ability to**		
C324.1	Determine the parameters of the Power System Network.	[E]
C324.2	Analyse the power network with the different load flow methods.	[A]
C324.3	Evaluate the short circuit current values of the given power system network for different fault conditions.	[E]
C324.4	Analyze the load frequency control of various network systems.	[A]
C324.5	Perform optimal dispatch scheduling for the given power networks.	[A]
Course Contents:		
1. Determination of voltage and power at the sending end, voltage regulation and analyse its performance using medium nominal Pi method.		
2. Determination of voltage and power at the sending end, voltage regulation and analyse its performance using medium nominal T method.		
3. Load flow solution using Gauss-Seidel Method.		
4. Load flow solution using Newton-Raphson method in Rectangular Coordinates.		
5. Economic Load Scheduling of generators neglecting losses		
6. Economic Load Scheduling of generators considering losses		
7. Unsymmetrical Fault Analysis.		
8. Short Circuit Analysis of IEEE 14 bus system		
9. Load Frequency control of a single area system with and without PI controller.		
10.Load Frequency control of a tie line area network		
	Total Hours :	**45**
Reference Books:		
1	D.P Kothari and I.J. Nagrath, “Modern Power System Analysis”, Tata McGraw-Hill Education Pvt. Ltd, 4th Edition, 2011	
2	B.R.Gupta, “ Power System Analysis and Design”, S.ChandPvt.Ltd, 2005	
3	Hadi Saadat., “Power System Analysis” Tata McGraw-Hill PublishingCompany Limited.2008	
Web References:		
1	http://www.power-analysis.com	
2	http://www.4shared.com/power system analysis	
3	http://iitm.vlab.co.in/?sub=46&brch=144	
4	http://nptel.ac.in/courses/108104051	

Assessment Methods & Levels (based on Bloom'sTaxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	**Rubric based Continuous Assessment[60 marks] (in %)**	**End Semester Examination [40 marks] (in %)**
Remember	-	-
Understand	-	-
Apply	20	20
Analyse	20	20
Evaluate	20	20
Create	-	-

16EE325	POWER SYSTEM PROTECTION & SWITCHGEAR	3/0/0/3
Nature of Course	D (Theory application)	
Course Pre Requisites:	Generation, Transmission and Distribution, Power System Analysis	

Course Objectives:

1. To learn the fundamentals of protective equipments used in power systems
2. To give a broad coverage on types of protective relays
3. To study about the theory of arching and various circuit breakers.
4. To provide a strong background for working in a practical power system protection.

Course Outcomes

Upon completion of the course, students shall have ability to

C325.1	Identify the transient behaviours in power system and to apply necessary protection.	[U]
C325.2	Classify the working of various relaying scheme.	[U]
C325.3	Implement an appropriate relaying scheme for different power apparatus.	[AP]
C325.4	Exemplify the function of various CBs and related switching issues.	[AP]
C325.5	Identify the causes of overvoltage and protection against overvoltage.	[U]

Course Contents

Protection: Fundamentals of protection and switchgear in Power systems. Relays – General classification, Principle of operation, types and applications, characteristics, Torque equation, Relaying Schemes, Relay Co-ordination. **Apparatus and line protection** – Line Protection – Distance, Differential protection and Carrier current protection. Generator protection – protection against abnormal condition, stator and rotor protection. Transformer Protection – Incipient fault – Differential protection, Feeder and Bus bar protection. **Protection against over voltages** – Causes of over voltage, Ground wires, Surge absorbers and diverters. , Fault clearing process, Theory of arcing and arc quenching. **Circuit breakers** – types– rating and comparison, RRRV, current chopping, interruption of capacitive current, Resistor switching. Introduction to Static relays, Digital relays, Microprocessor based relays- Outline of miniature circuit breakers and Moulded case circuit breakers.

Total Hours	**60**

Text Books:

1	Badri Ram, Vishwakarma “Power System Protection and Switchgear” Tata McGraw Hill, 2011
2	B. Ravindranath, and N. Chander, ‘Power System Protection & Switchgear’, New Age Publishers, 2010

Reference Books:

1	Y.G Paithangar, “Fundamentals of Power System Protection” PHI learning Pvt Ltd, 2nd edition ,2010
2	C.L. Wadhwa, ‘Electrical Power Systems’, New Age International (P) Ltd., 2017.

Web References:

1	http://nptel.ac.in/downloads/108101039/
2	http://nptel.ac.in/courses/108101039/3
3	http://nptel.ac.in/courses/Webcourse contents/IIT%20Bombay/Power%20System%20Protection/TOC_M1.html
4	http://www.idc-online.ac.za/electrical-engineering/electrical-power-system- protection.html

Assessment Methods & Levels (based on Blooms'Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C325.1& C325.2	Understand	Group Assignment	**5**
C325.3	Apply	Online Quiz	**5**
C325.4	Understand	Field study	**6**
C325.5	Understand	Class Presentation	**4**

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment**			**End Semester Examination (60 Marks)**
	CIA1 (6 Marks)	**CIA2 (6 Marks)**	**Term End Assessment (8 Marks)**	
Remember	-	-	-	-
Understand	50	50	50	50
Apply	50	50	50	50
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

16EE326	ELECTRIC DRIVES AND CONTROL	3/0/2/4

Nature of Course: D (Theory application)

Pre Requisites: Electrical Machines – I, 16 Electrical Machines – II, Power electronics

Course Objectives:

1. To understand the basic concepts and various control techniques involved with DC and AC Drives.
2. To study and analyze the operation of the converter / chopper fed dc drive and to solve simple problems.
3. To study and understand the operation of both classical and modern induction motor drives.

Course Outcomes

Upon completion of the course, students shall have ability to

C326.1 Understand the concept, application fields and development trend of Power Drivers System. [U]

C326.2 Learn characteristics and control of solid state DC motors drives [R]

C326.3 Understand the stable steady state operation and transient dynamics of motor-load system. [U]

C326.4 Understand characteristics and control of induction motor drives & Synchronous motor drives [U]

C326.5 Apply digital control techniques in AC and DC drives [AP]

C326.6 Analyze the converter fed motor under different torque/speed conditions. [A]

Course Contents

Drive characteristics: Equations governing motor load dynamics - Equilibrium operating point and its steady state stability -Mathematical condition for steady state stability - Multi quadrant dynamics in the speed torque plane -Basics of braking –Dynamic braking-Plugging-Regenerative braking Typical load torque characteristics -Acceleration, deceleration, starting and stopping. **Dc motor drives:** Steady state analysis of single, two and four quadrant converter fed D.C motor drive: Continuous and discontinuous conduction mode - Chopper fed D.C drive: Time ratio control and current limit control - Operation of four quadrant chopper. **Induction motor drives:** Stator voltage control - Slip-power recovery drives - Adjustable frequency drives: v/f control, constant slip-speed control and constant air-gap flux control – Basics of voltage/current fed inverters – Block diagram of closed loop drive. **Synchronous motor drives:** Open loop volts/hertz control and self-control of synchronous motor: Marginal angle control and power factor control - Permanent magnet synchronous motor. Applications of Adjustable Speed Drives (ASDs) in Industries and in Electric Utility Power Plants. Harmonic Analysis in ASDs. **Digital control and drive applications:** Digital techniques in speed control - Advantages and limitations - Microprocessor/Microcontroller and PLC based control of drives, networking of drives - Selection of drives and control schemes for Steel rolling mills, Paper mills, Cement mills, Machine tools, Lifts and Cranes. Solar and battery powered drives.

List of Experiments

1. Speed control DC motor using three phase rectifier

2. Speed control of three phase induction motor using PWM inverter

3. Speed control of chopper fed DC motor

4. Simulation of closed loop control of converter fed DC motor

5. Simulation of closed loop control of three phase synchronous motor

6. FPGA/DSP based motor control

7. DSP based motor control

8. Simulation of closed loop control of chopper fed DC motor.

9. Simulation of three-phase synchronous motor drive.

10. PLC based drives.

Total Hours	**75**

Text Books:

1. R. Krishnan, Electric Motor & Drives: Modeling, Analysis and Control', Prentice Hall of India, New Delhi, 2011.
2. Gopal.K.Dubey, Fundamentals of Electrical Drives', Narosa Publishing House, New Delhi, 2012.

Reference Books:

1. Bimal K. Bose. Modern Power Electronics and AC Drives', Pearson Education, 2015.
2. S.K. Pillai, A First Course on Electrical Drives', Wiley Eastern Limited, 2015.
3. Vedam Subramanyam, Electric Drives: Concepts and Applications, Tata McGraw Hill Ltd, New Delhi, 2014.
4. Shaahin Filizadeh, Electric Machines and Drives: Principles, Control, Modeling, and Simulation, CRC Press LLC, New York, 2013

Web References:

1. http://en.wikipedia.org/wiki/Industrial drives Control
2. http://en.wikibooks.org/wiki/Drives
3. http://en.wikipedia.org/wiki/Electric motors
4. https://www.coursera.org/learn/electronics

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment				End Semester Examination (Theory) [40 marks]
	Theory			Practical	
	CIA1 [6 marks]	CIA2 [6 marks]	Term End Assessment [8 marks]	Rubric based CIA [40 Marks]	
Remember	20	10	10	-	20
Understand	50	50	50	40	30
Apply	30	40	40	30	30
Analyse	0	0	0	30	20
Evaluate	0	0	0	0	0
Create	0	0	0	0	0

16EE327	PROTOTYPE MODULE LABORATORY	0/0/3/2

Nature of Course: P (Practical)

Co Requisites: Electronic Circuits Laboratory, Power Electronics Laboratory

Course Objectives:

To expose the students to design and fabricate simple electrical modules

Course Outcomes

Upon completion of the course, students shall have ability to

C327.1	Understand and design the basic electrical circuits	[U]
C327.2	Examine the working and characteristics of low pass and high pass filter.	[U]
C327.3	Apply the Microprocessor and microcontroller concept to electrical drives.	[AP]

Course Contents

1. Design and fabrication of bipolar ± 5V constant voltage power supply.
2. Design and fabrication of bipolar ± (0-12 V), 1A variable power supply.
3. Design and fabrication of higher order active Butterworth low pass filter module.
4. Design and fabrication of higher order active Chebyshev high pass filter module.
5. Design and fabrication of domestic ups.
6. Realization of driver circuit to drive an Electromagnetic relay using Microprocessor with required protection.
7. Realization of an isolation circuit using Opto coupler which is required for microcontroller interfacing.

Total Hours	45

Reference Books:

1. Mahmood Nahvi, Joseph Edminister, “Schaum’s Outline of Electric Circuits”, McGraw Hill Education, 6th Edition, 2014.
2. Sudhakar and Shyammohan S Pillai, “Circuits and Networks”, Tata McGraw Hill, New Delhi, 4th edition, 2010.

