NATIONAL INSTITUTE OF TECHNOLOGY DURGAPUR

B Tech in Electrical Engineering

CONTENTS

Vision:

- To impart quality education and focus on research and innovation in Electrical Sciences to cater to the need of the country.

Mission:

- To impart quality education for producing qualified and motivated Engineers and Researchers who will contribute meaningfully to the growth and development of the country.
- To encourage the faculties and the students for research-oriented teaching-learning environment in the department with a focus on excellence and innovation.
- To pursue creative research and consultancy developing new technologies in Electrical Engineering to serve the needs of industry and country as a whole.
- To create congenial atmosphere for collaborative research, consultancy, and other technical activities.

Programme Educational Objectives:

PEO_S	DESCRIPTION
PEO-1	Excel in professional career and or higher education by possessing fundamental understanding and knowledge of Electrical Engineering.
PEO-2	Analyse real life problems and be able to provide solution that is technically sound, economically feasible, socially acceptable and sustainable in a world of emerging technologies.
PEO-3	Acquiring knowledge of major technological advancements and research initiatives and be able to drive industrial growth and technological advancement in the chosen field of interest.
PEO-4	Exhibit professionalism, ethical attitude, communication skills, team work and leadership quality in their profession and adapt to current trends by engaging in lifelong learning.

Program Outcomes (POs) of Electrical Engineering Department:

POs	DESCRIPTION
PO-1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO-2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO-3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO-4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO-5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO-6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO-7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO-8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO-9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO-10	**Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO-11	**Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO-12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs) of Electrical Engineering Department:

PSOs	DESCRIPTION
PSO-1	Acquire specific knowledge and demonstrate their skills on testing of insulating materials and high voltage equipment.
PSO-2	Acquire knowledge and demonstrate their skills on design, simulation, fabrication, testing and operation & control of electrical systems.

CURRICULUM and SYLLABI of B. Tech in EE (2018-19 onwards)

CURRICULUM OF 2018 ONWARD UNDERGRADUATE ADMISSION BATCH

First semester and second semester are common to all branches of Engineering. Some of the courses are grouped for interchange between first and second semester for half of the students totaling credit unit 44 in first year (1st and 2nd semester combined).

L= Lecture hour/ week; T= Tutorial hour/ week; S= Sessional/ practical hour/ week

C= Subject credit point; H= Subject contact hour/ week.

Semester - I							
Sl. No	Code	Subject	L	T	S	C	H
1	MAC01	Mathematics - I	3	1	0	4.0	4
2	PHC01	Engineering Physics	2	1	0	3.0	3
3	CYC01	Engineering Chemistry	2	1	0	3.0	3
4	XEC01	Engineering Mechanics	2	1	0	3.0	3
5	ESC01	Environmental Science	2	0	0	2.0	2
6	XES51	Engineering Graphics	1	0	3	2.5	4
7	HSS51	Professional Communication Laboratory	1	0	2	2.0	3
8	PHS51	Physics Laboratory	0	0	2	1.0	2
9	CYS51	Chemistry Laboratory	0	0	2	1.0	2
10	WSS51	Workshop Practice	0	0	3	1.5	3
11	XXS51	Co-curricular Activities - I	0	0	2	1.0	2
		TOTAL	13	4	14	24.0	31

Semester - II							
Sl. No	Code	Subject	L	T	S	C	H
1	MAC02	Mathematics - II	3	1	0	4.0	4
2	CSC01	Introduction to Computing	2	1	0	3.0	3
3	ECC01	Basic Electronics	2	1	0	3.0	3
4	EEC01	Electrical Technology	2	1	0	3.0	3
5	BTC01	Life Science	2	0	0	2.0	2
6	XXC01	The Constitution of India and Civic Norms	1	0	0	1.0	1
7	XES52	Graphical Analysis using CAD	0	0	2	1.0	2
8	CSS51	Computing Laboratory	0	0	2	1.0	2
9	ECS51	Basic Electronics Laboratory	0	0	2	1.0	2
10	EES51	Electrical Technology Laboratory	0	0	2	1.0	2
11	XXS52	Co-curricular Activities - II	0	0	2	1.0	2
		TOTAL	12	4	10	21.0	26

CURRICULUM OF 2018 ONWARD UNDERGRADUATE ADMISSION BATCH
ELECTRICAL ENGINEERING- B.TECH.

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	ECC331	Analog Electronics	3	1	0	4.0	4
5	PHC332	Electromagnetic Field Theory	3	0	0	3.0	3
6	PHS382	Physics Laboratory	0	0	3	1.5	3
7	EES351	Electrical and Electronics Measurements Lab	0	0	3	1.5	3
8	XXS381	Co-curricular Activities - III (Optional)	0	0	0	0.0	0
		TOTAL	15	4	6	22.0	25
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	MEC431	Fluid and Thermal Engineering	3	0	0	3.0	3
5	YYO44*	Open Elective - I	3	0	0	3.0	3
6	EES451	Network Analysis and Synthesis Laboratory	0	0	3	1.5	3
7	ECS481	Analog Electronics Laboratory	0	0	3	1.5	3
8	MES481	Fluid and Thermal Engineering Laboratory	0	0	3	1.5	3
9	XXS481	Co-curricular Activities - IV (Optional)	0	0	0	0.0	0
		TOTAL	15	3	9	22.5	27
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	YYO54*	Open Elective - 2	3	0	0	3.0	3
6	ECS581	Digital Electronics Laboratory	0	0	3	1.5	3
7	EES551	Control Systems Laboratory	0	0	3	1.5	3
8	EES552	Electrical Machines Laboratory - I	0	0	3	1.5	3
9	XXS581	Co-curricular Activities - V (Optional)	0	0	0	0.0	0
		TOTAL	15	4	9	23.5	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	Advanced Power Systems	3	1	0	4.0	4
3	EEC602	Microprocessor and Microcontroller	3	1	0	4.0	4
4	EEE610 --	Depth Elective - 1	3	0	0	3.0	3
5	EEE610 --	Depth Elective - 2	3	0	0	3.0	3
6	EES651	Electrical Machines - II Laboratory	0	0	3	1.5	3
7	EES652	Power Electronics Laboratory	0	0	3	1.5	3
8	EES653	Power System Laboratory	0	0	3	1.5	3
9	XXS681	Co-curricular Activities - VI (Optional)	0	0	0	0.0	0
		TOTAL	15	2	9	21.5	26
Semester - VII							
Sl.	Code	Subject	L	T	S	C	H
1	MSC731	Principles of Management	3	0	0	3.0	3
2	EEE710 --	Depth Elective - 3	3	0	0	3.0	3
3	EEE710 --	Depth Elective - 4	3	0	0	3.0	3
4	EEE710 --	Depth Elective - 5	3	0	0	3.0	3
5	YYO74*	Open Elective - 3	3	0	0	3.0	3
6	EES751	Microprocessor and Microcontroller Laboratory	0	0	3	1.5	3
7	EES752	Advanced Power System Laboratory	0	0	3	1.5	3
8	EES753	Electrical machine Design Laboratory	0	0	3	1.5	3
9	EES754	Vocational Training / Summer Internship and Seminar	0	0	2	1.0	2
10	EES755	Project - I	0	0	3	1.0	3
		TOTAL	15	0	14	21.5	29
Semester - VIII							
Sl.	Code	Subject	L	T	S	C	H
1	EEE810 --	Depth Elective - 6	3	0	0	3.0	3
2	YYO84*	Open Elective - 4	3	0	0	3.0	3
3	YYO85*	Open Elective - 5	3	0	0	3.0	3
4	EES851	Project - II	0	0	15	5.0	15
5	EES852	Project Seminar	0	0	0	1.0	0
6	EES853	Viva Voce	0	0	0	1.0	0
		TOTAL	9	0	15	16.0	24

CREDIT UNIT OF THE PROGRAM:

Semester	I + II	III	IV	V	VI	VII	VIII	TOTAL
Credit Unit	45.0	22.0	22.5	23.5	21.5	21.5	16.0	172.0

2021 ONWARD UNDERGRADUATE ADMISSION BATCH
OPEN ELECTIVE COURSE BASKETS
THE STUDENT CAN OPT ANY OPEN ELECTIVE SUBJECT(S) THAT ARE OFFERED IN A PARTICULAR SEMESTER, EXCEPT THE SUBJECT(S) WITH HIS/ HER OWN DEPARTMENT CODE.

OPEN ELECTIVE SUBJECT(S) THAT ARE OFFERED IN A PARTICULAR SEMESTER BY EE DEPARTMENT

Basket– 1 (4th Semester)

Subject Code	Subject Name
EEO440	Fundamentals of Power Systems
EEO441	Concept of Industrial Electronics
EEO442	Energy Conservation, Audit and ICT & IOT Application for Monitoring
EEO443	Network Theory

Basket– 2 (5th Semester)

Subject Code	Subject Name
EEO540	Measurement and Instrumentation
EEO541	Fundamentals of Control Systems
EEO542	Power System Analysis and Design

Basket– 3 (7th Semester)

Subject Code	Subject Name
EEO740	Concept of Electrical Machines & Drives
EEO741	Biomedical Instrumentation
EEO742	Renewable Energy
EEO743	Flight control systems

Basket– 4 (8th Semester)

Subject Code	Subject Name
EEO840	Microgrid systems
EEO841	Biomedical Instrumentation
EEO842	Renewable Energy
EEO843	Digital Image Processing

Basket– 5 (8th Semester)

Subject Code	Subject Name
EEO850	Soft Computing Techniques
EEO851	Embedded Systems and Applications
EEO852	Micro-Electro-Mechanical Systems

2018 ONWARD UNDERGRADUATE ADMISSION BATCH

DEPTH ELECTIVE COURSE BASKETS

THE STUDENTS PRIMARILY WILL OPT FROM THE DEPTH ELECTIVE SUBJECT(S) THAT ARE OFFERED IN A PARTICULAR SEMESTER BY HIS/ HER OWN DEPARTMENT. HOWEVER, A STUDENT CAN OPT FOR DEPTH ELECTIVE SUBJECT(S) THAT ARE OFFERED BY OTHER DEPARTMENT IN A PARTICULAR SEMESTER, WITH THE PERMISSION/ CONSENT FROM HIS/ HER HEAD OF THE DEPARTMENT AND THE CONCERNED TEACHER OF THAT SUBJECT.

