NATIONALINSTITUTEOFTECHNOLOGYDURGAPUR

CURRICULUM&SYLLABUS OF

BACHELOROFTECHNOLOGY IN ELECTRICAL ENGINEERING

2023ONWARDADMISSIONBATCH

V0:

First Year Curriculum Recommended by members of UGAC	19.08.2023
First Year Curriculum Approved by the Chairman, Senate	19.08.2023
First Year Curriculum & Syllabus ratified in the 71st Senate meeting (Item No. 71.5(b))	18.12.2023
Entire Curriculum and Syllabus Recommended by UGAC	09.12.2024
Entire Curriculum and Syllabus Approved by the 73rd Senate (Item No. 73.8)	23.03.2025

CURRICULUM

GROUP – 1

FIRSTSEMESTER

Semester-I							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MAC01	Mathematics-I	3	1	0	4	4
2	CSC01	Compute rProgramming	2	1	0	3	3
3	XEC01	Engineering Mechanics	2	1	0	3	3
4	XEC02	Basic Electrical and Electronics Engineering	3	0	0	3	3
5	ESC01	Ecology and Environment	2	0	0	2	2
6	CYC01	Engineering Chemistry	3	0	0	3	3
7	CSS51	Computer Programming Laboratory	0	0	3	2	3
8	XES52	Basic Electrical and Electronics Engineering Laboratory	0	0	3	2	3
9	CYS51	Engineering Chemistry Laboratory	0	0	2	1	2
		TOTAL	**15**	**3**	**8**	**23**	**26**

SECONDSEMESTER

Semester-II							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MAC02	Mathematics-II	3	1	0	4	4
2	CSC02	Data Structure and Algorithms	2	1	0	3	3
3	PHC01	Engineering Physics	2	1	0	3	3
4	HSC01		2	0	2	3	4
5	CSS52	Data Structure and Algorithms Laboratory	0	0	3	2	3
6	XES51	Engineering Graphics	0	1	3	3	4
7	PHS51	Engineering Physics Laboratory	0	0	2	1	2
8	XXS51	Extra Academic Activities	0	0	2	1	2
		TOTAL	9	4	12	20	25

GROUP – 2

FIRSTSEMESTER

Semester-I							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MAC01	Mathematics-I	3	1	0	4	4
2	CSC01	Computer Programming	2	1	0	3	3
3	XEC01	Engineering Mechanics	2	1	0	3	3
4	PHC01	Engineering Physics	2	1	0	3	3
5	HSC01	Professional Communication	2	0	2	3	4
6	CSS51	Computer Programming Laboratory	0	0	3	2	3
7	XES51	Engineering Graphics	0	1	3	3	4
8	PHS51	Engineering Physics Laboratory	0	0	2	1	2
9	XXS51	Extra Academic Activities	0	0	2	1	2
		TOTAL	**11**	**5**	**12**	**23**	**28**

SECONDSEMESTER

Semester-II							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MAC02	Mathematics-II	3	1	0	4	4
2	CSC02	Data Structure and Algorithms	2	1	0	3	3
3	XEC02	Basic Electrical and Electronics Engineering	3	0	0	3	3
4	ESC01	Ecology and Environment	2	0	0	2	2
5	CYC01	Engineering Chemistry	3	0	0	3	3
6	CYS51	Engineering Chemistry Laboratory	0	0	2	1	2
7	CSS52	Data Structure and Algorithms Laboratory	0	0	3	2	3
8	XES52	Basic Electrical and Electronics Engineering Laboratory	0	0	3	2	3
		TOTAL	**13**	**2**	**8**	**20**	**23**

Semester-III							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1.	MAC331	Mathematics-III	3	1	0	4.0	4
2.	EEC301	Network Analysis and Synthesis	3	1	0	4.0	4
3.	EEC302	Electrical and Electronics Measurements	3	1	0	4.0	4
4.	EEC303	Electromagnetic Field Theory	3	1	0	4.0	4
5.	ECC331	Analog Electronics	3	1	0	4.0	4
6.	ECS381	Analog Electronics Laboratory	0	0	3	2.0	3
7.	EES351	Electrical and Electronics Measurements Lab	0	0	3	2.0	3
		TOTAL	**15**	**5**	**6**	**24.0**	**26**
Semester-IV							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	EEC401	Power Systems – I	3	1	0	4.0	4
2	EEC402	Electrical Machines – I	3	1	0	4.0	4
3	EEC403	Digital Electronics	3	1	0	4.0	4
4	EEC404	Microprocessor and Microcontroller	3	1	0	4.0	4
5	MEC431	Fluid and Thermal Engineering	3	0	0	3.0	3
7	EES451	Network Analysis and Synthesis Laboratory	0	0	3	2.0	3
8	MES481	Fluid and Thermal Engineering Laboratory	0	0	3	2.0	3
		TOTAL	**15**	**4**	**6**	**23.0**	**25**
Semester-V							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	EEC501	Electrical Machines – II	3	1	0	4.0	4
2	EEC502	Control Systems	3	1	0	4.0	4
3	EEC503	Power Systems – II	3	1	0	4.0	4
4	EEC504	Power Electronics	3	1	0	4.0	4
5	EEE51X	Depth Elective - 1	3	0	0	3.0	3
6	ECS581	Digital Electronics Laboratory	0	0	3	2.0	3
7	EES551	Control Systems Laboratory	0	0	3	2.0	3
8	EES552	Electrical Machines Laboratory – I	0	0	3	2.0	3
		TOTAL	**15**	**4**	**9**	**25.0**	**28**

Semester-VI							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	HSC631	Economics and Management Accountancy	3	0	0	3.0	3
2	EEC601	High Voltage and Insulation Engineering	3	1	0	4.0	4
3	CSC6XX	Artificial Intelligence & Machine Learning	3	0	2	4.0	5
4	EEE61X	Depth Elective - 2	3	0	0	3.0	3
5	EEE61X	Depth Elective - 3	3	0	0	3.0	3
6	EES651	Electrical Machines - II Laboratory	0	0	3	2.0	3
7	EES652	Power Electronics Laboratory	0	0	3	2.0	3
8	EES653	Power System Laboratory	0	0	3	2.0	3
		TOTAL	**15**	**1**	**11**	**23.0**	**27**
Semester-VII							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MSC731	Principles of Management	3	0	0	3.0	3
2	EEC701-	Power System Operation and Control	3	0	0	3.0	3
3	EEE71X	Depth Elective - 4	3	0	0	3.0	3
4	EEE71X	Depth Elective - 5	3	0	0	3.0	3
5	YYO74X	Open Elective - 1	3	0	0	3.0	3
6	EES751	Microprocessor and Microcontroller Laboratory	0	0	3	2.0	3
7	EES752	High Voltage and Insulation Engineering Laboratory	0	0	3	2.0	3
8	EES753	Electrical Machine Design Sessional	0	0	3	2.0	3
9	EES754	Vocational Training / Summer Internship and Seminar	0	0	2	1.0	3
10	EES755	Project - I	0	0	3	1.0	3
		TOTAL	**15**	**0**	**14**	**23.0**	**30**
Semester-VIII							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	EES851	Project - II	0	0	15	6.0	15
2	EES852	Comprehensive Viva	0	0	0	1.0	0
		TOTAL	**0**	**0**	**15**	**7.0**	**15**

CREDITUNITOFTHEPROGRAM:

Semester	**I+II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**TOTAL**
CreditUnit	43	23	22	22	21	21	10	162

OPEN ELECTIVE SUBJECT(S) THAT ARE OFFERED IN 7th SEMESTER BY EE DEPARTMENT

Subject Code	Subject Name
EEO740	Measurement and Instrumentation
EEO741	Fundamentals of Control Systems
EEO742	Power System Analysis and Design
EEO743	Fundamentals of Mobile Robots
EEO744	Fundamentals of Power Systems
EEO745	Concept of Industrial Electronics
EEO746	Energy Conservation, Audit and ICT & IOT Application for Monitoring
EEO747	Network Theory
EEO748	Electrical Engineering Materials
EEO749	Micro grid systems
EEO750	Digital Image Processing
EEO751	Soft Computing Techniques
EEO752	Embedded Systems and Applications
EEO753	Micro-Electro-Mechanical Systems
EEO754	Biomedical Instrumentation
EEO755	Concept of Electrical Machines & Drives
EEO756	Renewable Energy
EEO757	Flight control systems
EEO758	Industrial Process Control & Instrumentation
EEO759	Electric and Hydrogen Fuel Cell Vehicles

DEPTH ELECTIVE COURSE BASKETS:

FIFTH SEMESTER:

Subject Code	Subject Name
EEE510	Renewable Energy Systems
EEE511	Embedded Systems
EEE512	Digital Signal Processing
EEE513	Numerical Analysis

SIXTH SEMESTER:

Subject Code	Subject Name
EEE610	Instrumentation
EEE611	Modern Control Systems
EEE612	Special Electrical Machines
EEE613	Signal and System
EEE614	Advanced Power Electronics
EEE615	Soft Computing Theory and Applications
EEE616	Power System Transients & Power Quality
EEE617	Smart Grid
EEE618	Power system Reliability
EEE619	Process Dynamics & Control
EEE620	Electrical Wiring Estimating & Costing

SEVENTH SEMESTER:

Subject Code	Subject Name
EEE710	Advanced Power Converters
EEE711	Generalized Theory of Electrical Machines

EEE712	Electrical Drives
EEE713	FACTS Device
EEE714	Generation & Utilization of Electrical Power
EEE715	Advanced Control Systems
EEE716	Design of Flight Control Law
EEE717	Power system restructuring & deregulation

DETAILED SYLLABUS

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
MAC01	MATHEMATICS - I	PCR	3	1	0	4	4
Pre-requisites		Basic concepts of function, limit, differentiation and integration.					
Course Outcomes	• CO1: learn the fundamentals of differential calculus of single and several variables. • CO2: learn the basic concepts of convergence of infinite series. • CO3: understand the basic concepts of integral calculus along with its various applications. • CO4: acquire the theoretical knowledge of vector calculus and its engineering applications.						
Topics Covered	**Functions of Single Variable:** Review of limit, continuity and differentiability. Mean value theorems: Rolle's Theorem, Lagrange's Mean Value Theorem (MVT), Cauchy's MVT, Taylor's theorem, Taylor's and Maclaurin's series. (8) **Functions of several variables:** Limit, continuity and differentiability of functions of several variables, partial derivatives and their geometrical interpretation, derivatives of composite and implicit functions, derivatives of higher order and their commutativity, Homogeneous function, Euler's theorem and its converse, Exact differential, Jacobian, Taylor's & Maclaurin's series, Maxima and Minima, Necessary and sufficient condition for maxima and minima (no proof). (11) **Sequences and Series:** Real sequences and their convergence, Series of positive terms, Necessary and sufficient condition for convergence, p-series, geometric series, Comparison test, D Alembert's ratio test, Cauchy's root test, Alternating series, Leibnitz's rule, Absolute and conditional convergence. (6) **Integral Calculus:** Review of the idea of integration as a limit of a sum, Mean value theorems of integral calculus, Area and length in Cartesian and polar co-ordinates, Volume and surface area of solids of revolution in Cartesian and polar forms, Improper integrals and their convergence, Beta and Gamma functions. (12) **Multiple Integrals:** Evaluation of double and triple integrals, Change of order of integration, Change to better coordinates, Area and volume by double integration, Volume by triple integration. (10) **Vector Calculus:** Vector valued functions and its differentiability, Line integral, Surface integral, Volume integral, Gradient, Curl, Divergence, Green's theorem in the plane (including vector form), Stokes' theorem, Gauss's divergence theorem and their engineering applications. (9)						
Text Books, and/or reference material	**Text Books:** 1. Kreyszig, E., Advanced Engineering Mathematics: 10th edition, Wiley India Edition, 2010. 2. Murray, D.A., Differential and Integral Calculus, FB & C Limited, 2018. 3. Marsden, J. E; Tromba, A. J.; Weinstein: Basic Multivariable Calculus, Springer, 2014. 4. Murray Spiegel, Schaum's Outline of Vector Analysis, ation, Tata McGraw Hill Educ .1980 **Reference Books:** 1. Tom Apostal, Calculus-Vol-I & II, Wiley Student Edition, 2011. 2. Thomas and Finny: Calculus and Analytic Geometry, 11th Edition, Addison Wesley.						

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MAC01	CO1	2	3	2	3	1	1	-	-	1	1	1	2
	CO2	2	3	2	3	-	1	-	-	1	1	2	2
	CO3	2	3	2	3	-	1	1	-	-	2	2	2
	CO4	3	3	2	3	1	1	-	1	-	2	1	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>CSC01</td><td>COMPUTER PROGRAMMING</td><td>PCR</td><td>2</td><td>1</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2">Basic knowledge of computer.</td><td colspan="6">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: To understand basics of computer programming, program flow, and programming constructs.
• CO2: Develop concepts on basic and complex data types, conditional and iterative statements.
• CO3: Exercise the concepts of user defined functions to solve real time problems.
• CO4: Inscribe C programs that use Pointers to access arrays, strings and functions.
• CO5: Exercise user defined data types including structures and unions to solve problems.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Introduction to C: Phases of developing a running computer program in C. (2L)
Data types, size and values. Char, Unsigned and Signed data types. Number systems and representations. Constants, Overflow. (3L)
Data concepts in C: Constants, Variables, Expressions, Operators, and operator precedence in C. (2L)
Statements: Declarations, Input-Output Statements, Compound statements, Selection Statements. (2L)
Conditions, Logical operators, Precedences. Repetitive statements, While construct, Do-while Construct, For construct. (3L)
Arrays. Strings. Multidimensional arrays and matrices. (3L)
Pointers: Pointer variables. Declaring and dereferencing pointer variables. Pointer Arithmetic. Examples. Accessing arrays through pointers. Pointer types, Pointers and strings. String operations in C. (6L)
Dynamic memory allocation. (2L)
Modular Programming: Functions: The prototype declaration, Function definition.
(3L)
Function call: Passing arguments to a function, by value, by reference. Scope of variable names. Recursive function calls, Tail recursion. (4L)
Sorting problem: Sorting in arrays with an example of Bubble sort. Sorting in strings. (3L)
Search problem: Linear search and binary search. (2L)
More Data-types in C: Structures in C: Motivation, examples, declaration, and use. Operations on structures. Passing structures as function arguments. type defining structures. (4L)
File input-output in C. Streams. Input, output and error streams. Opening, closing and reading from files. Programming for command line arguments. (3L)</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">Text Books:
1. P. Deitel, H. Deitel. C How to Program. Pearson Education India, 7th Ed.
2. B. W. Kernighan, Dennis M. Ritchie. The C Programming. Prentice Hall Software Series, 2nd Ed.</td></tr>
</table>

	Reference Books: 1. P. Dey and M. Ghosh. Computer fundamentals and programming in C. Oxford press, 2013. 1. Y. Kanetkar. Let Us C. BPB Publications, Sixteenth edition, 2017.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CSC01	CO1	2	2	1	-	1	2	-	-	-	-	-	-
	CO2	3	2	1	-	1	1	1	-	-	-	-	-
	CO3	2	2	1	-	-	2	-	-	-	-	-	-
	CO4	3	2	2	-	-	1	-	-	-	-	-	-
	CO5	3	1	2	-	1	2	-	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)#	Total Hours	
XEC01	**ENGINEERING MECHANICS**	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
		CT+MT+EA					
Course Outcomes	• CO1: Acquire knowledge of mechanics and ability to draw free body diagrams. • CO2: Apply knowledge of mechanics for solving special problems like truss and frame analysis. • CO3: Ability to calculate centroid, moments of inertia for various shapes. • CO4: Learn momentum and energy principles. • CO5: Knowledge on virtual Work Principle and its application						
Topics Covered	Engineering Mechanics; measurement and SI units. [1] Vectors and force as a vector; Resultant of a system of forces on a particle; free body diagram and conditions of equilibrium of a particle; problems on particles; equilibrium of particles in space. [2] Resultant of a system of forces and couples on a rigid body; conditions of equilibrium of a rigid body; free body diagrams of rigid bodies subjected to different types of constraints; simple space problems of rigid bodies. [4] Coefficients of static and kinetic friction; problems involving friction; theories of friction on square threaded power screw and flat belt. [5] Simple trusses; analysis of trusses by method of joints and method of sections. [5] Centre of gravity and centre of mass; centroids of lines, curves and areas; first moment of area; second moment of area; polar moment of inertia; radius of gyration of an area; parallel axis theorem; mass moment of inertia. [4] Path, velocity, acceleration; rectilinear and curvilinear motion; motion of system of particles; introduction to the concept of plane kinematics of rigid bodies. [6] Newton's second law of motion; dynamic equilibrium and D'Alembert's principle; linear momentum; angular momentum; rectilinear and curvilinear motion; principles of work–energy and impulse–momentum; impact of system of particles; introduction to the concept of plane kinetics of rigid bodies. [12]						

	Principle of Virtual Work, Solution of Problems on Mechanics using Principle of Virtual Work [3]
Text Books, and/or reference material	1) S P Timoshenko and D H Young, Engineering Mechanics, 5th Edition 2) J L Meriam and L G Kraige, Engineering Mechanics, 5th Edition, Wiley India 3) F P Beer and E R Johnston, Vector Mechanics for Engineers 4) I H Shames, Engineering Mechanics

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XEC01	CO1	1	-	-	-	-	-	-	-	-	-	-	1
	CO2	1	1	1	1	-	-	-	-	-	-	-	1
	CO3	1	1	-	-	-	-	-	-	-	-	-	1
	CO4	1	2	-	-	-	-	-	-	-	-	-	1
	CO5	-	2	2	2	2	1	-	-	-	1	-	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				Credit
			Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	
PHC01	**Engineering Physics**	**PCR**	**2**	**1**	**0**	**3**	**3**
Pre-requisites:		Course Assessment methods: (Continuous (CT), mid-term (MT) and end assessment (EA))					
NIL		CT+MT+EA					
Course Outcomes		• CO1: To realize and apply the fundamental concepts of physics such as superposition principle, simple harmonic motion to real world problems. • CO2: Learn about the quantum phenomenon of subatomic particles and its applications to the practical field. • CO3: Gain an integrative overview and applications of fundamental optical phenomena such as interference, diffraction and polarization. • CO4: Acquire basic knowledge related to the working mechanism of lasers and signal propagation through optical fibers.					
Topics Covered		**Harmonic Oscillations** - Linear superposition principle, Superposition of two perpendicular oscillations having same and different frequencies and phases, Free, Damped and Forced vibrations, Equation of motion, Amplitude resonance, Velocity resonance, Quality factor, sharpness of resonance, [8] **Wave Motion**: Longitudinal waves, Transverse waves, Wave equation, phase velocity and group velocity, Maxwell's equations, Electro-magnetic waves in free space. [3] **Introductory Quantum Mechanics** - Inadequacy of classical mechanics, Blackbody radiation, Planck's quantum hypothesis, de Broglie's hypothesis, Heisenberg's uncertainty principle and applications, Schrodinger's wave equation and applications to simple problems: Particle in a one-dimensional box, Simple harmonic oscillator, Tunnelling effect. [8] **Interference & Diffraction** - Huygens' principle, Young's experiment, Superposition of waves, Conditions of sustained Interference, Concepts of coherent sources, Interference by division of wavefront, Interference by division of amplitude with examples, The Michelson interferometer and some problems; Fraunhofer diffraction, Single slit, Multiple slits, Resolving power of grating. [13] **Polarisation** - Polarisation, Qualitative discussion on Plane, Circularly and elliptically polarized light, Malus law, Brewster's law, Double refraction (birefringence) - Ordinary and extra-ordinary rays, Optic axis etc.; Polaroid, Nicol prism, Retardation plates and analysis					

	of polarized lights. [5] **Laser and Optical Fiber** - Spontaneous and stimulated emission of radiation, Population inversion, Einstein's A & B co-efficient, Optical resonator and pumping methods, He-Ne laser. Optical Fibre– Core and cladding, Total internal reflection, Calculation of numerical aperture and acceptance angle, Applications. [5]
Text Books, and/or reference material	**TEXT BOOKS**: 1. The Physics of Vibrations and Waves, H. John Pain, Willy and Sons 2. A Text Book of Oscillations and Waves, M. Goswami and S. Sahoo, Scitech Publications 3. Engineering Physics, H. K. Malik and A. K. Singh, McGraw-Hill. **REFERENCE BOOKS**: 1. Vibrations and Waves in Physics, Iain G. Main, Cambridge University Press 2. Quantum Physics, R. Eisberg and R. Resnick, John Wiley and Sons 3. Fundamental of Optics, Jankins and White, McGraw-Hill 4. Optics, A. K. Ghatak, Tata McGraw-Hill 5. Waves and Oscillations, N. K. Bajaj, Tata McGraw-Hill 6. Lasers and Non-linear Optics, B. B. Laud, New Age International Pvt Lt

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PHC01	CO1	3	2	1	1	1	-	-	1	-	-	-	1
	CO2	3	2	-	2	-	-	-	-	-	-	-	1
	CO3	3	2	2	2	1	1	1	1	1	-	1	1
	CO4	3	2	2	2	1	1	1	-	1	-	1	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYC01	**Engineering Chemistry**	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
None		CT+MT+EA					
Course Outcomes	• CO1: Students will get the knowledge of fundamentals as well industrial applications of polymer, petroleum products, organometallic compounds and others. • CO2: Students will be able to elucidate the structure of different organic compounds and to analyze the structure-property correlation. • CO3: Students will be aware on the role played by different metals in biological systems and also the ecological impact of metals. • CO4: Students will be able to understand and analyze thermodynamical, kinetic as well as electrochemical aspects of chemical systems and apply the understanding in the technical field.						
Topics Covered	**ORGANIC CHEMISTRY** i. **Polymer chemistry and polymer engineering:** Fundamental concept on polymer chemistry; synthesis and application of important polymers, Rubber and plastic materials; vulcanization, structure-property correlation: Concept of Molecular weight of polymer, Glass transition temperature. Engineered polymer: Thermally stable, flame retardant, Conducting						

	polymer. (5L) ii. **Petroleum Engineering and oil refinery:** Origin of petroleum, separation principle and techniques of distillation of crude oil, thermal and catalytic cracking of petroleum, uses of different fractions, knocking, anti-knock compounds, octane number and cetane number. High octane and Aviation fuel. Bio-diesel. (3L) iii. **Structure elucidation of organic compounds by modern spectroscopic methods:** Application of UV-Visible (Lambert-Beers law), concept of chromophore, auxochrome, hypso-, hyper-, bathochromic, red shift. FT-IR spectroscopy and Mass spectroscopy (including instrumentation). (4L) **INORGANIC CHEMISTRY** i. **Coordination Chemistry:** Crystal Field Theory of octahedral and tetrahedral complexes, colour and magnetic properties, LMCT, MLCT, IVCT. Isomerism and stereochemistry.(5L) ii. **Bioinorganic Chemistry:** Metal ions in biological systems: Fe, Cu (2L) iii. **Industrial applicationof Organometallic complexes:** π-acid ligands, stabilization of metal low oxidation state and 18 electron rules, metal carbonyls and nitrosyls, metal-alkene complexes, Various catalytic cycles of industrial importance. (4L) iv. **Environmental Chemistry:** Metal toxicity (As, Hg, Pb and Cd) and its remediation (1L) **PHYSICAL CHEMISTRY** i. **Chemical Thermodynamics:** 2nd law of thermodynamics: Concept of thermodynamic engine (Carnotand reverse Carnot cycle), entropy, free energy. Temperature and pressure dependence of entropy and free energy. Change in phase: phase diagram of single component system. Cryogenics: Joule Thomson experiment. (5L) ii. **Chemical Kinetics:**Rate expression of Reversible reaction, parallel reaction,and Consecutive reaction with proper examples. Temp effect on reaction rate.(3L) iii. **Catalysis:** Types of catalysis, Rate expression for Catalysed reaction, Acid-base and Enzyme catalysis.(2L) iv. **Electrochemistry:**EMF, Nernst Equation, Application of electrochemistry in chemical processes. Electrochemical cell, Fuel cell, Li-ion battery(3L).
Text Books, and/or reference material	Suggested Text Books: (i) Physical Chemistry by P. Atkins, Oxford (ii) A guidebook to mechanism in Organic chemistry: Peter Sykes; Pearson Edu. (iii) Inorganic Chemistry Part-I & II, R. L. Dutta, The new book stall Suggested Reference Books: **Organic Chemistry**: (i) Basic stereochemistry of organic molecules: S. Sengupta; Oxford University press (ii) Engineering Chemistry: Wiley (iii) Elementary Organic Spectroscopy: William Kemp, ELBS with Macmillan **Inorganic Chemistry:** (i) Inorganic Chemistry: Principle structure and reactivity, J. E. Huheey, E. A. Keiter and R. L. Keiter, Pearson Education (ii) Bioinorganic Chemistry -- Inorganic Elements in the Chemistry of Life: An

	Introductionand Guide, 2nd Edition, Wolfgang Kaim, Brigitte Schwederski, Axel Klein. (iii) Inorganic Chemistry Fourth Edition, Shriver & Atkins, Oxford **Physical Chemistry:** (i) Physical Chemistry by G.W Castellan (ii) Physical Chemistry by P. C. Rakshit

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CYC 01	CO1	1	2	-	-	-	-	-	-	-	-	-	-
	CO2	1	-	-	-	-	-	2	-	-	-	-	-
	CO3	1	2	1	1	1	-	-	-	-	-	-	-
	CO4	-	1	-	-	2	-	1	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)#	Total Hours	
ESC01	**Ecology and Environment**	PCR	2	0	0	2	2
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
NIL		CT+MT+EA					
Course Outcomes	• CO1: Understand the importance of environment and ecosystem. • CO2: Understand the fundamental aspect of pollutant tracking and its implementation in natural and anthropogenic pollution of air and water system. • CO3: Understand the scientific basis of local and as well as global issues. • CO4: Apply of knowledge to develop sustainable solution.						
Topics Covered	**UNIT – I: INTRODUCTION (2)** Multidisciplinary nature of Environmental Studies: Definition, Scope, and Importance. **UNIT–II: FUNDAMENTALS OF ECOLOGY (9)** Definition, Components of Environment; Fundamentals of Ecology and Ecosystem; Components and Classification of Ecosystem; Energy flow in Ecosystem: Tropic level, Food Chain, Food Web, Ecological Pyramid; Biogeochemical cycles: Carbon, Nitrogen, Sulphur, Phosphorus, and Water Cycle; Biosphere and Biodiversity; Conservation. **UNIT–III: FUNDAMENTALS OF ENVIRONMENT (10)** **Environmental Pollution:** Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Solid Wastes, and Natural hazards: Floods, earthquakes, cyclones, and landslides. **Environmental Issues:** Climate change and global warming; acid rain; and ozone layer depletion. **Environment Quality:** Ambient air quality standards, Water quality parameters and standards: pH, Turbidity, Hardness, Sulphate, Phosphates, Iron, Dissolved Oxygen, BOD, and COD. **UNIT– IV: NATURAL RESOURCES (3)** Mineral Resources, Energy Resources: Conventional and Non-Conventional.						

	UNIT- V- GREEN TECHNOLOGY & ENVIRONMENTAL ETHICS (4) Sustainability: Carbon Sequestration, Green building practices, Green computing; Carrying capacity; and Environment Protection Acts/laws.
Text Books, and/or reference material	1. A Basic Course in Environmental Studies. Deswal & Deswal. Pub. Dhanpat Rai & Sons 2. Ecology. Odum. Pub. Oxford & IBH 3. Environmental Engineering. Peany et.al. Pub. McGraw Hill 4. A Text Book of Environmental Engg. Venugpal Rao. Pub. PHI 5. A Basic Course in Environmental Studies. Deswal & Deswal. Pub. Dhanpat Rai & Sons 6. Environmental Studies. Bharucha. Pub. University of Press 7. Environmental Chemistry and Pollution, S. S. Dara & D. D. Mishra, S. Chand Publishing

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ESC01	CO1	3	-	-	-	-	-	2	-	-	-	-	-
	CO2	1	-	-	-	-	-	2	-	-	-	-	-
	CO3	2	-	-	-	-	-	2	-	-	-	-	-
	CO4	1	-	3	-	-	2	1	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
HSC01	**Professional Communication**	PCR	2	0	2	4	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
None		CT+EA					

Course Outcomes	• CO1: Learners will acquire linguistic proficiency in terms of improvement in their listening, speaking, reading, and writing skills. • CO2: Learners will acquire better communicative ability. • CO3: The course will help learners improve their social connectivity skill.
Topics Covered	Vocabulary 1. Word Formation, Use of Prefixes and Suffixes (1) 2. Synonyms, Antonyms (1) 3. Prefixes and Suffixes from Foreign Languages, Words from Foreign Languages (1) 4. Abbreviations and Acronyms (1) 5. Technical Vocabulary (1) Grammar 1. Identifying Common Errors in Articles and Prepositions (1) 2. Common Errors in Noun-Pronoun Agreement and Subject-Verb Agreement (1) 3. Misplaced Modifiers and Tenses (1) 4. Redundancies and Clichés (1) Reading 1. Reading and Its Importance, Techniques of Effective Reading (1) 2. Improving Comprehension Skills, Techniques for Good Comprehension (1)

	3. Skimming and Scanning (1) 4. Comprehension, Intensive and Extensive Reading (2) Writing 1. Sentence Structures, Phrases and Clauses, Punctuation (2) 2. Organising Principles of Paragraphs (2) 3. Formal Letters, Letters of Complaint, Requisition Letters, Job Application, and Résumé (2) 4. Nature and Style of Sensible Writing, Defining, Describing, Classifying, Providing Examples and Evidence (2) 5. Essay Writing (2) 6. Précis Writing (2) 7. Report Writing (2) Oral Communication 1. Listening Comprehension (4) 2. Pronunciation, Intonation, Stress, and Rhythm (4) 3. Communication at the Workplace (4) 4. Everyday Conversation (4) 5. Group Discussion (4) 6. Interviews (4) 7. Formal Presentations (4)
Text Books, and/or reference material	**Text Book:** 1. English for Engineers –Sudharshana & Savitha (Cambridge UP) **Reference Books:** 2. *English*—Kulbhushan Kumar (Khanna Book Publishing) 3. *Remedial English Grammar*—F. T. Wood (Macmillan)

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
HSC01	CO1	1	--	--	1	--	1	--	1	2	3	1	--
	CO2	1	--	--	1	--	2	--	2	2	3	2	--
	CO3	--	--	--	1	--	3	--	3	3	3	2	--

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
MAC02	**MATHEMATICS - II**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
Basic concepts of set theory, differential equations, and probability.		CT+MT+EA					

Course Outcomes	• CO1: learn the basic concepts of linear algebra and be able to apply the same to solve various engineering problems. • CO2: understand fundamentals of ordinary differential equations and their applications. • CO3: acquire the theoretical knowledge of Fourier Series, Fourier & Laplace transforms, and learn about their applications. • CO4: learn the basic concepts of probability theory.
Topics Covered	**Introduction to Algebraic structures:** Group, subgroup, ring, subring, integral domain, and field. (3) **Linear Algebra:** Vector spaces over field, linear dependence and independence of vectors, linear span of a set of vectors, basis and dimension of finite dimensional vector space, elementary row/column operations, rank of a matrix, solutions of system of linear (homogeneous and non-homogeneous) equations, eigenvalues and eigenvectors, characteristic polynomials, Cayley-Hamilton theorem (without proof), Diagonalization of matrices. (15) **Ordinary Differential Equations (ODE):** Review of first order ODE, Picard's theorem (Statement Only), ODE of first order and of the first degree (exact ODE, rules for finding integrating factors), ODE of first order and of the higher degree (ODE solvable for x, solvable for y; Clairaut's equation, singular solution), homogeneous and non-homogeneous linear ODE with constant coefficients and variable coefficients (Euler–Cauchy type), linear dependence of solutions, Wronskian determinant, Solution of simultaneous ODEs $(dx/P = dy/Q = dz/R;\ dx/dt = ax + by,\ dy/dt = cx + dy)$, properties of nonlinear ODEs, phase plane analysis. (18) **Fourier series:** Piecewise smooth and periodic functions, Fourier series of a function in an interval, Dirichlet conditions, Convergence of Fourier series, Fourier sine and cosine series, Complex form of Fourier series. (4) **Fourier Transforms:** Fourier Integral Theorem (statement only), Different forms of Fourier Integrals, Fourier Transform and its inversion formula, Properties of Fourier Transform, Convolution. (7) **Laplace Transforms:** Laplace transforms and its Properties, Inverse Laplace transforms, Convolution theorem, Applications to ODE. (4) **Probability:** Random variables and probability distributions (discrete and continuous), Binomial, Poisson, Uniform and Normal distributions. (5)
Text Books, and/or reference material	**Text Books:** 1. Kreyszig, E., Advanced Engineering Mathematics: 10th edition, Wiley India Edition (2010). 2. Strang, G., Linear algebra and its applications (4th Edition), Thomson (2006). 3. Murray, D.A., Introductory Course in Differential Equations, Khosla Publishing House (2021). **4. Debnath, L., Integral Transforms and Their Applications, CRC Press (1995).** **5. Baisnab, A.P., Jas, M., Elements of Probability and Statistics, McGraw Hill Education (2017).**

	Reference Books: 1. Kumaresan, S., Linear algebra - A Geometric approach, Chaukhamba Auriyantaliya (2017). 2. Ross, S.L., Differential Equations, 3rd Edition, Wiley Student Edition (2017). 3. Shivamoggi, A., Integral Transforms for Engineers, PHI (2003). 4. Grinstead, C.M., Snell, J.L., Introduction to probability, American Mathematical Society (2012).