Web References:

1. http://www.electrical4u.com/circuit-analysis.htm
2. http://www.technologystudent.com
3. https://www.coursera.org/learn/power-electronics

Assessment Methods & Levels (based on Bloom’s Taxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Rubric based Continuous Assessment[60 marks] (in %)	End Semester Examination [40 marks] (in %)
Remember	-	-
Understand	40	40
Apply	20	20
Analyse	30	30
Evaluate	10	10
Create	-	-

16EE328	Simulation Laboratory - II	0/0/3/2

Nature of Course: P (Practical)

Co Requisites: Power System Analysis

Course Objectives:

To design, to simulate and to analyze the power system network

Course Outcomes

Upon completion of the course, students shall have ability to

C328.1	Understand and execute the basic commands in MATLAB	[U]
C328.2	Write the coding to simulate the various types of network in power system	[U]
C328.3	Apply the concepts of optimum loading conditions to various power generation systems	[AP]
C328.4	Analyze the conditions for designing the equations for the power system network.	[A]
C328.5	Analyze the various frequency control of network systems	[A]
C328.6	Evaluate the transient stability analysis of various network systems	[E]

Course Contents

1. Introduction To Matlab And Its Basic Commands
2. Matlab Program To Simulate Ferranti Effect
3. Matlab Program To Model Transmission Lines
4. Matlab Program To Solve Load Flow Equations By Gauss-Seidel Method
5. Matlab Program To Find Optimum Loading Of Generators Neglecting Transmission Losses
6. Matlab Program To Find Optimum Loading Of Generators With Penalty Factors
7. Matlab Program To Solve Swing Equation Using Point-By-Point Method
8. Simulink Model of Single Area Load Frequency Control with and without PI Controller And Without PI Controller In Simulink.
9. Simulink Model For Two Area Load Frequency Control
10. Simulink Model For Evaluating Transient Stability Of Single Machine Connected To Infinite Bus

Total Hours	**45**

Reference Books:

1. John J Grainger and William D Stevenson J, “Power System Analysis “ McGraw-Hill, Edition 2003.
2. J.B.Gupta, “A Course in Power Systems” S.K. Kataria & Sons, 2013

Web References:

1. www.power-analysis.com
2. www.4shared.com/power system analysis
3. http://as.wiley.com/WileyCDA/Section/id-815373.html

Assessment Methods & Levels (based on Bloom's Taxonomy)		
Summative assessment based on Continuous and End Semester Examination		
Bloom's Level	**Rubric based Continuous Assessment[60 marks] (in %)**	**End Semester Examination [40 marks] (in %)**
Remember	-	-
Understand	40	40
Apply	20	20
Analyse	30	30
Evaluate	10	10
Create	-	-

16EE401	Smart Grid Technology	3/0/0/3
Nature of Course	D (Theory application)	
Pre requisites	**Generation, Transmission and Distribution**	

Course Objectives:

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

1	Need, benefit and function of smart grid and its international view.
2	Smart Grid technologies and energy efficient alternatives
3	Smart Grid technologies, different smart meters and advanced metering infrastructure.
4	The power quality management issues in Smart Grid.
5	The high performance computing for Smart Grid applications

Course Outcomes:

Upon completion of the course, students shall have ability to

C401.1	Understand the need, benefit and function of smart grid	[U]
C401.2	Apply Smart Grid technologies and energy efficient alternatives	[AP]
C401.3	Analyse the issues on power quality management using smart meters	[A]
C401.4	Identify the high performance computing system in Smart Grid applications	[R]

Course Contents:

Introduction-Introduction to smart grid-, Difference between conventional grid & smart grid, Concept of Resilient & Self-Healing Grid, Need, Benefits and functions of Smart Grid, opportunities and challenges of smart grid Electricity. Electricity network-Local energy networks- Electric transportation- Low carbon central generation-Attributes of the smart grid- Alternate views of a smart grid. . National and International Initiatives in Smart Grid. Case study on Smart Grid Initiative for Power Distribution Utility in India. **Smart Grid Technologies (Transmission and Distribution)** Transmission**-** Smart energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring. Distribution **-**DMS, Volt/VAr control, Fault Detection, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers. Plugin Hybrid Electric Vehicles (PHEV). **Efficient Electric End – Use technology alternatives** - Existing technologies – lighting - Space conditioning - Indoor air quality. **Smart Grid components and Power quality management-**Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, Phasor Measurement Unit (PMU), Intelligent Electronic Devices(IED) & their applications for monitoring & protection. Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources; Power Quality Conditioners for Smart Grid, Web based Power Quality Monitoring, Power Quality Audit. Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL). Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid. **Security and Privacy:** Cyber Security Challenges in Smart Grid, Defense Mechanism, Privacy Challenges.

Total Hours:	**45**

Text Books:

1	Janaka Ekanayake, Kithsiri Liyanage, Jianzhong.Wu, AkihikoYokoyama, Nick Jenkins, “Smart Grid: Technology and Applications”- Wiley, 2012
2	James Momoh, “Smart Grid: Fundamentals of Design and Analysis”-Wiley, IEEE Press, 2012.
3	Clark W Gellings, “The Smart Grid, Enabling Energy Efficiency and Demand Side Response”- CRC Press, 2009. Wiley, 2012.

Reference Books:	
1	1. Smart Grid Applications, Communications, and Security. Lars T. Berger, Krzysztof Iniewski, ISBN: 978-1-118-00439-5.
2	E. Smart Grid Handbook, 3 volume Set Chen-Ching Liu, Stephen McArthur, Seung-Jae LeeJohn Wiley & Sons, 1 Aug 2016 - Science - 1900 pages.
3	Salman K. Salman "Introduction to the Smart Grid: Concepts, Technologies and Evolution" 2017, ISBN: 978-1-78561-119-3.
Web References:	
1	http://whatis.techtarget.com/reference/Smart-Grid-Technology-Overview
2	https://www.nist.gov/engineering-laboratory/smart-grid
3	http://www.nsgm.gov.in/en/nsgm
4	https://www.edx.org/course/smart-grids-electricity-future-ieeex-smartgrid-x-0
5	http://theinstitute.ieee.org/ieee-roundup/blogs/blog/free-online-course-covers-the-future-of-smart-grids
6	https://onlinecourses.nptel.ac.in/noc18_ee42

Assessment Methods & Levels (based on Blooms 'Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C401.1	Understand	Assignments	**5**
C401.2	Apply	Technical Online Quiz	**5**
C401.3	Analyse	Class Presentation	**5**
C401.4	Remember	Tutorials	**5**

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA1 [6 marks]	CIA2 [6 marks]	Term End Examination [8 marks]	
Remember	20	20	10	10
Understand	60	60	70	60
Apply	10	10	10	20
Analyse	10	10	10	10
Evaluate	-	-	-	-
Create	-	-	-	-

16EE402	Energy Management	3/0/0/3

Nature of Course : G (Theory)

Course Objectives:

1	To introduce about Energy Management Systems (EMS).
2	To enable the students to understand the scope for energy saving in residential sector, industries and commercial establishments.
3	To analyze the concepts of New technologies and new products are coming up in the market, for energy saving.
4	To learn the Knowledge of thermodynamic principles, usage of thermal insulation in buildings, lighting devices and new electric motor.
5	To realize energy conservation is better way to meet demand in short span of time rather than constructing new power plant.

Course Outcomes:

Upon completion of the course, students shall have ability to

C402.1	Understand Energy scenario and conservation	[U]
C402.2	Analyze the different energy consuming systems and energy auditing.	[AN]
C402.3	Remember the energy management approach	[R]
C402.4	Apply the energy management scheme for different applications.	[AP]
C402.5	Analyze the control of boiler and furnace	[AN]

Course Contents:

Energy Scenario and Conservation: Energy Scenario - Energy conservation and its importance- Energy Conservation Act-2001 and its features. Economics of various Energy Conservation schemes- -Case studies-Energy conservation in Centrifugal pumps, Fans &Blowers, Air compressor- -Design consideration Refrigeration Air conditioning. **Energy Systems, Management and Auditing:** Illumination – Lux, Lumens, Types Of Lighting, Efficiency, LED Lighting-– Heat load estimation - Energy conservation in cooling towers & spray ponds-Energy monitoring, auditing & targeting- Role of Energy Managers in Industries -Energy auditing- needs & types- energy audit instruments - Energy management approach understanding energy costs, bench marking, energy performance- maximizing system efficiencies. **Energy Efficiency and Case studies:** Energy efficiency–energy efficient motors , energy efficient transformers - energy efficiency in lighting -Case studies. Organizational background desired for energy management motivation, Detailed process of M&T-Thermostats, Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters.

Total Hours: 45

Text Books:

1	Craig B. Smith, Kelly Parmenter, Energy Management Principles, 2nd Edition, Elsevier, 2015
2	Wayne C. Turner, Steve Doty Energy management handbook 8th edition 2013
3	Energy Manager Training Manual (4 Volumes) at www.Energymanager Training.Com, A Website Administered By Bureau Of Energy Efficiency (BEE), A Statutory Body Under Ministry Of Power, Government Of India, 2009.

Reference Books:

1	Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects
2	Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities
3	Xingrang liu, Ramesh bansal, Thermal Power Plant Modeling Control and Efficiency Improvement , CRC press 2016

Web References:	
1	http://nptel.ac.in/video.php?subjectId=108102047
2	http://textofvideo.nptel.iitm.ac.in/108102047/lec20.pdf
3	https://www.edx.org/course/Energy management system

Assessment Methods & Levels (based on Bloom's Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Tentative Assessment Component**	**Marks**
C402.1	Understand	Quiz	**4**
C402.2	Remember	Quiz	**4**
C402.3	Analyze	Problem solving	**4**
C402.4	Apply	Group Assignment	**4**
C402.5	Understand	Class presentation	**4**

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	**Continuous Assessment**			**End Semester Examination [50 marks]**
	CIA-I [10 marks]	**CIA-II [10 marks]**	**CIA-III [10 marks]**	
Remember	20	20	20	20
Understand	80	20	20	40
Apply	-	-	60	20
Analyze	-	60	-	20
Evaluate	-	-	-	-
Create	-	-	-	-

16EE403	OPTIMIZATION TECHNIQUES	3/0/0/3
Nature of Course:	Problematic	
Pre Requisites:	Nil	

Course Objectives:

1. To learn various methods of linear programming.
2. To determine the solutions of unconstrained one & n dimensional optimization.
3. To determine the solutions of constrained optimization technique.
4. To perform dynamic programming for optimal solutions.

Course Outcomes:
Upon completion of the course, students shall have ability to

C403.1 Recognize the importance and value of Optimization Techniques in solving practical problems in industry [R]
C403.2 Understand Optimization models and apply them to real life problems [U]
C403.3 Design new models to improve decision making and develop Critical thinking and objective analysis of decision problems [AP]

Course Contents:

Linear programming with one dimensional optimization techniques – formulation - Graphical and simplex methods - Big-M method - Two phase method - Dual simplex method - Primal Dual problems. Necessary and sufficient conditions – Unrestricted search methods - Fibonacci and golden section method - Quadratic Interpolation methods, cubic interpolation and direct root methods. **Unconstrained n dimensional optimization techniques** – direct search methods – Random search – pattern search and Rosen brock's hill climbing method - Descent methods - Steepest descent, conjugate gradient, quasi - Newton method. **Constrained optimization Techniques and Dynamic programming** - Necessary and sufficient conditions – Equality and inequality constraints - Kuhn-Tucker conditions - Gradient projection method - cutting plane method - penalty function method. - principle of optimality - recursive equation approach - application to shortest route, cargo - loading, allocation and production schedule problems.

Total Hours	45

Text Books:

1. D.P.Kothari and J.S.Dhillon, "Power System Optimization", 2nd Edition, PHI learning private limited, 2013.
2. Jizhong Zhu, "Optimization of Power System Operation" 2nd Edition, John Wiley & sons, 2016.
3. S.S. Rao :Optimization Theory and applications, Wiley Eastern Ltd. 2012.

Reference Books:

1. Rao S.S., 'Optimization: Theory and Application' Wiley Eastern Press, 2 nd edition 2012.
2. Taha, H.A., Operations Research –An Introduction, Prentice Hall of India,2013.
3. Fox, R.L., 'Optimization methods for Engineering Design', Addition Wiely, 2005.

Web References:

1. http://nptel.ac.in/courses/108101040/28
2. http://www.brad.ac.uk/staff/vtoropov/burgeon/thesis_sameh/chap5.pdf
3. nptel.ac.in/courses/Webcourse.../OPTIMIZATION%20METHODS/.../M1L4slides.pdf
4. www.springer.com/cda/content/document/cda.../9783540729617-c2.pdf?SGWID

5. www.open.ac.uk/courses/modules/m373

Assessment Methods & Levels (based on Blooms'Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C403.1	Remember	Class room & Online Quiz	**6**
C403.2	Understand	Class Presentation	**6**
C403.3	Apply	Group Assignment	**8**

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment**			**End Semester Examination**
	CIA1	**CIA2**	**Term End Assessment**	
Remember	20	10	10	10
Understand	50	50	50	50
Apply	30	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

16EE404	POWER SYSTEM OPERATION AND CONTROL	3/0/0/3

Nature of Course	G (Theory analytical)
Pre-Requisites	Power System Analysis

Course Objectives:

1. To understand the concepts of real power, reactive power, voltage and frequency in power system operation.
2. To implement the various control actions and economic load dispatch for power system operation and control.
3. To learn the modern techniques in computer control of power systems.