DEPTH ELECTIVE COURSE BASKETS:

SIXTH SEMESTER

Subject Code	Subject Name
EEE610	Numerical Analysis
EEE611	Instrumentation
EEE612	Modern Control Systems
EEE613	Special Electrical Machines
EEE614	Signals and Systems
EEE615	Advanced Power Electronics
EEE616	Soft Computing Theory and Applications

SEVENTH SEMESTER

Subject Code	Subject Name
EEE710	Renewable Energy Systems
EEE711	Advanced Power Converters
EEE712	Generalized Theory of Electrical Machines
EEE713	Electrical Drives
EEE714	Power System Planning, Operation and Control
EEE715	Embedded Systems
EEE716	FACTS Device
EEE717	Generation & Utilization of Electrical Power
EEE718	Advanced Control Systems
EEE719	Microprocessor & Embedded Systems
EEE720	Digital Signal Processing
EEE721	Design of Flight Control Law
EEE722	Power system restructuring & deregulation

EIGHTH SEMESTER

Subject Code	Subject Name
EEE810	Power System Transients & Power Quality
EEE811	Smart Grid
EEE812	Power system Reliability

Detailing of the Syllabi:

Semester - I							
Sl. No	Code	Subject	L	T	S	C	H
1	MAC01	Mathematics - I	3	1	0	4.0	4
2	PHC01	Engineering Physics	2	1	0	3.0	3
3	CYC01	Engineering Chemistry	2	1	0	3.0	3
4	XEC01	Engineering Mechanics	2	1	0	3.0	3
5	ESC01	Environmental Science	2	0	0	2.0	2
6	XES51	Engineering Graphics	1	0	3	2.5	4
7	HSS51	Professional Communication Laboratory	1	0	2	2.0	3
8	PHS51	Physics Laboratory	0	0	2	1.0	2
9	CYS51	Chemistry Laboratory	0	0	2	1.0	2
10	WSS51	Workshop Practice	0	0	3	1.5	3
11	XXS51	Co-curricular Activities - I	0	0	2	1.0	2
		TOTAL	13	4	14	24.0	31

Department of Mathematics							
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	
MAC 01	MATHEMATICS - I	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
Basic concepts of function, limit, differentiation, and integration.		CT+MT+EA					
Course Outcomes	• CO1: To introduce the fundamentals of differential calculus of single and several variables • CO2: To develop the basic concepts of integral calculus including multiple integrals and its application in finding area, volume, centre of mass, centre of gravity etc. • CO3: To introduce the fundamental concepts of vector calculus • CO4: To develop the concept of convergence						
Topics Covered	**Functions of Single Variable:** Rolle's Theorem and Lagrange's Mean Value Theorem (MVT), Cauchy's MVT, Taylor's and Maclaurin's series, Asymptotes & Curvature (Cartesian, Polar form). (8) **Functions of several variables:** Function of two variables, Limit, Continuity and Differentiability, Partial derivatives, Partial derivatives of implicit function, 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), Stationary points, Lagrange's method of multipliers. (10) **Sequences and Series:** Sequences, Limit of a Sequence and its properties, Series of positive terms, Necessary condition for convergence, Comparison test, D Alembert's ratio test, Cauchy's root test, Alternating series, Leibnitz's rule, Absolute and conditional convergence. (6) **Integral Calculus:** Mean value theorems of integral calculus, Improper integral and it classifications, Beta and Gamma functions, Area and length in Cartesian and polar co-ordinates, Volume and surface area of solids of revolution in Cartesian and polar forms. (12) **Multiple Integrals:** Double integrals, Evaluation of double integrals, Evaluation of triple integrals, change of order of integration, Change of variables, Area and volume by double integration, Volume as a triple integral. (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 applications. (10)						
Text Books, and/or reference material	**Text Books:** 1. E. Kreyszig, Advanced Engineering Mathematics: 10th edition, Wiley India Edition (2010). 2. Daniel A. Murray, Differential, and Integral Calculus, Fb & c Limited, 2018. 3. Marsden, J. E; Tromba, A. J.; Weinstein: Basic Multivariable Calculus, Springer, 2014. **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.						

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

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)

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, etc. [8] **Wave Motion** - Wave equation, Longitudinal waves, Transverse waves, Electro-magnetic waves. [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. Vibrations and Waves in Physics, Iain G. Main, Cambridge University Press 3. Engineering Physics, H. K. Malik and A. K. Singh, McGraw-Hill. **REFERENCE BOOKS**: 1. Quantum Physics, R. Eisberg and R. Resnick, John Wiley, and Sons 2. Fundamental of Optics, Jankins and White, McGraw-Hill 3. Optics, A. K. Ghatak, Tata McGraw-Hill 4. Waves and Oscillations, N. K. Bajaj, Tata McGraw-Hill 5. 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)

<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>CYC 01</td><td>Engineering Chemistry</td><td>PCR</td><td>2</td><td>1</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">None</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO1: Introduced to chemical thermodynamics, kinetics, electrochemistry, absorption, and catalytic processes for engineering applications
• CO2: To learn fundamentals of polymer chemistry and petroleum engineering.
• CO3: Introduced to basic spectroscopic techniques for structure determination and characterization.
• CO4: To study few inorganic and bioinorganic compounds of industrial importance.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">ORGANIC CHEMISTRY
i. Fundamentals of organic reaction mechanisms; Few important reactions and their mechanism along with their applications; Robinson annulation, Hydroboration reaction, Organometallic reagents (Gilman reagents), Metathesis using Grubb’s catalyst and Wittig reaction. (3)
ii. Fundamental concept on stereochemistry and application: Conformation and configuration of organic compounds, Diastereo-selective, enantio-selective, regio-selective, stereo-specific, and stereo-selective reactions. (3)
iii. Polymer chemistry and polymer engineering: Fundamental concept on polymer chemistry; synthesis and application of important polymers, Rubber, and plastic materials. Conducting polymer. (2)
iv. Petroleum Engineering and oil refinery: origin of mineral oils, separation principle and techniques of distillation of crude oil, Uses of different fractions, octane number, cetane number, Knocking, anti-knock compounds, and Bio-Fuel. (2)
v. Structure elucidation of organic compounds by modern spectroscopic methods; Application of UV-Visible and FT-IR spectroscopy. (3)
INORGANIC CHEMISTRY
i. Coordination Chemistry: Crystal Field Theory of octahedral and tetrahedral complexes, colour and magnetic properties, Jahn-Teller distortion, pseudo Jahn-Teller distortion, Isomerism, and stereochemistry. (5)
ii. Bioinorganic Chemistry: Heme and non-heme O_2 transport protein (Haemoglobin, Myoglobin), Chlorophyll and photosynthesis. (3)
iii. Inorganic Materials: Introduction towards industrially important inorganic materials like cementing material, refractory material, fertiliser, inorganic polymer. (2)
iv. Organometallic Chemistry: π-acid ligands, stabilization of metal low oxidation state and 18 electron rules, metal carbonyls and nitrosyls, metal-alkene complexes. (4)
PHYSICAL CHEMISTRY
i. Thermodynamics: 2nd law of thermodynamics, entropy, free energy, Gibbs Helmholtz equation, change of phase. Cryogenics: joule Thomson experiment. (4)
ii. Chemical Kinetics: 2nd and 3rd order rate expression, Reversible reaction, Chain reaction, Consecutive reaction, Temp effect on reaction rate. (4)
iii. Electrochemistry: Electrochemical cell, Effect of pH, precipitation, and complex formation on EMF of oxidation/reduction processes. (2)
iv. Absorption: Physical and Chemical absorption, Absorption isotherms. (1)
v. Catalysis: Types of catalysis, Rate expression for Catalysed reaction, Acid-base and Enzyme catalysis. (2)</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">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:</td></tr>
</table>

	(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	
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	
ESC01	**Environmental Science**	PCR	2	0	0	2	2
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
		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	**Introduction:** Multidisciplinary nature of Environmental Studies; Basic issues in Environmental Studies. [2] Human population and the Environment. [1] Social issues and the Environment. [1] **Constituents of our Environment & the Natural Resources:** Atmosphere– its layers, their characters; Global warming, Ozone depletion, Acid rain, etc. [5] Hydrosphere - Its constituents, Oceans, Groundwater, Surface waters; Hydrological cycle. [4] Lithosphere - constituents of lithosphere; Rock and Mineral resources; Plate Tectonic Concept and its importance. [5] Biosphere– its components; Ecosystems and Ecology; Biodiversity; Biomes. [5] Natural disaster and their management – Earthquakes, Floods, Landslides, Cyclones. [3] **Pollution:** Pollutants and their role in air and water pollution. [2]
Text Books, and/or reference material	1. Environmental Studies – Benny Joseph – Tata McgrawHill-2005 2.Environmental Studies – Dr. D.L. Manjunath, Pearson Education-2006. 3.Principles of Environmental Science and Engineering – P. V. Rao, PHI. 4. Environmental Science and Engineering – Meenakshi, Prentice Hall India. 5.Environmental studies – R. Rajagopalan – Oxford Publication - 2005. 6. Text book of Environmental Science & Technology – M. A. Reddy – BS Pub.

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	
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. 1^{st}, 2^{nd}, 3^{rd} and 4^{th} 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 Books, 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**	
HSS51	**Professional Communication Lab**	PCR	1	0	2	3	2
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
None		CT+EA					

Course Outcomes	• CO1: Improvement in linguistic proficiency of the learners • CO2: Improvement in communicative ability of the learners
Topics Covered	1. Professional Communication: Introduction (1) 2. Technical Writing: Basic Concepts (2) 3. Style in Technical Writing (3) 4. Technical Report (2) 5. Recommendation Report (2) 6. Progress Report (1) 7. Technical Proposal (3) 8. Business Letters (3) 9. Letters of Job Application (2) 10. Writing Scientific and Engineering Papers (3) 11. Effective Use of Graphic Aids (2) 12. Presentation Techniques (6) 13. Group Discussion (6) 14. Interview Techniques (6)
Text Books, and/or reference material	**Text Book:** 1. English for Engineers –Sudharshana & Savitha (Cambridge UP) **Reference Books:** 1. Technical Communication—Raman & Sharma (Oxford UP) 2. Effective Technical Communication—M A Rizvi (McGraw Hill Education)

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

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
HSS51	CO1	-	-	-	-	-	1	-	-	1	3	-	3
	CO2	-	-	-	-	-	2	-	-	2	3	-	3

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 (CT) and end assessment (EA))
NIL	CT+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 Books, and/or reference material	**SUGGESTED BOOKS**: 1) A Text Book on Practical Physics – K. G. Majumdar. 2) Practical Physics – Worsnop and Flint **REFERENCE**: 1) Instruction sheets

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	i. Experiments based on pH metry: Determination of dissociation constant of weak acids by meter. ii. Experiments based on conductivity measurement: Determination of amount of HCl conductometric titration with NaOH. iii. Estimation of metal ion: Estimation of Fe^{2+} by permangnomentry iv. Estimation of metal ion: Determ. of total hardness of water by EDTA titration. v. Synthesis and characterization of inorganic complexes: e. g. $Mn(acac)_3$, $Fe(acac)_3$, c bis(glycinato)copper (II) monohydrate and their characterization by m. p. , FTIR etc. vi. Synthesis and charact. of organic compounds: e.g. Dibenzylideneacetone. vii. Synthesis of polymer: polymethylmethacrylate viii. Verification of Beer-Lamberts law and determination of amount of iron present in a suppl solution. ix. Chromatography: Separation of two amino acids by paper chromatography x. 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**	
WSS51	**WORKSHOP PRACTICE**	PCR	**0**	**0**	**3**	**3**	**1.5**
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					

Course Outcomes

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

Topics Covered

M/c shop & Carpentry shop -- 3X3= 9hrs.