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MAC02	CO1	3	3	2	1	2	-	2	-	-	-	1	2
	CO2	3	3	2	2	2	-	2	-	-	1	-	2
	CO3	3	3	2	2	3	1	1	-	1	1	1	2
	CO4	3	2	1	3	2	1	1	1	1	-	-	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSC02	Data Structure and Algorithms	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
CSC01 (Computer Programming)		CA+ MT + ET [CA: 15%, MT: 25%, ET: 60%]					
Course Outcomes		• CO1: Understanding the fundamental concepts of abstract data types, data structures, algorithms and time complexity analysis of algorithms. • CO2: Implementation of different abstract data types (array, linked list, stack, queue, tree, graph). • CO3: Implementation of different sorting and searching techniques along with their performance evaluation. • CO4: Analysis of the suitability/compatibility of different data structures based on the types of applications. • CO5: Design and development of algorithms for real-life applications. •					
Topics Covered		**Introduction:** Abstract Data Type (ADT), Data Structures, Concept of static and dynamic memory allocation, Algorithm, Analysis of time and space complexity of algorithms, Asymptotic notations: Big Oh, Big Omega and Big Theta notations, Impact of data structure on the performance of an algorithm. (6L) **Array:** Array as an ADT, Single and multi-dimensional array, Memory representation (row major and column major) of array, Address calculation for array elements. (2L) **Linked list:** Linked list as an ADT, Memory allocation and deallocation for a linked list, Linked list versus array, Types of linked lists: singly linked list, doubly linked list and circular linked list, Operations on linked list: creation, display, insertion and deletion (in different positions), Concatenation, Searching, Sorting, Applications of linked list: Representations and operations on polynomials, sparse matrices, etc., Array vs. Linked List. (6L)					

	Stack: Stack as an ADT, Push and pop operations on stacks, Array implementation of stack, Linked list implementation of stack, Applications of stack: Recursion, Function call, Evaluation of postfix expression using stack, Conversion of infix to postfix using stack. (5L) **Queue:** Queue as an ADT, Enqueue and dequeue operations, Array implementation of queue, Limitation of array implementation, Circular queue, Linked list implementation of queue, Priority queue. (4L) **Binary Tree:** Binary Tree, Definition and properties, Representation of binary tree in memory: linked representation, array representation, Binary tree traversal (Preorder, Inorder and Postorder), Binary search tree, Heap (8L) **Searching Algorithms:** Linear search and binary search. (2L) Sorting Algorithms: Selection sort, Insertion sort, Quick sort, and Merge sort. (5L) **Graphs Algorithms:** Graph representation using Adjacency matrix and Adjacency list, Breadth First Search and Depth First Search algorithms. (4L)
Text Books, and/or reference material	**Text Books:** 1. R. F. Gilberg and B. A. Forouzan, "Data Structures: A pseudocode approach with C", 2nd Edition, CENGAGE Learning. 2. A. V. Aho, J. D. Ullman and J. E. Hopcroft, “Data Structures and Algorithms”, Addition Wesley. 3. Lipschutz, “Data Structures (Schaum’s Outline Series)”, Tata Mcgraw Hill. 4. E. Horowitz, S. Sahni, S. Anderson-Freed, “Fundamentals of Data Structures in C”, Universities Press; Second edition (2008). **Reference Books:** 1. Y. Langsam, M. J. Augenstein and A. N. Tanenbaum, "Data Structures using C and C++", Pearson, 2006. 2. Knuth, Donald E. The Art of Computer Programming. 3rd ed. Vols 1&2. Reading, MA: Addison-Wesley, 1997. ISBN: 0201896834. ISBN: 0201896842. ISBN: 0201896850. 3. Kleinberg and Eva Tardos. Algorithm Design. Addison-Wesley 2005 ISBN-13: 978-0321295354.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CSC02	CO1	3	-	1	1	1	-	-	-	-	-	-	-
	CO2	3	2	1	2	2	-	-	-	-	-	-	1
	CO3	3	2	1	2	2	-	-	-	-	-	-	1
	CO4	3	3	2	3	3	-	-	-	-	-	-	1
	CO5	3	3	3	3	3	-	-	-	-	-	-	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XEC02	**Basic Electrical and Electronics Engineering**	PCR	3	0	0	3	3
Pre-requisites			Course Assessment methods				
(10+2) level mathematics and physics			CT+MT+EA				

Course Outcomes	CO1: Learn the fundamentals of electric circuits and analyze the circuits using laws and network theorems. CO2: Gain the knowledge about magnetic circuits, electromagnetism and the basics of generation of alternating voltage. CO3: Understand the behaviour of single phase and poly-phase AC circuits. CO4: Understand the fundamentals of semiconductor devices. CO5: Analyze the design and characteristics of transistor-based electronic circuits. CO6: Evaluate operational amplifier-based circuits and logic gates.
Topics Covered	1. Introduction to Electrical systems, Fundamentals of Electric Circuits: Ohm's laws, Kirchhoff's laws, Independent and Dependent sources, Analysis of simple circuits. (4) 2. Network theorems (DC): Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem. (5) 3. Magnetic circuits: Review of fundamental laws of electromagnetic induction, Self and mutual inductances, Solution of magnetic circuits. (3) 4. Generation of alternating voltage and current, E.M.F. equation, Average and R.M.S. value, Phase and phase difference, Phasor representation of alternating quantity, Behaviour of AC circuits, Resonance in series and parallel R-L-C circuits. (6) 5. Poly-phase system, Advantages of 3-phase system, Generation of 3-phase voltages, Voltage, current and power in a star and delta connected systems, 3-phase balanced and unbalanced circuits. (3) 6. Semiconductor Devices: Construction, working and V-I characteristics of diode, Zener diode, Zener diode as a voltage regulator, LED. (6) 7. Transistors:Introduction to BJT, FET, MOSFET; CMOS, working principle, and V-I characteristics of Transistors, biasing of BJT circuits-fixed bias, emitter bias, feedback bias, voltage divider bias, transistor as an amplifier. (8) 8. Operational amplifier:Introduction, applications: inverting, non-inverting amplifier, unity follower, integrator, differentiator, summing circuit .(4) 9. Introduction of logic gates, memory: ROM, RAM. (3)
Text Books, and/or reference material	**TEXT BOOKS** 1. Electrical & Electronic Technology by Hughes, Pearson Education India. 2. Introduction Electronic Devices & Circuit Theory, 11/e, 2012, Pearson: Boylestad & Nashelsky. 3. Electronics: Fundamentals and Applications By D. Chattopadhyay, P. C. Rakshit; New Age Int. Publication. **REFERENCE BOOKS** 1. Advanced Electrical Technology by H. Cotton, Reem Publication Pvt. Ltd. 2. Electrical Engineering fundamentals by Vincent Deltoro, Pearson Edu. India. 3. The Art of Electronics 3e, by Paul Horowitz, Winfield Hill. 4. Electronics - Circuits and Systems, Fourth Edition by Owen Bishop. 5. Electronics Fundamentals: Circuits, Devices & Applications (8e) by Thomas L. Floyd & David M. Buchla.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XEC02	CO1	3	3	3	3	3	1	1	1	1	1	1	1
	CO2	3	3	3	3	2	1	2	1	1	1	1	1
	CO3	3	3	3	3	3	2	2	1	1	1	1	1
	CO4	2	3	2	2	-	1	-	-	-	-	-	1
	CO5	3	2	1	2	2	1	-	-	2	-	-	1
	CO6	3	2	2	2	3	-	-	-	2	-	-	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS51	**COMPUTER PROGRAMMING LABORATORY**	PCR	0	0	3	3	2
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					

Course Outcomes	CO1: To understand the principle of operators, loops and branching statements. CO2: Implementation of function, recursion, arrays, and pointers based several types of assignments. CO3: To detail out the operations of strings. CO4: To understand structure and union. CO5: Application of C-programming to solve various types of problems.
Topics Covered	**List of Experiments:** 1. Programs on expression evaluation. 2. Programs on conditional statements and branching 3. Programs on iterations/loops. 4. Applications of Arrays 5. Programs on basics of functions and pointers. 6. Programs on string using array and pointers. 7. Programs on recursion. 8. Programs on structures, union. 9. Programs on File Operations. 10. Case Studies.
Text Books, and/or reference material	**Text Books:** 1. Y. Kanetkar, "Let Us C", BPB Publications, Sixteenth edition, 2017. 2. B. S. Gottfried, "Programming with C", McGraw Hill Education, 4th Ed., 2018. 3. E. Balagurusamy, "Computing Fundamentals and C Programming", McGraw Hill Education; Second edition, 2017. **Reference Books:** 1. P. Dey and M. Ghosh, “Computer fundamentals and programming in C”, Oxford press, 2013. 2. R. Thareja, “Computer fundamentals and programming in C”, Oxford press, 2013. 3. Schaum’s Outline, Programming with C.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CSS51	CO1	3	3	2	-	-	2	-	-	-	-	-	-
	CO2	2	2	1	-	-	1	-	-	-	-	-	-
	CO3	3	2	2	-	-	1	-	-	-	-	-	-
	CO4	2	3	2	-	-	2	1	-	-	-	-	-
	CO5	3	3	3	-	1	2	1	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	**Title of the course**	Program Core (PCR) / Electives (PEL)	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	
PHS51	**Physics Laboratory**	PCR	**0**	**0**	**2**	**2**	**1**
Pre-requisites		Course Assessment methods: (Continuous evaluation (CE) and end assessment (EA))					
NIL		CE+EA					
Course Outcomes	CO1: To realize and apply different techniques for measuring refractive indices of different materials. CO2: To realize different types of waveforms in electrical signals using CRO. CO3: To understand charging and discharging mechanism of a capacitor. CO4: To understand interference, diffraction and polarization related optical phenomena. CO5: To acquire basic knowledge of light propagation through fibers.						
Topics Covered	1. Find the refractive index of a liquid by a travelling microscope. 2. Determine the refractive index of the material of prism using spectrometer. 3. Determination of amplitude and frequency of electrical signals by oscilloscope. 4. To study the characteristics of RC circuits. 5. To study Brewster's law/Malus' law using laser light. 6. To study the diffraction of light by a grating. 7. To study the interference of light by Newton's ring apparatus. 8. To determine numerical aperture of optical fiber. 9. Determination of Planck constant.						
Text and/or reference material	**SUGGESTED BOOKS**: 1) A Text Book on Practical Physics – K. G. Mazumdar and B. Ghosh 2) Practical Physics – Worsnop and Flint						

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PHS51	CO1	3	2	1	-	-	-	-	-	2	1	-	1
	CO2	3	2	1	-	-	1	-	-	2	1	-	1
	CO3	3	1	-	-	-	-	-	-	2	1	-	1
	CO4	3	2	-	1	-	1	1	-	2	1	-	1
	CO5	3	2	1	-	1	1	1	-	2	1	-	1

Correlation levels 1, 2 or 3 as defined below: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CYS51	**CHEMISTRY LABORATORY**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
None		CT+EA					

Course Outcomes	• CO1: To learn basic analytical techniques useful for engg applications. • CO2: Synthesis and characterization methods of few organic, inorganic and polymer compounds of industrial importance. • CO3: Learn chromatographic separation methods. • CO4: Applications of spectroscopic measurements.
Topics Covered	1. Experiments based on pH metry: Determination of dissociation constant of weak acids by pH meter. 2. Experiments based on conductivity measurement: Determination of amount of HCl by conductometric titration with NaOH. 3. Estimation of metal ion: Estimation of Fe^{2+} by permangnomentry 4. Estimation of metal ion: Determ. of total hardness of water by EDTA titration. 5. Synthesis and characterization of inorganic complexes: e. g. $Mn(acac)_3$, $Fe(acac)_3$, cis-bis(glycinato)copper (II) monohydrate and their characterization by m. p. , FTIR etc. 6. Synthesis and charact. of organic compounds: e.g.Dibenzylideneacetone. 7. Synthesis of polymer: polymethylmethacrylate 8. Verification of Beer-Lamberts law and determination of amount of iron present in a supplied solution. 9. Chromatography: Separation of two amino acids by paper chromatography 10. Determination of saponification value of fat/ vegetable oil
	Suggested Text Books: 1. Vogel's Quantitative Chemical Analysis (6th Edition) Prentice Hall 2. Advanced Physical Chemistry Experiments: By Gurtu&Gurtu 3. Comprehensive Practical Organic Chemistry: Qualitative Analysis By V. K. Ahluwalia and S. Dhingra Suggested Reference Books: 1. Practical Chemistry By R.C. Bhattacharya 2. Selected experiments in Physical Chemistry By N. G. Mukherjee

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CYS51	CO1	2	1	-	1	-	-	-	-	-	-	-	-
	CO2	-	1	-	1	1	2	-	-	-	-	-	-
	CO3	2	-	-	1	1	-	-	-	-	-	-	-
	CO4	-	1	-	1	1	-	-	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XES51	**ENGINEERING GRAPHICS**	PCR	1	0	3	4	2.5
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					

Course Outcomes	• CO1: Ability of mental visualization of different objects • CO2: Theoretical knowledge of orthographic projection to solve problems on one/two/three dimensional objects • CO3: Able to read/interpret industrial drawing and to communicate with relevant people
Topics Covered	Graphics as language of communication; technical drawing tools and their up-keep; types of lines; construction of geometrical figures; lettering and dimensioning. [6] Construction and use of scales; construction of curves of engineering importance such as curves of conic section; spirals, cycloids, involutes and different loci of points; use of equations for drawing some curves. [9] Descriptive geometry: necessity and importance of orthographic projection; horizontal and vertical reference planes; coordinate of points; orthographic projection of points and lines situated in different quadrants, viz. 1st, 2nd, 3rd and 4th quadrants; traces of lines. First angle and third angle projection of lines and planes; views from top, front and left (or right); true length and true inclination of lines with planes of projections; primary auxiliary projection of points, lines and planes; auxiliary plan and auxiliary elevation. [9] Projection of simple regular solids, viz. prisms, cubes, cylinders, pyramids, cones, tetrahedrons, spheres, hemi-spheres etc. [6] Section of solids; section by perpendicular planes; sectional views; true shapes of sections. [6] Dimensional techniques; international and national standards (ISO and BIS). [3] Freehand graphics. [3]
Text and/or reference material	1)… Engineering Drawing and Graphics – K Venugopal 2)… Engineering Drawing – N D Bhat 3)… Practical Geometry and Engineering Graphics – W Abbott

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XES51	CO1	1	-	-	-	-	-	-	-	-	-	-	-
	CO2	1	1	-	-	-	-	-	-	-	-	-	-
	CO3	1	-	1	-	-	-	-	-	-	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XES52	**Basic Electrical and Electronics Laboratory**	PCR	0	0	3	3	2
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					

Course Outcomes	CO1: Learn to analyse the electric circuits using network theorems. CO2: Understand the characteristics of fluorescent lamp and compact fluorescent lamp. CO3: Analyze the behaviour of single phase and three phase AC circuits. CO4: Understand the application of electronics components, diode circuits as rectifier circuits and voltage regulators. CO5: Evaluate and study the performance of the transistor as a switch. CO6: Create inverting and non-inverting amplifier circuits using Op-Amp.
Labs Conducted.	1. Verification of the network theorems (DC). 2. Study of the characteristics of fluorescent and compact fluorescent lamp. 3. Analysis of the three phase system for star and delta connected load. 4. Study of the series and parallel R-L-C circuit. 5. Identify and understand the use of different electronic and electrical instruments, various electronic components. 6. Study of half-wave and full-wave (bridge) rectifier with and without capacitor filter circuit. Zener diode as a voltage regulator. 7. Study the performance of a transistor as a switch through NOT gate. 8. Realization of Inverting and Non-inverting amplifier using Op-Amp.
Text Books, and/or reference material	**TEXT BOOK** 1. Handbook of Laboratory Experiments in Electronics and Electrical Engineering by A M Zungeru , J M Chuma, H U Ezea. 2. Experiments Manual for use with Electronic Principles (Engineering Technologies and the Trades) by Albert Paul Malvino Dr., David J. Bates, et al. **REFERENCE BOOKS** 1. Laboratory Courses in Electrical Engineering (5th Edition) by S. G. Tarnekar, P. K. Kharbanda, S. B. Bodhke, S. D. Naik, D. J. Dahigaonkar (S. Chand Publications). 2. The Art of Electronics 3e, by Paul Horowitz, Winfield Hill. 3. Electronic Principles, by Albert Paul Malvino Dr. and David J. Bate.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XES52	CO1	3	3	3	3	3	1	1	1	2	2	2	3
	CO2	3	3	2	3	3	3	1	1	2	2	2	3
	CO3	3	3	2	3	3	2	1	1	2	2	2	3
	CO4	3	3	3	3	3	1	1	1	2	2	2	3
	CO5	3	2	1	2	2	1	-	-	2	-	-	-
	CO6	3	2	2	2	3	-	-	-	2	-	-	-
	CO7	3	3	2	2	-	-	-	-	2	-	-	-

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSS52	**DATA STRUCTURES AND ALGORITHMS LABORATORY**	PCR	0	0	3	3	2
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					

Course Outcomes	CO1: Understanding the suitability and compatibility of array and linked list implementations for different application problems. CO2: Understanding the concept of abstract data types from real-life scenarios and their implementation in computing system. CO3: Identify, design and implementation of stack, queue, binary tree, and graph as applicable for given problem. CO4: Implementation of different searching and sorting techniques using appropriate data structures and perform efficiency analysis. CO5: Create efficient algorithms for real-life applications.
Topics Covered	**List of Experiments:** 1. Application of arrays using dynamic memory allocation. 2. Implementation and Applications of linked lists. 3. Implementation of stack, and applications of stack. 4. Implementation of queue, applications of queue: Priority queue. 5. Implementation of Binary tree, Binary tree traversal: Preorder, Inorder and Postorder traversal. 6. Implementation of binary search tree and operations on it. 7. Implementation of linear search, binary search (recursive, non-recursive). 8. Implementation of different sorting algorithms. 9. Implementation of graph algorithms: Breadth first search, Depth first search. 10. Case Studies.
Text Books, and/or reference material	**Text Books:** 1. S. Lipschutz, “Data Structures (Schaum’s Outline Series)”, McGraw Hill Education; First edition (2017). 2. E. Horowitz, S. Sahni, S. Anderson-Freed, “Fundamentals of Data Structures in C”, Universities Press; Second edition (2008). 3. E. Balagurusamy, "Programming in ANSI C", McGraw Hill Education India Private Limited, Seventh edition (2017). **Reference Books:** 1. B. S. Gottfried, "Programming with C", McGraw Hill Education, 4thEd. (2018).

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CSS52	CO1	-	1	1	1	-	-	-	-	-	-	-	-
	CO2	-	1	1	3	-	-	-	-	-	-	-	-
	CO3	2	2	3	2	1	-	-	-	-	-	-	-
	CO4	2	2	2	1	1	-	-	-	-	-	-	-
	CO5	3	3	3	3	3	-	1	1	-	-	1	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
XXS51	**Extra Academic Activities**	PCR	**0**	**0**	**2**	**2**	**1**

Pre-requisites	Course Assessment methods (Continuous (CT) and end assessment (EA))
NIL	CT+EA

Course Outcomes	• CO1: Social Interaction through the medium of sports • CO2: Team building and self defence
Topics Covered	**YOGA** • Introduction of Yoga- Suryanamaskar. 1L • Sitting Posture / Asanas – Padmasana, Vajrasana, Ardha Kurmasana, Ustrasana, Janusirshasana, Gomukhasana, Bhadrasana. 7L • Mudra- Gyana Mudra, Chin Mudra. 1L • Laying Posture/ Asana-Pavana Mukhtasana, Uttana Padasana, Sarpasana, Bhujangasana (Cobra Pose), Eka Pada Salabhasana, Dhanurasana, Chakrasana, Viparitkarani, Ardha Halasana (Half Plough Pose), Naukasana (Boat Posture), Shavasana (Relaxing Pose) , Makarasana. 7L • Meditation-Om Chant.1L • Standing Posture / Asana-Tadasana (Mountain Pose), Vrikshana (Tree Pose), Ardha Chandrasana, Padahastasana, Ardha Chakrasana (Half Wheel Posture). 5L • Pranayama-Deep Breathing, Anulom Vilom, Shitali, Bhramari. 5L • Kriya- Kapalbhati 1L **TAEKWONDO** • Introduction About Taekwondo- Meaning Of Taekwondo, Korean Language Of Dress, Fighting Area, Punch, Block, Kicks Etc. 1L • Stance- Ready Stance, Walking Stance, Front Stance, Back Stance. 2L • Punch Technique- Front Fist Punch, Double Fist Punch, With Stance Etc. Blocks- Upper Blocks, Middle Block, Side Block, Suto Etc. 4L • Foot Technique- Standing Kick, Front Kick, Doliyo, Back Kick Etc. 6L • Poomsae (Forms)- Jang, Yi Jang. 6L • Self Defense Technique- Self Defense from Arms, Fist and Punch. 4L • Sparring (Kyorugi)- One Step Sparring 2L • Combination Technique- Combined Kick And Punch. 2L • Project Work 1L

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XXS51	CO1	-	-	-	-	-	2	-	-	2	-	-	1
	CO2	-	-	-	-	-	-	-	2	3	-	-	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Semester - III							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	**MAC331**	**Mathematics - III**	**3**	**1**	**0**	**4.0**	**4**
2	**EEC301**	**Network Analysis and Synthesis**	**3**	**1**	**0**	**4.0**	**4**

3	EEC302	Electrical and Electronics Measurements	3	1	0	4.0	4
4	EEC303	Electromagnetic Field Theory	3	1	0	4.0	4
5	ECC331	Analog Electronics	3	1	0	4.0	4
6	ECS381	Analog Electronics Laboratory	0	0	3	2.0	3
7	EES351	Electrical and Electronics Measurements Lab	0	0	3	2.0	3
		TOTAL	15	5	6	24.0	26

<table>
<tr><td colspan="8">Department of Mathematics</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td>Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td><td></td></tr>
<tr><td>MAC331</td><td>MATHEMATICS-III</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="3">Basic knowledge of topics included in MAC01 & MAC02</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">● CO1: Acquire the idea about mathematical formulations of phenomena in physics and engineering.
● CO2: To understand the common numerical methods to obtain the approximate solutions for the intractable mathematical problems.
● CO3: To understand the basics of complex analysis and its role in modern mathematics and applied contexts.
● CO4: To understand the optimization methods and algorithms developed for solving various types of optimization problems.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Partial Differential Equations (PDE): Formation of PDEs; Lagrange method for solution of first order quasilinear PDE; Charpit method for first order nonlinear PDE; Homogenous and Nonhomogeneous linear PDE with constant coefficients: Complementary Function, Particular integral; Classification of second order linear PDE and canonical forms; Initial & Boundary Value Problems involving one dimensional wave equation, one dimensional heat equation and two dimensional Laplace equation. [14]

Numerical Methods: Significant digits, Errors; Difference operators; Newton's Forward, Backward and Lagrange’s interpolation formula; Numerical solutions of nonlinear algebraic/transcendental equations by Bisection and Newton-Raphson methods; Trapezoidal and Simpson’s 1/3 rule for numerical integration; Euler’s method and modified Eular's methods for solving first order differential equations. [14]
Complex Analysis: Functions of complex variable, Limit, Continuity and Derivative; Analytic function; Harmonic function; Conformal transformation and Bilinear transformation; Complex integration; Cauchy’s integral theorem; Cauchy’s integral formula; Taylor’s theorem, Laurent’s theorem (Statement only); Singular points and residues; Cauchy’s residue theorem. [17]

Optimization:
Mathematical Preliminaries: Hyperplanes and Linear Varieties; Convex Sets, Polytopes and Polyhedra. [2]

Linear Programming Problem (LPP): Introduction; Formulation of linear programming problem (LPP); Graphical method for its solution; Standard form of LPP; Basic feasible solutions; Simplex Method for solving LPP. [9]</td></tr>
</table>

Text Books, and/or reference material	**Text Books:** 1. An Elementary Course in Partial Differential Equations-T. Amarnath 2. Numerical Methods for scientific & Engineering Computation- M.K.Jain, S.R.K. Iyengar & R.K. Jain. 3. Foundations of Complex Analysis- S. Ponnuswami 4. Operations Research Principles and Practices- Ravindran, Phillips, Solberg 5. Advanced Engineering Mathematics- E. Kreyszig **Reference Books:** 1. Complex Analysis-L. V. Ahfors 2. Elements of partial differential equations- I. N. Sneddon 3. Operations Research- H. A. Taha

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO8	PO9	PO10	PO11	PO1 2
MAC331	CO1	3	3	3	2	2	1	2	-	-	-	-	2
	CO2	3	3	2	2	2	1	2	-	-	-	1	2
	CO3	3	3	2	2	3	-	1	-	-	1	-	2
	CO4	3	2	2	3	2	1	1	-	1	-	-	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEC301	NETWORK ANALYSIS AND SYNTHESIS	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
MAC02(MATHEMATICS -II), EEC01 (ELECTRICAL TECHNOLOGY)		CT+MT+EA					
Course Outcomes	Upon successful completion of this course, students should be able to: ● CO1: Apply the knowledge of basic circuital law, Network Theorem and network topology concepts in the formulation and solution of different electric network problems. ● CO2: Apply the Laplace transform to linear circuits and systems and analyze the signal synthesis, steady-state responses and transient response of DC and AC circuits using classical and Laplace transform methods. ● CO3: Evaluate two-port network parameters, their inter-relationship, different connections, representation two port network as T, Π and lattice form and also apply two-port network analysis in the design and analysis of filter and attenuator networks. ● CO4: Demonstrate the concept of complex frequency and analyze the behavior of the circuit's response in frequency domain, understand the significance of network functions, pole- zero plots, Bode plot etc. of one and two port networks. ● CO5: Synthesize one port network function, analyze and design different filters.						
Topics Covered	Network Theorems (AC): Analysis of networks with dependent sources, mesh analysis, nodal analysis, source transformation technique, superposition theorem, Thevenin's theorem, Norton's theorem, maximum power transfer theorem, solution of networks with AC sources. for circuit analysis with both independent and dependent sources, Super node						

	& super mesh analysis, Coupled Circuits: Ideal Transformer, Analysis of multi-winding coupled circuits, Analysis of single tuned and double tuned coupled circuits. (8) Network Topology: Network graph, Tree, Incidence matrix - Fundamental cut-sets and fundamental loops - Tie set and cut set schedules. Formulation of equilibrium equation on loop basis and node basis, Formulation of equilibrium equation in matrix form - Duality, Construction of dual of a network. (4) Laplace transform and its application: concept of Laplace transform, properties of Laplace Transform, Laplace transform of some basic and periodic function,waveform Synthesis,inverse Laplace Transform, solution of integro-differntial equations. Application of Laplace Transform: transformed circuit, time response of circuits: Voltage/current relations for R, L, C and their equations in time domain. Initial and final conditions, first and second order differential equations, steady state and transient response. Analysis of transient and steady state responses using Classical technique as well as by Laplace transforms. Steady state response to step, ramp, impulse and sinusoidal input functions. Convolution theorem and application (12) Two-Port parameters: Open circuit, short circuit, transmission and hybrid parameters, relationship between parameter sets, reciprocity and symmetry conditions, parallel connections, parallel connection of two port networks. Network equivalents - Analysis of T, n, ladder and lattice networks. (8) Network Functions and frequency response: Network functions for one port and two port networks, driving point and transfer functions, ladder network, general network, poles and zeros of network functions, restrictions on Pole and zero locations for driving point functions and Transfer functions, time domain behavior from pole and zero plot. Frequency response of R, L, C circuits. Amplitude and phase plot, Bode plot. (5) Fundamentals of Network Synthesis: Hurwitz polynomials, positive real functions, basic synthesis procedure, synthesis of one port networks with two kinds of elements. Properties and synthesis of L-C, R-C, R-L driving point impedances, synthesis of R-L-C functions (11) Passive Filter as a Two Port Network - Characteristics of different Ideal Filtersusing T & π networks. (6)
Textbooks, and/or reference material	Textbooks: 1. Kuo Franklin F., Network analysis and synthesis, 1st ed., Wiley International, 1962. 2. Van Valkenburg M.E., Network analysis, 3rd ed., Eastern Economy Edition, 1983. Reference Books: 1. Roy Chaudhary D., Network and systems, Wiley Eastern Limited. 2. Chattopadhyay D &Rakshit P C-Fundamental of Electric Circuit Theory-S chand& company Ltd. 3. Edminister Joseph A., NahviMohmood, Electric Circuits, 3rd ed., Tata McGraw Hill.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	1	2	1	3	3	3	3
CO2	3	3	3	3	3	1	2	1	3	3	3	3
CO3	3	3	3	3	3	1	2	1	3	3	3	3
CO4	3	3	3	3	3	1	2	1	3	3	3	3

CO5	3	3	3	3	3	1	2	1	2	3	3	3

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="7">Department of Electrical Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EEC302</td><td>ELECTRICAL & ELECTRONIC MEASUREMENT</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="4">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="3">None</td><td colspan="4">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">Upon successful completion of this course, the student should be able to
● CO1: Develop an idea about the measurement processes
● CO2: Learn the operating principle of various analog instruments for measurement of voltage, current, power and energy
● CO3: Gain knowledge about Potentiometer and various resistance measurement techniques
● CO4: Acquire knowledge of AC Bridges for measurement of inductance, capacitance, frequency, Quality factor, Dissipation factor & Instrument Transformers
● CO5: Get familiarize with Cathode Ray Oscilloscope and introduce to Digital Instrumentation</td></tr>
<tr><td>Topics Covered</td><td colspan="6">Basics of Measurement: Significance of measurement, Direct & Indirect methods of measurement, Classification of instruments, Static and dynamic characteristics of measurement system, Various types of error in measurement system, Error analysis by conventional and statistical methods, uncertainty analysis. (6)
Basic electrical Instruments: Various torques in electrical instruments, various types of damping in electrical instruments, Principle of operation of Permanent Magnet Moving Coil (PMMC) instrument, use of shunt and multiplier to extend the range of PMMC instruments, Temperature compensation of PMMC instruments, principle of operation of Moving Iron (MI) instruments, Linearization of scale of MI instrument, extension of range of moving coil and iron instrument, Measurement of 3-phase power and wattmeter errors. Principle of operation of single-phase energy meter, Creep in energy meter and its compensation, testing of energy meter, Phantom loading (14)
Potentiometers: Basic principle of ordinary slide wire potentiometer, principle of operation of DC Crompton's Potentiometer, Measurement of voltage, current, resistance and power by potentiometer, calibration of voltmeter, ammeter and wattmeter by potentiometer, Drysdale polar potentiometer, Gall Tinsley Coordinate potentiometer (6)
Measurement of Resistance: Measurement of medium resistance by Wheatstone bridge, measurement of low resistance by Kelvin Double Bridge, measurement of high resistance by direct deflection method, loss of charge method and Megger. (4)
AC Bridges: Comparison of measurement methods with whetstone bridge, Measurement of inductance, capacitance and frequency, Quality factor, Dissipation factor by AC Bridges (8)
Instrument Transformers: Disadvantages of using shunts and multipliers for very high current and voltage measurement, Use of Current transformer for measurement of current, construction of current transformer, current transformer errors, effect of sudden open circuit of current transformer, use of potential transformer for voltage</td></tr>
</table>

	measurement, construction of potential transformer, potential transformer errors. (6) Measurement of phase and frequency: Measurement of frequency by electrical resonance frequency meter and Weston frequency meter. Measurement of phase or power factor by dynamometer type instrument, moving iron power factor meters, measurement of phase difference by synchroscope. (4) Cathode Ray Oscilloscope: Construction and principle of operation, Measurement of current, phase difference and frequency by CRO, Sampling Oscilloscope, Theory of storage oscilloscope, Digital Storage Oscilloscope. (4) Digital Instruments: Advantages of digital instruments over their analog counterparts, Different types of digital voltmeters, digital multimeter, digital frequency meter. (4)
Textbooks, and/or reference material	Suggested Textbooks: 1. Electrical Measurements & Measuring Instruments by Golding & Widdis, Wheeler's Student Edition 2. Electronic Instrumentation by HS Kalsi, Tata McGraw- Hill. Suggested Reference Books: 1. A course in Electrical and Electronic Measurements and Instrumentation by A.K.Sawhney, Dhanpat Rai & Co.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	1	1	3	1	2	2
CO2	3	3	3	3	3	2	1	1	2	1	2	2
CO3	3	3	3	3	3	2	1	1	2	1	1	1
CO4	3	3	3	3	3	3	2	2	2	1	2	2
CO5	3	3	3	3	3	2	2	1	3	2	2	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	**Title of the course**	**Program Core (PCR) / Electives (PEL)**	**Total Number of contact hours**				**Credit**
			Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Total Hours**	
EEC303	**Electromagnetic Field Theory**	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods: (Continuous (CT), mid-term (MT) and end assessment (EA))					
NIL		CT+MT+EA					
Course Outcomes	CO1: Acquire basic knowledge of laws governing electric field and apply the same to solve electrostatic field problems. CO2: Able to explain fundamental laws governing magnetic fields and evaluate the physical quantities of magnetic fields (Field intensity, Flux density etc.). CO3: Gain an integrative overview of electromagnetic waves, its propagation in different media and different phenomena related to electromagnetic wave propagation. CO4: Acquire basic knowledge related to wave guides and transmission line.						
Topics Covered	**Concept of Electrostatics:** Review of vector calculus, Cartesian, cylindrical and spherical coordinate systems, Electric vector field and scalar potential field, Electric Fields due to point charge and continuous charge distributions, Relation between electric field intensity and electric potential; Interpretation of potential gradient, Integral and differential form of Gauss's Law, Divergence of electrostatic field, Gauss's divergence theorem, Gauss's Law of						

	electrostatics and its applications, Laplace's equation, Poisson's equation, Continuity equation, Analyses of single dielectric configurations, Parallel plate, coaxial cylinders and concentric spheres, Analyses of multi-dielectric configurations: Parallel plate, coaxial cylinders and concentric spheres. Boundary Conditions, Uniqueness Theorem, Electric field analysis by method of images. [16] **Concept of Magnetostatics:** Magnetic field intensity, Lorentz force, Curl of a vector field, Stoke's theorem, Curl of magnetic field, Ampere's Circuital law in integral and differential form, Stoke's theorem, Curl of and divergence of magnetic field, Concepts of scalar and vector potentials, Self and mutual inductance, Forces due to Magnetic Fields, Magnetic Torque and Moment, Magnetic boundary conditions. [12] **Concept of Electromagnetic Waves:** Faraday's law of electromagnetic induction, Concept of displacement current, Maxwell's equations, Time varying potentials, Derivation of the electromagnetic wave equation, attenuation and phase constants, intrinsic impedances, Electromagnetic wave equations in loss-free and lossy media, Concept of dissipation factor, Skin depth and skin effect, Some examples. [10] **Concept of Transmission lines and Wave Guides:** Introduction to Transmission lines, Transmission Line equations, Wave guides, TE, TM and TEM waves [6]
Text Books, and/or reference material	**TEXT BOOKS:** 1. M. N. O. Sadiku, Principles of Electromagnetics, Oxford University Press, New Delhi , 2009. 2. W. H. Hayt Jr. and J. A. Buck, Engineering Electromagnetics, McGraw Hill, New York , 2010. 3. Introduction to Electromagnetic Theory – A Modern Perspective, T. L. Chow, Jones and Bartlett Publishers, Inc. **REFERENCE BOOKS:** 1. Joseph A. Edminister, Schaum's Outline of Electromagnetics, 4th Edition, Tata Mcgraw Hill, 2010. 2. Classical Electrodynamics, W. Greiner, Springer International Edition 3. Classical Electrodynamics, J. D. Jackson, John Wiley

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PHC332	CO1	3	2	-	1	1	-	-	-	2	1	-	1
	CO2	3	2	1	1	-	1	-	-	1	1	-	1
	CO3	3	2	1	1	1	-	-	-	1	1	-	1
	CO4	3	2	1	-	-	1	1	-	2	1	-	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECC331	**Analog Electronics**	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
Physics (PHC01) Electrical Technology (EEC01)		CT+MT+EA					

Basic Electronics (ECC01)	
Course Outcomes	CO # 1. **Understanding** the fundamental knowledge of analog devices and circuits CO # 2. **Familiarizing** with the design of complex electronic circuits with the help of these fundamentals. CO # 3. **Enriching** historical developments with facts that led to IC technology. CO # 4. **Acquainting** with the present-day design tools using which one can synthesize and analyze the complex design problems. CO # 5. **Implementing** the devices and circuits as a basic building block of electrical communication and other areas and enhancing problem solving skills.
Topics Covered	**Module 1**: Signals and Amplifiers [3L + 1T] Signals; frequency spectrum of signals; analog and digital signals; amplifiers; circuit models for amplifiers; frequency response of amplifiers. **Module 2**: Operational Amplifiers and its Applications [4L + 2T] Characteristics of Operational Amplifiers and learning how to apply basic op-amps to design sophisticated op-amp circuits, including summing amplifiers, instrumentation amplifiers, integrators, and differentiators. **Module 3**: Diodes and its Applications [3L + 1T] Characteristics of Junction Diodes and how to use diodes to analyze diode circuits operating in the various bias regions: forward, reverse and breakdown; application of diodes in voltage regulator and rectifier circuits. **Module 4**: MOS Field Effect Transistors [4L + 2T] The physical structure of the MOS transistor; how the voltage between two terminals of the transistor controls the current that flows through the third terminal, and the equations that describe these current voltage characteristics; analysis and design of circuits that incorporate MOS transistors, resistors, and dc sources. **Module 5**: Bipolar Junction Transistors [3L + 1T] The physical structure of the bipolar transistor; how the voltage between two terminals of the transistor controls the current that flows through the third terminal, and the equations that describe these current voltage characteristics; analysis and design of circuits that incorporate bipolar transistors, resistors, and dc sources. **Module 6**:Transistor Amplifiers [5L + 2T] The use of MOS or bipolar transistor to make an amplifier; obtaining linear amplification from fundamentally non-linear MOS and bipolar transistor; modelling linear operation of a transistor around a bias point by an equivalent circuit that can be used in the analysis and design of transistor amplifiers; three basic ways to connect MOS or bipolar transistor to construct amplifiers with different properties; practical circuits for MOS and bipolar transistor amplifiers that can be constructed using discrete components. **Module 7**: Differential and Multistage Amplifiers [4L + 2T] The essence of the operation of the MOS and bipolar transistor differential amplifiers which includes rejection of common mode noise or interference and amplify differential signals; structure, analysis, and design of amplifiers composed of two or more stages in cascade. **Module 8**: Feedback in Amplifiers [3L + 1T] The general structure and advantages of negative feedback in amplifier circuit design; appropriate feedback topology to employ with amplifiers of each of the four types (voltage, current, transconductance, and transresistance); intuitive and insightful approach for the analysis of practical feedback amplifier circuits; why and how negative feedback amplifiers become unstable or oscillatory and how to design the circuit to ensure stable operation. **Module 9**: Frequency Response [4L + 2T] Low frequency response of discrete circuit common source and common emitter amplifiers; internal capacitive effects and high frequency model of the MOSFET and the BJT; high frequency response of common source and common emitter amplifiers; useful tools for the analysis of high frequency response in amplifiers; high frequency response of common gate and cascode amplifiers; high frequency response of source and emitter followers; high frequency response of differential amplifiers; other wideband amplifier configurations. **Module 10**: Building Blocks of Integrated Circuit Amplifiers [4L + 1T] Integrated Circuit (IC) design philosophy; IC biasing current sources, current mirrors, and current steering circuits; the basic gain cell; cascode amplifier; current mirror circuits with improved performance; some practical transistor pairings. **Module 11**: Output stages and Power Amplifiers [3L + 1T] Classification of output stages; class A output stage; class B output stage; class AB output stage; biasing the class AB circuit; variations on the class AB configuration; CMOS class AB output stages; IC power amplifiers; class D power amplifiers; power transistors. **TOTAL number of classes = 40 Lectures and 16 Tutorials**

Text Books, and/or reference material	**Text Books:** 1. Microelectronic Circuits by A S Sedra and K C Smith, Oxford University Press. 2. Electronic Devices by Thomas L Floyd, Pearson Education. **Reference Books:** 1. Semiconductor Devices and Circuits by Aloke K Dutta, Oxford University Press. 2. Electronic Devices and Circuits by Mohammad Rashid, Cengage Learning. 3. Electronic Circuits: Discrete and Integrated by Schilling and Belove, McGraw-Hill Education. 4. Electronic Device and Circuit Theory by Robert Boylestad and Louis Nashelsky, Prentice Hall India. 5. Electronic Devices and Circuits by David A Bell, Oxford.