Course Outcomes:

Upon completion of the course, students shall have ability to

C404.1	Remember the basic concepts of power system operation and control	[R]
C404.2	Analyze the operation of power system using economic load dispatch and unit commitment solution methodologies.	[A]
C404.3	Analyze the operation of power system using static and dynamic analysis	[A]
C404.4	Apply the control methodologies in determining real & reactive power, voltage & frequency in power systems.	[AP]
C404.5	Understand the concepts of network protocols used in smart grid power systems	[U]

Course Contents:

Power system operation and control: Load forecasting, unit commitment: constraints in unit commitment: spinning reserve, thermal unit constraints, hydro constraints, fuel constraints and other constraints; unit commitment solution methods: Priority-list methods, forward dynamic programming approach, numerical problems only in priority-list method using full-load average production cost. Economic load dispatch: concepts & problems. Governor Control, EDC, AVR, system voltage control, security control. **Real power, Reactive power, Voltage & Frequency control:** - Speed-load characteristics; concept of control area, LFC control of a single-area system, Economic controller added to LFC: Static and dynamic analysis of uncontrolled and controlled cases. Multi-area systems: Two-area system modelling; static analysis, uncontrolled case; Load Compensation- power factor correction, load balancing-Maximum load ability of transmission lines-Line Compensation.- Typical excitation system, modelling, static and dynamic analysis, stability compensation; generation and absorption of reactive power: Relation between voltage, power and reactive power at a node; method of voltage control: Injection of reactive power. Tap-changing transformer, transformer and MVAR injection of switched capacitors, tie line with frequency bias control of two-area system. **Computer Control of Power Systems:** Energy control centre: Functions – Monitoring, and control. Need of computer control of power systems. Overview of Protocols - Modbus, Distributed Network Protocol (DNP), IEC 870-5 and 60870 series, Benefits from the IEC (International Electro technical Commission) communication Standards. Concept of energy control centre (or) load dispatch centre and the functions, SCADA, EMS and PMU functions, state estimation, security analysis and control.

Various operating states: State transition diagram showing various state transitions and control strategies. Smart grid integration.	
Total Hours:	**45**
Text Books:	
1	Allen J. Wood, Bruce F. Wollenberg, 'Power Generation Operation and Control', Wiley India 2nd Edition, 2013.
2	AbhijitChakrabarti&SunitaHalder, 'Power System Analysis- Operation & Control', PHI New Delhi, 3 rd Edition, 2010.
3	D.P. Kothari and I.J. Nagrath, ‗Modern Power System Analysis', Third Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 2013.
Reference Books:	
1	P. Kundur, ‗Power System Stability and Control', McGraw Hill Publications, 2012.
2	Olle. I. Elgerd, ‗Electric Energy Systems Theory – An Introduction', Tata McGraw Hill Publishing Company Ltd, New Delhi, Second Edition, 2015.
3	P.S.R Murty, 'Operation and control in Power System', Book Syndicate, 2nd Edition, 2011.
Web References:	
1	https://nptel.ac.in/courses/108102047/33
2	https://nptel.ac.in/courses/108104052/8
3	https://nptel.ac.in/courses/108105104/6
4	https://nptel.ac.in/courses/108106022/
5	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-

Assessment Methods & Levels (based on Blooms'Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C404.1	Remember	Quiz	4
C404.2	Analyze	Case Study	4
C404.3	Analyze	Case Study	4
C404.4	Apply	Problem Solving Assignment	4
C404.5	Understand	Class Presentation	4

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	**Continuous Assessment**			**End Semester Examination [60 Marks]**
	CIA1 [6Marks]	**CIA2 [6 Marks]**	**Model Exanmination [8 Marks]**	
Remember	20	14	10	12
Understand	16	22	18	16
Apply	32	48	24	32
Analyse	32	16	48	40
Evaluate				
Create				

16EE405	POWER QUALITY	3/0/0/3
Nature of Course:	**D** (Theory application)	
Pre-Requisites	Power System Analysis	

Course Objectives:

1	To introduce the power quality problem
2	To educate on production of voltages sags, over voltages and harmonics and methods of control.
3	To study overvoltage problems
4	To study the sources and effect of harmonics in power system
5	To impart knowledge on various methods of power quality monitoring.

Course Outcomes:

Upon completion of the course, students shall have ability to

C405.1	Remember the importance of power quality	[R]
C405.2	Analyze the voltage sags and interruptions in power system	[A]
C405.3	Analyze the problems on over voltages in power system.	[A]
C405.4	Understand the effects of harmonics in power system	[U]
C405.5	Apply various power quality monitoring tools and techniques.	[AP]

Course Contents

Introduction To Power Quality: Terms and definitions: Overloading - under voltage – over voltage. Concepts of transients –long and short duration 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 - ITI curve. **Voltage Sags, Interruptions And Over Voltages :** Sources of sags and interruptions - estimating voltage sag performance. Analysis and calculation of various faulted condition. Voltage sag due to induction motor starting. Analysis of voltage sag Estimation of the sag severity - mitigation of voltage sags, active series compensators. Static transfer switches and fast transfer switches. 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. An introduction to computer analysis tools for transients, PSCAD and EMTP. **Harmonics And Power Quality Monitoring:** 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 – resonance. Harmonic distortion evaluation - devices for controlling harmonic distortion - passive and active filters. IEEE and IEC standards. Monitoring considerations – monitoring and diagnostic techniques for various power quality problems -modeling of power quality (harmonics and voltage sag) problems by mathematical simulation tools -power line disturbance analyzer – quality measurement equipment - harmonic / spectrum analyzer –flicker meters - disturbance analyzer. Applications of expert systems for power quality monitoring.

Total Hours	**45**

Text Books:	
1	Roger. C. Dugan, Mark. F. McGranagham, Surya Santoso, H.Wayne Beaty, 'Electrical Power Systems Quality' McGraw Hill, 2013.
2	Eswald.F.Fudis and M.A.S.Masoum, "Power Quality in Power System and Electrical Machines," Elseviar Academic Press, 2013.
3	J. Arrillaga, N.R. Watson, S. Chen, 'Power System Quality Assessment', Wiley, 2011
Reference Books:	
1	G.T. Heydt, 'Electric Power Quality', 2nd Edition. (West Lafayette, IN, Stars in a Circle Publications, 2014.
2	M.H.J Bollen, 'Understanding Power Quality Problems: Voltage Sags and Interruptions',New York: IEEE Press, 2013.
3	G.J.Wakileh, "Power Systems Harmonics – Fundamentals, Analysis and Filter Design," Springer 2007.
Web References:	
1	http://nptel.ac.in/courses/108106025/
2	https://onionesquereality.wordpress.com/.../more-video- lectures-iit-open
3	https://nptel.iitg.ernet.in/Elec_Engg/.../Video-EEE.pdf
4	https://www.coursera.org/learn/energy-101

Assessment Methods & Levels (based on Bloom's Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C405.1	Remember	Quiz	4
C405.2	Analyze	Writing Skills	4
C405.3	Analyze	Class Presentation	4
C405.4	Understand	Group Assignment	4
C405.5	Apply	Class Presentation	4

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6marks]	Model Examination [8 marks]	
Remember	50	-	20	20
Understand		50	40	40
Apply	50	50	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

16EE406	HIGH VOLTAGE ENGINEERING	3/0/0/3
Nature of Course	: G (Theory analytical)	
1. Course pre-requisites	: Generation, Transmission and Distribution	

2. Course Objectives

1	To expose the students to the basic causes of over voltages in power systems
2	To illustrate the fundamentals of breakdown and partial discharge in insulating solid and gas at high voltages
3	To understand the generation and measurement of high voltages and currents
4	To understand the concepts of high voltage testing.

Course Outcomes:
Upon completion of the course, students shall have ability to

C406.1	Identify the causes and types of overvoltage.	[U]
C406.2	Illustrate different methods of generating and measuring various high voltages and currents.	[AP]
C406.3	Analyse various breakdown phenomena occurring in gaseous, liquid and solid dielectrics.	[A]
C406.4	familiarize international standards of designing and testing	[AP]

Course Contents:

Causes Of Over Voltages & High Voltage Testing In Electrical Power Systems- Causes of over voltages and its effect on power system – Lightning, switching surges and temporary over voltages – Insulation Co-ordination. High voltage testing of electrical power apparatus – Power frequency, impulse voltage and DC testing – International and Indian standards. **Electrical Breakdown In Gases, Solids And Liquids -**Basic Gaseous breakdown in uniform and non-uniform fields – corona discharges – Vacuum breakdown - conduction and breakdown in pure and commercial liquids – breakdown mechanisms in solid and composite dielectrics. **Generation & Measurement Of High Voltages And High Currents -**Generation of High DC, AC, impulse voltages and currents. Tripping and control of impulse generators. High Voltage DC: Rectifier circuits, Voltage multipliers, Van-de-graph and electrostatic generators. High Voltage AC: Cascaded transformers and tesla coils. Measurement of High voltages and High currents and impulse current using using sphere gaps, peak voltmeters, potential dividers, high speed CRO – Digital techniques in high voltage measurement**.**

Total Hours: 45

Text Books:

1	Naidu, M.S. and Kamaraju,V., 'High Voltage Engineering', 4th Edition, Tata McGraw-Hill Publishing Company, New Delhi,5th Edition, 2013.
2	Subir Ray,' An Introduction to High Voltage Engineering' PHI Learning Private Limited, New Delhi, Second Edition, 2013
3	L.L. Alston, 'High Voltage Technology', Oxford University Press, First Indian Edition, 2011.

Reference Books:

1	E. Kuffel and W.S. Zaengl, 'High Voltage Engineering Fundamentals', Butterworth – Heinemann II Edition, 2000.
2	C.L.Wadwa, "High Voltage Engineering", III Edition New Age International, 2007.
3	Gallagher T J and Pearmain A J , High Voltage Measurement Testing and Design, Wiley.

Web References:

1	http://nptel.ac.in/courses/108104048/ui/Course_home1_1.html

Assessment Methods & Levels (based on Blooms'Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C406.1	Remember	Online Quiz	**5**
C406.2	Understand	Problem solving Assignment	**5**
C406.3	Analyse	Online Group Assignment	**5**
C406.4	Apply	Class presentation	**5**

Summative assessment based on Continuous and End Semester Examination					
Bloom's Level	**Continuous Assessment**				**End Semester Examination (Theory) [60 marks]**
	Theory			**Formative Assessment [20 Marks]**	
	CIA-I [6 Marks]	**CIA-II [6 Marks]**	**Model Examination [8 Marks]**		
	20	20	20	20	20
Understand	70	30	30	30	70
Apply	-	30	30	30	-
Analyse	10	20	20	20	10
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

16EE407	COMPUTER NETWORKS	3/0/0/3

Nature of Course: D (Theory application)

Pre Requisites: Nil

Course Objectives:

1. To Understand the division of network functionalities into layers
2. To familiar with the components required to build different types of networks.
3. To expose to the required functionality at each layer
4. To Learn the flow control and congestion control algorithms

Course Outcomes

Upon completion of the course, students shall have ability to

C407.1	Identify the components required to build different types of networks	[U]
C407.2	Choose the required functionality at each layer for given application	[AP]
C407.3	Identify solution for each functionality at each layer	[AP]
C407.4	Trace the flow of information from one node to another node in the network	[AP]

Course Contents:

Fundamentals & Link Layer -Building a network – Requirements - Layering and protocols - Internet Architecture – Network software – Performance ; Link layer Services - Framing - Error Detection - Flow control . Media Access & Internetworking - Media access control - Ethernet (802.3) - Wireless LANs – 802.11 – Bluetooth - Switching and bridging – Basic Internetworking (IP, CIDR, ARP, DHCP,ICMP) .Routing (RIP, OSPF, metrics) – Switch basics – Global Internet (Areas, BGP, IPv6), Multicast – addresses – multicast routing (DVMRP, PIM) .Transport Layer - Overview of Transport layer - UDP - Reliable byte stream (TCP) - Connection management - Flow control - Retransmission – TCP Congestion control - Congestion avoidance (DECbit, RED) – QoS – Application requirements .Application Layer -Traditional applications -Electronic Mail (SMTP, POP3, IMAP, MIME) – HTTP – Web Services – DNS – SNMP.