- Introduction on machining process.
- Introduction to machine tools- Lathe, Shaper, Milling and Drill machine.
- Introduction to woods- Types, structure, disease and defect of wood.
- Introduction to wood working machines and tools.
- Making of dovetail joint and bridle joint.

Welding Shop & Sheet metal -- 3X3= 9hrs.

- Introduction to welding.Safety and precautions in welding.
- Formation of weld bead by SMAW on mild steel flat.
- Formation of weld bead by oxy-fuel welding on mild steel flat.
- Introduction to sheet Metal works.
- Tools and Machines used in sheet metal works.
- Concept of development, marking out of metal sheets.
- Cutting and joining of metal sheets.
- Safety precautions, General warning needed in the shop floor.

Black smithy & Foundry -- 3X3= 9hrs.

- Introduction Smithing and Forging- Tools, Machines, Furnaces and its accessories, fuels.
- Safety and precautions in blacksmithy.
- Making of bars of different cross-sections.
- Making of hexagonal headed bolts.
- Forge welding.
- Introduction to Foundry Technology.
- Preparation of sand mould using Solid/Split Pattern.

Fitting & Electrical shop -- 3X3= 9hrs.

- Introduction to hand metal cutting tools with specifications, nomenclature and their use.
- Marking tools, measuring tools and their use.
- Fitting of joints of mild steel flats.
- Introduction to electrical hazards and safety precaution.
- Wire jointing and soldering.
- PVC Conduit Wiring controlled by separate single way switches.
- PVC Cashing Capping Wiring for two-way switches.
- Conduit wiring for the connection of a Calling Bell with In & Out Indicators.
- Batten Wiring and Cleat Wiring.
- Tube Light Connection.

	• Insulation Resistance Testing of 1ph / 3ph Motor and House Wiring. • Earth Resistance Testing. • DOL Starter Connection. **Viva voce -- 1X3= 3hrs.**
Text Books, and/or reference material	1. Workshop Technology Part I and Part II by W. A. J. Chapman 2. Elements of Workshop Technology S. K. Hazra Chowdhury, A. K. Hazra Chowdhury and Nirjhar Roy 3. Mechanical Workshop Practice by K. C. John

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

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
WSS51	CO1	2	-	-	-	-	1	-	-	-	1	-	-
	CO2	1	-	1	-	-	1	-	-	-	1	-	-
	CO3	1	-	2	-	-	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	
XXS-51	**Co-curricular 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: Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them • CO3: Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes. • CO4: Personality development through community engagement • CO5: Exposure to social service						
Topics Covered	**YOGA** • Introduction of Yoga. • Sitting Posture/Asanas- Padmasana, Vajrasana, Ardha kurmasana, Ustrasana, Bakrasana, Sasankasana, Janusirshasana, Suryanamaskar. • Mudra- Gyana mudra, Chin mudra, Shuni mudra, Prana mudra, Adi mudra, Anjali mudra. • Laying Posture/Asanas- Pavana Muktasana, Uttana Padasana, Sarpasana, Bhujangasana (Cobra Pose), Eka Pada Śalabhāsana, Dhanurasana, Chakrasana, Viparitkarani. • Meditation- Yog nidra, Om chant, Pray chant. • Standing Posture/Asanas- Tadasana (Mountain Pose), Vrikshasana (Tree Pose), Ardha chandrasana, Trikonasana, Utkatasana, Padahastasana. • Pranayama- Deep breathing, Anulom Vilom, Suryabhedi, Chandrabhedi. • Kriya- Kapalbhati, Trataka. **ATHLETICS** • Introduction of Athletic. • Starting Technique for Track events- Standing start, Crouch start & Block start. • Finishing Techniques. • Relay Race- 4×100m, 4×400m & Baton Exchange Technique & Rules. • Track Marking with Fundamentals- 200m, 400m and Diagonal Distance Radius, Straight Distance, Staggers of Different Lanes & Curve Distance. **BASKETBALL** • Introduction and Players stance and ball handling. • Passing- Two hand chest pass, two hand bounce pass, One hand baseball pass, Side arm pass, Overhead pass, Hook pass.						

- Receiving- Two hand receiving, one hand receiving, receiving in stationary position, Receiving while jumping and Receiving while running.
- Dribbling- Dribble, High dribble, Low dribble, Reverse dribble, Rolling dribble.
- Rules of Basketball.
- Basketball game.

VOLLEYBALL

- Introduction of Volleyball
- Service- Underarm service, Sidearm service, Tennis service, Floating service, Jump service.
- Pass: Underarm pass- Ready position, Teaching stage of underarm pass and Upper hand pass- Volley pass, Back pass, Short set, Jump set & Underarm set.
- Rules and their interpretation.

FOOTBALL

- Introduction of Football
- Push pass- Instep inside, Instep outer side.
- Kicking- Spot kick, Instep kick, Lofted kick.
- Dribbling- One leg, Both legs, Instep.
- Trapping- Rolling ball sole trapping, High ball sole trapping, High ball chest trapping, High ball thigh trapping.
- Throwing- Standing throw, Running throw, Seating throw.
- Goal Keeping- Griping the ball, Full volley, Half volley, Drop Kick.
- Rules and their interpretation.

CRICKET

- Introduction of Cricket
- Batting gripping & Stance, Bowling gripping technique.
- Batting front foot defense & Drive.
- Batting Back foot defense & Drive.
- Batting Square cut.
- Bowling medium pace, Bowling off break.
- Fielding drill, Catching (Short & High).
- Rules & Regulation.

BADMINTON

- Basic introduction about Badminton and Badminton court.
- Racket parts, Racket Grip, Shuttle Grip.
- Basic stance, Basic Footwork, Shadow practice (Full court movement).
- Strokes services: Forehand- Overhead & Underarm, Backhand- Overhead & Underarm.
- Match practice (Single & Double).
- Rules & Regulation.

TABLE TENNIS

- Introduction of Table Tennis.
- Basic Stance and Grip (Shake hand & Pen hold).
- Service Basic.
- Stroke: Backhand- Push, Deep Push, Chop, Rally, Drive, Drop Shot, Flick, Block, Smash.
- Stroke: Forehand- Push, Deep Push, Chop, Rally, Drive, Drop Shot, Flick, Block, Smash.
- Rules and their interpretations.
- Table Tennis Match (Singles & Doubles).

NCC

- FD-1 General Introduction and words of command.
- FD-2 Attention, Stand at ease and Stand easy, Turning and inclining at the halt.
- FD-3 Sizing, Forming up in three Ranks Numbering, Open and Close order March and Dressing.
- FD-4 Saluting at the halt, Getting on parade, Dismissing and falling out.
- FD-5 Marching, Length of pace and Time of Marching in quick time and Halt, Slow March and Halt.
- FD-7 Turning on the March and Wheeling.
- FD-12 Parade practice.

TAEKWONDO

- Introduction about Taekwondo- Meaning of Taekwondo, Korean language of dress, Fighting area, Punch, Block, Kicks etc.
- Stance- Ready stance, Walking stance, Fighting stance, Front stance, Back stance, Cat stance etc.

	• Punch Technique- Front fist punch, Rear fist punch, Double fist punch, With stance etc. Blocks- Upper blocks, Middle block, Side block, Suto etc. • Foot Technique (Balgisul)- Standing kick (Saseochagi), Front kick (Abchagi), Doliyo (Chagi), Abdal chagi (Butterfly kick), Back kick etc. **NSS** • Swachha Bharat Mission • Free Medical Camp • Sanitation drive in and around the campus. • Unnat Bharat Abhiyaan • Matribhasha Saptah celebration

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	-	-	3	-	-	-
	CO2	-	-	-	-	-	-	-	2	-	-	-	-
	CO3	-	-	-	-	-	-	1	-	-	-	-	3
	CO4	-	-	-	-	-	-	-	-	2	2	-	-
	CO5	-	-	-	-	-	3	1	-	-	-	-	-

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

Semester - II							
Sl. No	**Code**	**Subject**	**L**	**T**	**S**	**C**	**H**
1	MAC02	Mathematics - II	3	1	0	4.0	4
2	CSC01	Introduction to Computing	2	1	0	3.0	3
3	ECC01	Basic Electronics	2	1	0	3.0	3
4	EEC01	Electrical Technology	2	1	0	3.0	3
5	BTC01	Life Science	2	0	0	2.0	2
6	XXC01	The Constitution of India and Civic Norms	1	0	0	1.0	1
7	XES52	Graphical Analysis using CAD	0	0	2	1.0	2
8	CSS51	Computing Laboratory	0	0	2	1.0	2
9	ECS51	Basic Electronics Laboratory	0	0	2	1.0	2
10	EES51	Electrical Technology Laboratory	0	0	2	1.0	2
11	XXS52	Co-curricular Activities - II	0	0	2	1.0	2
		TOTAL	12	4	10	21.0	26

Department of Mathematics							
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	
MAC 02	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: Develop the concept of basic linear algebra and matrix equations so as to apply mathematical methods involving arithmetic, algebra, geometry to solve problems. • CO2: To acquire the basic concepts required to understand, construct, solve and interpret differential equations. • CO3: Develop the concepts of Laplace transformation & Fourier transformation with its property to solve ordinary differential equations with given boundary conditions which are helpful in all engineering & research work. • CO4: To grasp the basic concepts of probability theory.
Topics Covered	**Elementary algebraic structures:** Group, subgroup, ring, subring, integral domain, and field. (5) **Linear Algebra:** Vector space, Subspaces, Linear dependence and independence of vectors, Linear span, Basis and dimension of a vector space. Rank of a matrix, Elementary transformations, Matrix inversion, Solution of system of Linear equations, Eigen values and Eigen vectors, Cayley-Hamilton Theorem, Diagonalization of matrices. (15) **Ordinary Differential Equations:** Existence and uniqueness of solutions of ODE (Statement Only), Equations of first order but higher degree, Clairaut's equation, Second order differential equations, Linear dependence of solutions, Wronskian determinant, Method of variation of parameters, Solution of simultaneous equations. (12) **Fourier series:** Basic properties, Dirichlet conditions, Sine series, Cosine series, Convergence. (4) **Laplace and Fourier Transforms:** Laplace transforms, Inverse Laplace transforms, Convolution theorem, Applications to Ordinary differential equations. Fourier transforms, Inverse Fourier transform, Fourier sine and cosine transforms and their inversion, Properties of Fourier transforms, Convolution. (10) **Probability:** Historical development of the subject and basic concepts, Axiomatic definition of probability, Examples to calculate probability, Random numbers. Random variables and probability distributions, Binomial distribution, Normal distribution. (10)
Text Books, and/or reference material	**Text Books:** 1. E. Kreyszig, Advanced Engineering Mathematics: 10th edition, Wiley India Edition (2010). 2. Gilbert Strang, Linear algebra and its applications (4th Edition), Thomson (2006). 3. Shepley L. Ross, Differential Equations, 3rd Edition, Wiley Student Edition (2017). **Reference Books:** 1. S. Kumaresan, Linear algebra - A Geometric approach, Prentice Hall of India (2000). 2. C. Grinstead, J. L. Snell, Introduction to Probability, American Mathematical Society.