Mapping of CO (Course outcomes) with PO (Program Outcomes)

PO / CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO#1	3	3	3	2	2	-	-	-	-	-	-	3
CO#2	2	2	3	2	3	1	-	-	-	-	-	2
CO#3	2	2	3	3	3	2	1	-	-	-	-	2
CO#4	2	3	2	3	3	-	-	-	-	-	-	-
CO#5	2	3	3	3	3	-	-	-	-	-	-	2

Correlation levels 1, 2 or 3 are defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EES351	ELECTRICAL & ELECTRONIC MEASUREMENT LABORATORY	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT), and end assessment (EA))					
None		CT+EA					
Course Outcomes		• CO 1: To measure power and energy in single phase and three phase circuit. • CO2: To understand the operation of DC potentiometer • CO3: Introduction to industrial power measurement with CT and PT • CO4: Measurement of inductance, capacitance, and capacitance by AC bridges. • CO5: To measure earth resistance • CO6: To measure displacement, force, pressure by transducers					
Topics Covered		**List of Experiments:** 1. Measurement of power in single phase circuit by three voltmeter and ammeter method 2. Measurement of power in three phase circuit by two wattmeter method 3. Calibration of DC potentiometer 4. Calibration of Energy meter 5. Measurement of power by CT and PT 6. Measurement of Earth resistance by three electrode method 7. Measurement of displacement by LVDT 8. Measurement of inductance by Anderson's Bridge 9. Measurement of capacitance by Schering Bridge 10. Measurement of frequency Wien's Bridge					

Textbooks, and/or reference material	Suggested Textbooks: 1. Electrical Measurements & Measuring Instruments by Golding & Widdis, Wheeler's Student Edition 2. Electronic Instrumentation by HS Kalsi, Tata McGraw- Hill Suggested Reference Books: 1. A course in Electrical and Electronic Measurements and Instrumentation by A.K.Sawhney, Dhanpat Rai & Co.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	1	1	1	2	2	3
CO2	3	3	3	3	3	2	1	1	1	2	2	3
CO3	3	3	3	3	3	3	2	2	2	2	2	3
CO4	3	3	3	3	3	1	1	1	1	2	2	3
CO5	3	3	3	3	3	3	2	2	2	2	2	3
CO6	3	3	3	3	3	2	1	1	3	2	2	3

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Course Name	Program Core (PCR)/ Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECS381	Analog Electronics Laboratory	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT), and end assessment (EA))					
Basic Electronics (ECC01) Analog Electronics (ECC331)		CT+EA					
Course Outcomes	**CO#1**: Acquire knowledge of identifying analog Integrated Circuits. **CO#2**: Gain knowledge of designing linear and non-linear analog circuits using transistor. **CO#3**: Develop skills to design amplifiers and oscillators. **CO#4**: Acquire skills to implement analog circuits using breadboard. **CO#5**: Develop acquaintance to use electronic test and measurement instruments.						
List of Experiments	**Experiment:1** DESIGN AND SET UP AN RC COUPLED COMMON EMITTER AMPLIFIER USING VOLTAGE DIVIDER BIASED BIPOLAR JUNCTION TRANSISTOR TO PLOT ITS FREQUENCY RESPONSE AND DETERMINE THE GAIN-BANDWIDTH PRODUCT. **Experiment:2** DESIGN, SETUP AND PLOT THE FREQUENCY RESPONSE OF COMMON SOURCE JFET AMPLIFIER AND OBTAIN THE BANDWIDTH. **Experiment:3** DESIGN AND TEST A 1 KHZ RELAXATION OSCILLATOR USING UJT. **Experiment:4** COMPLEMENTARY SYMMETRY CLASS B PUSH PULL POWER AMPLIFIER. **Experiment:5** LINEAR APPLICATION OF OP-AMP (INVERTING AMPLIFIER, NON-INVERTING						

	AMPLIFIER). **Experiment:6** ● DESIGN AND IMPLEMENTATION OF INTEGRATOR AND DIFFERENTIATOR USING IC 741 OP-AMP. ● DESIGN AND IMPLEMENTATION OF ADDER AND SUBTRACTOR USING OP-AMP. **Experiment:7** ● DESIGN AND IMPLEMENTATION OF RC PHASE SHIFT OSCILLATOR USING IC 741 OP-AMP. ● DESIGN AND IMPLEMENTATION OF WIEN BRIDGE OSCILLATOR USING IC 741 OP-AMP. **Experiment:8** DESIGN AND IMPLEMENTATION OF ASTABLE MULTIVIBRATOR USING IC 555. **Experiment:9** DESIGN AND IMPLEMENTATION OF VOLTAGE REGULATOR USING IC 723. **Experiment:10** TO STUDY SOLDERING AND DE-SOLDERING TECHNIQUES.
References	**Reference Manuals:** 1. Brian Dean, Introduction to Analog& Digital Circuits Lab Manual, Kendall Hunt Pub Co, 2018. 2. *NAVAS, K. A.*, Electronics Lab Manual (VOLUME 1 and 2), PHI, Sixth Edition. 3. Departmental Lab Manual.

Mapping of CO (Course outcomes) and PO (Program Outcomes)												
PO CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO#1	2	1	2	-	-	-	-	-	1	1	-	1
CO#2	2	3	3	2	1	-	-	-	1	1	-	1
CO#3	2	3	3	1	1	-	-	-	1	1	-	1
CO#4	1	2	3	2	1	-	-	-	2	1	-	1
CO#5	2	1	2	2	1	1	-	-	3	1	1	1

Correlation levels 1, 2 or 3 are defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Semester - IV							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	**EEC401**	**Power Systems – I**	**3**	**1**	**0**	**4.0**	**4**
2	**EEC402**	**Electrical Machines – I**	**3**	**1**	**0**	**4.0**	**4**
3	**EEC403**	**Digital Electronics**	**3**	**1**	**0**	**4.0**	**4**
4	**EEC404**	**Microprocessor and Microcontroller**	**3**	**1**	**0**	**4.0**	**4**
5	**MEC431**	**Fluid and Thermal Engineering**	**3**	**0**	**0**	**3.0**	**3**
7	**EES451**	**Network Analysis and Synthesis Laboratory**	**0**	**0**	**3**	**2.0**	**3**
8	**MES481**	**Fluid and Thermal Engineering Laboratory**	**0**	**0**	**3**	**2.0**	**3**

		TOTAL	**15**	**4**	**6**	**23.0**	**25**

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEC401	POWER SYSTEMS - I	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC 301 (NETWORK ANALYSIS AND SYNTHESIS)		CT+MT+EA					

Course Outcomes	On completion of the course, the students will be able to: ● CO1: find out economical voltage, minimum consumer voltage for different kinds of loads for transmission of electrical energy and suggest remedy to improve the voltage if needed. ● CO2: evaluate different parameters associated with electrical design and mechanical design of transmission line including the presence of neighboring communication lines. ● CO3: analyze the performance of short, medium, long distance transmission lines. ● CO4: apply the knowledge to find out different important parameters of insulators and know different methods to improve the performance parameters of the insulators. ● CO5: select the appropriate type of power cables to be used for different applications and determine operating voltage, charging current, charging kVAR, insulation resistance, and dielectric power loss of power cables. ● CO6: mitigate different adverse situation that may arise due to corona.
Topics Covered	Distribution Systems: Systems of distribution, economics and copper efficiencies, calculations on distribution and feeders, Kelvin Law. (10) Electrical Design of Overhead Lines: Conductor materials, resistance, inductance, self and mutual GMD calculations for single, twin and multi- circuit lines including bundled conductors, cases of symmetrical and unsymmetrical lines. Capacitance: calculation for single twin and multi circuit lines effect of earth. Choice of transmission voltage, influencing factors, spacing between conductors, current rating of overhead lines. (10) Mechanical Design of Overhead Lines: Mechanical properties of different types of overhead conductors, factors of safety in relation to working conditions, calculation of sag. Supports at different levels: effect of change of temperature and loading: sag templates and stringing charts. Supports for overhead lines: low voltage high voltage and extra high voltage lines. Span length: basic and economic spans. Ground clearance of conductors. (6) Insulators: Materials used, types of insulators for low voltage, high voltage and extra high voltage lines and outdoor switchyard, bushing insulators, voltage distribution in a string of suspension insulators, methods of potential equalization; arching horns and grading rings, reasons of overhead line insulator failure, puncture and flashover voltage, design criteria. (7) Insulated Cables: Types of L. V. Cables for distribution systems: conductor materials, important types of insulating materials, high voltage cables, Stresses developed, economical stress and grading of dielectric materials, screened and pressure cables, mechanism of cable break down charging Current, power factor and losses in cables, determination of current Rating of cables. (8) Transmission and Performance: Classification of transmission lines, calculation of regulation and efficiency, Nominal T. Nominal II and rigorous methods, generalized circuit parameters (A,B,C and D constants) Ferranti effect and losses in open circuited lines. Calculation of phase modifier capacity. (7) Corona: Reasons for corona, critical disruptive voltage and visual critical voltage Effects of pressure, temperature and irregularity of conductor surface, Losses in corona and its reduction. (4) Inductive interference: Electrostatic and electromagnetic interference with adjacent lines. (4)

Textbooks, and/or reference material	Textbooks: 1. The Transmission and Distribution of Electrical Energy by H. Cotton & H. Barber,Publisher: Hodder Arnold,ISBN 13: 9780340147719, ISBN 10 : 0340147717. 2. Power System Analysis by D. P. Kothari & I. J. Nagrath,Publisher: Tata McGraw Hill Education,ISBN: 0-07-049489-4 Reference Book: 1. Power system analysis by John J. Grainger & William D. Stevenson,Publisher: Tata McGraw Hill Education,ISBN 10: 0070585156, ISBN 13: 978-0070585157

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	2	1	1	1	1	0	1	1
CO2	2	2	3	1	2	2	1	0	1	0	1	1
CO3	2	2	3	2	2	2	1	0	1	0	1	1
CO4	2	2	2	1	2	2	1	0	1	0	1	1
CO5	2	2	2	1	2	2	1	0	1	0	1	1
CO6	2	2	1	1	2	1	1	0	1	0	1	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEC402	ELECTRICAL MACHINES - I	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC01 (ELECTRICAL TECHNOLOGY)		CT+MT+EA					
Course Outcomes	• CO 1: Able to understand the fundamental principles and classification of electromagnetic machines. ● CO2: Ability to design an armature winding • CO3: Able to learn about the constructional details and principle of operation of dc machines. • CO4: Acquire knowledge about the working of dc machines as generators and motors. • CO5: Acquire knowledge about the constructional details, principle of operation of transformers. • CO6: Acquire knowledge about testing and applications of dc machines & transformers.						
Topics Covered	DC Machines: Armature winding: Lap winding, wave winding, equalizer rings. (8) Generator: Construction of dc machines, Emf equation, types of generators, losses, efficiency, armature reaction, commutation, interpoles, compensating windings, dc generator characteristics, voltage build-up of a dc shunt generator, parallel operation of dc generators. (12) Motor: DC motor principle, counter Emf, speed and torque equations, load characteristics, speed control, starting of dc motors, three-point and four-point starters, testing of dc machines. (12) Transformer: Single-phase transformer: Construction and types, principle of operation, Emf equation, transformer on no-load, transformer on load, equivalent resistance, magnetic						

	leakage, equivalent circuit, phasor diagram, open and short circuits tests, voltage regulation, losses, efficiency, all-day efficiency, separation of hysteresis and eddy current losses, parallel operation, auto transformer. (12) Three-phase transformer: Three-phase transformer connections and vector groups, equivalent circuit, determination of equivalent circuit parameters, parallel operation, three phase to two-phase conversion and vice-versa, tap-changers on transformers, testing of transformers, cooling. (12)
Textbooks, and/or reference material	Textbooks: 1. A. E. Fitzgerald, C. Kingsley and S. Umans, Electric Machinery, McGraw-Hill Co. Inc. 2. D. P. Kothari and I. J. Nagrath, Electrical Machines, Tata McGraw-Hill. Reference Books: 1. M.G. Say, Alternating Current Machines, Pitman Publishing. 2. Alexander S. Langsdorf, Theory of Alternating Current Machinery, Tata McGraw-Hil

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	1	2	1	1	2	1	2	1
CO2	3	3	3	3	3	3	2	1	2	2	2	2
CO3	3	2	3	2	2	2	1	1	1	1	2	2
CO4	2	2	2	3	2	2	1	1	1	1	2	2
CO5	3	3	3	2	2	2	1	2	1	1	2	3
CO6	3	3	3	3	2	2	2	2	2	2	2	3

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEC403	DIGITAL ELECTRONICS	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
Nil		CT+MT+EA					
Course Outcomes	CO 1: Acquire an idea about digital electronics and its applications. CO 2: To learn the fundamentals of different numbers of systems and codes and code conversion techniques. CO 3: To study about the Boolean algebra and basic logic gates along with their digital design procedure using elementary logic gates. CO 4: To learn about the different sequential and combinational logic circuits and their use in digital electronics applications. CO 5: Learn about the Analog to Digital Converter (ADC), Digital to Analog Converter (DAC), and data conversion and acquisition techniques.						

Topics Covered	**Introduction to Digital Electronics:** Introduction to Digital Electronics, History and Evolution of Computation and Computers, Computer Components, Interface and Languages, Application of Digital Electronics in Modern Society, Digital Data Generation Circuits, Analog and Digital Circuits in Digital Circuits and Computers, Properties of Digital Signals. (6) **Number Systems and Codes:** Decimal Number System, Binary Numbers System, Octal Number System, Hexadecimal Numbers System, Numbers Conversions, Gray Code, Excess-3 Code, BCD Code, Hamming Code, Code Conversion, Error Detection and Correction Codes - error detection by parity checking, Principle of error correction. (6) **Boolean Algebra and Logic Gates:** Binary arithmetic, Binary Addition, Binary Subtraction, Binary Multiplication, Binary Division, 1s Complement, 2s Complement, Signed Binary Number, Introduction to Logic Gates, Basic Logic Gate Operations, Universal Gates, Logic Gate ICs and their Pin Diagrams, Realization of logic gates using switches and lamps, Designing of Practical Logic Circuit Using Gates. (6) **Digital Arithmetic and Arithmetic Circuits:** Introduction to Adder and Subtractor Circuits, Half Adder, Full Adder, Half Subtractor, Full Subtractor, Multi-Bit Ripple-Carry Adder and Subtractor circuits, 4-Bit Binary Adder Circuits with Carry Look-Ahead, 4-Bit BCD Adder and Subtractor Circuits, Multiplier and Divider Circuits. (6) **Logic Families:** Introduction to Transistors (MOS and BJT), Role of Transistors in Digital Electronics, Transistors as a switch, Transistors in modern digital electronics, Transistor Fabrication, VLSI Basics, IC Fabrication and Packaging Concepts, Introduction to logic families and their importance and applications. (4) **Minimization Techniques Logic Synthesis:** Demorgan's Theorem, Sum of Product (SOP), Product of Sum (POS), Canonical forms, Minimization of logical function, Algebraic method, Karnaugh Map method, Quine Mccluskey Method, Combinational Circuit Design and their Applications. (6) **Combinational Circuits:** Multiplexer, Demultiplexer, Switching Phenomena of MUX/DEMUX, Designing higher order MUX/DEMUX from lower order MUX/DEMUX, Role of MUX/DEMUX in data acquisition, MUX/DEMUX ICs and Pin Diagrams, Realization of MUX/DEMUX IC switching, Decoder, Encoder, Types of Decoder and Encoder, Decoder Driver. (8) **Sequential Circuits:** Definition, Moore and Miley Machines; Elements of Sequential Circuits - Latches and Registers, Different kinds of Flip-Flops, R-S Flip-Flops, J-K Flip-Flops, D-Flip-Flops, and T-Flip-Flops, Master-Slave arrangement, Typical sequential circuits - counters, shift registers, designing of sequential circuits and their applications. (8) **Multivibrators:** Introduction to multivibrators, role of transistors and op-amps, Introduction to 555 Timer IC, Applications of 555 Timer IC in analog and digital electronics, Schmitt Trigger circuit and its applications. (4) **Data Acquisition:** Need for Data Acquisition, Data Conversion, Analog to Digital Converter (ADC), Digital to Analog Converter (DAC), and Data Conversion and Acquisition Techniques, Introduction to Different DAC & ADC ICs, data acquisition system (DAS), DAS components, Introduction to GUI, PC Based Data Acquisition Systems, USB-Based DAQ Cards, Introduction to LabVIEW. (6).
Textbooks, and/or reference material	Textbooks: 1. Fundamentals of Digital Logic - Anand Kumar – PHI 2. Digital Electronics - G. K. Kharate – Oxford 3. Digital Logic and Computer Design - M. Morris Mano – PHI Reference Books: 1. Digital Fundamentals - Floyd, UBS 2. Digital Systems: Principles and Applications - Tocci, Widmer and Moss, Pearson Edu.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	2	2	1	1	1	1	1	1	1
CO2	2	3	3	3	3	1	2	1	2	0	2	1
CO3	2	3	3	3	3	0	2	1	2	0	2	0
CO4	2	3	3	3	3	2	1	1	2	0	2	2
CO5	2	2	2	2	2	1	1	3	2	0	1	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="7">Department of Electrical Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EEC404</td><td>MICROPROCESSOR & MICROCONTROLLER</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2"></td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">• CO 1: Demonstrate programming proficiency using the various addressing modes and data transfer instructions of the target microprocessor microcontroller.
• CO2: Describe key H/W and S/W attributes of microprocessors/microcontrollers.
• CO3: Outline of the major architectural features of microprocessors.
• CO4: Identify—and exercise—opportunities for hardware and software trade-offs.
• CO5: Design of interfacing circuits such as memory, keyboard, display, ADC, DAC, DMA etc. and programming in assembly language for typical microprocessor-based system.</td></tr>
<tr><td>Topics Covered</td><td colspan="6">Fundamentals of digital and microprocessors-based systems. (6)
Basic microprocessor architectures, organizations and functional components. Instruction sets, assembly language programming, Micro operations of instructions. (10)
Memory Classification: ROM, EPROM, EEPROM, RAM, Memory Interfacing with 8085, Address decoding for Memory mapped I/O and I/O mapped I/O. (8)
Various types of Interrupts in 8085. (4)
Programmable Peripheral Devices and Interfacing with 8085: 8255, 8259, 8257, 8251, 8253, ADC, DAC and Practical Applications. (10)
8051 Architecture and Special Function Registers, Organizations and Pin out details, Instruction sets, Special Function Registers, Assembly language programming, Memory Interfacing with 8051, Practical applications. (10)
8086 Microprocessor, Architectures, Organizations and Pin out details, Interrupts, Minimum and Maximum modes of operation, Instruction sets, Assembly language programming. (8)</td></tr>
</table>

Text Books, and/or reference material	Text Books: 1. The 8085 Microprocessor: Author: Ramesh Gaonkar, Pub: PRI 2. The 8051 Microcontroller and Embedded System: Author: Muhammad Ali Mazidi & J. G. Mazidi. 3. Advanced Microprocessors and Interfacing: Author: Badri Ram, Tata McGraw-Hill Publishing Co. Ltd. Reference Books: 1. Embedded Systems Design, Heath Steve, Second Edition-2003, Newness, 2. Computers as Components; Principles of Embedded Computing System Design, Wayne Wolf Harcourt India, Morgan Kaufman Publishers, First Indian Reprint. 2001. 3.Embedded Systems Design – A unified Hardware /Software Introduction, Frank Vahid and Tony Givargis, John Wiley, 2002.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

Pos COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	3	2	1	3	1	1	1	
CO2	3	1	2									1
CO3	3	3	3									1
CO4	3	3	3	3	3	1	1	2	3	3	3	3
CO5	3	3	3	3	3	3	1	3	2	3	2	3

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Mechanical Engineering							
Course Code	Title of the Course	Programme core (PCR)/Electives (PEL)	Total number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
MEC-431	Fluid and Thermal Engineering	PCR	3	0	0	3	3

Pre-requisites	Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))
Knowledge of Engineering Mechanics, Differential Equations etc	CT+MT+EA
Course Outcomes	● Co1: Study of fundamentals of Fluid Mechanics ● Co2: Understanding the principles of Hydraulic Machines such as Pelton Turbine in energy conversion ● Co3: Principle of Reciprocating and Centrifugal pump ● Co4: Study of basics of Thermodynamics ● CO5: Study of principle of steam turbine, boiler et

Topics Covered	Definition of fluid, Difference between solid and fluid, Continuum Concept, Knudsen No, density, specific volume, bulk modulus, compressibility of fluid. (01) Viscosity, Newton's law of viscosity, different types of fluid, effect of pressure and temperature on viscosity, numerical problem. (02) Fluid pressure, hydrostatic law of pressure, pressure variation with space in static fluid, absolute, gauge and vacuum pressure, pressure measuring devices, numerical problem. (03) Fluid kinematics, definition of flow field, Lagrangian and Eulerian approach of describing fluid motion. (01) Representation of velocity and acceleration in Cartesian coordinate, temporal, convective and total acceleration. (01) Steady and unsteady flow, uniform and non-uniform flow, laminar and turbulent flow, flow visualisation, stream line and path line. (01) Differential form of continuity equation in cartesian coordinate for compressible and incompressible flow. (01) Derivation of Euler's equation along a stream line, Bernaullis equation, pressure head, kinetic head and datum head. (01) Application of Bernaullis principle, flow measuring device, venturimeter, orifice meter and pitot tube, numerical problems. (03) Hydraulic machines, dynamic force on fixed and moving vanes. (01) Turbine and its classification, Pelton turbine and its working principle, numerical problems.(01) Pump and its classification reciprocating pump and its working principle.(01) Centrifugal pump, working principle, velocity diagram, characteristics curve, numerical problem. (03) Brief study of Thermodynamics as a pre-requisite to power plant engineering Energy analysis of steady state flow system, example with mechanical power transfer to and from steady state flow devices like compressor, turbine etc. System equilibrium, requirement for internal and total reversibility, cause of effect of irreversibility, concept of heat engine, its working cycle, its efficiency with Carnot cycle, Effect of increase in saturation pressure on phase transformation, properties of steam, use of steam table, Mollier chart. (10) Basic devices in steam power plant and their schematic arrangement, fundamental concept of processes involved in them , simple Rankine cycle with steady flow of working fluid (water and steam),performance parameter for efficient plant operation, effect of increase in boiler pressure on operating cycle performance, internal and external irreversibility associated with various practical processes during energy and mass transfer through the devices, reheat regeneration and their combined application for improvement of plant operation, a few numerical problems, brief description of super heater, economiser in power plant. (10) Introduction to gas turbine power plant. (01)
Text books, and/or Reference material	Suggested Text Books: 1. Hydraulic and Fluid Mechanics- Jagdish Lal 2. Hydraulic Machinery- Jagdish Lal 3. Introduction to Fluid Mechanics and fluid Machines- Som and Biswas 4. Engineering Thermodynamics- P K Nag 5. Introduction to Power Plant Engineering - P K Nag References: 1. Introduction to Fluid Mechanics - Fox, Mcdonald and Pritchard

Mapping of CO (Course Outcome) and PO (Programme Outcome) for MEC-431

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	1	2	2	1	2	1	2	3	2	1
CO2	2	3	1	2	2	1	2	1	2	3	2	1
CO3	2	3	1	2	2	1	2	1	2	3	2	1
CO4	2	3	1	2	2	1	2	1	2	3	2	1
CO5	2	3	1	2	2	1	2	1	2	3	2	1

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="7">Department of Electrical Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EES451</td><td>NETWORK ANALYSIS AND SYNTHESIS LABORATORY</td><td>PCR</td><td>0</td><td>0</td><td>3</td><td>3</td><td>1.5</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT), and end assessment (EA))</td></tr>
<tr><td colspan="2"></td><td colspan="5">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">● CO 1: Prepare laboratory reports that clearly communicate experimental information in a logical and scientific manner.
● CO2: Students will get the basic concepts of passive components and their configurations and about how to use experimental equipment’s such as function generator, CRO, regulated power supply etc.
● CO3: Predict and measure the transient and sinusoidal steady-state responses of simple RL, RC and RLC circuits.
● CO4: Able to apply linearity and superposition concepts to analyze RL, RC, and RLC circuits in time and frequency domains.
● CO5: Able to analyze resonant circuits both in time and frequency domains.
● CO6: Able to construct and make time and frequency domain measurements on elementary RL, RC, and RLC circuits.
● CO7: Evaluate the parameters of two port networks to analyze the performance of transmission lines
● CO8: Apply computer mathematical and simulation programs to solve circuit problems.</td></tr>
<tr><td>Topics Covered</td><td colspan="6">List of Experiments:
1. Determination of transient response of current in RL and RC circuits with step voltage input.
2. Determination of transient response of current in RLC circuit with step voltage input for under-damped, critically damped and over-damped cases.
3. Determination of frequency response of current in RLC circuit with sinusoidal ac input.
4. Determination of frequency response characteristics of a low pass and high pass active filters.
5. Determination of z and h parameters (dc only) for two port networks.
6. Determination of the driving point and transfer impedance of coupling circuit.
7. To verify different Network Theorem for ac Circuit.
8. Locus diagram of RC and RL circuit.
9. Generation of Periodic, Exponential, Sinusoidal, damped sinusoidal, Step, Impulse, and Ramp signals using MATLAB in both discrete and analog form.
10. Determination of transient and frequency response characteristics of RL, RC and RLC circuits using MATLAB.
11. Determination of frequency response characteristics of a T-network low pass and high pass passive filters using MATLAB</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="6">Text Books:
1. Kuo Franklin F., Network analysis and synthesis, 1st ed., Wiley International, 1962.
2. Van Valkenburg M.E., Network analysis, 3rd ed., Eastern Economy Edition, 1983.
Reference Books:
1. Roy Chaudhary D., Network and systems, Wiley Eastern Limited.
2. Chattopadhyay D &Rakshit P C-Fundamental of Electric Circuit Theory-S chand& company Ltd.
3. Edminister Joseph A., NahviMohmood, Electric Circuits, 3rd ed., Tata McGraw Hill.</td></tr>
</table>

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	1	2	1	3	3	3	3
CO2	3	3	3	3	3	1	2	1	3	3	3	3
CO3	3	3	3	3	3	1	2	1	3	3	3	3
CO4	3	3	3	3	3	1	2	1	3	3	1	1
CO5	3	3	3	3	3	1	2	1	3	3	1	1
CO6	3	3	3	3	3	1	2	1	3	3	3	3
CO7	3	3	3	3	3	1	2	1	3	3	1	1
CO8	3	3	3	3	3	1	2	1	3	3	3	3

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Mechanical Engineering

Course Code	Title of the course	Programme Core(PCR)/Electives(PEL)	Total no of contact hours				Credit
MES-481	Fluid and Thermal Engineering Sessional	PCR	Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	2
			0	0	3	3	

Pre-requisites	Course Assessment methods (Continuous (CT), and end assessment (EA))
Theory of hydraulic machine and power plant engineering	CT+EA

Course Outcome	• Co1: Study of calibration of Venturi meter • Co2: Study the performance characteristics of Pelton and Francis turbine • Co3: Understanding the performance characteristics of centrifugal pump Co4: Understanding the function, and construction of Lancashire Boiler • Co5: Study the principle of diesel and petrol engine
Topics Covered	1. Calibration of Venturimeter 2. Friction loss computation in pipe flow 3. Performance of centrifugal pump 4. Performance test of pelton turbine 5. Performance test of Francis turbine 6. Calibration of Vacuum gauge (Bourdon gauge tube) 7. Model study of Lancashire Boiler 8. To study the performance of 4 stroke petrol engine 9. To study the performance of diesel engine using rope brake dynamometer under variable load condition.
Text books, and/or Reference material	Suggested Text Books: 1. Introduction to Fluid Mechanics-Fox, Mcdonald and Pritchard 2. Introduction to Fluid Mechanics and fluid Machines- Som and Biswas 3. Introduction to Power Plant Engineering - P K Nag Suggested Reference Books: Fluid Mechanics- J F Douglas, J M Gasiorek, J A Swaffied, L B Jack

Mapping of CO (Course Outcome) and PO (Programme Outcome) for MES-481

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	2	3	1	3	2	1	2	1	3	2	2	2
CO2	2	3	1	3	2	1	2	1	3	2	2	2
CO3	2	3	1	3	2	1	2	1	3	2	2	2
CO4	2	3	1	3	2	1	2	1	3	2	2	2
CO5	2	3	1	3	2	1	2	1	3	2	2	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Subject for Non-Departmental Students: (4th Semester)

Subject Code	Subject Name
EEC431	**CONTROLSYSTEMENGINEERING**

)epartment of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEC431	CONTROL SYSTEM ENGINEERING	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
ECC 303(SIGNALS AND SYSTEMS)		CT+MT+EA					
Course Outcomes	• CO1: To get the knowledge of basic objectives of control system design • CO2: To derive input-output relationship of systems based on their mathematical modeling governed by basic laws of physics • CO3: To justify stability of systems based on their transfer functions, time domain and frequency domain specifications • CO4: To develop concepts on root pattern with variable gains and comment on the stability • CO5: To determine the stability of closed-loop system based on open loop frequency response • CO6: To be able to design controllers so as to meet design specifications both in time as well as frequency domain • CO7: To be able to realize the controller both in software simulation through MATLAB coding as well as in real-time environment.						
Topics Covered	**ıtroduction to control systems:** Historical development, Open and Closed loop systems, Applications, Effects of feedback, Types of feedback control systems, Servomechanism. (4)						

	athematical Models of Physical Systems: Concept of Linearization, Modeling of electrical networks, Modeling of mechanical system elements, Transfer functions, Block diagram Algebra, Signal flow graph and Mason's Gain formula. (6) **troduction to State Variable Approach:** Concepts of state, state variables and state model state models for linear Continuous-time systems, state transition matrix. (4) epresentation of Control Components: Electrical components, Mechanical components, Electromechanical Components. (2) **ime domain analysis and design specification of linear systems:** Standard signals, Transient response and s-plane root locations of Second and higher order systems, Design specifications, steady state errors and error constants, effects of adding poles and zeros to transfer functions, P, PI, PD and PID controllers. (6) **oncepts of Stability and Algebraic Criterion:** Concept of stability, Concept of Stable and Unstable Characteristic equation &necessary conditions for stability, Routh-Hurwitz stability criteria. (4) **oot Locus Technique:** The concept of root locus, Analytical construction of Root Loci, Root-locus Plots with MATLAB. Design using root locus (4) **requency Response Analysis and Stability Studies in Frequency Domain:** Frequency domain specifications, correlation between time and frequency response, Polar plots, Bode plots, Nyquist stability criterion, Relative stability, conditionally stable system, M and N loci on complex and gain phase plane, MATLAB tools and case studies. (8) **esign and Compensation Techniques:** Preliminary considerations of classical Design, Realization of Basic compensators, Frequency domain and s-plane design techniques, Example of control systems. Design with MATLAB. (4)
Text Books, and/or reference material	Suggested Text Books: 1. J. Nagrath and M Gopal, Control system Engineering, New Age International Publishers 2. K. Ogata, Modern Control Engineering, Prentice Hall. 3. B. C. Kuo, Automatic Control system, John Wiley & Sons Suggested Reference Books: 1. Norman S. Nise, Control system Engineering, John Wiley & Sons 2. B. Shahian and M. Hassul, Control System Design using MATLAB, Prentice Hall.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	2	2	2	1	3	1	2	2

CO2	3	3	3	3	2	2	2	1	3	1	1	1
CO3	3	3	3	2	2	1	2	2	3	1	1	1
CO4	2	3	2	2	1	1	2	1	2	1	1	1
CO5	3	3	3	2	2	1	3	1	2	1	1	1
CO6	2	3	3	2	3	2	3	1	3	1	1	1
CO7	2	3	3	3	3	3	3	2	3	1	1	1

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High

Mapping of CO (Course Outcome) and PO (Programme Outcome)