Total hours 45

Text Books:

1. Larry L. Peterson, Bruce S. Davie, “Computer Networks: A Systems Approach”, Fifth Edition, Morgan Kaufmann Publishers, 2011.
2. Nader. F. Mir, “Computer and Communication Networks”, Pearson Prentice Hall Publishers, 2010.

Reference Books:

1. James F. Kurose, Keith W. Ross, “Computer Networking - A Top-Down Approach Featuring the Internet”, Fifth Edition, Pearson Education, 2009
2. Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, “Computer Networks: An Open Source Approach”, Mc Graw Hill Publisher, 2011.
3. Behrouz A. Forouzan, “Data communication and Networking”, Fourth Edition, Tata McGraw – Hill, 2011.

Web References:

1. http://nptel.ac.in/courses/106105081/1
2. http://nptel.ac.in/courses/Webcourse/contents/IIT%20Kharagpur/Computer%20networks/New_index1.html
3. http:// https://www.udacity.com/course/computer-networking--ud436

Assessment Methods & Levels (based on Blooms'Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C407.1	Understand	Class room Quiz	**4**
C407.2	Apply	Online Quiz	**5**
C407.3	Apply	Group Assignment	**6**
C407.4	Apply	Class Presentation	**5**

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment**			**End Semester Examination**
	CIA1	**CIA2**	**Term End Assessment**	
Remember	20	10	10	10
Understand	50	50	50	50
Apply	30	40	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

16EE408	Soft Computing Techniques	3 /0/ 0 /3
Nature of Course	: G (Theory)	

Course Objectives:

1. To study different approaches and architecture of intelligent control
2. To impart the knowledge on various architectures of Artificial Neural Network
3. To understand the concept of fuzziness involved in electrical systems
4. To expose the ideas about Genetic Algorithm for implementing optimization problems

Course Outcomes:
Upon completion of the course, students shall have ability to

C408.1	Understand the concepts of soft computing and artificial intelligent control system	[U]
C408.2	Analyze the ideology of fuzzy logic systems in electrical system	[A]
C408.3	Analyze the performance of Neural Network	[A]
C408.4	Apply genetic algorithm in power system optimization problems	[AP]

Course Contents:

FUZZY LOGIC SYSTEM: Evolution of Soft Computing - Soft Computing Constituents - Conventional AI to Computational Intelligence - Machine Learning Basics- Approaches to intelligent control: Architecture for intelligent control, Symbolic reasoning system, rule based systems, the AI approach. Knowledge representation. Expert systems. Introduction to Fuzzy logic, crisp sets and fuzzy sets, Introduction to fuzzy logic modeling and control. Fuzzification, Fuzzy membership functions, inferencing and Defuzzification. Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Case Study: Implementation of fuzzy logic controller in Aerospace and in home automation. **ARTIFICIAL NEURAL NETWORKS:** Fundamentals – Biological neural network – Artificial neuron – Activation function – Learning rules - Perceptron Networks – Adaline – Madaline – Back propagation networks – Learning factors – Linear separability- Adaptive Networks - Feed Forward Networks - Supervised Learning Neural Networks - Radial Basis Function Networks - Unsupervised Learning Neural Networks - Adaptive Resonance Architectures .Case study: Identification and control of linear and nonlinear dynamic systems using Neural Network-Stability analysis of Neural-Network interconnection systems.
GENETIC ALGORITHM: Terminologies – Concept of GA-Genetic operators – Selection, cross-over and mutation – Fitness function, Encoding, adjustment of free parameters. Optimization techniques like ant-colony search techniques for solving optimization problems.
Case Study: GA application to power system optimization problem.

Total Hours: 45

Text Books:

1	S.N.Sivanandam, S.N.Deepa, **"**Principles of Soft Computing**"**, second edition, Wiley, India,2011
2	Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Third Edition, John Wiley & Sons Ltd, UK, 2011.
3.	David.E.Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Pearson Education Inc., 2009.

Reference Books:

1	Simon Haykin, **"**Neural Networks & Learning Machines**"**, Third edition, Pearson, 2016**.**
2	Nazmul siddique, "Intelligent control, A hybrid approach based on Fuzzy logic, Neural networks and Genetic Algorithm", Springer International Publisher, Switzerland, 2014.
3.	S. Rajasekaram & G.A. Vijyalakshmi Pai, Neural Networks, Fuzzy Logic and Genetic

	Algorithms, PHI Learning Private Limited, INDIA, 2011.
Web References:	
1	http://homepages.cae.wisc.edu/~ece539/fall03/notes/application.pdf
2	https://www.springer.com/us/book/9781852332938
3	http://user.engineering.uiowa.edu/~ie238/Lecture/Soft_computing.pdf
4	http://www.ijarcs.info/index.php/Ijarcs/article/viewFile/5408/4830
5	https://nptel.ac.in/courses/106105173/2
6	http://www.cse.iitm.ac.in/~vplab/courses/soft_computing.htm

Assessment Methods & Levels (based on Bloom'sTaxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C408.1	Understand	Online Quiz	**5**
C408.2	Analyse	Group Assignment	**5**
C408.3	Analyse	Power Point Presentation	**5**
C408.4	Apply	Group Assignment	**5**

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment**			**End Semester Examination [50 marks]**
	CIA-I [10 marks]	**CIA-II [10 marks]**	**Term End Examination [10 marks]**	
Remember	20	20	20	20
Understand	70	30	30	30
Apply	-	30	30	30
Analyse	10	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

16EE409	VLSI DESIGN	3/0/0/3
Nature of Course	D (Theory Application)	
Pre-requisites	Linear and Digital Integrated Circuits	

Course Objectives:

1	To understand the VLSI design problems, design methodologies and manufacturing technology.
2	To design the MOS circuits based on design rules and analyse the circuit as inverters and logic gates.
3	To expose the layouts of application specific devices and to become familiar with digital circuits programming.

Course Outcomes:
Upon completion of the course, students shall have ability to

C409.1	Understand the VLSI design problems, design domains and CMOS fabrication Technology	[U]
C409.2	Analyse the characteristics of MOS transistors and the design concepts of MOS circuits	[A]
C409.3	Analyse the CMOS circuits as inverters and transmission gates with stick diagram.	[A]
C409.4	Understand the device layouts of specific applications.	[U]
C409.5	Apply modelling concepts of HDL programming for the design of digital circuits.	[AP]

Course Contents:

Introduction to VLSI design methodologies: Moore's law, VLSI design problem, design domains, design methods and technologies.**VLSI Fabrication Technology & MOS transistors**: Fabrication- NMOS, PMOS, CMOS, Twin tub process and Silicon on insulator Technology – MOS transistors-Enhancement mode & Depletion mode, NMOS transistor current equation – second order effects. MOSFET as a Switch, MOS Layers-Stick Diagrams- Design rules and layout, Sheet resistance, Area capacitance of layers, Transistor sizing, power dissipation. **CMOS CIRCUIT-** NMOS Inverter –CMOS inverter - Switching characteristics. Pass Transistor and Transmission gates- NMOS and CMOS Logic gates- Stick Diagram, Layout Design Rules. ASICS: Types of ASICS– Physical Design flow – Programming Technology - Anti fuse - Static RAM – EPROM,EEPROM technology- PREP Benchmarks - Actel ACT - Xilinx LCA – Altera FLEX - Altera MAX - Xilinx I/O blocks**. Programming VLSI**: Review of VLSI Design automation tools - Fundamental VHDL units Design of 2 bit Adders and Multipliers using VHDL. Verilog HDL- Module and ports-Gate level, behavioral and dataflow modeling for 2 bit adders and multipliers.

Total Hours:	**45**

Text Books:

1	D.A.Pucknell, K.Eshraghian, 'Basic VLSI Design', Prentice Hall of India, New Delhi, 3 rd Edition,2012.
2	M.J.S .Smith, " Application Specific Integrated Circuits, Addison – Wesley Longman Inc., 2013.

3	Samir Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis”, 2nd edition, 2013
Reference Books:	
1	N.H.Weste, K.Eshraghian, ‘Principles of CMOS VLSI Design: a system perspective’,Pearson Education, India, 2013.
2	Volnei A. Pedroni, ‘Circuit Design and Simulation with VHDL’, MIT Press,2nd edition 2010
3	S.H.Gerez, " Algorithms for VLSI Design Automation ", John Wiley & Sons, 2011.
Web References:	
1	https://www.coursera.org/learn/electronics
2	https://nptel.ac.in/courses/117101105/
3	https://www.nptel.ac.in/courses/117106093/

Assessment Methods & Levels (based on Bloom’sTaxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C409.1	Understand	Online Quiz	**4**
C409.2	Analyse	Group Assignment	**4**
C409.3	Analyse	Group Assignment	**4**
C409.4	Understand	Class Presentation	**4**
C409.5	Apply	Group Assignment	**4**

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment				End Semester Examination (Theory) [60 marks]
	Theory			Formative Assessment [20 Marks]	
	CIA-I [6 Marks]	CIA-II [6 Marks]	Model Examination [8Marks]		
Remember					
Understand	50	50	40	40	40
Apply			30	30	30
Analyse	50	50	30	30	30
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

16EE410	Wireless Sensor Networks	3/0/0/3
Nature of Course	: D (Theory Application)	
Course Prerequisites	: Nil	

Course Objectives:

1	To realise the architecture and networking of wireless sensors.
2	To get ample knowledge of infrastructure, various sensor network platforms and tools
3	To analyze different operating systems

Course Outcomes:

Upon completion of the course, students shall have ability to

C410.1	Understand the basic knowledge of sensor networks	[U]
C410.2	Explore the routing and gateways for WSN	[U]
C410.3	Realize the MAC protocols used for different communication standards.	[A]
C410.4	Comprehend the infrastructure, sensor network platforms and tools	[U]
C410.5	Be familiar with the operating systems	[AP]

Course Contents:

Overview of Wireless Sensor Networks (WSNs): Introduction, Constraints, Challenges, Advantages, Applications & Key definitions. **Architectures:** Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes, Network Architecture, Sensor Network Scenarios, Optimization Goals, Figures of Merit, Gateway Concepts. Routing Protocols: Energy-Efficient Routing, Geographic Routing, Joint Routing and Information Aggregation.**Networking Sensors:** Physical Layer and Transceiver Design Considerations, MAC Protocols: Low Duty Cycle Protocols, Wakeup Radio Concepts, S MAC & B MAC, The Mediation Device Protocol, MAC Address assignment and Name Management. Infrastructure Establishment: Topology Control, Clustering, Time Synchronization, Localization and Localization Services. Sensor Tasking and Control: Task-Driven Sensing, Roles of Sensor Nodes and Utilities, Information-Based Sensor Tasking. **Sensor Network Platforms and Tools**: Sensor Node Hardware – Berkeley Motes, Programming Challenges, Operating Systems: Introduction, Design Issues, Examples: TinyOS, Mate, Magnet OS, EYES OS, Node-Level Simulators: ns-2, TOSSIM & State-centric programming. Underwater WSN control. Quality of a sensor network; Real-time traffic support and security protocols.

Total Hours: 45

Text Books:

1	Waltenegus Dargie , Christian Poellabauer, “Fundamentals Of Wireless Sensor Networks Theory And Practice”, By John Wiley & Sons Publications ,2014.
2	Holger Karl & Andreas Willig, " Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2012.
3	Feng Zhao, Leonidas Guibas, “Wireless Sensor Networks”, Elsevier Publications, 2011.