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	
CSC01	**INTRODUCTION TO COMPUTING**	PCR	2	1	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					

Basic knowledge of computer.	CT+MT+EA
Course Outcomes	CO1: Recognize the changes in hardware and software technologies with respect to the evolution of computers and describe the function of system software's (operating Systems) and application software's, languages, number system, logic gates. CO2: Illustrate the flowchart and inscribe an algorithm for a given problem Inscribe C programs using operators. CO3: Develop conditional and iterative statements to write C programs. CO4: Exercise user defined functions to solve real time problems CO5: Inscribe C programs that use Pointers to access arrays, strings and functions. CO6: Exercise user defined data types including structures and unions to solve problems.
Topics Covered	Fundamentals of Computer: History of Computer, Generation of Computer, Classification of Computers 2L Basic Anatomy of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output devices. [2] Languages: Assembly language, high level language, compiler, and assembler (basic concepts) [1] Binary & Allied number systems representation of signed and unsigned numbers. BCD, ASII. Binary Arithmetic & logic gates. [2] Basic concepts of operating systems like MS DOS, MS WINDOW, UNIX, Algorithm & flow chart. [1] C Fundamentals: The C character set identifiers and keywords, data type & sizes, variable names, declaration, statements. [2] Operators & Expressions: Arithmetic operators, relational and logical operators, type, conversion, increment and decrement operators, bit wise operators, assignment operators and expressions, precedence, and order of evaluation. Input and Output: Standard input and output, formatted output -- printf, formatted input scanf. [8] Flow of Control: Statement and blocks, if - else, switch, loops - while, for do while, break and continue, go to and labels. [5] Fundamentals and Program Structures: Basic of functions, function types, functions returning values, functions not returning values, auto, external, static and register Variables, scope rules, recursion, function prototypes, C pre-processor, command line arguments. [5] Arrays and Pointers: One-dimensional, two-dimensional arrays, pointers and functions, multi-dimensional arrays. [10] Structures Union and File: Structure, union, structures and functions, arrays of structures, file read, file write.[5]
Text Books, and/or reference material	Text Books: 1. Let us C by Kanetkar 2. C Programming by Gottfried 3. Introduction to Computing by Balaguruswamy 4. The C-programming language by Dennis Ritchie Reference Books: 1. Computer fundamental and programming in C by P Dey and M. Ghosh 2. Computer fundamental and programming in C by Reema Thareja 3. programming with C by Schaum Series

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	3	1	2	1	-	-	-	-	-	-	-	-
	CO2	-	2	1	2	1	-	-	-	-	-	-	-
	CO3	1	2	-	-	3	-	-	-	-	-	-	-
	CO4	1	3	1	2	3	-	-	-	-	-	-	1
	CO5	2	1	-	-	3	-	-	-	-	-	-	-
	CO6	2	-	3	-	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	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	

		(PEL)					
ECC01	**Basic Electronics**	PCR	2	1	0	3	3

Pre-requisites	Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))
(10+2) level mathematics and physics	CT+MT+EA

Course Outcomes	• CO1: Knowledge of Semiconductor physics and devices. • CO2: Have an in depth understanding of basic electronic circuit, construction, operation. • CO3: Ability to make proper designs using these circuit elements for different applications. • CO4: Learn to analyze the circuits and to find out relation between input and output.
Topics Covered	1. **Semiconductors** 1.1. Concept of band formation in solids; Fermi-Dirac distribution function, concept of Fermi level, invariance of Fermi level in a system under thermal equilibrium 1.2. Definitions of insulator, conductor and semiconductor using band diagram 1.3. Crystalline structure of semiconductor 1.3.1. Covalent bond 1.3.2. Generation of holes and electrons 1.3.3. Effect of temperature on semiconductor 1.4 Intrinsic semiconductor 1.5 Doping and Extrinsic semiconductor 1.5.1 n-Type semiconductor and band diagram 1.5.2 p-Type semiconductor and band diagram 1.5.3 Mass-action law of semiconductor 1.6. Conductivity of semiconductor (including mathematical expression) 1.7 Carrier transport phenomenon. (03 hrs.) 2. **Diodes** 2.1. Construction 2.2. Unbiased diode; Depletion layer and Barrier potential; junction capacitance (expression only) 2.3. Principle of operation with forward biasing and reverse biasing 2.4. Characteristics 2.5 Diode's three models/equivalent circuits. (02 hrs.) 3.**Diode Circuits** 3.1 Diode rectifier 3.1.1 Half wave rectifier 3.1.2 Full wave rectifier: centre tap and bridge rectifier 3.1.3 Capacitive filter and DC power supply (Numerical problems) 3.2 Special Diodes 3.2.1 Zener diode: Avalanche breakdown and Zener breakdown and characteristics. 3.2.2 Zener diode as a voltage regulator 3.2.3 Display devices: LED and LCD. (03 hrs.) 4.**Bipolar Junction Transistor (BJT)** 4.1 n-p-n and p-n-p transistor and their constructions 4.2 Principle of operation 4.3 Transistor configuration: common base, common emitter, and common collector 4.4 Transistor characteristics: input and output characteristics of CB and CE configurations 4.5 DC load line: quiescent (Q) point; cut-off, active, and saturation region 4.6 Amplifier: Principle of operation 4.7 Transistor as a switch. (04 hrs.) 5.**Transistor Biasing** 5.1 Need of biasing 5.2 Methods of biasing: base resistor or fixed bias, emitter feedback, voltage divider biasing 5.3 Stability of Q-point (qualitative discussions) 5.4 (Numerical problems). (02 hrs.) 6.**Single Stage Amplifier:** classification of amplifiers (voltage amplifier, current amplifier, power amplifier etc.) Class-A CE Amplifier with coupling and bypass capacitors, Qualitative discussions of magnitude characteristics of frequency response (graph only) (02 hrs.) 7.**Feedback Amplifier** 7.1 Positive and negative feedback 7.2 Deduction of gain with negative feedback, explanation of stability of gain with negative feedback, other effects of negative feedback (no deduction), numerical problems. (03 hrs.) 8.**Other Semiconductor Devices**

	8.1 JFET: Construction, principle of operation, characteristics 8.2 MOSFET: Construction, principle of operation, characteristics 8.3 Power Electronic Device-SCR: Brief discussions. (02 hrs.) 9.**Operational Amplifier** 9.1 Characteristics of ideal operational amplifier 9.2 Pin Configuration of IC 741, 9.3 Analysis of simple operational amplifier circuits: concept of virtual ground; noninverting amplifier and inverting amplifier. 9.4 Applications: voltage follower, summer, differentiator, integrator, and comparator (04 hrs) 10.**Oscillator** 10.1 Positive feedback and condition of oscillation 10.2 R-C phase-shift oscillator, Wien bridge oscillator. (02 hrs.) 11.**Boolean Algebra** 11.1 Boolean algebra, De Morgan's theorem, simplification of Boolean expressions 11.2 Number system, range extension of numbers, overflow 11.3 Different codes: gray code, ASCII code and BCD codes and them Applications. (01 hrs.) 12. **Logic Gates** 12.1 NOT, OR, AND, NOR, NAND, EX-OR, EX-NOR gates 12.2 Simplification of logic functions 12.3 Realizations of logic expressions using logic gates. (01 hrs.) 13. CRO and its applications and other test and measurement instruments. (01 hrs.)
Text Books, and/or reference material	Text Books: 1. Introduction Electronic Devices & Circuit Theory,11/e, 2012, Pearson: Boylestad&Nashelsky 2. Electronic Principles, by Albert Paul Malvino Dr. and David J. Bates, 7/e. Reference Books: 1. Integrated Electronics by Millman, Halkias and Parikh, 2/e, McGrawHill. 2. ELECTRONICS Fundamentals and Applications by Chattopadhyay and Rakshit,15/e, New Age Publishers. 3. The Art of Electronics by Paul Horowitz, Winfield Hill, 2/e, Cambridge University. 4. Electronics - Circuits and Systems by Owen Bishop, 4/e, Elsevier. 5. Electronics Fundamentals: Circuits, Devices & Applications by Thomas L. Floyd & David M. Buchla, 8/e, Pearson Education.