Semester - V							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	**EEC501**	**Electrical Machines – II**	**3**	**1**	**0**	**4.0**	**4**
2	**EEC502**	**Control Systems**	**3**	**1**	**0**	**4.0**	**4**
3	**EEC503**	**Power Systems – II**	**3**	**1**	**0**	**4.0**	**4**
4	**EEC504**	**Power Electronics**	**3**	**1**	**0**	**4.0**	**4**
5	**EEE51X**	**Depth Elective - 1**	**3**	**0**	**0**	**3.0**	**3**
6	**ECS581**	**Digital Electronics Laboratory**	**0**	**0**	**3**	**2.0**	**3**
7	**EES551**	**Control Systems Laboratory**	**0**	**0**	**3**	**2.0**	**3**
8	**EES552**	**Electrical Machines Laboratory – I**	**0**	**0**	**3**	**2.0**	**3**
		TOTAL	**15**	**4**	**9**	**25.0**	**28**

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEC501	ELECTRICAL MACHINES - II	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC402 (ELECTRICAL MACHINES - I		CT+MT+EA					
Course Outcomes		● CO1: Ability to understand of basic construction and principle of operation of an AC machine ● CO2: Ability to determine the alternator voltage regulation ● CO3: Ability to Synchronize an alternator with an infinite bus ● CO4: Ability to understand the starting methodology of a synchronous motor and determine the variation of synchronous machine performance with excitation ● CO5: Ability to assess performance of an induction motor based on appropriate experimentation ● CO6: Ability to start an induction motor by appropriate means & controlling its speed in effective way					
Topics Covered		**Construction, principle of operation, Characteristics & Regulation of Synchronous Generator: Construction**:Constructional Features of round rotor and salient pole machines – Armature windings – Integral slot and fractional slot windings; Distributed and concentrated windings – distribution, pitch and winding factors – E.M.F Equation. Harmonics in generated e.m.f. – suppression of harmonics. Method of excitation. Method of excitation (5)					

	Cylindrical Rotor Synchronous Generator: leakage reactance – synchronous reactance and impedance –armature reaction, equivalent circuit–Phasor Diagram, Open Circuit and Short Circuit Characteristics, Synchronous Reactance, Load Characteristics, Zero Power Factor Characteristics, Voltage Regulation, determination of voltage regulation by different methods, Power Angle Characteristics. (8) **Salient-Pole Theory:** Blondel's Two-Reaction Concept, Direct Axis and Quadrature Axis Synchronous Reactance, phasor diagram, Power Angle Characteristics, Slip Test. (3) **Parallel Operation of synchronous generators**: need of parallel operation, synchronizing of alternators and its condition, method of synchronization, sharing of Load between the alternators, synchronizing power. Effect of change of excitation and mechanical power input of alternator operating in parallel. operation of alternator connected to infinite busbar, effect of excitation and driving torque (6) **Synchronous Motor:** Constructional features, Methods of Starting, equivalent circuit, Phasor Diagram, Torque and Power Relations in Non-Salient Pole and Salient Pole Motors, V-Curves, Synchronous Condenser, Hunting, Applications. (6) **Three Phase Induction Motor:** Constructional Features of Slip Ring and Squirrel Cage Type Motors, Principle of Operation, Flux and MMF Wave, No-Load Speed and Slip, Rotor Quantities Referred to Stator, Relationship Between Input Voltage and Current, Equivalent Circuit, Analysis of Equivalent Circuit. (4) Torque Speed Characteristics, Starting, Maximum and Full Load Torque, Condition for Maximum Torque, Regions of Stable and Unstable Operations, Effect of rotor resistance and supply frequency on Speed Torque Characteristics, Performance Characteristics, and Circle Diagram. (4) Starting of Slip Ring and Squirrel Cage Motors, High Starting Torque Motors. (3) Speed Control of induction motors. (3) Single phase induction motor: Constructional features, various types, rotating magnetic field theory, Equivalent circuit, Determination of constants, methods of starting, Applications. (4)
Text Books, and/or reference material	Suggested Text Books: 1. A. S. Langsdorf, Theory of A. C. Machines, Tata McGraw Hill. Suggested Reference Books: 1. I. L. Kosow, Electric Machinery & Transformers, PHI. 2. E. Fitzgerald, C.M. Kingsley (Jr) and S. D. Umans, Electric Machinery, Tata McGraw Hill.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	3	1	1	1	1	1	1
CO2	3	2	3	3	2	2	1	1	1	1	1	1
CO3	3	3	3	2	2	3	1	1	1	1	1	2
CO4	3	3	3	3	2	3	1	1	1	1	1	1
CO5	3	3	3	3	2	2	1	1	1	1	1	1
CO6	3	3	3	3	2	3	1	1	1	1	1	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core / (PCR)	Total Number of contact hours				Credit
			Lecture	Tutorial	Practical	Total	

		Electives (PEL)	(L)	(T)	(P)	Hours	
EEC502	CONTROL SYSTEMS	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC301 (NETW ORK ANALYSIS AND SYNTHESIS), ECC331 (ANALOG ELECTRONIC S), EEC402 (ELECTRICAL MACHINES-1), EEC403 (DIGITAL ELECTRONICS)		CT+MT+EA					
Course Outcomes	• CO1: Acquire the knowledge and skills to identify the basic elements and structures of feedback control systems. • CO2: To develop the mathematical model of the physical systems. • CO3: To analyze the time response of the open loop & closed loop systems. • CO4: To analyze the stability of control systems using different tools. • CO5: To learn frequency response analysis and stability studies in Frequency Domain • CO6: To learn control system design using various kinds of compensator & to apply computer skills with MATLAB • CO7: To develop and analyze state space models						
Topics Covered	Introduction to control systems: Historical development, Open and Closed loop systems, Applications, Effects of feedback, Different practical control systems, Types of feedback control systems, Servomechanism. (6) Mathematical Models of Physical Systems: Modeling of electrical networks, modeling of mechanical system elements, Transfer functions, Block diagram Algebra, Signal flow graph and Mason's Gain formula. (6) Representation of Control Components: Electrical & Electronic components, Mechanical components, Electromechanical Components. (4) Time domain analysis and design specification of linear systems: Standard signals, Transient response and S-plane root locations of Second and higher order systems, Design specifications, steady state errors and error constants, effects of adding poles and zeros to transfer functions, P, PI, PD and PID controllers. (8) Concepts of Stability and Algebra Criterion: Concept of stability, characteristic equation necessary conditions for stability, Routh-Hurwitz stability criteria. (4) Root Locus Technique: The root locus concept, construction of Root Loci, Important properties parameters design by Root locus method, Root-locus Plots with MATLAB. (6) Frequency Response Analysis and Stability Studies in Frequency Domain: frequency domain specifications, correlation between time and frequency response, Polar plots, Bode plots, Nyquist stability criterion, Relative stability, conditionally stable system, M and N loci on complex and gain phase plot MATLAB tools and case studies. (10) Design and Compensation Technique: Preliminary considerations of classical Design, Realization of Basic compensators, Frequency domain and S-plane design techniques, Example of control systems. Design with MATLAB. (6) Introduction to State Variable Approach: Concepts of state, state variables and state models for linear Continuous-time systems, Electrical & Mechanical systems, solutions of state equations, state transition matrix, Controllability and Observability. (6)						
Text Books, and/or reference material	Text Books: 1.J. Nagrath and M Gopal, Control system Engineering, New Age International Publishers 2. K. Ogata, Modern Control Engineering, Prentice Hall. 3. B. C. Kuo, Automatic control system, John Wiley & Sons Reference Books: 1. Norman S. Nise, Control system Engineering, John Wiley & Sons 2. B. Shahian and M. Hassul, Control System Design using MATLAB, Prentice Hall.						

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	1	2	1	2	1	3	3
CO2	3	3	2	3	3	1	2	1	2	1	3	1
CO3	3	3	2	3	3	2	2	1	2	1	2	1
CO4	3	3	2	3	3	2	2	1	2	1	2	1
CO5	3	3	2	3	3	2	2	1	2	1	2	1
CO6	3	3	2	3	3	2	2	1	2	1	3	3
CO7	3	3	2	3	3	2	2	1	2	1	1	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="8">Department of Electrical Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EEC503</td><td>POWER SYSTEMS - II</td><td>PCR</td><td>3</td><td>1</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="6">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2">EEC401(POWER SYSTEMS – I)</td><td colspan="6">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">On completion of the course, the students will be able to:
CO1: analyze the behavior of the power systems under symmetrical and unsymmetrical fault conditions and select suitable protective schemes and circuit breakers, in addition to deployment of suitable current limiting reactors at strategic locations for expansion of the existing systems.
CO2: select bus bar arrangements suitable for any particular application in substations or generating stations. Besides, they also become acquainted with the layout of substation equipment.
CO3: be familiarized with different types of circuit interrupting devices along with their constructions, properties, operating principles, testing and appropriate placements.
CO4: be acquainted with various types of relays and their deployment, their characteristics, connections etc.
CO5: understand and design the diverse schemes used in practice to protect power systems transmission lines, generators, transformers, bus bars etc.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Short circuit calculation: Symmetrical and asymmetrical short circuits, factors influencing short circuit capacity, methods of limiting short circuit levels. Symmetrical components, sequence impedance, analysis of unsymmetrical short circuit in power systems, methods of measuring sequence components for protective relays. (15)
System of Bus bars: Different bus bar arrangements, indoor and outdoor substations, bus bar materials spacing etc. conventional layout representation. (6)
Circuit Interruption Devices: Fuses and their characteristics, circuit breakers, arc characteristics, mechanism of arc extinction, current chopping, resistance switching, L.V. air and oil circuit breakers H.V. oil circuit breakers, Air blast circuit Breakers for H.V. and E.H.V. systems, Sulphur Hexafluoride (SF6) circuit breaker, Vacuum circuit breaker, Multi break devices, miniature circuit breakers, Circuit breaker contacts, material and construction rating of circuit breakers, testing and maintenance. (8)
Protective Relays: Basic requirement of protective relays and classification on their</td></tr>
</table>

	application and principle of operation. Over current relays, directional relays, characteristics and connections. Distance relays, impedance, reactance and mho relays. Differential relays, percentage differential relays, biased beam relay, Translay relay, negative sequence relay, static relays. (12) Protective Relaying Schemes: Protection of alternators and transformers, circulating current protection, Relay plug setting and time multiplier setting. Busbar, feeders and transmission line protection time graded protection differential protection distance protection and carrier current protection. (15)
Text Books, and/or reference material	Text Books: 1. The Art and Science of Protective Relaying, by: C. R. Mason, Published by: Wiley Eastern Limited, ISBN: 978-81-7409-232-3 2. Relays: Their Theory and Practice, by: A. R. Van C. Warrington, Publisher: Springer, ISBN: 9780412153808, 0412153807 Reference Books: 1. Switchgear Protection and Power Systems, by: S. S. Rao, Publisher: Khanna Publishers, ISBN: 978-81-7409-232-3 2. Power System Engineering, by: D. P. Kothari and I. J. Nagrath, Publisher: Tata McGraw Hill, ISBN: 9780070647916

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	1	2	1	1	0	1	0	1	1
CO2	2	2	3	2	2	1	1	0	1	0	1	1
CO3	2	2	2	3	2	1	1	0	1	0	1	1
CO4	2	3	3	2	2	1	1	0	1	0	1	1
CO5	2	3	3	3	2	2	1	0	1	0	1	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

)epartment of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEC504	POWER ELECTRONICS	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
ECC331 (ANALOG ELECTRONICS), EEC403 (DIGITAL ELECTRONICS)		CT+MT+ EA					

Course Outcomes	• CO1: Acquire an idea about semiconductor devices • CO2: To learn the detail operation of the ac-dc components • CO3: To learn the detail operation of the dc-dc components • CO4: To learn the detail operation of the dc-ac components • CO5: To learn the detail operation of the ac-ac components • CO6: To identify the utilization of the components in Industry
Topics Covered	Characteristics and specifications, operations, V-1 characteristics, two transistor analogy, Turn OFF and Turn ON characteristics, Series and Parallel operation of Thyristors, Protection against over voltage and overcurrent, Thermal characteristic protection against dv/dt and di/dt, commutation methods of Thyristors. Different triggering circuits and their design. Similar characteristics for BJT, MOSFET, IGBT (12) Uncontrolled rectifiers: Single phase and multiphase different circuit arrangements and their operation, analysis, performance evaluations. (6) Controlled rectifier: Semi Controlled and fully controlled converters, single phase and multiphase, different circuit arrangements and their operation analysis performance evaluations. (7) DC-DC Converters: Classification, principles of operation, step down (Buck) and step up (Boost) switched mode power supply, Buck-Boost Converter, H-bridge converter, their analysis, design, performance evaluation, applications. (12) Inverters: Classification, theory of operation, 1200, 1800 mode of conduction, PWM switching topology, performance evaluation, applications. (12) AC-AC voltage regulator using Thyristor and TRIAC, Cycloconverters: Theory and their applications. (5) Industrial applications. (2)
Text Books, and/or reference material	Text Books: 1. B. K. Bose, Power Electronics and AC Drives, Prentice- Hall 2. N. Mohan, T. M. Underland&Riobbins, Power Electronics: Converters, Applications & Design, John-Wiley. Reference Books: 1. L. Umanand, Power Electronics, Essentials & Applications, Wiley India Pvt. Ltd. 2. Robert W. Erickson & D. Maksimovic, Fundamentals of Power Electronics, Springer International Editio

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	3	1	3	1	2	1	3	3
CO2	3	3	3	2	3	1	3	1	2	1	3	3
CO3	3	3	3	2	3	1	3	1	2	1	3	3
CO4	3	3	3	2	3	1	3	1	2	1	3	3
CO5	3	3	3	2	3	1	3	1	2	1	3	3
CO6	1	3	3	3	3	2	3	2	2	3	3	3

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

DEPTH ELECTIVE-I:

FIFTH SEMESTER

Subject Code	Subject Name

EEE510	**Renewable Energy Systems**
EEE511	**Embedded Systems**
EEE512	**Digital Signal Processing**
EEE513	**Numerical Analysis**

<table>
<tr><td colspan="8">Department of Electrical Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EEE510</td><td>RENEWABLE ENERGY SYSTEMS</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="3">EEC01 (ELECTRICAL TECHNOLOGY)</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">· CO1: To understand the basics of Energy System and overall energy resources
· CO2: To design the solar and wind power plant
· CO3: To understand the tidal, geothermal energy, biomass and other resources and principles
· CO4: To understand the energy conservation opportunities and energy saving</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Introduction: Energy system as electrical system, Energy chain, National and International Energy scenario, various non-conventional energy resources-importance, classification, relative merits and demerits, Carbon emission, carbon credit, Paris environmental meet for awareness of emission. (9)
Solar photovoltaic: Introduction, solar radiation & its relationship with photovoltaic effect. Photovoltaic concentration, photovoltaic systems-standalone, Solar Constants, Definition of solar thermal: Thermal characteristics of solar radiation, solar collectors: -materials, types, focusing. Solar thermal power plant: layout and arrangement, solar cooling, recent developments. (8)
Wind power and its sources, site selection criterion, wind characteristics, momentum theory, Classification of wind machines. Wind mills-different design & their control, wind generators- different types, wind farms & grid. Wind generation in India. Wind Power and maximum power equation. Wind penetration & its effects, economic issues, recent developments, international scenario. (6)
Principles of tidal power generation, components of power plant, Single and two basin systems, Estimation of energy, Maximum and minimum power ranges. Ocean and geothermal Energy, geothermal power plant. OTEC Principle, Open cycle and closed cycle. (4)
Bio fuel, Conversion of biomass, Biofuel classification, Biomass production for Energy farming, direct combustion for heat-pyrolysis-thermochemical process, Anaerobic digestion- Digester sizing- waste and residues, vegetable oils and biodiesels, Applications of Biogas, Social and environmental aspects. (5)
Fuel Cell: Basic construction & principle of operation of fuel cell, Fuel cell power plants & its integration with wind and solar photovoltaic systems. Geothermal Energy, Dry Steam power plant, Single and Double Flash power plant and integration in electrical system/Grid. (5)
Energy conservation opportunities, Type of energy audit, energy audit report. Saving of energy with energy economics. (5)</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">Text Books:
1. G.D. Rai, Non-conventional energy resources, Khanna Publishers, New Delhi, 2003.
2. N. G. Clavert, Wind Power Principle, their application on small scale, Calvert Technical Press.
3. Fuel Cell Handbook, Parsons Inc.
4. Earnest and T. Wizelius, Wind Power Plants and Projects development, PHI</td></tr>
</table>

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1		1	1	1			1	1
CO2	3	3	2	1	1	1	1				1	1
CO3	2	3	3	2	1	1	1	1	1		1	1
CO4	2	3	3	2		1	1	1	1		2	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="7">Department of Electrical Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EEE511</td><td>EMBEDDED SYSTEMS</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2">EEC602(MICROPROCESSOR & MICROCONTROLLER)</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">• CO1: Comparing different microprocessor architectures and justifying their field of application.
• CO2: Given peripheral devices such as memory, ADC, DIOs, etc., design of interfacing circuit, and writing algorithms to fulfil a given specific application.
• CO3: Programming processor specific and processor independent software for different complex embedded system applications.
• CO4: Developing software involving Real Time Operating System.
• CO5: Knowledge of advanced microcontrollers and RTOS features.</td></tr>
<tr><td>Topics Covered</td><td colspan="6">Introduction to Embedded systems: Introduction - Features - Microprocessors - ALU - Von Neumann and Harvard Architecture, Classification, SPP, ASIC, ASIP CISC and RISC - Instruction pipelining. General characteristics of embedded system, introduction to different components etc. (8)

Microcontroller 89CX51/52 Series: Characteristics and Features, Overview of Architectures, and Peripherals, Timers, Counters, Serial communication, Digital I/O Ports. (7)

Microcontroller PIC Series: Characteristics and Features, Overview of architectures, and Peripherals, Interrupts, Timers, watch-dog timer, I/O port Expansion, analog-to-digital converter, UART, I2C and SPI Bus for Peripheral Chips, Accessories and special features. (8)

ARM Architecture: Evolution, Characteristics and Features, Overview of architectures, Modes, Registers etc. (7)

Software architecture and RTOS: Software Architecture: Round Robin- Round Robin with interrupts -Function Queue. Scheduling Architecture RTOS: Architecture -Tasks and Task States -Tasks and Data -Semaphores and Shared Data Message Queues -Mail Boxes and pipes -Timer Functions -Events -Memory Management, Interrupt Routines. (7)

Basic design using a real time operating system: Overview. General principles. Design of</td></tr>
</table>

	an embedded system. Development Tool: Cross-Compiler, Cross-Assemblers, Linker/locator. PROM Programmers, ROM, Emulator, In-Circuit Emulators. Debugging Techniques. Instruction set simulators. The assert macro. (5)
Text Books, and/or reference material	Text Books: 1. Embedded Systems Architecture, Programming and Design, Ral Kamal TMH, 2008. 2. An Embedded Software Primer, D.E. Simon. Pearson Education, 1999. 3. Design with PIC Microcontrollers, J.B. Peatman,Pearson Education, 1998 Reference Books: 1. Embedded Systems Design, Heath Steve, Second Edition-2003, Newnes, 2. Computers as Components; Principles of Embedded Computing System Design, Wayne Wolf Harcourt India, Morgan Kaufman Publishers, First Indian Reprint. 2001. 3. Embedded Systems Design – A unified Hardware /Software Introduction, Frank Vahid and Tony Givargis, John Wiley, 2002.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1		2	1	3	1	1	1	
CO2	3	1	2	1	1			1				1
CO3	3	3	3	3	3	1	1	1	1	1	1	1
CO4	3	3	3	3	3	1	1	1	1	1	1	1
CO5	3	3	3	1								1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEE512	DIGITAL SIGNAL PROCESSING	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
Nil		CT+MT+EA					
Course Outcomes	• CO1: To understand the properties signals and systems. • CO2: To understand the concept of signal processing. • CO3: To analyze discrete time signals and systems in time as well as frequency domain. • CO4: To design digital filters. • CO5: To get acquainted with digital processors recently used.						
Topics Covered	Introduction: Signals, systems and signal processing, concept of frequency in continuous and discrete time signal. (2) Discrete-time Signals and Systems: Discrete time signals and systems, analysis of LTI						

	system and implementation correlation. (6) Z-transform: Review, Analysis of LTI system in z-domain. (4) Frequency Domain Analysis: Frequency analysis of continuous-time and discrete-time signals and LTI systems, LTI system as frequency selective filter, inverse system and deconvolution. (6) Discrete Fourier Transform: Properties and Applications, Analysis using DFT. (6) Fast Fourier Transform Algorithms: FFT algorithms and Applications, linear filtering approach to computation of DFT. (6) Implementation of Discrete-Time System: FIR system, IIR system, representation of numbers, quantization of filter coefficients, round-off effects. (2) Design of Digital Filters: Design of FIR and IIR filters. (6) DSP Processors. (2) Recent Developments. (2)
Text Books, and/or reference material	Text Books: 1. J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles Algorithms and Applications, Pearson Education, 2005 2. A. V. Oppenheim, R. W. Schafer, Digital Signal Processing, Pearson Education, 2004 Reference Books: 1. S. K. Mitra - Digital Signal Processing: A computer-based approach, TMH, 2001 2. L. R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, Pearson Education,

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	1	1	1	2	3	2	2
CO2	3	3	3	2	3	1	1	1	2	3	2	2
CO3	3	2	2	2	2	1	1	1	2	3	2	2
CO4	3	3	3	2	2	1	1	2	2	3	2	2
CO5	3	2	3	2	3	1	1	1	2	3	2	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEE513	NUMERICAL ANALYSIS	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
		CT+MT+EA					
Course Outcomes	● CO 1: To acquire an idea about engineering mathematics and linear algebra ● CO2: To learn the Basic concept of numerical computation ● CO3: To learn about solution techniques for linear and nonlinear equations ● CO4: To understand and learn the numerical solution of ordinary differential equation and integration						

Topics Covered	Preliminaries of Computing: Basic Concepts, round-off errors, floating point arithmetic, convergence. (2) Numerical solution of Nonlinear Equations: Bisection Method, fixed point iteration, Newton's method, error analysis for iterative methods, computing roots of polynomials. (6) Interpolation and polynomial approximation: Lagrange polynomial, divided differences, Hermite interpolation. (4) Numerical Integration and Differentiation: Trapezoidal rule, Gaussian quadrature, Euler - Maclaurian formula. (6) Applied Linear Algebra: Direct methods for solving linear systems, numerical factorization, eigenvalue problems. (4) Initial Value Problem (IVP) of Ordinary differential equation (ODE): Euler's method, Taylor's method, Classical and higher order Runge-Kutta methods Convergence and stability analysis, Multistep method. (6) Numerical Linear Algebra: Direct methods, Iterative methods, Jacobi or simultaneous iterations, Gauss - Seidel or Successive iterations. (8) Approximation Theory: Least - square approximation. (2) Approximating Eigenvalues: Power method, Householder's method. (2) Boundary Value problem for ODE: Shooting methods. (2)
Text Books, and/or reference material	Text Books: 1. Richard L. Burden and J. Douglas Faires, Numerical Analysis, 9th Edition, Cengage Learning 2. J. Matthews and K. Fink, Numerical Methods Using MATLAB, Prentice Hall, 1999. Reference Books: 1. Introductory Methods of Numerical Analysis - S. S. Satry, 4th Edition, Prentice Hall of India Limited

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	2	2	1	1	1	1	1
CO2	3	3	2	3	3	2	2	1	1	1	1	1
CO3	3	3	2	3	3	2	2	1	1	1	1	1
CO4	3	3	2	3	3	2	2	1	1	1	1	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
ECS581	**Digital Electronics Laboratory**	PCR	0	0	3	3	1.5

Pre-requisites	Course Assessment methods (Continuous (CT) and end assessment (EA)):
Basic Electronics (ECC01) Digital Electronics (EEC403)	Assignments and End Semester Examination
Course Outcomes	**CO#1**: Understand digital circuits as basic building blocks of electrical communication, control system with enhanced problem solving skills. **CO#2**: Enrich knowledge of historical developments with facts that led to Integrated Circuits domain. **CO#3**: Design and develop complex digital circuits for electronics appliances. **CO#4**: Develop subsystems for the design of digital computers.
Topics Covered	**Experiment :1** ● DESIGN OF HALF ADDER AND HALF SUBTRACTOR CIRCUIT USING NAND GATES ONLY. ● DESIGN OF 5-BIT EVEN / ODD PARITY CHECKER CIRCUIT USING XOR GATE. **Experiment: 2** ● REALIZATION OF MULTIPLEXER AS UNIVERSAL LOGIC GATE. ● DESIGN FULL ADDER AND FULL SUBTRACTOR CIRCUIT USING 4:1 MULTIPLEXER. **Experiment: 3** ● REALISING A BCD TO DECIMAL DECODER CIRCUIT USING DECODER DRIVER AND SEVEN SEGMENT LED DISPLAY. ● VERIFYING THE FUNCTION TABLE OF 8 TO 3 LINE PRIORITY ENCODER. **Experiment: 4** ● DESIGN OF FOUR BIT ONE'S COMPLEMENT BINARY ADDER / SUBTRACTOR CIRCUIT. ● DESIGN OF FOUR BIT TWO'S COMPLEMENT BINARY ADDER / SUBTRACTOR CIRCUIT. ● DESIGN OF FOUR AND FIVE BIT DIGITAL MAGNITUDE COMPARATOR. **Experiment: 5** ● VERIFICATION OF EXCITATION TABLE OF J-K FLIP-FLOP. ● VERIFICATION OF EXCITATION TABLE OF D FLIP-FLOP. ● DESIGNS OF T TYPE FLIP-FLOP FROM D TYPE FLIP-FLOP. **Experiment: 6** ● DESIGN OF ASYCHRONOUS UP COUNTER USING J-K FLIP-FLOP. ● DESIGN OF SYCHRONOUS UP COUNTER USING D FLIP-FLOP. **Experiment: 7** ● STUDY OF ASYNCHRONOUS DECADE COUNTER IC7490 IN DIFFERENT MODES. ● STUDY OF ASYNCHRONOUS BINARY COUNTER OR MOD 16 COUNTER IC7493 IN DIFFERENT MODES. **Experiment: 8** ● STUDY OF SYNCHRONOUS DECADE COUNTER IC74160 IN DIFFERENT MODES. ● STUDY OF SYNCHRONOUS UP / DOWN COUNTER IC74192. **Experiment: 9** ● STUDY OF 64-BIT READ / WRITE MEMORY. ● STUDY OF 4-BIT UNIVERSAL SHIFT REGISTER. **Experiment: 10** ● STUDY OF 4-BIT ARITHMATIC LOGIC UNIT.

Text Books, and/or reference material	**Text Books:** 1. M. Morris Mano, Digital Design, 3rd Edition, Prentice Hall of India Pvt. Ltd., 2003 / Pearson Education (Singapore) Pvt. Ltd., New Delhi, 2003. **REFERENCES** 1. John.M Yarbrough, Digital Logic Applications and Design, Thomson Learning, 2002. 2. Charles H.Roth. Fundamentals of Logic Design, Thomson Learning, 2004. 3. William H. Gothmann, Digital Electronics, 2nd Edition, PHI, 1982. 4. Thomas L. Floyd, Digital Fundamentals, 8th Edition, Pearson Education Inc, New Delhi, 2005 5. Donald D. Givone, Digital Principles and Design, TMH, 2016. 6. John F.Wakerly, Digital Design, Fourth Edition, Pearson/PHI, 2006.

Mapping of CO (Course outcomes) with PO (Program Outcomes)

PO / CO	PO #1	PO #2	PO #3	PO #4	PO #5	PO #6	PO #7	PO #8	PO #9	PO #10	PO #11	PO #12
CO#1	3	2	1	1	-	-	-	-	-	1	1	1
CO#2	3	3	2	2	1	-	-	-	-	1	-	-
CO#3	3	3	2	2	1	-	-	-	-	1	-	-
CO#4	3	2	-	1	-	-	-	-	-	-	-	-

Department of Electrical Engineering

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EES551	CONTROL SYSTEMS LABORATORY	PCR	0	0	3	3	1.5

Pre-requisites	Course Assessment methods (Continuous (CT) and end assessment (EA))
EEC301 (NETW ORK ANALYSIS AND SYNTHESIS) ECC 331 (ANALOG ELECTRONIC S), EEC402 (ELECTRICAL MACHINES- 1), EEC403 (DIGITAL ELECTRONICS)	CT+EA
Course Outcomes	· CO1: To understand the dynamic behavior of real-time systems. · CO2: To simulate physical systems in real-time environment. · CO3: To design control system to improve the performance characteristics of real-time systems. · CO4: To determine the parameters and transfer function of physical systems from real-time experimentation. · CO5: To get acquainted with MATLAM programming, MATLAB-SIMULINK in order to simulate, analyze and design of control system design for different plants under consideration.
Topics Covered	List of Experiments 1. DC Servo Speed Control System 2. DC Servo Position Control System 3. Temperature Control System 4. Process Simulator 5. Linear System Simulator

	6. Lead and Lag Network 7. P, PI and PID controller 8. Determination of Transfer Function of DC Motor 9. Study of Different real-time systems through Simulation in MATLAM environment. 10.PID Design Method for DC motor Speed Control using MATLAB 11.Root Locus Design Method for DC motor Speed Control using MATLAB 12.DC motor Speed Control Based on Frequency Response using MATLAB
Text Books, and/or reference material	Suggested Text Books: 1. J.Nagrath and M Gopal, Control system Engineering, New Age InternationalPublishers. 2. K. Ogata, Modern Control Engineering, Prentice Hall Suggested Reference Books: 1. B. Shahian, M. Hassul, Control System Design using MATLAB, Prentice Hall. Laboratory Manuals

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	2	2	1	3	1	1	1
CO2	3	3	2	3	3	2	2	1	3	1	1	1
CO3	3	3	2	3	3	2	2	1	3	1	1	1
CO4	3	3	2	3	3	2	2	1	3	1	1	1
CO5	3	3	2	3	3	2	2	1	3	1	1	1

Correlation levels 1, 2 or 3 as defined below:
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Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EES552	ELECTRICAL MACHINES LABORATORY - I	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
EES51 (ELECTRICAL TECHNOLOGY LAB.), EEC402 (ELECTRICAL MACHINES-I)		CT+EA					

Course Outcomes	· CO1: Ability to determine the equivalent circuit parameters and evaluate the efficiency of a single-phase transformer · CO2: Ability to connect three single-phase transformers as a three-phase transformer in different configurations · CO3: Ability to determine the characteristics of dc shunt and series generators · CO4: Ability to start and control the speed of a dc shunt motor · CO5: Ability to connect two single-phase transformers in parallel · CO6: Ability to determine the losses in a dc machine and evaluate the efficiency.
Topics Covered	List of Experiments: 1. Determination of equivalent circuit parameters of a single-phase transformer. 2. No-load and load characteristics of a dc shunt generator. 3. Speed control of a dc shunt motor. 4. Open-circuit and load characteristics of a dc series generator. 5. Ward Leonard method of speed control of a dc shunt motor. 6. Three-phase transformer connections. 7. Parallel operation of single-phase transformers. 8. Swinburne's test of a dc machine.
Text Books, and/or reference material	Text Books: 1. A. E. Fitzgerald, C. Kingsley and S. Umans, Electric Machinery, McGraw-Hill Co. Inc. 2. D. P. Kothari and I. J. Nagrath, Electrical Machines, Tata McGraw-Hill. Reference Books: 1. M.G. Say, Alternating Current Machines, Pitman Publishing. 2. Laboratory manuals

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	2	1	1	1	2	2	2	2
CO2	3	2	2	2	2	1	1	2	2	2	1	1
CO3	3	2	2	3	1	2	1	1	2	2	2	1
CO4	3	2	2	2	1	1	1	2	2	2	1	2
CO5	3	2	2	3	1	2	1	1	2	2	1	2
CO6	2	2	2	2	1	1	1	1	2	2	1	1

Correlation levels 1, 2 or 3 as defined below:
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Semester - VI							
Sl.	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	**HSC631**	**Economics and Management Accountancy**	**3**	**0**	**0**	**3.0**	**3**
2	**EEC601**	**High Voltage and Insulation Engineering**	**3**	**1**	**0**	**4.0**	**4**
3	**CSC6XX**	**AI & ML**	**3**	**0**	**2**	**4.0**	**5**
4	**EEE61X**	**Depth Elective - 2**	**3**	**0**	**0**	**3.0**	**3**
5	**EEE61X**	**Depth Elective - 3**	**3**	**0**	**0**	**3.0**	**3**
6	**EES651**	**Electrical Machines - II Laboratory**	**0**	**0**	**3**	**2.0**	**3**
7	**EES652**	**Power Electronics Laboratory**	**0**	**0**	**3**	**2.0**	**3**
8	**EES653**	**Power System Laboratory**	**0**	**0**	**3**	**2.0**	**3**

<table>
<tr><td colspan="8">Department of Management Studies</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>HSC631</td><td>Economics and Management Accountancy</td><td>PCR</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="3">NIL</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">● CO1: To review basic economic principles with students.
● CO2: To introduce students' basic capital appraisal methods used for carrying out economic analysis of different alternatives of engineering projects or works.
● CO3: Enable the students to gain a good knowledge of financial accounting so that to enable them to prepare, analyses and interpret financial statements for taking business decisions.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">
PART 1: Economics
Group A: Microeconomics
<table>
<tr><th>Sl. No.</th><th>Name</th><th>L</th><th>T</th><th>P</th><th>Cr</th><th>H</th></tr>
<tr><td>Unit 1:</td><td>Economics: Basic Concepts</td><td>2</td><td>0</td><td>0</td><td>2</td><td>2</td></tr>
<tr><td>Unit 2:</td><td>Theory of Consumer Behavior</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td>Unit 3:</td><td>Theory of Production, Cost and Firms</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td>Unit 4:</td><td>Analyses of Market Structures: Perfect Competition</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td>Unit 5:</td><td>Monopoly Market</td><td>2</td><td>0</td><td>0</td><td>2</td><td>2</td></tr>
<tr><td>Unit 6:</td><td>General Equilibrium & Welfare Economics</td><td>2</td><td>0</td><td>0</td><td>2</td><td>2</td></tr>
<tr><td>TOTAL</td><td></td><td>15</td><td>0</td><td>0</td><td>15</td><td>15</td></tr>
</table>
Group B: Macroeconomics
<table>
<tr><th>Sl. No.</th><th>Name</th><th>L</th><th>T</th><th>P</th><th>Cr</th><th>H</th></tr>
<tr><td>Unit 1:</td><td>Introduction to Macroeconomic Theory</td><td>2</td><td>0</td><td>0</td><td>2</td><td>2</td></tr>
<tr><td>Unit 2:</td><td>National Income Accounting</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td>Unit 3:</td><td>Determination of Equilibrium Level of Income</td><td>4</td><td>0</td><td>0</td><td>4</td><td>4</td></tr>
<tr><td>Unit 4:</td><td>Money, Interest and Income</td><td>2</td><td>0</td><td>0</td><td>2</td><td>2</td></tr>
<tr><td>Unit 5:</td><td>Inflation and Unemployment</td><td>2</td><td>0</td><td>0</td><td>2</td><td>2</td></tr>
<tr><td>Unit 6:</td><td>Output, Price and Employment</td><td>2</td><td>0</td><td>0</td><td>2</td><td>2</td></tr>
<tr><td>TOTAL</td><td></td><td>15</td><td>0</td><td>0</td><td>15</td><td>15</td></tr>
</table>
PART 2: Management Accountancy
Sl. No. Name L T P Cr H
</td></tr>
</table>

Unit 1:	**Introduction to Accounting**: Accounting Environment of Business; Objectives of Accounting; Accounting Equations and principles. Books of Accounting: Journal, Ledger, Cash book.	4	0	0	4	4
Unit 2:	**Financial Statement Preparation and Analysis:** Preparation of Trial Balance, Trading, Profit & Loss account and Balance Sheet. Case study discussion.	5	0	0	5	5
Unit 3:	**Financial Ratio Analysis:** Common Size Statements; Computation of Financial Ratios; Interpretation and analysis of Financial Ratios with the help of case studies.	5	0	0	5	5
TOTAL		**14**	**0**	**0**	**14**	**14**

Text Books, and/or reference material

PART 1: Economics

Group A: Microeconomics

1. Koutsoyiannis: Modern Microeconomics
2. Maddala and Miller: Microeconomics
3. AnindyaSen: Microeconomics: Theory and Applications
4. Pindyck&Rubenfeld: Microeconomics

Group B: Microeconomics

1. W. H. Branson: Macroeconomics – Theory and Policy (2nd ed)
2. N. G. Mankiw: Macroeconomics, Worth Publishers
3. Dornbush and Fisher: Macroeconomic Theory
4. Soumyen Sikder: Principles of Macroeconomics

PART 2: Management Accountancy

1. Gupta, R. L. and Radhaswamy, M: Financial Accounting; S. Chand & Sons
2. Ashoke Banerjee: Financial Accounting; Excel Books
3. Maheshwari: Introduction to Accounting; Vikas Publishing
4. Shukla, MC, Grewal TS and Gupta, SC: Advanced Accounts; S. Chand & Co.

