NATIONAL INSTITUTE OF TECHNOLOGY ANDHRA PRADESH

SYLLABI
FOR B.TECH. PROGRAM

From 2017-18 Batch onwards

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

SCHEME OF INSTRUCTION
B.Tech. (Electrical and Electronics Engineering) Course Structure
I - Year

Physics Cycle							
S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	MA101	Mathematics – I	3	0	0	03	BSC
2	HS101	English for Technical Communication	2	0	2	03	HSC
3	PH101	Physics	3	0	0	03	BSC
4	EC101	Basic Electronic Engineering	3	0	0	03	ESC
5	CE102	Environmental Science and Engineering	2	0	0	02	ESC
6	BT101	Engineering biology	2	0	0	02	ESC
7	CS101	Problem Solving& Comp Programming	3	0	0	03	ESC
8	CS102	Problem Solving& Comp Programming Lab	0	1	2	02	ESC
9	PH102	Physics Laboratory	0	1	2	02	BSC
10	EA101	EAA: Games and Sports	0	0	3	00	MDC
		TOTAL	**18**	**2**	**9**	**23**	

Chemistry Cycle							
S.No	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	MA151	Mathematics – II	3	0	0	03	BSC
2	ME102	Engineering Graphics	1	1	4	04	ESC
3	CY101	Chemistry	3	0	0	03	BSC
4	EE101	Basic Electrical Engineering	3	0	0	03	ESC
5	ME101	Basic Mechanical Engineering	3	0	0	03	ESC
6	CE101	Engineering Mechanics	3	0	0	03	ESC
7	ME103	Workshop Practice	0	1	2	02	ESC
8	CY102	Chemistry Laboratory	0	1	2	02	BSC
9	EA151	EAA: Games and Sports	0	0	3	00	MDC
		TOTAL	**16**	**3**	**11**	**23**	

II - Year I - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat.Code
1	MA 201	Mathematics-III	3	0	0	3	BSC
2	EC 235	Analog Electronics	3	0	0	3	PCC
3	CS 235	Data Structures	3	0	0	3	PCC
4	EE 201	Circuit Theory-I	3	0	0	3	PCC
5	EE 202	Electric & Magnetic Fields	3	0	0	3	PCC
6	EE 203	Electrical Measurements & Instrumentation	3	0	0	3	PCC
7	EC 236	Analog Electronics Lab	0	1	2	2	PCC
8	CS 236	Data Structures Lab	0	1	2	2	PCC
		TOTAL	**18**	**2**	**4**	**22**	

II - Year II - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat Code
1	MA 251	Mathematics-IV	3	0	0	3	BSC
2	EC 285	Digital Electronics	3	0	0	3	PCC
3	EE 251	Circuit Theory-II	3	1	0	4	PCC
4	EE252	Electrical Machines – I	3	0	0	3	PCC
5	EE 253	Power Systems-I	3	0	0	3	PCC
6	EC 286	IC Application Lab	0	1	2	2	PCC
7	EE 254	Electric Circuits Lab	0	1	2	2	PCC
8	EE 255	Electrical Measurements & Instrumentation Lab	0	1	2	2	PCC
		TOTAL	**15**	**4**	**6**	**22**	

III - Year I – Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	SM 312	Engineering Economics & Accountancy	3	0	0	3	HSC
2	EE 301	Control Systems	3	1	0	4	PCC
3	EE 302	Electrical Machines-II	3	0	0	3	PCC
4	EE 303	Power Systems-II	3	0	0	3	PCC
5	EE 304	Micro Processors & Microcontrollers	3	0	0	3	PCC
6		Elective-I	3	0	0	3	DEC
7	EE 305	Electrical Machines-I Lab	0	1	2	2	PCC
8	EE 306	Electrical Simulation Lab	0	1	2	2	PCC
9	EP349	EPICS	0	0	0	2*	
		TOTAL	**18**	**3**	**4**	**23**	

*Credits are not considered for computation of SGPA and CGPA

III - Year II - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	EE 351	Power System Operation & Control	3	1	0	4	PCC
2	EE 352	Power Electronics	3	0	0	3	PCC
3	EE 353	Power System Protection	3	0	0	3	PCC
4	EE 354	Electrical Machines-III	3	0	0	3	PCC
5	EE 355	Digital Signal Processing	3	0	0	3	PCC
6		Open-Elective I	3	0	0	3	OPC
7		MOOCS/NPTEL Course	0	0	0	0	MDC
8	EE 356	Control Systems Lab	0	1	2	2	PCC
9	EE357	Electrical Machines Lab -II	0	1	2	2	PCC
10	EE341	Seminar	0	0	2	1	PCC
11	EP399	EPICS	0	0	0	2*	
		TOTAL	**18**	**3**	**6**	**24**	

*Credits are not considered for computation of SGPA and CGPA

IV - Year I - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	SM401	Industrial Management	3	0	0	3	ESC
2	EE 401	Electric Drives	3	0	0	3	PCC
3	EE 402	HVDC&FACTS	3	0	0	3	PCC
4		Elective-II	3	0	0	3	DEC
5		Open- Elective II	3	0	0	3	OPC
6	EE 449	Project Work - A	0	0	4	2	PRC
7	EE 403	Power Electronics Lab	0	1	2	2	PCC
8	EE 404	Embedded Systems Lab	0	1	2	2	PCC
9	EE 405	Power Systems Lab	0	1	2	2	PCC
		TOTAL	**15**	**3**	**10**	**23**	

IV - Year II - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1		Elective -III	3	0	0	3	DEC
2		Elective -IV	3	0	0	3	DEC
3		Elective -V	3	0	0	3	DEC
4		Elective -VI	3	0	0	3	DEC
5		Elective -VII	3	0	0	3	DEC
6	EE 499	Project Work -B	0	0	8	4	PCC
		TOTAL	**15**	**0**	**8**	**19**	

*****The result of the Mandatory Audit Course (Self Study) completed by the student either in 6thor 7thsemester will be reported in this semester

List of Department Elective Courses

DAC (UG) will recommend a list of MOOCS courses and student can complete one of such MOOCS courses.

III Year I Semester

1. EE 311 Computer Organization
2. EE 312 Electrical Engineering Materials
3. EE 313 Utilization of Electrical Energy

4. EE 314 Industrial Instrumentation & Automation

III Year II Semester

1. EE 390 Linear Control Systems - Open Elective – I
2. EE391 Soft Computing Techniques - Open Elective – II

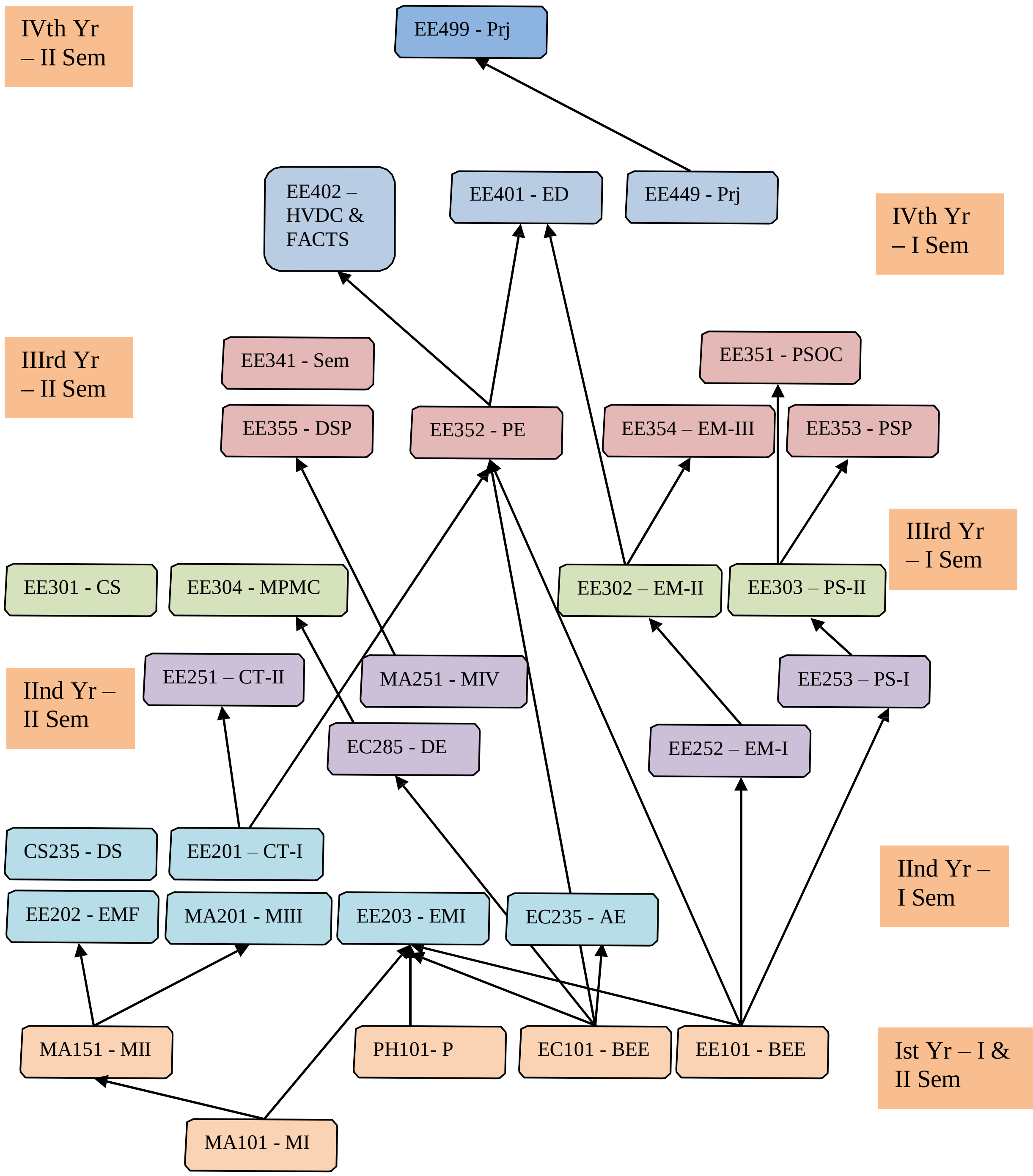
IV Year I Semester

1. EE 411 Design of Electrical Systems
2. EE 412 Computer Methods in Power Systems
3. EE 414 Switched Mode Power Conversion
4. EE 415 Digital Control Systems
5. EE 416 Modeling & Analysis of Electrical Machines
6. EE 5112 Control & Integration of Renewable Energy Systems (Common to M.Tech.)
7. EE 5214 Smart Grid Technologies (Common to M.Tech)
8. EE 440 New Venture Creation - Open Elective – II
9. EE 441 Principles of Electrical Power Conversion - Open Elective – II

IV Year II Semester

1. EE 461 Distribution System Planning & Automation
2. EE 462 High Voltage Engineering
3. EE 463 Advanced Electrical Drive Systems
4. EE 464 Planning an Entrepreneurial Venture
5. EE 465 Real Time Control of Power Systems
6. EE 466 Advanced Power Conversion Systems
7. EE 467 Illumination Technology
8. EE 5163 Power Quality Improvement Techniques (Common to M.Tech)
9. EE 5164 Electric Vehicles (Common to M.Tech)
10. EE 5261 Power System Deregulation (Common to M.Tech)

BTech in Electrical and Electronics Engg
Pre Requisite Chart



DETAILED SYLLABUS

MA 101	MATHEMATICS – I	BSC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the students will be able to

CO1	solve the consistent system of linear equations
CO2	apply orthogonal and congruent transformations to a quadratic form
CO3	determine the power series expansion of a given function
CO4	find the maxima and minima of multivariable functions
CO5	solve arbitrary order linear differential equations with constant coefficients
CO6	apply the concepts in solving physical problems arising in engineering

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	1	-	-	-	-	-	-	-	1	1	1	1
CO2	3	3	1	2	1	-	-	-	-	-	-	-	-	-	1	-
CO3	3	3	1	2	1	-	-	-	-	-	-	-	1	-	-	-
CO4	3	3	1	2	1	-	-	-	-	-	-	-	1	-	1	1
CO5	3	3	1	2	1	-	-	-	-	-	-	-		-	-	1
CO6	3	3	1	3	1	-	-	-	-	-	-	-	2	1	1	2

Detailed Syllabus

Matrix Theory: Linear dependence and independence of vectors; Rank of a matrix; Consistency of the system of linear equations; Eigenvalues and eigenvectors of a matrix; Caley-Hamilton theorem and its applications; Reduction to diagonal form; Reduction of a quadratic form to canonical form - orthogonal transformation and congruent transformation; Properties of complex matrices - Hermitian, skew-Hermitian and Unitary matrices.

Differential Calculus: Taylor's theorem with remainders; Taylor's and Maclaurin's expansions; Asymptotes; Curvature; Curve tracing; Functions of several variables - partial differentiation; total differentiation; Euler's theorem and generalization; Change of variables - Jacobians; maxima and minima of functions of several variables (2 and 3 variables) - Lagrange's method of multipliers.

Ordinary Differential Equations: Geometric interpretation of solutions of first order ODE �′ = ��(�, �); Exact differential equations; integrating factors; orthogonal trajectories; Higher order linear differential equations with constant coefficients - homogeneous and non-homogeneous; Euler and Cauchy's differential equations; Method of variation of parameters; System of linear differential equations; applications in physical problems - forced oscillations, electric circuits, etc.

Reading:

1. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House, 5th Edition, 2016.

2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition, 2015.

3. B. S. Grewal, Higher Engineering Mathematics, Khanna Publications, 2015.

HS101	ENGLISH FOR TECHNICAL COMMUNICATION	HSC	2-0-2	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the students will be able to

CO1	Understand basic principles of grammar and vocabulary
CO2	Write clear and coherent paragraphs
CO3	Write effective résumé, cover letter and letters for a variety of purposes
CO4	Prepare technical reports and interpret graphs
CO5	Develop reading comprehension skills
CO6	Comprehend English speech sounds, stress and intonation

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	-	-	-	-	-	1	-	-	-	3	-	1	-	-	-	-
CO2	-	-	-	-	-	1	-	-	-	3	-	1	-	-	-	-
CO3	-	-	-	-	-	1	-	-	-	3	-	1	-	-	-	-
CO4	-	-	-	-	-	1	-	-	-	3	-	1	-	-	-	-
CO5	-	-	-	-	-	1	-	-	-	3	-	1	-	-	-	-
CO6	-	-	-	-	-	1	-	-	-	3	-	1	-	-	-	-

Detailed Syllabus:

1. Grammar Principles (Correction of sentences, Concord) and Vocabulary Building (synonyms and antonyms): Idioms and Phrasal verbs--patterns of use and suggestions for effective employment in varied contexts

2. Effective Sentence Construction - strategies for bringing variety and clarity in sentences- removing ambiguity - editing long sentences for brevity and clarity

3. Reported speech - contexts for use of reported speech - its impact on audiences and readers- active and passive voice- reasons for preference for passive voice in scientific English

4. Paragraph-writing: Definition of paragraph and types- features of a good paragraph - unity of theme- coherence- linking devices- direction- patterns of development.

5. Note-making - definition- the need for note-making - its benefits - various note formats- like tree diagram, block or list notes, tables, etc.

6. Letter-Writing: Its importance in the context of other channels of communication- qualities of effective letters-types -personal, official, letters for various purposes- emphasis on letter of application for jobs - cover letter and resume types -examples and exercises

7. Reading techniques: Definition- Skills and sub-skills of reading- Skimming and Scanning - their uses and purposes- examples and exercises.

8. Reading Comprehension - reading silently and with understanding- process of comprehension- types of comprehension questions.

9. Features of Technical English - description of technical objects and process- Report-Writing- definition- purpose -types- structure- formal and informal reports- stages in developing report- proposal, progress and final reports-examples and exercises

10. Book Reviews- Oral and written review of a chosen novel/play/movie- focus on appropriate vocabulary and structure - language items like special vocabulary and idioms used

Language laboratory

1. English Sound System -vowels, consonants, Diphthongs, phonetic symbols- using dictionary to decode phonetic transcription-- Received Pronunciation, its value and relevance- transcription of exercises

2. Stress and Intonation –word and sentence stress - their role and importance in spoken English-Intonation in spoken English -definition, patterns of intonation- –falling, rising, etc.- use of intonation in daily life–exercises

3. Introducing oneself in formal and social contexts- Role plays- their uses in developing fluency and communication in general.

4. Oral presentation - definition- occasions- structure- qualities of a good presentation with emphasis on body language and use of visual aids.

5. Listening Comprehension -Challenges in listening, good listening traits, some standard listening tests- practice and exercises.

6. Debate/ Group Discussions-concepts, types, Do’s and don’ts- intensive practice.

Reading:

1. English for Engineers and Technologists (Combined Edition, Vol. 1 and 2), Orient Blackswan, 2006.
2. Ashraf, M Rizvi. Effective Technical Communication. Tata McGraw-Hill, 2006.
3. Meenakshi Raman and Sangeetha Sharma, Technical Communication: Principles and Practice 2nd Edition, Oxford University Press, 2011.

Software:

1. Clear Pronunciation – Part-1 *Learn to Speak English.*
2. Clear Pronunciation – Part-2 *Speak Clearly with Confidence*
3. Study Skills
4. English Pronunciation

PH101	PHYSICS	BSC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the students will be able to

CO 1	Solve engineering problems using the concepts of wave and particle nature of radiant energy.
CO 2	Understand the use of lasers as light sources for low and high energy applications
CO 3	Understand the nature and characteristics of new Materials for engineering applications.
CO 4	Apply the concepts of light propagation in optical fibers, light wave communication systems, holography and for sensing physical parameters.
CO 5	Apply the knowledge of Solar PV cells for choice of materials in efficient alternate energy generation.

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	1	-	-	-	-	-	-	-	-	-	1	1	-
CO2	3	3	1	1	-	-	-	-	-	-	-	-	-	1	1	-
CO3	3	3	1	1	-	-	-	-	-	-	-	-	-	1	1	-
CO4	3	3	1	`1	-	-	-	-	-	-	-	-	-	1	1	-
CO5	3	3	1	1	-	-	-	-	-	-	-	-	-	1	1	-

Detailed Syllabus:

Quantum Mechanics: Concepts and Experiments that led to the discovery of Quantum Nature. Heisenberg uncertainty principle; Schrodinger time independent and time dependent wave equations, The free particle problem - Particle in an infinite and finite potential well, Quantum mechanical tunneling. MB, BE and FD distributions.

Wave and Quantum Optics:

Interference and Diffraction: Concept of interference and working of Fabry-perot Interferometer and its application as wavelength filter. Multiple beam diffraction and Working of diffraction Gratings, Application of Grating as wavelength splitter.

Polarization Devices: Principles, Working and applications of Wave Plates, Half Shade Polarimeter, Polariscope, Isolators and Liquid Crystal Displays.

Lasers: Basic theory of Laser, Concept of population inversion and Construction and working of He-Ne, Nd-YAG, CO_2 Lasers, LED, White light LED, Semiconductor Laser, Holography and NDT.

Optical Fibers: Structure, Types, Features, Light guiding mechanism and applications in Communications and Sensing.

Solar Cells: Solar spectrum, photovoltaic effect, materials, structure and working principle, I-V characteristics, power conversion efficiency, quantum efficiency, emerging PV technologies, applications.

Magnetic and Dielectric Materials:

Magnetic Materials and Superconductors: Introduction - Weiss Theory of Ferromagnetism – Properties – Domains – Curie Transition - Hard and soft magnetic materials – Spinel Ferrites – Structure – Classification – Applications - Meissner effect - Type-I and Type-II Superconductors – Applications.

Dielectric Materials: Introduction to Dielectrics, Dielectric constant – Polarizability - Properties and types of insulating materials **-** Polarization mechanisms in dielectrics(Qualitative) – Frequency and temperature dependence of polarization – Dielectric loss Clausius-Mossotti Equation(Qualitative)– dielectric Breakdown – Applications.

Functional and Nano Materials:

Functional Materials: Fiber reinforced plastics, fiber reinforced metals, surface acoustic wave materials, Bio-materials, high temperature materials and smart materials - Properties and applications.

Nanomaterials: Introduction, classification, properties, different methods of preparation and applications.

Reading:

1. Halliday, Resnic and Walker, Fundamentals of Physics, John Wiley, 9th Edition, 2011.
2. Beiser A, Concepts of Modern Physics, McGraw Hill International, 5th Edition, 2003.
3. Ajoy Ghatak, Optics, Tata McGraw Hill, 5th Edition, 2012.
4. S.O. Pillai,Solid State Physics, New Age Publishers, 2015.

EC101	BASIC ELECTRONIC ENGINEERING	ESC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the students will be able to

CO1	Comprehend the characteristics of semiconductor devices, and operational amplifiers
CO2	Understand the principles of working of amplifiers
CO3	Understand and design of simple combinational and basics of sequential logic circuits
CO4	Understand the principles of electronic measuring instruments and Transducers
CO5	Understand the basic principles of electronic communication

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	-	-	1	-	-	-	-	-	-	-	-	-	-
CO2	3	3	1	-	-	1	-	-	-	-	-	-	-	-	-	-
CO3	3	3	1	-	-	1	-	-	-	-	-	-	-	-	-	-
CO4	3	3	1	-	-	1	-	-	-	-	-	-	-	-	-	-
CO5	3	3	1	-	-	1	-	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

Electronics Systems: Introduction to electronics, review of p-n junction operation, diode applications, Zener diode as regulator.

Transistor and applications: Introduction to transistors, BJT Characteristics, biasing and applications, simple RC coupled amplifier and frequency response. FET and MOSFET characteristics and applications.

Feedback in Electronic Systems: open loop and closed loop systems, Negative and positive Feedback, merits and demerits, Principles of LC and RC oscillators.

Integrated Circuits: Operational amplifiers – characteristics and linear applications

Digital Circuits: Number systems and logic gates, Combinational Logic circuits, Flip-Flops, counters and shift registers, data converters, Analog to Digital and Digital to Analog converters (ADC/DAC's), Introduction to microprocessors and microcontrollers.

Laboratory measuring instruments: principles of digital multi-meters, Cathode ray oscilloscopes (CRO's).

Electronics Instrumentation: Measurement, Sensors, principles of LVDT, strain gauge and thermocouples. Introduction to data acquisition system.

Principles of Communication: Need for Modulation, Definitions of various Modulation and Demodulation techniques, AM radio transmitter and receiver, brief understanding of FM and mobile communications.

Reading:

1. Bhargava N. N., D C Kulshreshtha and S C Gupta, Basic Electronics & Linear Circuits, Tata McGraw Hill, 2nd Edition, 2013.
2. Malvino and Brown,Digital Computer electronics, McGraw Hill, 3rd Edition,1993.
3. Keneddy and Davis, Electronic Communication Systems, McGraw Hill, 4th Edition, 1999.
4. Helfrick and Cooper, Modern Electronic Instrumentation and Measurement Techniques, Prentice Hall India, 2011.
5. Salivahanan, N Suresh Kumar, Electronic Devices and circuits, McGraw Hill publications,3rdEdition, 2012.
6. Neil Storey, Electronics A Systems Approach, Pearson Education Publishing Company Pvt. Ltd, 4th Edition, 2009.

CE102	ENVIRONMENTAL SCIENCE AND ENGINEERING	ESC	2-0-0	2 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the students will be able to

CO1	Identify environmental problems arising due to engineering and technological activities and the science behind those problems.
CO2	Estimate the population - economic growth, energy requirement and demand.
CO3	Analyze material balance for different environmental systems.
CO4	Realize the importance of ecosystem and biodiversity for maintaining ecological balance.
CO5	Identify the major pollutants and abatement devices for environmental management and sustainable development

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	-	-	2	3	1	-	-	-	-	1	2	-	-
CO2	3	3	3	-	-	2	3	1	-	-	-	-	1	2	-	-
CO3	3	3	3	-	-	2	3	1	-	-	-	-	1	2	-	-
CO4	3	3	3	-	-	2	3	1	-	-	-	-	1	2	-	-
CO5	3	3	3	-	-	2	3	1	-	-	-	-	1	2	-	-

Detailed Syllabus:

Introduction to Environmental Science: Environment and society, major environmental issues: Ozone layer depletion, Acid rains, global climate change etc., sustainable development, Environmental impact assessment, environmental management

Natural Resources Utilization and its Impacts: Energy, minerals, water and land resources, Resource consumption, population dynamics, urbanization.

Ecology and Biodiversity: Energy flow in ecosystem, food chain, nutrient cycles, eutrofication, value of biodiversity, biodiversity at global, national and local levels, threats for biodiversity, conservation of biodiversity

Water Pollution: Sources, types of pollutants and their effects, water quality issues, contaminant transport, self-purification capacity of streams and water bodies, water quality standards, principles of water and wastewater treatment.

Air Pollution: Sources, classification and their effects, Air quality standards, dispersion of pollutants, control of air pollution, automobile pollution and its control.

Solid Waste Management: Sources and characteristics of solid waste, effects, Collection and transfer system, disposal methods

Reading:

1. G.B. Masters, Introduction to Environmental Engineering and Science, Pearson Education, 2013.
2. Gerard Kiely, Environmental Engineering, McGraw Hill Education Pvt. Ltd., Special Indian Edition, 2007.
3. W P Cunningham, M A Cunningham, Principles of Environmental Science, Inquiry and Applications, Tata McGraw Hill, 8^{th} Edition, 2016.
4. M. Chandrasekhar, Environmental science, Hi Tech Publishers, 2009.

BT101	ENGINEERING BIOLOGY	ESC	2 – 0 – 0	2 Credits

Pre-requisites: None.

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

CO1	Realize the significance of biomolecules for sustaining life
CO2	Identify the difference between unicellular to multi-cellular organisms
CO3	Understand heredity, variation and central dogma of life
CO4	Analyze and understand the concepts of biology for engineering the cell

Course Articulation Matrix:

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	3	3	1	-	-	-	-	-	-	-	-	-	2	-	-
CO2	2	3	3	1	-	-	-	-	-	-	-	-	-	2	-	-
CO3	2	3	3	1	-	-	-	-	-	-	-	-	-	2	-	-
CO4	2	3	3	1	-	-	-	-	-	-	-	-	-	2	-	-

Detailed Syllabus:

Molecules of life, water and carbon - chemical basis of life, protein structure and function, nucleic acids and the RNA world, carbohydrates, lipids, membranes and first cells.

Cell structure and function, inside the cell, cell–cell Interactions, cellular respiration and fermentation, photosynthesis, cell cycle, biological signal transduction.

Gene structure and expression, Mitosis, Meiosis, Mendel and the gene, DNA and the gene: synthesis and repair, how genes work, transcription, RNA processing, and translation, control of gene expression, analyzing and engineering genes, genomics.

Engineering concepts in biology – genetic engineering, disease biology and biopharmaceuticals, stem cell engineering, metabolic engineering, synthetic biology, neuro transmission, biosafety and bioethics.

Reading:

1. Quillin, Allison Scott Freeman, Kim Quillin and Lizabeth Allison, Biological Science, Pearson Education India, 2016.

2. Reinhard Renneberg, Viola Berkling and Vanya Loroch, Biotechnology for Beginners, Academic Press, 2017.

CS101	PROBLEM SOLVING AND COMPUTER PROGRAMMING	ESC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Design algorithms for solving simple mathematical problems including computing, searching and sorting
CO2	Compare and contrast algorithms in terms of space and time complexity to solve simple mathematical problems
CO3	Explore the internals of computing systems to suitably develop efficient algorithms
CO4	Examine the suitability of data types and structures to solve specific problems
CO5	Apply control structures to develop modular programs to solve mathematical problems
CO6	Apply object oriented features in developing programs to solve real world problems

Course Articulation Matrix:

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	1	1	1	2	1	-	-	-	-	-	3	3	3	3	3
CO2	2	1	2	1	2	3	-	-	-	-	-	3	3	2	2	2
CO3	1	2	2	2	2	1	-	-	-	-	-	3	3	2	2	1
CO4	2	2	2	2	2	2	-	-	-	-	-	2	3	2	1	2
CO5	2	2	3	1	2	2	-	-	-	-	-	2	3	2	2	2
CO6	2	2	3	2	2	2	-	-	-	-	-	2	3	2	2	2

Detailed Syllabus:

Fundamentals of Computers, Historical perspective, Early computers, Components of a computers, Problems, Flowcharts, Memory, Variables, Values, Instructions, Programs.

Problem solving techniques – Algorithmic approach, characteristics of algorithm, Problem solving strategies: Top-down approach, Bottom-up approach, Time and space complexities of algorithms.

Number systems and data representation, Basics of C++, Basic data types.

Numbers, Digit separation, Reverse order, Writing in words, Development of Elementary School Arithmetic Testing System, Problems on Date and factorials, Solutions using flow of control constructs, Conditional statements - If-else, Switch-case constructs, Loops - while, do-while, for.

Functions – Modular approach for solving real time problems, user defined functions, library functions, parameter passing - call by value, call by reference, return values, Recursion, Introduction to pointers.

Sorting and searching algorithms, large integer arithmetic, Single and Multi-Dimensional Arrays, passing arrays as parameters to functions

Magic square and matrix operations using Pointers and Dynamic Arrays, Multidimensional Dynamic Arrays String processing, File operations.

Structures and Classes - Declaration, member variables, member functions, access modifiers, function overloading, Problems on Complex numbers, Date, Time, Large Numbers.

Reading:

1. Walter Savitch, Problem Solving with C++, Ninth Edition, Pearson, 2014.
2. Cay Horstmann, Timothy Budd, Big C++, Wiley, 2nd Edition, 2009.
3. R.G. Dromey, How to solve it by Computer, Pearson, 2008.

CS102	PROBLEM SOLVING AND COMPUTER PROGRAMMING LAB	ESC	0 – 1 – 2	2 Credits

Pre-requisites: None.

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

CO1	Design and test programs to solve mathematical and scientific problems
CO2	Develop and test programs using control structures
CO3	Implement modular programs using functions
CO4	Develop programs using classes

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	2	1	2	1	-	-	-	-	-	-	3	3	3	3
CO2	1	1	2	1	2	2	-	-	-	-	-	-	3	3	2	2
CO3	1	2	3	2	2	1	-	-	-	-	-	-	3	3	2	2
CO4	2	2	2	2	2	3	-	-	-	-	-	-	2	3	2	1

Detailed Syllabus:

Laboratory:

1. Programs on conditional control constructs.
2. Programs on loops (while, do-while, for).
3. Programs using user defined functions and library functions.
4. Programs on arrays, matrices (single and multi-dimensional arrays).
5. Programs using pointers (int pointers, char pointers).
6. Programs on structures.
7. Programs on classes and objects.

Reading:

1. Walter Savitch, Problem Solving with C++, Ninth Edition, Pearson, 2014.
2. Cay Horstmann, Timothy Budd, Big C++, Wiley, 2nd Edition, 2009.
3. R.G. Dromey, How to solve it by Computer, Pearson, 2008.

PH102	PHYSICS LABORATORY	BSC	0 – 1 – 2	2 Credits

Pre-requisites: None

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

CO1	Use CRO, signal generator, spectrometer, polarimeter and GM counter for making measurements
CO2	Test optical components using principles of interference and diffraction of light
CO3	Determine the selectivity parameters in electrical circuits
CO4	Determine the width of narrow slits, spacing between close rulings using lasers and appreciate the accuracy in measurements

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	2	-	3	-	-	-	-	3	2	-	-	-	1	-	-
CO2	3	2	-	3	-	-	-	-	3	2	-	-	-	1	-	-
CO3	3	2	-	3	-	-	-	-	3	2	-	-	-	1	-	-
CO4	3	2	-	3	-	-	-	-	3	2	-	-	-	1	-	-

Detailed Syllabus:

1. Determination of Wavelength of Sodium light using Newton's Rings.
2. Determination of Wavelength of He-Ne laser – Metal Scale.
3. Measurement of Width of a narrow slit using He- Ne Laser.
4. Determination of Specific rotation of Cane sugar by Laurent Half-shade Polarimeter.
5. Determination of capacitance by using R-C circuit.
6. Determination of resonating frequency and bandwidth by LCR circuit.
7. Measurement of half-life of radioactive source using GM Counter.
8. Diffraction grating by normal incidence method.

Reading:

1. Physics Laboratory Manual.

MA 151	MATHEMATICS - II	BSC	3-0-0	3 Credits

Pre-requisites: MA101: Mathematics-I

Course Outcomes: At the end of the course, the students will be able to

CO 1	analyze improper integrals
CO 2	evaluate multiple integrals in various coordinate systems
CO 3	apply the concepts of gradient, divergence and curl to formulate engineering problems
CO 4	convert line integrals into surface integrals and surface integrals into volume integrals
CO 5	apply Laplace transforms to solve physical problems arising in engineering

Course Articulation Matrix

PO/PSO CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	2	1	-	-	-	-	-	-	-	-	1	2	-
CO2	3	3	1	2	1	-	-	-	-	-	-	-	-	1	2	-
CO3	3	3	1	2	1	-	-	-	-	-	-	-	-	1	2	-
CO4	3	3	1	2	1	-	-	-	-	-	-	-	-	1	2	-
CO5	3	3	1	2	1	-	-	-	-	-	-	-	-	1	2	-

Detailed Syllabus

Integral Calculus: Convergence of improper integrals; Beta and Gamma integrals; Differentiation under integral sign; Double and Triple integrals - computation of surface areas and volumes; change of variables in double and triple integrals.

Vector Calculus: Scalar and vector fields; vector differentiation; level surfaces; directional derivative; gradient of a scalar field; divergence and curl of a vector field; Laplacian; Line and Surface integrals; Green's theorem in a plane; Stoke's theorem; Gauss Divergence theorem.

Laplace Transforms: Laplace transforms; inverse Laplace transforms; Properties of Laplace transforms; Laplace transforms of unit step function, impulse function, periodic function; Convolution theorem; Applications of Laplace transforms - solving certain initial value problems, solving system of linear differential equations, finding responses of systems to various inputs viz. sinusoidal inputs acting over a time interval, rectangular waves, impulses etc.

Reading:

1. R. K. Jain and S. R. K. Iyengar, *Advanced Engineering Mathematics*, Narosa Publishing House, 5th Edition, 2016.
2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition, 2015.
3. B. S. Grewal, Higher Engineering Mathematics, Khanna Publications, 2015.

ME102	ENGINEERING GRAPHICS	ESC	1 - 1 - 4	4 Credits

Pre-requisites: None.

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

CO1	Recall BIS standards and conventions while drawing Lines, printing Letters and showing Dimensions.
CO2	Classify the systems of projection with respect to the observer, object and the reference planes.
CO3	Construct orthographic views of an object when its position with respect to the reference planes is defined.
CO4	Analyse the internal details of an object through sectional views.
CO5	Relate 2D orthographic views to develop 3D Isometric View.
CO6	Construct 2D (orthographic) and 3D (isometric) views in CAD environment.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	2	2	2	-	1	-	-	-	1	2	-	-	-	-	-	-
CO2	2	2	2	-	1	-	-	-	1	2	-	-	-	-	-	-
CO3	2	2	2	-	1	-	-	-	1	2	-	-	-	-	-	-
CO4	2	2	2	-	1	-	-	-	1	2	-	-	-	-	-	-
CO5	2	2	2	-	1	-	-	-	1	2	-	-	-	-	-	-
CO6	2	2	2	-	1	-	-	-	1	2	-	-	-	-	-	-

Detailed Syllabus:

Introduction: Overview of the course, Lines Lettering and Dimensioning: Types of lines, Lettering, Dimensioning, Geometrical Constructions, Polygons, Scales

Orthographic Projection: Principles of Orthographic projection, Four Systems of Orthographic Projection.

Projection of Points: Projections of points when they are situated in different quadrants.

Projections of Lines: Projections of a line parallel to one of the reference planes and inclined to the other, line inclined to both the reference planes, Traces.

Projections of Planes: Projections of a plane perpendicular to one of the reference planes and inclined to the other, Oblique planes.

Projections of Solids: Projections of solids whose axis is parallel to one of the reference planes and inclined to the other, axis inclined to both the planes.

Section of Solids: Sectional planes, Sectional views - Prism, pyramid, cylinder and cone, true shape of the section.

Isometric Views: Isometric axis, Isometric Planes, Isometric View, Isometric projection, Isometric views – simple objects.

Auto-CAD Practice: Introduction to Auto-CAD, DRAW tools, MODIFY tools, TEXT, DIMENSION, PROPERTIES

Reading:

1. N.D. Bhat and V.M. Panchal, Engineering Graphics, Charotar Publishers, 2013.
2. Sham Tickoo, AutoCAD 2017 for Engineers & Designers, Dreamtech Press, 23rd Edition, 2016.

CY101	CHEMISTRY	BSC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the students will be able to

CO1	The basic knowledge of the organic reaction mechanism and intermediates.
CO2	The basic knowledge of methods of chemical structure analysis and the instrumentation involved.
CO3	The potential energy aspects of fuel cells, rechargeable batteries and new materials for their fabrication.
CO4	About optical fibres, liquid crystals, LCD, LED, OLED, conducting polymers and their applications.
CO5	The quantum and thermodynamic aspects of various types of bonding, coordination complexes and chemical and enzymatic reactions.
CO6	The synthetic methodologies, importance and applications of nanomaterials in different fields.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	-	2	-	2	-	2	-	-	-	-	1	-	-
CO2	3	3	3	-	2	-	2	-	2	-	-	-	-	1	-	-
CO3	3	3	3	-	2	-	2	-	2	-	-	-	-	1	-	-
CO4	3	3	3	-	2	-	2	-	2	-	-	-	-	1	-	-
CO5	3	3	3	-	2	-	2	-	2	-	-	-	-	1	-	-
CO6	3	3	3	-	2	-	2	-	2	-	-	-	-	1	-	-

Detailed syllabus

Quantum Chemistry and Chemical Bonding: Emergence of Quantum Theory; Postulates of Quantum Mechanics, Operators and Observables, Schrodinger Equation, Particle in a One-Dimensional Box and Colour of Conjugate Molecules, Hetero-diatomic Molecule as Harmonic Oscillator and Rigid Rotor, Hydrogen Atom, LCAO-MO Theory (MO Diagram of CO and NO Molecules).