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

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ECC01	CO1	2	3	2	2	-	1	-	-	-	-	-	1
	CO2	3	2	1	2	2	1	-	2	2	-	-	1
	CO3	3	2	2	2	3	-	-	-	2	-	-	1
	CO4	3	3	2	2	-	-	-	-	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	
EEC01	ELECTRICAL TECHNOLOGY	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	Upon successful completion of this course, the student should be able to • CO1: learn the fundamentals of Electric Circuits and Network theorems and analysis of electrical network based on these concepts. • CO2: develop an idea on Magnetic circuits, Electromagnetism and learning the working principles of some fundamental electrical equipment's • CO3: learn about single phase and poly-phase AC circuits and analysis of such circuits based on these concepts. • CO4: introduce the basic concept of single-phase transformer. • CO5: analyze the transient phenomena in electrical circuits with DC excitation.
Topics Covered	Introduction: Overview of Electrical power generation systems (2) Fundamentals of Electric Circuits: Ohm's laws, Kirchhoff's laws, Independent and Dependent sources, Analysis of simple circuits. (4) Network theorems: Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem (4) Magnetic circuits: Review of fundamental laws of electromagnetic induction, transformer and rotational emfs, Solution of magnetic circuits. Analysis of coupled circuits (self-inductance, mutual inductance, and dot convention) (8) Transients with D.C. excitation for R-L and R-C circuits. (3) 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, Behavior of A.C. circuits, Resonance in series and parallel R-L-C circuits. AC Network: Superposition theorem, Thevenin's theorem, Norton's theorem, maximum power transfer theorem, solution of networks with AC sources. (10) Single-Phase Transformer, equivalent circuits, open circuit and short circuit tests (6) 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, Power measurement in 3-phase circuits. (5)
Textbooks/ Reference material	Textbooks: 1. Electrical & Electronic Technology by Hughes, Pearson Education India Reference Books: 1. Advanced Electrical Technology by H. Cotton, Reem Publication Pvt. Ltd 2. Electrical Engineering fundamentals by Vincent Deltoro, Pearson Education India

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

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	
BTC01	LIFE SCIENCE	PCR	2	0	0	2	2
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
		CT+MT+EA					

Course Outcomes	CO1: Basic understanding of basic cellular organization of organisms and cellular communications, structure and functions of the macromolecules and their biosynthesis and cata--bolism. CO2: To give an understanding of the key features of the structure, growth, physiology and behavior of bacteria, viruses, fungi and protozoa CO3: To introduce molecular biology to understand biological processes in various applications. CO4: To provide a foundation in immunological processes and an overview of the interaction between the immune system and pathogens. CO5: To provide knowledge about biological and biochemical processes that require engineering expertise to solve them
Topics Covered	**1. Cell Biology (4)** a) Introduction to life science: prokaryotes & eukaryotes Definition; Difference b) Introduction to cells - Define cell, different types of cell c) Cellular organelles - All organelles and functions in brief d) Cellular communications Introduction to basic signaling; endocrine, paracrine signaling; concepts of receptor, ligand, on-off switch by phosphorylation/dephosphorylation **2. Biochemistry (4)** a) Biological function of carbohydrate and lipid - Introduction, structure and function b) Biological function of nucleic acids and protein - structure and function c) Catabolic pathways of Macromolecules - Introduction to catabolism, hydrolysis and condensation reactions; Catabolism of glucose- Glycolysis, TCA; overall degradation of proteins and lipids d) Biosynthesis of Macromolecules Generation of ATP (ETS), Generation of Glucose (Photosynthesis) **3. Microbiology (5)** a) Types of microorganisms and their general features - Bacteria, Yeast, Fungi, Virus, Protozoa- general introduction with practical significance and diseases b) Microbial cell organization - Internal and External features of cell- bacterial cell wall, viral capsule, pilus etc, c) Microbial nutritional requirements and growth - Different Sources of energy; growth curve d) Basic microbial metabolism - Fermentation, Respiration, Sulfur, N_2 cycle **4. Immunology (5)** a) Basic concept of innate and adaptive immunity - Immunity-innate and adaptive, differences, components of the immune system b) Antigen and antibody interaction - Antigen and antibody, immunogen, factors affecting immunogenicity, basic antigen-antibody mediated assays, introduction to monoclonal antibody c) Functions of B cell - B cell, antibody production, memory generation and principle of vaccination d) Role of T cell in cell-mediated immunity - Th and Tc, functions of the T cell with respect to different pathogen and cancer cell **5. Molecular Biology (5)** a) Prokaryotic Genomes (Genome organization & structure) - Nucleoid, circular or linear b) Eukaryotic Genomes (Genome organization & structure) - Intron, exon, packaging, chromatin c) Central Dogma (Replication, Transcription and Translation) d) Applications of Molecular Biology (Diagnostics, DNA-fingerprinting, Recombinant products etc.) - Introduction to Recombinant DNA, fingerprinting, cloning **6. Bioprocess Development (5)** a) Microbial growth kinetics - Batch, fed-batch and continuous systems, Monod Equation b) Enzyme kinetics, kinetics of enzyme inhibition and deactivation Definition of enzymes, activation energy, Concepts of Km, Vmax, Ki c) Microbial sterilization techniques and kinetics Introduction to sterilization, dry and moist sterilization d) Thermodynamics of biological system - Concepts of Enthalpy, Entropy, favorable

	reactions, exergonic and endergonic reactions e) Material and energy balance for biological reactions - Stoichiometry
Text Books, and/or reference material	1. Biotechnology 01 Edition, authored by U. Satyanarayana, BOOKS & ALLIED (P) LTD. 2. Biochemistry by Lehninger. McMillan publishers 3. Microbiology by Pelczar, Chan and Krieg, Tata McGraw Hill 4. Brown, T.A., Genetics a Molecular Approach, 4th Ed. Chapman and Hall, 1992 5. Kuby J, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002. 6. Bioprocess Engineering: Basic Concepts (2nd Ed), Shuler and Kargi, PHI.

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

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
BTC01	CO1	2	1	1	-	1	-	-	-	-	-	-	-
	CO2	2	1	1	-	1	-	1	-	-	-	-	-
	CO3	2	1	1	-	1	-	-	-	-	-	-	-
	CO4	2	1	1	-	1	-	-	1	-	-	-	1
	CO5	2	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	
XXC01	The Constitution of India and Civic Norms	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
NIL		CT+MT+EA					
Course Outcomes							
Topics Covered		**1.** Historical background of the Making of Indian Constitution (1 Hour) **2.** Preamble and the Philosophical Values of the Constitution (1 Hour) **3.** Brief Overview of Salient Features of Indian Constitution (1 Hour) **4.** Parts I & II: Territoriality and Citizenship (1 Hour) **5.** Part III: Fundamental Rights (2 Hours) **6.** Part IV: Directive Principles of State Policy (1 Hour) **7.** Part IVA: Fundamental Duties (1 Hour) **8.** Union Government: President, Prime Minister and Council of Ministers (2 Hours) **9.** Parliament: Council of States and House of the People (1 Hour) **10.** State Government: Governor, Chief Mister and Council of Ministers (1 Hour) **11.** State Legislature: Legislative Assemblies and Legislative Councils (1 Hour) **12.** Indian Judiciary: Supreme Court and High Courts (1 Hour) **13.** Centre-State Relations (1 Hour) **14.** Reservation Policy, Language Policy and Constitution Amendment (1 Hour)					
Text Books, and/or reference material		Primary Readings: 1) P. M. Bakshi, *The Constitution of India*, 18th ed. (2022) 2) Durga Das Basu, *Introduction to the Constitution of India*, 25th ed. (2021) 3) J.C. Johari, *Indian Government and Politics*, Vol. II, (2012) Secondary Readings: Granville Austin, *The Indian Constitution: Cornerstone of a Nation* (1966; paperback ed. 1999); Granville Austin, *Working a Democratic Constitution: The Indian Experience* (1999; paperback ed. 2003).					

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	**GRAPHICAL ANALYSIS USING CAD**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: Introduction to graphical solution of mechanics problems • CO2: Knowledge on graphical solution methods for solving equilibrium in coplanar force system • CO3: Introducing Maxwell diagram and solution of plane trusses by graphical method • CO4: Determination of centroid of plane figures by graphical method • CO5: Exposure to AutoCAD software for computer aided graphical solution						
Topics Covered	• Graphical analysis of problems on statics. [14] • Graphical solution of engineering problems using CAD (with the help of "AutoCAD") [14]						
Text Books, and/or reference material	1)… Engineering Drawing and Graphics – K Venugopal 2)… AutoCAD — George Omura 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
XES52	CO1	2	-	-	-	-	-	-	-	-	-	-	-
	CO2	1	2	-	-	-	-	-	-	-	-	-	-
	CO3	2	1	-	-	-	-	-	-	-	-	-	-
	CO4	2	1	-	-	-	-	-	-	-	-	-	-
	CO5	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	
CSS51	**COMPUTING LABORATORY**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: To understand the principle of operators, loops, branching statements, function, recursion, arrays, pointer, parameter passing techniques • CO2: To detail out the operations of strings • CO3: To understand structure, union • CO4: Application of C-programming to solve various real time problems						
Topics Covered	**List of Experiments:** 1. Assignments on expression evaluation 2. Assignments on conditional branching, iterations, pattern matching 3. Assignments on function, recursion 4. Assignments on arrays, pointers, parameter passing						

	5. Assignments on string using array and pointers 6. Assignments on structures, union
Text Books, and/or reference material	**Text Books:** 1. Let us C by Kanetkar 2. C Programming by Gottfried 3. Introduction to Computing by Balaguruswamy 4. The C-programming language by Dennis Ritchie **Reference Books:** 1. Computer fundamental and programming in C by P Dey and M. Ghosh 2. Computer fundamental and programming in C by Reema Thareja 3. programming with C by Schaum Series

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	-	1	-	-	-	-	-	-	-	-	-
	CO2	-	2	1	3	-	-	-	-	-	-	-	-
	CO3	-	1	-	2	1	-	-	-	-	-	-	-
	CO4	-	-	3	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	
ECS 51	**Basic electronics Lab**	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
NIL		CT+EA					
Course Outcomes	• CO1: Acquire idea about basic electronic components, identification, and behavior. • CO2: To determine IV characteristics of these Circuit elements for different applications. • CO3: Learn to analyze the circuits and observe and relate input and output signals.						
Labs Conducted.	1. To know your laboratory: To identify and understand the use of different electronic and electrical instruments. 2. To identify and understand name and related terms of various electronics components used in electronic circuits.: Identify different terminals of components, fid their values and observe numbering associate with it. 3. Use of oscilloscope and function generator: Use of oscilloscope to measure voltage, frequency/time and Lissajous figures of displayed waveforms. 4. Study of half wave and Full-wave (Bridge) rectifier with and without capacitor filter circuit.: 5. Realization of basic logic gates: Truth table verification of OR, AND, NOT, NOT and NAND logic gates from TTL ICs 6. Regulated power supply: study LM78XX and LM79XX voltage regulator ICs 7. Transistor as a Switch: study and perform transistor as a switch through NOT gate 8. Zenner diode as voltage regulator 9. To study clipping and Clamping circuits 10. To study different biasing cirtis. 11. Study of CE amplifier and observe its frequency response.						
Text Books, and/or reference material	Text Books: 1. Experiments Manual for use with Electronic Principles (Engineering Technologies & the Trades) by Albert Paul Malvino Dr., David J. Bates, et al. Reference Books: 1. The Art of Electronics 3e, by Paul Horowitz, Winfield Hill 2. Electronic Principles, by Albert Paul Malvino Dr. and David J. Bates						

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

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
ECS51	CO1	3	2	1	2	2	1	-	-	2	-	-	-
	CO2	3	2	2	2	3	-	-	-	2	-	-	-
	CO3	3	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	
EES51	ELECTRICAL TECHNOLOGY LABORATORY	PCR	0	0	2	2	1
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
None		CT+EA					