CO-PO MAPPING of Economics and Management Accountancy (HSC631)

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

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEC601	High Voltage and Insulation Engineering	PCR	4	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC401 (POWER SYSTEM-1), EEC503 (POWER SYSTEM-1I)		CT+MT+EA					
Course Outcomes	• CO1: To understand the basics of high voltage engineering and insulation • CO2: To design and develop high voltage insulation system with strong physics background,						

	• CO3: To understand the basics of generation and measurement of high voltage • CO4: To understand the high voltage testing techniques and on-line conditioned monitoring of high voltage power apparatus. • CO5: To develop the ability to estimate, analyse over voltages in power system and outline the principles of insulation coordination.
Topics Covered	Overview of Insulation, Air as an Insulation, Concept of Dielectric Strength, Electric field and electrode configuration, Properties of electrical insulation. Parameters responsible for Break down Voltage of Insulating material. [7] Introduction to Breakdown of Insulation. Breakdown mechanism of insulting systems of Gas, Liquid, Solid, and Vacuum. [7] Generation of DC high voltages and AC High Voltages, Generation of impulse voltages and currents: - Analysis of different circuits, Marx multi-stage impulse generator [7] Measurement of High voltages and currents: Sphere gap, spark gap, road gaps, electrostatic voltmeter, generating voltmeter Impulse voltage measurement, measurement of high DC and impulse current. [7] Introduction to testing of High Voltage Power Apparatus. Brief reviews of high voltage Testing-Methods for High Voltage Power Apparatus like Cables, Line Insulator, Power capacitors, bushings, transformers, circuit breakers etc [4] Introduction to Lightning phenomenon, Insulation Coordination. [3] Planning and Designing of High Voltage laboratory, Introduction of High Voltage Virtual Laboratory (HVVL) and ICT enabled High Voltage laboratory. [4] HVDC Transmission: Introduction, type, converter station, rectification, advantages. [4] Transient in power system and insulation coordination: Introduction, transient, travelling wave in transmission lines, capacitor switching, over voltage due to arcing ground, line design based on lightning, switching surge test voltage characteristics, insulation coordination and overvoltage protection [6] Nondestructive Insulation Test Techniques: Loss in a dielectric, measurement of resistivity, measurement of dielectric constant and loss factor, High voltage Schering bridge, Measurement of large capacitor, Partial discharge, bridge circuit, PD measuring device. [7]
Text Books, and/or reference material	Text Books: Text Books: 1. C.L.Wadhwa, High Voltage Engineering 2.M S Naidu & Kamraju, High Voltage Engineering Reference Books: 1. D.P. Kothari & I.J. Nagrath, Modern Power System Analysis, Tata Mc-Graw Hill 2. Subir Ray, Electrical Power Systems, PHI

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	2	1	1	2	2	2	2
CO2	3	2	2	2	2	2	2	2	2	2	2	2
CO3	3	2	2	3	3	3	2	2	2	2	2	2
CO4	3	2	3	3	3	3	2	2	2	2	2	2
CO5	3	3	3	2	2	2	2	2	2	2	2	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Computer Science and Engineering				
Course	Title of the	Program Core	Total Number of contact hours	Credit

Code	course	(PCR) / Electives (PEL)	Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
CSC6XX	Artificial Intelligence and Machine Learning	PCR	3	0	2	5	4
Pre-requisites		Course Assessment methods (Continuous evaluation (CE) and end assessment (EA))					
Basic Concepts of Probability and Statistics, Knowledge of Algorithm analysis		CE+EA					
Course Outcomes	• CO1: Identify problems where artificial intelligence (AI) techniques are applicable • CO2: Understand to apply search strategies to solve the problems. • CO3: Principal models used in machine learning and Apply them in machine learning to appropriate problems • CO4: Formulate valid solutions for problems involving uncertain inputs or outcomes by using decision making techniques. • CO5: Understanding different supevised and unsupervised learning methods.						
Topics Covered	**Introduction to Artificial Intelligence (AI):** What is Intelligence, Reasoning and Planning, Learning and Adaptation, and interaction with the real world, A brief history of AI, Application areas of AI, State of the art. (2) **Problem solving by search:** Problem types, Illustrative search problems; Search Space, Search tree; BFS, DFS, UCS; Local search; Hill climbing; Heuristics; A* search (6) **Knowledge Representation:** Propositional, predicate logic, first order logic, resolution and unification (5) **Reasoning under Uncertainty:** Conditonal independence representation, exact inference through variable elimination, and approximate inference through sampling. (5) **Introduction to Machine Learning:** Basic concepts, bias-variance trade off, evaluation metrics etc. (2) **Supervised Learning:**Simple linear regression, multiple linear regression, logistic regression, support vector machine, decision trees, Introduction to artificial neural network. (14) **Unsupervised Learning:**Clusteringalgorithms, k-means/k-medoid, hierarchical clustering (6) **Dimensionality reduction:** Principal component analysis. (2) **Sessional experiments:** Study of PROLOG programming language to implement different search techniques, Implementation of different machine learming techniques (linear and logistic regression; Decision Trees; Support Vector Machine; artificial neural network; Clustering techniques) by programming in Python						
Text Books, and/or reference material	**Text Books:** 1.Artificial intelligence : A Modern Approach- Stuart Russell, Peter Norvig, Prentice Hall, Fourth edition, 2020 2. Tom M. Mitchell, "Machine Learning", McGraw Hill Education, International Edition, 2010 **Reference Books:** 1. Elaine Rich, Kevin Knight and Shivashankar B Nair, "Artificial Intelligence", Tata McGraw Hill, 3rd Edition 2017. 2. Ethem Alpaydin, "Introduction to Machine Learning", Third Edition, , MIT Press, 2014						

Departmental Elective- II & III:
SIXTH SEMESTER

Subject Code	Subject Name
EEE610	Instrumentation

EEE611	**Modern Control Systems**
EEE612	**Special Electrical Machines**
EEE613	**Signal and System**
EEE614	**Advanced Power Electronics**
EEE615	**Soft Computing Theory and Applications**
EEE616	**Power System Transients & Power Quality**
EEE617	**Smart Grid**
EEE618	**Power system Reliability**
EEE619	**Process Dynamics & Control**
EEE620	**Electrical Wiring Estimating & Costing**

<table>
<tr><td colspan="8">Department of Electrical Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EEE610</td><td>INSTRUMENTATION</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="3">ECC331 (ANALOG ELECTRONICS), EEC403 (DIGITAL ELECTRONICS)</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO 1: Given specifications of different measuring instruments for measurement of particular parameter of some known electrical system, compare and judge to find the most suitable one.
• CO2: Given application of electrical engineering for measurement of particular parameter along with specified range and accuracy, choose most suitable measuring instrument with the understanding of individual working principles, also judge to fit the given application.
• CO3: For some specific parameter to be measured, along with the given range, resolution, accuracy and output format, choose suitable sensor, design associated signal conditioning and analog/digital processing circuit to meet the desired specification.
• CO4: Give multi-parameter control application of electrical engineering design a suitable instrumentation, using PLC, suitable measuring instruments and actuators (including PLC programming).
• CO5: Design a suitable Data Acquisition System for some complex electrical system such as. Power system sub-station, motor protection and control etc.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Basic Concepts of Measurements, Purpose of Instrumentation, Process Variables, generalized configurations and Functional Descriptions of Measuring Instruments, Generalized Performance Characteristics of Instruments. (4)

Principles of Transducers, Functions and General Classification of Transducers. Resistive, Inductive, Capacitive, Piezo-electric, Photo-electric, Thermo-electric, Hall, Magneto strictive etc. (8)

Measurement of Process Variables, Pressure, Flow, Temperature, Liquid Level, Strain, Force, Torque, Linear and angular displacement/speed etc. (6)

Ultrasonic Instrumentation: Ultrasonic transmitter and receiver properties, propagation through medium and interfaces, application in Non-destructive Testing (NDT), measurement of process variables such as flow, level, thickness etc. (4)

Microprocessor based Instrumentations, Different Digital Instrumentation, Digital Measurement of Power Factor, Frequency and Time Period, Counters, Embedded systems, Microprocessor/Microcontrollers, classification, different field of application, design of microcontroller-based measuring instrument (4)

Programmable Logic Controller (PLC): Introduction, Application, Physical and functional</td></tr>
</table>

	components, Timers, Counters, Shift Registers, Memory, Ladder Diagram, PLC Programming, Interfacing with sensors and actuators. Advance PLCs, analog input output, HMI, SCADA, Communication protocols, PID control through PLC. (10) Data Acquisition Systems: Objective of a DAS, single channel DAS, Multi-channel DAS, Components used in DAS- Converter Characteristics-Resolution-Non-linearity, settling time, Monotonicity. (6)
Text Books, and/or reference material	Text Books: 1. Transduces and Instrumentation- D.V.S. Murthy Prentice-Hill. 2. Instrumentations: Devices and Systems- C.S.Rangan, G.R. Sarma, V.S.V. Mani. Principles of Industrial Instrumentation - D. Patranabis. Tata Mc. Graw Hill. Reference Books: 1. Instrumentation, Measurement and Analysis, Author: B. C. Nakra, K. K. Chaudhry - 2004. 2. Programmable Logic Controllers, Author: William Bolton, Newness Supervisory Control and Data Acquisition, Author: Stuart A. Boyer International Society of Automation. 3. Doebelin, Ernest O. Measurement system. Tata McGraw-Hill Education, 1968. Webster, John-G., ed. The Measurement, Instrumentation, and Sensors: Handbook. Springer, 1999

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1		2	1	3	1	1	1	
CO2	3	1	2									1
CO3	3	3	3	3	3	1	1	1	1	1	1	1
CO4	3	3	3	3	3	1	1	1	1	1	1	1
CO5	3	3	3	3	3	1	1	1	1	1	1	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEE611	MODERN CONTROL SYSTEMS	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEE502 (CONTROL SYSTEMS)		CT+MT+EA					
Course Outcomes	• CO 1: To understand the states for physical systems and represent LTI in state variable form • CO2: To analyze LTI continuous systems with state variable representation • CO3: To design state variable feedback control for LTI systems • CO4: To estimate states with Observers • CO5: To learn the concept of optimal control and optimal filtering						

Topics Covered	State Variable Analysis and Design: Concepts of state, variables and state model state models for linear continuous time systems. (4) Conversion of state variables models to transfer functions, solutions of state equations, state transition matrix, state transition flow graphs. (4) Eigenvalues, eigenvectors and stability similarity transformation, decompositions of transfer functions. (6) Canonical state variable models, controllability, and observability. (4) Linear State variable Feedback, Observer design. (8) MATLAB tools and case studies. (6) Optimal Feedback Control: Parameter optimization and optimal control problems, quadratic performance index, state regulator design, Linear Quadratic Optimal Control, Solving quadratic optimal control problems with MATLAB. (6) Stochastic Optimal Linear Estimation and Control: Linear Quadratic Guassian Control, Optimal filtering, Estimation, Kalman Bucy filter, Kalman filtering (4)
Text Books, and/or reference material	Text Books: 1. Digital control and state variable methods- M. Gopal 2. Discrete time control systems- K Ogata Reference Books: 1. Modern Control Engineering- K. Ogata 2. Digital Control of Dynamic systems - G.Franklin, J.Powell, M.L. Workman.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	1	2	1	2	1	3	3
CO2	3	3	2	3	3	1	2	1	2	1	3	3
CO3	3	3	2	3	3	2	2	1	2	1	3	3
CO4	3	3	2	3	3	2	2	1	2	1	3	3
CO5	3	3	2	3	3	2	2	1	2	1	3	3

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEE612	SPECIAL ELECTRICAL MACHINES	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					

EEC01 (ELECTRICAL TECHNOLOGY)	CT+MT+EA
Course Outcomes	• CO 1: Ability to understand the operation of AC Commutator machines and AC Series motor • CO2: To develop clear concept of Universal motor and Repulsion motor • CO3: To analyze and control the operation of Stepper motor • CO4: To analyze the operation of Switched Reluctance motor • CO5: To understand the operation of PM dc motor and Brushless dc motor • CO6: To learn the working of Single-phase synchronous motors
Topics Covered	AC Commutator machines: Production of different induced emfs, torque equations, characteristics. (3) AC Series motor: Introduction, compensated and uncompensated series motors, emf and torque equations, phasor diagrams, characteristics (3) Universal motor: Operating principle with ac and dc, comparison of speed for dc and ac supplies and characteristics. (3) Repulsion motor: Construction, principle of operation, phasor diagram and characteristics. (2) Stepper Motors: Introduction, operating principle, full step, half step, micro step, classification of stepper motors, motor windings, permanent magnet stepper motor, variable reluctance stepper motor, hybrid stepper motor, energization with 2-phases at a time, single-phase stepper motor, mathematical analysis of stepper motor, open loop control of 2- phase stepper motor, open loop control of 3-phase VR stepper motor, closed loop control of a stepper motor, slew speed, ramping, applications. (8) High speed operation of stepper motor: Introduction, Pull-out torque-speed characteristics for hybrid stepper motor, Pull-out torque-speed characteristics for variable reluctance stepper motor. (4) Switched Reluctance motor: Introduction; principle of operation; differences between SR and conventional reluctance motor, Torque expression, characteristics, control, advantages and disadvantages. (5) Permanent magnet materials and motors: Introduction; minor hysteresis loops and recoil line; stator frames of conventional PM dc motors; Equivalent circuit of a permanent magnet. (5) Brushless dc motor: Types of construction, principle of operation, modeling, motor characteristics and control, advantages and disadvantages. (5) Single-phase synchronous motors: Single-phase reluctance motor, hysteresis motor, Linear Induction motor. (4)
Text Books, and/or reference material	Text Books: 1. Special Electrical Machines: K. Venkataratnam, Universities Press. 2. Stepping Motors and Their Microprocessor Controls: T. Kenjo, Clarendon Press. Reference Books: 1. Permanent Magnet and Brushless DC Motors: T. Kenjo and S. Nagamori, Oxford University Press. 2. Electric Machinery Fundamentals: Stephen J. Chapman,McGraw-Hill Education.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1	3	2	3	1			2	
CO2	3	2	2	1	2	2	3	1			1	
CO3	3	2	2	1	3	2	3	1			2	
CO4	3	2	2	1	3	2	3	1			2	

CO5	3	2	2	1	3	2	3	1			2	
CO6	3	2	2	1	3	2	3	1			2	

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEE613	SIGNALS AND SYSTEMS	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
		CT+MT+EA					
Course Outcomes	● CO 1: To understand the properties of continuous and discrete signals and systems, sampling process. ● CO2: To analyze LTI discrete time systems in the time domain. ● CO3: To understand and frequency response of discrete time signals and systems. ● CO4: To learn time frequency characterization of signal and systems ● CO5: To get the knowledge of linear feedback systems in discrete time domain.						
Topics Covered	Introduction: Signals, systems and sampling (2) Discrete-time Signals and Systems: Discrete time signals and systems, Analysis of LTI system, system described differential and difference equation (6) The Z-transform: Review, Analysis of LTI system in z-domain. (4) Fourier Series Representation of Periodic Signals and Filtering (4) Frequency Domain Analysis: Frequency analysis of continuous-time and discrete-time signals and LTI systems, Continuous time Fourier Transform (6) Discrete Fourier Transform: Properties and Applications, Analysis using DFT (6) Fast Fourier Transform Algorithms: FFT algorithms and Applications, linear filtering approach to computation of DFT (6) Time and Frequency characterization of Signals and Systems: The magnitude and phase representation of Frequency Response of LTI systems (6) Feedback LTI Systems. (2)						
Text Books, and/or reference material	Text Books: 1. Signals and Systems, A. V. Oppenheim, Alan A. Willsky and S. Hamid 2. Signals, Systems and Inference, A. V. Oppenheim, G. C. Varghese Reference Books: 1. Linear Signals and Systems, B. P. Lathi						

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**2**	**3**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**1**
CO2	**3**	**3**	**2**	**3**	**1**	**2**	**2**	**1**	**1**	**1**	**1**	**1**
CO3	**3**	**3**	**2**	**3**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**1**

CO4	**3**	**3**	**2**	**3**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**1**
CO5	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**1**

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEE614	ADVANCED POWER ELECTRONICS	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC 504 (POWER ELECTRONICS), EEC 502 (CONTROL SYSTEMS)		CT+MT+EA					

Course Outcomes	● CO1: To review of basic Power Electronic Systems ● CO2: To learn the operation of isolated and non-isolated type Switch-Mode DC-DC Converters ● CO3: To understand the concept of Multilevel Converters and modulation techniques ● CO4: To understand converter dynamics and control, modelling techniques. ● CO5: To familiarize with different Gate and Base Drive circuits for Power Devices ● CO6: To get acquainted with the state-of-the-art applications of power electronics in Industry and utility systems
Topics Covered	Review of Power Electronic Systems. Overview of Some Modern Power Semiconductor Devices. (2) Switch-Mode DC-DC Converters: Introduction, Control of DC-DC converters, Buck, Boost, Buck-Boost, Full bridge Converter. (4) Isolated Switching DC Power Supplies: Comparison between Linear & Switching Power Supply, Specification of SMPS, Different Topologies, Flyback, Forward, Push-Pull, Half and Full Bridge), Control Requirements & Techniques, Practical SMPS Design Consideration. (4) Multilevel Converters: Introduction, different topologies, Neutral Point Clamped (NPC), Flying Capacitor Converter, Cascaded Multilevel Converters. (4) Different PWM techniques for Inverters: Space Vector PWM technique, Carrier Based Modulation technique. (4) Converter Dynamics and Control: State Space Averaging, Converter transfer function, concept of controller design. (4) Gate and Base Drive circuits for Power Devices: Concept, different gate driver circuits applicable to converters. (2) **Applications: DC Drives, AC Drives, Power Conditioners and Uninterruptible Power Supplies (6)** **Power Electronics in Power Systems: HVDC Transmission, FACTS Devices, Micro Grid. Integration of Renewable Energy in Electric Power Systems. (10)** **Power Electronics in Electric Vehicles: Drive and Charging Systems. (4)**
Text Books, and/or reference material	Text Books: 1. N. Mohan, T. M. Undeland and W. P. Robbins, Power Electronics, Converters, Applications and Design, John-Wiley & Sons 2. H. W. Whittington, Switch Mode Power Supplies: Design and Construction, Research Studies Press. 3. Joseph Vithayathil, "Power Electronics - Principles and Applications", McGraw Hill Inc., New York, 1995. Reference Books: 1. R. W. Erickson and D. Maksimovic, Fundamental of Power Electronics, Springer 2. E. Acha, V. G. Agelidis, O. Anaya-Lara and T. J. E. Miller, Power Electronic Control in Electrical Systems, Newnes

	3. L. Umanand, Power Electronics, Essential and Applications,Wiley India Pvt. Ltd.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	2	2	2	1	3
CO2	3	3	3	3	3	3	3	2	2	1	2	2
CO3	3	3	3	3	3	3	3	2	2	1	2	2
CO4	3	3	3	3	3	3	3	2	2	1	2	2
CO5	3	3	3	3	3	3	3	2	2	1	2	2
CO6	3	3	3	3	3	3	3	2	2	2	3	3

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="7">Department of Electrical Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EEE615</td><td>SOFT COMPUTING THEORY AND APPLICATION</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2">EEE513 (NUMERICAL ANALYSIS)</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">● CO1: For the given linear and non-linear problems under practical limitations, compare classical analytical method and soft computing technique.
● CO2: For a given single objective problem (SOP), apply binary coded genetic algorithm (BCGA) and real coded genetic algorithm (RCGA) with different types of crossover, mutation and also understand the impact of different parent selection strategies.
● CO3: For a given non-linear or non-derivative problem, tune the control parameters of adaptive particle swarm optimization (APSO) for efficiently controlling the global exploration and local exploitation.
● CO4: For a given multi-objective problem, explain the significance of Difference vector in Differential Evolutionary (DE) technique and also illustrate self-adaptive differential evolutionary (SADE) technique.
● CO5: For a given problem, logically clarify the impact of hidden layers in artificial neuron network (ANN) and also stepwise explicate the back-propagation algorithm of ANN.
CO6: For a given problem, describe fuzzy knowledge base controller (FKBC) showing information and computational flow with membership function, rule base and defuzzification.</td></tr>
<tr><td>Topics Covered</td><td colspan="6">Introduction to soft-computing techniques and its necessity. (1)
Fundamentals of genetic algorithm, Genetic algorithm, Encoding, Fitness function, Reproduction, Genetic modelling, Cross Over, Inversion and Deletion, Mutation operator, Bit-wise operators, examples. (7)
Basic Steps in Particle Swarm Optimization algorithm, Bird flocking & fish schooling, velocity, inertia weight factor, pbest solution, gbest solution, local optima, global optima, examples, new modifications of PSO, Parameter Selection in PSO; (7)
Fundamentals of Differential Evolution algorithm, difference vector and its significance, Mutation and crossover, comparisons among DE, PSO and GA, Examples, new</td></tr>
</table>

	modifications of DE, Improved DE schemes for noisy optimization problems. (8) Fuzzy set theory, Fuzzy systems, crisp sets and fuzzy sets, fuzzy set operations and approximate reasoning, Fuzzification, inferencing and defuzzification, Fuzzy knowledge and rule bases, examples. (8) Biological neural networks, Model of an artificial neuron, neural network architecture, Characteristics of neural network, learning methods, Taxonomy of neural network architecture, Back propagation networks, architecture of a back propagation network, back propagation learning, Examples, RBF network, Associative memory, Adaptive resonance theory. (9) Applications of Soft Computing to various fields of engineering. (2)
Text Books, and/or reference material	Text Books: 1. Devendra K. Chaturvedi, "Soft Computing- techniques and its application in electrical engineering", Springer, 2008. 2. Carlos A. Coello,Garry B. Lamont, David A. van Veldhuizen, "Evolutionary Algorithms for solving Multi-objective Problems", Second Edition, Springer, 2007. Reference Books: 1.Jyh-Shing Roger Jang, Chuen-Tsai Sun &EijiMizutani, Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence, Prentice Hall 2. S. Rajasekaran and G. A. VijayalakshmiPai, Neural Networks, Fuzzy Logic and genetic Algorithm Synthesis and Applications, PHI 3. L. A. Zadeh, Fuzzy Sets and Applications, John Wiley & Sons

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2	1	1	1	2	2	2	1
CO2	3	3	2	2	3	1	1	1	2	3	2	1
CO3	3	2	2	1	2	1	1	1	2	3	2	1
CO4	3	2	2	1	2	1	1	1	2	3	2	1
CO5	3	2	2	1	2	1	1	1	2	3	2	1
CO6	3	2	2	2	2	2	1	2	2	3	2	1

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Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEE 616	POWER SYSTEM TRANSIENTS & POWER QUALITY	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC 301 (NETWORK ANALYSIS AND SYNTHESIS)		CT+MT+EA					
Course Outcomes	On completion of the course, the students will be able to: ● CO1: Get an idea about nature of power system transients and analyze the electrical transients in power systems. ● CO2: Understand causes of the transients and how these can be reduced or eliminated.						

	• CO3: Acquire knowledge of various power quality problems like transients and harmonics etc, their mitigation and measuring techniques. • CO4: Apply the concept of power system transients and power quality to solve various power system abnormal situations. • CO5: Evaluate the response of power system in presence of various transient & power quality related issues. • CO6: Design various circuits to protect power system in presence of various transient & power quality related issues.
Topics Covered	**Fundamental Notions about Electrical Transients: -** Introduction, Circuit Parameters, Mathematical Statement of the Problem and its physical Interpretation, The Principle of Superposition (2) **Simple Switching Transients: -** The circuit closing Transient, the recovery Transient initiated by the removal of a short circuit, Double frequency transients (3) **Damping: -** Some observation on the RLC circuits, the generalized damping curves, Resistance Switching, Load Switching, Other forms of damping, Damping and frequency (3) **Abnormal Switching Transients: -** Normal and abnormal Switching Transients, Current suppression, Capacitance switching, Transformer Magnetizing Inrush Current, Ferro resonance (4) **Transients in DC circuits: -** Introduction, Interruption of Direct Current in low voltage circuits, Transients associated with HVDC circuit Breakers, Commutation Transients- The current Limiting static circuit breaker (3) **Travelling waves and other Transients on Transmission Lines: -** Circuit with distributed constants, the wave equation, Reflection and Refraction of travelling waves, Behaviour of Travelling waves at line termination, Lattice Diagram, Attenuation and Distortion of Travelling waves, switching operation involving Transmission Lines. (4) **Protection of systems and Equipments against Transient Overvoltages:-** Protection of Transmission Lines against Lightning, Lightning Shielding of substation, Surge Suppressors, Surge Capacitors and Reactors, Surge Protection of Rotating Machines (7) **Introduction to Power Quality: -** Definition of Power Quality, Power Quality Terminology, Power Quality Issues, Power Quality Progression (2) **Power Frequency Disturbance: -** Common Power Frequency Disturbances, Voltage Sags, Cure for Low-frequency Disturbances, Isolation Transformers, Voltage Regulators (3) **Harmonics:-** Definition, Harmonic Number, Odd and even harmonics, Harmonic Phase Rotation and Phase angle Relationship, Causes of voltage and current harmonics, Individual and Total Harmonic Distortion, Harmonic Signatures-Fluroscent Lighting, Adjustable Speed Drives, Personal Computer and Monitor, Effect of Harmonics on Power System Devices- Transformers, AC Motors, Capacitor Banks, Cables, Busways, Protective devices, Harmonic Current mitigation- Equipment Design, Harmonic Current Cancellation, Harmonic Filters (7) **Power Quality Measuring Devices and Measurement: -** Harmonic Analyzers, Transient-Disturbance Analyzers, Oscilloscopes, Data Loggers and Chart Recorders, True RMS Meters, Power Quality Measurement (5)
Text Books, and/or reference material	**Text Books:** 1. "Electrical Transients in Power Systems", by Allan Greenwood; John Wiley & Sons; 2nd edition, April 1991. 2. "Power Quality", by C. Sankaran; First Indian reprint, CRC press; 2009. **Reference Books:** 1. "Power system transients: A Statistical approach", by C. S. Indulkar and D. P. Kothari; PHI Learning Private Ltd., 2nd edition 2010. 2. "Understanding Power Quality Problems: Voltage Sags and Interruptions", by Math H.J. Bollen; IEEE Press, 2001. 3. "Power System Quality Assessment", by J. Arrillaga, N. R. Watson, S. Chen; John Wiley & Sons, 2000. 4. "Transients in power systems", H.A.Peterson; Dover Publications, New York, 1963

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	1	1	0	1	0	0	0	0	0

CO2	2	2	2	1	1	1	1	0	0	0	0	0
CO3	2	3	3	1	1	1	1	0	0	0	0	0
CO4	2	3	3	1	2	2	1	0	0	0	0	1
CO5	2	2	2	2	2	1	2	0	1	0	1	0
CO6	2	2	3	1	2	1	2	0	1	0	1	1

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<table>
<tr><td colspan="7">Department of Electrical Engineering</td></tr>
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<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EEE617</td><td>SMART GRID</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2">EEC601 (ADVANCED POWER SYSTEMS), EEE714(POWER SYSTEM PLANNING, OPERATION OF CONTROL SYSTEM AND STABILITY)</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">· CO1: To understand various aspects of smart grid
· CO2: To study various smart transmission and distribution technologies
· CO3: To appreciate distribution generation and smart consumption and know the regulations and market models for smart grid
· CO4: To realize the operation of various Systems and its Functions used in the smart grid.
· CO5: To know about the initiative, present status, future aspects and development for smart gird.</td></tr>
<tr><td>Topics Covered</td><td colspan="6">Introduction: Smart Grid Concept, overview of Micro Grid, Green Grid, Intelligent Grid and Smart Grid, Necessity of Smart Grid. (2)

Impact of Smart Grid: Business Value Chain Generation, Transmission and Distribution, Customer Services, Market, Original Equipment Manufacturer (OEM). (3)

Fundamental Infrastructure: Concept of Electrinet SM, Local Energy Networks, Electric Transportation, Low-Carbon Central Generation, Attributes of Smart Grid, Complexity and Standard Organization. (4)

Architecture of Smart Grid: Visualizing the Power System in Real Time, Framework of Smart Grid, Increasing System Capacity, Relieving Bottlenecks, Enabling a Self-Healing Grid, Enhanced Connectivity to Consumers, Fast Simulation and Modeling, Energy Resources in Advanced Automation. (7)

Systems And Functions: Distributed Control System (DCS), Energy Management Systems (EMS), Supervisory Control and Data Acquisition (SCADA), Distribution Automation (DA), Power Electronics-Based Controllers, Power Market Tools Advanced Meter Infrastructure (AMI), Demand Response, Distributed Energy Resources (DERs), Distributed Generation (DG), Electric Vehicle (EV), Energy Storage (ES). (8)

Electric Energy Efficiency: Power Plant Electricity Use, Electric Energy Efficiency in Power Production & Delivery, Efficiency in Power Delivery, Conservation Voltage Reduction. (4)

Perfect Power System: Vision of Perfect Power System, Perfect Electric Energy Service System, Design Criteria, Perfect Power System Configurations, Fully Integrated Power System, Smart Grid Module with Core Factors, Graphical Representation of Smart Grid Features. (6)</td></tr>
</table>

	Smart Grid Progress: Status of Smart Grid in European Country, US, Present Power Scenario in India, Recent Initiatives, Strategy and Planning to Implement Smart Grid in Developed and Developing Countries. (6)
Text Books, and/or reference material	Text Books: 1. Fereidoon P. Sioshansi, "Smart Grid: Integrating Renewable, distributed & Efficient Energy", Academic Press (imprint of Elsevier), 2012. 2. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability", Artech House, Boston London, 2011 Reference Books: 1. Clark W. Gellings, "The smart grid: enabling energy efficiency and demand response", The Fairmont-CRC Press, 2010. 2. James Momoh, "Smart Grid: Fundamentals of Design and Analysis", Wiley-IEEE Press, 2012.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	2	1	1	0	0	0	0	0
CO2	2	2	3	1	1	1	1	0	1	0	0	1
CO3	2	3	3	2	2	2	1	0	1	0	0	1
CO4	2	3	2	1	2	2	1	0	1	0	0	1
CO5	2	2	3	1	2	2	1	0	1	0	0	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEE618	Power system Reliability	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC401(POWER SYSTEMS-I) EEC501(POWER SYSTEMS– II) EEC 601: ADVANCED POWER SYSTEMS		CT+MT+EA					
Course Outcomes	CO1: Understand the importance of maintaining reliability of power system components CO2: Assess the different models of system components used in reliability studies. CO3: Apply expressions for Reliability analysis of series-parallel and Non-series parallel systems in practical power systems. CO4: Evaluate reliability of generation, transmission and distribution systems using different reliability indices. CO5: Analyse required for generation, transmission and distribution systems expansion. CO6: Design reliable power system considering generation, transmission & distribution together.						
Topics Covered	Basic Reliability Concepts: The general reliability function. The exponential distribution, Definition of different reliability indices, Mean time to failures, series and parallel systems, Recursive techniques, Simple series and parallel system models. 8 Generating Capacity – Basic Probability Methods: The generation system model, Loss of load indices, Capacity expansion analysis, scheduled outages. Load forecast uncertainty Loss of energy indices. The frequency and duration method. 8						

	Transmission Systems Reliability Evaluation: Radial configuration, Conditional probability approach, Network configurations, State selection, System and load point Indices. 8 Distribution Systems Reliability Evaluation: Evaluation Techniques, Additional interruption indices, Effect of lateral distribution protection, Effect of disconnects. 6 Introduction to Power System Planning: Basic Principles, Power System Elements, Power System Structure , Power System Studies, Power System Planning Issues, Static Versus Dynamic Planning, Transmission Versus Distribution Planning, Long-term Versus Short-term Planning, Basic Issues in Transmission Planning 6 Single-bus Generation Expansion Planning: Problem Definition, Problem Description, Mathematical Development 2 Multi-bus Generation Expansion Planning: Problem Description, Mathematical Formulation 2 Network Expansion Planning: Problem Definition, Problem Description, Problem Formulation 2
Text Books, and/or reference material	**TEXT BOOKS:** 1. "Reliability evaluation of Engineering systems", Roy Billinton and Ronald N Allan, BS Publications. 2. "Reliability Engineering", Elsayed A. Elsayed, Prentice Hall Publications. 3. "Reliability Evaluation of Power Systems", Roy Billinton and Ronald Allan Pitam springer, 1996. 4. "Electric Power System Planning Issues Algorithms and Solutions", **Seifi**, Hossein, **Sepasian**, Mohammad Sadegh, Springer **REFERENCES:** 1. "Reliability Engineering: Theory and Practice", By Alessandro Birolini, Springer Publications. 2. "An Introduction to Reliability and Maintainability Engineering", Charles Ebeling, TMH Publications. 3. "Reliability Engineering", E. Balaguruswamy, TMH Publications.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	1	1	1	1	0	1	1	0	0	1	0	1
CO2	2	2	2	1	1	1	1	0	0	0	0	0
CO3	2	2	2	2	2	1	1	0	0	0	0	0
CO4	3	3	3	3	3	3	2	0	0	1	1	0
CO5	2	2	2	2	1	1	1	0	1	0	0	0
CO6	3	3	3	3	3	2	2	0	1	1	1	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	

EEE619	Process Dynamics & Control	PEL	3	0	0	3	3

Pre-requisites	Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA)
MAC01,MAC02,EEC301,EEC502	CT+MT+EA