Reference Books:

1	Kazem Sohrby, Daniel Minoli, “Wireless Sensor Networks”: Technology, Protocols and Applications, Wiley-Inter science, 5th Edition, 2017.
2	Philip Levis, And David Gay "TinyOS Programming” by Cambridge University Press 2009.

3	Wireless Sensor Networks and Energy Efficiency: Protocols, Routing and Management, Noor Zaman, Khaled Ragab and Azween Bin Abdullah, IGI Global Publisher, January, 2012.
Web References:	
1	www.ni.com/white-paper/7142/en
2	https://www.elprocus.com/architecture-of-wireless-sensor-network-and-applications
3	https://www.coursera.org/courses?query=wireless%20sensor%20networks

Assessment Methods & Levels (based on Bloom's Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C410.1	Understand	Quiz	**4**
C410.2	Understand	Class Presentation	**4**
C410.3	Analyse	Writing Skills	**4**
C410.4	Understand	Group Assignment	**4**
C410.5	Apply	Class Presentation	**4**

Summative assessment based on Continuous and End Semester Examination					
Bloom's Level	**Continuous Assessment**				**End Semester Examination (Theory) [60 marks]**
	Theory			**Formative Assessment [20 Marks]**	
	CIA-I [6 Marks]	**CIA-II [6 Marks]**	**Model Examination [8 Marks]**		
Remember	-		-	-	-
Understand	100	60	70	70	70
Apply		-	20	20	20
Analyse	-	40	10	10	10
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

16EE411	ARM and Arduino Processor	3/0/0/3
Nature of Course	G (Theory Analytical)	
Pre-requisites	Microprocessors and Microcontrollers Fundamentals	

Course Objectives:

1	To understand the Arduino controller with interfacing applications.
2	To analyse the programming concepts of ARM processor and its interfaces.
3	To realise the microcomputer and its peripheral programming

Course Outcomes:

Upon completion of the course, students shall have ability to

C411.1	Realise the features of Arduino controller	[R]
C411.2	Apply the arduino controller for various types of interfacing applications	[AP]
C411.3	Program the ARM processor with its instruction sets for timer, serial interfaces and signal conversions	[AP]
C411.4	Understand and program for Raspberry pi board.	[U]

Course Contents:

Arduino Environment and programming - Arduino program - setup() and loop() functions, main interface of an Arduino through its pins, UART communication protocol to gain controllability and observability, Serial library to communicate with the Arduino through the serial monitor. **Transducer Interface –** Sensor interface, LCD interface, Servo Control, PWM signal generation concepts, GPS, GSM interface with Arduino Uno. **C Programming for ARM:** ARM instruction set**-** overview of C compiler and optimization, Basic C data types, C Looping structures, Register allocations, function calls, pointer aliasing, structure arrangement, bitfields, unaligned data and Endianness, Division, floating point, Inline functions and inline assembly, Portability issues. C programs for General purpose I/O, general purpose timer, PWM Modulator, UART,I^2C Interface, SPI Interface, ADC, DAC. **Raspberry Pi** - Introduction about raspberry pi family, OS installation, GPIO, UART, C programming in Raspberry pi, basic computation in raspberry pi, Python scripts based accessing of GPIO pins in raspberry pi.

Total Hours: 45

Text Books:

1	Richard Blum , “Arduino Programming in 24 Hours”, Pearson Education; 1st edition, 2015, ISBN-10: 9332552436
2	Simon Monk , “Programming Arduino: Getting Started with Sketches”, McGraw-Hill Education; 2nd edition, June 2016, ISBN-10: 1259641635

Reference Books:

1	O'Reilly Media , “Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects”, Michael Margolis Publisher, 2nd edition, 2015.
2	J.m Hughes O′Reilly, “Arduino - A Technical Reference”, 1st edition, May 2016, ISBN-10: 1491921765
3	Simon Monk, Shroff/O'Reilly, “Raspberry Pi Cookbook: Software and Hardware Problems and Solutions”, 2nd Edition, 2016, ISBN-10: 9352133897.

Web References:

1	https://www.coursera.org/learn/raspberry-pi-platform
2	https://www.coursera.org/learn/arduino-platform

3	https://www.coursera.org/learn/interface-with-arduino
4	http://nptel.ac.in/courses/106105159/16
5	https://ocw.mit.edu/OcwWeb/Electrical-Engineering-and-Computer-Science/6-002Circuits-and-ElectronicsFall2000/CourseHome/index.htm
6	https://www.edx.org/course/embedded-systems-shape-world-utaustinx-ut-6-10x

Assessment Methods & Levels (based on Bloom'sTaxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C411.1	Remember	Quiz	**6**
C411.2	Apply	Technical presentation	**4**
C411.3	Apply	Group Assignment	**4**
C411.4	Understand	Class presentation	**6**

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment				End Semester Examination (Theory) [60 marks]
	Theory			Formative Assessment [20 Marks]	
	CIA-I [6 Marks]	CIA-II [6 Marks]	Model Examination [8 Marks]		
Remember	50		20	20	20
Understand			20	20	20
Apply	50	100	60	60	60
Analyse					
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

16EE412	Automotive Electronics	3/0/0/3

Nature of Course	: D (Theory application)
Pre- Requisites	: -

Course Objectives:

1	To instill a fundamental understanding of various electronic functionalities in automotives
2	To make them gain knowledge on lighting system, sensors and accessories employed in automotives.
3	To make them familiar with Digital Engine Control System and electronic dashboard instruments
4	To broaden the importance of vehicle intelligence system and future of autonomous cars

Course Outcomes:

Upon completion of the course, students shall have ability to

C412.1	Understand the principles and construction of automotive batteries and charging system.	[U]
C412.2	Comprehend the functions of starting, ignition and injection system pertaining to electronic management techniques.	[U]
C412.3	Analyse the functionalities and types of lighting system and accessories of automotive systems.	[A]
C413.4	Apply the function of automotive sensors in suitable monitoring applications.	[AP]
C413.5	Assess the role of electronic dashboard instruments and vehicle intelligence technology in advanced design of automotives.	[E]

Course Contents:

Batteries and Charging System: Automotive fundamentals, Batteries-Principles and construction of lead-acid battery. Characteristics of battery, rating capacity and efficiency of batteries, Types of batteries used in electric vehicles, Advanced charging system technology**. Starting, Injection and Ignition Systems**: Types, Construction & working, of Starting system, Electronic Ignition systems, Distributor less ignition system, Electronic fuel injection systems and Digital Engine control System. **Lighting System and Accessories: Lighting System** - Overview of interior and exterior lights, Headlight dazzling & preventive methods, Intelligent lighting system **Accessories -**Electrical fuel pump, Speedometer, Fuel, oil & temperature gauges, Horn, Wiper system. **Automotive Sensors:** Basic sensor arrangement, Oxygen sensors, Crank angle position sensors, Vehicle speed sensor, Detonation sensor, Altitude sensor, Mass Air Flow sensor and Throttle position sensors. **Electronic dashboard instruments and Vehicle Intelligence** -Onboard diagnosis system, security and warning system (anti - lock braking system, Tyre pressure monitoring system, Collision avoidance system, Key less entry system and Electronic power steering system.)Vehicle Intelligence- Introduction - Architecture for vision based autonomous road vehicles features-applications

Total Hours:	**45**

Text Books:

1	Judge. A.W., Modern Electrical Equipment of Automobiles, Chapman & Hall, London, 2012.
2	Vinal. G.W. , Storage Batteries, John Wiley & Sons Inc., New York, 4th edition, 2012.
3	Bosch Automotive Electrics and Automotive Electronics, Springer,5th Ed,2014

Reference Books:	
1.	William B. Ribbens, Understanding Automotive Electronics, 6th Edition, Butterworth, Heinemann Woburn, 2003.
2.	Automotive Hand Book, Robert Bosch, Bently Publishers, 2004.
3.	Hod Lipson, Melba Kurman, Driverless: Intelligent Cars and the Road Ahead, MIT Press, 2016
Web References:	
1	www.boschindia.com/.../automotive_electronics.../automotive-electronics.html
2	www.innovianstechnologies.com/automotive-electronics
3	https://www.electronicsweekly.com/market-sectors/automotive-electronics

Assessment Methods & Levels (based on Bloom'sTaxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C412.1	Understand	Class room Quiz	**4**
C412.2	Understand	Online Quiz	**4**
C412.3	Analyse	Class Presentation	**4**
C412.4	Apply	Mini Project Proposal	**4**
C412.5	Evaluate	Group Assignment	**4**

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	[60 marks]
Remember	10	-	10	10
Understand	40	-	40	40
Apply	-	20	20	20
Analyse	-	20	20	20
Evaluate	-	10	10	10
Create	-	-	-	-

16EE413	Design of Electrical Machines	3/0/0/3
Nature of Course:	G (Analytical)	
Pre requisites:	Electrical Machines I & Electrical Machines II	

Course Objectives:

1	To learn the basic design concepts.
2	To design DC machines, Transformers, Induction and Synchronous machines.
3	To apply the design procedures in CAD of electrical machines.

Course Outcomes:

Upon completion of the course, students shall have ability to

C413.1	Remember the basic design concepts	[R]
C413.2	Understand the design of core, yoke, windings and cooling systems of transformers	[U]
C413.3	Analyze the design of squirrel cage and slip ring induction machines	[A]
C413.4	Understand the design of synchronous machines and their thermal behaviour.	[U]
C413.5	Apply the design procedures in CAD of electrical machines.	[AP]

Course content:

Basic Design Concepts: Considerations and Limitations in design - Choice of specific electric and magnetic loadings - Concept of magnetic circuit -MMF calculation for various types of electrical machines - Real and apparent flux density of rotating machines - Thermal considerations, heat flow, temperature rise, rating of machines - Output Equation; Main Dimensions; Choice of number of poles; Armature design; Design of air gap; Design of field poles and field coil; Design of commutator and brushes. **Design of Transformers -** Output rating of single phase and three phase transformers; Optimum design of transformers; Design of core, yoke and windings for core and shell type transformers; Design of tanks and cooling tubes of transformers. **Design of Three Phase Induction Motors:** Output Equation; Main dimensions; Design of stator; Design of squirrel cage and slip ring rotor; **Design of Synchronous Machines -** Output Equation; Main dimensions; Short circuit ratio-Design of stator and rotor of cylindrical pole and salient pole machines; Design of damper winding; Design of field coil; Cooling of large alternators. **Introduction to Computer aided Design of Electrical Machines:** Limitations (assumptions) of traditional designs, need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation. Introduction to FEM based machine design. Introduction to complex structures of modern machines-PMSMs, BLDCs, SRM and claw-pole machines.

Total Hours:	**45**

Text Books:

1	A.K.Sawhney, 'A Course in Electrical Machine Design', Dhanpat Rai and Sons, New Delhi, 2013.
2	S. K. Sen, "Principles of Electrical Machine Design with computer programmes", Oxford and IBH Publishing, 2013.
3	M.V. Deshpande, "Electrical Machine Design" Third Edition, PHI Learning Pvt Ltd., 2013.

Reference Books:

1	R.K.Agarwal, 'Principles of Electrical Machine Design', S.K.Kataria and Sons, Delhi, 2012.
2	M.G. Say, "Theory & Performance & Design of A.C. Machines", ELBS London, 2008.
3	K. M. V. Murthy, "Computer Aided Design of Electrical Machines", B.S. Publications, 2008.