Course Outcomes	Upon successful completion of this course, the student should be able to • CO1: understand the principle of superposition. • CO2: understand the principle of maximum power transfer • CO3: understand the characteristics of CFL, incandescent Lamp, carbon lamp. • CO4: understand the calibration of energy meter. • CO5: understand open circuit and short circuit test of single-phase transformer. • CO6: analyze RLC series and parallel circuits • CO7: understand three phase connections. • C08: understand determination of B-H curve
Topics Covered	**List of Experiments:** 1. To verify Superposition and Thevenin's Theorem. 2. To verify Norton and Maximum power transfer theorem 3. Characteristics of fluorescent and compact fluorescent lamp 4. Calibration on energy meter 5. To perform the open circuit and short circuit test on single phase transformer 6. To study the balanced three phase system for star and delta connected load 7. Characteristics of different types of Incandescent lamps 8. Study of Series and parallel R-L-C circuit 9. Determination of B-H Curve for magnetic material
Textbooks, and/or reference material	Textbooks: 1. Handbook of Laboratory Experiments in Electronics and Electrical Engineering by A M Zungeru (Author), J M Chuma (Author), H U Ezea (Author) 2. Laboratory Courses in Electrical Engineering (5^{th} Edition) by S. G. Tarnekar, P. K. Kharbanda, S. B. Bodhke, S. D. Naik, D. J. Dahigaonkar (S. Chand Publications)

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	1	1	2	2	2	3
CO2	3	3	3	3	3	1	1	1	2	2	2	3
CO3	3	3	3	3	3	1	1	1	2	2	2	3

CO4	3	3	3	3	3	1	1	1	2	2	2	3
CO5	3	3	3	3	3	1	1	1	2	2	2	3
CO6	3	3	3	3	3	1	1	1	2	2	2	3
CO7	3	3	3	3	3	1	1	1	2	2	2	3
CO8	3	3	3	3	3	1	1	1	2	2	2	3

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**	
XXS-52	**Co-curricular Activities**	PCR	**0**	**0**	**2**	**2**	**1**
Pre-requisites	Course assessment methods: (Continuous evaluation((CE) and end assessment (EA)						
NIL	CE + EA						
Course Outcomes	• CO1: Social Interaction: Through the medium of sports • CO2: Ethics: Recognize different value systems including your own, understand the moral dimensions of your decisions, and accept responsibility for them • CO3: Self-directed and Life-long Learning: Acquire the ability to engage in independent and life-long learning in the broadest context socio-technological changes. • CO4: Personality development through community engagement • CO5: Exposure to social service						
Topics Covered	**YOGA** • Sitting Posture/Asanas- Gomukhasana, Swastikasana, Siddhasana, Ustrasana, Janusirsasana, Ardha Matsyendrasana (Half-Spinal Twist Pose), Paschimottanasana, Shashankasana, Bhadrasana. • Mudra- Vayu, Shunya, Prithvi, Varuna, Apana, Hridaya, Bhairav mudra. • Laying Posture/Asanas- Shalabhasana (Locust Posture), Dhanurasana (Bow Posture), Ardha Halasana (Half Plough Pose), Sarvangasana (Shoulder Stand), Halasana (Plough Pose), Matsyasana, Supta Vajrasana, Chakrasana (Wheel Posture), Naukasana (Boat Posture), Shavasana (Relaxing Pose), Makaraasana. • Meditation- 'Om'meditation, Kundalini or Chakra Meditation, Mantrameditation. • Standing Posture/Asanas- Ardha Chakrsana (Half Wheel Posture), Trikonasana (Triangle Posture), Parshwa Konasana (Side Angle Posture), Padahastasana, Vrikshasana (Tree Pose), Garudasana (Eagle Pose). • Pranayama- Nadi sodha, Shitali, Ujjayi, Bhastrika, Bhramari. • Bandha- Uddiyana Bandha, Mula Bandha, Jalandhara Bandha, Maha Bandha. • Kriya- Kapalabhati, Trataka, Nauli. **ATHLETICS** • Long Jump- Hitch kick, Paddling, Approach run, Take off, Velocity, Techniques, Flight & Landing • Discus throw, Javelin throw and Shot-put- Basic skill & Technique, Grip, Stance, Release & Follow through. • Field events marking. • General Rules of Track & Field Events. **BASKETBALL** • Shooting- Layup shot, Set shot, Hook shot, Jump shot. Free throw. • Rebounding- Defensive rebound, Offensive rebound. • Individual Defensive- Guarding the man without ball and with ball. • Pivoting. • Rules of Basketball.						

- Basketball game.

VOLLEYBALL

- Spike- Straight spike, Body turn spike, Tip spike, Back attack, Slide spike, Wipe out spike.
- Block- Single block, Double block, Triple block, Group block.
- Field Defense- Dig pass, Double pass, Roll pass.
- Rules and their interpretation.

FOOTBALL

- Dribbling- Square pass, Parallel pass, Forward pass.
- Heading (Standing & Running)- Fore head, Side fore head, Drop heading, Body covering during heading.
- Kicking- Full volley, Half volley, Drop kick, Back volley, Side volley, Chiping (lobe).
- Tackling: Covering the angle, Chessing time sliding chese, Heading time shoulder tackle etc.
- Feinting- Body movement to misbalance the opponent and find space to go with ball.
- Rules of Football.

CRICKET

- Batting straight drive.
- Batting pull shot.
- Batting hook shot.
- Bowling good length, In swing.
- Bowling out swing, Leg break, Goggle.
- Fielding drill.
- Catching (Long & Slip).
- Wicket keeping technique.
- Rules & Regulation.

BADMINTON

- Net play- Tumbling net shot, Net Kill, and Net Lift.
- Smashing.
- Defensive high clear/Lob.
- Half court toss practice, Cross court toss drop practice, Full court Game practice.
- Player Positioning, Placements.
- Rules & Regulation.
- Doubles & Mixed doubles match practice.

TABLE TENNIS

- Stroke: Backhand- Topspin against push ball, Topspin against deep ball, Topspin against rally ball, Topspin against topspin.
- Stroke: Forehand- Topspin against push ball, Topspin against deep ball, Topspin against rally ball, Topspin against topspin.
- Stroke- Backhand lob with rally, Backhand lob with sidespin, Forehand lob with rally, Forehand lob with sidespin.
- Service: Backhand/Forehand- Push service, Deep push service, Rally service.
- Service: Backhand sidespin (Left to right & Right to left).
- Service: Forehand- High toss backspin service, High toss sidespin service, High toss reverse spin service.
- Rules and their interpretations.
- Table Tennis Match (Singles & Doubles).

NCC

- FD-6 Side pace, Pace Forward and to the Rear.
- FD-7 Turning on the March and Wheeling.
- FD-8 Saluting on the March.
- FD-9 Marking time, Forward March and Halt in Quick Time.
- FD-10 Changing step.
- FD-11 Formation of Squad and Squad Drill.
- FD-12 Parade practice.

TAEKWONDO

	• Poomsae (Forms)- Jang, Yi Jang. • Self Defense Technique- Self defense from arms, Fist and Punch. • Sparring (Kyorugi)- One step sparring, Two step sparring, Fight (Free sparring). • Combination Technique- Combined kick and punch. • Board Breaking (Kyokpa)- Sheet breaking. • Interpretation Rules above Technique of Taekwondo. **NSS** • No Smoking Campaign • Anti- Terrorism Day Celebration • Any other observation/celebration proposed by Ministry/institute • Public Speaking • Discussion on Current Affairs • Viva voce

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

Course	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
XXS52	CO1	-	-	-	-	-	2	-	-	3	-	-	-
	CO2	-	-	-	-	-	-	-	2	-	-	-	-
	CO3	-	-	-	-	-	-	1	-	-	-	-	3
	CO4	-	-	-	-	-	-	-	-	2	2	-	-
	CO5	-	-	-	-	-	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	**ECC331**	**Analog Electronics**	**3**	**1**	**0**	**4.0**	**4**
5	**PHC332**	**Electromagnetic Field Theory**	**3**	**0**	**0**	**3.0**	**3**
6	**PHS382**	**Physics Laboratory**	**0**	**0**	**3**	**1.5**	**3**
7	**EES351**	**Electrical and Electronics Measurements Lab**	**0**	**0**	**3**	**1.5**	**3**
8	**XXS381**	**Co-curricular Activities - III (Optional)**	**0**	**0**	**0**	**0.0**	**0**
		TOTAL	**15**	**4**	**6**	**22.0**	**25**

Department of Mathematics							
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	
MAC331	MATHEMATICS-III	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
Basic knowledge of topics included in		CT+MT+EA					

MAC01 & MAC02	
Course Outcomes	• 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.
Topics Covered	**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: Complimentary 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 formulae; 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]
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	PO7	PO8	PO9	PO10	PO11	PO12
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)

<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>EEC301</td><td>NETWORK ANALYSIS AND SYNTHESIS</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">MAC02(MATHEMATICS -II), EEC01 (ELECTRICAL TECHNOLOGY)</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">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 two port network function, analyze and design different filters.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Network Theorems 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. (5)
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. (6)

Time and Frequency 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. (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: poles and zeros 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. Bode plot. (5)

Fundamentals of Network Synthesis: Causality and stability, Hurwitz polynomials, positive real functions, synthesis of one port networks with two kinds of elements. Properties and synthesis of L-</td></tr>
</table>

	C, R-C, R-L driving point impedances, synthesis of R-L-C functions. Properties of transfer functions, zeros of transmission, synthesis of Y21 and Z21 with a 1- Ohm termination, synthesis of constant - resistance networks. (12) Passive Filter as a Two Port Network - Characteristics of Ideal Filter - Low pass and High Pass Filter. Design of constant K, m derived and composite filters (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)

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	
EEC302	ELECTRICAL & ELECTRONIC MEASUREMENT	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
None		CT+MT+EA					
Course Outcomes	• CO1: develop an idea about the measurement processes • CO2: learn the operating principle of ammeter, voltmeter, wattmeter and energy meter • CO3: gain knowledge about Potentiometer and various resistance measurement techniques • CO4: acquire knowledge of AC Bridges & Instrument Transformers • CO5: get familiarize with CRO and introduction to Digital Instrumentation						
Topics Covered	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 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 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 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	
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) Basic Electronics (ECC01)	CT+MT+EA
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)