Course Outcomes	**CO1**: To understand the concept of process and modelling of different types of physical process. **CO2**: To characterize and to emphasizes of different modes of control action. **CO3**: To understand, design and implement different type of control schemes for efficient control. **CO4**: To comprehend the working of final control elements **CO5**: To design, implement and analyze control strategies different industry based process control system.
Topics Covered	**General Overview of Process**: Process Control and Automation. Servo and Regulatory Control, Basic process control loop block diagram. Characteristic parameters of a process – Process Quantity, Process Potential, Process Resistance, Process Capacitance, Process Lag, Self-Regulation Process modelling: Formulating Process models, state space models, transform domain models, frequency response models, Impulse response models, Interrelation between process model forms process equations-their limitations - general approach. Typical processes and derivation of their transfer functions. [10] **Different Control actions:** Features of non-linear PID control – position and velocity forms of PID controllers – anti-reset windup – bumpless transfer – practical forms of P+I+D control modes, selection of control modes for different processes –control schemes for flow, level, pressure and temperature. Methods of controller tuning, Ziegler – Nichols continuous cycling, damped oscillations, process reaction curve method – Cohen and Coon method, time – integral criteria. Electronic PID controller design, Pneumatic Controllers - brief analysis **Improvement of Control Scheme:** Compensation of Time delay, Inverse response compensation. Different control strategies - schemes, brief analysis and uses (i) Ratio control, (ii) Cascade control, (iii) Feedforward control, (iv) Selective control (v) Spilt range control [6] **Final Control Element:** Actuators (Pneumatic Actuators, Electrical Actuators) and Control Valves (Globe, Ball, Butterfly, Gate, Pinch), Different Parts, Fail Position, Valve characteristics, Cv, Single & Double Seated Valves, Valve sizing, Valve selection, Cavitation, Flashing, Noise prediction and Noise Control. Control Valve Accessories: Air Filter Regulator, I/P Converter, Pneumatic Positioner, Electro-Pneumatic Positioner, Limit Switches, Motion Transmitters. Brief study of Safety Valves and Solenoid valves, special control valves. Piping and Instrumentation Drawing (P&I D) of control loops [10] **Case Studies:** Chemical Reactor, Biological Reactor, Distillation Column Control: Dynamic Model, Control Problem setting, synthesis of the nonlinear control law, Electric Oven Temperature Control, Reheat Furnace Temperature control, Thickness and Flatness Control System for metal Rolling, Computer-Aided control of Electric Power Generation Plant: MATLAB Simulation Results and analysis. [8]
Text Books, and/or reference material	**Text Books:** 1. S. Bhanot, Process Control – Principles and Applications, Oxford University Press. 2. B. Roffel, B.H.L. Betlem, “Advanced Practical Process Control” Springer, 2004. 3. Jean Pierre Corriou, “Process Control: Theory and applications” Springer, 2004. 4. D. P. Eckman, Automatic Process control, John Wiley, New York 5. S. K. Singh, Process Control, PHI **Reference Books:** 6.B. G. Liptak, Instrument Engineers Handbook, Chilton Book Co., Philadelphia **7.** P. Harriot, Process control, Mc Graw Hill, New York 8**.** G. Stephanopoulos, Chemical process Control, PHI 9**.** C. D. Johnson, Process Control Instrumentation Technology, PHI 10.C.A. Smith and A.B. Corrupio," Principles and Practice of Automotive Process Control", John Wiley, New York, 1976

EEE620												
COS / PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	1	-	-	-	1	-	1	-	1	2
CO2	1	2	3	1	2	-	-	-	1	-	1	1
CO3	1	2	3	2	2	1	-	1	-	1	1	1
CO4	1	1	2	1	1	2	1	-	-	1	3	2
CO5	2	2	3	2	2	1	2	1	-	-	1	1

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Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEE620	Electrical Wiring Estimating & Costing	PCR	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC401 (POWER SYSTEM-1), EEC503 (POWER SYSTEM-1I)		CT+MT+EA					
Course Outcomes	C01: To prepare an estimate of quantity and cost of the material for an electrical project. C02: Exposure to design and estimation of Installation, wiring and earthing. CO3: Able to design of overhead and underground distribution systems. CO4: Acquire knowledge about testing and able to prepare estimates for repairs and maintenance of electrical devices and equipment						

Topics Covered	Estimating, Purpose of estimating and costing, Electrical Schedule, contingencies, overhead charges, profit, purchase system, Electrical symbols and standards, circuit representation, wiring system, methods of wiring, types of wiring materials, accessories, wiring tools, domestic and industrial panel wiring. I. E. rules. [7] Introduction, conductor, cable and wire, General rules for wiring, Determination number of points, determination of total load, determination of sub circuits, Determination of ratings of main switch and distribution board, determination size of the conductor, Earthing systems, methods of earthing, earth electrode and earthing load, specification of earth wire and earth plate, measurement of earth resistance, protection against lightning, Inspection of internal wiring installations, inspection of new installations, testing of installations and wiring installations. [10] Estimating and Costing of Domestic and Industrial Wiring Layout for domestic wiring, Load calculation, Cable selection, Earthing, Selection of switchgear, Overall Estimating and costing, Layout for domestic wiring, Load calculation, Cable selection, Earthing, Selection of switchgear, Overall Estimating and costing, Megger and earth tester. [8] Transmission lines, Line supports, Factors governing height of pole, Conductor materials, size of conductor for overhead Transmission line: cross arms, pole brackets and clamps, guys and stays, conductors configuration spacing and clearances, span lengths, overhead line insulators, insulator materials lightning arrestors, erection of supports, setting of stays, Earthing of lines, Guarding of overhead lines, Clearances of conductor from ground, Spacing between supports conductors, underground distribution system, Materials and accessories required for underground distribution system, Methods of lying of underground cable. [10] Introduction, starter, motor, Materials and cost required for maintenance work, Estimation of repairing cost and overall cost, Tools used for repairs & maintenance work Preparation of cost schedule for repair and maintenance, service line, methods of service lines. [7]
Text Books, and/or reference material	Text Books: 1. Electrical Estimating and Costing, Surajit Singh, Dhanpat Rai 2. Electrical Design Estimating and Costing, Raina & Bhattacharya, New Age International Publishers Reference Books: 1. Installation commissioning & Maintenance of Electrical Equipments, Tarlok Singh Singh, Katson 2. Electrical Systems Design, M. K. Giridharan, IK International Pvt. Ltd

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	2	1	1	1	2	2	2	2
CO2	3	2	2	2	3	2	1	1	2	2	1	1
CO3	3	2	3	2	1	1	1	1	2	2	1	1
CO4	3	2	2	2	2	1	1	2	2	2	1	1
CO5	3	2	2	2	2	1	1	1	2	2	1	1

CO6	3	2	2	2	1	1	1	1	2	2	2	2

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Department of Electrical Engineering							
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			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EES651	ELECTRICAL MACHINES LABORATORY - II	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
EES553 (ELECTRICAL MACHINES LABORATORY - I), EEC402 (ELECTRICAL MACHINES-I), EEC504 (ELECTRICAL MACHINES-II)		CT+EA					
Course Outcomes	• CO1: Ability to determine the equivalent circuit parameters of a single-phase Induction Motor and also a three-phase Induction Motor. • CO2: Ability to calculate the parameters of a synchronous machine and evaluate the voltage regulation of an alternator • CO3: Ability to synchronize two three-phase alternators and to observe sharing of loads between them • CO4: Ability to obtain the V-curves of a synchronous motor • CO5: Ability to determine the efficiency of dc machines • CO6: Ability to determine the efficiency and temperature rise of a transformer						
Topics Covered	List of Experiments: 1. To perform no-load and blocked-rotor tests on a single-phase Induction Motor. 2. To perform no-load and blocked-rotor tests on a three-phase Induction Motor. 3. Voltage regulation of an alternator. 4. Parallel operation of two three-phase alternators. 5. To determine the V-curves of a synchronous motor. 6. Determination parameters of a salient pole synchronous machine. 7. Hopkinson's test on dc shunt machines 8. The Sumpner's test of transformer 9. Determination of positive, negative and zero sequence impedances of a synchronous machine						
Text Books, and/or reference material	Text Books: 1. A. S. Langsford, Theory of A. C. Machines, Tata McGraw Hill. 2. I. L. Kosow, Electric Machinery & Transformers, PHI Reference Books: 1. Laboratory manuals						

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	3	2	1	1	1	2	2	2	2

CO2	3	2	2	2	3	2	1	1	2	2	1	1
CO3	3	2	3	2	1	1	1	1	2	2	1	1
CO4	3	2	2	2	2	1	1	2	2	2	1	1
CO5	3	2	2	2	2	1	1	1	2	2	1	1
CO6	3	2	2	2	1	1	1	1	2	2	2	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="8">Department of Electrical Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EES652</td><td>POWER ELECTRONICS LABORATORY</td><td>PCR</td><td>0</td><td>0</td><td>3</td><td>3</td><td>1.5</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT) and end assessment (EA))</td></tr>
<tr><td colspan="3">EES553 (ELECTRICAL MACHINES LABORATORY - I), EEC402 (ELECTRICAL MACHINES-I), EEC501 (ELECTRICAL MACHINES-II)</td><td colspan="5">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">· CO1: To understand the principal of power electronics devices
· CO2: To understand the detail operation of the ac-dc/ dc-dc/ ac-ac/ dc-an components
· CO3: To understand the implementation of the components for dc and ac machine control.
· CO4: To develop the ability to design and implement different converters and gate driver circuits
· CO5: To understand the control of the converters</td></tr>
<tr><td>Topics Covered</td><td colspan="7">List of Experiments:
1. Microprocessor Based Single Phase Firing Circuit
(a) To study half wave converter circuit using Microprocessor
(b) To study AC voltage regulator circuit using Microprocessor
2. Single Phase Bridge Inverter Using IGBT</td></tr>
</table>

	3. Three Phase SCR Module (a) Three Phase Half Controlled Bridge Rectifier with R and R-L load (b) Three Phase Fully Controlled Bridge Rectifier R and R-L load (c) Three Phase AC Voltage Controller with R and R-L load 4. Speed Control of 30 AC Induction Motor Using IPM and MICRO-2407 (a) Open Loop Control of Three Phase Induction Motor by using V/F control (b) Closed Loop Control of Three Phase Induction Motor by using V/F control. 5. Speed Control of DC Motor by Using Single Phase Triggering and Device module 6. Four Quadrant Operation of DC-DC Chopper 7. Simulation of Gate Driver Circuits of Power Converters by Using PSpice 8. Simulation of Basic DC-DC Converters by Using Multisim 9. Modelling and control of Buck and Boost Converter by Using MATLAB Closed Loop Control of Boost Converter by Using Multisim
Text Books, and/or reference material	Text Books: 1.N. Mohan, T. M. Undeland and W. P. Robbins, Power Electronics, Converters, Applications and Design, John-Wiley & Sons 2. JosephVithayathil, "Power Electronics - Principles and Applications", McGraw Hill Inc., New York, 1995. Reference Books: 1. Laboratory Manuals

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	1	3	1	3	3
CO2	3	3	3	3	3	3	3	1	3	1	3	3
CO3	3	3	3	3	3	3	3	1	3	1	3	3
CO4	3	3	3	3	3	3	3	1	3	1	3	3
CO5	3	3	3	3	3	3	3	1	3	1	3	3

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EES653	POWER SYSTEMS LABORATORY	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
EEC401 (POWERSY STEMS-I) EEC503(POWER SYSTEMS- II)		CT+EA					
Course Outcomes	● CO 1: Understand various types of relay implementation using static circuits. ● CO2: Realization of characteristics for over current, distance and differential relays using test bench. ● CO3: Realize the various dynamic characteristics of digital relays for protection of transmission lines, transformers. ● CO4: Identify the new developments in protective relaying and applications						
Topics Covered	List of Experiments: 1. Study of Inverse Definite Minimum Time over-current relay. 2. Study of Directional over-current relay (inverse) type CDD. 3. Study of Numerical Distance protection Relay. 4. Parallel Feeder Protection.						

	5. Negative sequence protection of three-phase induction motor. 6. Study of over-voltage relay. 7. Study of Biased Differential Relay 8. Biased Differential Protection of a single-phase Transformer 9. Restricted E/F Protection of 3-phase Transformer 10. Overcurrent and Earth fault protection scheme for three phase system. 11. To study load flow and different dynamic events of the given network usingMATLAB. 12. Study of Cable Fault Locator.
Text Books, and/or reference material	Laboratory Manuals

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	2	1	1	1	2	2	2
CO2	3	3	3	3	3	2	1	1	1	2	2	3
CO3	3	3	3	3	3	3	2	2	2	2	2	3
CO4	3	3	3	3	3	2	1	1	2	2	2	3

Correlation levels 1, 2 or 3 as defined below:
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Semester - VII						
Code	**Subject**	**L**	**T**	**S**	**C**	**H**
MSC731	**Principles of Management**	**3**	**0**	**0**	**3.0**	**3**
EEC701-	**Power System Operation and Control**	**3**	**0**	**0**	**3.0**	**3**
EEE71X	**Depth Elective - 4**	**3**	**0**	**0**	**3.0**	**3**
EEE71X	**Depth Elective - 5**	**3**	**0**	**0**	**3.0**	**3**
YYO74X	**Open Elective - 1**	**3**	**0**	**0**	**3.0**	**3**
EES751	**Microprocessor and Microcontroller Laboratory**	**0**	**0**	**3**	**2.0**	**3**
EES752	**High Voltage and Insulation Engineering Laboratory**	**0**	**0**	**3**	**2.0**	**3**
EES753	**Electrical Machine Design Sessional**	**0**	**0**	**3**	**2.0**	**3**
EES754	**Vocational Training / Summer Internship and Seminar**	**0**	**0**	**2**	**1.0**	**3**
EES755	**Project - I**	**0**	**0**	**3**	**1.0**	**3**
	TOTAL	**15**	**0**	**14**	**23.0**	**30**

Department of Management Studies							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
MSC731	**PRINCIPLES OF MANAGEMEN**	PCR	3	0	0	3	3

	T						

Pre-requisites	Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))
	CT+MT+EA
Course Outcomes	• CO1:To make budding engineers aware of various management functions required for any organization • CO:To impart knowledge on various tools and techniques applied by the executives of an organization • CO3:To make potential engineers aware of managerial function so that it would help for their professional career • CO4:To impart knowledge on organizational activities operational and strategic bothin nature • C05: To impart knowledge on each functional area of management like Marketing, Finance, Behavioral Science, Quantitative Techniques and Decision Science
Topics Covered	**UNIT I: Management Functions and Business Environment: Business environment-macro,** **Business environment -micro; Porter's five forces, Management functions – overview,** **Different levels and roles of management, Planning- Steps, Planning and environmental** **analysis with SWOT, Application of BCG matrix in organization (12)** **UNIT II: Quantitative tools and techniques used in management: Forecasting techniques,** **Decision analysis (6)** **UNIT III: Creating and delivering superior customer value: Basic understanding of marketing, Consumer behavior-fundamentals, Segmentation, Targeting & Positioning,** **Product Life cycle. (8)** **UNIT IV: Behavioral management of individual: Motivation, Leadership, Perception, Learning. (8)** **UNIT V: Professional ethics: Introduction to Professional ethics, Morals, values and Ethics,** **Ethics in Business. (2)**
Text Books, and/or reference material	Text Books: 1. Marketing Management 15th Edition, Philip Kotler and Kelvin Keller, Pearson India 2. Management Principles, Processes and practice, first edition, Anil Bhat and Arya Kumar, Oxford Higher education 3. Organizational Behavior,13 th edition, Stephen P Robbins, Pearson Prentice hall India 4. Operations Management, 7th edition (Quality control, Forecasting), Buffa &Sarin, Willey 5. A.C. Fernando: Business Ethics & Corporate Governance, Pearson Education 2nd edition

CO-PO mapping

Course Code	Course Title	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MSC731	Principles of	CO1							2		2	1	1	3
		CO2							1		1			3

	Management	**CO3**							**1**	**2**	**2**	**2**	**2**	3
		CO4							**1**	**2**	**2**	**1**	**1**	3
		CO5							**2**	**2**	**2**	**2**	**1**	3

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEC701	POWER SYSTEM OPERATION AND CONTROL	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC 401 (POWER SYSTEM-I), EEC 503 (POWER SYSTEM-II)		CT+MT+EA					

Course Outcomes	On completion of the course, the students will be able to: • CO1: Analyse the performance of interconnected power systems by performing power flow analysis. • CO2: Perform operation scheduling of different power plants (Hydro and Thermal) for both stable, economic operation as well as understand different types of tariff applicable for power system operation • CO3: Model different power system equipment like governor, turbine, transmission line, generator, load and perform regulation of active, reactive power and frequency of the system by designing suitable controllers. • CO4: Estimate the size and type of power factor correcting device required for optimal as well as stable economic operation of power system. • CO5: understand cause, effect as well as control of different types of overvoltage conditions that arise in a power system. • CO6:perform stability analysis of power system to obtain operating limits satisfying the reliability criteria.
Topics Covered	Load flow studies: Network model formulation, formation of Ybus, load flow problem, Gauss-Siedel method, Newton-Raphson method, Decoupled load flow studies, comparison of load flow methods. Advantages and disadvantages. (8) Economic operation of power system: Incremental fuel cost, economic dispatch neglecting transmission losses, transmission loss as a function of plant generation, General loss formula, Optimum load dispatch considering transmission losses.(4) Optimal Hydrothermal Scheduling: Classification of hydro plants, long range problem, short range problem, hydro model, equality and inequality constraints, transmission losses. (4) Load frequency control: Necessity of keeping frequency constant, load frequency of single area, load frequency of single area model of speed governing system, load frequency control of two area system, block diagram representation of an isolated power system, steady state analysis, dynamic analysis, uncontrolled system, uncontrolled system, proportional plus integral control of single area and its block diagram, steady state response (proportional plus integral control), dynamic response (proportional plus integral control). (5) Automatic Generation Control: Types of alternator exciters, exciter modelling, modelling of alternator, static and dynamic performances of AVR, compensation in AVR loop. (4) Power system stability: Steady state stability, transient stability, Infinite bus, stability limit, power angle curve, swing equation, swing curve, M and H constants, equivalent systems equal area criteria, multi machine stability concept and methods for improving stability. (7)

	Tariffs: Introduction, Types of Tariff-Flat demand tariff, straight line meter rate tariff, Block meter type tariff, Two part tariff, Power factor tariff, Peak load tariff, three part tariff.(2) Power Factor Improvement: Introduction, Disadvantages of low power factor, causes of low power factor, power factor improvement, power factor correction by static capacitor. Economics of power factor improvement. (4) Protection against over voltages: voltage surge, causes of over voltages, lightning, protection against lightning, earthing screen, overhead ground wire, lightning arrester, surge absorber. (4)
Text Books, and/or reference material	Suggested Text Books: 1. P. M. Anderson & A. A. Fouad, Power system control and stability, Wiley Inter science 2. D.P. Kothari & I.J. Nagrath, Modern Power System Analysis, Tata Mc-Graw Hill 3. Hadi Sadaat, Power System Analysis, Tata Mc-Graw Hill Suggested Reference Books: 1. Hadi Sadaat, Power System Analysis, Tata Mc-Graw Hill 2. A. Chakraborti, S. Halder; Power System Analysis: Operation and Control, PHI Learning Pvt. Ltd.; Third edition.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2	3	2	2	0	0	1	1	1
CO2	2	3	2	2	2	3	2	0	0	1	1	1
CO3	2	3	3	2	3	2	2	0	0	1	1	1
CO4	3	3	2	2	2	2	1	0	0	1	0	1
CO5	1	2	2	2	1	1	1	0	0	1	0	0
CO6	3	3	3	2	2	2	2	0	0	1	1	1

Correlation levels 1, 2 or 3 as defined below:
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Departmental Elective-IV & V:
SEVENTH SEMESTER

Subject Code	Subject Name
EEE710	**Advanced Power Converters**
EEE711	**Generalized Theory of Electrical Machines**
EEE712	**Electrical Drives**
EEE713	**FACTS Device**
EEE714	**Generation & Utilization of Electrical Power**
EEE715	**Advanced Control Systems**
EEE716	**Design of Flight Control Law**
EEE717	**Power system restructuring & deregulation**

<table>
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<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EEE710</td><td>ADVANCED POWER CONVERTERS</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="3">EEC504(POWER ELECTRONICS), EEC502(CONTROL SYSTEMS)</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO 1: To get an overview of Power Electronic Converters.
• CO2: To learn the operation of Switch-Mode DC-DC Converters and some advanced converters.
• CO3: To understand the concept of Switch Mode DC-AC Inverters, Multilevel Inverters& modulation techniques.
• CO4: To familiarize with EMI & EMC issues in power electronic systems.
• CO5: To get acquainted with design of power electronic systems
• CO6: To get acquainted with practical applications, simulation, and hands on training of power electronic converters.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Overview of basic power electronics converters. (2)

Switch-Mode DC-DC Converters: Introduction, Control of DC-DC converters, Buck, Boost, Buck-Boost, Cuk, Full bridge Converter, and Some advanced converters: Tristate, Interleaved, Multiphase & Higher order converters. (8)

Switch Mode DC-AC Inverters: Single Phase & Three-Phase Inverters, PWM switching schemes, space vector modulation, reduction of harmonics, output voltage control, Multilevel Inverters. (8)

AC voltage controllers: Single phase and three phase ac voltage controllers, Voltage control, Harmonic analysis, operation waveforms PWM, Matrix converters, Z-source converter (6)

Electromagnetic Interference (EMI) and Electromagnetic Compatibility (EMC) Issues: EMI reduction At Source, EMI Filters, EMI Screening, EMI Measurement and Specifications. (4)

Design considerations: snubber circuit, driver circuit, temperature control and heat sink, materials, windings. Design of converter and chopper circuits. Triggering circuits for converter and choppers. MMF equations, magnetic. Design of transformers and inductors. (8)

Some practical applications, literature study, simulation, and hands on training of power electronic converters. (6)</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">Text Books:
1. N. Mohan, T. M. Undeland and W. P. Robbins, Power Electronics, Converters, Applications and Design, John-Wiley & Sons
2. H. W. Whittington, Switch Mode Power Supplies: Design and Construction, Research Studies Press.
3. Joseph Vithayathil, "Power Electronics - Principles and Applications", McGraw Hill Inc., New York, 1995.
Reference Books:
1. R. W. Erickson and D. Maksimovic, Fundamental of Power Electronics, Springer
2. E. Acha, V. G. Agelidis, O. Anaya-Lara and T. J. E. Miller, Power Electronic Control in Electrical Systems, Newnes
3. L. Umanand, Power Electronics, Essential and Applications,Wiley India Pvt. Ltd.</td></tr>
</table>

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	2	2	2	1	3
CO2	3	3	3	3	3	3	3	2	2	1	2	2
CO3	3	3	3	3	3	3	3	2	2	1	2	2
CO4	3	3	3	3	3	3	3	2	2	1	2	2
CO5	3	3	3	3	3	3	3	2	2	1	2	2
CO6	3	3	3	3	3	3	3	2	2	2	3	3

Correlation levels 1, 2 or 3 as defined below:
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<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EEE711</td><td>GENERALIZED THEORY OF ELECTRICAL MACHINES</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2">EEC402 (ELECTRICAL MACHINES-1), EEC501 (ELECTRICAL MACHINES- II)</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">• CO 1: To understand the basic concept of Generalized theory of Electrical machines
• CO2: To learn about Reference Frame theory
• CO3: To transform 3-phase quantities to 2-phase quantities and vice-versa.
• CO4: To model a 3-phase induction machine
• CO5: To model a 3-phase synchronous machine
• CO6: To perform both steady-state and transient analysis of DC machines</td></tr>
<tr><td>Topics Covered</td><td colspan="6">Generalized Machines: Kron’s primitive machine, Voltage, power and torque equations of Kron’s primitive machine, Basic two-pole machine diagrams. (6)

Reference Frame theory: Commonly used reference frames, Equations of transformation, 3- axis to 2-axis transformation, Park’s transformation, Clarke’s transformation. (4)

Theory of symmetrical Induction machines: Dynamic modeling of three-phase induction machine, generalized model of three-phase induction machine in arbitrary reference frame, derivation of induction machine model in stator, rotor and synchronously rotating reference frames from the arbitrary reference frame model, Space-phasor model of induction machine, Normalized model of induction machine, Dynamic performance during sudden change in load torque. (12)

Synchronous Machines: Stator and rotor flux linkages, Voltage and torque equations in machine variables, mathematical modeling of synchronous machine, Swing equation, and state- space representation of Swing equation. (8)

DC machines: DC generator: Steady-state analysis, transient analysis under different conditions. (6)

DC motor: Steady-state analysis, transient analysis under different conditions. (6)</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="6">Text Books:
1. Analysis of Electrical Machinery: P. C. Krause, McGraw-Hill.
2. Electric Motor Drives, Modelling Analysis and Control: R. Krishnan, Prentice-Hall Of India Pvt. Limited.
Reference Books:</td></tr>
</table>

	1. Modern Power Electronics and AC Drives: B. K. Bose, Prentice Hall. 2. Generalized Theory of Electrical Machines: P. S. Bimbhra, Khanna Publisher.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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CO3	3	3	3	3	3	3	1	1	1	1	2	2
CO4	3	3	3	3	3	2	1	1	1	1	2	2
CO5	3	3	3	3	3	2	1	1	1	1	2	2
CO6	3	3	3	3	3	3	1	1	1	1	2	2

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<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EEE 712</td><td>ELECTRICAL DRIVES</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2">EEC402 (ELECTRICAL MACHINES-1), EEC504 (POWER ELECTRONICS), EEC502 (CONTROL SYSTEMS), EEC 501 (ELECTRICAL MACHINES-II)</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">• CO 1: Acquire an idea general drives application in Industry
• CO2: To learn the detail operation of the dc drives
• CO3: To learn the detail operation of the ac drives
• CO4: To identify the drives and machine combinations for any particular application
• CO5: To develop a clear idea about the dynamic performance of the drives</td></tr>
<tr><td>Topics Covered</td><td colspan="6">DC drives: Braking of dc motors, speed control of dc motors, Single-phase half and full-controlled rectifier control of separately excited dc motor, three phase half and full-controlled and half controlled rectifier control of separately excited dc motor, chopper-controlled dc drives, closed loop control of dc drives. (12)

AC drives: Braking of ac motors, speed control of ac motors, basic inverters circuits, variable voltage frequency control, VSI fed induction motor drives, AC voltage controller, cycloconverter, closed loop control of induction motor drives. (12)

Heating and selection of power rating of drive motors: Heating and temperature rise of motors, selection of motor power capacity, equivalent current, torque and power methods. (6)

Transients and Dynamics: Equation of motion, equivalent system, dynamics during dynamic braking of dc shunt motor, speed, time of braking and current during dynamic braking, dynamics during counter current braking of dc shunt motor, energy associated with transient process of dc shunt motor, dynamic response of induction motor, dynamics during starting and braking of induction motor. (8)</td></tr>
</table>

	Industrial application of motors: Cement mill, paper mill, textile mills etc. (4)
Text Books, and/or reference material	Text Books: 1. G. K. Dubey, Fundamentals of Electrical Drives, Narosha Publishing House, 2001. 2. N. K. De and P. K. Sen, Electric Drives, PHI, 2001. Reference Books: 1. V. Subrahmanyam, Electric Drives, Tata McGraw Hill. 2. S. K. Pillai, A first course in electrical drives, New Age international, 1989.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	1	2	1	1	1	1	1	1	1
CO2	3	3	3	3	3	2	1	1	1	1	2	2
CO3	3	3	3	3	3	2	1	1	1	1	2	2
CO4	3	3	3	3	2	3	1	1	1	1	1	2
CO5	3	3	3	3	3	2	1	1	1	1	1	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEE713	FACTS DEVICE	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC401(POWER SYSTEMS-I), EEC504(POWER ELECTRONICS), EEC503(POWER SYSTEMS–II)		CT+MT+EA					
Course Outcomes	• CO 1: Understand the basic concept of FACTS devices. • CO2: Acquire knowledge about working principles of FACTS devices and their operating characteristics of FACTS devices. • CO3: Acquire an idea about modelling of various FACTS devices and their interaction in power system. • CO4: Understand how FACTS devices improve various power system performances like power flow control, stability etc.						
Topics Covered	Introduction: Basics of Power Transmission Networks, Control of Power Flow in AC Transmission Line, Flexible AC Transmission, System Controllers, Concept and General System of Considerations, Checklist of possible benefits from FACTS technology, Application of FACTS Controllers in Distribution Systems. (2) Traditional Compensation: Analysis of Uncompensated AC Line, Passive Reactive Power Compensation, Compensation by a Series Capacitor Connected at the Mid-point of the						

	Line, Shunt Compensation Connected at the Midpoint of the Line, Basics of Phase Shifting, Effects and Applications of different Compensators. (6) Static Var Compensator (SVC): Analysis of SVC, Configuration of SVC, Variable Impedance Type Static Var Generators, TCR, TSR, TSC, FC-TCR.SVC Controller, Harmonics and Filtering, Modeling and applications of SVC. (6) Static Synchronous Compensator (STATCOM): Switching Converter Type Var Generators, Basic concept and Principle of Operation of STATCOM, Basic converter configurations, Control of converters, modeling and applications of STATCOM. (5) Static Series Compensators: Basic Concepts of Controlled Series Compensation, Operation of TCSC, Analysis of TCSC, Control of TCSC, Modeling of TCSC for Stability Studies, Mitigation of Sub-synchronous, Applications of TCSC. (6) Static Synchronous Series Compensator: Operation of SSSC and the Control of Power Flow, Modeling and Control of SSSC, SSSC with an Energy Source, Analysis of SSR with a SSSC, Applications of SSSC. (5) Static Phase Shifting: Basic Principle of a PST, Configurations of SPST, Improvement of Transient Stability Using SPST, Damping of Low Frequency Power Oscillations, Applications of SPST. (5) Combined Compensators: Unified Power Flow Controller (UPFC), Basic operating principles, Conventional transmission control capabilities, Functional control of shunt converter and series converter, Basic control systems for P and Q control, Interline Power Flow Controller. (7)
Text Books, and/or reference material	Text Books: 1. Yong Hua Song and Allan T Johns, “Flexible ac transmission systems (FACTS), the Institution of Electrical Engineers (UK), 2002. 2. N. G. Higorani& L. Gyugui, “Understanding FACTS”, IEEE press, Standard Publishers Distributor, Delhi Reference Books: 1. K.R. Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New age International (P) Ltd. 2008 2. R. Mohan Mathur and Rajiv K. Varma, “Thyristor-Based FACTS Controllers for Electrical Transmission Systems”, IEEE Press, John Wiley & Sons, 2002

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	1	1	1	2	3	2	1
CO2	3	3	3	2	3	1	1	1	2	3	2	1
CO3	3	2	2	1	2	1	1	1	2	3	2	1
CO4	3	2	2	2	2	1	1	2	2	3	2	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEE714	GENERATION & UTILIZATION OF ELECTRICAL POWER	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end					

	assessment (EA))
	CT+MT+EA
Course Outcomes	• CO 1: understand electrical power generation by thermal, hydro and nuclear power plant • CO2: understand the principle of operation of different types of lamps and selection of lamps for different applications. • CO3: understand different electric traction systems. • CO4: understand different heating methods and their applications. • CO5: create awareness of electrical energy conservation.
Topics Covered	Generation: Importance of electrical energy; Generation of electrical energy by conventional methods; Thermal power plant - merits and demerits, selection of site, layout and working of the plant, components of the plant; Hydro power plant - merits and demerits, selection of site, layout and working principle, classification of the plant, Elements of the plant - water turbines, generator, etc.; Nuclear power plant - merits and demerits, selection of site, nuclear fission process, constituents of the plant, layout and working of the plant, nuclear reactor (15) Illumination: Nature of light; Concept of illumination, luminous intensity, and luminance; polar curve, M.H.C.P., M.S.C.P, M.H.S.C.P; laws of illumination; photometer; Sources of light; Types of lighting scheme; Design of indoor and outdoor lighting system. (8) Electric Traction: Traction system; Duty cycle of traction drives; Calculations of traction drive ratings and energy consumption; Systems of track electrification; Traction motors; DC and AC traction drives. (8) Electric Heating: Advantages of electric heating; Classification of electric heating; Resistance heating; Electric arc furnace, Induction heating; Dielectric heating. (6) Economics Aspect of Power: Generation cost; Interest and depreciation; Load curve and choice of generating stations, Tariff; Economics of power factor improvement plant. (5)
Text Books, and/or reference material	Text Books: 1. C. L. Wadhwa, Generation, Distribution and Utilization of Electrical Energy, New Age International (P) Limited. Reference Books: 1. S. C. Tripathy, Electric Energy Utilisation and Conservation, Tata McGraw Hill. 2. N.V. Suryanarayana, Utilisation of Electric Power, Wiley Eastern Ltd.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2	2	2	1	1	1	2	1
CO2	3	3	3	3	2	3	2	2	2	1	2	2
CO3	3	2	2	2	2	2	2	1	1	1	2	1
CO4	3	2	2	3	2	2	2	2	1	1	2	1
CO5	2	2	2	2	2	3	2	2	1	1	1	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEE715	ADVANCED CONTROL SYSTEMS	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEE502 (CONTROL SYSTEMS)		CT+MT+EA					

Course Outcomes	• CO 1: To understand discrete systems, sampling and hold process • CO2: To analyse LTI discrete systems in time domain • CO3: To understand the concept of stability in discrete time, correlation with s-plane • CO4 To learn the frequency domain analysis of discrete systems • CO5: To design controller system for digital control implementation • CO6: To understand nonlinear systems and to determine its stability • CO7: To design controller for nonlinear systems
Topics Covered	Design of control systems by classical methods: Practical approaches of control system design, some practical Problems, hardware realization, Use of MATLAB in design practice (6) Sampled Data Control Systems: The sampling process, signal reconstruction, difference equations, Z-transform theory, Z-transfer functions (pulse transfer functions), inverse Z-transform and response of linear discrete systems, Z-transform analysis of sampled data control systems, Z and S domain relationship stability analysis in Z-plane (12) Root Locus analysis, Frequency domain Analysis of sampled data system, Compensator design, State space analysis of sampled data systems, MATLAB based Examples. (12) Non-linear Control Systems: Introduction, Classification of Non-linearities, Phenomena exhibited due to presence of non-linear element in control system, Phase plane analysis, singular points, Describing function method of analysis, Lyapunov Stability, Region of Attraction. (12)
Text Books, and/or reference material	Text Books: 1. Digital control and state variable methods- M. Gopal 2. Discrete time control systems- K Ogata 3. Modern Control Engineering- K. Ogata 4. Digital Control of Dynamic systems. G.Franklin, J.Powell, M.L. Workman. 5. Nonlinear Systems - H. K. Khalil Reference Books: 1. Nonlinear System Analysis - M. Vidyasagar 2. Applied Nonlinear Control - Jean-Jacques E Slotine, Weiping Li

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	1	1	2	1	1	1	1	1
CO2	3	3	2	3	1	1	2	1	1	1	1	1
CO3	3	3	2	3	1	1	2	1	1	1	1	1
CO4	3	3	2	3	1	1	2	1	1	1	1	1

CO5	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**1**
CO6	**3**	**3**	**2**	**3**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**1**
CO7	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**1**

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="7">Department of Electrical Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EEE716</td><td>DESIGN OF FLIGHT CONTROL LAW</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">CONTROL SYSTEMS (EEC502, EEC431)
FUNDAMENTALS OF CONTROL SYSTEMS (EEO541)</td><td colspan="5">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2">Nil</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">CO1: To develop the concept of the aerodynamics, 6 degrees of freedom motion of aircraft and understanding the role of control surfaces for aircrafts.
CO2: To understand the longitudinal & lateral dynamics of aircrafts and to identify different modes.
CO3: To develop the concept of Static and Dynamic Stability.
CO4: To develop insight on margin criterion, the closed loop response specifications and their relation with the stability and flying qualities of the aircrafts.
CO5: To design control law based on Classical Control Theory for Longitudinal and Lateral/Directional dynamics, Autopilots and UAVs to meet the desired margin and flying qualities criteria</td></tr>
<tr><td>Topics Covered</td><td colspan="6">Motions of Aircraft: Primary Definitions, 6 DOF Motion, Aerodynamic Angles, Forces and Torques, Position and Orientation of Aerial vehicles, Stability-Frame and Body-Frame, Euler’s Equations, Overview of equation of motions (6)
Linearization of Equations of Motion: Small Disturbance Theory and Linearization of Equations of Motion, Stability and Control Derivatives in brief (4)
Stability and Control: Concept of Static Stability & Dynamic Stability, Longitudinal static stability, Lateral/directional static stability, (4)
Longitudinal Dynamics: Aircraft Longitudinal Dynamics, Longitudinal Motion Approximations, Short period mode, Phugoid mode, Influence of Stability Derivatives, Transfer Functions, Flying Qualities (4)
Lateral Dynamics: Aircraft Lateral Dynamics, Lateral-Directional Equations, Dutch Roll, Roll and Spiral Modes, Approximate Models, Transfer Functions, Flying Qualities (4)
Classical Design Techniques for Aircraft Control: Review of Control System Analysis/Synthesis Techniques, Closed loop performance specifications, Longitudinal Stability Augmentation System and Control Augmentation System Designs, Lateral Stability Augmentation System and Control Augmentation System Designs (10)
Classical Design Techniques for Autopilots & Unmanned Aerial Vehicles: Concept of Autopilot design, Introduction to Unmanned Aerial Vehicles (UAV) Design of Fixed Wing Unmanned Aircrafts, Design of Rotary Wing Unmanned Aircrafts (10)</td></tr>
</table>

Text Books, and/or reference material	Suggested Text Books: 1.Aircraft Control and Simulations by Stevens and Lewis, Wiley and Sons, 3rd Edn 2.Flight Stability and Automatic Control by Nelson, WCB/McGraw-Hill, 2nd Edn Suggested Reference Books: 1.Dynamics of Flight Stability and Control by Etkin and Reid, John Wiley & Sons, 3rd Edn 2.Introduction to Flight by Anderson, McGraw-Hill, 2nd Edn 3.Small Unmanned Aircraft: Theory and Practice by Randal W. Beard, Timothy W. McLain, Princeton University Press, 2012 4.Introduction to multicopter design and control by Quan Quan, Singapore: Springer, 2017.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	2	1	2	1	3	1	1	1
CO2	2	2	3	1	2	1	2	1	2	1	1	1
CO3	3	3	3	2	2	1	2	1	3	1	1	1
CO4	3	3	2	2	1	1	2	1	3	1	1	1
CO5	3	3	3	2	2	1	3	1	2	1	1	1

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEE 717	POWER SYSTEM RESTRUCTURING & DEREGULATION	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
EEC 601: ADVANCED POWER SYSTEMS EEE 714: POWER SYSTEM PLANNING, OPERATION OF CONTROL SYSTEM AND STABILITY		CT+EA					
Course Outcomes		● CO1: To understand the basic concept of regulation and deregulation or restructuring in the power system. ● CO2: Learn about bundled and unbundled power system structure. ● CO3: Acquire knowledge about different type of market models and its operations. ● CO4: To become an entrepreneur or can become a consultant in power system bussiness and operation. ● CO5: To understand the electricity power business and technical issues in a restructured power system in both Indian and world scenario.					