Web References:	
1	https://nptel.ac.in/courses/117108124/16
2	https://www.youtube.com/watch?v=quYggqvMAw8
3	https://nptel.ac.in/courses/108105062/34
4	https://elearn.univ-ouargla.dz/2013-2014/courses/MET302/document/8178001462Computer.pdf?cidReq=MET302

Assessment Methods & Levels (based on Bloom's Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C413.1	Remember	Class room Quiz	3
C413.2	Understand	Online Quiz	4
C413.3	Analyze	Design based problem solving tutorial	5
C413.4	Understand	Class Presentation	3
C413.5	Apply	Group Assignment	5

Summative assessment based on Continuous and End Semester Examination					
Bloom's Level	**Continuous Assessment**				**End Semester Examination (Theory) [60 marks]**
	Theory			**Formative Assessment [20 Marks]**	
	CIA-I [6 Marks]	**CIA-II [6 Marks]**	**Term End Examination [8 Marks]**		
Remember	50	20	20	20	20
Understand	50	30	30	30	30
Apply	-	50	50	50	50
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

16EE414	Special Electrical Machines	3/0/0/3

Nature of Course	: D (Theory application)

Course Objectives:

1	To learn the working operation and performance characteristics of Stepper motor
2	To realize the performance characteristics of Switched reluctance motors.
3	To impart knowledge on the performance of Permanent Magnet Brushless DC and Permanent Magnet Synchronous motors.
4	To know about the control strategies of Linear and Servo motor.

Course Outcomes:
Upon completion of the course, students shall have ability to

C414.1	Interpret the operation and characteristics of stepping motors.	[U]
C414.2	Understand the constructional features and operation of Switched reluctance motor.	[U]
C414.3	Differentiate the Synchronous reluctance motor and Switched reluctance motor.	[A]
C414.4	Illustrate the household and vehicle application aspects of Brushless DC motor and Permanent Magnet Synchronous motors.	[AP]
C414.5	Analyse the performance of Linear and Servo motors.	[A]

Course Contents:

Stepping Motors and Switched Reluctance Motor - Constructional features – Principle of operation – Variable reluctance motor – Hybrid motor –Permanent Magnet Stepper motor– Torque equations – Modes of excitations – Characteristics –Microprocessor control of stepping motors – Closed loop control. – **Switched Reluctance motor-**Rotary and Linear SRMs -Constructional features – Principle of operation – Torque production mechanism-Power Converters and their controllers – Methods of Rotor position sensing – Sensor less operation – Closed loop control of SRM. **Permanent Magnet Motors: Brushless D.C. motors** - Introduction -Principle of operation, Permeance coefficient -Principle of operation – Types – Magnetic circuit analysis – EMF and torque equations –Commutation – Power controllers – Motor characteristics and control. Application aspect related to vehicle and household **Permanent Magnet Synchronous Motor** - Principle of operation – Ideal PMSM – EMF and Torque equations – Armature reaction MMF –Synchronous Reactance – Sine wave motor with practical windings – Phasor diagram –Torque/speed characteristics - Power controllers - Converter Volt-ampere requirements.Torque Controllers, Self-control, Vector control, Current control schemes. **Linear and Servo motors** - Linear Induction motor (LIM) classification - construction - Principle of operation - DC Linear motor (DCLM) types - circuit equation - DCLM control applications. Servomotor-Constructional features, Principle of operation, Types, Characteristics, Control strategies. Application of linear and servo motor in automation industries.

Total Hours:	**45**

Text Books:

1	Berker Bilgin , James Weisheng Jiang , Ali Emadi “Switched Reluctance Motor Drives: Fundamentals to Applications” CRC press, 2018
2.	R.Krishnan, “Permanent Magnet Synchronous and Brushless Dc Motor Drives”

	T &F India, 2016
3	Dr.Duanek Hanselman,"Brushless Motors: Magnetic Design, Performance, and Control of Brushless DC and Permanent Magnet Synchronous Motors" E-Man Press LLC, 2012
Reference Books:	
1	Ahmed Tahor, Abdel Ghani Aissabui "Switched Reluctance Motor - Concept, Control and Applications", InTech Open, 2017
2	Riazollah Firoozian "Servo Motors and Industrial Control Theory "Springer International Publishing AG; 2nd edition, 2014
3	V.V.Athani, "Stepper Motors: Fundamentals, Applications and Design " New Age publisher,2nd edition, 2014
Web References:	
1	https://www.elprocus.com/stepper-motor-types-advantages-applications/
2	https://electrical-engineering-portal.com/characteristics-and-work-principles-of-switched-reluctance-sr-motor
3	https://www.edn.com/design/sensors/4406682/Brushless-DC-Motors---Part-I--Construction-and-Operating-Principles

Assessment Methods & Levels (based on Bloom's Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C414.1	Understand	Classroom Quiz	**4**
C414.2	Understand	Group Assignment	**4**
C414.3	Analyze	Technical Presentation	**4**
C414.4	Apply	Online Quiz	**4**
C414.5	Analyze	Group Assignment	**4**

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	
Remember	30	-	-	10
Understand	50	20	20	30
Apply	20	50	50	30
Analyse	-	30	30	30
Evaluate	-	-	-	-
Create	-	-	-	-

16EE415	PLC and Automation	3/0/0/3

Nature of Course	: **D & K** (Theory application and Theory Programming)
Pre requisites	: NIL

Course Objectives:

1	To expose the rudiments of PLC and Industrial Automation
2	To know various types and programming of programmable logic controllers
3	To familiarize with different types of HMI and Installation and maintenance procedures for PLC
4	To learn the architecture and tools of Supervisory Control and Data Acquisition System
5	To learn the basic principles of communication protocols

Course Outcomes:

Upon completion of the course, students shall have ability to

C4115.1	Gain knowledge about the architecture of PLC and I/O modules	[R]
C4115.2	Understand the basic building blocks of PLC Programming and apply it in to practical issues.	[AP]
C4115.3	Understand the necessity of HMI in automation and its panel types.	[U]
C4115.4	Recognise the Installation and maintenance procedures and networking for PLC	[R]
C4115.5	Understand the architecture and demonstrate basic programming of SCADA	[U,AP]
C4115.6	Understand the Principle of communication protocols	[U]

Course Contents:

Introduction: Proximity sensor, Light sensor, Temperature Sensor, Smart sensors**, Programmable Logic Controllers:** History and developments in industrial automation, Architecture of industrial automation Control elements in industrial automation. PLC introduction, Basics of PLC, Advantages, Capabilities of PLC-Architecture of PLC, Scan cycle, Types of PLC, Types of I/O modules- Configuring a PLC, PLC wiring. **PLC Programming:** Types of Programming , Simple process control programs using Relay Ladder Logic , PLC logical functions - Timers and counters ,data transfer-comparison and manipulation instructions.. HMI system and PLC networking: Necessity and Role in Industrial Automation, Text display, operator panels, Touch panels, Panel PCs , Integrated displays, interfacing PLC to HMI. Installation and maintenance procedures for PLC, Troubleshooting of PLC. **SCADA:** Overview, Architecture of SCADA, Tools, Tag, Internal & External graphics, Alarm logging, Tag logging, structured tags, Trends-history-Report generation, Scripts for SCADA application. Communication protocols of SCADA: BUS configurations used for industrial automation – GPIB, HART and OLE/OPC protocols–Industrial field bus – FIP (Factory Instrumentation Protocol), PROFIBUS (Process field bus), Bit bus - Server/Client Configuration – Interfacing of SCADA with PLC.

Total Hours:	**45**

Text Books:

1	William Bolton, “Programmable Logic controllers”, Elsevier, Sixth Edition, 2015.
2	Robert Radvannovshy,” Handbook of SCADA/Control System Security”,CRC Press.Second Edition,2016.

Reference Books:	
1	Frank D. Petruzella, “Programmable Logic controllers”, Mc Graw Hill, Fifth Edition, 2017.
2	John.W.Webb & Ronald A. Reis, “Programmable logic controllers: Principles and Applications”, Prentice Hall India, 2003.
3	WinCC V7.2, Software Manual,2013.
Web References:	
1	https://nptel.ac.in/courses/112102011/12
2	https://nptel.ac.in/courses/108106022/10
3	https://swayam.gov.in/course/1395-industrial-automation-and-control
4	https://freevideolectures.com/course/2345/industrial-automation-and-control

Assessment Methods & Levels (based on Bloom’s Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C4115.1	Remember & Understand	Classroom Quiz	**4**
C4115.2	Understand & Apply	Group Assignment	**4**
C4115.3	Apply	Technical Presentation	**3**
C4115.4	Remember & Understand	Online Quiz	**3**
C4115.5	Understand	Flow chart	**3**
C4115.6	Understand	Power Point Presentation	**3**

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment			End Semester Examination [50 marks]
	CIA-I [10 marks]	CIA-II [10 marks]	Term End Examination [10 marks]	
Remember	30	20	20	20
Understand	50	50	50	50
Apply	20	30	30	30
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

16EE416	SERVO DRIVES IN ROBOTICS	3/0/0/3
Nature of Course	: G (Theory)	

Course Objectives:

1	To understand the basic laws and concepts of robots.
2	To impart the knowledge of servo motors drives and power transmission.
3	To understand the concepts sensors and vision systems.
4	To understand the concepts of robots in various industries for automation.

Course Outcomes:

Upon completion of the course, students shall have ability to

C416.1	Understand the basic Robotic systems	[U]
C416.2	Understand the concepts of servo mechanisms and control of electric drives	[U]
C416.3	Analyze the selection of sensor to the robotic system	[A]
C416.4	Apply Robots in Manufacturing and Processing Industries	[AP]

Course Contents:

INTRODUCTION TO FUNDAMENTAL CONCEPTS OF ROBOTICS

History, Present status and future trends in Robotics and automation - Laws of Robotics- Robot definitions - Robotics systems and robot anatomy - Structure of a Robot, Classification of Robots: Cartesian, Cylindrical, Spherical, Articulated, SCARA -Specification of Robots - Degrees of Freedom of Serial and Parallel Manipulators- resolution, repeatability and accuracy of a manipulator. **SERVO MOTORS DRIVES AND POWER TRANSMISSION SYSTEMS** Types – Constructional features - Principle of operation – Feedback system - Sizing of servomotors - Robot drive mechanisms, hydraulic – electric – servomotor- stepper motor - pneumatic drives, Mechanical transmission method - Gear transmission, Belt drives, cables, Roller chains, Link - Rod systems - Rotary-to-Rotary motion conversion, Rotary-to-Linear motion conversion, Rack and Pinion drives, Lead screws, Ball Bearing screws, End effectors. **CONTROL OF ELECTRICAL DRIVES:** Introduction – Parts of Electrical Drives- Fundamental Torque Equations – Speed Torque Conventions and Multi-quadrant Operation – Nature & Classification of Load Torques - Modes of Operation –Closed-Loop Control of Drives. **SENSORS and VISION SYSTEMS:** Principle of operation, types and selection of Position& velocity sensors, Potentiometers, Encoders, Resolvers, LVDT, Tacho-generators, Internal and External State Sensors, Proximity sensors. Limit switches – Tactile sensors - Touch sensors - Force and torque sensors, Robot End Effectors. Vision Systems. VISION SYSTEMS FOR ROBOTICS: Robot vision systems, Image capture- solid state cameras – Image representation - Grey scale and colour images, image sampling and quantization - Image processing and analysis –Image data reduction – Segmentation - Feature extraction - Object Recognition.**FACTORY AUTOMATION** Flexible Manufacturing Systems concept - Automatic feeding lines, transfer lines, automatic inspection - Computer Integrated Manufacture - CNC, intelligent automation. HMI Systems, DCS and SCADA, Wireless controls.

Total Hours:	**45**

Text Books:

1	Deh S R., "Robotics Technology and Flexible Automation", Tata McGraw Hill Publishing, Company Ltd., 2010.
2	Mikell P Grooveret. al., "Industrial Robots - Technology, Programming and Applications", McGraw Hill, New York, 2012.
3	Saeed B Niku," Introduction to Robotics Analysis,Systems,Applications""PHI Pvt Ltd, New Delhi,2016.