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**	
PHC332	**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: Able to apply fundamental knowledge of different co- ordinate systems to describe the spatial variations of the physical quantities dealt in electromagnetic field theory. CO2: Able to explain fundamental laws governing electromagnetic fields and evaluate the physical quantities of electromagnetic 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 Field and Maxwell's Equations** Vector field, Divergence of vector field, Divergence of electrostatic field, Gauss's divergence theorem, Gauss's Law of electrostatics and its applications, Laplace's equation, Poisson's equation, Continuity equation. [7] Curl of a vector field, Stoke's theorem, Curl of magnetic field, Ampere's Circuital law and its applications, Curl of electric field and divergence of magnetic field, Concepts of scalar and vector potentials. [7] Faraday's law of electromagnetic induction, Self-Inductance, Mutual-Inductance, L-C-R Circuit, Concept of displacement current, Maxwell's equation in free space, Poynting theorem. Some examples. [9] **Electromagnetic Waves** Derivation of the electromagnetic wave equation. Plane waves in vacuum. Energy, Momentum and intensity of electromagnetic waves. Electromagnetic waves in isotropic, Anisotropic medium, Conducting medium. Skin effect. Propagation of electromagnetic waves in ionized gases, Reflection, Refraction and Dispersion of electromagnetic waves, Fresnel's equations. Some examples. [12] **Wave Guide** Wave guides, TE, TM and TEM waves, Transmission line and Telegrapher's equation. [7]
Text Books, and/or reference material	**TEXT BOOKS:** 1. Introduction to Electrodynamics, David J. Griffiths, Prentice-Hall International, Inc., Englewood Cliffs. 2. Foundations of Electromagnetic Theory, J. R. Reitz, F. J. Milford and R. W. Christy, Addison-Wesley Publishing Company, Inc. 3. Introduction to Electromagnetic Theory – A Modern Perspective, T. L. Chow, Jones and Bartlett Publishers, Inc. **REFERENCE BOOKS:** 1. Classical Electricity and Magnetism, W. K. H. Panofsky and M. Phillips, Addison-Wesley. 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)

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	
PHS382	**Physics Laboratory**	PCR	**0**	**0**	**3**	**3**	**1.5**
Pre-requisites		Course Assessment methods (Continuous (CT), and end assessment (EA))					
PHS51		CT+EA					
Course Outcomes	CO1: To realize and apply different techniques for measuring resonance, Q-factor of series L-C-R circuit. CO2: To determine the Self-Inductance, Mutual Inductance and verification of Faraday's law. CO3: To determine the thermoelectric power of a given thermocouple. CO4: To apply the concepts to measure the horizontal component of the earth's magnetic field using a						

	vibrational and deflection magnetometer CO5: To calculate the loss of a magnetic specimen by B-H loop measurement.
Topics Covered	1. Study of series L-C-R Resonant Circuit: (i) To draw the resonance curve (ii) To determine the Q- Factor of the circuit (iii) To study the variation of impedance with frequency (iv) verification of maximum power transfer theorem. 2. Verification of Faraday's law. 3. To determine the mutual inductance (M) of two coils. 4. Determination of Self-Inductance of a coil. 5. To verify Fresnel's equation for reflection of electromagnetic waves. 6. Draw the (Thermo EMF) – Temperature curve of given thermocouple and hence find thermoelectric power at a given temperature. 7. Determination of horizontal component of the earth's magnetic field using a vibrational and deflection magnetometer. 8. To draw the B-H loop of a given specimen.
Text Books, 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
PHS382	CO1	3	2	1	-	2	1	1	2	3	2	1	1
	CO2	3	2	1	-	2	1	1	2	3	2	1	1
	CO3	3	2	1	1	2	1	1	2	3	2	1	1
	CO4	3	2	1	-	2	1	1	2	3	2	1	1
	CO5	3	2	1	1	1	1	1	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	
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)

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	**MEC431**	**Fluid and Thermal Engineering**	**3**	**0**	**0**	**3.0**	**3**
5	**YYO44***	**Open Elective - I**	**3**	**0**	**0**	**3.0**	**3**
6	**EES451**	**Network Analysis and Synthesis Laboratory**	**0**	**0**	**3**	**1.5**	**3**
7	**ECS481**	**Analog Electronics Laboratory**	**0**	**0**	**3**	**1.5**	**3**
8	**MES481**	**Fluid and Thermal Engineering Laboratory**	**0**	**0**	**3**	**1.5**	**3**
9	**XXS481**	**Co-curricular Activities - IV (Optional)**	**0**	**0**	**0**	**0.0**	**0**
		TOTAL	**15**	**3**	**9**	**22.5**	**27**

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. • CO2: To learn the fundamentals of different numbers of systems and codes and code conversion techniques. • CO2: To study about the Boolean algebra and basic logic gates along with their digital design procedure using elementary logic gates. • CO3: To learn about the different sequential and combinational logic circuits and their use in digital electronics applications. • CO4: Learn about the Analog to Digital Converter (ADC), Digital to Analog Converter (DAC), and data conversion and acquisition techniques. • CO5: To study the different types of Codes (Gray code, Excess-3 code, BCD Code etc.) and Code converters						
Topics Covered	Introduction to Digital Electronics: History and Evolution of Computation and Computers, Application of Digital Electronics in Modern Society. (4) 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, BCD to 7-Segment Decoder: 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, Realization of logic gates using switches. (6) Digital Arithmetic and Arithmetic Circuits: Half Adder, Full Adder, Half Subtractor, Full Subtractor, Multi-Bit Ripple-Carry Adder and Subtractor circuits, Basics of Binary Multiplier and Divider Circuits. (5) Logic Families: Transistors (MOS and BJT) as switch, Different logic families such as RTL, DCTL, DTL, HTL, TTL, ECL, MOS & CMOS logic family their importance and applications. (5)						

	Minimization Techniques Logic Synthesis: Demorgan's Theorem, SOP/POS forms, Minimization of logical function, Algebraic method, Karnaugh Map method, Quine Mccluskey Method. (6) Combinational Circuits: Multiplexer, Demultiplexer, Decoder, Encoder, Decoder Driver, Combinational Circuit Design and Their Applications. (6) Sequential Circuits: Definition, Moore and Miley Machines; Elements of Sequential Circuits - Latches and Registers, Different kinds of Flip-Flops - R-S, J-K, Master-Slave arrangement, D, and T Type Registers; Typical sequential circuits -counters, shift registers and sequence generator; synchronous and asynchronous circuits. (8) Multivibrators: Definition of different types of Multivibrators, their realization by logic gates, op-amp and transistors, 555 Timer IC and Schmitt Trigger circuit and their applications. (6) A/D & D/A Converter: Need for Data conversion, Analog to Digital Converter (ADC), Digital to Analog Converter (DAC), and data conversion and acquisition techniques, Different types of DAC & ADC ICs, data conversion and acquisition techniques, Introduction to GUI and PC Based Data Acquisition Systems, Data Acquisition System Components (Software and Hardware).(4)
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)

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 etc.

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)

Open Elective: Basket– 1 (4th Semester)

Subject Code	Subject Name
EEO440	**Fundamentals of Power Systems**
EEO441	**Concept of Industrial Electronics**
EEO442	**Energy Conservation, Audit and ICT & IOT Application for Monitoring**
EEO443	**Network Theory**

<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>EEO440</td><td>FUNDAMENTALS OF POWER 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">Nil</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• 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.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">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</td></tr>
</table>

	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	
EEO441	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 403(DIGITAL ELECTRONICS)		CT+MT+EA					
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) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEO442	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)

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	
EEO443	NETWORK THEORY	PEL	3	0	0	3	3
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	• 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.
Topics Covered	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) 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	
EES451	NETWORK ANALYSIS AND SYNTHESIS LABORATORY	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT), and end assessment (EA))					
		CT+EA					

Course Outcomes	• 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.
Topics Covered	**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
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. 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	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 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	
ECS481	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)

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	**CONTROL SYSTEM ENGINEERING**
EEC-432	**ELECTRICAL MACHINES**
EES481	**CONTROL SYSTEMS LABORATORY**
EES-482	**ELECTRICAL MACHINES LABORATORY**

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	
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	**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:** 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) **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, Concept of Stable and Unstable 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. Design using root locus (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 (Program 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)

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	
EEC-432	ELECTRICAL MACHINES	PCR	2	1	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: Theory of electromechanical energy conversion, the concepts of voltage generation and fundamental torque equation. • CO2: Basic understanding of the principles of operation and construction of direct and alternating current machines and transformers. • CO3: A study of theory and concept of Electric Machines (AC & DC). • CO4: Deriving equivalent circuit of electrical machines. • CO5: Studying the performance and characteristics of Electrical machines (AC & DC).
Topics Covered	Basic principle of Faraday's law of electro-magnetic induction, energy conversion and magnetic circuit. (4) Transformer: Construction and principle of operation of single-phase transformer, Step-up and Step-down transformer, E.M.F. equation, Equivalent circuits, phasor diagram, Open circuit and short circuit tests, losses and efficiency, All day efficiency, Auto transformer. (8) D.C. Machines Construction, Methods of excitation and classifications, Simple lap and wave windings, emf equation, characteristics of different dc generator, armature reaction, Commutation, Back e.m.f in a d.c. motor, Motor Starter, Speed and torque equations, Speed vs torque characteristics and speed control of DC motors, losses in dc machines, Applications. (12) Induction Motor: Pulsating and rotating magnetic field construction and principle of operation of Single and three phase induction motors, cage and wound rotor induction motors, comparison between them slip, equivalent circuits, no load and blocked rotor tests, Circle diagram, Torque/speed curve Starting and speed control, Applications of single phase and three phase induction motors. (12) Synchronous Machines: Construction-alternators-turbo & hydro generators, principle of operation, emf equation, excitation control, synchronization load sharing synchronous motor operation, Synchronous condenser, applications of synchronous generator and motor. (6)
Text Books, and/or reference material	Text Books: 1. Electrical Machinery by P S Bimbhra 2. Electrical Technology Vol-II by B L Thereza Reference Book: 1.Electrical Machines by J B Gupta

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	2	2	2	2	3	1	1	1	2	3	2	1
CO3	2	2	2	2	3	1	1	1	2	3	2	1

CO4	3	3	3	3	2	1	1	1	2	3	2	1
CO5	3	3	3	3	2	1	1	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="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>EES481</td><td>CONTROL SYSTEMS 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">ECC303(SIGNALS AND SYSTEMS)</td><td colspan="5">CT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">• CO 1: To understand the dynamic behaviour 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 MATLAB programming, MATLAB-SIMULINK in order to simulate, analyze and design of control system design for different plants under consideration.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">List of Experiments:
1. DC Servo Speed Control System
2. DC Servo Position Control System
3. Temperature Control System 4. Linear System Simulator
5. Lead and Lag Network
6. P, PI and PID controller
7. Study of Different real-time systems through Simulation in MATLAB
8. PID Design Method for DC motor Speed Control using MATLAB
9. Root Locus Design Method for DC motor Speed Control using MATLAB
10.DC motor Speed Control Based on Frequency Response using MATLAB</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="7">Suggested Text Books:
1. J. Nagrath and M Gopal, Control system Engineering, New Age InternationalPublishers.
2. 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</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	2	3	3	2	2	1	3	1	3	3
CO2	3	3	2	3	3	3	3	1	3	1	3	3
CO3	3	3	2	3	3	2	2	1	3	1	3	3
CO4	3	3	2	3	3	2	2	1	3	1	3	3