Topics Covered	Introduction – Market Models, Power market Entities, Key issues in regulated and deregulated power markets [4] Deregulation of electric utilities, Competitive whole sale electricity market: Transmission expansion in new environment, Transmission open access, pricing electricity in deregulated environment [7] Fundamentals of Deregulation: Privatization and deregulation, Motivations for Restructuring the Power industry; Restructuring models and Trading Arrangements: Components of restructured systems, Independent System Operator (ISO): Functions and responsibilities, Trading arrangements (Pool, bilateral & multilateral) [10] Different models of deregulation: U K Model, California model, Australian and New Zealand models, Deregulation in Asia including India, Bidding strategies, forward and Future market [8] Available Transfer Capability, Congestion management, Ancillary services. Wheeling charges and pricing: Wheeling methodologies, pricing strategies [6] Power Market Development – Electricity Act, 2003 - Key issues and solution; Indian power market, Congestion Management, Day Ahead Market [6]
Text Books, and/or reference material	TEXT BOOKS: 1. Loi Lei Lai, 'Power System Restructuring and Deregulation', John Wiley & Sons Ltd., 2001. 2. Lorrin Philipson, H. Lee Willis, 'Understanding Electric Utilities and Deregulation' Taylor & Francis, 2006. REFERENCE BOOKS: 1. Mohammad Shahidehpour, Muwaffaq Alomoush, 'Restructured Electrical Power Systems', Marcel Dekker, Inc., 2001. 2. Mohammad Shahidehpour, Hatim Yamin, 'Market operations in Electric power systems', John Wiley & son ltd., 2002.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2	2	1	0	0	0	0	1
CO2	2	2	2	1	2	2	1	0	0	0	0	1
CO3	3	3	3	2	2	2	1	0	0	0	0	1
CO4	2	2	2	2	2	2	1	1	1	1	1	1
CO5	2	2	3	2	2	2	1	0	1	1	1	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Open Elective: Basket:

7th Semester:

Subject Code	Subject Name
EEO740	**Measurement and Instrumentation**

EEO741	**Fundamentals of Control Systems**
EEO742	**Power System Analysis and Design**
EEO743	**Fundamentals of Mobile Robots**
EEO744	**Fundamentals of Power Systems**
EEO745	**Concept of Industrial Electronics**
EEO746	**Energy Conservation, Audit and ICT & IOT Application for Monitoring**
EEO747	**Network Theory**
EEO748	**Electrical Engineering Materials**
EEO749	**Micro grid systems**
EEO750	**Digital Image Processing**
EEO751	**Soft Computing Techniques**
EEO752	**Embedded Systems and Applications**
EEO753	**Micro-Electro-Mechanical Systems**
EEO754	**Biomedical Instrumentation**
EEO755	**Concept of Electrical Machines & Drives**
EEO756	**Renewable Energy**
EEO757	**Flight control systems**
EEO758	**Industrial Process Control & Instrumentation**
EEO759	**Electric and Hydrogen Fuel Cell Vehicles**

<table>
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<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EEO740</td><td>MEASUREMENTS AND INSTRUMENTATION</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="2">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2">EEC01 (ELECTRICAL TECHNOLOGY)</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">· CO1: Given specifications of different measuring instruments for measurement of particular parameter of some known electrical system, compare and judge to find the most suitable one.
· CO2: Given application of electrical engineering for measurement of particular parameter along with specified range and accuracy, choose most suitable measuring instrument with the understanding of individual working principles, also judge to fit the given application.
· CO3: For some specific parameter to be measured, along with the given range, resolution, accuracy and output format, choose suitable sensor, design associated signal conditioning and analog/digital processing circuit to meet the desired specification.
· CO4: Given parameters to identify the location of fault.</td></tr>
<tr><td>Topics Covered</td><td colspan="6">Method of measurement, Measurement system, Classification of instruments, Definition of accuracy, Precision, Resolution, Speed of response, Error in measurement, Classification of errors. (3)
Measurement of Voltage and Current: Principle of operation and torque equation of Moving coil, Moving iron instruments. (5)

Extension of instrument ranges. (2)

Measurement of Power & Energy: Principle of operation of Electrodynamic & Induction type wattmeter, Power measurement by two wattmeter, Construction, theory and application of AC energy meter. (6)

Measurement of resistance: Measurement of medium, low and high resistances, Megger (6)</td></tr>
</table>

	AC Bridges: Measurement of Inductance, Capacitance, Frequency, mutual inductance (8) Localization of Cable fault: Methods used for localization of ground and short circuit fault. (4) Sensors & Transducers: Introduction to sensors & Transducers, Strain gauge, LVDT, Temperature transducers, Piezo-electric transducer, pressure transducer, Flow measurement using magnetic flow measurement. (8)
Text Books, and/or reference material	Text Books: 1. K. Sawhney, A course in Electrical & Electronic Measurements & Instrumentation, Dhanpat Rai& sons. 2. E. W. Golding & F. C. Widdis, Electrical Measurement & Measuring Instruments, Wheeler Publishing Reference Books: 1. H. S. Kalsi, Electronics Instrumentation, Mc-Graw Hill Education. 2. A. J. Bouwens, Digital Instrumentation, Tata Mc-Graw hill.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	1	1	1	2	2	2	2
CO2	3	2	3	2	2	2	1	1	3	2	1	2
CO3	3	2	3	2	2	2	1	1	2	1	2	1
CO4	3	2	2	2	2	2	2	2	2	1	1	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEO741	FUNDAMENTALS OF CONTROL SYSTEMS	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
MAC01 (MATHEMATICS-I) MAC02 (MATHEMATICS-II)		CT+MT+EA					
Course Outcomes	● CO1: To get the knowledge of basic objectives of control system design ● CO2: To derive input-output relationship of systems based on their mathematical modeling governed by basic laws of physics ● CO3: To justify stability of systems based on their transfer functions, time domain and frequency domain specifications ● CO4: To develop concepts on root pattern with variable gains and comment on the stability ● CO5: To determine the stability of closed-loop system based on open loop frequency response ● CO6: To be able to design controllers so as to meet design specifications both in time as well as frequency domain ● CO7: To be able to realize the controller both in software simulation through MATLAB coding as well as in real-time environment.						

Topics Covered	**Introduction to control systems:** Historical development, Open and Closed loop systems, Applications, Effects of feedback, Types of feedback control systems, Servomechanism. (4) **Mathematical Models of Physical Systems:** Modeling of electrical networks, Modeling of mechanical system elements, Transfer functions, Block diagram Algebra, Signal flow graph and Mason's Gain formula. (6) **Introduction to State Variable Approach:** Concepts of state, state variables and state model state models for linear Continuous-time systems, state transition matrix. (4) Representation of Control Components: Electrical components, Mechanical components, Electromechanical Components. (2) **Time domain analysis and design specification of linear systems:** Standard signals, Transient response and s-plane root locations of Second and higher order systems, Design specifications, steady state errors and error constants, effects of adding poles and zeros to transfer functions, P, PI, PD and PID controllers. (6) **Concepts of Stability and Algebraic Criterion:** Concept of stability, Characteristic equation & necessary conditions for stability, Routh-Hurwitz stability criteria. (4) **Root Locus Technique:** The concept of root locus, Analytical construction of Root Loci, Root-locus Plots with MATLAB. (4) **Frequency Response Analysis and Stability Studies in Frequency Domain:** Frequency domain specifications, correlation between time and frequency response, Polar plots, Bode plots, Nyquist stability criterion, Relative stability, conditionally stable system, M and N loci on complex and gain phase plane, MATLAB tools and case studies. (8) **Design and Compensation Techniques:** Preliminary considerations of classical Design, Realization of Basic compensators, Frequency domain and s-plane design techniques, Example of control systems. Design with MATLAB. (4)
Text Books, and/or reference material	Suggested Text Books: 1. J. Nagrath and M Gopal, Control system Engineering, New Age International Publishers 2. K. Ogata, Modern Control Engineering, Prentice Hall. 3. B. C. Kuo, Automatic Control system, John Wiley & Sons Suggested Reference Books: 1. Norman S. Nise, Control system Engineering, John Wiley & Sons 2. B. Shahian and M. Hassul, Control System Design using MATLAB, Prentice Hall.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	2	2	2	1	3	1	2	2
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CO3	3	3	3	2	2	1	2	2	3	1	1	1
CO4	2	3	2	2	1	1	2	1	2	1	1	1
CO5	3	3	3	2	2	1	3	1	2	1	1	1
CO6	2	3	3	2	3	2	3	1	3	1	1	1
CO7	2	3	3	3	3	3	3	2	3	1	1	1

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Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEO742	POWER SYSTEM ANALYSIS AND DESIGN	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
		CT+MT+EA					

Course Outcomes	· CO1: Given Specification leads to design of network, choice of optimal Voltage, Transmission line and its material, considering the factors like sag, tension and corona. · CO2: Given Specification leads to study of suitable system parameters and incorporating laws of Power systems to choose the most applicable. · CO3: Given Specification emphasizes on the different Tariff structures, by which one can able to judge, compare and select a suitable Tariff plan. · CO4: Given Specification emphasize on the design of equipment's, on the basis of power factor. · CO5: Given specification will give knowledge about the different types of faults and its severity, which can help to design the protection schemes for those faults
Topics Covered	Fundamentals of Power systems: Transmission line (single phase and three phase), per unit systems, Line constants. (1) Load characteristics: Introduction, connected load, variable Load on Power Station, Load Curves, Important terms and factors, Load duration curve-Load curves and selection of generating units, base load and peak load of power station. (6) Mechanical Design of Overhead Lines, Sag and Tension: General consideration, Line supports, type of steel towers, Sag and tension, Sag and tension calculation, Parabolic method, Catenary method, Sag and tension charts. (7) Corona: Phenomenon of corona, disruptive critical voltage, visual critical voltage, corona loss, factors and conditions affecting corona loss. (3) Balanced and unbalanced fault: Introduction, effects of faults, symmetrical fault, symmetrical components, unsymmetrical faults. (5) Load flow studies: Network model formulation, formation of Ybus, load flow problem, Gauss-Siedel method, Newton-Raphson method, Decoupled load flow studies, comparison of load flow methods. Advantages and disadvantages. (7) Power system stability: Steady state stability, transient stability, equal area criteria, swing equation, multi machine stability concept and methods for improving stability. (8) Economic operation of power system: Incremental fuel cost, economic dispatch neglecting transmission losses, transmission loss as a function of plant generation, General loss formula, Optimum load dispatch considering transmission losses. (5)
Text Books, and/or reference material	Text Books: 1. H. Cotton & H. Barber, The Transmission and Distribution of Electrical Energy, Hodder Arnold 2. 2. A. R. Bergen, V. Vittal, Power Systems Analysis, Pearson Edition Reference Books: 1. John J. Grainger & William D. Stevenson, Power system analysis, Tata McGraw Hill Education. 2. D. P. Kothari & I. J. Nagrath, Modern Power System Analysis, Tata McGraw Hill Education

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	3	3	3	2	2	2	2	2	1	1	2	2
CO2	3	3	2	2	1	1	1	1	2	1	2	2
CO3	3	2	1	1	1	2	1	2	1	1	1	2
CO4	3	3	2	1	2	1	1	2	1	2	2	1
CO5	3	3	3	2	1	2	1	2	1	1	1	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering

Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEO743	Fundamentals of Mobile Robots	PEL	3	0	0	3	3

Pre-requisites	Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA)
MAC01,MAC02	CT+MT+EA

Course Outcomes	CO1: To get the knowledge of basic objectives of mobile robots and its familiarization. CO2: To realize and to apply the fundamental concepts of mobile robots. CO3: To develop concepts on the localization strategies, mapping technique and implementation of various algorithms. CO4: To develop concepts and its application of path planning and navigation. CO5:To be able to design mobile robots for specific application.
Topics Covered	Introduction To Mobile Robotics:Introduction – Locomotion of the Robots. Classification - Legged, Wheeled, Aerial – Key Issues on Locomotion – Legged Mobile Roots -Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues. [4] Unmanned aerial system (UAS):Platforms- configurations- characteristics-applications- propulsion- Internal combustion - on-board flight control- payloads- sensing / surveillance- weaponized- delivery- communications- command/control- telemetry - launch/ recovery systems- Ground control stations. [4] Field robots**:** Aerial robots- Collision Avoidance-Robots for agriculture, mining, exploration, underwater, Civilian and military applications, Nuclear applications, Space applications. [4] Underwater robots:Robotics in Water - Basics Representation of Underwater Robot - Types and Classification of Underwater Robotics - Differentiating Aerial and Underwater Robotics - Overview about Environmental Factors affecting object in water. [4] Control of mobile robots: Control design basics, Cruise-Controllers, Performance Objectives. Simple robot - State space model, Linearization, LTI system, stability. PID control, basic control algorithms [8] Localization**:** Introduction-Challenges of Localization- Map Representation- Probabilistic Map based Localization- Monte carlo localization- Landmark based Navigation-Globally unique localization- Positioning beacon systems- Route based localization. [8] Planning and navigation:Introduction-Path planning overview- Road map path planning- Cell decomposition path Planning-Potential field path Planning-Obstacle avoidance [10]
Text Books, and/or reference material	1. R. Siegwart, I. R. Nourbakhsh, “Introduction to Autonomous Mobile Robots”, The MIT Press, 2011. 2. Peter Corke , Robotics, Vision and Control: Fundamental Algorithms in MATLAB, Springer Tracts in Advanced Robotics, 2011. 3. S. M. LaValle, “Planning Algorithms”, Cambridge University Press, 2006. (Available online http://planning.cs.uiuc.edu/) 4. Thrun, S., Burgard,W., and Fox, D., Probabilistic Robotics. MIT Press, Cambridge, MA, 2005. 5. Melgar, E. R., Diez, C. C., Arduino and Kinect Projects: Design, Build, Blow Their Minds, 2012. 6. H. Choset, K. M. Lynch, S. Hutchinson, G. Kantor, W. Burgard, L. E. Kavraki, and S. Thrun,

	Principles of Robot Motion: Theory, Algorithms and Implementations, PHI Ltd., 2005.

EEO743

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

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEO744	FUNDAMENTALS OF POWER SYSTEMS	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
Nil		CT+MT+EA					
Course Outcomes	• CO1: Given Specification leads to design of network, choice of optimal Voltage, Transmission line and its material. • CO2: Given Specification leads to study of suitable system parameters and in corporation laws of Power systems to choose the most applicable. • CO3: Given Specification emphasizes on the different Tariff structures, by which one can able to judge, compare and select a suitable Tariff plan. • CO4: Given Specification facilitates the design of equipment's on the basis of power factor. • CO5: Given specification will give knowledge about the different types of faults and its severity, which can help to design the protection schemes for those faults.						
Topics Covered	Power System Network: Single phase transmission, three phase transmission, complex power, Basic Structure of power system, overhead and underground systems, overhead line conductors, Transmission, and distribution systems in India. (2) Generating Stations: Steam Power station, Hydro-electric power station, Gas turbine power station, nuclear power station, classification, Comparison of various power stations. (5) Supply Systems: AC power supply scheme, Comparison of DC and AC transmission, Advantages of High transmission voltage, various systems of power transmission, comparison of conductor material in overhead system, comparison of conductor material in underground system, Choice of transmission voltage. (5) Line Parameters and Performance of Transmission Lines: Line resistance, Inductance,						

	Capacitance, Representation of Lines, per unit method, advantages of per unit systems, short transmission line, medium length transmission line, long transmission line, Evaluation of ABCD parameter, equivalent pi and T circuit. (8) Conductors: Introduction, Type of Conductor, Skin effect, Kelvin's economy law, modified Kelvin's law, Limitations of Kelvin's law (4) Overhead Line Insulators: Type of insulator, voltage distribution over insulator string. (3) Tariffs: Introduction, Types of Tariff-Flat demand tariff, straight line meter rate tariff, Block meter type tariff, Two-part tariff, Power factor tariff, Peak load tariff, three-part tariff (3) Power Factor Improvement: Introduction, Disadvantages of low power factor, causes of low power factor, power factor improvement, power factor correction by static capacitor. Economics of power factor improvement. (5) Power Systems Fault and Protection: Symmetrical components, Symmetrical faults and unsymmetrical faults, Switches, fuses, circuit breakers, protective systems, protective relays, (5) Power System Earthing: Type and methods of earthing, earth resistance, Design of Earthing grid, Tower footing resistance, measurement of earth resistance, neutral grounding. (2)
Textbooks, and/or reference material	Textbooks: 1. H. Cotton & H. Barber, The Transmission and Distribution of Electrical Energy, Hodder Arnold 2. A. R. Bergen, V. Vittal, Power Systems Analysis, Pearson Edition Reference Books: 1. John J. Grainger & William D. Stevenson, Power system analysis, Tata McGraw Hill Education. 2. D. P. Kothari & I. J. Nagrath, Power System Analysis, Tata McGraw Hill

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3	2	1	1	1		1			1
CO2	3	3	2	1	1	1			1			
CO3	3	1	3	1	2	3		1				2
CO4	3	3	2	1	2	2	1		1			1
CO5	3	3	2	1	2	1	1	1	1		1	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEO745	CONCEPT OF INDUSTRIAL ELECTRONICS	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
ECC 331 (ANALOG ELECTRONICS), EEC		CT+MT+EA					

403(DIGITAL ELECTRONICS)	
Course Outcomes	• CO 1: Acquire an idea about semiconductor devices • CO2: Learn the basic operation of the ac-dc/ dc-dc/ dc-ac/ ac-ac components • CO3: Identify the application of the components in different fields of Engineering • CO4: Identify the utilisation of the components in Industry
Topics Covered	Review of Power Electronic Systems: Overview of Some Modern Power Semiconductor Devices. (2) Digital Electronics: Overview, Number Systems, Integrated Circuits, Logic Families, Pin Identification. (6) Uncontrolled rectifiers: Single phase and multiphase different circuit arrangements and their operation, analysis, performance evaluations. (6) Controlled rectifier: Semi Controlled and fully controlled converters, single phase and multiphase, different circuit arrangements and their operation analysis performance evaluations. (6) DC-DC Converters: Classification, principles of operation, step down (Buck) and step up (Boost) switched mode power supply, Buck-Boost Converter. (6) Inverters: Classification, theory of operation, square wave Inverter, PWM switching topology, performance evaluation, applications. (6) Applications: DC Drives, AC Drives, Power Conditioners and Uninterruptible Power Supplies, Power Line Disturbances, Power Conditioners, UPS. (6) Other Residential and Industrial Applications. (4)
Textbooks, and/or reference material	Textbooks: 1. B. K. Bose, Power Electronics and AC Drives, Prentice- Hall 2. N. Mohan, T. M. Underland&Riobbins, Power Electronics: Converters, Applications & Design, John-Wiley. Reference Books: 1.L. Umanand, Power Electronics, Essentials & Applications, Wiley India Pvt. Ltd

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	2	2	2	1	3
CO2	3	3	3	3	3	3	3	2	2	1	2	2
CO3	3	3	3	3	3	3	3	2	2	1	2	2
CO4	3	3	3	3	3	3	3	2	2	1	2	2

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core / (PCR)	Total Number of contact hours				Credit
			Lecture	Tutorial	Practical	Total	

		Electives (PEL)	(L)	(T)	(P)	Hours	
EEO746	ENERGY CONSERVATION, AUDIT AND ICT & IOT APPLICATION FOR MONITORING	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC01 (ELECTRICAL TECHNOLOGY)		CT+MT+EA					
Course Outcomes	• CO 1: To understand the Overall Energy Scenario (National & International • CO2: To build the skill in Energy management • CO3: To be able to conduct the energy audit. • CO4: To understand the energy saving • CO5 :To understand the energy monitoring through ICT & IoT						
Topics Covered	Overall understanding Energy Scenario National and International perspective, Energy system as electrical system, Energy chain, National and International Energy scenario, various non-conventional energy resources-importance, classification, relative merits and demerits, Carbon emission, carbon credit, International environmental meet for awareness of Green House emission (GHG). (10) Definition and Objective of Energy Management, General Principles of Energy Management, Energy Management Skills, Energy Management Strategy. (6) Energy Audit: Need, Types, Methodology and Approach. Energy Management Approach, Understanding Energy Costs, Energy performance, Matching energy usage to requirements, maximizing system efficiency, Optimizing the input energy requirements, Fuel and Energy substitution. (6) Procedures and Techniques for Energy Audit, Data gathering: Level of responsibilities, energy sources, control of energy and uses of energy get Facts, figures and impression about energy /fuel and system operations, Past and Present operating data, Special tests, Questionnaire for data gathering. Analytical Techniques: Incremental cost concept, mass and energy balancing techniques, inventory of Energy inputs and rejections, Heat transfer calculations, Evaluation of Electric load characteristics, process and energy system simulation. (8) Evaluation of saving opportunities: Determining the savings in Rs, Noneconomic factors, Conservation opportunities, estimating cost of implementation. Energy Audit Reporting: The plant energy study report- Importance, contents, effective organization, report writing and presentation. (6) Basics of Information Communication Technology (ICT), Internet of Things (IoT). Basic sensors for Energy Monitoring and Evaluation, Application of ICT and IoT for energy monitoring. Remote supervision of Energy use. (6)						
Text Books, and/or reference material	Suggested Text Books: 1. Energy for a sustainable world: Jose Goldenberg, Thomas Johansson, A.K.N.Reddy, Robert Williams (Wiley Eastern). 2. Energy policy for: B.V. Desai (Weiley Eastern), 3. Modeling approach to long term demand and energy implication: J.K.Parikh. 4. Energy Policy and Planning: B.Bukhootsow						

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	2	1	3	2	2	1	2	1	3	2

CO2	2	2	1	1	2	1	2	3	1	1	2	2
CO3	2	2	1	1	3	1	2	2	1	2	1	2
CO4	1	3	1	3	2	1	3	1	1	2	2	1
CO 5	2	3	1	1	2	2	3	2	2	2	1	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="8">Department of Electrical Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EEO747</td><td>NETWORK THEORY</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="3">MAC02(MATHEMATICS -II), EEC01 (ELECTRICAL TECHNOLOGY)</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: Apply the knowledge of basic circuital law, like nodal analysis and mesh analysis, to write the equations for large linear and coupled circuits.
• CO2: Apply Thevenin’s and Norton’s theorems to 12nalyse and design for maximum power transfer.
• CO3: Apply the Laplace transform to linear circuits and systems and 12nalyse the signal synthesis.
• CO4: Evaluate the performance of RL, RC, and RLC circuits by the application of Laplace transform.
• CO5: Analyze the given network using graph theory technique.
• CO6: Analyze the given network using different two port network parameters.
• CO7: Determine the response of a network using the network function and draw pole-zero plots, Bode plot etc.
• CO8: They will also be able to synthesize the network functions.
• CO9: Students should be able to design the passive filters.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Introduction to circuit variables and circuit elements, Review of Kirchhoff s Laws, Independent and dependent Sources, Source Transformations. Solution methods applied to dc and phasor circuits: Mesh and node analysis of network containing independent and dependent sources Network topology, Network graphs, Trees, Incidence matrix, Tie-set matrix and Cut-set matrix. (8)

Network theorems applied to dc and phasor circuits: Thevenin’s theorem, Norton’s theorem, Superposition theorem, Reciprocity theorem, Millman’s theorem, Maximum power transfer theorem. (6)

Laplace transform, properties Laplace Transforms and inverse Laplace transform of common functions, Important theorems: Time shifting theorem, Frequency shifting theorem, Time differentiation theorem, Time integration theorem, s domain differentiation theorem, s domain integration theorem, Initial value theorem, Final value theorem Partial Fraction expansions for inverse Laplace transforms, Solution of differential equations using Laplace transforms Transformation of basic signals and circuit into s- domain Transient analysis of RL, RC, and RLC networks with impulse, step, pulse, exponential and sinusoidal inputs. (8)

Two-Port parameters: Open circuit, short circuit, transmission and hybrid parameters, relationship between parameter sets, reciprocity and symmetry conditions, parallel connections, parallel connection of two port networks. Network equivalents - Analysis of T, n, ladder, and lattice networks. (8)</td></tr>
</table>

	Network functions for the single port and two ports, properties of driving point and transfer functions, Poles and Zeros of network functions, Significance of Poles and Zeros. Time domain response from pole zero plot, Impulse Response Network functions in the sinusoidal steady state, Magnitude and Phase response. (5) Resonance: Series resonance, bandwidth, Q factor and Selectivity, Parallel resonance. Coupled circuits: single tuned and double tuned circuits, dot convention, coefficient of coupling, Analysis of coupled circuits. (7)
Text Books, and/or reference material	Text Books: 1. Kuo Franklin F., Network analysis and synthesis, 1st ed., Wiley International, 1962. 2. Van Valkenburg M.E., Network analysis, 3rd ed., Eastern Economy Edition, 1983. Reference Books: 1. Roy Chaudhary D., Network and systems, Wiley Eastern Limited. 2. Chattopadhyay D &Rakshit P C-Fundamental of Electric Circuit Theory-S chand& company Ltd. Edminister Joseph A., NahviMohmood, Electric Circuits, 3rd ed., Tata McGraw Hill.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	3	3	1	2	1	3	3	3	2
CO2	3	3	2	3	3	1	2	1	3	3	3	2
CO3	3	3	2	3	3	1	2	1	3	3	2	3
CO4	3	3	2	3	3	1	2	1	3	3	2	3
CO5	3	3	1	1	1	1	1	1	2	3	1	2
CO6	3	3	1	3	3	1	1	1	3	3	1	2
CO7	3	3	3	3	3	1	3	1	3	3	3	2
CO8	3	3	3	1	1	1	3	1	3	3	3	2
CO9	3	3	3	1	1	1	3	1	3	3	3	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEO748	Electrical Engineering Materials	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
None		CT+MT+EA					
Course Outcomes		After completion of this subject, the students will be able to: ● CO1: understand the fundamentals of atomic structure and basic properties of conductors. ● CO2: understand the basic properties of dielectric materials along with their applications. ● CO3: understand the basic properties of magnetic materials and their applications. ● CO4: acquire basic knowledge of superconductors and their					

	applications.
Topics Covered	**Atomic Structure:** Review of Rutherford's Model and Bohr's Model related to simple Hydrogen atom; Nuclear binding energy and mass defect. Types of bonding and crystal structures, Atomic arrangement in solids, Band theory of solids; Conductors, Insulators and Semiconductors, Conductors: Electrical conductivity of metals, Lorentz theory, free electron theory, electron scattering. Intrinsic materials and alloys. Resistivity of conductors including alloys. Theory of electrical and thermal conduction in solids, temperature dependence of resistivity, skin effect, Hall effect. (12) **Dielectric materials:** Electrical properties of insulating materials: Volume and surface resistivity, dielectric constant, dielectric dissipation factor and dielectric strength. Thermal endurance of insulating materials. Polarization of dielectrics: Non-polar and polar dielectrics; Electronic, relaxation, ionic, dipole and interfacial polarization; Classification of dielectrics by polarization mechanism; Frequency dependence of permittivity and dielectric dissipation factor. Dielectric relaxation, Methods of modelling of dielectric relaxation, Electrets. Types of dielectric materials: Solid insulating materials-glass, mica, porcelain and ceramics-thermoplastics, cross-linking, thermosetting polymers, epoxy resins-silicon-hydrophobic insulators-composite Insulators-Paper and Pressboards-Oil impregnation-insulating liquids- mineral oil, vegetable oils, synthetic insulating liquids, Degradation of oil-paper insulation, Relaxation phenomenon for composite dielectrics like oil-paper insulation. Gaseous dielectrics: Properties of gases, breakdown phenomena gaseous insulation-air, Sulphur Hexafluoride-Nano dielectric materials as insulation. (16) **Magnetic Materials:** Atomic interpretation of ferromagnetic materials, Atomic exchange force, crystallographic forces, magnetic anisotropy, magnetostriction, Curie-Weiss law, Curie law, Curie temperature of ferromagnetic materials, Soft magnetic material, CRGO, Ni-Fe alloy and applications Hard magnetic materials Alnico, Alcomax and application, Ferrite-ferromagnetic materials and their applications, Piezo-electric materials. (10) **Superconductors:** Theory of super conductivities, critical field, critical current density, transition temperature; normal and superconductivity steps, Types of super conductor, high temperature superconductor and applications. (4)
Text Books, and/or reference material	**Text Books:** 1. Electrical Engineering Material by A. J. Dekker 2. Electrical Engineering Material by B. M. Tareev 3. Dielectric Materials and applications by A. Von Hipple. **Reference Books:** 1. Kuchler, High Voltage Engineering-Fundamentals, Technology and Application, Springer,2017. 2. K.C Kao, Dielectric Phenomena in solids, Elsevier, 2004.