4	Peter Corke," Robotics, Vision and Control: Fundamental Algorithms In MATLAB" first edition 2011.
Reference Books:	
1	S K Saha, —Introduction to Roboticsǁ, Tata Mcgraw Hill, 2010.
2	Mittal R K, Nagrath I J, —Robotics and Controlǁ, Tata McGraw Hill, 2010
3	Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy, Prentice Hall of India P Ltd., 2010.
Web References:	
1	https://ocw.mit.edu/courses/mechanical-engineering/2-12-introduction-to-robotics-fall-2416/
2	https://www.edx.org/course/robotics-columbiax-csmm-103x
3	https://www.futurelearn.com/courses/begin-robotics

Assessment Methods & Levels (based on Bloom'sTaxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C416.1	Understand	Quiz	5
C416.2	Understand	Technical presentation	5
C416.3	Analyze	Group discussion	5
C416.4	Apply	Case Study	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination
	CIA-I [6 marks]	CIA-II [6marks]	Term End Examination [8marks]	[60 marks]
Remember	40	20	20	20
Understand	60	60	40	40
Apply	-	20	20	20
Analyse	-	-	20	20
Evaluate	-	-	-	-

16EE417	FLEXIBLE AC TRANSMISSION SYSTEMS	3/0/0/3
Nature of Course	D (Theory application)	
Course pre-requisites	17EE313 Generation, Transmission and Distribution	

Course Objectives:

1	To understand the concepts of FACTS
2	To expose the applications of FACTS controllers in power systems
3	To learn about shunt & series compensation schemes
4	To learn the simulation of FACTS Controllers
5	To understand the phenomenon of SSR & its mitigation techniques

Course Outcomes:
Upon completion of the course, students shall have ability to

C417.1	Realize the concept of FACTS.	[R]
C417.2	Understand the various types of compensation schemes.	[U]
C417.3	Implement the various FACTS controllers.	[A]
C417.4	Apply the knowledge to simulate various FACTS controllers.	[AP]
C417.5	Understand about the phenomena of sub synchronous resonance.	[U]

Course Contents:

Introduction: Introduction, Electrical Transmission Network, Necessity, Power Flow in AC system, Relative importance of controllable parameter, Opportunities for FACTS, Possible benefits for FACTS Technology, Types of FACTS Controllers & its Applications. Advanced FACTS devices. **Types of Compensation Techniques**: Need for compensation, shunt and series compensation, Configuration, Operating characteristics, Thyristor Controlled Reactor (TCR), Thyristor Switched Capacitor (TSC), Comparison of TCR and TSC, Variable impedance type series compensation, Thyristor Switched Series Capacitor (TSSC), Thyristor Controlled Series Capacitor (TCSC), Basic operating control schemes for TSSC & TCSC. **Static Voltage Phase Angle Regulator & Second Generation Facts Controllers**: Objectives of voltage and phase angle Regulators- Operations an Control Applications-TCVR Model and Thyristor Controlled Voltage and Phase Angle Regulator, TCPAR Model characteristics**,** STATCOM and UPFC Introduction, Circuit model, Principle of operation, Basic operating principles and control structure, Introduction to sub synchronous resonance (SSR) - mitigation by FACTs controllers, NGH, SSR damping scheme, Simulation and study of FACTS under dynamic conditions.

Total Hours: 45

Text Books:

1	Zhang, Xiao-Ping, Rehtanz, Christian**,** Pal**,** Bikash "Flexible AC Transmission Systems: Modelling and Control" Springer 2012.
2	K.R. Padiyar, "FACTS Controllers for Power Transmission and Distribution" New Age International Publishers, 2016
3	Rajiv K. Varma R. Mohan Mathur "Thyristor-Based FACTS Controllers for Electrical Transmission Systems" Wiley (12 August 2011)

Reference Books:

1	Narain G.Hingorani, Laszio Gyugyi, "Understanding FACTS concept and Technology",Standard Publisher, Delhi, 2015.
2	Gyugyi L., "Unified power flow control concept for flexible AC transmission ", IEEE Proc-C, Vol.139, No.4, July 2013.
3	Einar V.Larsen, Juan J. Sanchez-Gasca, Joe H.Chow, " Concepts for design of FACTS Controllers to damp power swings ", IEEE Trans on Power Systems, Vol.10, No.2, May 2010

Web References:

1	http://nptel.ac.in/courses/108104052/1

Assessment Methods & Levels (based on Blooms'Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C417.1	Remember	Online Quiz	**4**
C417.2	Understand	Class room Quiz	**4**
C417.3	Analyse	Problem Solving Assignment	**4**
C417.4	Apply	Online Group Assignment	**4**
C417.5	Understand	Class Presentation	**4**

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment**			**End Semester Examination [60 marks]**
	CIA I [6 Marks]	**CIA II [6 Marks]**	**Model Examination [8 marks]**	
Remember	20	20	20	20
Understand	70	30	30	30
Apply	-	30	30	30
Analyse	10	20	20	20
Evaluate	-	-	-	-
Create	-	-	-	-

16EE418	MODELLING AND SIMULATION OF POWER ELECTRONIC CIRCUITS	2/0/1/3

Nature of Course	E (Theory skill based)
Pre-requisites	Power Electronics, Control Systems

Course Objectives:

1	To expose the basic theoretical and practical applications of power semiconductor devices with simulation.
2	To develop basic AC-DC, DC-DC, DC-AC conversion circuit fed drives.
3	To provide the basis for further study of controllers for power electronics circuits.

Course Outcomes:
Upon completion of the course, students shall have ability to

C418.1	Understand basic applications of various power semiconductor devices.	[U]
C418.2	Analyse and design various machine models.	[A]
C418.3	Apply AC/DC rectifier circuits to DC Motors.	[AP]
C418.4	Design basic and advanced DC/DC converter circuits.	[AP]
C418.5	Understand the role of power electronic systems for improvement of power quality.	[U]
C418.6	Analyse and design inverter circuits for control of drives.	[A]

Course Contents:

Introduction to MATLAB and Modelling of Power Devices: Introduction to Sim Power Systems Tool Box, Modelling of Diode, SCR, MOSFET, IGBT in Simulation, Simulation of gate/base drive circuits, Simulation of Snubber circuit. Introduction to electrical machine modelling: Induction, DC, and Synchronous machines.

MATLAB Simulation of Rectifier and chopper fed drives: Simulation of single and three phase converters-Uncontrolled, Semi controlled and fully controlled converter fed DC motor drive, Dual Converter. Simulation of DC-DC converter fed dc motor drives-Buck, Boost, Buck-Boost Converters, Simulation of four quadrant operations of DC-DC converter. Simulation of Power factor correction schemes with PWM .

Simulation of Inverter fed drives: Simulation of single and three phase inverters with MOSFET and IGBT, Space Vector Representation, Pulse-width modulation methods for voltage and waveform control. Simulation of Inverter fed Induction and BLDC motor drives.

Lab Component

1. Modelling of Diode, SCR,IGBT,MOSFET [A]
2. Implementation of Single phase converter Fed Drives [AP]
3. Implementation of Three phase converter Fed Drives [AP]
4. Implementation of Dual Converter Fed Drives [AP]
5. Design of Buck converter Fed Drives [A]

6. Design of Boost converter Fed Drives [A]	
7. Design of Buck-Boost converter Fed Drives [A]	
8. Implementation of six step inverter fed BLDC motor [AP]	
9. Implementation of speed control of Synchronous Drive [AP]	
10. Implementation of SVPWM for Inverter Fed Induction Motor Drive [AP]	
Total Hours:	**45**

Text Books:

1	Rashid M.H., "Power Electronics Circuits, Devices and Applications", Prentice Hall India,3rd Edition, New Delhi, 2014.
2	Randall Shaffer., "Fundamentals of Power Electronics with MATLAB", Firewall Media,India, 2010.
3	Dr. Shailendra Jain Modelling and Simulation using MATLAB Simulink, Wiley, 2ndEdition, 2015
4	Viktor M. Perelmuter ,"Electrotechnical Systems Simulation with Simulink® and Sim PowerSystemsTM", CRC Press, Taylor & Francis Group,2013

Reference Books:

1	Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics Converters,Applications, and Design", 3 rd Edition, John Wiley & Sons, 2009.
2	Haitham Abu-Rub., Etal., "High Performance Control of AC Drives with Matlab/Simulink Models", Wiley Publications.2010.

Web References:

1	https://www.mathworks.com/support/books/book54209.html?category=1
2	http://nptel.ac.in/downloads/108105066/
3	http://nptel.ac.in/courses/108101038/

Online Resources:

1	https://www.coursera.org/specializations/power-electronics

Assessment Methods & Levels (based on Bloom'sTaxonomy)

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment				End Semester Examination [60 marks]
	CIA-I [6 marks]	CIA-II [6 marks]	CIA-III [8 marks]	Rubrics based Lab component [20 marks]	
Remember	20	-	10	-	10
Understand	50	40	20	20	20
Apply	-	20	40	20	40
Analyse	30	40	30	40	30
Evaluate	-	-	-	-	-
Create	-	-	-	20	-

16EE501	RENEWABLE ENERGY SOURCES	3/0/0/3
Nature of Course:	D (Theory application)	
Pre Requisites:	**Nil**	

Course Objectives:

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

1. To understand different non-conventional energy systems and its applications.
2. To advance student's knowledge and assimilate new technologies.
3. To study simple techno-economical storage methods of renewable energy systems.

Course Outcomes:

Upon completion of the course, students shall have ability to

C501.1	Remember the concepts of Kyoto Protocol	[R]
C501.2	Understand the energy scenario in India and Integrated Resource Plan	[U]
C501.3	Apply the concepts of Solar and wind energy in the operation of power plants	[AP]
C501.4	Comprehend the various methods to generate other energy sources –biomass, tidal and geothermal	[U]
C501.5	Understand the different energy storage methods and hybrid systems	[U]

Course Content:

INTRODUCTION: Importance and types of renewable sources of energy, , Limitations of RE sources, Present Indian and international energy scenario of conventional and RE sources, Kyoto protocol, concept of clean development mechanism and prototype carbon funds **WIND ENERGY & SOLAR ENERGY:** Power in the Wind – Types of Wind Power Plants (WPPs)–Components of WPPs-Working of WPPs- Site selection of WPPs, Solar Power, Solar thermal, solar photovoltaic, maximum power point tracking, Applications. **OTHER ENERGY SOURCES AND STORAGE METHODS:** Methods to generate - Biomass energy, tidal energy, geothermal energy and its applications, Storage methods of chemical, electromagnetic and thermal energy. Hybrid energy systems.

Total Hours:	**45**

TEXT BOOKS:

1	John Twidwell and Tony Weir, “Renewable Energy Resources”, 3rd Edition, Routledge, 2015
2	B.H. Khan, “Non-Conventional Energy Resources”, 2nd Edition, Tata McGraw Hill, New Delhi, 2010
3	Rai, G.D, “Non Conventional Energy Sources”, Khanna Publishers, 2010.

REFERENCE BOOKS:

1	G.N. Tiwari, “Solar Energy”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
2	Aldo Vieira Da Rosa, “Fundamentals of Renewable Energy Processes”, Academia Press, 2012.
3	G. Masters, “Renewable and Efficient Electric Power Systems”, IEEE-Wiley Publishers, 2013.

Web References:	
1	http://unfccc.int/kyoto_protocol/items/2830.php
2	https://www.coursera.org/learn/wind-energy
3	https://www.edx.org/course/solar-energy-delftx-et3034x-0

Assessment Methods & Levels (based on Blooms' Taxonomy)			
Formative assessment based on Capstone Model (Max. Marks:20)			
Course Outcome	**Bloom's Level**	**Assessment Component**	**Marks**
C501.1	Remember	Quiz	**3**
C501.2	Understand	Class presentation	**4**
C501.3	Apply	Group Assignment	**5**
C501.4	Apply	Quiz	**5**
C501.5	Understand	Group Assignment	**3**

Summative assessment based on Continuous and End Semester Examination				
Bloom's Level	**Continuous Assessment**			**End Semester Examination [60 marks]**
	CIA I [6 MARKS]	**CIA II [6 MARKS]**	**Model Examination [8 marks]**	
Remember	30	20	10	20
Understand	70	40	70	60
Apply	-	40	20	20
Analyse				
Evaluate	-	-	-	-
Create	-	-	-	-

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16EE502	ENERGY AUDITING,CONSERVATION AND MANAGEMENT	3/0/0/3

Nature of Course : G (Theory)

Course Objectives:

1	To introduce about Energy Management Systems (EMS).
2	To enable the students to understand the scope for energy saving in residential sector, industries and commercial establishments.
3	To analyze the concepts of New technologies and new products are coming up in the market, for energy saving.
4	To learn the Knowledge of thermodynamic principles, usage of thermal insulation in buildings, lighting devices and new electric motor.
5	To realize energy conservation is better way to meet demand in short span of time rather than constructing new power plant.