Chemical Thermodynamics, Equilibrium and Kinetics: Enthalpy and Free Energy Changes in Chemical Reactions; Relevance of C_p and C_v in Gas Phase Reactions, Chemical Potential; Heat

Capacity of Solids, Absolute Entropy and Third Law of Thermodynamics, Rates of Enzyme-Catalysed Homogeneous and Heterogeneous Surface-Catalysed Chemical Reactions

Electrochemistry and Chemistry of Energy Systems: Electrodes and Electrochemical Cells; Potentiometric and Amperometric Sensors; Li-Ion and Ni-Cd Rechargeable Batteries; Fuel Cells (Methanol-Oxygen); Electrochemical Theory of Corrosion; Factors Affecting Rate of Corrosion; Sacrificial Anodic and Impressed Current Cathodic Protection of corrosion.

Coordination Chemistry and Organometallics: Shapes of Inorganic Compounds; Crystal Field and Molecular Orbital Theories; MO-Diagram for an Octahedral Complex; Metal Ions in Biology; Organometallic Chemistry (Metal Carbonyls).

Basics of Organic Chemistry: Classification of Organic reaction and their mechanisms. Reaction intermediates: formation, structure and properties. Named Reactions: Skraup's synthesis, Diels-Alder reaction, Click Reactions.

Engineering Materials and Application: Introduction to Optical fibres, types of optical fibres, applications of optical fibres. Liquid Crystals: LCD, LED, OLED, Conducting Polymers and applications.

Instrumental Methods of Chemical Analysis: Gas- and Liquid-Chromatographic Separation of Components of Mixtures; UV-Visible, FTIR, NMR and Mass Spectral Methods of Analysis of Structures of Organic Compounds.

Reading:

1. P. Atkins and Julio de Paula, Physical Chemistry, Freeman & Co. 8th Edition, 2017.

2. Atkins and Shriver, Inorganic Chemistry, Oxford University Press, 4th Edition, 2008.

3. Clayden, Greaves, Warren and Wothers, Organic Chemistry, Oxford University Press, 2014.

4. Shashi Chawla, Engineering Chemistry, Dhanpat Rai & Co. 2017.

5. Paula Bruce, Organic Chemistry, Pearson, 8th Edition, 2013.

EE101	BASIC ELECTRICAL ENGINEERING	ESC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course, the students will be able to

CO1	Analyze and solve electric and magnetic circuits
CO2	Identify the type of electrical machines for a given application
CO3	Recognize the ratings of different electrical apparatus
CO4	Identify meters for measuring electrical quantities and requirements of illumination

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	-	-	-	1	-	-	-	-	-	-	-	-	-
CO2	3	3	2	-	-	-	1	-	-	-	-	-	-	-	-	-
CO3	3	3	2	-	-	-	1	-	-	-	-	-	-	-	-	-
CO4	3	3	2	-	-	-	1	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

DC Circuits: Kirchoff's Voltage and Current Laws, Superposition Theorem, Star-Delta Transformations

AC Circuits: Complex representation of Impedance, Phasor diagrams, Power & Power Factor, Solution of 1-ϕ Series & Parallel Circuits, Solution of 3-ϕ circuits and Measurement of Power in 3-ϕ circuits

Magnetic Circuits: Fundamentals and solution of Magnetic Circuits, Concepts of Self and Mutual Inductances, Coefficient of Coupling

Single Phase Transformers: Principle of Operation of a Single Phase Transformer, EMF Equation, Phasor Diagram, Equivalent Circuit of a 1-ϕ Transformer, Determination of Equivalent circuit parameters, calculation of Regulation & Efficiency of a Transformer

DC Machines: Principle of Operation, Classification, EMF and Torque Equations, Characteristics of Generators and Motors, Speed Control Methods and Applications

Three Phase Induction Motor: Principle of Rotating Magnetic Field, Principle of Operation of 3-ϕ Induction Motor, Torque – Speed Characteristics of 3-ϕ Induction Motor, Applications Measuring Instruments: Moving Coil and Moving Iron Ammeters and Voltmeters Illumination: Laws of illumination and luminance.

Reading:

1. Edward Hughes, Electrical & Electronic Technology, Pearson, 12th Edition, 2016.
2. Vincent Del Toro, Electrical Engineering Fundamentals, Pearson, 2nd Edition, 2015.
3. V N Mittle and Arvind Mittal, Basic Electrical Engineering, Tata McGraw Hill, 2nd Edition, 2005.
4. E. Openshaw Taylor, Utilization of Electrical Energy, Orient Longman, 2010.

ME101	BASIC MECHANICAL ENGINEERING	ESC	3 - 0 - 0	3 Credits

Pre-requisites: None.

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

CO1	Identify Materials for Engineering Applications
CO2	Describe the functions and operations of Conventional, NC, CNC and 3D Printing methods of manufacturing.
CO3	Select a power transmission system for a given application.
CO4	Understand the concepts of thermodynamics and functions of components of a power plant.
CO5	Understand basics of heat transfer, refrigeration, internal combustion engines and Automobile Engineering.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	1	-	1	1	-	-	-	-	-	-	2	-	-
CO2	3	3	3	1	3	1	1	-	-	-	-	-	-	2	-	-
CO3	3	3	3	1	-	1	1	-	-	-	-	-	-	2	-	-
CO4	3	3	3	1	-	1	1	-	-	-	-	-	-	2	-	-
CO5	3	3	3	1	-	1	1	-	-	-	-	-	-	2	-	-

Detailed Syllabus:

Engineering Materials: Introduction to Engineering Materials, Classification and Properties

Manufacturing Processes: Castings – Patterns & Moulding, Hot Working and Cold Working, Metal Forming processes: Extrusion, Drawing, Rolling, Forging, Welding – Arc Welding & Gas Welding, Soldering, Brazing.

Machine Tools: Lathe – Types – Operations, Problems on Machining Time Calculations, Drilling M/c – Types – Operations, Milling M/c – Types – Operations – Up & Down Milling, Shaping M/c –Operations–Quick Return Mechanism, Planer M/c.– Operations–Shaper Vs Planer, Grinding M/c–Operations. Introduction to NC/CNC Machines, 3D Printing

Power Transmission: Transmission of Power, Belt Drives, Gears and Gear Trains –Simple Problems

Fasteners and Bearings: Fasteners – Types and Applications, Bearings – Types and Selection,

Thermodynamics: Energy Sources – Conventional/Renewable, Thermodynamics – System, State, Properties, Thermodynamic Equilibrium, Process & Cycle, Zeroth law of Thermodynamics, Work & Heat, First law – Cyclic process, Change of State, C_p, C_v, Limitations of First law, Thermal Reservoirs, Heat Engine, Heat Pump/Refrigerator, Efficiency/CoP, Second law, PMM2, Carnot Cycle, Entropy – T-s and P-v diagrams.

Thermal Power Plant: Layout of Thermal Power Plant & Four circuits – Rankine cycle, T-s & P-v diagrams, Boilers – Babcock & Wilcox, Cochran Boilers, Comparison of Fire Tube &Water Tube Boilers, Steam Turbines – Impulse Vs. Reaction, Compounding – Pressure & Velocity Compounding, Condensers – Jet Condenser and Surface Condenser; Cooling Towers.

I.C. Engines: 2-Stroke & 4-Stroke Engines, P-v Diagram; S.I. Engine, C.I. Engine, Differences

Refrigeration: Vapor Compression Refrigeration Cycle – Refrigerants, Desirable Properties of Refrigerants

Heat Transfer: Modes of Heat Transfer, Thermal Resistance Concept, Composite Walls & Cylinders, and Overall Heat Transfer Coefficient – problems

Automobile Engineering: Layout of an Automobile, Transmission, Clutch, Differential, Internal Expanding Shoe Brake

Reading:

1. M.L. Mathur, F.S. Mehta and R.P. Tiwari, R.S. Vaishwnar, Elements of Mechanical Engineering, Jain Brothers, New Delhi, 2008.
2. Praveen Kumar, Basic Mechanical Engineering, Pearson Education, India, 2013.
3. P.N. Gupta, M.P. Poonia, Elements of Mechanical Engineering, Standard Publishers, 2004.
4. C.P. Gupta, Rajendra Prakash, Engineering Heat Transfer, NemChand Brothers, New Delhi, 1994.
5. B.S. Raghuvanshi, Workshop Technology, Vol. 1&2, Dhanpath Rai & Sons, New Delhi, 1989.

CE101	ENGINEERING MECHANICS	ESC	3 – 0 – 0	3 Credits

Pre-requisites: None.

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

CO1	Determine the resultant force and moment for a given system of forces
CO2	Analyze planar and spatial systems to determine the forces in members of trusses, frames and problems related to friction
CO3	Calculate the motion characteristics of a body subjected to a given force system
CO4	Determine the deformation of a shaft and understand the relationship between different material constants
CO5	Determine the centroid and second moment of area

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	2	-	-	1	-	-	-	-	-	-	-	1	-	-
CO2	3	3	2	-	-	1	-	-	-	-	-	-	-	1	-	-
CO3	3	3	2	-	-	1	-	-	-	-	-	-	-	1	-	-
CO4	3	3	2	-	-	1	-	-	-	-	-	-	-	1	-	-
CO5	3	3	2	-	-	1	-	-	-	-	-	-	-	1	-	-

Detailed syllabus:

Introduction - Specification of force vector, Formation of Force Vectors, Moment of Force – Cross product – Problems, Resultant of a general force system in space, Degrees of freedom - Equilibrium Equations, Kinematics – Kinetics – De' Alemberts principle, Degree of Constraints – Freebody diagrams.

Spatial Force systems - Concurrent force systems - Equilibrium equations – Problems, Problems (Vector approach) – Tension Coefficient method, Problems (Tension Coefficient method), Parallel force systems - problems, Center of Parallel force system – Problems.

Coplanar Force Systems - Introduction – Equilibrium equations – All systems, Problems on Coplanar Concurrent force system, Coplanar Parallel force system, Coplanar General force system – Point of action, Method of joints, Method of sections, Method of sections, Method of members, Friction – Coulombs laws of dry friction – Limiting friction, Problems on Wedge friction, Belt Friction-problems.

Mechanics of Deformable Bodies - Stress & Strain at a point- Normal and shear stresses, Axial deformations – Problems on prismatic shaft, tapered shaft and deformation due to self-weight, Deformation of Stepped shaft due to axial loading, Poisson's Ratio – Bulk Modulus - Problems, change in dimensions and volume.

Centroid & Moment of Inertia - Centroid and M.I – Arial – Radius of Gyration, Parallel axis– Perpendicular axis theorem – Simple Problems.

Dynamics of Particles - Rectilinear Motion – Kinematics Problems, Kinetics – Problems, Work & Energy – Impulse Moment, Curvilinear Motion – Normal and tangential components.

Reading:

1. J.L. Meriam, L.G. Kraige, Engineering Mechanics, John Wiley &Sons, 7th Edition, 2012.
2. Timoshenko, Young, Engineering Mechanics, McGraw Hill Publishers, 3rd Edition, 2006.
3. Gere, Timoshenko, Mechanics of Materials, CBS Publishers, 2nd Edition, 2011.

ME103	WORKSHOP PRACTICE	ESC	0 - 0 – 3	2 Credits

Pre-requisites: None.

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

CO1	Study and practice on machine tools and their operations
CO2	Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry and welding
CO3	Identify and apply suitable tools for machining processes including turning, facing, thread cutting and tapping
CO4	Apply basic electrical engineering knowledge for house wiring practice

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	1	-	-	1	-	-	2	2	-	-	-	2	-	-
CO2	3	3	1	-	-	1	-	-	2	2	-	-	-	2	-	-
CO3	3	3	1	-	-	1	-	-	2	2	-	-	-	2	-	-
CO4	3	3	1	-	-	1	-	-	2	2	-	-	-	2	-	-

Detailed Syllabus:

Fitting Trade: Preparation of T-Shape Work piece as per the given specifications, Preparation of U-Shape Work piece which contains: Filing, Sawing, Drilling, Grinding, and Practice marking operations.

Plumbing: Practice of Internal threading, external threading, pipe bending, and pipe fitting, Pipes with coupling for same diameter and with reducer for different diameters and Practice of T-fitting, Y-fitting, Gate valves fitting.

Machine shop: Study of machine tools in particular Lathe machine (different parts, different operations, study of cutting tools), Demonstration of different operations on Lathe machine, Practice of Facing, Plane Turning, step turning, taper turning, knurling and parting and Study of Quick return mechanism of Shaper. Demonstration of the working of CNC and 3D Printing Machines.

Power Tools: Study of different hand operated power tools, uses and their demonstration and Practice of all available Bosch Power tools.

Carpentry: Study of Carpentry Tools, Equipment and different joints, Practice of Cross Half lap joint, Half lap Dovetail joint and Mortise Tenon Joint.

CY102	CHEMISTRY LABORATORY	BSC	0- 1 - 2	2 Credits

Pre-requisites: None.

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

CO1	Select a suitable methodology and compare the strategies involved in the estimation of metal content, iodine content, active chlorine or hardness of water for various applications.
CO2	Apply a selective instrumental method in the place of tedious and complex titration processes for repeated and regulated analysis of acids, bases, redox compounds, etc.
CO3	Test and validate optical activity, corrosion inhibitor efficiency and absorption isotherm of selective compounds and processes.

Course Articulation Matrix

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	3	3	-	2	-	2	-	2	-	-	-	-	1	-	-
CO2	3	3	3	-	2	-	2	-	2	-	-	-	-	1	-	-
CO3	3	3	3	-	2	-	2	-	2	-	-	-	-	1	-	-

Detailed Syllabus:

Cycle-I

1. Standardization $KMnO_4$ solution: Understanding the redox process, electron transfer, importance of qualitative and quantitative analysis.
2. Estimation of Hematite: Understanding the importance on purity of a ore, % of metal content (for Fe).
3. Hardness of Water: Understanding of metal complexes, multi dentate ligands, importance of purity of ground water, (EDTA method; complexometry).
4. Analysis of bleaching powder for available chlorine: Understanding the importance and purity of potable water, back titration (Iodometry).
5. Preparation of nanomaterials: Understanding the importance of nanomaterials, their preparation and characterization.

Cycle II

1. pH metry: Concept of pH, Instrumentation, calibration, determination of the concentrations by instrumental methods

2. Conductometry: Concept of conductivity, importance of conductivity
3. Potentiometry: Determination of the redox potential of the reaction
4. Colorimetry: Importance of Beers and Lamberts law,
5. Photochemical experiment: Importance of visible light and its application for a redox process, importance of coloring agent
6. Preparation of bakelite / polypyrrole: Concepts of organic reactions and application for the organic material preparation.
7. Corrosion experiment: Concept of corrosion, importance of corrosion agents
8. Adsorption experiment: Understanding phenomena of adsorption and absorption
9. Analysis of a drug: Importance of the purity, concentrations of a drug molecule.
10. Preparation of bakelite / red azo dye / Aspirin / Fe(acac) / polypyrrole: Concepts of organic reactions and application for the organic material preparation

Reading:

1. Charles Corwin, Introductory Chemistry laboratory manual: Concepts and Critical Thinking, Pearson Education, 2012.
2. David Collins, Investigating Chemistry: Laboratory Manual, Freeman & Co., 2006.

MA 201	**Mathematics – III** **(Common to EEE, MME, Chemical and Bio-Tech)**	**BSC**	**3 - 0 - 0**	**3 Credits**

Pre-requisites: MA151- Mathematics - II

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

CO1	Obtain the Fourier series for a given function
CO2	Find the Fourier transform of a function and Z- transform of a sequence
CO3	Determine the solution of a PDE by variable separable method
CO4	Understand and use of complex variables and evaluation of real integrals

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	--	--	--	--	1	1	--	2	3	1
CO2	3	3	2	3	--	--	--	--	1	1	--	2	3	1
CO3	3	3	2	3	--	--	--	--	1	1	--	2	3	1
CO4	3	3	2	3	--	--	--	--	1	1	--	2	3	1

Fourier Series: Expansion of a function in Fourier series for a given range - Half range sine and cosine expansions
Fourier Transforms: Fourier transformation and inverse transforms - sine, cosine transformations and inverse transforms - simple illustrations.
Z-transforms: Z- transform and Inverse Z-transforms – Properties – convolution theorem- simple illustrations.
Partial Differential Equations: Method of separation of variables - Solution of one dimensional wave equation, one dimensional heat conduction equation and two dimensional steady state heat conduction equations with illustrations.
Complex Variables: Analytic function - Cauchy Riemann equations - Harmonic functions - Conjugate functions - complex integration - line integrals in complex plane - Cauchy's theorem (simple proof only), Cauchy's integral formula - Taylor's and Laurent's series expansions - zeros and singularities - Residues - residue theorem, use of residue theorem to evaluate the real integrals of the type $\int_0^{2\pi} f\,(Cos\theta,\, Sin\theta)\; d\theta$, $\int_{-\infty}^{\infty} f\,(x)dx$ without poles on the real axis.

Reading:

1. R.K.Jain and S.R.K.Iyengar, *Advanced Engineering Mathematics*, Narosa Pub. House,Fifth edtion, 2016.
2. Erwyn Kreyszig, *Advanced Engineering Mathematics*, John Wiley and Sons, 8th Edition, 2008.
3. B.S.Grewal, *Higher Engineering Mathematics*, Khanna Publications, 44th edition, 2017.

EC235	Analog Electronics	PCC	3 –0–0	3 Credits

Pre-requisites: EC101-Basic Electronics Engineering

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand operation of analog devices and circuits.
CO2	Examine the operation of oscillators and amplifiers.
CO3	Design multi-vibrators and wave shaping circuits

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	-	3	-	-	1	-	1	3	2
CO2	3	3	2	2	2	-	3	-	-	1	-	1	3	2
CO3	3	3	2	3	2	-	3	-	-	1	-	1	3	2

Detailed Syllabus:

Over View of Semi-Conductor Physics: Introduction, static characteristics of PN-Junction diode, zener diode, BJT, FET and MOSFETs

Power Supplies: Single phase half wave, full wave and bridge rectifiers with filters (LC and π), Regulated power supply, series voltage regulator, and principles of uninterrupted power supply

Transistor Amplifiers: Bias stability and thermal runway, analysis of amplifier circuits using h-parameters, emitter follower, simplified CE hybrid model, CE short circuit current gain, single stage CE amplifier response, low frequency response of an RC coupled amplifier, gain-band width product, high frequency response of two cascaded CE stages.

Feedback Amplifiers and Oscillators: Analysis of voltage series, voltage shunt, current series, current shunt, feedback amplifiers, stability of negative feedback amplifiers, analysis of RC phase-shift, Wien bridge, LC-oscillators (using BJT's only) and crystal oscillators.

Direct Coupled Amplifiers: Analysis of differential amplifier configurations, CMRR, stability and drift problems, compensation techniques

Power Amplifiers: Classification of power amplifiers, analysis of class-A, class-B and class-AB operations, push-pull amplifiers and complementary symmetry, harmonic distortion, and cross-over distortion in power amplifiers

Wave Shaping Circuits: RC-low pass, high pass circuits, response to step, pulse ramp and square wave inputs, differentiating and integrating circuits, clipping circuits using diodes-single level and two-level clipping, clamping circuits using diodes.

Multivibrators and Sweep Circuits: Introduction to voltage sweep circuits, boot strap and miller sweep circuits, Astable and Monostable Multi-vibrators and Triggering methods.

Reading:

1. Ramakanth A. Gayakwad: Operational Amplifiers and Linear integrated circuits, Edition 4, PHI, 2000.
2. Stanley: Operational Amplifiers with Linear Integrated Circuits, Edition 4, Pearson Education India, 2002.
3. U. A. Bakshi, A. P. Godse: Linear integrated, Technical Publications, 2010.

CS235	Data Structures	PCC	3 –0–0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the concept of ADT
CO2	Identify data structures suitable to solve problems
CO3	Develop and analyze algorithms for stacks, queues
CO4	Develop algorithms for binary trees and graphs
CO5	Implement sorting and searching algorithms
CO6	Implement symbol table using hashing techniques

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	3	-	-	-	-	1	-	2	3	2
CO2	3	3	-	-	3	-	-	-	-	1	-	2	3	2
CO3	3	3	-	-	3	-	-	-	-	1	-	2	3	2
CO4	3	3	-	-	3	-	-	-	-	1	-	2	3	2
CO5	3	3	-	-	3	-	-	-	-	1	-	2	3	2
CO6	3	3	-	-	3	-	-	-	-	1	-	2	3	2

Detailed Syllabus

Introduction to Data Structures, Asymptotic Notations, Theorems and Examples based on Asymptotic Notations, Linear and Nonlinear Data Structures, Stack Data Structure and its Applications, Queue Data Structure and its Applications, Singly, Doubly and Circular Linked Lists, Trees and tree traversals, Dynamic Sets and Operations on Dynamic Sets, Binary Search Tree and its Operations, Heap Data Structure, Priority Queue, AVL Trees, Direct Addressing; Introduction to Hashing, Collision Resolution by Chaining, Collision Resolution by Open Addressing, Lower Bound for Comparison based Sorting Algorithms, Insertion Sort, Merge Sort, Quick Sort, Heap Sort and Counting Sort, Radix Sort, Introduction to Graphs and Representation of Graphs, Depth First Search (DFS), Breadth First Search (BFS), Applications: BFS and DFS, Prim's Algorithm for finding Minimum Spanning Tree (MST), Kruskal's Algorithm for finding MST, Dijkstra's Algorithm for Single Source Shortest Paths, Floydd-Warshall Algorithm for All-Pairs Shortest Path Problem

Reading:

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, Introduction to Algorithms, Second Edition, PHI, 2009.
2. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, Third Edition, Pearson Education, 2006.
3. Ellis Horowitz, SartajSahni and SanguthevarRajasekaran, Fundamentals of Computer Algorithms, Second Edition, Universities Press, 2011.
4. Michael T.Goodrich and Roberto Tamassia, Algorithm Design: Foundations, Analysis and Internet Examples, Second Edition, Wiley-India, 2006.

EE201	Circuit Theory - I	PCC	3–0–0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Evaluate steady state and transient behavior of single port networks for DC and AC excitations.
CO2	Examine behavior of linear circuits using Laplace transform and transfer functions of single port and two port networks
CO3	Analyze series and parallel resonant circuits.
CO4	Synthesize waveforms using step, ramp and impulse functions.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	2	1	1	1	1	-	2	3	1
CO2	3	3	3	3	3	2	1	1	1	1	-	2	3	1
CO3	3	3	3	3	3	2	1	1	1	1	-	2	3	1
CO4	3	3	3	3	3	2	1	1	1	1	-	2	3	2

Detailed syllabus

Circuit Elements and Relations:

Types of Sources and Source Transformations, Dot- convention, Formation of loop and node equations, Graph of a network Incidence matrix, Dual- networks.

Steady State Analysis of Circuits for Sinusoidal Excitations:

Single phase Series, Parallel, Series Parallel circuits, Solution of AC networks using mesh and nodal analysis, 3-phase balanced and unbalanced network analysis, Neutral voltage calculations, complex power.

Time Domain Analysis:

Solution of network equations in time domain, Classical differential- equations approach, Initial conditions & evaluation, applications to simple RLC circuits only.

Applications of Laplace Transforms in Circuit Theory:

Laplace transforms of various signals of excitation, Laplace transformed networks, determination and representation of initial conditions, Waveform synthesis, Response for impulse function and its relation to network admittance, Convolution integral and applications.

Resonance:

Series and Parallel resonance, Bandwidth, Q-factor and selectivity.

Reading:

1. M.E.Van Valken Burg: Network Analysis, 3rd Edition, Pearson Education,2015.
2. G.K Mittal & Ravi Mittal: Network Analysis, 14th Edition, Khanna Publications.,2003.
3. M.L. Soni and J.C. Gupta: A course in Electrical Circuits Analysis, Dhanpat Rai& Co. (P), 2001.
4. Gopal G Bhise, Prem R Chadha &Durgesh C. Kulshreshtha Gopal: Engineering Network Analysis and Filter Design, Umesh Publications,2012
5. S.R. Paranjothi: Electric Circuit Analysis, New Age International Pub.,2002.
6. De Carlo & Lin: Linear circuit Analysis, Oxford University Press, 2nd Edition,2010.

EE202	**Electric and Magnetic Fields**	PCC	3 - 0 - 0	**3 Credits**

Pre-requisites: MA151 – Mathematics - II

Course Outcomes: At the end of the course the student will be able to:

CO1	Compute electric & magnetic fields for symmetrical charge and current configurations and the force between charges and currents.
CO2	Calculate capacitance and inductance of common conductor configurations and the energy stored.
CO3	Analyze time varying fields and compute the energy stored in electromagnetic fields
CO4	Understand the Electro-mechanical Energy conversion from the concepts of field-energy and coenergy

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	1	2	-	-	1	1	1	-	3	3	2
CO2	3	3	1	1	2	-	-	1	1	1	-	3	3	2
CO3	3	3	1	1	2	2	-	1	1	1	-	3	3	2
CO4	3	2	1	1	2	-	-	1	1	1	-	3	3	2

Detailed Syllabus

Overview of Coordinate System and Vector Algebra:

Scalar and vector fields, overview of coordinate system, calculus of scalar and vector fields in Cartesian and curvilinear coordinates

Electrostatics: Coulomb’s law, Electrical filed intensity, electric flux density, electric field due to point, line, sheet, spherical charge distributions, Gauss’ law and its applications, Divergence and curl of electrostatic field, Energy expended in moving a charge in an electric field, electric potential, potential due to point, line, spherical charge distributions, potential gradient, Poisson’s and Laplace’ equations, Uniqueness theorem, Electric dipole, Dipole moment, potential and electric filed due to an electric dipole, Torque on an Electric dipole in an electric field, resistance, capacitance, Dielectrics, Energy in electrostatic field, boundary conditions.

Magnetostatics: Biot-Savart’s law, magnetic flux density, magnetic field intensity, magnetic field due to straight wire, surface, solenoid, toroid carrying steady current Ampere’s Law and its applications, Divergence and curl of Magnetic field, Comparison of magnetostatics and electrostatics, Magnetic scalar and vector potentials, Lorentz force, inductance, self and mutual inductance of solenoid, toroidal and other simple configurations, conductors, magnetic materials, Hall effect, energy in magneto static fields, boundary conditions.

Time Varying Fields: Equation of continuity, Faraday’s law, Lenz’s law, transformer emf and motional emf, inconsistency of Ampere’s law, displacement current, Maxwell’s equations, electromagnetic wave, Poynting theorem, energy in electro-magnetic fields.

Magnetically Coupled Circuits & Electromechanical Energy Conversion: Review of basic concepts, magnetizing inductance, modeling linear and nonlinear magnetic circuits. Principles of energy flow, concept of field energy and co-energy, Derivation of torque expression for various machines using the principles of energy flow and the principle ofcoenergy.

Reading:

1. William H.Hayt Jr. & John A.Buck: Engg. Electromagnetics, TMH 8th Edition, 2012.
2. David J.Griffiths: Introduction to Electrodynamics, PHI 4thEdition, 2013.
3. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff: Analysis of Electric Machinery & Drive systems- IEEE Press, 3rdEdition, 2013.
4. Matthew Sadiku: Elements of Electromagnetics, Oxford University Press, 2007.

5. Nathan Ida: Engg. Electromagnetics, Springer 2nd Edition, 2005
6. A.E Fitzgerald, C. Kingsely and S.Umans: Electrical Machines by, MGH, 5th Edition.

EE203	Electrical Measurements and Instrumentation	PCC	3-0-0	3- Credits

Pre-requisites: EE101 – Basic Electrical Engineering, EC101 - Basic Electronics Engineering, PH101 - Physics, and MA101 - Maths

Course outcomes: At the end of the course the student will be able to:

CO1	Compare performance of MC, MI and Dynamometer types of measuring instruments, Energy meters and CRO.
CO2	Determine the circuit parameters using AC and DC bridges.
CO3	Compute the errors in CTs and PTs.
CO4	Select transducers for the measurement of temperature, displacement and strain
CO5	Understand operating principles of electronic measuring instruments.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	1	1	1	2	2	1	1	3	1
CO2	3	2	2	1	1	1	1	1	2	2	1	1	3	1
CO3	3	2	2	1	1	1	1	1	2	2	1	1	3	1
CO4	3	2	2	1	1	1	1	1	2	2	1	1	3	1
CO5	3	2	2	1	3	1	1	1	2	2	1	2	3	2

Detailed Syllabus:

Analog Ammeters and Voltmeters: PMMC and MI Instruments, Construction, Torque Equation, Range Extension, Effect of temperature, Classification, Errors, Advantages and Disadvantages.

Analog Wattmeters and Power Factor Meters: Power and Power Factor, Electrodynamometer type wattmeter, power factor meter, Construction, theory, torque equation, Advantages and disadvantages, active and reactive power measurement in single phase, Measurement in three phase.

Analog Energy Meter: Single phase induction type energy meters, construction, theory, Operation, lag adjustments, Max Demand meters/indicators.

DC and AC Bridges: Measurement of resistance, Wheatstone Bridge, Kelvin's Bridge, Kelvin's Double Bridge, loss of charge method for measurement of high resistance, Measurement of inductance, Capacitance, Maxwell's Bridge, De-Sauty Bridge, Anderson Bridge, Schering Bridge, Wien Bridge, Applications and Limitations.

Instrument Transformers: Current Transformer and Potential Transformer - construction, theory, phasor diagram, errors, testing and applications.

Transducers: Measurement of Temperature, RTD, Thermistors, Thermocouple, LVDT, Strain Gauge, Piezoelectric Transducers, Digital Shaft Encoders, Tachometer, Hall effect sensors.

Electronic Instruments: Digital Voltmeters, CRO, measurement of voltage and frequency, Lissajous Patterns, Wave Analyzers, Harmonic Distortion Analyzer, LCR Q-meter

Reading:

1. A. K. Sawhaney- A course in Electrical Measurements Electronic Measurements and Instrumentation- DhanpatRai and Sons,2015
2. W.D. Coopers and Helfrick- Modern Electronic instrumentation and Measurements Techniques, Printice Hall of India P. Ltd.2002
3. E.W. Gowlding and F.C.Widdis: Electrical Measurements and Measuring Instruments, Reem, 2011.

EC236	Analog Electronics Lab	PCC	0 –1–2	2 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Test electronic circuits using experiment boards.
CO2	Design electronic circuits to meet specific requirements
CO3	Understand methods of designing electronic circuits

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	-	3	-	-	1	-	1	3	2
CO2	3	3	2	2	2	-	3	-	-	1	-	1	3	2
CO3	3	3	2	3	2	-	3	-	-	1	-	1	3	2

Detailed syllabus:

List of Experiments

1. Characteristics of Semiconductor devices: Diode, BJT,FET.
2. Transistorbiasing
3. Zener diode as aregulator
4. Frequency Response of single stage CEamplifier.
5. RC Phase shiftOscillator
6. OPAMP IC 741 Inverting and non-invertingamplifiers.
7. Clippers andClampers
8. Rectifiers andFilters
9. OPAMP 741 LogarithmicAmplifier
10. Multi-vibrators

Reading:

1. J. Millman, Microelectronics, Mc grawhill,1987.
2. Ramakant A. Gayakwad, Operational amplifiers and Linear IC technology, PHI,1987
3. Robert L. Boylested, Electronic Devices and Circuit Theory, 9th Edition, Pearson.

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CS236	Data Structures Lab	PCC	0 –1–2	2 Credits

Pre-requisites: CS235 – Data Structures

Course Outcomes: At the end of the course the student will be able to:

CO1	Develop ADT for stack and queue applications
CO2	Implement tree and graph algorithms
CO3	Implement and analyze internal and external sorting algorithm
CO4	Design and implement symbol table using hashing technique

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	3	-	-	-	-	-	-	-	3	2
CO2	3	3	-	-	3	-	-	-	-	-	-	-	3	2
CO3	3	3	-	-	3	-	-	-	-	-	-	-	3	2
CO4	3	3	-	-	3	-	-	-	-	-	-	-	3	2

Detailed syllabus:

1. Write a program to implement stack usingarrays.
2. Write a program to evaluate a given postfix expression usingstacks.
3. Write a program to convert a given infix expression to postfix form usingstacks.
4. Write a program to implement circular queue usingarrays.
5. Write a program to implement double ended queue (de queue) usingarrays.
6. Write a program to implement a stack using two queues such that the push operation runs in constant time and the pop operation runs in lineartime.
7. Write a program to implement a stack using two queues such that the push operation runs in linear time and the pop operation runs in constanttime.
8. Write a program to implement a queue using two stacks such that the enqueue operation runs in constant time and dequeue operation runs in lineartime.
9. Write a program to implement a queue using two stacks such that the enqueue operation runs in linear time and dequeue operation runs in constanttime.
10. Write programs to implement the following data structures: Single linked list, Double linkedlist
11. Write a program to implement a stack using a linked list such that the push and pop operations of stack still take O(1)time.
12. Write a program to implement a queue using a linked list such that the enqueue and dequeue operations of queue take O(1)time.
13. Write a program to create a binary search tree (BST) by considering the keys in given order and perform the following operations on it: Minimum key, Maximum key, Search for a given key, Find predecessor of a node, Find successor of a node, delete a node with givenkey
14. Write a program to construct an AVL tree for the given set of keys. Also write function for deleting a key from the given AVLtree.
15. Write a program to implement hashing with (a) Separate Chaining and (b) Open addressingmethods.
16. Implement the following sorting algorithms: Insertion sort, Merge sort, Quick sort.Heapsort
17. 17. Write programs for implementation of graph traversals by applying:(a)BFS (b) DFS
18. Writeprogramstofindoutaminimumspanningtreeofasimpleconnectedundirectedgraphbyapplying: (a) Prim’s algorithm (b) Kruskal’salgorithm
19. Write a program to implement Dijkstra’s algorithm for solving single source shortest path problem using priorityqueue.
20. Write a program to implement Floydd-Warshall algorithm for solving all pairs shortest pathproblem.

MA251	Mathematics-IV (Common to EEE, MME, Chemical and Bio-Tech)	BSC	3– 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Interpret an experimental data using interpolation / curve fitting
CO2	Solve numerically algebraic/transcendental and ordinary differential equations
CO3	Understand the concepts of probability and statistics
CO4	Obtain the series solutions for ordinary differential equations

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	--	--	--	--	1	1	--	2	3	1
CO2	3	3	2	3	--	--	--	--	1	1	--	2	3	1
CO3	3	3	2	3	--	--	--	--	1	1	--	2	3	1
CO4	3	3	2	3	--	--	--	--	1	1	--	2	3	1

Detailed Syllabus:

Numerical Methods:
Curve fitting by the method of least squares. Fitting of (i) Straight line (ii) Second degree parabola (iii) Exponential curves - Gauss-Seidal iteration method to solve a system of equations - Numerical solution of algebraic and transcendental equations by Regula-Falsi method and Newton-Raphson's method - Lagrange interpolation, Forward and backward differences, Newton's forward andbackward interpolation formulae - Numerical differentiationwith forward and backward differences -Numerical Integration with Trapezoidal rule, Simpson's 1/3 rule and Simpson's 3/8 rule - Taylor series method, Euler's method, modified Euler's method, 4th order Runge-Kutta method for solving first order ordinary differential equations.

Probability and Statistics: Random variables,discrete and continuous random variables, Mean and variance of Binomial, Poisson and Normal distributions and applications.
Testing of Hypothesis –Null and alternate hypothesis, level of significance and critical region-Z-test for single mean and difference of means, single proportion and difference of proportions - t-test for single mean and difference of means - F-test for comparison of variances, Chi-square test for goodness of fit - Karl Pearson coefficient of correlation, lines of regression and examples.

Series Solution: Series solution of Bessel and Legendre's differential equations - Bessel function of first kind, Recurrence formulae, Generating function, Orthogonality of Bessel functions - Legendre polynomial, Rodrigue's formula, Generating function, Recurrence formula, Orthogonality of Legendre polynomials.

Reading:

1. M. K. Jain, S.R.K.Iyengarand R.K.Jain, Numerical methods for Scientific and Engineering Computation, New Age International Publications,2008.
2. S.C.Gupta and V.K.Kapoor, Fundamentals of Mathematical Statistics, S.Chand& Co,2006.
3. Erwyn Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition,2008.
4. B.S.Grewal, Higher Engineering Mathematics, Khanna Publications,2009.

EC285	Digital Electronics	PCC	3 –0–0	3 Credits

Pre-requisites: EC101 - Basic Electronics Engineering

Course Outcomes: At the end of the course the student will be able to:

CO1	Design combinational and sequential digital circuits to meet a given specification and be able to represent logic functions in multiple forms-understanding the advantages and disadvantages of each.
CO2	UnderstandhowCMOStransistorscanbeusedtorealizedigitallogiccircuitsandunderstand basic characteristics of logic gates (such as power, noise margins, timing, tri-state circuitry, etc.).
CO3	UnderstandnumericalandcharacterrepresentationsindigitallogicincludingASCII,sign magnitude, 2's complement, and floating point and the corresponding design of arithmetic circuitry.
CO4	Understand the importance and need for verification and testing of digital logic circuits.
CO5	Understand the principle of operation and design of a wide range of electronic circuits such as computer RAM and ROM.
CO6	Understand how convert signals from analog to digital and digital to analog.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	-	1	-	-	-	-	1	-	1	3	1
CO2	2	2	-	1	-	-	-	-	-	1	-	1	3	1
CO3	2	2	-	1	1	-	-	-	-	1	-	1	3	1
CO4	2	2	3	1	-	-	-	-	-	1	-	1	3	2
CO5	2	2	-	1	1	-	-	-	-	1	-	1	3	2
CO6	2	2	3	1	-	-	-	-	-	1	-	1	3	1

Detailed syllabus:

Number system and codes: Analog versus digital, merits of digital system, number systems, base conversions, complements of numbers, weighted and unweighted codes, and error detecting and correcting codes.

Switching algebra and switching functions: Boolean algebra, postulates, theorems and switching algebra, completely and incompletely specified switching functions, minimization of Boolean functions using Karnaugh map and Quine McCluskey methods.

Logic Families: Characteristic parameters, Transistor-Transistor logic, TTL subfamilies, CMOS logic family, Implementation of Boolean function using CMOS logic, various logic gate ICs.