Mapping of CO (Course outcome) and PO (Programme Outcome)

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
EEO748	CO1	3					1	2					1
	CO2	3	1	1									1
	CO3	1	2	3									1
	CO4	2	3			1							1

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEO749	Microgrid systems	PEL	3	0	0	3	3
Pre-requisites:		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
XEC 02		CT+MT+EA					

Course Outcomes	● **CO1:** Acquire an idea about microgrid and its operations. ● **CO2:** Gain the knowledge of different components of the microgrid systems and analyse different types of microgrid and different control strategies. ● **CO3:** Evaluate and calculate different parameters of the renewable sources and the energy storage system of microgrid. ● **CO4:** Understand the concept of microgrid clusters and their applications. ● **CO5:** Learn the future applications of microgrid and its role in the electrical ecosystem.
Topics Covered	1. **Introduction:** What is microgrid, advantage of microgrid over traditional systems, architecture of microgrid, operating modes of microgrid. **(4L)** 2. **Components of microgrid:** Local sources, different loads, storage system, different power electronic converters and their applications, monitoring and control system, operation of microgrid under grid connected and islanded modes, islading algorithms and different islanding techniques. **(10L)** 3. **Classifications of microgrid:** AC, DC, and hybrid microgrid, architecture and components of different microgrids,classification based on control strategies, centralized and decentralized control **(8L)** **4. Renewable sources in microgrid:** PV source, modelling of PV source, MPPT of PV source, different components of wind turbine, MPPT control of wind turbine, solar energy conversion system, wind energy conversion system. **(6L)** 5. **Energy storage system (ESS):** Advantage of ESS, different types of ESS, integration of ESS, algorithm for charging amd discharging, importance of storage system in microgrid **(4L)** 6. **Microgrid Clusters** : Introduction to microgrid clusters, advantages of microgrid clusters, different types of microgrid clusters and their applications. (**3L**) 7. **Role of microgrid in future electricity ecosystem:** Decarbonisation, digitalization, decentralization, load forecasting, load shedding, energy management. **(7L)**
Text Books, and/or Reference Material	**Text Book:** 1. Microgrid: Advanced Control Methods and Renewable Energy System Integration by Magdi S. mahmaud **2.** Microgrid design, optimisation and applications by A.K.pandy, S.Padmanaban. **Reference Book:** 1. Microgrid Technologies by C.Sharmeela, P.Shivaraman, P.Sanjeevikumar (Wiley)

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	2	2	1	1	1	1	1	1	1
CO2	2	3	3	3	3	1	2	1	2	0	2	1
CO3	2	3	3	3	3	0	2	1	2	0	2	0

CO4	2	3	3	3	3	2	1	1	2	0	2	2
CO5	2	2	2	2	2	1	1	3	2	0	1	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEO750	DIGITAL IMAGE PROCESSING	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
		CT+MT+EA					
Course Outcomes	· CO1: Good understanding of several image enhancement techniques and their application to solve real life problem · CO2: Sufficient expertise in both theory and application of several image processing tasks such as image restoration, image compression, and image segmentation. · CO3: Expertise of several techniques for analysis of images · CO4: Develop basic problem-solving skills as they apply to different situations as an						
Topics Covered	Introduction: Image digitization, Pixel relationship, Distance transformation, Image transformation viz. 2-D DFT, 2-D discrete cosine transform (DCT) (8) Image Enhancement: Point and algebraic operations, edge detection and sharpening, Filtering in the spatial domain, Histogram equalization, Histogram specification, sharpening filters and gradient operators, Introduction to frequency domain filtering using Fourier Transform; Basics of 2D Fourier Transform, Butterworth and Gaussian filters. (10) Image Restoration: Degradation models, Mean Filters, Order Statistics, Adaptive filters, Band reject Filters, Band pass Filters, Notch Filters, Optimum Notch Filtering, Inverse Filtering, Wiener filtering. (6) Color Image Processing: Color image fundamentals - RGB, HSI and CMY models (8) Image Segmentation: Contour and shape dependent feature extraction, textural features, region-based and feature-based segmentation and level set method. (10)						
Text Books, and/or reference material	Text Books: 1. Digital Image Processing by Rafael C Gonzalez & Richard E Woods 2. Fundamentals of Digital Image Processing by Anil K Jain 3. Digital Image Processing by William K Pratt						

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3	2	2	1	1	2	3	2	2
CO2	3	3	3	2	3	2	1	1	2	3	2	2
CO3	3	3	2	2	2	2	1	1	2	3	2	2
CO4	3	3	3	2	2	2	1	2	2	3	2	2

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

<table>
<tr><td colspan="8">Department of Electrical Engineering</td></tr>
<tr><td rowspan="2">Course Code</td><td rowspan="2">Title of the course</td><td rowspan="2">Program Core (PCR) / Electives (PEL)</td><td colspan="4">Total Number of contact hours</td><td rowspan="2">Credit</td></tr>
<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EEO751</td><td>SOFT COMPUTING TECHNIQUE</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="3">EEE 610(NUMERICAL ANALYSIS)</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">· CO1: For a given non-linear or non-derivative problem, tune the control parameters of adaptive particle swarm optimization (APSO) for efficiently controlling the global exploration and local exploitation.
· CO2. Analyze the genetic algorithms, PSO, DE and their applications
· CO3: For a given single objective problem (SOP), apply binary coded genetic algorithm (BCGA) and real coded genetic algorithm (RCGA) with different types of crossovers, mutation and also understand the impact of different parent selection strategies.
· CO4: For a given multi-objective problem, explain the significance of Difference vector in Differential Evolutionary (DE) technique and also illustrate self-adaptive differential evolutionary (SADE) technique.
· CO5: For a given problem, describe fuzzy knowledge base controller (FKBC) showing information and computational flow with membership function, rule base and defuzzification.
· CO6: For a given problem, logically clarify the impact of hidden layers in artificial neuron network (ANN) and also stepwise explicate the back propagation algorithm of ANN.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Hard Computing and Soft-Computing techniques, Conventional & non-conventional approaches, limitations of hard computing techniques, merits & demerits of soft-computing techniques, practical examples associated with soft-computing techniques. (3)
Fundamental concept of optimization techniques and necessity of optimization techniques, types of optimization techniques, coding, fitness/objective function, algorithms. (2)
Introduction of Particle Swarm Optimization (PSO) algorithm, Bird flocking & fish schooling, velocity, inertia weight factor, pbest solution, gbest solution, local optima, global optima, Flowchart/algorithm, examples, new modifications of PSO, Parameter Selection in PSO. (6)
Introduction of genetic algorithm, Binary coding & decoding, Genetic modelling, Reproduction, Crossover, Mutation, importance of crossover and mutation operators, parent selection strategy, parent selection methods, Flowchart/algorithm, drawback of binary coded genetic algorithm (BCGA), real coded genetic algorithm (RCGA), examples. (6)
Fundamentals of Differential Evolution algorithm, difference vector and its significance, Mutation and crossover, comparisons among DE, PSO and GA, Examples, new modifications of DE, Improved DE schemes for noisy optimization problems. (6)
Biological neural networks, Model of an artificial neuron, neural network architecture, Characteristics of neural network, learning methods, Taxonomy of neural network architecture, Back propagation networks, architecture of a back propagation network, back propagation learning, Examples, RBF network, Associative memory, Adaptive resonance theory. (7)
Fuzzy set theory, Fuzzy systems, crisp sets and fuzzy sets, fuzzy set operations and approximate reasoning, Fuzzification, inferencing and defuzzification, Fuzzy knowledge and rule bases, examples. (6)
Applications of Soft Computing to various fields of engineering. (6)</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">Text Books:
1. Devendra K. Chaturvedi, “Soft Computing- techniques and its application in electrical engineering”, Springer, 2008.
2. Carlos A. Coello,Garry B. Lamont, David A. van Veldhuizen, “Evolutionary Algorithms for solving Multi-objective Problems”, Second Edition, Springer, 2007.
Reference Books:
1. Jyh-Shing Roger Jang, Chuen-Tsai Sun &EijiMizutani, Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence, Prentice Hall
2. S. Rajasekaran and G. A. VijayalakshmiPai, Neural Networks, Fuzzy Logic and genetic</td></tr>
</table>

	Algorithm Synthesis and Applications, PHI 3. L. A. Zadeh, Fuzzy Sets and Applications, John Wiley & Sons

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	2	2	1	1	1	2	2	2	1
CO2	3	3	3	2	3	1	1	1	2	2	2	1
CO3	3	2	2	1	2	1	1	1	2	3	2	1
CO4	3	2	2	1	2	1	1	1	2	3	2	1
CO5	3	2	2	1	2	1	1	1	2	3	2	1
CO6	3	2	2	2	2	1	1	2	2	3	2	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEO752	EMBEDDED SYSTEMS AND APPLICATION	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC403 (DIGITAL ELECTRONICS)		CT+MT+EA					
Course Outcomes	· CO1: Demonstrate programming proficiency using the various addressing modes and data transfer instructions of the target microprocessor microcontroller. · CO2: Identify—and exercise—opportunities for hardware and software trade-offs. · CO3: Design of interfacing circuits such as memory, keyboard, display, ADC, DAC, DMA etc. and programming in assembly language for typical microprocessor-based system. · CO4: Given peripheral devices such as memory, ADC, DIOs, etc., design of interfacing circuit, and writing algorithms to fulfil a given specific application. · CO5: Programming processor specific and processor independent software for different complex embedded system applications.						
Topics Covered	Introduction to Embedded systems: Introduction – Features – Microprocessors – ALU - Von Neumann and Harvard Architecture, Classification, SPP, ASIC, ASIP, CISC and RISC - Instruction pipelining. General characteristics of embedded system, introduction to different components etc. (3) Basic Microprocessor architectures, organizations and Instruction sets. (4) Memory Classification: ROM, EPROM, EEPROM, RAM. (4) Various types of Interrupts. (2) Programmable Peripheral Devices and Interfacing 8255, 8259, 8257, 8251, 8253, ADC, DAC and Practical Applications. (4) Microcontroller 89CX51/52 Series: Characteristics and Features, Overview of Architectures, and Peripherals, Timers, Counters, Serial communication, Digital I/O Ports.						

	(3) Microcontroller PIC Series: Characteristics and Features, Overview of architectures, and Peripherals, Interrupts, Timers, watch-dog timer, I/O port Expansion, analog-to-digital converter, UART, I2C and SPI Bus for Peripheral Chips, Accessories and special features. (4) ARM Architecture: Evolution, Characteristics and Features, Overview of architectures, Modes, Registers etc. (6) Software architecture and RTOS: Software Architecture: Round Robin- Round Robin with interrupts -Function Queue. Scheduling Architecture RTOS: Architecture -Tasks and Task States -Tasks and Data -Semaphores and Shared Data Message Queues -Mail Boxes and pipes -Timer Functions -Events -Memory Management, Interrupt Routines. (6) Applications of Embedded systems in different field of engineering. (6)
Text Books, and/or reference material	Text Books: 1. The 8085 Microprocessor: Author: Ramesh Gaonkar, Pub: PRI 2. The 8051 Microcontroller and Embedded System: Author: Muhammad Ali Mazidi & J. G. Mazidi. 3. Advanced Microprocessors and Interfacing: Author: Badri Ram, Tata McGraw-Hill Publishing Co. Ltd. Embedded Systems Architecture, Programming and Design, Ral Kamal TMH, 2008. Reference Books: 1. Embedded Systems Design, Heath Steve, Second Edition-2003, Newnes, 2. Computers as Components; Principles of Embedded Computing System Design, Wayne Wolf Harcourt India, Morgan Kaufman Publishers, First Indian Reprint. 2001. 3. Embedded Systems Design – A unified Hardware /Software Introduction, Frank Vahid and Tony Givargis, John Wiley, 2002.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1		2	1	3	1	1	1	
CO2	3	1	2	1	1			1				1
CO3	3	3	3	3	3	1	1	1	1	1	1	1
CO4	3	3	3	3	3	1	1	1	1	1	1	1
CO5	3	3	3	1								1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEO753	MICRO-ELECTROMECHANICAL SYSTEM	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
		CT+MT+EA					
Course Outcomes	· CO1: Understanding the fundamentals of MEMS technology and its applications · CO2: To study and learn the different aspects of Microfabrication						

	Procedures. · CO3: To learn about the Microfabrication Procedures. · CO4: To study about the Microsensors and Micro actuators and their application. · CO5: Learn about the RF-MEMS and Bio-MEMS techniques and applications. · CO6: To learn the modelling and computer simulation techniques for MEMS designs.
Topics Covered	Introduction to MEMS: Introduction to MEMS technology, Why MEMS, Advantages, Applications, examples of MEMS devices, MEMS in Electronic Industries, VLSI Technology for fabrication of integrated circuits chips. (3) Fundamentals of Microfabrication Procedures: Introduction to Thin Film Technology, Clean rooms, Surface Micromachining, MEMS fabrications process flow (Deposition, Lithography and Etching), MEMS fabrication instruments, MEMS fabrication bench, Micromachining, Surface Modelling. (3) Thin Film Deposition Techniques: Substrate Materials, Silicon Wafer, Metal Polymer, Plastic substrate, Thin Film Deposition Process, Physical Deposition process, Chemical Vapour Deposition, Sputtering, Electrodeposition, Electroplating, and Oxidation. (5). Fundamentals of Lithography: Introduction to Thin Film Technology, Different Lithography Technique, Mask and Mask Material, Photoresists, Positive Photoresists, Negative Photoresists, Lift-off, LIGA. (5) Etching Procedures: Need for etching process, different etching techniques, wet etching, dry etching, etching materials, Chemical Etching, Plasma Etching, precautions. (5) Micro sensors and Micro actuators: Accelerometers, Gyroscopes, Angle-Sensors, Pressure Sensor, Microphones and MEMS sensors. (3) Introduction to BioMEMS: MEMS technology in biomedical applications, Microelectrodes for Biomedical Engineering, Introduction to Microfluidics and its Applications. (4) RF MEMS: MEMS for telecommunications (RF MEMS), RF MEMS Components, RFMEMS applications, Recent RF MEMS development, RF MEMS Limitations, RF MEMS Challenges. (3) Computational Modeling of MEMS and MEMS Devices: Overview of MEMS-CAD software; followed by tour of MEMS Design Centre, COMSOL, IntelliSuite. (4) Recent Development in Micro technology: Introduction to Nanotechnology, Carbon Nanotube, Graphene, CNT Sensors Graphene Sensors. (3)
Text Books, and/or reference material	Text Books: 1. An Introduction to Microelectromechanical Systems Engineering: Nadim Maluf, Artech House, 2000 2. Microsystem Technology: Wolfgang Menz, Jürgen Mohr, Oliver Paul, John Wiley & Sons, 2008. Reference Books: 1. An Introduction to Microelectromechanical Systems Engineering: Nadim Maluf, Kirt Williams, Artech House, 2004. 2. Fundamentals of Microfabrication: The Science of Miniaturization, Marc J. Madou, CRC Press; 2nd Ed. 2002. 3. MEMS: A Practical Guide to Design, Analysis, and Applications: Jan Korvink Oliver Paul, William Andrew; 1 edition (November 14, 2005

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2	1	1	1	1	1	1	1

CO2	3	3	3	3	3	1	2	2	2	1	2	1
CO3	3	3	3	3	3	1	2	2	2	1	2	1
CO4	3	3	3	3	3	2	2	2	2	1	2	2
CO5	3	3	3	2	3	1	2	2	2	1	2	2
CO6	2	2	3	2	3	1	1	1	3	0	3	1

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<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EEO754</td><td>BIOMEDICAL INSTRUMENTATION!</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="3"></td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO 1: Familiarization with biomedical equipment’s and transducers
• CO2: Introduction to biomedical signal conditioners
• CO3: Acquiring knowledge about development of bio potentials and their measurements.
• CO4: Introduction patient health care monitoring
• CO5: Introduction to computerized imaging techniques</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Introduction to biomedical Instrumentation, biomedical electronics, Components of Analog and digital circuits. (8)

Various types of signal conditioners, signal conditioning processes. (8)

Generation of Nernst Potential, Establishment of diffusion potential, Goldmann Equation, Measurement of membrane potential, resting potential, action potential. (6)

Use of electrodes for measurement of bio potentials, polarization in electrodes, principle of operation of Ag/AgCl electrode, Equivalent circuit of electrode. (6)

Measurement of ECG, Einthoven triangle method, unipolar and bipolar limb leads, ECG amplifiers, Problems encountered in ECG recording. (6)

Introduction to medical imaging, Radiography, Computerized tomography, X Ray, -CT, MRI. (8)</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">Text Books:
1. John Enderle. Joseph Brinzino, Introduction to Biomedical Engineering, Elsevier, 2012.
2. John G Webster, Medical Instrumentation, Application & Design, John Wiley & Sons, 2009
Reference Books:
1. L. Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation & Measurements, PHI, 2014
2. Arthur C Guyton, John E Hall, Textbook of Medical Physiology, Elsevier, 2006:</td></tr>
</table>

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	1	1	3	1	1	2
CO2	3	3	3	3	3	3	1	1	3	1	1	2
CO3	3	3	3	3	3	3	1	1	3	1	1	2
CO4	3	3	3	3	3	3	1	1	3	1	1	2
CO5	3	3	3	3	3	3	1	1	3	1	1	2

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Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEO755	CONCEPT OF ELECTRICAL MACHINES & DRIVES	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC 501, EEC 504		CT+MT+EA					

Course Outcomes	Upon successful completion of this course, the student should be able to ● CO 1: Get an introductory draft of electrical drive system and discuss different drive systems stability based on fundamental torque equations. ● CO2: Explore the motoring principle and design of different parameters of DC and AC motors. ● CO3: Calculate different parameters of starters and breakers for DC and AC drive system and know about different starting and braking techniques. ● CO4: Understand multi-quadrant operation of DC and AC drive systems and the speed torque characteristics. ● CO5: Recognize different speed control techniques of DC and AC drives and compute different speed control system parameters.
Topics Covered	Concept of electrical drives; Classification, group, individual, multi-motor electric drives; Classification of control schemes and components of electric drives, closed loop control of industrial drives. (6) Speed-Torque characteristics of dc drives; Basic parameter, types of loads, quadrant diagram. Speed-Torque characteristics of dc shunt and series motor. Types of starters and braking (dynamic, regenerative braking) of dc drive. (8) Speed control of dc motor: Basic parameters, method of speed control of dc shunt and series motor. Speed control of dc series motor in a crane using dynamic braking. Introduction to soft control of dc drive. (8) Induction Motor Drives: Three phase I.M., analysis and performance. Operation with unbalanced source voltages and single phasing, analysis of I.M. fed from non-sinusoidal voltage supply. Starting, Braking. Speed control methods of IM, v/f-controlled induction motors, controlled current and controlled slip operation and its application. (12) Stepper, universal, servo and switch reluctance motor drives, solar and battery powered

	drives, Energy conservation in Electrical Drives. (5) Industrial application of electrical drives: Electric traction, paper mill, textile mill, and coal mines. (3)
Text Books, and/or reference material	Text Books: 1. G. K. Dubey, Fundamentals of Electrical Drives, Narosha Publishing House, 2001. Reference Books: 1. N. K. De and P. K. Sen, Electric Drives, PHI, 2001.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	3	2	1	1	1	1
CO2	3	3	3	3	3	3	2	2	1	1	1	1
CO3	3	3	3	3	2	2	2	1	1	1	1	1
CO4	3	3	3	2	3	2	2	1	1	1	1	1
CO5	3	3	3	2	2	2	2	1	1	1	1	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEO756	RENEWABLE ENERGY	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC01 (ELECTRICAL TECHNOLOGY)		CT+MT+EA					
Course Outcomes	· CO1: To understand the basics of Energy System and overall energy resources · CO2: To design the solar and wind power plant · CO3: To understand the tidal, geothermal energy, biomass and other resources and principles · CO4: To understand the energy conservation opportunities and energy saving						
Topics Covered	Introduction: Energy system as electrical system, Energy chain, National and International Energy scenario, various non-conventional energy resources-importance, classification relative merits and demerits, Carbon emission, carbon credit, Paris environmental meet for awareness of emission. (9) Solar photovoltaic: Introduction, solar radiation & its relationship with photovoltaic effect. Photovoltaic concentration, photovoltaic systems-standalone, Solar Constants, Definition of solar thermal: Thermal characteristics of solar radiation, solar collectors: -materials, types, focusing. Solar thermal power plant: layout and arrangement, solar cooling, recent developments. (8) Wind power and its sources, site selection criterion, wind characteristics, momentum theory, Classification of wind machines. Wind mills-different design & their control, wind generators- different types, wind farms & grid. Wind generation in India. Wind Power and						

	maximum power equation. Wind penetration & its effects, economic issues, recent developments, international scenario. (6) Principles of tidal power generation, components of power plant, Single and two basin systems, Estimation of energy, Maximum and minimum power ranges. Ocean and geothermal Energy, geothermal power plant. OTEC Principle, Open cycle and closed cycle. (4) Bio fuel, Conversion of biomass, Biofuel classification, Biomass production for Energy farming, direct combustion for heat-pyrolysis-thermochemical process, Anaerobic digestion- Digester sizing- waste and residues, vegetable oils and biodiesels, Applications of Biogas, Social and environmental aspects. (5) Fuel Cell: Basic construction & principle of operation of fuel cell, Fuel cell power plants & its integration with wind and solar photovoltaic systems. Geothermal Energy, Dry Steam power plant, Single and Double Flash power plant and integration in electrical system/Grid. (5) Energy conservation opportunities, Type of energy audit, energy audit report. Saving of energy with energy economics. (5)
Text Books, and/or reference material	Text Books: 1. G.D. Rai, Non-conventional energy resources, Khanna Publishers, New Delhi, 2003. 2. N. G. Clavert, Wind Power Principle, their application on small scale, Calvert Technical Press. 3. Fuel Cell Handbook, Parsons Inc. 4. Earnest and T. Wizelius, Wind Power Plants and Projects development, PHI

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1		1	1	1			1	1
CO2	3	3	2	1	1	1	1				1	1
CO3	2	3	3	2	1	1	1	1	1		1	1
CO4	2	3	3	2		1	1	1	1		2	1

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEO757	FLIGHT CONTROL SYSTEMS	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
CONTROL SYSTEMS (EEC431) FUNDAMENTALS OF CONTROL SYSTEMS (EEO541)		CT+MT+EA					
Course Outcomes		• **CO1:** To develop the concept of the aerodynamics, 6 degrees of freedom motion of aircraft and understanding the role of control surfaces. • **CO2:** To understand the longitudinal and lateral dynamics of aircrafts and to identify different modes. • **CO3:** To develop the concept of Static and Dynamic Stability of Aircrafts. • **CO4:** To develop insight on margin criterion, the closed loop response specifications and their relation with the stability and flying qualities of the aircrafts.					

	• **CO5:** To design control law based on Classical Control Theory for Longitudinal and Lateral/directional dynamics to meet the desired margin and flying qualities criteria.
Topics Covered	Motions of Aircraft: Primary Definitions, 6 DOF Motion, Aerodynamic Angles, Forces and Torques, Aircraft Position and Orientation, Stability-Frame and Body-Frame, Euler's Equations (6) Linearization of Equations of Motion: Small Disturbance Theory and Linearization of Equations of Motion, Stability and Control Derivatives in brief (4) Longitudinal Dynamics: Aircraft Longitudinal Dynamics, Longitudinal Motion Approximations, Short period mode, Phugoid mode, Influence of Stability Derivatives, Transfer Functions, Flying Qualities (5) Lateral Dynamics: Aircraft Lateral Dynamics, Lateral-Directional Equations, Dutch Roll, Roll and Spiral Modes, Approximate Models, Transfer Functions, Flying Qualities (5) Stability and Control: Static Stability Basics, Longitudinal static stability, Lateral/directional static stability, Dynamic Stability (5) Classical Design Techniques for Flight Control (Longitudinal Mode): Review of Control System Analysis/Synthesis Techniques, closed loop performance specifications, Longitudinal Stability Augmentation System and Control Augmentation System Designs, Concept of Autopilot design related to longitudinal mode (7) Classical Design Techniques for Flight Control (Lateral/Directional Mode): Review of Control System Analysis/Synthesis Techniques, Closed loop performance specifications, Longitudinal Stability Augmentation System and Control Augmentation System Designs, Lateral Stability Augmentation System and Control Augmentation System Designs, Design for Aileron to Rudder interconnect gain, Concept of Autopilot design related to lateral/directional mode (10)
Text Books, and/or reference material	Suggested Text Books: 1.Aircraft Control and Simulations by Stevens and Lewis, Wiley and Sons, 3rd Edn 2.Flight Stability and Automatic Control by Nelson, WCB/McGraw-Hill, 2nd Edn Suggested Reference Books: 1.Introduction to Flight by Anderson, McGraw-Hill, 2nd Edn 2.Dynamics of Flight Stability and Control by Etkin and Reid, John Wiley & Sons, 3rd Edn

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	2	1	2	1	3	1	1	1
CO2	2	2	3	1	2	1	2	1	2	1	1	1
CO3	3	3	3	2	2	1	2	1	3	1	1	1
CO4	3	3	2	2	1	1	2	1	3	1	1	1
CO5	3	3	3	2	2	1	3	1	2	1	1	1

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EEO758</td><td>Industrial Process Control & Instrumentation</td><td>PEL</td><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td></tr>
<tr><td colspan="3">Pre-requisites</td><td colspan="5">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA)</td></tr>
<tr><td colspan="3">MAC01,MAC02</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">CO1: To understand the concept of process and modelling of different types of physical process.
CO2: To characterize and to emphasizes of different modes of control action.
CO3: To understand, design and implement different type of control schemes for efficient control.
CO4: To comprehend the working of final control elements
CO5: To design, implement and analyze control strategies different industry based process control system.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">General Overview of Process: Process Control and Automation. Servo and Regulatory Control, Basic process control loop block diagram. Characteristic parameters of a process – Process Quantity, Process Potential, Process Resistance, Process Capacitance, Process Lag, Self-Regulation
Process modelling: Formulating Process models, Typical processes and derivation of their transfer functions. [10]
Different Control actions: Characteristics of ON/OFF, P, P+I, P+D, P+I+D control modes – non-linear PID control – position and velocity forms of PID controllers – anti-reset windup – bumpless transfer – practical forms of P+I+D control modes, selection of control modes for different processes –control schemes for flow, level, pressure and temperature.
Methods of controller tuning, Ziegler – Nichols continuous cycling, damped oscillations, process reaction curve method – Cohen and Coon method, time – integral criteria.
Pneumatic Controllers - brief analysis [8]
Improvement of Control Scheme:
Different control strategies - schemes, brief analysis and uses
(i) Ratio control, (ii) Cascade control, (iii) Feedforward control, (iv) Selective control
(v) Spilt range control [6]
Final Control Element:
Actuators (Pneumatic Actuators, Electrical Actuators) and Control Valves (Globe, Ball, Butterfly, Gate, Pinch), Different Parts, Fail Position, Valve characteristics, Cv, Single & Double Seated Valves, Valve sizing, Valve selection, Cavitation, Flashing, Noise prediction and Noise Control.
Brief study of Safety Valves and Solenoid valves, special control valves. Piping and Instrumentation Drawing (P&I D) of control loops [10]
Case Studies: Chemical Reactor, Biological Reactor, Distillation Column Control: Dynamic Model, Control Problem setting, synthesis of the nonlinear control law,
Electric Oven Temperature Control, Reheat Furnace Temperature control, Thickness and Flatness Control System for metal Rolling, Computer-Aided control of Electric Power Generation Plant: MATLAB Simulation Results and analysis. [8]</td></tr>
</table>

Text Books, and/or reference material	**Text Books:** 1. D. P. Eckman, Automatic Process control, John Wiley, New York 2. P. Harriot, Process control, Mc Graw Hill, New York 3. G. Stephanopoulos, Chemical process Control, PHI 4. C. D. Johnson, Process Control Instrumentation Technology, PHI 5. S. Bhanot, Process Control – Principles and Applications, Oxford University Press. 6. S. K. Singh, Process Control, PHI 7. S. Sundaram, Process Dynamics and Control, Cengage Learning **Reference Books:** 8. B. G. Liptak, Instrument Engineers Handbook, Chilton Book Co., Philadelphia 9. B. Roffel, B.H.L. Betlem, "Advanced Practical Process Control" Springer, 2004. 10. Jean Pierre Corriou, "Process Control: Theory and applications" Springer, 2004. 11. C.A. Smith and A.B. Corrupio," Principles and Practice of Automotive Process Control", John Wiley, New York, 1976

EEO744

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

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEO759	Electric and Hydrogen Fuel Cell Vehicles	PEL	3	0	0	0	3
Pre-requisites:		Course Assessment methods (Continuous (CT), Mid Sem (MS) and end assessment (EA))					
Electrical Technology		CT+MS+EA					
Course Outcomes		• **CO1:** To acquire an idea about conventional vehicles and their components. • **CO2:** To learn the fundamentals of Electric Vehicles (EVs) and their components. • **CO3:** To study about the Hybrid Electric Vehicles (HEVs) and their components. • **CO4:** To learn about the different types of EV Energy Sources and Charging Systems. • **CO5:** To study the Electric Propulsion Unit. • **CO6:** To study about the Hydrogen Fuel Cell Vehicles (HFCVs).					
Topics Covered		**Electric Vehicles (EVs):** **Introduction to Conventional Vehicles:** Introduction to Vehicular Technology, Fundamentals of					

	Automobile Engineering, Components and Functions of Fuel Fed Cars, Mechanical Power Transmission System, Vehicle Performance, Vehicle Power Source and Vehicle Classifications. [8] **Introduction to Electric Vehicles (EVs):** History of Electric Vehicles, Recent Developments in EV Technologies, EV Applications and Advantages, Components of EVs, Mechanical Power Transmission in EVs, Types of EVs, impacts of EVs. [4] **Introduction to Hybrid Electric Vehicles (HEVs):** Introduction tothe Hybrid Electric Vehicles (HEVs), Components of HEVs, environmental impacts of HEVs, Classifications of HEVs, Mechanical Power Transmission in HEVs, series and parallel of hybrid electric drive trains, impact of HEVs. [4] **EV Energy Sources and Charging Systems:** Introduction to EV Energy Systems, Batteries, Battery Banks, Battery Bank Performance, Battery Parameters, Energy Storage Requirements for HEVs, Battery Charging Basics, EV Battery Charging Circuits, EV Battery Charging Levels, Wireless Charging, Smart Charging. [8] **Electric Propulsion Unit:** Introduction to Electric Motors, Motors used in EVs and HEVs, Applications of Motor Induction Motors, Permanent Magnet Motors and BLDC Motors. [6] **Hydrogen Fuel Cell Vehicles (HFCVs):** **Introduction:** Hydrogen as transportation fuel, Recent advancement in H_2 Fuel Cell Vehicle (FCV) technologies, Hydrogen Storage in FCV (Pressurized tank storage, Hydrogen uptake in metal based compound, Cryogenic liquid hydrogen storage). [2] **Principles of H_2 Fuel Cell:** Basic construction and principle of operation of fuel cell, Fuel cell Thermodynamics, H_2 Fuel Cell, Electrical Characteristics of real H_2 fuel cell, Types of fuel cell used in FCV, Proton exchange membrane H_2 fuel cell, Solid Oxide Fuel cell, Direct methanol fuel cell, Phosphoric acid fuel cell, Alkaline fuel cell, Unitized reversible fuel cell, H_2 Fuel Cell for EVs. [6] **H_2 Fuel Cell Hybrid Vehicle:** H_2 Fuel Cell for Hybrid Vehicles, Series hybrid, Parallel hybrid, Series-parallel hybrid, Basic control strategies of HFCVs. [4]
Text Books, and/or reference material	TEXTBOOK: 1. Iqbal Husain, “Electric and Hybrid Vehicles Design Fundamentals”, CRC Press, Boca Raton, Florida, USA, 2003. 2. Pasquale Corbo, Fortunato Migliardini, Ottorino Veneri, “Hydrogen Fuel Cells for Road Vehicles”, Springer. 3. Mehmet Sankır, Nurdan Sankir, “Hydrogen Electric Vehicles”, Wiley 4. Gilbert M. Masters, “Renewable and Efficient Electric Power Systems,” John Wiley & Sons REFERENCES: 1. Chan, “Modern Electric Vehicle Technology”, Oxford 2002

CO-PO Mapping: EEO745

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	0	0	1	1	1	1	0	1	1	1	0	1
CO2	0	1	1	1	1	1	1	1	1	1	1	1
CO3	0	1	1	1	1	1	1	1	1	1	1	1
CO4	0	1	1	1	1	1	1	1	1	1	1	1
CO5	1	1	1	1	1	1	1	1	1	1	1	1
CO6	1	0	1	1	1	1	1	1	1	1	1	1

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EES751	MICROPROCESSORS AND	PCR	0	0	3	3	1.5

	MICROCONTROLLERS LABORATORY						

Pre-requisites	Course Assessment methods (Continuous (CT) and end assessment (EA))
EEC403 (DIGITAL ELECTRONICS)	CT+EA

Course Outcomes	• CO 1: develop programming proficiency using the various addressing modes and data transfer instructions of the target microprocessor microcontroller. • CO2: Implement key H/W and S/W attributes of microprocessors/microcontrollers. • CO3: Programme for various interfacing hardware • CO4: Programme in C/C++ language for typical microprocessor-based system.
Topics Covered	List of Experiments 1. 8085/8051/8086 assembly language programming practice 2. µP/µC controlled stepper motor drive 3. µP/µC controlled 7-segment display control 4. µP/µC controlled digital I/O 5. µP/µC controlled elevator simulator 6. µP/µC controlled DAC & ADC 7. µP/µC controlled traffic light simulation control 8. µP/µC controlled keyboard display control
Text Books, and/or reference material	Suggested Text Books: 1. Douglas V. Hall, Microprocessors and interfacing: programming and hardware, Tata Mc-Graw Hill 2. Badri ram, Advanced Microprocessors and Interfacing, Tata McGraw-Hill Publishing Co. Ltd. 3. Ramesh Gaonkar, The 8085 Microprocessor, PHI

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs / COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	3	3	2	1	1	1	1	1
CO2	3	1	2	1	3	3	2	1	1	1	1	1
CO3	3	3	3	3	3	3	2	2	1	1	1	1
CO4	3	3	3	3	3	1	2	2	1	1	1	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EES752	High Voltage and Insulation Engineeringlaboratory	PCR	0	0	3	3	1.5

Pre-requisites	Course Assessment methods (Continuous (CT) and end assessment (EA))
EEC401(POWER SYSTEMS-I)	CT+EA

Course Outcomes	· CO1: Understand the Electric Field Distribution and concept of Dielectric strength of insulating material · CO2: Able to measure and calibrate the high Voltage with sphere-sphere gap electrode combination. · CO3: Able to conduct the destructive test i.e., high voltage test of gaseous, liquid and solid insulation and high Voltage power apparatus

	· CO4: Able to conduct the non-destructive test of high Voltage power apparatus
Topics Covered	List of experiments: 1. Analysis of Electrostatic Field in a Parallel Plate Capacitor Using Single & Multi Dielectrics 2. Calibration of Power frequency High Voltage and Measurement of Partial Discharge with sphere-sphere gap arrangement 3. Study the Characteristics of Impulse Voltage and the wave shape of Lighting impulse voltage 4. Study of Capacitance & Tan Delta of insulating material 5. Study the variation of Volume Resistivity of Transformer oil with temperature 6. Power Frequency Withstand Voltage test on 11 kV High voltage line materials 7. Measurement of BDV, Flash point and Fire point of Insulating oils 8. Study of Paschen's Law and insulation resistance of paper 9. Survey of lighting in the classroom and spatial magnetic field in the vicinity of overhead power lines. 10. Survey of Magnetic field in 33KV power line and surrounding of 33/11KV and 11kV/415 V substation.
Text Books, and/or reference material	Laboratory Manuals

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	3	3	2	1	1	1	1	1
CO2	3	1	2	1	3	3	2	1	1	1	1	1
CO3	3	3	3	3	3	3	2	2	1	1	1	1
CO4	3	3	3	3	3	1	2	2	1	1	1	1

Correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Department of Electrical Engineering							
Course Code	Title of the course	Program Core (PCR) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EES753	ELECTRICAL MACHINE DESIGN SESSIONAL	PCR	0	0	3	3	2
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
EEC402 (ELECTRICAL MACHINES -I), EEC501 (ELECTRICAL MACHINES - II)		CT+EA					
Course Outcomes	· CO1: Students will be able to use standard methods to determine accurate modeling/simulation parameters for various general-purpose transformers and induction machines. · CO2: Students will be able to know the relationship between the design variables; current density, electric fields, flux density, weight etc.; and how their interaction affects the design performance. · CO3: Students will be able to choose appropriate materials for electrical machine design. · CO4: Students will be able to use modeling/simulation parameters with standard						

	equivalent circuit models to correctly predict the expected performance of various general-purpose transformers and induction machines. · CO5: Students will be able to use accepted national and international standards to select appropriate electrical machines to meet specified performance requirements.
Topics Covered	Major considerations in Electrical Machine Design - Electrical Engineering Materials – Space factor – Choice of Specific Electrical and Magnetic loadings - Thermal Considerations - Heat flow – Temperature rise - Rating of machines – Standard Specifications. DC machines Design: Output Equations – Main Dimensions - Magnetic circuit calculations – Carter's Coefficient - Net length of Iron –Real & Apparent flux densities – Selection of number of poles – Design of Armature – Design of commutator and brushes – performance prediction using design values. Design of Transformer: Output Equations – Main Dimensions - KVA output for single and three phase transformers – Window space factor – Overall dimensions – Operating characteristics – Regulation – No load current – Temperature rise in Transformers – Design of Tank - Methods of cooling of Transformers. Design of Induction Motors: Output equation, Standard frame size, Stator core, Shape and number of stator slots, Stator winding, Length of air gap, Rotor core, Design of rotor bars and slots, Design of end rings, No load current, Losses and Efficiency, Temperature rise.
Text Books, and/or reference material	Text Books: 1. A. K. Sawhney & A. Chakrabarti, Electrical Machine Design, Dhanpat Rai & Co. Reference Books: 2. S. K. Sen, Principles of Electrical Machine Design with Computer Programs, Oxford & IBH Publishing Company Pvt. Limited.

Mapping of CO (Course Outcome) and PO (Programme Outcome)

POs COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	3	1	1	1	1	2	3
CO2	3	3	3	3	3	3	1	1	1	1	2	3
CO3	3	3	3	3	3	3	1	1	1	1	2	3
CO4	3	3	3	3	3	3	2	1	2	2	3	3
CO5	2	2	2	2	2	2	2	1	2	2	2	3

Correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)