Course Outcomes:

Upon completion of the course, students shall have ability to

C502.1	Understand the role of Energy Managers in Industries	[U]
C502.2	Evaluate Total Energy Systems Energy Audit.	[E]
C502.3	Understand energy consumption & energy saving potentials	[U]
C502.4	Perceive the Organizational background of energy management motivation	[AP]

Course Contents:

Energy Scenario and Conservation

Energy Scenario -Energy conservation and its importance- Energy Conservation Act-2001 and its features. Economics of various Energy Conservation schemes- -Case studies- Energy conservation in Centrifugal pumps, Fans &Blowers, Air compressor- -Design consideration Refrigeration Air conditioning .**Energy Systems, Management and Auditing** Illumination – Lux, Lumens, Types Of Lighting, Efficiency, LED Lighting-– Heat load estimation - Energy conservation in cooling towers & spray ponds-Energy monitoring, auditing & targeting- Role of Energy Managers in Industries -Energy auditing- needs & types- energy audit instruments - Energy management approach understanding energy costs, bench marking, energy performance- maximizing system efficiencies. **Energy efficiency and Case studies:** Energy efficiency–energy efficient motors , energy efficient transformers -energy efficiency in lighting -Case studies. Organizational background desired for energy management motivation, Detailed process of M&T-Thermostats, Stoichiometry, Boilers, Furnaces And Thermic Fluid Heaters.

Total Hours: 45

Text Books:

1	Craig B. Smith, Kelly Parmenter, Energy Management Principles, 2nd Edition, Elsevier, 2015
2	Wayne C. Turner, Steve Doty Energy management handbook 8th edition 2013
3	Energy Manager Training Manual (4 Volumes) at www.Energymanager Training.Com, A Website Administered By Bureau Of Energy Efficiency (BEE), A Statutory Body Under Ministry Of Power, Government Of India, 2009.

Reference Books:

1	Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects
2	Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities
3	Xingrang liu, Ramesh bansal, Thermal Power Plant Modeling Control and Efficiency Improvement , CRC press 2016

Web References:	
1	http://nptel.ac.in/video.php?subjectId=108102047
2	http://textofvideo.nptel.iitm.ac.in/108102047/lec20.pdf
3	https://www.edx.org/course/Energy management system

Assessment Methods & Levels (based on Blooms'Taxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C502.1	Understand	Quiz	5
C502.2	Evaluate	Simulation Exercise	5
C502.3	Understand	Group Assignment	5
C502.4	Apply	Class presentation	5

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment				End Semester Examination (Theory) [60 marks]
	Theory			Formative Assessment [20 Marks]	
	CIA-I [6 Marks]	CIA-II [6 Marks]	Term End Examination [8 Marks]		
Remember	20	20	10	10	20
Understand	60	60	70	60	60
Apply	10	10	10	20	10
Analyse	10	10	10	10	10
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

16EE503	SMART GRID (Open Elective)	3/0/0/3
Nature of Course	:D (Theory Application)	
Pre-requisites	:Nil	

Course Objectives:

1	Need, benefit and function of smart grid and its international view.
2	Smart Grid technologies and energy efficient alternatives
3	Smart Grid technologies, different smart meters and advanced metering infrastructure.
4	The power quality management issues in Smart Grid.
5	The high performance computing for Smart Grid applications

Course Outcomes:

Upon completion of the course, students shall have ability to

C503.1	Understand the need, benefit and function of smart grid	[U]
C503.2	Apply Smart Grid technologies and energy efficient alternatives	[AP]
C503.3	Analyze the issues on power quality management using smart meters	[A]
C503.4	Identify the high performance computing system in Smart Grid applications	[R]

Course Contents:

Introduction to smart grid-, Difference between conventional grid & smart grid, Concept of Resilient & Self-Healing Grid, Need, Benefits and functions of Smart Grid, opportunities and challenges of smart grid Electricity. Electricity network-Local energy networks- Electric transportation- Low carbon central generation-Attributes of the smart grid- Alternate views of a smart grid. . National and International Initiatives in Smart Grid. Case study on Smart Grid Initiative for Power Distribution Utility in India. **Smart Grid Technologies:** Smart energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring. **-**DMS, Volt/VAr control, Fault Detection, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers. Plugin Hybrid Electric Vehicles (PHEV). Efficient Electric End – Use technology alternatives - Existing technologies – lighting - Space conditioning - Indoor air quality. **Smart Grid components and Power quality management:** Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, Phasor Measurement Unit (PMU), Intelligent Electronic Devices(IED) & their applications for monitoring & protection. Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources; Power Quality Conditioners for Smart Grid, Web based Power Quality Monitoring, Power Quality Audit. Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid

Total Hours: 45

Text Books:

1	Janaka Ekanayake, Kithsiri Liyanage, Jianzhong.Wu, AkihikoYokoyama, Nick Jenkins, “Smart Grid: Technology and Applications”- Wiley, 2012.
2	James Momoh, “Smart Grid: Fundamentals of Design and Analysis”-Wiley, IEEE Press, 2012

3	Clark W Gellings, “The Smart Grid, Enabling Energy Efficiency and Demand Side Response”- CRC Press, 2009. Wiley, 2012.
Reference Books:	
1	Smart Grid Applications, Communications, and Security. Lars T. Berger, Krzysztof Iniewski, ISBN: 978-1-118-00439-5.
2	Smart Grid Handbook, 3 volume Set Chen-Ching Liu, Stephen McArthur, Seung-Jae LeeJohn Wiley & Sons, 1 Aug 2016 - Science - 1900 pages.
3	Salman K. Salman “Introduction to the Smart Grid: Concepts, Technologies and Evolution” 2017, ISBN: 978-1-78561-119-3.
Web References:	
1	http://whatis.techtarget.com/reference/Smart-Grid-Technology-Overview
2	https://www.nist.gov/engineering-laboratory/smart-grid
3	http://www.nsgm.gov.in/en/nsgm
Online Resources:	
	https://www.edx.org/course/smart-grids-electricity-future-ieeex-smartgrid-x-0
	http://theinstitute.ieee.org/ieee-roundup/blogs/blog/free-online-course-covers-the-future-of-smart-grids
	https://onlinecourses.nptel.ac.in/noc18_ee42.

Assessment Methods & Levels (based on Bloom’sTaxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom’s Level	Assessment Component	Marks
C503.1	Understand	Assignments	**5**
C503.2	Apply	Technical Online Quiz	**5**
C503.3	Analyze	Class Presentation	**5**
C503.4	Remember	Tutorials	**5**

Summative assessment based on Continuous and End Semester Examination

Bloom’s Level	Continuous Assessment				End Semester Examination (Theory) [50 marks]
	Theory			Formative Assessment [20 Marks]	
	CIA-I [10 Marks]	CIA-II [10 Marks]	Term End Examination [10 Marks]		
Remember	20	20	10	20	20
Understand	60	60	70	60	60
Apply	20	20	20	20	20
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

16EE504	SERVO AND ROBOT DRIVES	3/0/0/3

Nature of Course	: G (Theory)

Course Objectives:

1	To understand the basic laws and concepts of robots.
2	To impart the knowledge of servo motors drives and power transmission.
3	To understand the concepts sensors and vision systems.
4	To understand the concepts of robots in various industries for automation.

Course Outcomes:
Upon completion of the course, students shall have ability to

C504.1	Understand the basic Robotic systems	[U]
C504.2	Understand the concepts of servo mechanisms and control of electric drives	[U]
C504.3	Analyze the selection of sensors to the robotic system	[A]
C504.4	Apply Robots in Manufacturing and Processing Industries	[AP]

Course Contents:

INTRODUCTION TO FUNDAMENTAL CONCEPTS OF ROBOTICS

History, Present status and future trends in Robotics and automation - Laws of Robotics- Robot definitions - Robotics systems and robot anatomy - Structure of a Robot, Classification of Robots: Cartesian, Cylindrical, Spherical, Articulated, SCARA -Specification of Robots - Degrees of Freedom of Serial and Parallel Manipulators- resolution, repeatability and accuracy of a manipulator. **SERVO MOTORS DRIVES AND POWER TRANSMISSION SYSTEMS**Types – Constructional features - Principle of operation – Feedback system - Sizing of servomotors - Robot drive mechanisms, hydraulic – electric – servomotor- stepper motor - pneumatic drives, Mechanical transmission method - Gear transmission, Belt drives, cables, Roller chains, Link - Rod systems - Rotary-to-Rotary motion conversion, Rotary-to-Linear motion conversion, Rack and Pinion drives, Lead screws, Ball Bearing screws, End effectors. **CONTROL OF ELECTRICAL DRIVES:** Introduction – Parts of Electrical Drives- Fundamental Torque Equations – Speed Torque Conventions and Multi-quadrant Operation – Nature & Classification of Load Torques - Modes of Operation –Closed-Loop Control of Drives. **SENSORS and VISION SYSTEMS** Principle of operation, types and selection of Position& velocity sensors, Potentiometers, Encoders, Resolvers, LVDT, Tacho-generators, Internal and External State Sensors, Proximity sensors. Limit switches – Tactile sensors - Touch sensors - Force and torque sensors, Robot End Effectors. Vision Systems. **VISION SYSTEMS FOR ROBOTICS**: Robot vision systems, Image capture- solid state cameras – Image representation - Grey scale and colour images, image sampling and quantization - Image processing and analysis– Segmentation - Feature extraction - Object Recognition- Image capturing and communication - JPEG, MPEGs and H.26x standards, packet video **FACTORY AUTOMATION** Flexible Manufacturing Systems concept - Automatic feeding lines, transfer lines, automatic inspection - Computer Integrated Manufacture - CNC, intelligent automation. HMI Systems, DCS and SCADA, Wireless controls.

Total Hours:	**45**

Text Books:

1	Deh S R., "Robotics Technology and Flexible Automation", Tata McGraw Hill Publishing, Company Ltd., 2010.
2	Mikell P Grooveret. al., "Industrial Robots - Technology, Programming and

	Applications", McGraw Hill, New York, 2012.
3	Saeed B Niku," Introduction to Robotics Analysis,Systems,Applications""PHI Pvt Ltd, New Delhi,2016.
4	Peter Corke," Robotics, Vision and Control: Fundamental Algorithms In MATLAB" first eition 2011.
Reference Books:	
1	S K Saha, —Introduction to Roboticsǁ, Tata Mcgraw Hill, 2010.
2	Mittal R K, Nagrath I J, —Robotics and Controlǁ, Tata McGraw Hill, 2010
3	Richard D Klafter, Thomas A Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Eastern Economy, Prentice Hall of India P Ltd., 2010.
Web References:	
1	https://ocw.mit.edu/courses/mechanical-engineering/2-12-introduction-to-robotics-fall-2504/
2	https://www.edx.org/course/robotics-columbiax-csmm-103x
3	https://www.futurelearn.com/courses/begin-robotics

Assessment Methods & Levels (based on Bloom'sTaxonomy)

Formative assessment based on Capstone Model (Max. Marks:20)

Course Outcome	Bloom's Level	Assessment Component	Marks
C504.1	Understand	Quiz	**5**
C504.2	Understand	Technical presentation	**5**
C504.3	Analyse	Group discussion	**5**
C504.4	Apply	Case Study	**5**

Summative assessment based on Continuous and End Semester Examination

Bloom's Level	Continuous Assessment			End Semester Examination
	CIA-I [6 marks]	CIA-II [6 marks]	Term End Examination [8 marks]	[60 marks]
Remember	40	20	20	20
Understand	60	60	40	40
Apply	-	20	20	20
Analyse	-	-	20	20
Evaluate	-	-	-	-
Create	-	-	-	-