Combinational Logic: Principles and practices, Logic design of combinational circuits code conversion, parity generation and checking, multiplexers, de-multiplexers, encoders, decoders, buffers, tri-state buffers, IC Versions of Combinational logic circuits.

Sequential Logic: Review of Flip-Flops, Finite State model of sequential Circuits, modulus counter, shift registers, IC Version of sequential logic circuits.

Semiconductor Memories: RAM, ROM (Cell Structures and Organization on Chip)

Data Conversion Circuits: D/A converter specifications, A/D converter specifications, D/A converters such as DAC 0808, DAC 1408/1508, Integrated circuit A/D Converters ADC 0808, ICL 7106/7107.

Reading:

1. Linear Integrated Circuits, S Salivahanan, TATA MC GrawHill.
2. Jain R.P, "Modern Digital Electronics", Third edition, Tata Mc GrawHill,2003
3. Floyd T.L., "Digital Fundamentals ", Prentice Hall, 9th Edition, 2006
4. Anil K. Mani: Digital Electronics-Principles and Integrated Circuits, Wiley-India, 2007.
5. Herbert Taub, Schilling: Digital Integrated Electronics, TATA MC Graw Hill, 2008.

EE251	Circuit Theory-II	PCC	3–1–0	4 Credits

Pre-Requisites: EE201 – Circuit Theory I

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze electric circuits using Network Theorems.
CO2	Evaluate Network Transfer function of Electrical Network
CO3	Analyze given waveform through Fourier series and Fourier Transformation.
CO4	Design filters, attenuators and single port networks.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	2	1	1	1	1	1	2	3	1
CO2	3	3	3	3	3	2	1	1	1	1	1	2	3	1
CO3	3	3	3	3	3	2	1	1	1	1	1	2	3	1
CO4	3	3	3	3	3	2	1	1	1	1	2	2	3	2

Detailed syllabus

Network Theorems:

Superposition theorem, Reciprocity theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Millman's theorem, Tellegen's theorem

Network Functions:

Driving point impedance and transfer functions of 1-port RLC Networks, Natural frequencies of a network, Poles and Zeros of driving point impedances

Two Port Networks:

Impedance, admittance, transmission and hybrid parameters of two-port networks and their inter-relationship

Fourier Transforms and Fourier series:

Review of Fourier series and evaluation of Fourier coefficients, Trigonometric and complex Fourier series for repetitive waveforms, Amplitude and phase spectrums, Fourier transforms and application to network analysis with non-sinusoidal repetitive waveform excitations.

Passive Filters and Attenuators:

Classification and general relations in filters, Constant K low pass, high pass and band pass filters, m-derived low pass, high pass and band pass filters, Attenuators–symmetrical and asymmetrical.

Reading:

1. M.E. Van Valkenburg : Network Analysis 3th Edition, PHIPublications,2002
2. Gopal G Bhise, Prem R Chadha &Durgesh C. Kulshreshtha Gopal: EngineeringNetwork Analysis and Filter Design, Umesh Publications,2012
3. N.C. Jagan, C. Lakshminarayana: Network Theory, BS publications,2003

EE252	Electrical Machines - I	PCC	3-0-0	3 Credits

Pre-requisites: EE101 - Basic Electrical Engineering

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the construction and principle of operation of DC machines, single phase and three phase transformers and auto transformers.
CO2	Analyze starting methods and speed control of DC machines.
CO3	Analyze parallel operation of DC Generators, single phase and three phase transformers
CO4	Evaluate the performance of DC machines and transformers.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	1	1	2	1	1	1	1	1	2	3	2
CO2	3	3	3	1	1	2	1	1	1	1	1	2	3	2
CO3	3	3	3	2	1	2	1	1	1	1	1	2	3	2
CO4	3	3	3	2	1	2	1	1	1	1	2	2	3	2

Detailed Syllabus:

DC Machines: Constructional details, Simplex and multiplex lap and wave windings; Methods of excitation, characteristics of saturated and un-saturated series, shunt, cumulatively and differentially compound excited machines operating as motors and generators; Armature reaction, demagnetizing and cross magnetizing ampere turns, compensating windings, commutation, inter poles.

Speed control methods of D.C. shunt & series motors, losses and efficiency; 3 point starter, 4- point Starter for D.C. motors. Testing of D.C. machines: No-load test, Direct load test, Hopkinson's and Field's test, Retardation test.

Single Phase Transformers: Construction, principle of operation, EMF equation, phasor diagram; Equivalent circuit, determination of equivalent circuit parameters, Losses, calculation of efficiency and regulation by direct and indirect methods; Predetermination of performance by Sumpner's test, Load sharing and operation of transformers in parallel, Separation of no load losses by experimental method, principle of auto transformer, Saving of copper compared to two winding transformer and its application.

Three Phase Transformer: Type of connections, Relation between line and phase voltages and currents, use of tertiary winding, Scott connection of transformers for phase conversion.

Reading:

1. P. S Bimbhra-Electrical Machines-Khanna Publishers,2002
2. A.E Fitzgerald, Charles Kingsley, Stephen D Umans Electrical Machines–TMH Publishers, 6th Edition, 2003.
3. Nagarath& D.P. Kothari: Electrical Machines, TMH Publishers, 4th Edition, 2004
4. J.B. Gupta: Theory &Performance of Electrical Machines SK Kataria& Sons, 4th Edition, 2006.
5. A.E. Clayton & C.I. Hancock Performance and Design of DCMachines.

EE253	Power Systems-I	PCC	3 – 0 – 0	3 Credits

Pre-requisites: EE101 - Basic Electrical Engineering

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the operation of conventional generating stations and renewable sources of electrical power.
CO2	Evaluate power tariff methods.
CO3	Determine the parameters of transmission lines
CO4	Understand the layout of substation, underground cables and corona.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	2	3	3	1	1	1	2	2	3	3
CO2	3	3	2	2	2	3	2	1	1	1	2	2	3	3
CO3	3	3	3	2	2	1	1	1	1	1	-	1	3	3
CO4	3	3	3	2	3	3	2	1	1	1	3	3	3	3

Detailed syllabus

Introduction: Typical Layout of an Electrical Power System Present Power Scenario in India.

Generation of Electric Power:

Conventional Sources (Qualitative): Hydro station, Steam Power Plant, Nuclear Power Plant and Gas Turbine Plant.

Renewable energy Sources (Qualitative): Wind Energy, Fuel Cells, and Solar Energy.

Economics of Generation: Introduction, definitions of connected load, maximum demand, demand factor, load factor, diversity factor, Load duration curve, number and size of generator units. Base load and peak load plants. Cost of electrical energy-fixed cost, running cost, Tariff on charge to customer.

AC Distribution: Introduction, AC distribution, Single phase, 3-phase, 3 phase 4 wire system, bus bar arrangement, Selection of site and layout of substation.

Overhead Line Insulators: Introduction, types of insulators, Potential distribution over a string of suspension insulators, Methods of equalizing the potential, testing of insulators.

Insulated Cables: Introduction, insulation, insulating materials, Extra high voltage cables, grading of cables, insulation resistance of a cable, Capacitance of a single core and three core cable s, Overhead lines versus underground cables, types of cables.

Transmission line sag calculation: The catenary curve, Sag tension calculations, Supports at different levels, Stringing Chart

Inductance and Capacitance Calculations of Transmission Lines: Line conductors, inductance and capacitance of single phase and three phase lines with symmetrical and unsymmetrical spacing, Composite conductors-transposition, bundled conductors, and effect of earth on capacitance.

Corona: Introduction, disruptive critical voltage, corona loss, Factors affecting corona loss and methods of reducing corona loss, Disadvantages of corona, interference between power and Communication lines. Numerical problems in corona

Reading:

1. W.D.Stevenson –Elements of Power System Analysis, Fourth Edition, McGraw Hill, 1984.
2. C.L. Wadhwa –Generation, Distribution and Utilization of Electrical Energy, Second Edition, New AgeInternational,2009
3. C.L. Wadhwa –Electrical Power Systems, Fifth Edition, New AgeInternational,2009
4. M.V.Deshpande –Elements of Electrical Power Station Design, Third Edition, Wheeler Pub.1998
5. H.Cotton& H. Barber-The Transmission and Distribution of Electrical Energy, Third Edition, ELBS,B.I.Pub.,1985

EC286	Integrated Circuit Applications Lab	PCC	0 –1–2	2 Credits

Pre-requisites: EC235 - Analog Electronics, EC285 - Digital Electronics

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze and design applications using OPAMP IC 741.
CO2	Design and construct waveform generation circuits
CO3	Verify the functionality of combinational and sequential circuit ICs.
CO4	Design combinational and sequential circuits using Digital ICs

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2	-	-	-	-	1	-	3	3	1
CO2	3	3	3	2	2	-	-	-	-	1	-	3	3	1
CO3	3	3	3	2	3	-	-	-	-	1	-	3	3	1
CO4	3	3	3	2	3	-	-	-	-	1	-	3	3	2

Detailed syllabus:

List of Experiments

1. Study and Operation of IC testers, pulse generator and digital trainer.
2. Measurement of Op Amp parameters:
3. Off set voltage
4. Off set current
5. CMRR
6. Slew rate
7. Open loop gain
8. Input impedance.
9. Op Amp monostable and astable multivibrators.
10. 555 timer: Monostable and astable multivibrators.
11. Characteristics of TTL NAND gate: (i) Sourcing (ii) Sinking(iii)Transfer
12. Study of flip-flops: RS, JK, T andD.
13. Mod-N counter using 7490 and74190.
14. Mod-N counter using 7492 and74192.
15. MUX and decoder ICSs (IC74153&74138).
16. Shift registers IC7495.

Reading:

1. J.MILLMAN, Microelectronics, Mc-Graw Hill,1987.
2. Ramakant A. Gayakwad, Operational amplifiers and Linear IC technology, PHI,1987

EE254	Electrical Circuits Lab	PCC	0– 1–2	2 credits

Pre-requisites: EE202 - Electric & Magnetic Fields, EE251 - Circuit Theory-II

Course Outcomes: At the end of the course the student will be able to:

CO1	Validate network theorems
CO2	Evaluatethetimeresponseandfrequencyresponsecharacteristicsof RLCseriescircuit and their resonance conditions.
CO3	Determine Z, Y and ABCD parameters for a given two port network.
CO4	Simulate and analyze electrical circuits using MATLAB / Pspice tools.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	2	2	1	1	1	2	2	1	2	3	2
CO2	3	3	2	2	2	1	1	1	2	2	1	2	3	2
CO3	3	3	2	2	2	1	1	1	2	2	1	2	3	2
CO4	3	3	2	3	3	1	1	1	3	2	1	3	3	3

Detailed syllabus:

List of Experiments

1. A) Verification of Kirchhoff’s laws and understanding spanning tree
2. B) Verification of Tellegen's Theorem
3. Verification of Superposition and Thevenin's theorem
4. Verification of Maximum Power Transfer and Reciprocity theorems
5. Analysis of two port networks: Determination of Z, Y, and ABCD parameters using two port network
6. Time response of 1st order RC circuit and 2^{nd} order RLC circuit
7. Frequency response analysis of 2^{nd} order RLC circuit
8. Analysis of series and parallel coupled circuits
9. Power factor improvement and harmonic power analysis in single - phase AC circuit
10. Analysis of 1- series and parallel AC circuits using R - L, R - C and R - L - C elements Elementary Matrix operations, simple calculations using array and vectors, creating script
11. Files and function files, solution of circuits using mesh and loop equations, and 3 - D surface plotting etc....

EE255	Electrical Measurements & Instrumentation Lab	PCC	0 - 1 - 2	2 Credits

Pre-requisites: EE203 - Electrical Measurements & Instrumentation

Course Outcomes: At the end of the course the student will able to**:**

CO1	Understand the usage of various types of Analog and Digital Meters and Oscilloscopes
CO2	Test the various Components, Magnetic materials and calibrate Energy meters
CO3	Measure the Resistance, Inductance and Capacitance using AC& DC bridges
CO4	Test the polarity of Transformer terminals and determine the errors in Potential Transformers and Current Transformers
CO5	Determine the characteristics of various transducers for Temperature, Pressure and Weight etc.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	3	2	2	2	3	2	2	2	2	3
CO2	3	3	2	3	3	2	2	2	3	2	2	2	2	3
CO3	3	3	2	3	3	2	2	2	3	2	2	2	2	2
CO4	3	3	2	2	2	2	2	2	3	2	2	2	2	2
CO5	3	3	2	2	2	2	2	2	3	2	2	2	2	2

Detailed Syllabus:

LIST OF EXPERIMENTS

1. Study and observe the oscilloscope as a test and measuring instrument.
   (Test the Resistors, Capacitors, Diodes, Transistors and measure AC/DC voltages, frequency, and phase and study the Lissageous patterns).
2. Obtain the B-H curve and B-H Loop of a magnetic specimen to obtain its hysteresis loss and also calculate its Steinnmetz's constant andcoefficient.
3. Calibrate the single phase energy meter by phantom loading for various loads and power factors.
4. Measurement of low resistance using Kelvin's Double Bridge.
5. Measurement of Inductance and Capacitance using Maxwell's Bridges.
6. Measurement of Inductance using Anderson's Bridge.
7. Measurement of Capacitance using ScheringBridge.
8. Measurement of Ratio error and Phase error of a Potential Transformer
9. Measurement of Ratio error and Phase error of a Current Transformer.
10. Measurement of Temperature using RTD and Thermistors
11. Measurement of pressure and Weight using Piezoelectric Transducers
12. Measurement of power factor using two-watt meter method

Reading:

1. A.K. Sawhney," A Course in Electric, Electronic Measurements & Instrumentation", Dhanpat Rai & Co.
2. William David Cooper and Helfric, "Modern Electronic Instrumentation and Measurement Techniques,PHI
3. E. W. Goelding and F. C. Widdis,"Electric Measurements and Measuring Instrument", A H Wheel &Co.

SM312	Engineering Economics & Accountancy	HSC	3 –0–0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand various methods of Economic Analysis and apply
CO2	Calculate Depreciation using various methods
CO3	Understand the electricity act and its implications on power markets
CO4	Sensitize the student to Macro Economic Environment.
CO5	Analyze the financial statements with ratios for investment decisions.
CO6	Analyze costs and their role in pricing
CO7	To develop effective presentation skills

Course Articulation Matrix:

CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	--	--	--	--	--	-	2	--	--	-	3	-	--	--
CO2	--	--	--	--	--	1	3	--	--	-	2	-	--	--
CO3	--	--	--	--	--	1	-	--	--	-	1	3	--	--
CO4	--	--	--	--	--	1	-	--	--	-	1	-	--	--
CO5	--	--	--	--	--	-	-	--	--	-	1	-	--	--
CO6	--	--	--	--	--	-	1	--	--	-	1	-	--	--
CO7	--	--	--	--	--	-	-	--	--	3	-	-	--	--

Detailed Syllabus:

POWER ECONOMICS

1. Introduction to Engineering Economics, Fundamental concepts, Time value of money, Cash flow and Time Diagrams, Choosing between alternative investment proposals, Methods of Economic analysis (Pay back, ARR, NPV, IRR and B/C ratio),
2. Depreciation and methods of calculating depreciation (Straight line, Sum of the years digit method, declining Balance Method, Annuity Method, Sinking Fund method).
3. National Income Accounting, Methods of Estimation, Various Concepts of National Income, Significance of National Income Estimation and its limitations
4. Inflation, Definition, Process and Theories of Inflation and Measures to Control,
5. New Economic Policy 1991, LPG, Power sector reforms in India, present pricing strategies, role of private sector participation in India. Role of technology in nation growth.
6. Power regulatory authority of India, type of deregulation, solar power generation drives, Discom revival, Power Markets, energy exchange and power exchange.
7. Demand supply and equilibrium price consumer surplus, producer surplus, latent demand.

ACCOUNTANCY

8. Analysis of financial statements, income statements and balance sheet (simple ratios).
9. Cost Accounting, Introduction, Classification of costs, Methods of Costing, Techniques of Costing, Cost sheet and preparation cost sheet, Breakeven Analysis, Meaning and its application, Limitation.

Presentations / Group Discussions on current topics.

Reading:

1. D N Dwivedi “Managerial Economics”, Vikas Publishing House Private Limited
2. Agrawal AN, “Indian Economy” Wiley Eastern Ltd, New Delhi
3. R.K Sharma and Sashi K Gupta,” Financial Management”, Kalyani Publications

4. Arora, M.N.” Cost Accounting”, Vikas Publication.

Source- Internet

- Latest trends in Indian Economy.
- Capitaline Plus Database –http://www.capitaline.com/
- Ministry of Finance –http:/finmin.nic.in/
- Database of Indian Economy -http://dbie.rbi.org.in
  Statistics of India – www.indiastat.com/ orhttp://mospi.nic.in/

EE301	Control Systems	PCC	3 –1–0	4 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze electromechanical systems by mathematical modelling.
CO2	Determine Transient and Steady State behavior of systems using standard test signals.
CO3	Analyze linear systems for steady state errors, absolute stability and relative stability using time domain and frequency domain techniques
CO4	Identify and design a control system satisfying specified requirements.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	1	1	1	2	1	1	2	3	1
CO2	3	3	3	3	3	1	1	1	2	1	1	2	3	1
CO3	3	3	3	3	3	1	1	1	2	1	1	2	3	1
CO4	3	3	3	3	3	1	1	1	2	1	1	2	3	2

Detailed Syllabus:

Introduction: System, control system, types of control systems, open-loop and closed loop systems, types of feedback, feedback and its effects. Concept of linearization with incremental changes.

Mathematical Modelling of Physical Systems: Mathematical modelling of Electrical, Mechanical and Electro-mechanical elements, D.C. motors. Block diagram representation. Concept and use of Transfer function.

Transfer Function from Block Diagrams and Signal Flow Graphs: Introduction, impulse response and its relation with transfer function of linear systems. Block diagram reduction technique and signal flow graph, Mason's gain formula.

State Variable Analysis of Linear Dynamic Systems: State variables, state variable representation of system, dynamic equations, merits for higher order differential equations and solution. Concept of controllability and observability and techniques to test them.

Time Domain Analysis of Control Systems: Introduction- typical Test signals, time domain indices, steady state error constants, concept of BIBO stability, absolute stability, Routh - Hurwitz Criterion. Effect of P, PI & PID controllers.

Root Locus Techniques: Introduction, Root loci theory, Application to system stability studies. Illustration of the effect of addition of a zero and a pole.

Frequency Domain Analysis of Control Systems: Introduction, polar plots, Nyquist stability criterion, Frequency domain indices (gain margin, phase margin, bandwidth), Bode plots, application of Bode plots, Introduction to lag and lead compensation.

Reading:

1. B.C.Kuo: Automatic Control Systems – Prentice Hall of India, 7th Edition,2004
2. I.J.Nagarath,M.Gopal: Control Systems Engineering, New Age Pub. Co, 6th – Edition,2017.
3. Francis Harvey Raven: Automatic control engineering, McGraw-Hill,2008.
4. Katsuhiko Ogata: Modern Control Engineering, Pearson Education India, 5th Edition,2015

EE302	Electrical Machines-II	PCC	3-0-0	3 Credits

Pre-requisites: EE252- Electrical Machines - 1

Course Outcomes: At the end of the course the student will be able to:

CO1	Understanding the construction and principle of operation of induction machines and synchronous machines.
CO2	Evaluate performance characteristics of induction machine and synchronous machines.
CO3	Analyze starting and speed control methods of induction machines and synchronous machines.
CO4	Analyze the effects of excitation and mechanical input on the operation of synchronous machine.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	2	1	1	1	1	2	2	3	1
CO2	3	3	3	2	2	2	3	1	1	1	2	2	3	1
CO3	3	3	3	2	2	2	1	1	1	1	2	2	3	3
CO4	3	3	3	2	2	2	1	1	1	1	2	2	3	2

Detailed Syllabus:

3-Phase Induction Motor:

Introduction: Constructional details, types, production of rotating magnetic field-principle of operation and practical rating of induction motors.

Analysis of Induction Motors: Phasor diagram, equivalent circuit, Torque equation-starting and maximum-torque, maximum-output, slip for maximum-output, Torque-slip characteristics, losses & efficiency and applications.

Starters and Testing of Induction Motors: Auto transformer, star delta and rotor resistance starters Testing-no load and blocked rotor tests-determination of equivalent circuit parameters, Pre-determination of performance from equivalent circuits and circle diagram.

Double cage induction motor: Construction, theory, equivalent circuit, Characteristics and applications.

Induction generator: Principle of operation, equivalent circuit and application.

Synchronous Generator:

Construction, types, practical rating of synchronous generators, winding factors, production of emf, harmonics, armature reaction, Synchronous reactance, phasor diagram, load characteristics, open circuit and short circuit tests.

Methods of pre-determination of regulation- Synchronous impedance, ampere turn, Potier triangle and ASA methods. Two reaction theory–analysis and its application for the pre-determination of regulation of salient pole alternator, phasor diagram. Slip test, power angle characteristics, synchronization and synchronizing power. Parallel operation and load sharing–operation on infinite bus-bar typical applications.

Synchronous Motor:

Theory of operation–phasor diagrams, variation of current and power factor with excitation. Hunting and its suppression, determination and pre-determination of V and inverted V curves, method of starting.

Reading:

1. P.S. Bimbhra: Electrical Machinery – Khanna Publishers, 7th Edition, 2011.
2. Charbs.I. Hubert: Electric Machines –Second Edition – Pearson, 2003.
3. Stephen.J.Chapman: Electric Machinery –McGraw Hill International Edition,2005.
4. A.E. Fitzgerald, Charles Kingsley, Stephen D. Umans: Electric Machinery –Sixth Edition TMH 2003.
5. M.G. Say: Alternating Current Machines-Fourth Edition-PitmanPublishing-1976.

EE303	Power Systems-II	PCC	3 – 0 – 0	3 Credits

Pre-requisites: EE253 - Power Systems-I

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze transmission line performance.
CO2	Apply shunt compensation techniques to control reactive power
CO3	Understand the role of per unit quantities
CO4	Analyze the travelling wave phenomenon on transmission lines
CO5	Determine the fault currents for symmetrical and unbalanced faults

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	1	1	1	1	1	2	1	3	2
CO2	3	3	3	3	3	1	1	1	1	1	2	1	3	1
CO3	3	3	3	3	3	1	1	1	1	1	2	1	3	1
CO4	3	3	3	3	3	1	1	1	1	1	2	1	3	2
CO5	3	3	3	3	3	1	1	1	1	1	2	1	3	2

Detailed Syllabus

Performance of Lines: Representation of lines, short transmission lines, medium length lines, nominal T and PI-representations, long transmission lines. The equivalent circuit representation of a long Line, A, B, C, D constants, Ferranti Effect, Power flow through a transmission line, receiving end power circle diagram.

Voltage Control: Introduction methods of voltage control, shunt and series capacitors / Inductors, tap changing transformers, synchronous phase-modifiers.

Compensation in Power Systems: Introduction- Concepts of Load compensation Load ability characteristics of overhead lines uncompensated transmission line Symmetrical line Radial line with asynchronous load Compensation of lines.

Per Unit Representation of Power Systems: The one line diagram, impedance and reactance diagrams, per unit quantities, changing the base of per unit quantities, advantages of per unit system.

Travelling Waves on Transmission Lines: Production of traveling waves, open circuited line, short circuited line, line terminated through a resistance, line connected to a cable, reflection and refraction at T-junction line terminated through a capacitance, capacitor connection at a T-junction, Attenuation of travelling waves.

Symmetrical Components: Significance of positive, negative and zero sequence components, Average 3-phase power in terms of symmetrical components, sequence impedances and sequence networks.

Fault Calculations: Fault calculations, sequence network equations, single line to ground fault, line to line fault, double line to ground fault, three phase fault, faults on power systems, and faults with fault impedance, reactors and their location, short circuit capacity of a bus.

Reading:

1. JohnJ.Grainger &W.D. Stevenson: Power System Analysis McGraw Hill International, 1994.
2. C.L. Wadhwa: Electrical Power Systems New Age International Pub. Co. Third Edition, 2001.
3. Hadi Saadat:PowerSystem Analysis – Tata Mc Graw Hill Pub.Co.2002
4. W.D. Stevenson: Elements of Power system Analysis, McGraw Hill International Student Edition.
5. D.P. Kothari and I.J. Nagrath, Modern Power System Analysis - Tata McGraw-Hill Pub. Co., New Delhi, Fourth Edition,2011

EE304	Microprocessors and Microcontrollers	PCC	3-0-0	3 Credits

Pre-requisites: EC285 - Digital Electronics

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the basic architectures of microprocessors and microcontrollers.
CO2	Write assembly language programs to perform a given task and interrupt service routines for all interrupt types
CO3	Interface memory and I/O devices to processor using peripheral devices
CO4	Write microcontroller programs and interface devices and also to understand IDE to develop code for embedded microcontrollers

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	1	1	1	1	1	1	1	1	2	3	1
CO2	3	3	3	2	2	1	1	1	2	1	1	2	3	3
CO3	3	3	3	3	3	3	2	1	3	2	2	3	3	3
CO4	3	3	3	3	3	3	2	1	3	2	2	3	3	3

Detailed Syllabus:

Introduction: Overview of the course, Functional elements of a microprocessor, overview of architecture of a general purpose microprocessor.

8086 Microprocessor: Internal Architecture of 8086, BIU and EU- Registers in of 8086- Memory segmentation- Addressing modes-register related and memory related- Instruction formats, Instruction set of 8086- Assembler directives, Tutorial- Problems on assembly language programming- Pin diagram of 8086 , Modes of operation- Timing diagrams of typical instructions- Fundamentals of I/O data transfer, Polling, Handshaking, interrupts-Steps in an interrupt process, Interrupt structure in 8086- Fundamentals of interfacing peripheral chips, Interfacing memory & I/O devices- Interfacing I/O- Programmable peripheral interface-8255, Modes of operation of 8255, Interfacing examples with 8255- Interfacing 8254 timer, Interfacing Digital to analog converters, Analog to Digital converters- Interfacing USART 8251.

Advanced Microprocessors: Multi-User/Multi-Tasking Operating System, Memory Management, qualitative analysis in architectural features of Intel 80286, 80386, Pentium, Pentium-pro, and Power PC.

8051 Microcontroller: 8051 architecture, memory organization, addressing modes & port structure, external memory access, counters and timers, Interrupts, serial communication, Microcontroller instructions -, moving data, logical operations, arithmetic operations, jump and call instructions – subroutines - Interrupts and returns. Microcontroller programming – Assembly Language Programming, timer and counter programming, Interrupt programming- Interfacing examples.

PIC Microcontroller: Introduction - Architecture – Memory organization – Assembly Language programming – simulation using Integrated Development Environment (IDE) - Programming of I/Oports – Addressing modes Bank switching – Look-up Table and Table processing – Timers and its programming – Interrupt programming- analog-to-digital converter (ADC) module- Synchronous Serial Port (SSP) Module -Interfacing examples.

Reading:

1. Douglas V. Hall : Microprocessors and Interfacing, TMH-Revised Second Edition,2005
2. Ray A.K., Bhurchandi K.M., ‘Advanced Microprocessor and Peripherals’, Tata McGraw-Hill Publications, 3rdEdition, 2013.
3. Kenneth J Ayala, ‘The 8051 Microcontroller’, Cengage Learning Publications, 3rdEdition, 2007.
4. PIC Microcontroller and Embedded Systems: Using Assembly and C for Pic18, Muhammad Ali Mazidi, Danny Causey, Rolin McKinlay Pearson Education, 2011.
5. Ramesh S. Gaonkar, ‘Microprocessor Architecture Programming and Applications with 8085’, Penram Intl. Publishing, 6thEdition, 2013.
6. Ajay V. Deshmukh: Microcontrollers – Theory and Applications, TMH, 2009.
7. Yu-Cheng Liu, Glem A. Gibson, “Microcomputer systems: The 8086/8088 Family Architecture programming and design”, Pearson Education India’ 2nd edition, 2015.

EE305	Electrical Machines Lab-I	PCC	0–1–2	2 Credits

Pre-requisites: EE252 - Electrical Machines - I

Course Outcomes: At the end of the course the student will be able to:

CO1	Select apparatus based on the ratings of DC Machines and Transformers.
CO2	Determine equivalent circuit parameters and performance of transformers.
CO3	Evaluate the performance of DC machines and transformers by direct and indirect loading methods.
CO4	Select braking and speed control methods of DC machines

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2	2	2	1	2	3	1	2	3	1
CO2	3	2	1	2	1	2	1	1	2	3	1	2	3	1
CO3	3	3	2	1	2	2	1	1	2	3	1	2	3	1
CO4	3	2	3	1	1	2	2	1	2	3	1	2	3	1

List of Experiments:

1. Determination of open circuit characteristic of D.C. machine
2. Determination of Load characteristics of D.C. generators
3. Speed control of D.C. motors using Armature control and Field control Methods
4. Brake test on D.C. Shunt motor
5. Swinburne’s Test on DC Machine
6. Retardation test on D.C. machines to determine the Moment of Inertia
7. Field's test on two identical D.C. Series machines
8. Hopkinson test on two identical D.C. machines
9. O.C. and S.C. tests on single phase transformer
10. Load test on single phase transformer
11. Sumpner's test on two single phase transformers
12. Scott connection of single phase transformers
13. Separation of no load losses of a single phase transformer

EE306	Electrical Simulation Lab	PCC	0 – 1 –2	2Credits

Pre-requisites: EE201 – Circuit Theory I, EE252 - Electrical Machines - I, EE301 - Control Systems, and EE303 - Power Systems-II

Course Outcomes: At the end of the course the student will be able to:

CO1	Simulate and analyses electrical and power electronic circuits.
CO2	Model, simulate and analyze the performance of DC Machines
CO3	Analyze performance of feedback and load frequency control systems
CO4	Evaluate the performance of transmission lines

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	1	1	1	3	2	1	3	3	2
CO2	3	3	3	3	3	1	1	1	3	2	1	3	3	2
CO3	3	3	3	3	3	1	1	1	3	2	1	3	3	2
CO4	3	3	3	3	3	1	1	1	3	2	1	3	3	2

Detailed Syllabus

Experiments:

1. Design and simulate the characteristics of first and second order circuits in time and frequency domain
2. Solution of first and second order differential equations using RK-4^{th} order method.
3. Simulation of bridge rectifiers using Pspice
4. Performance evaluation of medium and long transmission lines using MATLAB
5. Symmetrical component analysis using MATLAB
6. DC Motor Speed control using MATLAB/Simulink
7. Design and analyses the performance of feedback control system
8. Simulate and tune parameters of a PID controller for a given system
9. Load frequency control of single area and two area power system with Matlab /Simulink
10. Performance of FC-TCR compensator using PSCAD/ EMTDC/MATLAB
11. Permanent Magnet DC motor simulation using Matlab /Simulink
12. Transient stability studies of SMIB system using equal area criterion using MATLAB.

Reading:

1. C.L. Wadhwa: Electrical Power Systems –Third Edition, New Age International Pub. Co., 2001.

2. Hadi Sadat: Power System Analysis –Tata Mc Graw Hill Pub. Co.2002.

3. Control Systems Engineering-I.J. Nagrath & M. Gopal- New Age International Pub.Co

4. A.E. Clayton & C.I. Hancock Performance and Design of DC Machines.

EE311	Computer Organization	DEC	3– 0–0	3 Credits

Pre-requisites: EC 285 - Digital Electronics

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the characteristics of functional components of a computer system
CO2	Determine the architectural features and functional inter-relationships between CPU, Memory, IO and operating system
CO3	Analyzethehierarchicalstructureofcomputersystemcomponentsanddesignsub-systemsto improve and influence performance.
CO4	Design a memory organization for a choice of memory chips

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	2	1	1	1	1	1	-	1	-	-
CO2	3	3	1	3	1	2	2	2	2	2	2	2	2	1
CO3	3	3	3	3	3	3	3	3	3	3	-	3	2	1
CO4	3	2	3	3	2	2	2	2	2	2	-	1	1	1

Detailed syllabus

Introduction: Historical review, evolution and design considerations, Computer evolution and performance organization and architecture, Computer structure and function, Computer interconnection structures.

Interconnection structures: Bus Interconnection structures, Elements of bus design, Example bus systems, Signals, operations-PCI Bus and Furture bus, Bus commands and timing diagrams, Future bus and other bus standards

Internal Memory: Characteristics of hierarchical memory systems, components and types, Memory organization- Design of a memory organization system, Cache memory organization and elements of cache design, Mapping functions, replacement algorithms and hardware

Operating system support: OS as a resource manager, Role of memory management and techniques, Virtual memory, address translation and implementation

External memory: Types of external memory devices and characteristics, Input/output subsystem: Characteristics of I/O data transfer, External interfaces, Front system bus (FSB) and its implication in I/O data transfer

CPU – Arithmetic unit- Number systems and representations, Functions of ALU, Floating point number operations

CPU – Processing Unit: Machine instruction formats, Instruction execution, CISC Vs RISC processors, superscalar processors

CPU – Control Unit: Internal organization of CPU, micro-operations, Micro-programmed control unit, Minimization of control word size by grouping of control signals, Wide branch addressing, Advantages and disadvantages of Micro-programmed control unit, Hardwired control unit

Recent trends in computer systems: Parallel processing, Vector processing, optimization of main memory across processors

Reading:

1. Computer Organization and Design-The HW/SW Interface: Peterson and Hennessey, Elsevier
2. Computer organization and Architecture-Designing for performance: WilliamStallings,-PHI
3. Computer Organization: Hamacher, Vranesic and Zaky, McGraw Hill, ISE
4. Computer Organization: John P Hayes, McGraw Hill, ISE

EE312	Electrical Engineering Materials	DEC	3-0-0	3 Credits

Course Outcomes: At the end of the course, students will be able to

CO1	Analyze the characteristics of Insulating, conducting, super-conducting and semiconducting materials used in electrical machines and power conversion devices.
CO2	Evaluate the properties of dielectric and magnetic materials.
CO3	Understand the properties of special purpose materials used in electrical applications.
CO4	Identify suitable materials for manufacturing of electrical equipment's/devices.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	3	1	1	1	1	1	2	3	1
CO2	3	3	3	2	2	3	2	1	2	1	1	2	3	2
CO3	3	3	3	2	2	2	2	1	2	1	1	2	3	2
CO4	3	3	3	2	2	2	2	1	3	1	2	2	3	2

Detailed syllabus:

Conducting materials for Electrical Equipments: Introduction & material Classifications; resistance and its factors affecting it such as alloying & temperature, low resistivity & high resistivity materials; Copper, aluminum, Steel, manganin, Nichrome, mercury and tungsten etc. - resistivity, temperature coefficient, density, corrosion, contact resistance; copper alloys: Brass, Bronze, Silver, Gold, Platinum, superconductors and their applications; Semi-conducting Materials and their properties, silicon, germanium, Silicon Carbide (SiC), Gallium Nitride (GaN) devices.

Dielectric Materials: Introduction, types & electrical properties - volume resistivity, surface resistance, dielectric loss, dielectric strength, dielectric constant; Thermal Properties - Heat resistance, thermal stability, thermal conductivity, Electro-thermal breakdown in solid dielectrics; Chemical Properties - chemical resistance, weather ability; Gaseous materials - Air, Hydrogen, Nitrogen, SF6 materials and applications. Piezoelectric materials, pyroelectric materials, Liquid, gaseous & Nano-dielectrics materials and their application to HV power equipment with examples.

Insulating materials and applications: Introduction – Types, electrical characteristics; Electrical & Thermal properties- solid insulating materials, Mica, Micanite, Asbestos, Bakelite, rubber, plastics & thermo-plastics, Amino & epoxy resins, polystyrene, PVC, Ceramic materials (porcelain & steatite), glass, Cotton, Silk, Paper (dry & impregnated), Rubber, Bitumen, high voltage insulated cables, fiber sleeves.

Liquid insulating materials – Mineral oils, synthetic liquids, fluorinated liquids – their electrical, thermal and chemical properties – transformer oil, effect of moisture on insulation properties. Insulating varnishes for coating and impregnation.

Gaseous insulators – classification & properties- based on dielectric strength, dielectric loss, chemical stability & their applications.

MAGNETIC MATERIALS : Introduction - ferromagnetic materials and permeability, B-H curve, magnetic saturation, hysteresis loop (including) coercive force and residual magnetism, concept of eddy current and hysteresis loss, Curie temperature, magneto-striction effect, ageing of magnets, factors effecting permeability and hysteresis. Cast & cermet permanent magnets.

Soft & Hard Magnetic Materials- Alloyed steels with silicon, alloy steel for transformers, low silicon alloy steel for electric rotating machines. Cold rolled grain oriented steels for transformer, Nickel-iron alloys, and Soft Ferrites; hard magnetic materials- hard ferrites and cobalt steel & their applications.

SPECIAL PURPOSE MATERIALS: Stranded conductors, bimetals fuses, soft soldering and hard soldering materials, electric carbon materials, thermo couple, Galvanization and Impregnation of materials.

Materials for capacitors, lighting systems (like LCD, LED bulb surface, CFL, fluorescent etc.) and their properties.

Reading:

1. Electrical and Electronic Engineering Materials by SK Bhattacharya, Khanna Publishers, New Delhi Edition-2012.
2. A Course In Electrical Engineering Materials, by S. P. Seth, 3/E, 2011, Dhanpat Rai publications (2011).
3. Materials Science for Electrical and Electronic Engineers, by Ian Jones, Oxford University Press; Fourth Impression edition (22 May2007).
4. Electrical Engineering Material, by Adrianus J. Dekker, Prentice Hall India Learning Private Limited; 1st Edition (1970).
5. Electrical Engineering Materials, by R. K. Shukla, McGraw Hill Education, 2017.
6. Electrical Engineering Materials, by R K Rajput, Laxmi Publications, 2nd Edition, 2015.
7. Electrical Engineering Materials & Electrical Components, by K.B. Raina & Bhattai; S.K. Kataria & Sons; Edition (2013).
8. Electrical Engineering Materials, by T K Basak, New Age Science Publications, Edition: 1st Rev. Reprint, Feb 2014.

EE313	Utilization of Electrical Energy	DEC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to

CO1	Understand basic principles of electric heating and welding.
CO2	Determine the lighting requirements for flood lighting, household and industrial needs
CO3	Calculate heat developed in induction furnace
CO4	Evaluate speed time curves for traction

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1	3	3	1	1	1	2	2	3	2
CO2	3	3	3	2	1	3	3	1	1	1	2	2	3	3
CO3	3	3	2	2	1	3	2	1	1	1	2	2	3	2
CO4	3	3	2	2	1	3	2	1	1	1	2	3	3	2

Detailed syllabus:

Electrical Heating and Welding Advantages and methods of electric heating, resistance heating, induction heating and dielectric heating. Electric welding: Electric welding equipment, resistance welding and arc welding, comparison between AC and DC welding. Electrolysis process: principle of electrolysis, electroplating, metal extraction and metal processing, electromagnetic stirs.

Illumination Terminology, Laws of illumination, coefficient of Utilization and depreciation, Polar curves, photometry, integrating sphere, sources of light, fluorescent lamps, compact fluorescent lamps, LED lamps discharge lamps, mercury vapour lamps, sodium vapour lamps and neon lamps, comparison between tungsten filament lamps and fluorescent tubes. Basic principles of light control, Types and design of lighting scheme, lighting calculations, factory lighting, street lighting and flood lighting.

Electric Traction Systems of electric traction and track electrification- DC system, single phase and 3-phase low frequency and high frequency system, composite system, kando system, comparison between AC and DC systems, problems of single phase traction with current unbalance and voltage unbalance. Mechanics of traction movement, speed – time curves for different services. Evaluate speed time curves for traction trapezoidal and quadrilateral speed – time curves, tractive effort, power, specific energy consumption, effect of varying acceleration and braking, retardation, adhesive weight and braking retardation, coefficient of adhesion. Systems of train lighting, special requirements of train lighting, methods of obtaining unidirectional polarity constant output- single battery system, Double battery parallel block system, coach wiring, lighting by making use of 25KV AC supply.

Reading:

1. H. Partab: Modern Electric Traction, DhanpatRai& Co, 2007.
2. E. Openshaw Taylor: Utilisation of Electric Energy, Orient Longman, 2010.
3. H. Partab: Art & Science of Utilisation of Electric Energy, DhanpatRai& Sons, 1998.
4. N.V. Suryanarayana: Utilisation of Electrical power including Electric drives and Electric Traction, New Age Publishers, 1997.

EE314	Industrial Instrumentation and Automation	DEC	3-0-0	3 Credits

Pre-requisites: EE203 - Electrical Measurements & Instrumentation

Course Outcomes: At the end of the course the student will be able to:

CO1	Apply the concepts and analyze the performance of physical systems using transducers for measurement of physical quantities
CO2	Understand various Signal Conditioning operations and design Signal Conditioning circuitry of a measurement & instrumentation system
CO3	Exposure to the technology of Industrial Automation and Control
CO4	Implementation of various PLCs to Automation problems in industries.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2	3	2	2	1	1	2	2	3	2
CO2	3	3	3	3	3	2	2	1	2	2	2	2	3	2
CO3	3	3	3	3	2	2	2	1	2	1	3	2	3	2
CO4	3	3	3	3	3	2	1	1	3	2	3	2	3	2

Detailed Syllabus:

Introduction: Static and Dynamic characteristics of Instrument. Displacement and proximity gauges. Linear Variable Differential Transformer (LVDT), Hall-effect sensors.

Measurement of Temperature, Flow, Level and Viscosity: Thermocouple, Resistance Temperature Detector (RTD), Thermistor, Radiation Pyrometer, Differential Pressure flow-meter, Variable area flow-meter, Variable reluctance transducer, Turbine flow-meter, Ultrasonic flow-meter (Both transit time and Doppler Shift), electromagnetic flow-meter and Mass flow meter, Capacitance based and Float based method, pH -probe and viscosity measurement.

Measurement of Pressure, strain & Vibration: Elastic transducers (Bourdon Gauge, Bellow and Diaphragm Gauge). Low pressure measurement, Strain Gauge, unbalanced Wheatstone bridge, Load cell, Torque Cell, Piezo-eiectric sensors, accelerometers.

Signal Conditioning and Processing: Estimation of errors and Calibration, Fundamentals of 4-20 mA current loops, Regulators and power supplies for industrial instrumentation.

Basics of Data transmission: Synchro and Servo motor. IEEE-488 bus, RS 232 and RS 485 interface. Pneumatic and Hydraulic Instrumentation system

Automation: Benefits and Impact of Automation on Manufacturing and Process Industries; Architecture of Industrial Automation Systems. Data Acquisition systems and PC based automation.

Introduction to Automatic Control: P-I-D Control, Controller Tuning, Special Control Structures, Feed-forward and Ratio Control, Predictive Control, Control of Systems with Inverse Response, Cascade Control. Process and Instrumentation Diagrams;

Sequence Control: PLCs and Relay Ladder Logic, Scan Cycle, RLL Syntax, Structured Design Approach, Advanced RLL Programming, Hardware environment; Control of Machine tools: Introduction to CNC Machines.

Reading:

1. Doebelin, Measurement Systems, Applications and Design, Tata McGraw Hill, 2008.
2. Measurement & Instrumentation : Trends & Applications by M.K. Ghosh, S. Sen and S. Mukhopadhyay, Ane Books,2010
3. Fundamentals of Industrial Instrumentation Alok Barua, Wiley India Pvt Ltd,2011
4. Measurement and Instrumentation Principles, 3rdEdition, Alan S Morris, Butterworth-Heinemann, 2001
5. Industrial Instrumentation, Control and Automation, S. Mukhopadhyay, S. Sen and A. K. Deb, Jaico Publishing House,2013
6. Chemical Process Control, An Introduction to Theory and Practice, George Stephanopoulos, Prentice

Hall India,2012
7. Frank. D, Petruzella, “Programmable Logic Controllers”, Tata McGraw Hill ThirdEdition-2010.

EE351	Power Systems Operation and Control	PCC	3 – 1 – 0	4 Credits

Pre-requisites: EE303 - Power Systems-II

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze load flow methods, economic operation and load frequency control of power system.
CO2	Analyze the functions of Energy Management System (EMS).
CO3	Determine the stability of power system.
CO4	Understand power system deregulation and smart grid technologies.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	2	1	1	3	1	2	2	3	2
CO2	3	3	3	2	3	2	1	1	1	1	3	2	3	2
CO3	3	3	3	3	3	3	1	1	2	1	1	2	3	2
CO4	3	3	3	1	3	3	1	1	1	1	3	2	3	3

Detailed syllabus

Load Flow Studies: Introduction, Bus classification -Nodal admittance matrix - Load flow equations - Iterative methods - Gauss and Gauss Seidel Methods, Newton-Raphson Method-Fast Decoupled method-Merits and demerits of the above methods - System data for load flow study. **Control of Real-Power:** Effect of synchronous machine excitation-Power angle of a synchronous machine-Specification of bus voltages Capacitor banks, control by transformers.

Economic Operation of Power Systems: Distribution of load between units within a plant - Transmission loss as a function of plant generation, Calculation of loss coefficients - Distribution of load between plants.

Load Frequency Control: Introduction, load frequency problem-Megawatt frequency (or P-f) control channel, MVAR- voltages (or Q-V) control channel-Dynamic interaction between P-f and Q-V loops. Mathematical model of speed-governing system-Turbine models, division of power system into control areas, P-f control of single control area (the uncontrolled and controlled cases)-P-f control of two area systems (the uncontrolled cases and controlled cases)

Power System Stability: The stability problem- Steady state stability, transient stability and Dynamic stability-Swing equation. Equal area criterion of stability-Applications of Equal area criterion, Step-by-step solution of swing equation-Factors affecting transient stability, Methods to improve steady state and Transient stability, Introduction to voltage stability

Power System Deregulation (Qualitative Treatment Only): Introduction - Power system restructuring models- ~~r~~esponsibilities and functions of independent system operator (ISO), Ancillary Services

Smart – Grid Technologies (Qualitative Treatment Only): Components of smart – grid, Introduction to PMUs and their applications.

Reading:

1. C.L. Wadhwa, Electrical Power Systems, 3rd Edition, New Age International Publishing Co., 2001.
2. D.P.Kothari and I.J.Nagrath, Modern Power System Analysis, 4th Edition, Tata McGraw Hill Education Private Limited 2011.
3. Journal papers on smart grid.

EE352	Power Electronics	PCC	3 - 0 - 0	3 Credits

Pre-requisites: EE101 - Basic Electrical Engineering, EC101 - Basic Electronics Engineering, and EE201 - Circuit Theory-1

Course Outcomes: At the end of the course the student will be able to:

CO1	Select switching devices for a given power converter.
CO2	Evaluate the performance of phase-controlled rectifiers.
CO3	Design DC-DC converter for a given performance
CO4	Analyze and evaluate the operation of Inverters and ac voltage controllers

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	3	3	1	2	1	2	3	3	3
CO2	3	3	3	3	3	3	3	1	2	1	2	3	3	3
CO3	3	3	3	3	3	3	3	1	2	1	2	3	3	3
CO4	3	3	3	3	3	3	3	1	2	1	2	3	3	3

Detailed Syllabus

Introduction: Concept of power electronics, scope and applications, types of power converters, power semiconductor switches and their V-I characteristics Diodes, SCR, TRIAC, power MOSFET, IGBT. Thyristor ratings and protection, methods of SCR commutation, gate drive circuits, switching and conduction losses in a generic power semiconductor device.

Phase-Controlled Rectifiers: Principles of single-phase fully-controlled converter with R, RL, and RLE load, Principles of single-phase half-controlled converter with RL and RLE load, Principles of three-phase fully-controlled converter operation with RLE load, Effect of load and source inductances, Single phase and Three phase dual converters

DC-DC Converters: Introduction, Basic principles of step-down and step-up operation, chopper classification study of Buck, Boost and Buck-Boost regulators, Introduction to forward and fly back converters.

Inverters: Introduction, principle of operation, performance parameters, single phase bridge inverters with R, RL and RLC loads, 3-phase bridge inverters- 180 and 120 degrees mode of operation, Voltage control of single phase inverters –single pulse width modulation, multiple pulse width modulation, sinusoidal pulse width modulation.

A.C. Voltage Controllers: Introduction, principle of operation of single phase voltage controllers for R, R-L & R-L-E loads and its applications.

Reading:

1. M.H.Rashid, Power Electronics - Circuits, Devices and Applications, PHI, 2009.
2. P.S.Bimbhra, Power Electronics, Khanna Publishers, New Delhi, 2016.
3. Mohan Undeland Robin, Power Electronics - Converters, Applications and Design, John Wiley & Sons, 2006.

EE353	Power System Protection	PCC	3–0–0	3 Credits

Pre-requisites: EE303 - Power Systems-II

Course Outcomes: At the end of the course the student will be able to:

CO1	Evaluate electromagnetic, static and microprocessor based relays
CO2	Design protection schemes for power systems.
CO3	Select relay settings for overcurrent and distance relays.
CO4	Analyze quenching mechanisms used in air, oil, SF_6 and vacuum circuit breakers

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	3	2	1	1	2	1	2	1	3	3
CO2	3	3	3	3	3	2	1	1	2	1	3	1	3	3
CO3	3	3	2	2	2	2	1	1	2	1	2	1	2	1
CO4	3	3	2	2	2	2	1	1	2	1	2	1	2	1

Detailed syllabus

Introduction: Introduction, Need for power system protection, effects of faults, Fuses Introduction, fuse characteristics, types of fuses, application of HRC fuses, discrimination.

Overvoltage Protection and Insulation Coordination: Over voltage due to arcing ground and Peterson coil, lightning, horn gaps, surge diverters, rod gaps, expulsion type lightning arrester, valve type lightning arrester, ground wires, ground rods, counter poise, surge absorbers, insulation coordination, volt-time curves.

Protective Relays: Evolution of protective relays, zones of protection, primary and backup protection, essential qualities of protection, classification of protective relays and schemes, current transformers, potential transformers, basic relay terminology.

Operating Principles of Protective Relays: Electromagnetic relays, thermal relays, static relays, Amplitude and Phase comparators, Duality between AC and PC, Static amplitude comparator, integrating and instantaneous comparators, static phase comparators, coincidence type of phase comparator, introduction to microprocessor based protective relays.

Over-current Protection: Time-current characteristics, current setting, over current protective schemes, directional relay, protection of parallel feeders, protection of ring mains, Phase fault and earth fault protection, Combined earth fault and phase fault protective scheme, Directional earth fault relay.

Distance Protection: Impedance relay, reactance relay, MHO relay, input quantities for various types of distance relays, Effect of arc resistance, Effect of power swings, effect of line length and source impedance on the performance of distance relays, selection of distance relays, MHO relay with blinders, Reduction of measuring units, switched distance schemes, autore-closing.
Pilot Relaying Schemes: Wire Pilot protection, Carrier current protection.

AC Machines and Bus Zone Protection: Protection of Generators, Protection of transformers, Bus-zone protection, frame leakage protection.

Static Relays: Static over current relays, static directional relay, static differential relay, static distance relays, and Multi input comparators, concept of Quadrilateral and Elliptical relay characteristics.

Microprocessor Based Relays: Over current relays, directional relays, distance relays.

Circuit Breakers: Introduction, arcing in circuit breakers, arc interruption theories, re-striking and recovery voltage, resistance switching, current chopping, interruption of capacitive current, oil circuit breaker, air blast circuit breakers, SF6 circuit breaker, operating mechanism, selection of circuit breakers, high voltage d.c. breakers, ratings of circuit breakers, testing of circuit breakers.

Reading:

1. Badriram and D.N. Vishwakarma, Power System Protection and Switchgear, TMH2001.
2. U.A.Bakshi, M.V.Bakshi: Switchgear and Protection, Technical Publications, 2009.
3. C.Russel Mason – ―The art and science of protective relaying, Wiley Eastern,1995
4. L.P.Singh―ProtectiverelayingfromElectromechanicaltoMicroprocessorsnewAgeInternational.

EE354	Electrical Machines – III	PCC	3–0–0	3 Credits

Pre-requisites: EE302 - Electrical Machines-II

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze single phase induction motors and identify the suitable methods of starting.
CO2	Understand the operation principles of Reluctance motor, Stepper motor, Hysteresis motor, and Universal motor and identify the suitable applications.
CO3	Understand the operation principles and identify the suitable applications of PMDC, PMSM, BLDC, SR motors and Linear Induction motors.
CO4	Understand the energy efficient and super conducting machines

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	1	1	1	1	1	1	2	3	1
CO2	3	3	2	2	2	1	1	1	1	1	1	2	3	1
CO3	3	3	2	3	3	1	1	1	1	1	1	3	3	3
CO4	3	2	2	2	3	1	1	1	1	1	1	3	3	2

Detailed Syllabus:

Single Phase Induction Motors: Principle of operation, Double revolving field theory, speed-torque characteristics, Equivalent circuit, Phasor diagrams, Determination of equivalent circuit parameters, Starting methods, Split-phase starting, Resistance starting, Capacitance starting, Shade pole starting, Speed control methods, Applications, Principle of cross field theory, Problem on all the above motors.

Single Phase Synchronous Motors: Construction, principle of operation and applications of Reluctance motors, Hysteresis motors, Sub-synchronous motors

AC Series Motors: Construction, Principle of operation, Phasor diagrams and Characteristics of Single phase and Three Phase AC Series motors, Simple and compensated motors, Universal motors and their Applications, Problems on all the above motors

Schrage Motor: Construction, Principle of operation, Speed and power factor control, Applications

Special Purpose Machines: Construction and principle of operation of Stepper motors, Permanent magnet DC motors, Brushless DC motors, Permanent Magnet Synchronous Motors, Switched Reluctance Motors , Linear Induction motors and their Applications, Problems on all the above motors

Energy Efficient Machines: Construction, Basic Concepts, losses minimization and efficiency calculations of Energy efficient AC machines

Super Conducting Machines: Construction, Principle of operation and basic concepts of super conducting AC machines.

Reading:

1. A. E. Fitzgerald, C. Kingsley and Stepen D. Umans: Electric Machinery, Tata McGraw-Hill Pub., 2002.
2. P.S. Bimbhra: Generalized Theory of Electrical Machines, Khanna Pub.1997.
3. D.P. Kothari and I J Nagarath: Electric Machines: Tata McGraw-Hill Pub., Third Edition, 2004.
4. P.S. Kenjo and S.Nagamori: Permanent Magnet DC motors, Clarendon Press, Oxford, 1985.
5. J.B. Gupta: Theory and Performance of Electrical Machines, S. K. Kataria & Sons, 14th Edition, 2006.
6. H. Cotton: Advanced Electrical Technology, Reem Publications, 2011.
7. Stephen J. Chapman: Electric Machinery Fundamentals, Tata McGraw - Hill Education, 4th Edition, 2010.

EE355	Digital Signal Processing	PCC	3 - 0 - 0	3 Credits

Pre-requisites: MA251 - Mathematics-IV

Course Outcomes: At the end of the course the student will be able to:

CO1	Determine the dynamics of a Linear, Time Invariant and Causal digital systems using Convolution
CO2	Understand the sampling theorem and relationship between the time domain and frequency domain description of signals and systems
CO3	Determine the behavior of digital systems
CO4	Apply TMS320LF2407 digital signal processor for control applications

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	2	1	1	1	2	1	1	1	3	1
CO2	3	2	3	2	2	1	1	1	2	1	1	1	3	1
CO3	3	2	2	2	3	1	1	1	2	1	1	1	3	1
CO4	3	3	3	3	3	1	1	1	3	1	2	3	3	2

Detailed Syllabus:

Signals and Systems: Sampling, Discrete-time signals, aliasing, impulse response, LTI systems, convolution, difference equations.

Fourier analysis and Z-Transform: DTFT, properties, applications, Definition of z-transform, properties, inverse z-transform, one-sided z-transform, Transform analysis of Systems

Digital Filters: IIR and FIR filters, Synthesis of IIR & FIR filters

Discrete Fourier and Fast Fourier Transforms: DFT, DFT properties, FFT

Introduction to TMS320LF2407 Digital Signal Processor: Architecture, Basic Instruction set and simple applications

Reading:

1. Salivahanan, Vallavaraj, Gnanapriya: Digital signal processing –TMGH–2002
2. Proakis and Manolakis: Digital signal processing principles –algorithms and applications- PHI–2003
3. Oppenheim and Schaefer: Discrete time signal processing –PHI–1999
4. Hamid A. Tolyat: DSP based Electromechanical Motion Control-CRC press,2004

EE356	Control Systems Lab	PCC	0-1-2	2 Credits

Pre-requisites: EE202 - Electric & Magnetic Fields, EE251 - Circuit Theory-II

Course Outcomes: At the end of the course, students will be able to:

CO1	Evaluate the characteristics of a given AC and DC servo motor. Design and Analyze the performance of controllers for DC servo-motor applications.
CO2	Determine the performance of first and second order systems in time domain. Analyze second order systems using frequency domain analysis.
CO3	Design of feedback control systems
CO4	Simulate and analyze various control system approaches using MATLAB/SIMULINK tools.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	3	1	1	1	2	1	1	2	3	2
CO2	3	3	2	2	2	1	1	1	2	1	1	2	3	2
CO3	3	3	3	2	3	1	1	1	2	1	1	3	3	3
CO4	3	3	3	2	3	1	1	1	3	1	1	3	3	3

List of Experiments

Detailed Syllabus:

1. Speed-torque characteristics of AC servo-motor
2. Time-response of first and second order systems
3. Frequency-response of second order system
4. Study of P, PI & PID controller
5. Design and study of lag, lead and Lag-lead compensator networks
6. Determination of First order transfer function of DC servo motor (QUBE-Servo) using the bump test method.
7. Stability Analysis of the DC servo motor (QUBE Servo) for speed and position output functions.
8. Analysis the second order response of the DC Servo (QUBE Servo)Motor
9. Evaluation of position control of DC Servo motor (QUBE Servo) using PV controller
10. Design of two loop systems
11. a) Mathematical Models & Time Domain Analysis of LTI Systems
    b) Block diagram reduction technique
    c) Time domain analysis and steady state errors
    d) State space analysis
12. a) Simulation of a typical second order system and determination of step response and evaluation of time- domain specifications
    b) Evaluation of the effect of additional poles and zeroes on time response of second order system
    c) Evaluation of effect of pole location on stability
    d) Effect of loop gain of a negative feedback system on stability
13. a) To examine the relationships between open-loop frequency response and stability , open loop frequency and closed loop transient response
    b) To study the effect of addition closed loop poles and zeroes on the closed loop transient response
14. a) Effect of open loop and zeroes on root locus contour
    b) To estimate the effect of open loop gain on the transient response of closed loop system by using Root locus
    c) Comparative study of Bode, Nyquist and Root locus with respect to Stability.

15. To study the effect of P, PI, PD and PID controller on the step response of a feedback control system
16. a) Stability Analysis and SIMULINK Modelling.
    b) Nonlinear system Analysis using s using Matlab

EE357	Electrical Machines Lab-II	PCC	0–1–2	3 Credits

Pre-requisites: EE302 - Electrical Machines-II

Course Outcomes: At the end of the course the student will be able to:

CO1	Determine the performance of induction motor by direct and indirect loading methods.
CO2	Evaluate the parameters and performance of induction motor and synchronous motor.
CO3	Determine the V and inverted V curves of synchronous motor.
CO4	Determine the performance characteristics of Schrage motor.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2	2	2	1	2	3	1	2	3	1
CO2	3	2	1	2	1	2	1	1	2	3	1	2	3	1
CO3	3	3	2	1	2	2	1	1	2	3	1	2	3	1
CO4	3	2	3	1	1	2	2	1	2	3	1	2	3	1

LIST OF EXPERIMENTS

1. Determination of equivalent circuit parameters of three phase induction motor
2. Circle diagram of 3-phase induction motor
3. Brake test on 3-phase induction motor
4. Single phase operation of 3-phase induction motor
5. Speed control of 3-phase induction motor
6. Regulation of 3-phase alternator by E.M.F.method
7. Regulation of 3-phase alternator by Z.P.F.method
8. Determination of Xd and Xq of a Salient pole Synchronous Machine
9. Parallel operation of alternators
10. Determination of V and inverted V curves of 3-phase synchronous machine
11. Characteristics of 3-phase Schrage motor
12. Determination of equivalent circuit parameters of single phase induction motor
13. Determination of performance of induction generator

EE390	LINEAR CONTROL SYSTEMS	OPC	3–0–0	3 Credits

This course is not offered to Electrical Engineering students

Pre-requisites: None.

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

CO1	Analyze electromechanical systems using mathematical modelling
CO2	Determine Transient and Steady State behavior of systems using standard test signals
CO3	Analyze linear systems for steady state errors, absolute stability and relative stability
CO4	Design a stable control system satisfying requirements of stability and reduced steady state error

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	1	1	1	2	1	1	2	--	--
CO2	3	3	3	3	3	1	1	1	2	1	1	2	--	--
CO3	3	3	3	3	3	1	1	1	2	1	1	2	--	--
CO4	3	3	3	3	3	1	1	1	2	1	1	2	--	--

Detailed syllabus:

Introduction

Control system, types, feedback and its effects-linearization

Mathematical Modeling of Physical Systems:

Block diagram Concept and use of Transfer function. Signal Flow Graphs, Mason's gain formula.

Time Domain Analysis of Control Systems - BIBO stability, absolute stability, Routh-Hurwitz Criterion.

P, PI and PID controllers. Root Locus Techniques - Root loci theory, Application to system stability studies.

Introduction to state variables technique, Analysis of R-L, R-L-C networks.

Frequency Domain Analysis of Control Systems - polar plots, Nyquist stability criterion, Bode plots, application of Bode plots.

Reading:

1. B.C.Kuo, Automatic Control Systems, 7th Edition, Prentice Hall of India, 2009.
2. I.J. Nagarath and M. Gopal: Control Systems Engineering, 2nd Edition, NewAge Pub.Co.2008.

EE391	Soft Computing Techniques	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes:

CO1	Understand the concepts of population based optimization techniques
CO2	Examine the importance of exploration and exploitation in heuristic optimization techniques to attain near-global optimal solution
CO3	Evaluate the importance of parameters in heuristic optimization techniques
CO4	Apply for the solution of multi-objective optimization

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	3	1	1	1	2	1	1	2	--	--
CO2	3	3	2	2	3	1	1	1	3	1	1	3	--	--
CO3	3	3	2	2	3	1	1	1	3	1	3	3	--	--
CO4	3	3	2	2	3	1	1	1	3	1	3	3	--	--

Detailed Syllabus:

Fundamentals of Soft Computing Techniques

Definition-Classification of optimization problems- Unconstrained and Constrained optimization Optimality conditions- Introduction to intelligent systems- Soft computing techniques- Classification of meta-heuristic techniques - Single solution based and population based algorithms – Exploitation and exploration in population based algorithms - Properties of Swarm intelligent Systems - Application domain - Discrete and continuous problems - Single objective and multi-objective problems.

Genetic Algorithm and Particle Swarm Optimization

Genetic algorithms- Genetic Algorithm versus Conventional Optimization Techniques - Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators -Bird flocking and Fish Schooling – anatomy of a particle- equations based on velocity and positions

-PSO topologies - control parameters. Application to SINX maximization problem.

Ant Colony Optimization and Artificial Bee Colony Algorithms

Biological ant colony system - Artificial ants and assumptions - Stigmergic communications - Pheromone updating- local-global - Pheromone evaporation - ant colony system- ACO models-Touring ant colony system- max min ant system - Concept of elistic ants-Task partitioning in honey bees - Balancing foragers and receivers - Artificial bee colony (ABC) algorithms-binary ABC algorithms.

Shuffled Frog-Leaping Algorithm and Bat Optimization Algorithm

Bat Algorithm- Echolocation of bats- Behavior of microbats- Acoustics of Echolocation- Movement of Virtual Bats- Loudness and Pulse Emission- Shuffled frog algorithm-virtual population of frogs-comparison of memes and genes -memeplex formation- memeplex updation.

Application to multi-modal function optimization

Introduction to Multi-Objective optimization -Concept of Pareto optimality.

Reading:

1. Xin-She Yang, “Recent Advances in Swarm Intelligence and Evolutionary Computation”, Springer International Publishing, Switzerland, 2015.
2. Kalyanmoy Deb “Multi-Objective Optimization using Evolutionary Algorithms”, John Wiley & Sons, 2001.
3. James Kennedy and Russel E Eberheart, “Swarm Intelligence”, The Morgan Kaufmann Series in Evolutionary Computation, 2001.
4. Eric Bonabeau, Marco Dorigo and Guy Theraulaz, “Swarm Intelligence-From natural to Artificial Systems”, Oxford university Press, 1999.
5. David Goldberg, “Genetic Algorithms in Search, Optimization and Machine Learning”, Pearson

Education, 2007.
6. Konstantinos E. Parsopoulos and Michael N. Vrahatis, “Particle Swarm Optimization and Intelligence: Advances and Applications”, InformatIon science reference, IGI Global,2010.
7. N P Padhy, “Artificial Intelligence and Intelligent Systems”, Oxford University Press,2005.

SM704	Industrial Management (Electrical Engineering)	ESC	3 – 0 - 0	3 credits

Pre-requisites: None.

Course outcomes: At the end of the course the student will be able to:

CO1	Explain the four evolutionary phases of the organizational theories their circumstances and the consequences.
CO2	Examine organizational systems with time and motion study, inventory and quality for productivity improvements.
CO3	Understand the marketing management process to discuss marketing mix in formulation of marketing strategies
CO4	Calculate project schedule along with the interdependencies using PERT/CPM techniques.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	1	1	1	1	1	1	1	3	1	1	1	1	3
CO2	1	1	2	2	3	1	1	1	1	1	1	1	1	3
CO3	1	1	1	1	1	1	2	1	3	2	1	1	1	3
CO4	1	1	1	1	3	1	1	1	2	1	3	1	1	3

Detailed Syllabus

Introduction: Overview of organizational theory and theoretical perspectives

Rational and natural systems: The evolution of organizational theory - rational systems and Natural systems

Work study: Productivity and its role in the economy; Techniques for improving productivity; Method study; Principles of motion economy; Stop watch time study; Work sampling.

Inventory Management: Purpose of inventories; Inventory costs; ABC classification; Economic Order Quality management: Dimensions of quality; Process control charts; Acceptance sampling; Taguchi's Quality Philosophy; Quality function deployment; Introduction to TQM. Inventory Management: Purpose of inventories; Inventory costs; ABC classification; Economic Order Quantity (EOQ); P and Q systems of inventory control.

Organizational behavior I and II: The individual, The Group, Organization system (structure and culture) Organization its environment, design and change

Open systems and behavioral decision-making

Other management topics: Marketing management process; 4P's of marketing mix; Target marketing; Product life cycle and marketing strategies Project Management: Project activities; Network diagrams; Critical path method (CPM); Programme Evaluation and Review Technique (PERT).

Reading:

1) Robbins, S. P., & Judge, T. A. Organizationalbehavior.2001.
2) Jones, G. R., & Jones, G. R. (2013). *Organizational theory, design, and change*. Upper Saddle River, NJ: Pearson
3) Taylor, F.W. 1916. Principles of Scientific Management,30-144
4) Besterfield (2015). Total Quality Management. Pearson Education India; 4editions
5) Khanna,O. P. (1980). *Industrial engineering and management*, DhanpatRai.
6) Kottler, P., & Keller, K. L. (2011). Marketing Management 14e GlobalEdition.
7) Weber, M. Economy and Society 1978 pp.212-254,956-975

EE 401	Electric Drives	PCC	3-0-0	3Credits

Pre-requisites: EE302-Electrical Machines-II, and EE352-Power Electronics

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the various drive mechanisms and methods for energy conservation.
CO2	Apply power electronic converters to control the speed of DC motors and induction motors.
CO3	Evaluate the motor and power converter for a specific application.
CO4	Develop closed loop control strategies of drives

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	3	3	2	1	1	2	3	3	3
CO2	3	3	3	3	3	3	3	2	3	1	2	3	3	3
CO3	3	3	3	3	3	3	3	2	3	1	2	3	3	3
CO4	3	3	3	3	3	3	3	2	3	1	3	3	3	3

Detailed Syllabus:

Introduction to electric drives: Advantages of Electric drives, Parts of Electrical Drives, Electric Motors, Power Modulators, Sources, Choice of Electric Drives and selection of drives for various applications.

Dynamics of electrical drives: Fundamental torque equation, components of load torque, speed-torque characteristics of loads, Nature and classification of load torques,speed-torque convention & multi-quadrant operation. Equivalent values of drive parameters, loads with rotational motion, loads with translational motion, measurement of moment of inertia, components of load torques. Steady state stability, dynamic stability, load equalization. Basic principles of closed-loop control.

DC Motor Drives: Speed control of DC motors using single-phase and three-phase fully controlled and half controlled rectifiers in continuous and discontinuous mode of operation. Single quadrant, two quadrant and four quadrant chopper controlled drives in continuous and discontinuous mode of operation.

Induction Motor Drives: Speed control of cage induction motor with *v/f* control, slip power recovery scheme, static Scherbius and Krammer methods. Variable frequency and variable voltage control using VSI and CSI. AC and DC dynamic breaking methods.

Synchronous Motor Drives: Speed control methods of synchronous motor drive.

Reading:

1. G.K. Dubey: Fundamentals of Electric Drives –Narosa Publishers, Second edition, 2007.
2. S.B. Dewan, G.R. Slemom, A. Straughen: Power semiconductor drives, John Wiley &Sons.
3. VedamSubramanyam: Electric Drives Concepts & Applications –Tata McGraw Hill Edn. Pvt.Ltd, Second Edition, 2011.
4. V. Subrahmanyam: Thyristor Control of Electric Drives, Tata McGraw Hill Edn. Pvt.Ltd, 2010.
5. Werner Leonhard: Control of Electric Drives, Springer international edition2001.
6. NisitK.De and SwapanK.Dutta: Electric Machines and Electric Drives, PHI learning Pvt. Ltd, 2011.

EE 402	HVDC AND FACTS	PCC	3-0-0	3 Credits

Pre-requisites: EE 352 - Power Electronics

Course Outcomes: At the end of the course the student will be able to:

CO1	Compare HVDC and EHVAC transmission systems
CO2	Analyze converter configurations used in HVDC and evaluate the performance metrics.
CO3	Understand controllers for controlling the power flow through a dc link and compute filter Parameters
CO4	Apply impedance, phase angle and voltage control for real and reactive power flow in ac transmission systems with FACTS controller
CO5	Analyze and select a suitable FACTS controller for a given power flow condition

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	1	1	1	1	1	1	1	3	1
CO2	3	3	2	2	3	1	1	1	1	1	1	1	3	1
CO3	3	3	3	3	3	2	2	1	1	1	2	1	3	1
CO4	3	3	3	3	3	2	2	1	3	1	2	2	3	3
CO5	3	3	3	3	3	1	1	1	3	1	3	2	3	3

Detailed Syllabus:

HVDC Transmission: DC Power Transmission: Need for power system interconnections, Evolution of AC and DC transmission systems, Comparison of HVDC and HVAC Transmission systems, Types of DC links, relative merits, Components of a HVDC system, Modern trends in DC Transmission systems

Analysis of HVDC Converters: Pulse number, choice of converter configurations, Analysis of Graetz circuit with and without overlap, voltage waveforms, Analysis of two and three valve conduction mode, Converter Bridge characteristics, Inverter mode of operation, voltage waveforms

HVDC Control: Principles of DC link control, Converter Control characteristics, Control hierarchy Constant current Control, CEA Control, firing angle control of valves, starting and stopping of a dc link, Power control

Harmonics and Filters: effects of Harmonics, sources of harmonic generation, Types of filters –Design examples

Power Flow Analysis in AC/DC Systems: Modelling of DC links, solutions of AC-DC Power flow

Flexible AC Transmission Systems (FACTS): FACTS concepts and general system conditions: Power flow in AC systems, Relative importance of controllable parameters, Basic types of FACTS controllers, shunt and series controllers, Current source and Voltage source converters

Static Shunt Compensators: Objectives of shunt compensation, Methods of controllable VAR generation, Static Var Compensator, its characteristics, TCR, TSC, FC-TCR configurations, STATCOM, basic operating principle, control approaches and characteristics

Static Series Compensators: Objectives of series compensator, variable impedance type of series compensators, TCSC, TSSC-operating principles and control schemes, SSSC, Power Angle characteristics, Control range and VAR rating, Capability to provide reactive power compensation, external control

Combined Compensators: Introduction to Unified Power Flow Controller, Basic operating principles, Conventional control capabilities, Independent control of real and reactive power

Reading:

1. K.R.Padiyar: HVDC Power Transmission Systems –Technology and System Interactions, New Age International Publishers.
2. Kimbark: Direct Current Transmission, 1971.
3. Jos Arrillaga: High Voltage Direct Current Transmission, The Institution of electrical Engineers, 1998.
4. NarainG.Honorani, Laszlo Gyugyi: Understanding FACTS –Concepts and Technology of Flexible AC Transmission Systems, Wiley-IEEE Press, 2000.
5. Yong Hua Song, Allan T Johns: Flexible AC Transmission Systems, The Institution of electrical Engineers, 1999.

EE 403	Power Electronics Lab	PCC	0–1– 2	2 Credits

Pre-requisites: EE252 - Electrical Machines – 1, EE302 - Electrical Machines-2, EE352 - Power Electronics

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the operation of rectifiers, DC-DC converters. AC voltage controllers and inverter circuits.
CO2	Evaluate the various performance indices like ripple factor, THD.
CO3	Design the control circuit and the power circuit for DC-DC converters
CO4	Compare various options available for the drive circuit requirements

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	2	1	1	1	3	3	1	1	3	1
CO2	3	3	2	1	2	1	1	1	3	3	1	1	3	1
CO3	3	3	2	2	2	3	3	1	3	3	2	2	3	3
CO4	3	3	3	3	3	3	2	1	3	3	3	2	3	3

Detailed syllabus:

List of Experiments

1. Study of Characteristics of SCR, MOSFET &IGBT.
2. Study of single-phase half & fully controlled bridge converter with R, RL and RLE load.
3. Study of three-phase half & fully controlled bridge converter with R and RL load.
4. Study of single-phase dual converter with RL loads.
5. Study of AC voltage controller using TRIAC with R and RL load.
6. Study of DC-DC Buck converter
7. Study of DC-DC Boost converter
8. Study of DC-DC Buck-Boost converter
9. Study of speed control of DC motor using H-bridge converter
10. Study of uni-polar and bi-polar PWM based single-phase inverter using dSPACE-1104controller.
11. Study of 3-Phase PWM & non-PWM inverter using Dspace-1104controller.
12. Study of speed control of 3-Phase inverter fed induction motor based on open loop V/f control method using dSPACE-1104controller.
13. Study of speed control of 3-Phase inverter fed induction motor based on closed loop V/f (slip speed) control method using dSPACE-1104controller.

Reading:

1. M.H. Rashid: Power Electronics-Circuits, Devices and Applications, 3rd Edition, PHI, 2005.
2. Ned Mohan, T.M. Undeland and William P. Robbins: Power Electronics: Converters and Applications, 3rd Edition, John Wiley & Sons, 2009.

EE404	Embedded Systems Laboratory	PCC	0-1-2	2 Credits

Pre-Requisites: EE304 - Micro Processors & Microcontrollers, EE355 - Digital Signal Processing

Course Outcomes: At the end of the course the student will be able to:

CO1	Write Assembly and embedded C programs for 8086 Microprocessor, 8051 and 89C51 and PIC Microcontrollers
CO2	Interface 8086 Microprocessor, 8051 and 89C51 and PIC Microcontrollers with external peripheral devices
CO3	Handle interrupts for real time control applications using TMS320LF2407A DSP Controller
CO4	Generate PWM signals for motor control applications

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	1	1	1	2	2	1	3	3	3
CO2	3	3	3	2	3	1	1	1	3	2	1	3	3	3
CO3	3	3	3	3	3	3	1	1	2	2	2	3	3	3
CO4	3	3	3	3	3	2	1	1	3	2	2	3	3	3

List of Experiments

1. 8086 Assembly language programs and coding of instructions.
2. Interfacing of 8255 PPI and applications with 8086Microprocessor
3. Interfacing of 8254 and serial data transfer using 8251 USART with 8086Microprocessor.
4. Programming exercises on 8051 and PIC Microcontroller
5. Interface I/O devices with and handle external interrupts using 89C51microcontroller
6. PIC Serial Communication using Serial Peripheral Interface (SPI) and Interface PIC Microcontroller with an LCD using PIC microcontrollers simulator (MPLABIDE)
7. Verification of Sampling theorem withTMS320LF2407A
8. General programming exercises withTMS320LF2407A
    a) Arithmetic and logical operations
    b) Addressing modes
    c) Direct and indirect Data transfer
    d) Waveform generation
    e) Minimum and maximum values
9. Study of the GPIO Registers, ADC and interfacing with LEDs withTMS320LF2407A
10. PWM signal generation using Event Managers and dead time generation withTMS320LF2407A
11. Study of interrupts of TMS320LF2407 Processor withTMS320LF2407A
12. Control of DC motor with Chopper withTMS320LF2407A

EE405	Power Systems Laboratory	PCC	0-1-2	2 Credits

Pre-requisites: EE303 - Power Systems-II, EE353- Power System Protection

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the Reactive power control in a Tap Changing Transformer & long transmission lines
CO2	Determine the sequence components of unbalanced voltages and fault currents of Power system elements
CO3	Understand the characteristics of PV array
CO4	Evaluate the breakdown strength of Electrical Insulation and design ground grid for Substation

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	1	2	1	1	1	3	3	1	1	3	1
CO2	3	3	2	1	2	1	1	1	3	3	1	1	3	1
CO3	3	3	2	2	2	3	3	1	3	3	2	2	3	3
CO4	3	3	3	3	3	3	2	1	3	3	3	2	3	3

List of Experiments

1. Reactive Power Control Using Tap Changing Transformer
2. Characteristics of Artificial Transmission Line
   (a) Regulation and efficiency Characteristics
   (b) Reactive Power compensation
3. Determination of Sequence Reactance's and fault studies of Power System Elements (Alternator & 3-ΦTransformer)
4. Analysis of unbalanced voltages using Symmetrical Component Analyzer
5. Short circuit studies on a DC Network Analyzer
6. Determination of String efficiency of simulated string of insulators
7. Calibration of sphere gap arrangement for High voltage measurement using 100kV Test Transformer
8. Characteristics of PV Array
9. Grounding grid design for a two layer soil model using AUTOGRID PRO software simulation
10. Harmonic analysis of linear and non-linear Domestic and crest-factor loads and its mitigation using Passive filters
11. Dielectric test on Transformer oil
12. Tracking and Treeing test on surface of solid insulation
13. Generation of different Impulse waveforms
14. Flashover study of disc insulators and determination of string efficiency under
    a) Dry condition b) Wet condition

EE411	Design of Electrical Systems	DEC	3 – 0 – 0	3 Credits

Pre-requisites: EE252 - Electrical Machines – I, EE302 - Electrical Machines-II and EE354 - Electrical Machines-III

Course Outcomes: At the end of the course the student will be able to

CO1	Formulate mathematical modeling for electric, magnetic and thermal circuits of electrical machines.
CO2	Analyze design aspects of rotating electrical machines.
CO3	Understand optimum design procedure of transformers.
CO4	Evaluate Select suitable layout and rating of sub-station components.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	1	1	1	1	1	1	1	3	2
CO2	3	3	3	2	2	2	2	1	1	1	1	1	3	2
CO3	3	3	3	2	3	1	2	1	2	2	3	2	3	3
CO4	3	3	3	2	2	3	3	1	3	2	3	2	3	3

Detailed Syllabus:

Fundamentals for design of Rotating Machines

Magnetic Circuit: Magnetic leakage calculations, Effect of leakage flux, Slot leakage, tooth top leakage, Zig-Zag Leakage, over hang leakage. Leakage with fractional pitch windings, effect of saturation and load on leakage coefficient. Leakage reactance calculations of polyphase machines.

Electric Circuit: Design of DC-machine windings: Simplex, Duplex and Multiplex Lap and Wave Windings, Design of AC machine windings: Concentric windings, Mush windings, Double layer integral slot and fractional slot lap and wave windings.

Thermal Circuit: Theory of Solid body heating, Heating and Cooling Curves, Calculation of surface temperature rise and hotspot temperature. Methods of cooling: axial and radial, Induced & forced Ventilation. Cooling of DC machines and turbo alternators, Calculation of quantity of cooling medium.

Design of Rotating Machines: Relation between rating and dimensions of rotating machines, Choice of specific electric and magnetic loadings, Separation of main dimensions (D and L) for DC machines, Induction Machines and Synchronous Machines. Output equation for DC-machine, Selection of No. of Poles, No. of armature slots, Length of air-gap and field pole design. Stator design for induction and synchronous machine, design of rotor slots end rings and wound rotor for induction machine. Design of rotor for salient and non-salient pole synchronous machines.

Design of Transformers: Output equation, Choice of flux density, Design of rectangular, square and stepped cores, and Design for minimum cost and minimum losses. Design of windings. Cooling of transformers, Design of transformer tanks and cooling ducts.

Design of Substations: Layouts for indoor and out-door substations for single feeder, double feeder and multi-feeder. Design of Power Capacitors. Selection and design of circuit breakers and Isolators. Basic design aspects of gas insulated substations (GIS), Design of substation Grounding.

Reading:

1. A. K. Sawhney, A course in Electrical Machine Design, Dhanpat Rai& Co. New Delhi. 6thEdition, 2013.
2. JuhaPyrhonen, Tapani Jokinen, Valeria Hrabovcova, Design of Rotating Electrical Machines, John Wiley & Sons, New Delhi, India,2013.
3. Alexander Gray, Electrical Machine Design, McGraw Hill, New York, 2008.
4. M.G.Say, Performance and Design of Ac Machines, Pitman Pub.
5. E Clayton & N.N. Hancook, Performance and design of DC machines, CBS Pub. 3rdEdition, 1998.
6. H. Partab, Arts and Science of Utilization of Electrical Energy.

EE412	Computer Methods in Power Systems	DEC	3–0– 0	3 Credits

Pre-requisites: EE303 - Power Systems-II, EE251 - Circuit Theory-II

Course Outcomes: At the end of the course the student will be able to:

CO1	Design mathematical models for power system components.
CO2	Analyze and pick the best algorithm for a selected power system problem.
CO3	Generate input data suitable for load flow, fault calculations and state estimation.
CO4	Understand application of Load flow methods, contingency analysis and SCADA in modern Power systems.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	1	1	1	1	1	1	1	1	3	1
CO2	3	3	2	2	3	1	1	1	1	1	1	1	3	1
CO3	3	3	2	1	2	1	1	1	2	2	2	1	3	1
CO4	3	3	3	3	3	1	1	1	2	2	3	3	3	2

Detailed syllabus:

Incidence and network matrices:
Introduction, Graphs, Incidence matrices, Primitive matrices, Types of network matrices, formation of network matrix, PI-representation of off-nominal tap transformers, Y-bus by singular transformation, examples of formation of incidence matrices, formation of Y-bus by inspection.

Algorithms for formation of Z-bus matrix:
Step by Step algorithm for formation of Z-bus. Modification of Z-bus matrix for changes in the network, example of formation and modification of Z-bus matrix.

Short Circuit calculations:
Introduction, Short circuit calculations using $Zbus^{012}$, z_f^{abc}, y_f^{abc}, z_f^{012}, y_f^{012} matrices for various faults, example of short circuit calculations using $Zbus^{012}$ for L-L-L and L-G faults.

Sparsity Technique in Load Flow Studies:
Introduction, Sparsity technique for Y-bus and Gauss-Seidel method.

Review and Comparison of Gauss-Seidal, Newton-Raphson, Fast decoupled load flow methods. Concept of Contingency analysis. Forward-backward and substitution method for radial distribution systems.

Introduction to Real time control of Power System:
Introduction, linear State Estimation WLS equations, Types of measurements, D.C power flow based WLS equations, examples of D.C based WLS State Estimation, SCADA, communication systems. Role of PMUs in power systems.

Reading:

1. Stagg and El Abiad, Computer Methods in Power Systems Analysis, McGraw Hill ISE, 1986.
2. M.A.Pai: Computer Techniques in Power System Analysis, Tata McGraw-HillEducation-2005.
3. K.U.Rao: Computer Methods and Models in Power Systems, I.K. International Pvt. Ltd, 2009.

EE413	Switched Mode Power Conversion	DEC	3–0– 0	3 Credits

Pre-requisites: EE 352 - Power Electronics

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze the operation of DC-DC converters with current and voltage mode control
CO2	Analyze resonant converters and their control techniques
CO3	Design DC-DC converters and evaluate the stability of the system
CO4	Understand the operation and control of multilevel inverters

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	1	1	1	2	1	2	3	3	3
CO2	3	3	3	2	3	1	1	1	2	1	2	2	3	3
CO3	3	3	3	3	3	1	1	1	3	1	3	3	3	3
CO4	3	3	3	2	3	1	1	1	2	1	2	2	3	3

Detailed syllabus:

DC/DC Converters and Current Mode and Current Fed Topologies
Basic topologies of buck, boost converters, buck-boost converters and cuk converter, isolated DC/DC converter topologies: forward, and fly-back converters, half and full bridge topologies, modeling of switching converters. Voltage mode and current mode control of converters, peak and average current mode control, its advantages and limitations, voltage and current fed converters.

Resonant Converters
Need for resonant converters, types of resonant converters, methods of control, phase-modulation technique with ZVS in full-bridge topology, series resonant converter and resonant transition converter.

Converter Transfer Functions
Application of state-space averaging to switching converters, derivation of converter transfer functions for buck, boost, and fly-back topologies.

Power Converter Design
Design of filter inductor & capacitor, and power transformer, Ratings for switching devices, current transformer for current sensing, design of drive circuits for switching devices, considerations for PCB layout.

Controller Design
Introduction, mechanisms of loop stabilization, shaping E/A gain vs. frequency characteristic, conditional stability in feedback loops, stabilizing a continuous mode forward converter and discontinuous mode fly-back converter, feed-back loop stabilization with current mode control, the right-half plane zero.

Inverters
SVM technique, multilevel inverters and PWM methods.

Reading:

1. Ned Mohan Tore M. Undeland: Power Electronics: Converters, Applications, and Design, 3rd Edition, John Wiley & Sons, 2007.
2. Abraham I. Pressman, "Switching Power Supply Design", Mc Graw Hill International, Third Edition, 2009.
3. P.C. Sen: Modern Power Electronics, S.Chand-2005.
4. Andrzej M. Trzynadlowski Introduction to Modern Power Electronics, 2nd Edition, illustrated Publisher John Wiley & Sons, 2010.
5. Muhammad H. Rashid, Power electronics hand book, ISBN: 81 8147 3671.
6. Bin Wu: High-power Converters and AC Drives, IEEE Press, John Wiley & Sons, 2006.

EE414	Digital Control Systems	DEC	3 - 0 - 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Evaluate the output of a digital system for a given input.
CO2	Describe the dynamics of a Linear, Time Invariant and Causal digital systems through difference equations
CO3	Analyze digital systems using the Z-transformation, state space methods
CO4	Design digital controllers for physical systems

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	2	1	1	1	2	1	1	1	3	1
CO2	3	2	3	2	2	1	1	1	2	1	1	1	3	1
CO3	3	2	2	2	3	1	1	1	2	1	1	1	3	1
CO4	3	3	3	3	3	1	1	1	3	1	2	3	3	2

Detailed syllabus:

Introduction

Digital control systems - Quantizing and quantization error - Data acquisition - Conversion and distribution system

Z-P Lane Analysis of Discrete-Time Control Systems

Impulse sampling and data hold - Pulse transfer function - Realization of digital controllers and digital filters - Mapping between s-plane and z-plane - Stability analysis of closed loop systems in z-plane - Transient and steady state analyses

State Space Analysis

State space representation of digital control systems - Solution of discrete time state space equations - Pulse transfer function matrix - Discretization of continuous time state space equations - Lyapunov stability analysis

Pole Placement and Observer Design

Controllability - Observability

Quadratic Optimal Control Systems

Design via pole placement - State observers. - Quadratic optimal control - Steady state quadratic optimal control - Quadratic optimal control of a servo system

Reading:

1. M. Gopal: *Digital control engineering*, New Age Int. Ltd., India, 1998.
2. K. Ogata: *Discrete time control systems*, Pearson Education, 2006.
3. K. Ogata, "Modern control engineering"- PHI, 1991.
4. B. C. Kuo, "Digital control systems"- Holt Saunder's International Edition, 1991.

EE415	Modeling & Analysis of Electrical Machines	DEC	3–0–0	3 Credits

Pre-requisites: EE252 - Electrical Machines – I, EE302 - Electrical Machines-II

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the limitations of conventional models of electrical machines
CO2	Compute the torque produced in electrical machines using the concept of co-energy
CO3	Analyze the performance of machines using reference frame theory
CO4	Evaluate strategies to control the torque for a specific application

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	3	3	1	2	1	2	3	3	3
CO2	3	3	3	3	3	3	3	1	2	1	2	3	3	3
CO3	3	3	3	3	3	3	3	1	2	1	2	3	3	3
CO4	3	3	3	3	3	3	3	1	2	1	2	3	3	3

Detailed Syllabus:

Principles for electrical machine analysis and magnetically coupled circuits
Review of basic concepts, magnetizing inductance, Modelling linear and nonlinear magnetic circuits.

Electromechanical energy conversion
Principles of energy flow, concept of field energy and co-energy, Derivation of torque expression for various machines using the principles of energy flow and the principle of co-energy, Inductance matrices of induction and synchronous machines.

Theory of DC machines
Review of the DC machine, mathematical model of commutator, State-space model of a DC machine, and reduced order model & transfer function of the DC machine.

Reference Frame Theory
Concept of space vector, components of space vector, direct and quadrature axis variables.

Transformation
Types of transformation, condition for power invariance, zero-sequence component, Expression for power with various types of transformation, Transformations between reference frames, Clarke and Park's Transformations, Variables observed from various frames, Simulation studies.

Theory of symmetrical Induction Machines
Voltage and torque in machine variables, Derivation of dq0 model for a symmetrical induction machine, Voltage and torque equation in arbitrary reference frame variables, Analysis of steady-state operation, State-space model of induction machine in'd-*q*' variables, Simulation studies

Theory of synchronous machines
Derivation of *dq0* model for a salient pole synchronous machine with damper windings using Park's transformation, Torque expression of a salient pole synchronous machine with damper windings and identification of various components

Reading:

1. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff: "Analysis of Electric Machinery & Drive systems" IEEE Press, 2002.
2. E. Fitzgerald, Charles Kingsley, Stephen D. Umans: Electric Machinery, TMH, 5thEd.

EE5112	Control & Integration of Renewable Energy Sources	DEC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Knowledge on different renewable energy sources and storage devices
CO2	Recognize, model and simulate different renewable energy sources
CO3	Analyze, model and simulate basic control strategies required for grid connection
CO4	Implement a complete system for standalone/grid connected system

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	2	3	1	1	1	2	3	3	3
CO2	3	3	3	3	3	2	3	1	1	1	3	3	3	3
CO3	3	3	3	2	3	2	3	1	1	1	3	3	3	3
CO4	3	3	3	3	3	2	3	1	1	1	3	3	3	3

Detailed Syllabus:

Chapter-1: Introduction

Electric grid introduction, Supply guarantee and power quality, Stability, Effects of renewable energy penetration into the grid, Boundaries of the actual grid configuration, Consumption models and patterns, static and dynamic energy conversion technologies, interfacing requirements

Chapter-2: Dynamic Energy Conversion Technologies

Introduction to different conventional and nonconventional dynamic generation technologies, principle of operation and analysis of reciprocating engines, gas and micro turbines, hydro and wind based generation technologies, control and integrated operation of different dynamic energy conversion devices

Chapter-3: Static Energy Conversion Technologies

Introduction to different conventional and nonconventional static generation technologies, principle of operation and analysis of fuel cell, photovoltaic based generators, and wind based generation technologies, different storage technologies such as batteries, fly wheels and ultra-capacitors, plug-in-hybrid vehicles, control and integrated operation of different static energy conversion devices

Chapter-4: Real and reactive power control

Control issues and challenges in Diesel, PV, wind and fuel cell based generators, PLL, Modulation Techniques, Dimensioning of filters, Linear and nonlinear controllers, predictive controllers and adaptive controllers, Fault-ride through Capabilities, Load frequency and Voltage Control

Chapter-5: Integration of different Energy Conversion Technologies

Resources evaluation and needs, Dimensioning integration systems, Optimized integrated systems, Interfacing requirements, integrated Control of different resources, Distributed versus Centralized Control, Synchro Converters, Grid connected and Islanding Operations, stability and protection issues, load sharing, Cases studies

Reading:

1. Ali Keyhani Mohammad Marwali and Min Dai, "Integration and Control of Renewable Energy in Electric Power System" John Wiley publishing company
2. S. Chowdhury, S. P. Chowdhury, P. Crossley, "Microgrids and Active Distribution Networks", IET Power Electronics Series, 2012
3. G. Masters, "Renewable and Efficient Electric Power Systems", IEEE-Wiley Publishers, 2013.

4. Quing-Chang Zhong, “Control of Power Inverters in Renewable Energy and Smart Grid Integration”, Wiley, IEEEPress
5. Bin Wu, Yongqiang Lang, Navid Zargari, “Power Conversion and Control of Wind Energy Systems”, and Wiley2011.
6. Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics: Converters, Applications, and Design", Wiley Publishers
7. Selected scientific and engineering papers, articles from professional magazines, and industry internet sources as reference material.

EE5214	Smart Grid Technologies	DEC	3-0-0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand features of Smart Grid in the context of Indian Grid.
CO2	Assess the role of automation in Transmission/Distribution
CO3	Apply Evolutionary Algorithms for the Smart Grid/Distribution Generation.
CO4	Understand operation and importance of PMUs, PDCs, WAMS, Voltage and Frequency control in Micro Grids.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	1	2	2	1	1	1	1	2	2	3
CO2	3	2	2	2	1	2	2	1	2	1	1	1	2	2
CO3	3	3	3	3	3	2	2	1	2	1	2	3	3	2
CO4	3	3	3	3	2	2	2	1	3	1	2	3	3	3

Detailed Syllabus:

Introduction to Smart Grid: Introduction to Smart Grid - Working definitions of Smart Grid and Associated Concepts – Smart Grid Functions – Traditional Power Grid and Smart Grid – New Technologies for Smart Grid – Advantages – Indian Smart Grid – Key Challenges for Smart Grid.
Smart Grid Architecture: Components and Architecture of Smart Grid Design – Review of the proposed architectures for Smart Grid. The fundamental components of Smart Grid designs – Transmission Automation – Distribution Automation – Renewable Integration
Tools and Techniques for Smart Grid: Computational Techniques – Static and Dynamic Optimization Techniques – Computational Intelligence Techniques – Evolutionary Algorithms – Artificial Intelligence techniques.
Distribution Generation Technologies: Introduction to Renewable Energy Technologies – Micro grids – Storage Technologies –Electric Vehicles and plug – in hybrids – Environmental impact and Climate Change – Economic Issues.
Communication Technologies and Smart Grid: Introduction to Communication Technology – Synchro-Phasor Measurement Units (PMUs) – Wide Area Measurement Systems (WAMS).
Control of Smart Power Grid System: Load Frequency Control (LFC) in Micro Grid System – Voltage Control in Micro Grid System – Reactive Power Control in Smart Grid. Case Studies and Test beds for the Smart Grids.

Reading:

1. Stuart Borlase, Smart Grids, Infrastructure, Technology and Solutions, CRC Press,2013
2. Gil Masters, Renewable and Efficient Electric Power System, Wiley–IEEE Press, 2004.
3. A.G. Phadke and J.S. Thorp, “Synchronized Phasor Measurements and their Applications”, Springer Edition, 2010.
4. T. Ackermann, Wind Power in Power Systems, Hoboken, NJ, USA, John Wiley,2005

EE 440	New Venture Creation	OPC	3–0– 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to

CO1	Understand the process and practice of entrepreneurship and new venture creation
CO2	Identify entrepreneurial opportunities, preparation of a business plan for launching and new venture
CO3	Explore the opportunities in the domain of respective engineering disciplines for launching a new venture
CO4	Expose the students with the functional management issues of running a new venture

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	1	2	1	1	1	2	2	2	--	--
CO2	2	2	2	2	1	1	3	2	1	2	2	2	--	--
CO3	2	2	2	2	1	1	1	1	2	3	2	3	--	--
CO4	2	2	2	2	1	3	1	1	1	2	3	3	--	--

ENTREPRENEUR AND ENTREPRENEURSHIP

Entrepreneurship and Small Scale Enterprises (SSE), Role in Economic Development, Entrepreneurial Competencies, and Institutional Interface for SSE

ESTABLISHING THE SMALL SCALE ENTERPRISE

Opportunity Scanning and Identification, Market Assessment for SSE, Choice of Technology and Selection of Site, Financing the New/Small Enterprises, Preparation of the Business Plan, Ownership Structures and Organizational Framework

OPERATING THE SMALL SCALE ENTERPRISES

Financial Management Issues in SSE, Operational Management Issues in SSE, Marketing Management Issues in SSE, and Organizational Relations in SSE

Reading:

1. Holt: Entrepreneurship: New Venture Creation, PHI (P), Ltd.,2001.
2. Madhulika Kaushik: Management of New & Small Enterprises, IGNOU course material, 1995
3. B S Rathore S Saini: Entrepreneurship Development Training Material, TTTI, Chandigarh, 1988.
4. P.C.Jain: A Hand Book for New Entrepreneurs, EDI-Faculty & External Experts, EDII, Ahmedabad, 1986.
5. J.B. Patel, D.G Allampalli: A Manual on How to Prepare a Project Report, EDII, Ahmedabad, 1991.
6. J B Patel, S SModi : A Manual on Business Opportunity Identification and Selection, EDII, Ahmedabad, 1995.

EE441	Principles of Electric Power Conversion	OPC	3-0-0	3 Credits

Pre-requisites: EE101 - Basic Electrical Engineering, EC101 - Basic Electronics Engineering

Course Outcomes: At the end of the course the student will be able to:

CO 1	Understands the basics in the electric power conversion using power switching devices
CO 2	Evaluate the conversion for range of renewable energy sources with the help of available electrical machines drives
CO 3	Analyzes the different energy storage systems
CO 4	Identify the various Industrial and domestic applications

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	1	2	2	2	2	2	1	2	--	--
CO2	3	2	3	2	2	2	2	2	2	2	1	2	--	--
CO3	3	3	3	2	1	2	2	2	2	2	1	2	--	--
CO4	3	2	3	2	2	2	2	2	2	2	1	2	--	--

Detailed syllabus:

POWER ELECTRONIC DEVICES AND CONVERTERS:

V-I Characteristics of SCR, MOSFET and IGBT. Phase controlled rectifiers, DC-DC converters and Inverters.

APPLICATIONS TO ELECTRIC DRIVES:

Speed control of DC motor, Induction motors, PMSM and BLDC drives

APPLICATIONS TO RENEWABLE ENERGY:

Introduction to solar cell, solar panels, MPPT, wind and other renewable energy sources, Integration of renewable energy sources to the grid.

ENERGY STORAGE SYSTEMS:

Study of automotive batteries, SMF, pumped storage systems, super-capacitors, fly wheels - applications, Li-ion batteries and applications to electric vehicles.

DOMESTIC AND INDUSTRIAL APPLICATIONS:

Induction heating, melting, hardening, lighting applications and their control, UPS, battery chargers

Reading:

1. M.H.Rashid: Power Electronics-circuits, Devices and applications, Prentice Hall India, New Delhi,2009
2. P.S.Bhimbra: Power Electronics, Khanna publishers, New Delhi,2012
3. Ned Mohan, Undeland and Robbin: Power electronics converters, applications and design, John Willey & Sons, Inc. NewYork, 2006.

EE461	Distribution System Planning and Automation	DEC	3–0–0	3 Credits

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the characteristics and components of electric power distribution systems.
CO2	Analyze and evaluate the impact of geographical, demographical and economic factors on distribution systems
CO3	Understand the components of distribution automation systems.
CO4	Design, analyze and evaluate distribution system design based on forecasted data

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	1	-	-	-	-	-	-	-	-	1	1
CO2	3	3	2	2	1	1	-	-	2	1	1	2	3	2
CO3	3	3	2	2	1	1	1	1	1	2	1	2	1	1
CO4	3	3	2	2	1	2	1	-	1	1	3	2	3	3

Detailed syllabus:

Power sector in India
An overview of distribution systems, Distribution system planning-issues and aspects, Introduction to Distribution system forecasting techniques, Stochastic and time series techniques for forecasting, intelligent techniques based load forecasting techniques, Definitions and importance of various terms that characterize loads, Load management and types of tariffs

Distribution transformers (DTRs)
Basic design considerations, 3-ph and 1-ph DTRs-types of connections and its relevance in operation, Need for special types of distribution transformers, Cast resin, CSP, Amorphous core DTRs, Regulation and efficiency of transformers-use of predetermined curves

Sub-transmission system
Sub-stations site selection procedure, Sub-station capacity expansion, Location of new sub-stations and their rating, Sub-station bus schemes, VD and PL calculations for a service area with four and six feeders, VD and PL calculations for a service area with n-feeders, Characteristics of primary systems, Voltage drop (VD) and power loss (PL) calculations, Importance of power factor in distribution systems, Capacitors and their role in improving power factor

Distribution system protection
Distribution system protection devices, Problems in distribution systems and the need for automation

Distribution system automation (DSA)
General schematic, DSA-Hardware modules and their functions, DSA-Software modules and their functions, DSA-Alternatives in Communication media, Communication protocols for DSA schemes and need for OSA, Examples of DSA schemes, Distribution system grounding

Reading:

1. Turan Gonen: Electric power Distribution System Engineering, CRC Press, 2nd Edition.
2. A S Pabla: Electric Power Distribution, TMH, Fifth Edition
3. James A Momoh: Electric Power Distribution, Automation, Protection and Control, CRC Press.

EE462	High Voltage Engineering	DEC	3-0-0	3 Credits

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Design the insulation of HV power equipment.
CO2	Estimate electric field intensity of different electrode configurations.
CO3	Understand the testing methods of high voltage equipment
CO4	Using Non-Destructive Test Techniques for assessing the quality of insulation of high voltage Equipment
CO5	Understand the Breakdown mechanism of Gas, Liquid and solid insulation

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	3	-	1	-	2	1	2	2	3	2
CO2	3	3	2	3	3	-	2	-	2	1	2	2	3	2
CO3	3	3	2	3	3	-	2	-	2	1	3	2	3	2
CO4	3	3	2	3	3	-	2	-	2	1	3	2	3	2
CO5	3	2	2	2	3	-	1	-	2	1	2	2	3	2

Detailed syllabus:

ELECTRO STATIC FIELDS, THEIR CONTROL AND ESTIMATION

Electric Field intensity, Electric strength, classification of Electric Fields, control of electric Field intensity, basic equations for potential and field intensity in electrostatic fields, Analysis of electric field intensity in homogenous and multi-dielectric electric fields, numerical methods for estimation of electric field intensity. Applications of insulating materials in transformers, rotating machines, circuit breakers, cable power capacitors and bushings.

GENERATION OF HIGH DC AND AC VOLTAGES

Introduction, Rectifier circuits, Cockcroft- Walton voltage multiplier circuit, electrostatic generator, generation of high ac voltages by cascaded transformers, series resonant circuit.

GENERATION OF IMPULSE VOLTAGES AND CURRENTS

Definitions, impulse generator circuits, Analysis of impulse generator circuit, multistage impulse generator circuit, triggering of impulse generator, impulse current generation.

MEASUREMENT OF HIGH VOLTAGES AND CURRENTS

Introduction, sphere gap, uniform field spark gap, rod gap, electrostatic voltmeter, generating voltmeter, Fortes cue method, resistive and capacitive voltage dividers, measurement of high DC, AC and impulse currents.

HIGH VOLTAGE TESTING OF ELECTRICAL EQUIPMENT

Layout of high voltage laboratory with major testing and measuring equipment's, Determination of their ranges and ratings, earthing system, electromagnetic shielding and protective fencing. Testing of overhead line insulators, testing of cables, Testing of Bushings, Testing of power capacitors, testing of power transformers, testing of circuit breakers. IEC, ANSI, IEEE and Indian standards for testing electrical equipment.

NON-DESTRUCTIVE TEST TECHNIQUES

Measurement of resistance, measurement of dielectric constant and loss factor, High voltage Schering Bridge, measurement of large capacitances, partial discharges measuring and diagnostic techniques. Time domain and Frequency domain analysis of dielectric materials subjected to an electric field.

BREAKDOWN MECHANISM OF GASEOUS LIQUID AND SOLID INSULATING MATERIALS

Introduction, Mechanism of breakdown in gases, Townsend's first ionization coefficient, cathode processes, secondary effects, Townsend's second ionization coefficient, Townsend breakdown mechanism, streamer or kanal mechanism of spark, Paschen's law, Penning effect, Breakdown in non-uniform fields, principles of breakdown in solid and liquid dielectrics.

Reading:

1. Ravindra Arora & Wolfgang Mosch: High voltage Insulation Engineering, New Age International Publishers, 2016.
2. C.L. Wadhwa: High voltage Engineering, New Age International Publishers,2012.
3. E. Kuffel, W.S. Zaengl, J. Kuffel, High voltage Engineering Fundamentals, Newnes Publishers, 2011.
4. M.S. Naidu & Kamaraju, High- voltage Engineering, McGraw Hill Education (India) Private limited, 2013.

EE463	Advanced Electric Drive Systems	DEC	3 – 0 – 0	3 Credits

Pre-Requisites: None

Course Outcomes:

CO1	Design controllers for closed-loop operation of separately excited DC motor drives
CO2	Develop high performance induction motor drives using the principles of Scalar control and Direct Torque Control
CO3	Develop Vector controlled Induction Motor drives and PMSM drives
CO4	Implement control schemes for BLDC and Switched Reluctance Motor drives

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	3	-	1	-	2	1	2	2	3	2
CO2	3	3	2	3	3	-	2	-	2	1	2	2	3	2
CO3	3	3	2	3	3	-	2	-	2	1	3	2	3	2
CO4	3	3	2	3	3	-	2	-	2	1	3	2	3	2

Detailed Syllabus:

Separately Excited DC-motor Drives: Study of Dynamics of DC motor through state-space Model, Simplified Model of a Power Converter, Review of controllers, need for anti-windup feature for integral controllers, Speed control of a separately excited DC drive with inner current loop and outer speed loop, Design of current loop with pole-zero cancellation, Design of speed loop with symmetrical optimization technique

Induction Motor drives: Implementation of V/f control with slip compensation scheme, Review of dq0 model of 3-Ph IM with simulation studies, Principle of vector control of IM, Indirect vector control, Direct Torque Control of Induction Motor Drives

Permanent Magnet Drives: PM Synchronous motors: Types, Construction, operating principle, Expression for torque, Model of PMSM, Implementation of vector control for PMSM, Introduction to BLDC drives

Switched Reluctance Motor Drives: Review of Switched Reluctance Motor, converters for SRM drives, Control of SRM drives with hard and soft chopping techniques

Reading:

1. Modern Power Electronics & AC Drives – B.K. Bose, Pearson, First edition
2. Electric Motor Drives: Modeling, Analysis and Control – R. Krishnan – Prentice Hall
3. Vector Control of Electric Drives: Peter Vas, Oxford Publishers
4. High-power Converters and AC Drives: Bin-Wu, IEEE Press, John Wiley &Sons
5. Simulation of Power Electronic Circuits: M. B. Patil, V. Ramanarayanan, V.T. Ranganathan, Narosa Publications, 2013.

EE464	Planning an Entrepreneurial Venture	DEC	3-0-0	3 Credits

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to

CO1	Understand the process and practice of entrepreneurship and new venture creation.
CO2	Identify entrepreneurial opportunities, preparation of a business plan for launching a new venture
CO3	Explore the opportunities in the domain of Electrical, Electronics and Computer Engineering for launching a new venture
CO4	Understand the functional management issues of running a new venture

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	2	1	2	1	1	1	2	2	2	2	2
CO2	2	2	2	2	1	1	3	2	1	2	2	2	2	2
CO3	2	2	2	2	1	1	1	1	2	3	2	3	2	3
CO4	2	2	2	2	1	3	1	1	1	2	3	3	2	2

Detailed syllabus:

Entrepreneur and Entrepreneurship

Entrepreneurship and Small Scale Enterprises (SSE), Role in Economic Development, Entrepreneurial Competencies, and Institutional Interface for SSE.

Establishing the Small Scale Enterprise

Opportunity Scanning and Identification in the domain of Electrical, Electronics and Computer Engineering, Market Assessment for SSE, Choice of Technology and Selection of Site, Financing the New/Small Enterprises, Preparation of the Business Plan, and Ownership Structures and Organizational Framework

Operating the Small Scale Enterprises

Financial Management Issues in SSE, Operational Management Issues in SSE, Marketing Management Issues in SSE, and Organizational Relations in SSE

Reading:

1. Holt: Entrepreneurship: New Venture Creation, PHI (P), Ltd., 2001.
2. Madhulika Kaushik: Management of New & Small Enterprises, IGNOU course material, 1995.
3. B S Rathore S Saini: Entrepreneurship Development Training Material, TTTI, Chandigarh, 1988.
4. P.C.Jain: A Hand Book for New Entrepreneurs, EDI-Faculty & External Experts, EDII, Ahmedabad, 1986.
5. J.B. Patel, D.G Allampalli: A Manual on How to Prepare a Project Report, EDII, Ahmedabad, 1991.
6. J B Patel, S S Modi: A Manual on Business Opportunity Identification and Selection, EDII, Ahmedabad, 1995.

EE465	Real Time Control of Power Systems	DEC	3–0–0	3 Credits

Pre-Requisites: EE253 - Power Systems-I, EE303 - Power Systems-II, and EE351 - Power System Operation & Control

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the structure of Real Time Control of Modern Power Systems.
CO2	Compute the number of Analog and Digital data points required at a Sub-station.
CO3	Understand the functionalities of Remote terminal units, SCADA and PMUs.
CO4	Identify the standard protocols required for SCADA and Communication systems for Load Dispatch Centers.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	2	1	3	1	2	1	1	2	1	2	3	2
CO2	3	2	3	3	3	2	2	1	2	2	2	2	3	2
CO3	3	3	3	3	3	1	2	1	3	3	2	2	3	3
CO4	3	3	3	3	3	2	2	2	3	3	3	2	3	3

Detailed syllabus

Introduction to structure of Real time control of modern Power system.

Substation/ Generating Station: Layout of substation / Generating Station, Main Equipment in Sub Station/ Generating Station, Instrument Transformers and their importance in measurements and protection, important parameters necessary for Grid operation: Analog Points (MW, MVar, Tap Position, Voltage, Frequency), Status Points (CB Status, Isolator Sta tus, SOE Points), Alarms. Hardware required getting these parameters to RTU: Transducers & their connectivity.

Scada Functions: Introduction to SCADA: Grid Operation & Control, Difficulties in operating the large power systems manually, need for going to SCADA operation, advantages of SCADA operation. Data Acquisition, Monitoring and Event Processing, Control Functions, Time tagged data, Disturbance data collection and analysis, Reports and Calculations Man Machine Communication: operator's Console, VDU display and its use, operator dialogs. Mimic Diagram Functions and Printing Facilities.

Remote Terminal Unit (RTU) &Communication Practices: Major Components: RTU Panel, Interface Panel. D20M Main Processor, Analog Card, Status Card, Control Card, Modems. Types Of Communications: Power Line Carrier Communications, Microwave, Optical fiber, VSAT Communications. Types of Network Elements in LAN & WAN. Process of Data Communication.

Sub-Load Dispatch Center (SUB-LDC): Various Equipment in Sub LDC: (a) Work Stations: details (b) FEPS: Function of FEPS (Front End Processors). (c) Routers: function of routers, interconnectivity of the equipment by LAN, Functionality and responsibilities of Sub LDC.

Introduction to SCADA Protocols and Communication Standards for Electrical Power Systems: Power System Control requirements and evolution of Protocol for Communication, Protocols - Modbus, Distributed Network Protocol (DNP), IEC 870-5 and 60870 series, Benefits from the IEC (International Electro technical Commission) communication Standards. (Ref: www.dnp.org,www.modbus.org,www.kema.nl)

Introduction to PMUs and role of PMUs

Computer Control of Electrical Power Systems: Evolution of System Control, time scale of system control, online computer control, and Software Elements: State Estimation, Monitoring & Prediction, Generation & Load Control, Security Analysis; Software Coordination & Systems Simulation. State Load Dispatch Center (SLDC): Inter Connectivity of Sub-LDCs & SLDCs, Hierarchy of Data Transfer, Functions & Responsibilities of SLDC, Real Time Operation carried at SLDC.

Reading:

1. Mini S. Thomas and John D. McDonald, ‘Power System SCADA and Smart Grids, CRC Press.
2. Hassan Bevrani: Robust Power System Frequency Control, Power Electronics and Power Systems, Edition illustrated Publisher Springer, 2009.
3. Michael John Howard Sterling: Power system control, Volume 6 of IEE control engineering series, Edition illustrated Publisher Peregrinus [for] the Institution of Electrical Engineers, 1978.
4. Torsten Cegrell, “Power System Control- Technology", Prentice- Hall International series in systems and control Engineering, Prentice- Hall International Ltd., 1986.
5. S. Bennett and D.A. Linkens (Editors): Real Time Computer Control, IEE Control Engineering series (24), peter Peregrinus Ltd., 1984.
6. Real Time Systems by C.M. Krishna and Kangg. Shin, McGraw-Hill international companies, 1997.

EE466	Advanced Power Conversion Systems	DEC	3-0-0	3 Credits

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understands the basics in the electric power conversion using power switching devices
CO2	Evaluate the conversion for range of renewable energy sources with the help of available electrical machines drives
CO3	Analyzes the different energy storage systems
CO4	Identify the various Industrial and domestic applications

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	1	2	2	2	2	2	1	2	2	2
CO2	3	2	3	2	2	2	2	2	2	2	1	2	2	2
CO3	3	3	3	2	1	2	2	2	2	2	1	2	2	2
CO4	3	2	3	2	2	2	2	2	2	2	1	2	2	2

Detailed syllabus:

Power Devices and Converters

V-I Characteristics of Voltage controlled devices, principles of power conversion using Converters and Inverters.

Performance of Electric Drives

Energy conversion with DC, AC and Special machine drives

Energy Conversion from Renewable Energy Sources

Construction and working principles of solar panels, Solar Tracking system, energy conversion from wind and other renewable energy sources, grid interconnected systems.

Electric Vehicles

Energy storage in different types of batteries, Super capacitors, pumped storage systems, fly-wheels and electric vehicles applications.

Electrical Energy Applications

Induction heating: melting, hardening, lighting applications and their control, UPS, battery chargers.

Reading:

1. M.H. Rashid: Power electronics-circuits, Devices and applications, Prentice Hall India, New Delhi,2009
2. P.S. Bhimbra: Power electronics, Khanna publishers, New Delhi,2012
3. Ned Mohan, Undeland and Robbin: Power electronics converters, applications and design, John Willey & Sons, Inc. NewYork,2006.

EE467	Illumination Technology	DEC	3-0-0	3 Credits

Pre-Requisites: EE201 - Circuit Theory-I, EE251 - Circuit Theory-II, EC236 - Analog Electronics Lab, andEE352 - Power Electronics

Course Outcomes: At the end of the course, students will be able to

CO1	Evaluate the characteristics of illumination sources/devices.
CO2	Understand and determine the performance of various lighting systems.
CO3	Design of lighting controls and management
CO4	Understand the standards of lighting systems and commissioning

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	1	1	-	1	-	1	1	3	1
CO2	3	3	3	2	2	1	1	-	1	2	-	1	3	1
CO3	3	3	3	3	3	1	2	-	1	1	1	1	3	3
CO4	3	3	3	2	1	2	2	3	2	1	1	1	3	2

Detailed Syllabus:

Ballast based Systems: Introduction - Magnetic and Electronic Ballast – Dimming Electronic Ballast for Fluorescent lamps - Lamp Ballast interactions – Electronic Ballast for HID Lamps - Pulse start metal halide system, Compact Fluorescent lamp.

Solid State Lamps: Introduction - Review of Light sources - white light generation techniques-Characterization of LEDs for illumination application. Power LEDs- High brightness LEDs- Electrical and optical properties – LED driver considerations- Power management topologies- Thermal management considerations- Heat sink design- photometry and colorimetry - color issues of white LEDs- Dimming of LED sources -Designing usable lamp from white LEDs,- Luminaire design steps-SSL test standards. Dimming control scheme - Lighting controls for LED lamps.

Lighting Controls & management: Introduction to lighting control – lighting control strategies - Energy Management strategies – Switching Control – sensor technology - occupancy sensors – PIR – Ultrasonic – location, coverage area & mounting configuration – special features – Application. Photo sensors – spectral sensitivity – Photo sensor based control algorithms – Daylight-artificial light integrated schemes.

Commissioning of lighting controls: NASHRAE / IESNA standards & energy codes – international energy conservation code – compliance with controls Lighting Control Applications: Commercial lighting – stage and entertainment lighting – Architectural lighting – Residential Lighting Energy Management and building control systems.

Reading:

1. Arturas Zukauskus, Michael S. Shur and Remis Gaska, “Introduction to solid state lighting”, Wiley-Interscience, 2002.
2. E. Fred Schubert, “Light Emitting Diodes” (2nd edition), Cambridge University Press, 2006.
3. Craig DiLouie, Advanced Lighting Controls: Energy Saving Productivity, Technology & Applications, Fairmont Press, Inc., 2006.
4. Mohan, Undeland and Robbins, “Power Electronics: Converters, Applications and Design”, John Wiley and Sons, 1989.
5. Steve Winder, “Power Supplies for LED Driving” Newnens Publication, 2008.
6. Robert S Simpson, Lighting Control: Technology and Applications, Focal Press, 2003.
7. IES Lighting Handbook, 10th Edition IESNA, 2011.
8. Extract from Current Literature.
9. www.aboutlightingcontrols.org
10. www.ti.com

EE5163	Power Quality Improvement Techniques	DEC	3 - 0 - 0	3 Credits

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Assess the severity of power quality problems in distribution system
CO2	Evaluate the power quality indices used in industrial power system
CO3	Understand various mitigation techniques for compensating devices to improve the power quality
CO4	Simulate the compensating devices to improve the power quality

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	3	2	1	1	1	1	2	3	2
CO2	3	3	3	2	2	3	2	1	3	1	1	2	3	2
CO3	3	3	3	2	3	3	2	1	1	1	2	2	3	3
CO4	3	3	3	2	3	3	2	1	3	1	3	2	3	3

Detailed Syllabus:

Power Quality: Introduction; Power quality definition; Significance of power quality, Power quality terms: Transients, Long-duration voltage variations, Short-duration voltage variations, Voltage imbalance, Waveform distortion, Voltage fluctuation, CBEMA and ITI curves

Waveform Distortion: Introduction, Voltage versus current distortion, Harmonics versus transients, Harmonics indices: Total Harmonics Distortion (THD) and Total Demand distortion (TDD); Harmonic standards; Harmonic analysis; Harmonic phase sequence; Triplen harmonics; Inter-harmonics.

Harmonic Sources: Introduction; Harmonics generated from electrical machines such as transformers and rotating machines; Arcing devices; Static power conversion: Phase controlled and uncontrolled rectifiers, AC voltage regulators, Cycloconverters, Pulse width modulated inverters; Converter fed ac and dc drives.

Effects of Harmonic Distortion: Introduction; Resonances; Effects of harmonics on rotating machines; Effect of harmonics on static power plant; Power assessment with distorted waveforms; Effect of harmonics on measuring instruments; Harmonic interference with ripple control systems; Harmonic interference with power system protection; Effect of harmonics on consumer equipment; Interference with communication systems.

Harmonic Elimination: Introduction; Passive power filters: Design, Advantages and disadvantageous; Shunt active power filters: Operating principle, Configurations, State of the art, Design and control strategies. Three-phase four-wire shunt active power filters

Voltage Quality: Introduction; Sources of Sags, Swell, Unbalance and Harmonics; Voltage quality standards; Effects of sags, Swell, Unbalance and harmonics; Voltage sag magnitude due to fault; Voltage sag magnitude calculation based on influence of cross section of conductor, transformer and fault levels; Critical distance for a voltage sag magnitude; Causes of phase-angle jumps in voltage; Classification of voltage sags, voltage sag transformation due to transformers

Methods for improving Voltage Quality: Introduction; Series active power filters: Operating principle, Configurations, State of the art, Design and control strategies. Three-phase four-wire series active power filters.

Unified Power Quality Conditioner (UPQC): Introduction; design and control; Three-phase three-wire

UPQC and three-phase four-wire UPQC topologies, Multilevel inverters based UPQC topologies.

Simulation of Three-phase four-wire series active power filters, shunt active filter and combined series-shunt active filters using MATLAB/Simulink

Application of multilevel inverters for large rating active power filters.

Reading:

1. Electrical Power Systems Quality, Dugan Roger C, Santoso Surya, Mc Granaghan , Marks F. Beaty and H. Wayre, 3rd edition, McGraw Hill,2012.
2. Power System Harmonics, J. Arrillaga, N.R. Watson, John Wiley & Sons Ltd, Second Edition, 2003.
3. Instantaneous Power Theory and Applications to Power Conditioning, Hirofumi Akagi, Edson Hirokazu Watanabe, Mauricio Aredes, Wiley-IEEE Press,2007.
4. Understanding power quality problems, Math H. Bollen, IEEE Press.
5. MATLAB Simulink Documentation by Maths Works
6. IEEE Transactions and Standards.
7. Power Quality Enhancement Using Custom Power Devices, Ghosh Arindam, Ledwich Gerard, Springer, 2009.
8. Power Quality: Problems and Mitigation Techniques, Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, Wiley, 2014.

EE 5164	Electric Vehicles	DEC	3 – 0 – 0	3 Credits

Pre-Requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the basic concepts of electric vehicles and popular traction systems.
CO2	Analyze the characteristics of train movement other traction mechanics.
CO3	Understand the drive-train topologies and advanced propulsion techniques.
CO4	Analyze the various energy storage methodologies and systems of train lighting

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	1	3	3	3	2	1	1	2	3	3
CO2	3	3	3	3	2	2	2	3	2	1	1	2	3	3
CO3	3	3	2	3	3	2	2	2	3	2	3	3	3	3
CO4	3	3	3	2	2	2	2	2	3	2	3	3	3	3

Introduction: Conventional vehicles - basics of vehicle performance - vehicle power source characterization - transmission characteristics - mathematical models to describe vehicle performance - History of electric vehicles - social and environmental importance of electric vehicles - impact of modern drive-trains on energy supplies.

Methods of traction - track electrification - DC system - single phase and three-phase low frequency and high frequency system - composite system - kando system - comparison between AC and DC systems - problems of single phase traction with current unbalance and voltage balance.

Traction mechanics: Mechanics of traction movement - speed-time curves for different services - trapezoidal and quadrilateral speed-time curves - tractive effort requirements and problems - power - specific energy consumption - effect of varying acceleration and braking - Retardation - adhesive weight and braking retardation - coefficient of adhesion.

Electric drive-trains: Basic concept of electric traction - introduction to various electric drive-train topologies - power flow control in electric drive-train topologies - fuel efficiency analysis

Train lighting: Special requirements of train lighting - methods of obtaining unidirectional polarity constant output-single battery system - Double battery parallel block system - coach wiring - Lighting by making use of 25 KV AC supply.

Electric propulsion unit: Introduction to electric components used in electric vehicles - Configuration and control of DC Motor drives - Configuration and control of Induction Motor drives - Configuration and control of Permanent Magnet Motor drives - Configuration and control of Switch Reluctance Motor drives - Drive system efficiency, Concept of Hybrid Electric Vehicles

Energy storage: Introduction to Energy Storage Requirements in Electric Vehicles - Battery based energy storage and its analysis - Fuel Cell based energy storage and its analysis - Super Capacitor based energy storage and its analysis - Flywheel based energy storage and its analysis - Hybridization of different energy storage devices

Reading:

1. Ali Emadi, Advanced Electric Drive Vehicles, CRC Press, 2014.
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
3. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
4. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
5. H. Partab: Modern Electric Traction – Dhanpat Rai& Co, 2007.
6. S. Rao: EHV AC and HVDC Transmission Engineering and Practice, 3rd Edition, Khanna Pub, 1997.

EE5261	Power System Deregulation	DEC	3-0-0	3 Credit

Pre-Requisite: None

Couse Outcomes: At the end of the course the student will be able to

CO1	Understand Developments in power sector reform
CO2	Identify the roles and responsibilities of service entities in the power market
CO3	Analyze congestion management, transmission pricing, and ancillary services management

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	3	2	2	1	1	2	1	3	3	3	3
CO2	3	3	2	3	2	2	1	1	2	1	3	3	3	3
CO3	3	3	2	3	2	2	1	1	2	1	3	3	3	3

Detailed Syllabus:

Overview of Key Issues in Electric Utilities
Introduction –Restructuring models –Independent system operator (ISO) –Power Exchange -Market operations –Market Power –Standard cost –Transmission Pricing –congestion Pricing –Management of Inter zonal/Intra zonal Congestion.

OASIS: Open Access Same-Time Information System
Structure of OASIS -Posluing of Information –Transfer capability on OASIS –Definitions Transfer Capability Issues –ATC –TTC –TRM –CBM calculations –Methodologies to calculate ATC

Electricity Pricing
Introduction –electricity Price Volatility Electricity Price Indexes –challenges to Electricity Pricing –Construction of Forward Price Curves –Short-time Price Forecasting.

Power System Operation in a Competitive Environment
Introduction –Operational Planning Activities of ISO-The ISO in Pool Markets –The ISO in Bilateral Markets –Operational Planning Activities of a Genco

Ancillary Services Management
Introduction –Reactive Power as an Ancillary Service –a review –Synchronous Generators as Ancillary Service Providers.

Reading:

1. Kankar Bhattacharya, Math H.J. Boller, JaapE. Daalder,-Operation of Restructured Power System Klum, Academic Publisher–2001.
2. Ashikur Bhuiya: Power System Deregulation: Loss Sharing in Bilateral Contracts and Generator Profit Maximization, Publisher VDM Verlag, 2008.
3. Mohammad Shahidehpour, and Muwaffaqalomoush, -Restructured Electrical Power systems Marcel Dekker, Inc.2001.
4. Loi Lei Lai;-Power system Restructuring and Deregulation‖, Jhon Wiley& Sons Ltd., England.

EE235	Basic Electrical Engineering Laboratory	ESC	0–1– 2	2 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Select the range of apparatus based on the ratings of DC machines, transformers and induction machines.
CO2	Understand the operation of KVL, KCL and Superposition theorems applied to simple dc circuits.
CO3	Determine equivalent circuit parameters of transformers by conducting OC and SC tests.
CO4	Evaluate the performance of DC machines & its braking methods.
CO5	Evaluate the performance of AC machines and Transformers.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	2	2	1	2	3	1	1	--	--
CO2	3	3	3	2	1	2	1	1	2	3	1	1	--	--
CO3	3	3	3	1	1	2	1	1	2	3	1	1	--	--
CO4	3	3	3	1	1	2	2	1	2	3	1	1	--	--
CO5	3	3	3	1	1	2	2	1	2	3	1	1	--	--

Detailed syllabus

1. a) Verification of Kirchhoff's Voltage and Current Laws.
   b) Verification of Superposition Theorem.
2. Calculation of the Power factor and Power in a Single Phase Series R-L circuit
3. Measurement of Self and Mutual inductance of Coils.
4. No load test on a DC Machine.
5. Load Test on a DC Shunt Generator.
6. Speed Control of a DC Shunt Motor.
7. a) Determination of Equivalent Circuit Parameters of a Single Phase Transformer.
   b) Predetermination of Efficiency and Regulation of a Single Phase Transformer.
8. Direct Load test on a Single Phase Transformer.
9. Separation of No-load Losses of a Single phase Transformer.
10. Direct Load test on a Three Phase Induction Motor.
11. Measurement of energy

Reading

Manual for Basic Electrical Engineering Laboratory

EE236	NETWORK ANALYSIS	PCC	3–0–0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Apply the knowledge of basic circuital law and simplify the network using reduction techniques.
CO2	Analyze the circuits using Kirchhoff's law and network simplification theorems.
CO3	Determine the transient response and steady state response for given network.
CO4	Obtain the maximum power transfer to the load as well as analyze the series resonant and parallel resonant circuit.
CO5	Determine the parameters of a given Two-port network.

Course Articulation Matrix:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	2	1	1	1	1	-	2	--	--
CO2	3	3	3	3	3	2	1	1	1	1	-	2	--	--
CO3	3	3	3	3	3	2	1	1	1	1	-	2	--	--
CO4	3	3	3	3	3	2	1	1	1	1	-	2	--	--
CO5	3	3	3	3	3	2	1	1	1	1	-	2	--	--

Detailed syllabus

Circuit Elements and Relations:

Types of sources and source transformations – Dot convention and formation of loop and node equations.

Network Graphs and Analysis:

Graph of a network – incidence matrix Formation of equilibrium equations – Dual networks.

Time Domain Analysis:

Solution of network equations in time domain classical differential equations – approach – initial conditions and their evaluation – Applications to simple RLC circuits only.

Applications Of Laplace Transforms In Circuit Theory:

Laplace transformers of various signals of excitation – Waveform synthesis, Laplace transformed networks – Determination and representation of initial conditions – Response for impulse function only and its relation to network admittance – convolution integral and applications.

Steady State Analysis of Circuits for Sinusoidal Excitations: single-phase series, parallel, series-parallel circuits – Solution of AC networks using mesh and nodal analysis.

Resonance: Series and parallel resonance – Selectivity – Bandwidth – Q 1factors.

Network Theorems and Applications: Superposition theorem – Thevenin's and Norton's theorems –Millman's theorem – Maximum power transfer theorem – Tellegen's theorem – Their applications in analysis of networks.

Reading:

1. M.E.VanValken Burg: NetworkAnalysis, 3rdEdition, Pearson Education, 2015.
2. G.K Mittal & Ravi Mittal: Network Analysis, 14thEdition, Khanna Publications, 2003.
3. M.L. Soni and J.C. Gupta: A course in Electrical Circuits Analysis, Dhanpat Rai & Co. (P), 2001.
4. Gopal G Bhise, Prem R Chadha & Durgesh C. Kulshreshtha Gopal: Engineering Network Analysis and Filter Design, Umesh Publications, 2012
5. S.R. Paranjothi: Electric Circuit Analysis, New Age International Pub., 2002.
6. De Carlo & Lin: Linear circuit Analysis, Oxford University Press, 2nd Edition, 2010.

<u>OPEN ELECTIVES</u>

CE390	ENVIRONMENTAL IMPACT ANALYSIS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Identify the environmental attributes to be considered for the EIA study.
CO2	Formulate objectives of the EIA studies.
CO3	Identify the suitable methodology and prepare Rapid EIA.
CO4	Prepare EIA reports and environmental management plans.
CO5	Plan the methodology to monitor and review the relief and rehabilitation works.

Course Articulation Matrix

CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	2	1	2	-	-	3	3	1	-	2	1	-	-	1
CO2	2	1	2	-	-	3	3	1	-	2	1	-	-	1
CO3	2	1	2	-	-	3	3	1	-	2	1	-	-	1
CO4	2	1	2	-	-	3	3	1	-	2	1	-	-	1
CO5	2	1	2	-	-	3	3	1	-	2	1	-	-	1

Detailed Syllabus:

Introduction: The Need for EIA, Indian Policies Requiring EIA , The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA, Roles in the EIA Process. Government of India Ministry of Environment and Forest Notification (2000), List of projects requiring Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, International agreements.

Identifying the Key Issues: Key Elements of an Initial Project Description and Scoping, Project Location(s), Land Use Impacts, Consideration of Alternatives, Process selection: Construction Phase, Input Requirements, Wastes and Emissions, Air Emissions, Liquid Effluents, Solid Wastes, Risks to Environment and Human, Health, Socio-Economic Impacts, Ecological Impacts, Global Environmental Issues.

EIA Methodologies**:** Criteria for the selection of EIA methodology, impact identification, impact measurement, impact interpretation & Evaluation, impact communication, Methods-Adhoc methods, Checklists methods, Matrices methods, Networks methods, Overlays methods, Environmental index using factor analysis, Cost/benefit analysis, Predictive or Simulation methods. Rapid assessment of Pollution sources method, predictive models for impact assessment, Applications for RS and GIS.

Reviewing the EIA Report: Scope, Baseline Conditions, Site and Process alternatives, Public hearing. Construction Stage Impacts, Project Resource Requirements and Related Impacts, Prediction of

Environmental Media Quality, Socio-economic Impacts, Ecological Impacts, Occupational Health Impact, Major Hazard/ Risk Assessment, Impact on Transport System,Integrated Impact Assessment.

Review of EMP and Monitoring: Environmental Management Plan, Identification of Significant or Unacceptable Impacts Requiring Mitigation, Mitigation Plans and Relief & Rehabilitation, Stipulating the Conditions, What should be monitored? Monitoring Methods, Who should monitor? Pre-Appraisal and Appraisal.

Case Studies: Preparation of EIA for developmental projects- Factors to be considered in making assessment decisions, Water Resources Project, Pharmaceutical industry, thermal plant, Nuclear fuel complex, Highway project, Sewage treatment plant, Municipal Solid waste processing plant, Tannery industry.

Reading:

1. Jain R.K., Urban L.V., Stracy G.S., *Environmental Impact Analysis*, Van Nostrand Reinhold Co., New York, 1991.
2. Barthwal R. R., *Environmental Impact Assessment*, New Age International Publishers, 2002
3. Rau J.G. and Wooten D.C., *Environmental Impact Assessment,* McGraw Hill Pub. Co., New York, 1996.
4. Anjaneyulu Y., and Manickam V., Environmental Impact Assessment Methodologies, B.S. Publications, Hyderabad, 2007.
5. Wathern P., Environmental Impact Assessment- Theory and Practice, Routledge Publishers, London, 2004.

EE390	LINEAR CONTROL SYSTEMS	OPC	3 – 0 – 0	3 Credits

(This course is not offered to Electrical Engg students)

Pre-requisites: None

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

CO1	Analyze electromechanical systems using mathematical modelling
CO2	Determine Transient and Steady State behavior of systems using standard test signals
CO3	Analyze linear systems for steady state errors, absolute stability and relative stability
CO4	Design a stable control system satisfying requirements of stability and reduced steady state error

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	3	3	3	3	1	1	1	2	1	1	2	--	--
CO2	3	3	3	3	3	1	1	1	2	1	1	2	--	--
CO3	3	3	3	3	3	1	1	1	2	1	1	2	--	--
CO4	3	3	3	3	3	1	1	1	2	1	1	2	--	--

Detailed syllabus:

Introduction: Control system, types, feedback and its effects-linearization

Mathematical Modeling of Physical Systems: Block diagram Concept and use of Transfer function. Signal Flow Graphs, Mason's gain formula.

Time Domain Analysis of Control Systems - BIBO stability, absolute stability, Routh-Hurwitz Criterion.

P, PI and PID controllers. Root Locus Techniques - Root loci theory, Application to system stability studies.

Introduction to state variables technique, Analysis of R-L, R-L-C networks.

Frequency Domain Analysis of Control Systems - polar plots, Nyquist stability criterion, Bode plots, application of Bode plots.

Reading:

1. B.C.Kuo, Automatic Control Systems, 7th Edition, Prentice Hall of India, 2009.
2. I.J. Nagarath and M. Gopal: Control Systems Engineering, 2nd Edition, New Age Pub. Co.2008.

EE391	SOFT COMPUTING TECHNIQUES	OPC	3 – 0 – 0	3 Credits

(This course is not offered to Electrical Engg Students)

Pre-requisites: None

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

CO1	Understand the concepts of population based optimization techniques
CO2	Examine the importance of exploration and exploitation in heuristic optimization techniques to attain near-global optimal solution
CO3	Evaluate the importance of parameters in heuristic optimization techniques
CO4	Apply for the solution of multi-objective optimization

Course Articulation Matrix

CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	3	2	2	3	1	1	1	2	1	1	2	--	--
CO2	3	3	2	2	3	1	1	1	3	1	1	3	--	--
CO3	3	3	2	2	3	1	1	1	3	1	3	3	--	--
CO4	3	3	2	2	3	1	1	1	3	1	3	3	--	--

Detailed syllabus:

Fundamentals Of Soft Computing Techniques: Definition-Classification of optimization problems-Unconstrained and Constrained optimization Optimality conditions- Introduction to intelligent systems-Soft computing techniques- Classification of meta-heuristic techniques - Single solution based and population based algorithms – Exploitation and exploration in population based algorithms - Properties of Swarm intelligent Systems - Application domain - Discrete and continuous problems - Single objective and multi-objective problems.

Genetic Algorithm And Particle Swarm Optimization: Genetic algorithms- Genetic Algorithm versus Conventional Optimization Techniques - Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators -Bird flocking and Fish Schooling – anatomy of a particle- equations based on velocity and positions -PSO topologies - control parameters. Application to SINX maximization problem.

Ant Colony Optimization And Artificial Bee Colony Algorithms: Biological ant colony system - Artificial ants and assumptions - Stigmergic communications - Pheromone updating- local-global - Pheromone evaporation - ant colony system- ACO models-Touring ant colony system-max min ant system - Concept of elistic ants-Task partitioning in honey bees - Balancing foragers and receivers - Artificial bee colony (ABC) algorithms-binary ABC algorithms.

Shuffled Frog-Leaping Algorithm and Bat Optimization Algorithm: Bat Algorithm- Echolocation of bats-Behavior of microbats- Acoustics of Echolocation- Movement of Virtual Bats- Loudness and Pulse

Emission- Shuffled frog algorithm-virtual population of frogs-comparison of memes and genes - memeplex formation- memeplex updation.

Application to multi-modal function optimization

Introduction to Multi- Objetive optimization-Concept of Pareto optimality.

Reading:

1. Xin-She Yang, “Recent Advances in Swarm Intelligence and Evolutionary Computation,Springer International Publishing, Switzerland, 2015.
2. Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms, John Wiley & Sons, 2001.
3. James Kennedy and Russel E Eberheart, Swarm Intelligence, The Morgan Kaufmann Series in Evolutionary Computation, 2001.
4. Eric Bonabeau, Marco Dorigo and Guy Theraulaz, Swarm Intelligence-From natural to Artificial Systems, Oxford university Press, 1999.
5. David Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Pearson Education, 2007.
6. Konstantinos E. Parsopoulos and Michael N. Vrahatis, Particle Swarm Optimization and Intelligence: Advances and Applications, Information science reference, IGI Global, 2010.
7. N P Padhy, Artificial Intelligence and Intelligent Systems, Oxford University Press, 2005.

ME390	AUTOMOTIVE MECHANICS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Analyze operation and performance indicators of transmission systems, internal combustion engines and after treatment devices.
CO2	Understand operation of engine cooling system, lubrication system, electrical system and ignition system.
CO3	Understand fuel supply systems in an diesel and petrol vehicles
CO4	Analyze current and projected future environmental legislation and its impact on design, operation and performance of automotive power train systems.
CO5	Understand operation and performance of suspension, steering and braking system.
CO6	Understand layout of automotive electrical and electronics systems.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	1	1	-	-	-	1	2	-	-	-	-	-	1	1
CO2	1	1	-	-	-	1	2	-	-	-	-	-	2	2
CO3	1	1	-	-	-	1	2	-	-	-	-	-	-	1
CO4	1	1	-	-	-	1	2	-	-	-	-	-	3	3
CO5	1	1	-	-	-	1	2	-	-	-	-	-	-	1
CO6	1	1	-	-	-	1	2	-	-	-	-	-	3	2

Detailed syllabus

Introduction: Layout of an automotive chassis, engine classification.

Cooling Systems: Air cooling, air cleaners, Water cooling: Thermo syphon and pump circulation systems, Components of water cooling systems- Radiator, thermostat etc.

Engine Lubrication: Petroils system, Splash system, Pressure lubrication and dry sump system

Ignition System: Battery, Magneto and Electronic, Engine Starting drives

Fuel supply system: Components in fuel supply system, types of feed pumps, air cleaners, fuel and oil filters, pressure and dry sump systems.

Engine testing and Performance: Performance parameters, constant and variable speed test, heat balance test, performance characteristics. Engine Emissions: SI and CI engine emissions, emission control methods

Automotive electrical and electronics: Electrical layout of an automobile, ECU, sensors, windscreen wiper, Electric horn.

Transmission: Clutch- Single and multiplate clutch, semi & centrifugal clutch and fluid flywheel, Gear box: Sliding mesh, constant mesh and synchromesh gear box, selector mechanism, over drive, Propeller shaft and Differential.

Suspension System: Front and rear suspension, shock absorbers, Rear Axles mountings, Front Axle. Steering Mechanism: Manual and power steering systems, Braking System: Mechanical, Hydraulic and Air braking systems.

Engine service: Engine service procedure.

Reading:

1. S. Srinivasan, Automotive Mechanics, Tata McGraw-Hill, 2004.
2. K.M.Gupta, Automobile Engineering, Vol.1 and Vol.2, Umesh Publications, 2002
3. Kirpal Singh, Automobile Engineering, Vol.1 and Vol.2, Standard Publishers, 2003.
4. William H.Crouse and Donald L. Anglin, Automotive Mechanics, Tata McGraw-Hill, 2004
5. Joseph Heitner, Automotive Mechanics, East-West Press, 2000.

ME391	ENTREPRENEURSHIP DEVELOPMENT	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand entrepreneurship and entrepreneurial process and its significance in economic development.
CO2	Develop an idea of the support structure and promotional agencies assisting ethical entrepreneurship.
CO3	Identify entrepreneurial opportunities, support and resource requirements to launch a new venture within legal and formal frame work.
CO4	Develop a framework for technical, economic and financial feasibility.
CO5	Evaluate an opportunity and prepare a written business plan to communicate business ideas effectively.
CO6	Understand the stages of establishment, growth, barriers, and causes of sickness in industry to initiate appropriate strategies for operation, stabilization and growth.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	-	-	-	-	-	3	1	3	2	2	3	-	--	--
CO2	-	-	-	-	-	3	1	3	2	2	3	-	--	--
CO3	-	-	-	-	-	3	1	3	2	2	3	-	--	--
CO4	-	-	-	-	-	3	1	3	2	2	3	-	--	--
CO5	-	-	-	-	-	3	1	3	2	2	3	-	--	--
CO6	-	-	-	-	-	3	1	3	2	2	3	-	--	--

Detailed syllabus

Entrepreneur and Entrepreneurship: Introduction; Entrepreneur and Entrepreneurship; Role of entrepreneurship in economic development; Entrepreneurial competencies and motivation; Institutional Interface for Small Scale Industry/Enterprises.

Establishing Small Scale Enterprise: Opportunity Scanning and Identification; Creativity and product development process; Market survey and assessment; choice of technology and selection of site.

Planning a Small Scale Enterprises**:** Financing new/small enterprises; Techno Economic Feasibility Assessment; Preparation of Business Plan; Forms of business organization/ownership.

Operational Issues in SSE**:** Financial management issues; Operational/project management issues in SSE; Marketing management issues in SSE; Relevant business and industrial Laws.

Performance appraisal and growth strategies**:** Management performance assessment and control; Causes of Sickness in SSI, Strategies for Stabilization and Growth.

Reading:

1. G.G. Meredith, R.E.Nelson and P.A. Neek, The Practice of Entrepreneurship, ILO, 1982.
2. Dr. Vasant Desai, Management of Small Scale Enterprises, Himalaya Publishing House, 2004.
3. A Handbook for New Entrepreneurs, Entrepreneurship Development Institute of India, Ahmedabad, 1988.
4. Bruce R Barringer and R Duane Ireland, Entrepreneurship: Successfully Launching New Ventures, 3rd Edition, Pearson Edu., 2013.

EC390	COMMUNICATION SYSTEMS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand different modulation and demodulation schemes for analog communications.
CO2	Design analog communication systems to meet desired application requirements
CO3	Evaluate fundamental communication system parameters, such as bandwidth, power, signal to quantization noise ratio etc.
CO4	Elucidate design tradeoffs and performance of communications systems.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	1	1	-	-	1	1	-	-	-	-	-	-	1	1
CO2	1	1	-	-	1	1	-	-	-	-	-	-	1	1
CO3	1	1	-	-	1	1	-	-	-	-	-	-	1	1
CO4	1	1	-	-	1	1	-	-	-	-	-	-	1	1

Detailed syllabus

Signal Analysis**:** Communication Process, Sources of Information, Communication Channels, Modulation Process, Types of Communication, Random Process, Gaussian Process, Correlation Function, Power Spectral Density, Transmission of Random Process through an LTI Filter.

Noise Analysis: External Noise, Internal Noise, White Noise, Narrow Band Noise, Representation of Narrow Band noise In phase and Quadrature Components, Noise Figure, Noise Bandwidth, Noise Temperature.

Amplitude (Linear) Modulation: Linear Modulation Schemes, Generation of AM, Envelope Detector, DSB-SC Product Modulator, Switching Modulator, Ring Modulator, Coherent Detection, Costas receiver, SSB Signal Representation, Filtering Method, Phase Shift Method, Coherent Demodulation, VSB Modulator and Demodulator, Carrier Acquisition using Squaring Loop and Costas Loop, Receiver Model, SNR, Noise in SSB and DSB receivers using coherent detection, Noise in AM Receiver using Envelope detection, Threshold Effect.

Angle (Exponential) Modulation: Types of Angle Modulation, Relation between FM and PM, Narrow Band FM, Wideband FM, Transmission Bandwidth of FM Signals, Generation of FM using Direct and Indirect methods, FM Demodulation using Slope Circuit, Frequency Discriminator, Interference in Angle Modulation, Noise in FM Receiver, FM Threshold Effect, Pre-emphasis and De-emphasis in FM, Model of PLL for FM Demodulation.

Pulse Modulation: Sampling Process, PAM, PWM, PPM, Quantization, PCM, TDM, Digital Multiplexer Hierarchy, DM, DSM, Linear Prediction, DPCM, ADPCM, Noise in PCM System, Companding, Comparison of the Noise Performance of AM,FM,PCM and DM.

Information Theory: Uncertainty, Information, Entropy, Source Coding Theorem, Data Compaction, Mutual information, Channel Capacity, BSC Channel, Information Capacity Theorem, Bandwidth - Power Tradeoff, Huffman Coding.

Reading:

1. S.Haykin, Communication Systems, 4thEdn, John Wiley & Sons, Singapore, 2001.
2. B.P. Lathi, Modern Digital & Analog Communication Systems, 3rdEdition, Oxford University Press, Chennai, 1998.
3. Leon W.Couch II., Digital and Analog Communication Systems, 6thEdition, Pearson Education Inc., New Delhi, 2001.
4. A Bruce Carlson, PB Crilly, JC Rutledge, Communication Systems, 4thEdition, MGH, New York, 2002.

EC391	MICROPROCESSOR SYSTEMS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Develop basic understanding of microprocessor architecture.
CO2	Design Microprocessor and Microcontroller based systems.
CO3	Understand C, C++ and assembly language programming
CO4	Understand concept of interfacing of peripheral devices and their applications

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	1	1	1	-	2	-	-	-	-	-	-	-	1	1
CO2	1	1	1	-	2	-	-	-	-	-	-	-	1	1
CO3	1	1	1	-	2	-	-	-	-	-	-	-	1	1
CO4	1	1	1	-	2	-	-	-	-	-	-	-	1	1

Detailed syllabus

Microcomputer Organization: CPU, Memory, I/O, Operating System, Multiprogramming, Multithreading, MS Windows

80386 Micro Processors : Review of 8086,salient features of 80386,Architecture and Signal Description of 80386,Register Organization of 80386,Addressing Modes,80386 Memory management, Protected mode, Segmentation, Paging, Virtual 8086 Mode, Enhanced Instruction set of 80386, the Co- Processor 80387

Pentium & Pentium-pro Microprocessor: Salient features of Pentium microprocessor, Pentium architecture, Special Pentium registers, Instruction Translation look aside buffer and branch Prediction, Rapid Execution module, Memory management, hyper-threading technology, Extended Instruction set in advanced Pentium Processors

Microcontrollers: Overview of micro controllers-8051 family microcontrollers, 80196 microcontrollers family architecture, Instruction set, pin out, memory interfacing.

ARM Processor Fundamentals: Registers, current Program Status Registers, Pipeline Exceptions, Interrupts and Vector Table, Architecture Revisions, ARM Processor families, ARM instruction set, Thumb Instruction set-Exceptions Handing, Interrupts, Interrupt Handling schemes, firmware, Embedded operating systems, Caches-cache architecture, Cache policy, Introduction to DSP on the ARM, DSP on the ARM7TDMI,ARM9TDMI.

Case study-Industry Application of Microcontrollers

Reading:

1. Barry B. Brey, Intel Microprocessor Architecture, Programming and Interfacing-8086/8088, 80186, 80286, 80386 and 80486,PHI, 1995.
2. Muhammad Ali Mazidi and Mazidi, The 8051 Microcontrollers and Embedded systems,PHI,2008
3. Intel and ARM Data Books on Microcontrollers.

MM364	FUNDAMENTALS OF MATERIALS PROCESSING TECHNOLOGY	OPC	3 – 0 –0	03 Credits

Pre-requisites: None

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

CO1	Describe engineering materials.
CO2	Appreciate material processing techniques.
CO3	Select material processing technique for a given material and application.
CO4	Explain surface engineering techniques and their engineering significance.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	3	2	-	-	1	1	-	-	-	-	-	--	--
CO2	3	3	2	-	-	1	1	-	-	-	-	-	--	--
CO3	3	3	2	-	-	1	1	-	-	-	-	-	--	--
CO4	3	3	2	-	-	1	1	-	-	-	-	-	--	--

Detailed syllabus

Introduction to engineering materials: Metals, alloys and phase diagrams, ferrous metals, non-ferrous metals, super alloys, guide to processing of metals; ceramics-structure and properties of ceramics, traditional ceramics, new ceramics, glass, some important elements related to ceramics; polymers-fundamentals of polymer science and technology, thermoplastic and thermosetting polymers, elastomers; composite materials-classification of composite materials, metal matrix, polymer matrix and ceramic matrix composites.

Fundamental properties of materials: mechanical properties-stress-strain relationships, hardness, tensile properties, effect of temperature on properties, visco-elastic behavior of polymers, thermal properties and electrical properties of metals, polymers, ceramics and composites.

Metal casting fundamentals and metal casting processes: Overview of casting technology, melting and pouring, solidification and casting, sand casting, other expendable-mold casting processes, permanent-mold casting processes, casting quality, metals for casting.

Particulate processing of metals and ceramics: Powder metallurgy-characterization of engineering powders, production of metallic powders, conventional processing and sintering, alternative processing and sintering techniques, materials and products for powder metallurgy, design considerations in powder metallurgy, processing of traditional ceramics, processing of new ceramics, cermets and their processing.

Fundamentals of metal forming and shaping processes, such as rolling, forging, extrusion, drawing, sheet metal forming: Overview of metal forming, friction and lubrication in metal forming; bulk deformation processes in metal forming-rolling, other deformation processes related to rolling, forging, other deformation processes related to forging, extrusion, wire and bar drawing; cutting and bending operations, sheet-metal drawing, other sheet metal forming operations, dies and presses for sheet-metal processes, sheet-metal operations not performed in presses.

Fundamentals welding: Overview of welding technology, the weld joint, physics of welding, features of a fusion-welded joint; Welding processes-arc welding, resistance welding, oxy-fuel gas welding, other fusion welding processes, solid-state welding, weld quality, weldability; brazing, soldering and adhesive bonding.

Surface engineering and tribology: Importance of surface engineering, classification of surface engineering processes, introduction to thermal, mechanical, thermo-chemical and electro-chemical surface engineering processes with their advantages, limitations and applications.

Reading:

1. Kalpakjian and Schmid, Manufacturing Engineering and Technology, Prentice Hall, New Jersey, 2013.
2. Mikell P. Groover, Fundamentals of Modern Manufacturing, John Wiley & Sons, Inc., New Jersey, 2010.
3. DeGarmo, Black, and Kohser, Materials and Processes in Manufacturing, John Wiley & Sons, Inc, New York, 2011.
4. R. S. Parmar, Welding processes and Technology, Khanna Publishers, 2010.
5. H.S. Bawa, Manufacturing Technology-I, Tata McGraw Hill Publishers New Delhi, 2007.
6. Serope Kalpakjian, Manufacturing processes for Engineering Materials, Addison Wesley, 2001.

CH390	NANOTECHNOLOGY AND APPLICATIONS	OPC	3 – 0 – 0	3 Credits

Prerequisites: None

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

CO1	Understand the properties of nanomaterials
CO2	Synthesize nanoparticles
CO3	Characterize nanomaterials.
CO4	Scale up the production of nanoparticles
CO5	Evaluate safety and health related issues of nanoparticles

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	1	--	--	--	--	--	--	--	--	--	--	--	--	--
CO2	2	--	2	3	--	--	--	--	--	--	--	--	--	--
CO3	-	--	--	--	--	--	--	--	--	--	--	--	--	--
CO4	2	--	2	--	--	--	--	--	--	--	--	--	--	--
CO5	--	--	--	--	--	3	2	--	--	--	--	--	--	--

Detailed Syllabus:

Introduction to Nanotechnology: Introduction to nanotechnology and materials, Nanomaterials, Introduction to nanosizes and properties comparison with the bulk materials, Different shapes and sizes and morphology.

Fabrication of Nanomaterials: Top Down Approach Grinding, Planetary milling and Comparison of particles, Bottom Up Approach, Wet Chemical Synthesis Methods, Microemulsion Approach, Colloidal Nanoparticles Production, Sol Gel Methods, Sonochemical Approach, Microwave and Atomization, Gas phase Production Methods : Chemical Vapour Depositions.

Kinetics at Nanoscale: Nucleation and growth of particles, Issues of Aggregation of Particles, Oswald Ripening, Stearic hindrance, Layers of surface charges, Zeta Potential and pH.

Carbon Nanomaterials: Synthesis of carbon bucky-balls, List of stable carbon allotropes extended, fullerenes, metallofullerenes, solid C_{60}, bucky onions, nanotubes, nanocones.

Quantum mechanics: Quantum dots and its Importance, Pauli exclusion principle, Schrödinger's equation, Application of quantum Dots: quantum well, wire, dot, characteristics of quantum dots, Synthesis of quantum dots Semi-conductor quantum dots

Nanomaterials characterization: Fractionation principles of Particle size measurements, Particle size and its distribution, XRD, Zeta potential, Electronic band structure Electron statistics Application: Optical transitions in solids, photonic crystals, Microscopies SEM, TEM, Atomic Forced Microscopy, Scanning and Tunneling Microscopy.

Applications: Self-assembly and molecular manufacturing, Surfactant based system Colloidal system applications, Functional materials Applications, commercial processes of synthesis of nanomaterials.

Nanoinroganic materials of $CaCO_3$ synthesis, Hybrid Waste Water Treatments systems, Electronic Nanodevices,

Nanobiology: Biological synthesis of nanoparticles and applications in drug delivery, Nanocontainers and Responsive Release of active agents, Layer by Layer assembly for nanospheres, Safety and health Issues of nano materials, Environmental Impacts, Case Study for Environmental and Societal Impacts

Reading:

1. KulkarniSulabha K, Nanotechnology: Principles and Practices, Capital Publishing Company, 2007
2. Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
3. Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, 2005.
4. Gabor L. Hornyak, H.F. Tibbals, JoydeepDutta, John J. Moore, Introduction to Nanoscience and Nanotechnology, CRC Press, 2008.
5. Davies, J.H., The Physics of Low Dimensional Semiconductors: An Introduction, Cambridge University Press, 1998.

CH391	INDUSTRIAL SAFETY MANAGEMENT	OPC	3 – 0 – 0	3 Credits

Prerequisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Analyze the effects of release of toxic substances.
CO2	Select the methods of prevention of fires and explosions.
CO3	Understand the methods of hazard identification and prevention.
CO4	Assess the risks using fault tree diagram.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	--	--	--	--	--	3	2	1	--	--	--	--	--	--
CO2	--	--	--	--	--	3	2	1	--	--	--	--	--	--
CO3	--	--	--	--	--	3	2	1	--	--	--	--	--	--
CO4	--	--	--	`--	--	3	2	1	--	--	--	--	--	--

Detailed syllabus:

Introduction-Safety Programs, Engineering Ethics, Accident and Loss Statistics, Acceptable Risk, Public Perceptions, The Nature of the Accident Process, Inherent Safety.

Industrial Hygiene-Anticipation and Identification, Hygiene Evaluation, Hygiene Control.

Toxic Release and Dispersion Models-Parameters Affecting Dispersion, Neutrally Buoyant Dispersion Models, Dense Gas Dispersion, Toxic Effect Criteria, Effect of Release Momentum and Buoyancy, Release Mitigation.

Fires and Explosions-The Fire Triangle, Distinction between Fires and Explosions, Flammability Characteristics of Liquids and Vapors, Limiting Oxygen Concentration and Inerting, Flammability Diagram

Hazards Identification- Process Hazards Checklists, Hazards Surveys, Hazards and Operability Studies, Safety Reviews.

Risk Assessment- Review of Probability Theory, Event Trees, Fault Trees.

Safety Procedures: Process Safety Hierarchy, Managing Safety, Best Practices, Procedures-Operating, Procedures-Permits, Procedures-Safety Reviews and Accident Investigations.

Reading:

1. D. A. Crowl and J.F. Louvar, Chemical Process Safety (Fundamentals with Applications), Prentice Hall, 2011.
2. R.K. Sinnott, Coulson & Richardson's Chemical Engineering, Elsevier India, Volume 6, 2006.

CH392	INDUSTRIAL POLLUTION CONTROL	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Analyze the effects of pollutants on the environment.
CO2	Distinguish air pollution control methods
CO3	Assess treatment technologies for wastewater
CO4	Identify treatment technologies for solid waste
CO5	Select treatment methodologies for hazardous and E-waste

Course Articulation Matrix

PO PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	--	--	--	--	--	3	2	--	--	--	--	--	--	1
CO2	--	--	--	--	--	3	2	--	--	--	--	--	--	1
CO3	--	--	--	--	--	3	2	--	--	--	--	--	--	1
CO4	--	--	--	`--	--	3	2	--	--	--	--	--	--	1
CO5	--	--	--	--	--	3	2	--	--	--	--	--	--	1

Detailed Syllabus:

Introduction: Biosphere, Hydrological cycle, Nutrient cycle, Consequences of population growth, Pollution of air, Water and soil.

Air pollution sources & effects: Classification and properties of air pollutants, Emission sources, Behavior and fate of air pollutants, Effect of air pollution.

Meteorological aspects of air pollutant dispersion: Temperature lapse rates and stability, Wind velocity and turbulence, Plume behavior, Dispersion of air pollutants, Estimation of plume rise.

Air pollution sampling and measurement: Types of pollutant sampling and measurement, Ambient air sampling, Stack sampling, Analysis of air pollutants.

Air pollution control methods & equipment: Control methods, Source correction methods, Cleaning of gaseous effluents, Particulate emission control, Selection of a particulate collector, Control of gaseous emissions, Design methods for control equipment. Control of specific gaseous pollutants: Control of NOx emissions, Control of hydrocarbons and mobile sources.

Water pollution: Water resources, Origin of wastewater, types of water pollutants and their effects.

Waste water sampling, analysis and treatment: Sampling, Methods of analysis, Determination of organic matter, Determination of inorganic substances, Physical characteristics, Bacteriological measurement, Basic processes of water treatment, Primary treatment, Secondary treatment, Advanced wastewater treatment, Recovery of materials from process effluents.

Solid waste management: Sources and classification, Public health aspects, Methods of collection, Disposal Methods, Potential methods of disposal.

Hazardous waste management: Definition and sources, Hazardous waste classification, Treatment methods, Disposal methods.

E-waste: Sources, environmental and social issues, management practices

Reading:

1. Rao C.S., Environmental Pollution Control Engineering, Wiley Eastern Limited, India, 1993.
2. Noel de Nevers, Air Pollution and Control Engineering, McGraw Hill, 2000.
3. Glynn Henry J. and Gary W. Heinke, Environmental Science and Engineering, Prentice Hall of India, 2nd Edition, 2004.
4. Rao M.N., Rao H.V.N, Air Pollution, Tata McGraw Hill Publishing Ltd., 1993.
5. De A.K., Environmental Chemistry, Tata McGraw Hill Publishing Ltd., 1999.
6. George Tchobanoglous, Franklin Louis Burton, H. David Stensel, Metcalf & Eddy, Inc., Franklin Burton, Waste Water Engineering: Treatment and Reuse, McGraw Hill Education; 4thEdition, 2003.
7. E-waste recycling, NPCS Board of consultants and Engineers, Asia pacific business press Inc. 2015

CH393	SOFT-COMPUTING METHODS FOR CONTROL	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Use neural networks to control the process plants
CO2	Develop fuzzy logic based controllers for different processes
CO3	Combine fuzzy logic with neural networks for plant control
CO4	Design controllers using genetic algorithms

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	3	2	2	3	1	1	1	2	1	1	2	--	--
CO2	3	3	2	2	3	1	1	1	3	1	1	3	--	--
CO3	3	3	2	2	3	1	1	1	3	1	3	3	--	--
CO4	3	3	2	2	3	1	1	1	3	1	3	3	--	--

Detailed syllabus

Introduction to Artificial Neural Networks: Basic properties, Neuron Models, Feed forward networks.

Neural Networks Based Control: Representation and identification, modeling the plant, control structures – supervised control, Model reference control, Internal model control, Predictive control: Examples – Inferential estimation of viscosity an chemical process, Auto – turning feedback control.

Introduction to Fuzzy Logic: Fuzzy Controllers, Fuzzy sets and Basic notions – Fuzzy relation calculations – Fuzzy members – Indices of Fuzziness – comparison of Fuzzy quantities – Methods of determination of membership functions.

Fuzzy Logic Based Control: Fuzzy sets in commercial products – basic construction of fuzzy controller – Analysis of static properties of fuzzy controller – Analysis of dynamic properties of fuzzy controller – simulation studies – case studies – fuzzy control for smart cars.

Neuro – Fuzzy and Fuzzy – Neural Controllers: Neuro – fuzzy systems: A unified approximate reasoning approach – Construction of role bases by self-learning: System structure and learning.

Introduction to Genetic algorithms. Controller design using genetic algorithms.

Reading:

1. S. N. Sivanandam and S. N. Deepa, Principles of Soft Computing, John Wiley & Sons, 2007.
2. Bose and Liang, Artificial Neural Networks, Tata McGraw Hill, 1996.
3. Huaguang Zhang, Derong Liu, Fuzzy Modeling and Fuzzy Control, Birkhauser Publishers, 2006.

4. Kosco B, Neural Networks and Fuzzy Systems: A Dynamic Approach to Machine Intelligence, Prentice Hall of India, 1992.
5. Lakshmi C. Jain, N. M. Martin, Fusion of Neural Networks, Fuzzy Systems and Genetic Algorithms: Industrial Applications, CRC Press, 1998.
6. MuhammetÜnal, AyçaAk, VedatTopuz, Hasan Erdal, Optimization of PID Controllers using Ant Colony and Genetic Algorithms, Springer, 2013.

CS390	OBJECT ORIENTED PROGRAMMING	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand fundamental concepts in object oriented approach.
CO2	Analyze design issues in developing OOP applications.
CO3	Write computer programs to solve real world problems in Java.
CO4	Analyze source code API documentations.
CO5	Create GUI based applications.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	3	-	-	2	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	2	-	-	-	-	-	-	-	-	-
CO3	3	3	-	-	2	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	2	-	-	-	-	-	-	-	-	-
CO5	3	3	-	-	2	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

Object- oriented thinking, History of object-oriented programming, overview of java, Object-oriented design, Structure of java program. Types and modifiers, Classes, declaring objects in classes, Methods, constructors, garbage collection, Method overloading, passing objects as parameters, Inheritance, various forms and types of inheritance, Multilevel hierarchy, use of super, method overriding, Applications of method overriding, abstract classes, Packages with examples

Interfaces and implementation, Exception handling, types, throwing, creating own exceptions, Multithreading and concepts, its usage and examples, Input/output streams, String operations and examples, Collection classes-array, stack collection, bitset collection, Utility classes-string tokenizer, bitset, date, Applets- methods, creation, designing and examples, Event handling- event classes, Event listener interfaces, AWT classes, working with frames, AWT controls-layout manager, user interface components, Graphics programming

Reading:

1. Timothy Budd, Understanding object-oriented programming with Java, Pearson, 2000.
2. Herbert Schildt, The complete reference Java 2, TMH, 2017.

BT390	GREEN TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Address smart energy and green infrastructure
CO2	Build models that simulate sustainable and renewable green technology systems
CO3	Understand the history, global, environmental and economical impacts of green technology
CO4	Address non-renewable energy challenges

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	3	1	1	1	2	3	1	-	-	-	-	3	2
CO2	3	3	3	1	1	2	3	-	-	-	-	-	3	3
CO3	3	3	3	1	1	2	3	-	-	-	-	-	3	1
CO4	3	3	2	2	2	2	3	1	-	-	-	-	3	2

Detailed Syllabus:

Biomass Energy, basic concepts, sources of biomass energy, uses of biomass energy, science and engineering aspects of biomass energy, production of biomass electricity, transmission of biomass electricity, storage of biomass electricity.

Energy transformation from source to services; Energy sources, sun as the source of energy; biological processes; photosynthesis; food chains, classification of energy sources, quality and concentration of energy sources; fossil fuel reserves - estimates, duration; theory of renewability, renewable resources; overview of global/ India's energy scenario.

Environmental effects of energy extraction, conversion and use; sources of pollution from energy technologies, Criteria for choosing appropriate green energy technologies, life cycle cost; the emerging trends-process/product innovation-, technological/ environmental leap-frogging; Eco/green technologies for addressing the problems of Water, Energy, Health, Agriculture and Biodiversity.

First and second laws of thermodynamics and their applications – Thermodynamic processes - Irreversibility of energy – Entropy. Properties of steam and classification of steam engines. Carnot cycle - Rankine cycle, Current energy requirements, growth in future energy requirements, Review of conventional energy resources- Coal, gas and oil reserves and resources, Tar sands and Oil, Shale, Nuclear energy Option.

Biomass fuels, market barriers of biomass fuels, biomass fuel standardization, biomass fuel life cycle, Sustainability of biomass fuels, economics of biomass fuels, Fuel stoichiometry and analysis: Fuel stoichiometry relations; Estimation of air required for complete combustion; Estimation of minimum amount of air required for a fuel of known composition; Estimation of dry flue gases for known fuel composition; Calculation of the composition of fuel & excess air supplied, from exhaust gas analysis; Dew point of products; Flue gas analysis (O_2, CO_2, CO, NOx, SOx).

Biomass as a major source of energy in India: Fuel-wood use in rural households. Consequences for eco systems. Future energy scenario in rural areas. Utilization of biomass in industrial and semi-industrial settings. Future utilization of biomass in India. Future of landscape management: optimal management.

Reading:

1. AyhanDemirbas, Green Energy and Technology, Biofuels, Securing the Planet’s Future Energy Needs, Springer,2009.
2. Jay Cheng, Biomass to Renewable Energy Processes, CRC press, 2009.
3. Samir K.Khanal, Rao Y.Surampally, American Society of Civil Engineers,2010.

SM390	MARKETING MANAGEMENT	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand concepts and scope of marketing and market oriented strategic planning
CO2	Analyze macro level environment
CO3	Identify factors influencing consumer behavior in competitive global business environment
CO4	Identify tools and techniques for marketing management through integrated marketing communication systems.

Course Articulation Matrix

CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	2	1	2	-	-	-
CO2	2	2	-	-	-	-	-	-	2	1	2	-	-	--
CO3	2	2	-	-	-	-	-	-	2	1	2	-	-	-
CO4	2	2	-	-	-	-	-	-	2	1	2	-	-	-

Detailed Syllabus:

Importance of Marketing, Scope of Marketing, Core Marketing concepts company orientation towards market place-production concept, Product concept, selling concept and Marketing concept.

Market oriented Strategic planning – Defining corporate Mission and Vision Statement at Corporate level and at Business unit level. Assigning resources to Strategic Business units through B.C.G Matrix and G.E Model.

Analyzing Macro environment-Demographic environment. Economic Environment, Technical Environment, Social-Cultural Environment and political – Legal Environment.

Components of Marketing information systems- Internal Records, Marketing intelligence, Marketing research and Marketing Decision support system.

Consumer Behavior- Buying Decision process and the factors influencing consumer Behavior-Psychological factors, social factors, cultural factors and personal factors.

Importance of Market segmentation, Target market selection and positioning.

Importance of new product development process and the various stages involved.

The concept of product lifecycle and the various strategies used by the marketer in each stage.

Product characteristics and classification, Product mix and product line decisions Branding Decisions, Building Brand Equity.

Importance of Pricing, Factors influencing pricing decisions. Various pricing methods-cost based and demand based methods.

Role of Marketing channels-Channel functions and channel levels channel Design and channel Management Decisions, Managing Retailing. Wholesaling and logistics. Importance of Electronic channels.

Importance of integrated Marketing communication. Advantages and Disadvantages of Various promotional tools- Advertising, Sales promotion, personal selling, publicity and public Relations and Direct marketing.

Reading:

1. Philip Kotler, Marketing Management, PHI, 14th Edition, 2013.
2. William Stonton & Etzel, Marketing Management, TMH, 13thEdition, 2013.
3. Rama Swamy & Namakumari, Marketing Management, McMillan, 2013.

MA390	NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Solve nonlinear differential equations by numerical methods.
CO2	Determine the convergence region for a finite difference method.
CO3	Solve elliptic PDE by finite difference method
CO4	Solve a parabolic PDE by finite difference method
CO5	Solve a hyperbolic PDE by finite difference method

Course Articulation Matrix

CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	3	1	1	1	-	-	-	-	-	-	-	1	1
CO2	3	3	1	1	1	-	-	-	-	-	-	-	1	1
CO3	3	3	1	1	1	-	-	-	-	-	-	-	1	1
CO4	3	3	1	1	1	-	-	-	-	-	-	-	1	1
CO5	3	3	1	1	1	-	-	-	-	-	-	-	1	1

Detailed Syllabus:

Ordinary Differential Equations: Multistep (explicit and implicit) methods for initial value problems, Stability and Convergence analysis, Linear and nonlinear boundary value problems, Quasi-linearization, Shooting methods

Finite difference methods: Finite difference approximations for derivatives, boundary value problems with explicit boundary conditions, implicit boundary conditions, error analysis, stability analysis, convergence analysis.

Partial Differential Equations: Classification of partial differential equations, finite difference approximations for partial derivatives and finite difference schemes for Parabolic equations, Schmidt's two level, multilevel explicit methods, Crank-Nicolson's two level, multilevel implicit methods, Dirichlet's problem, Neumann problem, mixed boundary value problem, stability analysis.

Hyperbolic Equations: Explicit methods, implicit methods, one space dimension, two space dimensions, ADI methods.

Elliptic equations: Laplace equation, Poisson equation, iterative schemes, Dirichlet's problem, Neumann problem, mixed boundary value problem, ADI methods.

Reading:

1. M.K. Jain, Numerical Solution of Differential Equations, Wiley Eastern, 1984.
2. G.D. Smith, Numerical Solution of Partial Differential Equations, Oxford Univ. Press, 2004.
3. M.K.Jain, S.R.K. Iyengar and R.K. Jain, Computational Methods for Partial Differential Equations, Wiley Eastern, 2005.

MA391	**FUZZY MATHEMATICS AND APPLICATIONS**	**OPC**	**3 – 0 – 0**	**3 Credits**

Pre-requisites: None

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

CO1	Apply operations on Fuzzy sets
CO2	Solve problems related to Propositional Logic.
CO3	Apply Fuzzy relations to cylindric extensions.
CO4	Apply logic of Boolean Algebra to switching circuits.
CO5	Develop Fuzzy logic controllers

Course Articulation Matrix

CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	3	1	1	2	1	-	-	-	-	-	-	1	1
CO2	3	3	1	1	2	1	-	-	-	-	-	-	1	1
CO3	3	3	1	1	2	1	-	-	-	-	-	-	1	1
CO4	3	3	1	1	2	1	-	-	-	-	-	-	-	1
CO5	3	3	1	1	2	1	-	-	-	-	-	-	2	1

Detailed Syllabus:

Crisp set theory (CST): Introduction, Relations between sets, Operations on sets, Characteristic functions, Cartesian products of crisp sets, crisp relations on sets.

Fuzzy set theory (FST): Introduction, concept of fuzzy set (FS), Relation between FS, operations on FS, properties of standard operations, certain numbers associated with a FS, certain crisp sets associated with FS, Certain FS associated with given FS, Extension principle.

Propositional Logic (PL1): Introduction, Syntax of PL1, Semantics of PL1, certain properties satisfied by connectives, inference rules, Derivation, Resolution.

Predicate Logic (PL2): Introduction, Syntax of PL2, Semantics of PL2, certain properties satisfied by connectives and quantifiers, inference rules, Derivation, Resolution

Fuzzy Relations (FR): Introduction, Operati -cuts of FR, Composition of FR, Projections of FR, Cylindric extensions, Cylindric closure, FR on a domain.

Fuzzy Logic (FL): Introduction, Three-valued logics, N-valued logics and infinite valued logics, Fuzzy logics, Fuzzy propositions and their interpretations in terms of fuzzy sets, Fuzzy rules and their interpretations in terms of FR, fuzzy inference, More on fuzzy inference, Generalizations of FL.

Switching functions (SF) and Switching circuits (SC): Introduction, SF, Disjunctive normal form, SC, Relation between SF and SC, Equivalence and simplification of circuits, Introduction of Boolean Algebra BA, Identification, Complete Disjunctive normal form.

Applications: Introduction to fuzzy logic controller (FLC), Fuzzy expert systems, classical control theory versus fuzzy control, examples, working of FLC through examples, Details of FLC, Mathematical formulation of FLC, Introduction of fuzzy methods in decision making.

Reading:

1. M. Ganesh, Introduction to Fuzzy Sets and Fuzzy Logic, PHI, 2001.
2. G.J. Klir and B.Yuan, Fuzzy sets and Fuzzy Logic–Theory and Applications, PHI, 1997.
3. T. J. Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, 1995.

PH390	MEDICAL INSTRUMENTATION	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand the origin of bio-potentials and their physical significance.
CO2	Understand anatomy and functioning of human heart and its common problems.
CO3	Analyze ECG, ENG and EMG signals and instrumentation.
CO4	Compare different techniques of measuring blood pressure, blood flow and volume.
CO5	Interpret the principle and operation of therapeutic and prosthetic devices.
CO6	Differentiate between the various techniques for measurement of parameters.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	2	2	-	1	2	-	-	-	-	-	-	--	-
CO2	3	2	2	-	1	2	-	-	-	-	-	-	--	-
CO3	3	2	2	-	1	2	-	-	-	-	-	-	--	-
CO4	3	2	2	-	1	2	-	-	-	-	-	-	--	-
CO5	3	2	2	-	1	2	-	-	-	-	-	-	--	-
CO6	3	2	2	-	1	2	-	-	-	-	-	-	--	-

Detailed Syllabus:

General Introduction: The cell, body fluids, Musculoskeletal system, respiratory system, gastrointestinal system, Nervous system, endocrine system and circulatory system.

Origin of Bio potentials: electrical activity of Excitable cells: the resting state, The active state, Volume conductor fields, Functional organization of the peripheral nervous system: Reflex are & Junctional transmission.

The Electroneurogram (ENG): The H-Reflex, The Electromyogram (EMG), The Electrocardiogram (ECG), heart and the circulatory system, Electro conduction system of the heart and heart problems, ECG waveform and Physical significance of its wave features, Electrical behavior of cardiac cells, The standard lead system, The ECG preamplifier, DC ECG Amplifier, Defibrillator protection circuit, Electro surgery Unit filtering, Functional blocks of ECG system, Multichannel physiological monitoring system, Common problems encountered and remedial techniques.

Blood Pressure: indirect measurement of blood pressure, korotkoff sounds, auscultatory method using sphygmo manometer, Oscillometric and ultrasonic noninvasive pressure measurement, Direct measurement of blood pressure H2O manometers, electronic manometry, Pressure transducers,. Pressure amplifier designs, Systolic, diastolic mean detector circuits

Blood flow and Volume Measurement: indicator dilution methods, Transit time flow meter, DC flow meter, Electromagnetic flow meter AC electromagnetic flow meter, Quadrature suppression flow meter, Ultrasonic flow meter, Continuous-wave Doppler flow meter, Electric impedance plethysmography, chamber plethysmography, Photo plethysmography.

Pulse Oximetry: Principles of Operation, Absorption Spectrum, Sensor design, Pulse oximeter, Therapeutic and Prosthetic Devices.

Cardiac Pacemakers: Lead wires and electrodes, Synchronous Pacemakers, rate responsive pace making, Defibrillators, cardioverters, Electrosurgical unit, Therapeutic applications of laser, Lithotripsy Haemodialysis.

Reading:

1. John G Webster, Medical Instrumentation: Application and Design, John Wiley,3rd Edition, 2012.
2. Joseph J. Carr & John M. Brown , Introduction to biomedical Equipment Technology, 4th Edition, Prentice Hall India, 2001

PH391	ADVANCED MATERIALS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand the synthesis and properties of nanomaterials
CO2	Evaluate the usefulness of nanomaterials in medicine, biology and sensing
CO3	Understand modeling of composite materials by finite element analysis
CO4	Differentiate superconducting materials
CO5	Understand the characteristics and uses of functional materials

Course Articulation Matrix

CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	3	3	-	-	1	-	-	-	-	-	-	-	1
CO2	3	3	3	-	-	1	-	-	-	-	-	-	1	1
CO3	3	3	3	-	-	1	-	-	-	-	-	-	-	1
CO4	3	3	3	-	-	1	-	-	-	-	-	-	-	1
CO5	3	3	3	-	-	1	-	-	-	-	-	-	-	1

Detailed Syllabus:

Nano Materials: Origin of nanotechnology, Classification of nanomaterials, Physical, chemical, electrical, mechanical properties of nanomaterials. Preparation of nanomaterials by plasma arcing, physical vapour deposition, chemical vapour deposition (CVD), Sol-Gel, electro deposition, ball milling, carbonnanotubes(CNT).Synthesis, preparation of nanotubes, nanosensors, Quantum dots, nanowires, nanobiology, nanomedicines.

Biomaterials: Overview of biomaterials. Biomaterials, bioceramics, biopolymers, tissue grafts, soft tissue applications, cardiovascular implants, biomaterials in ophthalmology, orthopedicimplants, dental materials.

Composites: General characteristics of composites, composites classes, PMCs, MMCs, CMCs, CCCs, IMCs, hybrid composites, fibers and matrices, different types of fibers, whiskers, different matrices materials, polymers, metal, ceramic matrices, toughening mechanism, interfaces, blending and adhesion, composite modeling, finite element analysis and design.

Optical materials: Mechanisms of optical absorption in metals, semiconductors and insulators. Nonlinear optical materials, optical modulators, optical fibers. Display devices and materials photo-emissive, photovoltaic cells, charge coupled devices(CCD), laser materials.

Super conducting materials: Types of super conductors, an account of mechanism of superconductors, effects of magnetic field currents, thermal energy, energy gap, acoustic attenuation, penetration depth, BCS theory, DC and AC Josephson effects, high Tc superconductors, potential applications of superconductivity, electrical switching element, superconductor power transmission and transformers, magnetic mirror, bearings, superconductor motors, generators, SQUIDS etc.

Smart materials: An introduction, principles of smart materials, input – output decision ability, devices based on conductivity changes, devices based on changes in optical response, biological systems smart materials. Devices based on magnetization, artificial structures, surfaces, hetero structures, polycrystalline, amorphous, liquid crystalline materials.

Surface Acoustic Wave (SAW) Materials and Electrets: Delay lines, frequency filters, resonators, Pressure and temperature sensors, Sonar transducers. Comparison of electrets with permanent magnets, Preparation of electrets, Application of electrets.

Reading:

1. T.Pradeep, Nano: The Essentials; TATA McGraw-Hill,2008.
2. B.S. Murthy et al., Textbook of Nano science and Nanotechnology, University press, 2012.
3. Krishan K Chawla, Composite Materials; 2ndEdition, Springer 2006.

CY390	INSTRUMENTAL METHODS IN CHEMICAL ANALYSIS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand the concepts of ultraviolet and visible absorption and fluorescence techniques for material characterization.
CO2	Understand the various liquid, gas and size-exclusion chromatographic techniques the automated continuous analysis of environmental, industrial, production-line materials
CO3	Understand the concepts of various electroanalytical techniques for characterization of interfaces and traces of surface adsorbed-materials.
CO4	Understands the principles of thermogravimetry and differential thermal analyses (TGA and DTA) for applications into pharmaceuticals, drugs, polymers, minerals, toxins and in Finger Print Analysis
CO5	Identification of suitable analytical technique for characterization of chemical, inorganic and engineering materials

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	3	-	3	1	1	1	-	-	-	-	-	--	--
CO2	3	3	-	3	1	1	1	-	-	-	-	-	--	--
CO3	3	3	-	3	1	1	1	-	-	-	-	-	---	--
CO4	3	3	-	3	1	1	1	-	-	-	-	-	--	--
CO5	3	3	-	3	1	1	1	-	-	-	-	-	--	--

Detailed Syllabus:

UV-Visible Spectrophotometry and Fluorescence: Beer-Lambert’s law, limitations, Molecular fluorescence, influencing factors, basic instruments, standardization, quantitative methods, applications.

Atomic spectrometry, atomic absorption, X-ray fluorescence methods: Flame atomic emission and absorption, flame emission photometer, flame absorption spectrometer, spectral interferences, quantitative aspects, X-ray fluorescence principle, instrumentation, quantitative analysis.

Chromatorgraphy methods: Gas chromatography, High performance liquid chromatography, size exclusion chromatography, Principle, Basic instrumentation, terminology, NPC, RPC, Qualitative and Quantitative applications. Capillary Electrophoresis: Principle and application.

Thermoanalytical methods: Thermogravimetry, Differential thermal analysis, differential scanning calorimetry, Principle, Block diagram, Applications, Quantitative determinations

Electroanalytical methods: Coulometric methods, Polarography, Pulse voltametric methods, Amperometry, Principles, Applications, Electrochemical sensors, Ion selective, Potentiometric and amperometric Sensors, Applications.

Spectroscopic methods: Molecular absorption, Woodward rules, applications, Infrared absorption, functional group analysis, qualitative analysis, 1H- and 13C-NMR spectroscopy, Principle, Basic instrumentation, terminology, Interpretation of data, Quantitative applications

Mass spectrometry: Principles, Instrumentation, Ionization techniques, Characterization and applications.

Reading:

1. Gurdeep Chatwal and Sham Anand, Instrumental Methods of Chemical Analysis, Himalaya Publishing House, 1986.
2. Skoog, Holler and Kouch, Instrumental methods of analysis, Thomson, 2007.
3. Mendham, Denny, Barnes and Thomas, Vogel: Text book of quantitative chemical analysis, Pearson, 6Edotion, 2007.
4. William Kemp, Organic spectroscopy, McMillan Education, UK, 1991.
5. Instrumental methods of analysis – Willard, Meritt and Dean, PHI, 2005.

HS390	SOFT SKILLS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand corporate communication culture
CO2	Prepare business reports and proposals expected of a corporate professional
CO3	Employ appropriate speech in formal business situations
CO4	Exhibit corporate social responsibility and ethics
CO5	Acquire corporate email, mobile and telephone etiquette

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	3	1	3	2	-	-	-
CO2	-	-	-	-	-	-	-	3	1	3	2	-	-	-
CO3	-	-	-	-	-	-	-	3	1	3	2	-	-	-
CO4	-	-	-	-	-	-	-	3	1	3	2	-	-	-
CO5	-	-	-	-	-	-	-	3	1	3	2	-	-	-

Detailed Syllabus:

English Language Enhancement: Verbs and tenses, Phrasal verbs, Synonyms, Antonyms, Homonyms - Descriptive Words, Combining Sentences, Business Idioms, Indianisms in English.

Art of Communication, Communication process- Non-verbal Communication- Effective Listening.

Interpersonal and Intra Personal Communication Skills- Self-Awareness- Self-Esteem and Confidence- Assertiveness and Confidence- Dealing with Emotions-Team Concept- Elements of Teamwork- Stages of Team Formation- Effective Team-Team Player Styles-Leadership.

Campus to Company- Dressing and Grooming- The Corporate Fit- Business Etiquette- Communication; media etiquette- Group Discussions, Interviews, and Presentation Skills.

Interview Handling skills- Effective Resume-- Common Interview Mistakes- Body-language- Content Aid, Visual Aids- Entrepreneurial Skills Development.

Reading:

1. Robert M.Sherfield, Developing Soft Skills, Montgomery and Moody 4th Edition, Pearson, 2009.
2. K.Alex, Soft Skills: Know Yourself & Know The world, S. Chand; 2009.
3. Robert Bramson, Coping with Difficult People, Dell, 2009.

CE440	BUILDING TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Apply basic principles to develop stable, sustainable and cost-effective building plans
CO2	Identify different materials, quality and methods of fabrication & construction.
CO3	Adopt standard building provisions for natural ventilation and lighting.
CO4	Identify effective measures for fire proofing, damp proofing, and thermal insulation.

Course Articulation Matrix

CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	2	2	1	-	-	1	1	-	-	-	-	-	-	1
CO2	2	2	1	-	-	1	1	-	-	-	-	-	-	-
CO3	2	2	1	-	-	1	1	-	-	-	-	-	-	1
CO4	2	2	1	-	-	1	1	-	-	-	-	-	-	-

Detailed Syllabus:

Overview of the course, basic definitions, Buildings – Types, components, economy and design, Principles of planning of buildings and their importance. Definitions and importance of Grouping and circulation; Lighting and ventilation; How to consider these aspects during planning of building.

Termite proofing: Inspection, control measures and precautions, Lightning protection of buildings: General principles of design of openings, various types of fire protection measures to be considered while planning a building.

General requirements and extra requirements for safety against fire, special precautions, Vertical transportation in building – types of vertical transportation, Stairs, different forms of stairs, planning of stair cases, Other modes of vertical transportation – lifts, ramps, escalators.

Prefabrication systems in residential buildings – walls, openings, cupboards, shelves etc., planning and modules and sizes of components in prefabrication. Planning and designing of residential buildings against the earthquake forces, Principles, Seismic forces and their effect on buildings.

Air conditioning – process and classification of air conditioning, Dehumidification. Systems of air-conditioning, ventilation, functional requirements of ventilation.

Acoustics, effect of noise, properties of noise and its measurements, Principles of acoustics of building. Sound insulation – importance and measures.

Plumbing services – water supply system, maintenance of building pipe line, Sanitary fittings, principles governing design of building drainage.

Reading:

1. Building Construction - Varghese, PHI Learning Private Limited, 2008.
2. Building Construction - Punmia, B C, Jain, A J and Jain A J, Laxmi Publications, 2005.
3. Building Construction by S.P. Arora and S.P. Bindra – Dhanpat rai and Sons, New Delhi, 1996.
4. Building Construction – Technical Teachers Training Institute, Madras, Tata McGraw Hill, 1992.
5. National Building code of India, Bureau of Indian Standards, 2005.

EE440	NEW VENTURE CREATION	OPC	3–0– 0	3 Credits

(This course is not offered to Electrical Engg students)

Pre-requisites: None

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

CO1	Understand the process and practice of entrepreneurship and new venture creation
CO2	Identify entrepreneurial opportunities, preparation of a business plan for launching a new venture
CO3	Explore the opportunities in the domain of respective engineering disciplines for launching a new venture
CO4	Expose the students with the functional management issues of running a new venture

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	2	2	2	2	1	2	1	1	1	2	2	2	--	--
CO2	2	2	2	2	1	1	3	2	1	2	2	2	--	--
CO3	2	2	2	2	1	1	1	1	2	3	2	3	--	--
CO4	2	2	2	2	1	3	1	1	1	2	3	3	--	--

Detailed syllabus:

Entrepreneur and entrepreneurship: Entrepreneurship and Small Scale Enterprises (SSE), Role in Economic Development, Entrepreneurial Competencies, and Institutional Interface for SSE.

Establishing The Small Scale Enterprise: Opportunity Scanning and Identification, Market Assessment for SSE, Choice of Technology and Selection of Site, Financing the New/Small Enterprises, Preparation of the Business Plan, Ownership Structures and Organizational Framework.

Operating the Small Scale Enterprises: Financial Management Issues in SSE, Operational Management Issues in SSE, Marketing Management Issues in SSE, and Organizational Relations in SSE.

Reading:

1. Holt, Entrepreneurship: New Venture Creation, PHI(P), Ltd.,2001.
2. Madhulika Kaushik: Management of New & Small Enterprises, IGNOU course material, 1995
3. B S Rathore S Saini: Entrepreneurship Development Training Material, TTTI, Chandigarh, 1988.
4. P.C.Jain: A Hand Book for New Entrepreneurs, EDI-Faculty & External Experts, EDII, Ahmedabad,1986.
5. J.B. Patel, D.G Allampalli: A Manual on How to Prepare a Project Report, EDII, Ahmedabad, 1991.
6. J B Patel, S S Modi, A Manual on Business Opportunity Identification and Selection, EDII, Ahmedabad, 1995.

EE441	PRINCIPLES OF ELECTRIC POWER CONVERSION	OPC	3–0– 0	3 Credits

(This course is not offered to Electrical Engg students)

Pre-requisites: None

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

CO1	Understand the basics in the electric power conversion using power switching devices
CO2	Evaluate the conversion for range of renewable energy sources with the help of available electrical machines drives
CO3	Analyze the different energy storage systems
CO4	Identify the various Industrial and domestic applications

Course Articulation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	3	3	3	2	1	2	2	2	2	2	1	2	--	--	-
CO2	3	2	3	2	2	2	2	2	2	2	1	2	--	--	-
CO3	3	3	3	2	1	2	2	2	2	2	1	2	--	--	-
CO4	3	2	3	2	2	2	2	2	2	2	1	2	--	--	-

Detailed syllabus:

Power Electronic Devices and Converters: V-I characteristics of SCR, MOSFET and IGBT. Phase controlled rectifiers, DC-DC converters and Inverters.

Applications to Electric Drives: Speed control of DC motor, Induction motors, PMSM and BLDC drives

Applications to Renewable Energy: Introduction to solar cell, solar panels, MPPT, wind and other renewable energy sources, Integration of renewable energy sources to the grid.

Energy Storage Systems: Study of automotive batteries, SMF, pumped storage systems, super-capacitors, fly wheels - applications, Li-ion batteries and applications to electric vehicles.

Domestic And Industrial Applications: Induction heating, melting, hardening, lighting applications and their control, UPS, battery chargers

Reading:

1. M.H.Rashid: Power Electronics-circuits, Devices and applications, Prentice Hall India, New Delhi,2009.
2. P.S.Bhimbra: Power Electronics, Khanna publishers, New Delhi, 2012.
3. Ned Mohan, Undeland and Robbin: Power electronics converters, applications and design, John Willey & Sons,NewYork, 2006.

ME440	ALTERNATIVE SOURCES OF ENERGY	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Identify renewable energy sources and their utilization.
CO2	Understand basic concepts of solar radiation and analyze solar thermal systems for its utilization.
CO3	Understand working of solar cells and its modern manufacturing technologies.
CO4	Understand concepts of Fuel cells and their applications
CO5	Identify methods of energy storage.
CO6	Compare energy utilization from wind energy, geothermal energy, biomass, biogas and hydrogen.

Course Articulation Matrix

CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	2	-	2	-	-	3	3	-	-	-	-	-	3	3
CO2	2	-	2	-	-	3	3	-	-	-	-	-	3	3
CO3	2	-	2	-	-	3	3	-	-	-	-	-	3	3
CO4	2	-	2	-	-	3	3	-	-	-	-	-	3	3
CO5	2	-	2	-	-	3	3	-	-	-	-	-	3	3
CO6	2	-	2	-	-	3	3	-	-	-	-	-	1	2

Detailed Syllabus:

Introduction: Overview of the course; Examination and Evaluation patterns; Global warming; Introduction to Renewable Energy Technologies

Energy Storage: Introduction; Necessity of Energy Storage; Energy Storage Methods

Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Measurement of solar radiation data

Solar Thermal systems: Introduction; Basics of thermodynamics and heat transfer; Flat plate collector; Evacuated Tubular Collector; Solar air collector; Solar concentrator; Solar distillation; Solar cooker; Solar refrigeration and air conditioning; Thermal energy storage systems

Solar Photovoltaic systems: Introduction; Solar cell Fundamentals; Characteristics and classification; Solar cell: Module, panel and Array construction; Photovoltaic thermal systems.

Wind Energy: Introduction; Origin and nature of winds; Wind turbine siting; Basics of fluid mechanics; Wind turbine aerodynamics; wind turbine types and their construction; Wind energy conversion systems

Fuel cells: Overview; Classification of fuel cells; operating principles; Fuel cell thermodynamics

Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies; Urban waste to energy conversion; Biomass gasification.

Other forms of Energy: Introduction: Nuclear, ocean and geothermal energy applications; Origin and their types; Working principles

Reading:

1. Sukhatme S.P. and J.K.Nayak, Solar Energy - Principles of Thermal Collection and Storage, Tata McGraw Hill, New Delhi, 2008.
2. Khan B.H., Non-Conventional Energy Resources, Tata McGraw Hill, New Delhi, 2006.
3. J.A. Duffie and W.A. Beckman, Solar Energy - Thermal Processes, John Wiley, 2001.

ME441	ROBUST DESIGN	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand stages in engineering design and concept of robust design.
CO2	Develop quality loss functions and S/N ratios for S, N and L type objective functions.
CO3	Identify control and noise factors for a given product or process.
CO4	Conduct experiments using DOE concepts to decide the optimal setting of parameters
CO5	Apply quality loss function approach for fixing the component tolerances.

Course Articulation Matrix

CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	1	1	3	2	1	-	2	-	-	-	-	-	-	--
CO2	1	1	3	2	1	-	2	-	-	-	-	-	-	--
CO3	1	1	3	2	1	-	2	-	-	-	-	-	-	--
CO4	1	1	3	2	1	-	2	-	-	-	-	-	-	--
CO5	1	1	3	2	1	-	2	-	-	-	-	-	-	--

Detailed syllabus

Introduction: Taguchi's quality philosophy, causes of performance variation, concept of robust design, stages in product/process design, need for experimentation, QFD, process flow analysis, cause and effect diagram.

Design of Experiments**:** Principles of experimentation, Basic concepts of probability and statistics, Comparison of two means and two variances, Comparison of multiple (more than two) means & ANOVA, Factorial designs, fractional factorial designs, orthogonal arrays, standard orthogonal arrays & interaction tables, modifying the orthogonal arrays, selection of suitable orthogonal array design, analysis of experimental data.

Parameter Design**:** Loss function, average quality loss, S/N ratios, objective functions, selection of control & noise factors and their levels, strategy for systematic sampling of noise, classification of control factors, inner-array and outer-array design, data analysis, selection of optimum levels/values for parameters.

Tolerance Design: Experiments, selection of tolerances to be tightened, fixing the final tolerances.

Reading:

1. Taguchi G, Chowdhury S and Taguchi S, Robust Engineering, TMH, 2000.
2. Ross PJ, Taguchi Techniques for Quality Engineering, TMH, 2005.

EC440	ELECTRONIC MEASUREMENTS AND INSTRUMENTATION	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Apply knowledge of instruments for effective use
CO2	Select suitable instruments for typical measurements.
CO3	Identify various transducers to measure strain, temperature and displacement.
CO4	Understand data acquisition system and general purpose interfacing bus.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	2	2	1	-	1	1	1	-	-	-	-	-	1	1
CO2	2	2	1	-	1	1	1	-	-	-	-	-	1	1
CO3	2	2	1	-	1	1	1	-	-	-	-	-	1	1
CO4	2	2	1	-	1	1	1	-	-	-	-	-	1	1

Detailed syllabus

Measurement And Error: Sensitivity, Resolution, Accuracy and precision, Absolute and Relative types of errors, Statistical analysis, Probability of and Limiting errors, Linearity.

Instruments: D'Arsonval movement and basic principles of Measurement of Voltage, Current and Resistance in instruments. Analog and Digital Multimeters, Measurement of time and Frequency – Digital Frequency Meter and applications.

Impedance Measurement: Kelvin Bridge; Megger; Maxwell, Hay and Shering Bridges. Q-meter; Noise and Interference reduction techniques in Measurement Systems.

Oscilloscopes: Block diagram, probes, Deflection amplifier and delay line, Trigger Generator, Coupling, Automatic Time Base and Dual Trace Oscilloscopes, Pulse Measurements, Delayed Time Base, Analog Storage, Sampling and Digital Storage Oscilloscopes.

Special instruments: Wave Analyzer, Harmonic Distortion Analyzer, Spectrum Analyzer, FFT Analyzer.

Transducers (Qualitative Treatment Only): Classification and selection of Transducers, Introduction to strain, Load, force, Displacement, Velocity, Acceleration, Pressure and Temperature Measurements.

Introduction to Data Acquisition Systems (DAS): Block Diagram, Specifications and various components of DAS.

General purpose Instrumentation Bus (GP-IB): Protocol, SCPI Commands and Applications to DSO and DMM.

Reading:

1. Oliver and Cage, Electronic Measurements and Instrumentation, McGraw Hill, 2009
2. Helfrick Albert D. and Cooper William D., Electronic Instrumentation & Measurement Techniques, PHI, 2008.
3. D.A. Bell,Electronic Instrumentation and Measurements, 3rd Edition, Oxford, 2013.

MM499	METALLURGY FOR NON-METALLURGISTS	OPC	3-0-0	03 Credits

Pre-requisites: None

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

CO1	Discuss the characteristics and applications of metals and alloys.
CO2	Explain different fabrication techniques.
CO3	Correlate the microstructure, properties, processing and performance of materials.
CO4	Select metal/alloy for engineering applications.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	2	2	1	-	1	1	1	-	-	-	-	-	--	--
CO2	2	2	1	-	1	1	1	-	-	-	-	-	--	--
CO3	2	2	1	-	1	1	1	-	-	-	-	-	--	--
CO4	2	2	1	-	1	1	1	-	-	-	-	-	--	--

Detailed syllabus

Introduction to Metallurgy: Metals and Alloys classification, engineering applications of metals/alloys.

Structure of Metals and Alloys: Nature of Metallic Bonding, Crystal Structures of Metals, Structure of Alloys, Imperfections in Crystals.

Mechanical Properties: Plastic Deformation Mechanisms, Tensile, Creep, Fatigue, Fracture

Strengthening Mechanisms: Strain Hardening, Grain Size Refinement, Solid Solution Strengthening, Precipitation Hardening

Fabrication and Finishing of metal products: Metal Working and Machining

Testing of Metals: Destructive and Non-Destructive Testing, Inspection and Quality Control of Metals.

Engineering Alloys: Steel Products and Properties, Cast Irons, Tool Steels and High Speed Steels, Stainless Steels, selective non-ferrous metals and alloys.

Heat Treatment: Annealing, Normalizing, Hardening and Tempering.

Material selection processes: Case studies

Reading:

1. M. F. Ashby, Engineering Metals, 4th Edition, Elsevier, 2005.
2. R. Balasubramaniam (Adapted): Calister's Materials Science and Engineering, 7th Edition, Wiley India (P) Ltd, 2007.
3. R. Abbaschian, L. Abbaschian, R.E. Reed-Hill, Physical Metallurgy Principles, East-West Press, 2009.

4. V Raghavan, Elements of Materials Science and Engineering- A First Course, 5th Edition, PHI Publications, 2011

CH440	DATA DRIVEN MODELLING	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Identify disturbance models
CO2	Estimate parametric and non-parametric models
CO3	Determine the model structure
CO4	Validate the developed models

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	2	2	1	2	2	-	-	-	-	-	-	1	-	-
CO2	2	2	1	2	2	-	-	-	-	-	-	1	-	-
CO3	2	2	1	2	2	-	-	-	-	-	-	1	-	-
CO4	2	2	1	2	2	-	-	-	-	-	-	1	-	-

Detailed syllabus

System Identification - Motivation and Overview. Models of Discrete-Time LTI Systems – Convolution equation. Difference equations, Transfer functions, State-space models, Discretization, Sampling and Hold operations, Sampling theorem.

Disturbance models - random processes, representation of stationary processes, white-noise process, auto-covariance function (ACF), ARMA models. Parametric model structures - ARX, ARMAX, OE, BJ and PEM – structures and their applicability in real-time.

Linear Regression - Least Squares estimates, Statistical properties of LS Estimates. Weighted Least Squares, Recursive Least Squares, Maximum Likelihood Estimation and properties.

Estimation of non-parametric models - impulse / step response coefficients, frequency response models.

Estimation of parametric models - notions of prediction and simulation, predictors for parametric models, prediction-error methods, Instrumental Variable method.

Model Structure Selection and Diagnostics -estimation of delay and order, residual checks, properties of parameter estimates, model comparison and selection, model validation.

Reading:

1. Arun K. Tangirala. System Identification: Theory and Practice, CRC Press, 2014.
2. Karel J. Keesman, System Identification – An Introduction, Springer, 2011.
3. Nelles, O. Nonlinear System Identification, Springer-Verlag, Berlin, 2001.
4. Zhu, Y. Multivariable System Identification for Process Control, Pergamon, 2001.

5. Ljung, L. System Identification: Theory for the User, Prentice-Hall, 2nd Edition, 1999.
6. J. R. Raol, G. Girija, J. Singh, Modeling and Parameter Estimation of Dynamic Systems, The Institution of Electrical Engineers, 2004.
7. Rolf Johansson, System Modeling and Identification, Prentice Hall, 1993.

CH441	FUEL CELL TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None.

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand fuel cell fundamentals.
CO2	Analyze the performance of fuel cell systems.
CO3	Demonstrate the operation of fuel cell stack and fuel cell system.
CO4	Apply the modeling techniques for fuel cell systems

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	2	2											3	3
CO2	2	2		2									3	3
CO3	2	2		3									3	3
CO4	2	2											3	3

Detailed syllabus

Overview of Fuel Cells: What is a fuel cell, brief history, classification, how does it work, why do we need fuel cells, Fuel cell basic chemistry and thermodynamics, heat of reaction, theoretical electrical work and potential, theoretical fuel cell efficiency.

Fuels for Fuel Cells: Hydrogen, Hydrocarbon fuels, effect of impurities such as CO, S and others.

Fuel cell electrochemistry: electrode kinetics, types of voltage losses, polarization curve, fuel cell efficiency, Tafel equation, exchange currents.

Fuel cell process design: Main PEM fuel cell components, materials, properties and processes: membrane, electrode, gas diffusion layer, bi-polar plates, Fuel cell operating conditions: pressure, temperature, flow rates, humidity.

Main components of solid-oxide fuel cells, Cell stack and designs, Electrode polarization, testing of electrodes, cells and short stacks, Cell, stack and system modeling

Fuel processing: Direct and in-direct internal reforming, Reformation of hydrocarbons by steam, CO_2 and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, carbon decomposition, Sulphur tolerance and removal , Using renewable fuels for SOFCs

Reading:

1. Hoogers G, Fuel Cell Technology Hand Book, CRC Press, 2003.
2. O'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, Fuel Cell Fundamentals, Wiley, 2006.
3. F. Barbir, PEM Fuel Cells: Theory and Practice, Elsevier/Academic Press, 2nd Edition, 2013.

4. Subhash C. Singal and Kevin Kendall, High Temperature Fuel Cells: Fundamentals, Design and Applications
5. Laminie J, Dicks A, Fuel Cell Systems Explained, 2nd Edition, John Wiley, New York, 2003.

CH442	DESIGN OF EXPERIMENTS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Design experiments for a critical comparison of outputs
CO2	Propose hypothesis from experimental data
CO3	Implement factorial and randomized sampling from experiments
CO4	Estimate parameters by multi-dimensional optimization

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	--	--	--	3	2	--	--	--	--	--	--	2	--	--
CO2	3	3	--	3	--	--	--	--	--	--	--	2	--	--
CO3	3	--	--	3	2	--	--	--	--	--	--	2	--	--
CO4	--	--	--	3	2	--	--	--	--	--	--	2	--	--

Detailed syllabus

Introduction: Strategy of experimentation, basic principles, guidelines for designing experiments.

Simple Comparative Experiments: Basic statistical concepts, sampling and sampling distribution, inferences about the differences in means: Hypothesis testing, Choice of samples size, Confidence intervals, Randomized and paired comparison design.

Experiments with Single Factor; An example, The analysis of variance, Analysis of the fixed effect model, Model adequacy checking, Practical interpretation of results, Sample computer output, Determining sample size, Discovering dispersion effect, The regression approach to the analysis of variance, Nonparameteric methods in the analysis of variance, Problems.

Design of Experiments: Introduction, Basic principles: Randomization, Replication, Blocking, Degrees of freedom, Confounding, Design resolution, Metrology considerations for industrial designed experiments, Selection of quality characteristics for industrial experiments.

Parameter Estimation.

Response Surface Methods: Introduction, The methods of steepest ascent, Analysis of a second-order response surface, Experimental designs for fitting response surfaces: Designs for fitting the first-order model, Designs for fitting the second-order model, Blocking in response surface designs, Computer-generated (Optimal) designs, Mixture experiments, Evolutionary operation, Robust design, Problems.

Design and Analysis: Introduction, Preliminary examination of subject of research, Screening experiments: Preliminary ranking of the factors, active screening experiment-method of random balance, active screening experiment Plackett-Burman designs, Completely randomized block design, Latin squares, Graeco-Latin Square, Youdens Squares, Basic experiment-mathematical modeling, Statistical Analysis, Experimental optimization of research subject: Problem of optimization, Gradient optimization methods, Nongradient methods of optimization, Simplex sum rotatable design, Canonical analysis of the response surface, Examples of complex optimizations.

Reading:

1. Lazic Z. R., Design of Experiments in Chemical Engineering, A Practical Guide, Wiley, 2005.
2. Antony J., Design of Experiments for Engineers and Scientists, Butterworth Heinemann, 2004.
3. Montgomery D. C., Design and Analysis of Experiments, Wiley, 5thEdition, 2010.
4. Doebelin E. O., Engineering Experimentation: Planning, Execution, Reporting, McGraw-Hill, 1995.

CH443	CARBON CAPTURE, SEQUESTRATION AND UTILIZATION	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Identify the necessity of CO_2 capture, storage and utilization
CO2	Distinguish the CO_2capture techniques
CO3	Evaluate CO_2 Storage and sequestration methods
CO4	Assess Environmental impact of CO_2 capture and utilization

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	--	--	--	--	--	2	2	--	--	--	--	--	--	--
CO2	---	--	--	--	--	2	2	--	--	--	--	--	--	--
CO3	--	--	--	--	--	2	2	--	--	--	--	--	--	--
CO4	--	--	--	--`	--	2	2	2	--	--	--	--	--	--

Detailed syllabus

Introduction: Global status of CO_2 emission trends, Policy and Regulatory interventions in abatement of carbon footprint, carbon capture, storage and utilization (CCS&U)

CO_2 capture technologies from power plants: Post-combustion capture, Pre-combustion capture, Oxy-fuel combustion, chemical looping combustion, calcium looping combustion

CO_2 capture agents and processes: Capture processes, CO_2 capture agents, adsorption, ionic liquids, metal organic frameworks

CO_2 storage and sequestration: Geological sequestration methods, Biomimetic carbon sequestration

CO_2 Utilization: CO_2 derived fuels for energy storage, polymers from CO_2, CO_2 based solvents, CO_2 to oxygenated organics, Conversion into higher carbon fuels, High temperature catalysis

Environmental assessment of CO_2 capture and utilization: Need for assessment, Green chemistry and environmental assessment tools, Life cycle assessment (LCA), ISO standardization of LCA, Method of conducting an LCA for CO_2 capture and Utilization.

Reading:

1. Peter Styring, Elsje Alessandra Quadrelli, Katy Armstrong, Carbon dioxide utilization: Closing the Carbon Cycle, Elsevier, 2015.
2. Goel M,Sudhakar M, Shahi RV, Carbon Capture, Storage and, Utilization: A Possible Climate Change Solution for Energy Industry, TERI, Energy and Resources Institute, 2015.
3. Amitava Bandyopadhyay, Carbon Capture and Storage, CO_2 Management Technologies, CRC Press, 2014.

4. Fennell P, Anthony B, Calcium and Chemical Looping Technology for Power Generation and Carbon Dioxide (CO_2) Capture, Woodhead Publishing Series in Energy: No. 82, 2015.
5. Mercedes Maroto-Valer M, Developments in Innovation in Carbon Dioxide Capture and Storage Technology: Carbon Dioxide Storage and Utilization, Vol 2, Woodhead Publishing Series in Energy, 2014.

CS440	MANAGEMENT INFORMATION SYSTEMS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Determine key terminologies and concepts including IT, marketing, management, economics, accounting, finance in the major areas of business.
CO2	Design, develop and implement Information Technology solutions for business problems.
CO3	Analysis of computing systems and telecommunication networks for business information systems.
CO4	Understand ethical issues that occur in business, evaluate alternative courses of actions and evaluate the implications of those actions.
CO5	Plan projects, work in team settings and deliver project outcomes in time.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	-	-	1		3	-	-	2	-	-	2	-	--	-
CO2	-	-	1		3	-	-	2	-	-	2	-	--	-
CO3	-	-	1		3	-	-	2	-	-	2	-	--	-
CO4	-	-	1		3	-	-	3	-	-	2	-	-	-
CO5	-	-	1		3	-	-	2	-	-	3	-	--	-

Detailed syllabus

Organization and Information Systems, Foundation Concepts, Information Systems in Business, the Components of Information Systems, Competing with Information Technology, Fundamentals of Strategic Advantage, Using Information Technology for Strategic Advantage.

Changing Environment and its impact on Business, Kinds of Information Systems.

Computer Fundamentals, Computer Hardware, and Computer Systems: End User and Enterprise Computing, Computer Peripherals: Input, Output, and Storage Technologies, Computer Software, Application Software, System Software, Computer System Management, Data Resource Management, Technical Foundations of Database Management, Managing Data Resources

Telecommunication and Networks, Telecommunications and Networks, the Networked Enterprise, Telecommunications Network Alternatives

System Analysis and Development and Models, Developing Business/IT Strategies, Planning Fundamentals, Implementation Challenges, Developing Business/IT Solutions, Developing Business Systems, Implementing Business Systems

Manufacturing and Service Systems Information systems for Accounting, Finance, Production and Manufacturing, Marketing and HRM functions, Enterprise Resources Planning (ERP), Choice of IT, Nature of IT decision, Managing Information Technology, Managing Global IT, Security and Ethical Challenges, Security and Ethical Challenges, Security and Ethical, and Societal Challenges of IT, Security Management of Information Technology, Enterprise and Global Management of Information Technology.

Reading:

1. Kenneth J Laudon, Jane P. Laudon, Management Information Systems, 10th Edition, Pearson/PHI, 2007.
2. W. S. Jawadekar, Management Information Systems, 3rd Edition, TMH, 2004.

BT440	BIOSENSORS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand biosensing and transducing techniques
CO2	Understand principles of linking cell components and biological pathways with energy transduction, sensing and detection
CO3	Demonstrate appreciation for the technical limits of performance of biosensor
CO4	Apply principles of engineering to develop bioanalytical devices and design of biosensors

Course Articulation Matrix

CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	2	2	-	1	2	-	-	-	-	-	-	--	-
CO2	3	2	2	-	1	2	-	-	-	-	-	-	--	-
CO3	3	2	2	-	1	2	-	-	-	-	-	-	--	-
CO4	3	2	2	-	1	2	-	-	-	-	-	-	--	-

Detailed Syllabus:

General principles: A historical perspective; Signal transduction; Physico-chemical and biological transducers; Sensor types and technologies, Definitions and Concepts Terminology and working vocabulary; Main technical definitions: calibration, selectivity, sensitivity, reproducibility, detection limits, response time.

Physico-chemical transducers: Electrochemical transducers (amperometric, potentiometric, conductimetric); optical transducers (absorption, fluorescence, SPR); Thermal transducers; Piezoelectric transducers.

Biorecognition systems: Enzymes; Oligonucleotides and Nucleic Acids; Lipids (Langmuir-Blodgett bilayers, Phospholipids, Liposomes); Membrane receptors and transporters; Tissue and organelles (animal and plant tissue); Cell culture; Immunoreceptors; Chemoreceptors; Limitations & problems. Immobilization of biomolecules.

Biosensor Engineering: Methods for biosensors fabrication: self-assembled monolayers, screen printing, photolithography, micro-contact printing, MEMS. Engineering concepts for mass production.

Application of modern sensor technologies: Clinical chemistry; Test-strips for glucose monitoring; Urea determination; Implantable sensors for long-term monitoring; Environmental monitoring; Technological process control; Food quality control; Forensic science benefits; Problems & limitations.

Reading:

1. Donald G. Buerk, Biosensors: Theory and Applications, CRC Press, 2009.
2. Alice Cunningham, Introduction to Bio analytical Sensors, John Wiley& Sons, 1998.
3. Brian R. Eggins, Chemical Sensors and Biosensors, John Wiley& Sons, 2003.

SM440	HUMAN RESOURCE MANAGEMENT	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand principles, processes and practices of human resource management.
CO2	Apply HR concepts and techniques in strategic planning to improve organizational performance.
CO3	Understand tools to manage HR systems and procedures.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	2	2	-	-	-	-	-	-	2	1	2	-	-	-
CO2	2	2	-	-	-	-	-	-	2	1	2	-	-	-
CO3	2	2	-	-	-	-	-	-	2	1	2	-	-	-

Detailed Syllabus:

Introduction to Human Resource Management, Objectives, Scope and Significance of HRM, Functions of HRM, Problems and Prospects in HRM, Environmental scanning.

Human Resource Planning, Demand Forecasting Techniques, Supply Forecasting Techniques, Analyzing work and designing jobs, Recruitment and Selection, Interviewing Candidates.

Human Resource Development, Orientation, Training and Development, Management, Development, Performance Appraisal and Employee Compensation, Factors Influencing, Employee Remuneration and Challenges of Remuneration.

Industrial Relations, Industrial Disputes and Discipline, Managing Ethical Issues in Human Resource Management, Workers Participation in Management, Employee safety and health, Managing Global Human Resources and Trade Unions

International HRM, Future of HRM and Human Resource Information Systems

Reading:

1. Aswathappa, Human Resource Management — TMH., 2010.
2. Garry Dessler and Biju Varkkey, Human Resource Management, PEA., 2011.
3. Noe&Raymond,HRM: Gaining a Competitive Advantage, TMH, 2008.
4. Bohlander George W, Snell Scott A, Human Resource Management, Cengage Learning, 2009.

MA440	OPTIMIZATION TECHNIQUES	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Formulate and solve linear Programming Problems
CO2	Determine the optimum solution to constrained and unconstrained
CO3	Apply dynamic programming principle to Linear programming problems.
CO4	Determine the integer solutions to Linear Programming Problems.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	3	1	1	2	-	-	-	-	-	-	-	-	-
CO2	3	3	1	1	2	-	-	-	-	-	-	-	-	-
CO3	3	3	1	1	2	-	-	-	-	-	-	-	-	-
CO4	3	3	1	1	2	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

Linear Programming: Introduction and formulation of models, Convexity, Simplex method, Big-M method, Two-phase method, Degeneracy, non-existent and unbounded solutions, revised simplex method, duality in LPP, dual simplex method, sensitivity analysis, transportation and assignment problems, traveling salesman problem .

Nonlinear Programming: Introduction and formulation of models, Classical optimization methods, equality and inequality constraints, Lagrange multipliers and Kuhn-Tucker conditions, quadratic forms, quadratic programming problem, Wolfe's method.

Dynamic Programming: Principle of optimality, recursive relations, solution of LPP.

Integer Linear Programming: Gomory's cutting plane method, Branch and bound algorithm, Knapsack problem, linear 0-1 problem.

Reading:

1. Kanti Swarup, Man Mohan and P.K.Gupta, Introduction to Operations Research, S.Chand& Co., 2006
2. J.C.Pant, Introduction to Operations Research, Jain Brothers, New Delhi, 2008.
3. N.S.Kambo, Mathematical Programming Techniques, East-West Pub., Delhi, 1991.

MA441	OPERATIONS RESEARCH	OPC	3 – 0 – 0	3 Credits

Prerequisites: None

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

CO1	Formulate and solve linear programming problems
CO2	Determine optimum solution to transportation problem
CO3	Determine average queue length and waiting times of queuing models.
CO4	Determine optimum inventory and cost in inventory models.

Course Articulation Matrix

CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	3	1	1	2	-	-	-	-	-	-	-	-	-
CO2	3	3	1	1	2	-	-	-	-	-	-	-	-	-
CO3	3	3	1	1	2	-	-	-	-	-	-	-	-	-
CO4	3	3	1	1	2	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

Linear Programming: Formulation and graphical solution of LPP's. The general LPP, slack, surplus and artificial variables. Reduction of a LPP to the standard form. Simplex computational procedure, Big-M method, Two-phase method. Solution in case of unrestricted variables. Dual linear programming problem. Solution of the primal problem from the solution of the dual problems.

Transportation Problems: Balanced and unbalanced Transportation problems. Initial basic feasible solution using N-W corner rule, row minimum method, column minimum, least cost entry method and Vogel's approximation method. Optimal solutions. Degenracy in Transportation problems. Queueing Theory: Poisson process and exponential distribution. Poisson queues - Model (M/M/1):(∞/FIFO) and its characteristics.

Elements of Inventory Control: Economic lot size problems - Fundamental problems of EOQ. The problem of EOQ with finite rate of replenishment. Problems of EOQ with shortages - production instantaneous, replenishment of the inventory with finite rate. Stochastic problems with uniform demand (discrete case only).

Reading:

1. K.Swarup, Manmohan & P.K .Gupta, Introduction to Operations Research, S.Chand& Co., 2006
2. J.C. Pant, Introduction to Operations Research, Jain Brothers, New Delhi, 2008.
3. N.S. Kambo: Mathematical Programming Techniques, East-West Pub., Delhi, 1991.

PH440	NANOMATERIALS AND TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

Prerequisites: None

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

CO1	Understand synthesis and properties of nanostructured materials.
CO2	Analyze magnetic and electronic properties of quantum dots
CO3	Understand structure, properties and applications of Fullerenes and Carbon nanotubes.
CO4	Understand applications of nanoparticles in nanobiology and nanomedicine

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	1	1	1	-	-	-	-	-	-	-	-	--	--
CO2	3	1	1	1	-	-	-	-	-	-	-	-	--	--
CO3	3	1	1	1	-	-	-	-	-	-	-	-	--	--
CO4	3	1	1	1	-	-	-	-	-	-	-	-	--	--

Detailed Syllabus:

General properties of Nano materials: Origin of nanotechnology. Classification of nanomaterials. Fullerene, carbon nanotubes (CNT's), Nanoparticles. Physical, Chemical, Electrical, Optical, Magnetic and mechanical properties of nanomaterials.

Fullerenes and Carbon Nanotubes (CNT's): Introduction: Synthesis and purification. Preparation of fullerenes in the condensed phase,Transport, mechanical, physical properties of CNT's.

Investigation and manipulating materials in the Nanoscale: Electron microscope, scanning probe microscopes, optical microscopes for Nanoscience and Technology, X-Ray Diffraction.

SAMs and clusters: Growth process. Patterning monolayers. Types of clusters. Bonding and properties of clusters.

Semi conducting Quantum Dots: Introduction: Synthesis of Quantum Dots. Electronic structure of Nanocrystals, properties.

Nanobiology: Interaction between Biomolecules and Nanoparticle surgaces. Different types of Inorganic materials used for the synthesis of Hybrid Nano-bio assemblies. Nanoprobes for Analytical Applications.

Nanosensors: Nanosensorsbased on optical properties. Nanosensors based on quantum size effects. Nanobiosensors.

Nanomedicines: Developments of nanomedicines. Nanotechnology in Diagnostic Applications, materials for use in Diagnostic and therapeutic Applications.

Reading:

1. T. Pradeep, Nano: The Essentials; Tata McGraw-Hill, 2008.
2. W.R.Fahrner, Nanotechnology and Nanoelectronics; Springer,2006.
3. Rechard Booker and Earl Boysen, Nanotechnology, Willey, 2006.

PH441	BIOMATERIALS AND TECHNOLOGY	OPC	3 – 0 – 0	3 Credits

Prerequisites: None

Course Outcomes: At the end of the course the student will be able to:

CO1	Understand the structure and properties of biomaterials
CO2	Classify implant biomaterials
CO3	Evaluate biocompatibility of implants
CO4	Identify appropriate biomaterials for specific medical applications

Course Articulation Matrix

CO \ PO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	3	1	1	-	1	2	1	-	-	-	-	-	-
CO2	3	3	1	1	-	1	2	1	-	-	-	-	-	-
CO3	3	3	1	1	-	1	2	1	-	-	-	-	-	-
CO4	3	3	1	1	-	1	2	1	-	-	-	-	-	-

Detailed Syllabus:

Overview of biomaterials: Historical developments, impact of biomaterials, interfacial phenomena, tissue responses to implants.

Structure and properties of biomaterials: Crystal structure of solids, phase changes, imperfections in solids, non-crystalline solids, surface properties of solids, mechanical properties, surface improvements.

Types of biomaterials: Metallic implant materials, ceramic implant materials, polymeric implant materials composites as biomaterials.

Characterization of materials: Electric properties, optical properties, X-ray absorption, acoustic and ultrasonic properties.

Bio implantation materials: Materials in ophthalmology, orthopedic implants, dental materials and cardiovascular implant materials.

Tissue response to implants: Normal wound healing processes, body response to implants, blood compatibility, structure – property relationship of tissues.

Reading:

1. JoonPark, R.S. Lakes, Biomaterials an introduction; 3rd Edition, Springer, 2007
2. Sujatha V Bhat, Biomaterials; 2nd Edition, Narosa Publishing House, 2006.

CY441	CHEMISTRY OF NANOMATERIALS	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Demonstrate a systematic knowledge of the range and breadth of application of nanomaterials.
CO2	Review critically the potential impact, in all classes of materials, of the control of nanostructure
CO3	Describe the methods for the synthesis and nanostructural characterisation of such materials.
CO4	Identify the possible opportunities for nanomaterials in society development and enhancement.

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	3	1	1	1	-	2	2	-	-	-	-	-	--	-
CO2	3	1	1	1	-	2	2	-	-	-	-	-	--	-
CO3	3	1	1	1	-	2	2	-	-	-	-	-	--	-
CO4	3	1	1	1	-	2	2	-	-	-	-	-	--	-

Detailed Syllabus:

Introduction: Review the scope of nanoscience and nanotecnology, understand the nanoscience in nature, classification of nanostructured materials and importance of nanomaterials.

Synthetic Methods: Teach the basic principles for the synthesis of Nanostructure materials by Chemical Routes (Bottom-Up approach):-Sol-gel synthesis, microemulsions or reverse micelles, solvothermal synthesis, microwave heating synthesis and sonochemical synthesis and Physical methods (Top-Down approach):- Inert gas condensation, plasma arc technique, ion sputtering, Laser ablation, laser pyrolysis, and chemical vapour deposition method.

Techniques for characterization: Learning of characterization method by various techniques like, Diffraction Technique:-Powder X-ray diffraction for particle size analysis, Spectroscopy Techniques:- Operational principle and applications of spectroscopy techniques for the analysis of nanomaterials, UV-VIS spectrophotometers and its application for band gap measurement, Electron Microscopy Techniques:-Scanning electron microscopy (SEM)and EDAX analysis, transmission electron microscopy (TEM), scanning probe microscopy (SPM)BET method for surface area determination and Dynamic light scattering technique for particle size analysis.

Studies of nano-structured Materials:Synthesis, properties and applications of the following nanomaterials: fullerenes, carbon nanotubes, core-shell nanoparticles, nanoshells, self- assembled monolayers, and monolayer protected metal nanoparticles, nanocrystalline materials.

Reading:

1. T Pradeep, NANO: The Essentials, Mc. Graw Hill, 2007.
2. B S Murty, P Shankar, BaldevRai, BB Rath and James Murday, Textbook of Nanoscience and nanotechnology, Univ. Press, 2012.
3. Guozhong Cao, Nanostructures & Nanomaterials; Synthesis, Properties & Applications, Imperial College Press, 2007.
4. M.A. Shah and Tokeer Ahmad, Principles of Nanoscience and Nanotechnology, Narosa Pub., 2010.
5. Manasi Karkare, Nanotechnology: Fundamentals and Applications, IK International, 2008.
6. C. N. R. Rao, Achim Muller, K.Cheetham, Nanomaterials Chemistry, Wiley-VCH, 2007.

HS440	CORPORATE COMMUNICATION	OPC	3 – 0 – 0	3 Credits

Pre-requisites: None

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

CO1	Understand corporate communication culture
CO2	Prepare business letters, memos and reports
CO3	Communicate effectively in formal business situations
CO4	Exhibit corporate social responsibility and ethics
CO5	Practice corporate email, mobile and telephone etiquette
CO6	Develop good listening skills and leadership qualities

Course Articulation Matrix

PO / CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	3	1	3	2	-	-	-
CO2	-	-	-	-	-	-	-	3	1	3	2	-	-	-
CO3	-	-	-	-	-	-	-	3	1	3	2	-	-	-
CO4	-	-	-	-	-	-	-	3	1	3	2	-	-	-
CO5	-	-	-	-	-	-	-	3	1	3	2	-	-	-
CO6	-	-	-	-	-	-	-	3	1	3	2	-	-	-

Detailed Syllabus:

Importance of Corporate communication: Introduction to and definition of corporates – Communication, process, patterns and channels of communication- Barriers to communication and strategies to overcome them- Evolution of corporate culture- Role and contribution of individual group and organization - Role of psychology in communication.

Oral Communication: Techniques for improving oral fluency-Speech mechanics-Group Dynamics and Group Discussion – Debate and oral presentations.

Written Communication: Types and purposes- Writing business reports, and business proposals- Memos, minutes of meetings- Circulars, persuasive letters- Letters of complaint- ; language and formats used for drafting different forms of communication. Internal and external communication.

Corporate responsibility: Circulating to employees vision and mission statements- ethical practices- Human rights -Labour rights-Environment- governance- Moral and ethical debates surrounding -Public Relations - Building trust with stakeholders.

Corporate Ethics and Business Etiquette: Integrity in communication-Harmful practices and communication breakdown- Teaching how to deal with tough clients through soft skills. Body language- Grooming- Introducing oneself- Use of polite language- Avoiding grapevine and card pushing – Etiquette in e-mail, mobile and telephone.

Listening Skills: Listening- for information and content- Kinds of listening- Factors affecting listening and techniques to overcome them- retention of facts, data and figures- Role of speaker in listening.

Leadership Communication Styles: Business leadership -Aspects of leadership-qualities of leader-training for leadership-delegation of powers and ways to do it-humour-commitment.

Reading:

1. Raymond V. Lesikar, John D. Pettit, Marie E. Flatley Lesikar's Basic Business Communication - 7th Edition: Irwin, 1993
2. Krishna Mohan and Meera Banerji, Developing Communication Skills: Macmillan Publishers India,2000
3. R.C. Sharma & Krishna Mohan Business Correspondence and Report Writing: – 3rd Edition Tata McGraw-Hill,2008
4. Antony Jay & Ross Jay, Effective Presentation, University Press, 1999.
5. Shirley Taylor, Communication for Business, Longman, 1999.