CO5	3	3	2	3	3	2	2	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	
EES-482	ELECTRICAL MACHINES LABORATORY	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT), and end assessment (EA))					
EES51(ELECTRICAL TECHNOLOGY LAB), EEC432 (ELECTRICAL MACHINES)		CT+EA					
Course Outcomes	• CO1: Ability to determine the equivalent circuit parameters of a single-phase transformer • CO2: Ability to determine the parameters of single-phase as well as three phase induction motor. • CO3: Ability to determine the characteristics of dc shunt generator and series generator • CO4: Ability to control the speed of a dc shunt motor • CO5: Ability evaluate the voltage regulation of an alternator • CO6: Ability to determine the efficiency of dc machines						
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. Voltage regulation of an alternator. 6. To perform no-load and blocked-rotor tests on a three-phase Induction Motor. 7. To perform no-load and blocked-rotor tests on a single-phase Induction Motor. 8. Swinburne's test of a dc machine.						
Text Books, and/or reference material	Text Books: 1. Electrical Machinery by P S Bimbhra 2. Electrical Technology Vol-II by B L Thereza Reference Book: 1. Electrical Machines by J B Gupta						

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	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	1	2	1	1	1	2	3	2	1

Correlation levels 1, 2 or 3 as defined below:

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

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	**YYO54***	**Open Elective - 2**	**3**	**0**	**0**	**3.0**	**3**
6	**ECS581**	**Digital Electronics Laboratory**	**0**	**0**	**3**	**1.5**	**3**
7	**EES551**	**Control Systems Laboratory**	**0**	**0**	**3**	**1.5**	**3**
8	**EES552**	**Electrical Machines Laboratory - I**	**0**	**0**	**3**	**1.5**	**3**
9	**XXS581**	**Co-curricular Activities - V (Optional)**	**0**	**0**	**0**	**0.0**	**0**
		TOTAL	**15**	**4**	**9**	**23.5**	**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 design an AC machine and distinguish it from a DC 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	**Synchronous Generator:** Constructional Features of Salient Pole and Non-Salient Pole Machines, Arrangement of Field Winding in the two types of Machines. Armature Winding. (5) **Cylindrical Rotor Theory:** Phasor Diagram, Open Circuit and Short Circuit Characteristics, Synchronous Reactance, Load Characteristics, Zero Power Factor Characteristics, Voltage Regulation by different methods, Power Angle Characteristics. (10) **Salient-Pole Theory:** Blondel's Two-Reaction Concept, Direct Axis and Quadrature Axis Synchronous Reactance, Power Angle Characteristics, Slip Test. (3) Parallel Operation of synchronous generators, Load sharing. (4) **Synchronous Motor:** Constructional features, Methods of Starting, Phasor Diagram, Torque and Power Relations in Non-Salient Pole and Salient Pole Motors, V-Curves, Various Types of Excitations, Synchronous Condenser, Applications. (8) **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) / Electives (PEL)	Total Number of contact hours				Credit
			Lecture (L)	Tutorial (T)	Practical (P)	Total 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, 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 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 model state models for linear Continuous-time systems, 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="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>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="5">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="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">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="6">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 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)</td></tr>
<tr><td>Text Books, and/or reference material</td><td colspan="6">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</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	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)

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	
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)

Open Elective: Basket– 2 (5th Semester)

Subject Code	Subject Name
EEO540	**Measurement and Instrumentation**
EEO541	**Fundamentals of Control Systems**
EEO542	**Power System Analysis and Design**

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	
EEO540	MEASUREMENTS AND INSTRUMENTATION	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: 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.
Topics Covered	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) 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:

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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	
EEO541	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
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:

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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	
EEO542	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	
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:

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	
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:

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

Semester - VI						
Code	**Subject**	**L**	**T**	**S**	**C**	**H**
HSC631	**Economics and Management Accountancy**	**3**	**0**	**0**	**3.0**	**3**
EEC601	**Advanced Power Systems**	**3**	**1**	**0**	**4.0**	**4**
EEC602	**Microprocessor and Microcontroller**	**3**	**1**	**0**	**4.0**	**4**
EEE610 --	**Depth Elective - 1**	**3**	**0**	**0**	**3.0**	**3**
EEE610 --	**Depth Elective - 2**	**3**	**0**	**0**	**3.0**	**3**
EES651	**Electrical Machines - II Laboratory**	**0**	**0**	**3**	**1.5**	**3**
EES652	**Power Electronics Laboratory**	**0**	**0**	**3**	**1.5**	**3**
EES653	**Power System Laboratory**	**0**	**0**	**3**	**1.5**	**3**
XXS681	**Co-curricular Activities - VI (Optional)**	**0**	**0**	**0**	**0.0**	**0**
	TOTAL	**15**	**2**	**9**	**21.5**	**26**

Department of Management Studies				
Course	Title of the course	Program Core	Total Number of contact hours	Credit

Code		(PCR) / Electives (PEL)	Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
HSC631	Economics and Management Accountancy	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: 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.

Topics Covered

PART 1: Economics

Group A: Microeconomics

Sl. No.	Name	L	T	P	Cr	H
Unit 1:	Economics: Basic Concepts	2	0	0	2	2
Unit 2:	Theory of Consumer Behavior	3	0	0	3	3
Unit 3:	Theory of Production, Cost and Firms	3	0	0	3	3
Unit 4:	Analyses of Market Structures: Perfect Competition	3	0	0	3	3
Unit 5:	Monopoly Market	2	0	0	2	2
Unit 6:	General Equilibrium & Welfare Economics	2	0	0	2	2
	TOTAL	**15**	**0**	**0**	**15**	**15**

Group B: Macroeconomics

Sl. No.	Name	L	T	P	Cr	H
Unit 1:	Introduction to Macroeconomic Theory	2	0	0	2	2
Unit 2:	National Income Accounting	3	0	0	3	3
Unit 3:	Determination of Equilibrium Level of Income	4	0	0	4	4
Unit 4:	Money, Interest and Income	2	0	0	2	2
Unit 5:	Inflation and Unemployment	2	0	0	2	2
Unit 6:	Output, Price and Employment	2	0	0	2	2
	TOTAL	**15**	**0**	**0**	**15**	**15**

PART 2: Management Accountancy

Sl. No.	Name	L	T	P	Cr	H
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	ADVANCED POWER SYSTEMS	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 basics of High Voltage Engineering & power system stability • CO2: To design the insulation system and load management module • CO3: To design the High Voltage test system and Laboratory • CO4: To learn about the testing of High Voltage power apparatus and to understand on line monitoring and conditioned monitoring • CO5: Given specification of stability analysis leads to modeling of power system equipment's like transmission line, generator and design system to obtain operating limits to satisfy the reliability criteria. • CO6: Given specification leads to knowledge of regulation of active, reactive power and frequency of any system and its application in optimal load flow and scheduling						
Topics Covered	Overview of Insulation, Air as an Insulation, Concept of Dielectric Strength, Electric field and electrode configuration, Parameters responsible for Break down Voltage of Insulating material (4) Introduction to Breakdown of Insulation. Breakdown mechanism of insulting systems of Gas, Liquid, Solid, and Vacuum (7) Generation of AC high voltages and DC High Voltages, Generation of impulse voltages and currents: - Analysis of different circuits, Marx multi-stage impulse generator (8) Testing of High Voltage power Apparatus. Brief reviews of high voltage testing-Methods for High Voltage Power Apparatus, Introduction to Lightning phenomenon, Insulation Coordination. (5) Introduction to partial discharge phenomena and concepts of Online testing (3) Planning and Designing of High Voltage laboratory, Introduction of High Voltage virtual Laboratory (HVVL) and ICT enabled High Voltage laboratory (3) HVDC Transmission: Introduction, classification, Stability limits, HVDC cable transmission, economic comparison, conversion of three phase AC line to DC line, Advantages of HVDC transmission, Economic distance of HVDC transmission, components of an HVDC transmission (4) HVDC Converter station, converter unit, converter transformer, filters, reactive power source, smoothing reactor, HVDC system pole, ground electrodes, back-to-back HVDC station, two terminal HVDC systems, Multi terminal DC systems, DC circuit breakers, Limitations of HVDC transmission, application of HVDC transmission. (7)					

	Load flow studies: Network model formulation, Gauss- Siedel method, Newton-Raphson method, Decoupled load flow studies, comparison of load flow methods. (4) Economic operation of power system: Incremental fuel cost, economic dispatch neglecting transmission losses, General loss formula, Optimum load dispatch considering transmission losses. (3) 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. (8)
Text Books, and/or reference material	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
CO6	3	2	2	1	1	2	1	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 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	
EEC602	MICROPROCESSOR & MICROCONTROLLER	PCR	3	1	0	4	4
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC403 (DIGITAL ELECTRONICS)		CT+MT+EA					
Course Outcomes	• 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.						
Topics Covered	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)
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)

2018 ONWARD UNDERGRADUATE ADMISSION BATCH

DEPTH ELECTIVE COURSE BASKETS

THE STUDENTS PRIMARILY WILL OPT FROM THE DEPTH ELECTIVE SUBJECT(S) THAT ARE OFFERED IN A PARTICULAR SEMESTER BY HIS/ HER OWN DEPARTMENT. HOWEVER, A STUDENT CAN OPT FOR DEPTH ELECTIVE SUBJECT(S) THAT ARE OFFERED BY OTHER DEPARTMENT IN A PARTICULAR SEMESTER, WITH THE PERMISSION/ CONSENT FROM HIS/ HER HEAD OF THE DEPARTMENT AND THE CONCERNED TEACHER OF THAT SUBJECT

Departmental Elective: SIXTH SEMESTER

Subject Code	Subject Name
EEE610	Numerical Analysis
EEE611	Instrumentation
EEE612	Modern Control Systems
EEE613	Special Electrical Machines
EEE614	Signals and Systems
EEE615	Advanced Power Electronics
EEE616	Soft Computing Theory and Applications

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	
EEE610	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	
EEE611	INSTRUMENTATION	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
ECC331 (ANALOG ELECTRONICS), EEC403 (DIGITAL ELECTRONICS)		CT+MT+EA					
Course Outcomes	• 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.						
Topics Covered	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 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	
EEE612	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 • CO2: To analyses LTI continuous systems with state variable representation • CO3: To understand the advantages of state variable feedback control • CO4: To understand optimal control • CO5: To learn the concept of optimal filtering and state estimation as an essential part of control system design						
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. (4) Canonical state variable models, controllability, and observability. (4) Linear State variable Feedback, Observer design. (4)						

	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. (8) Stochastic Optimal Linear Estimation and Control: Linear Quadratic Guassian Control, Optimal filtering, Estimation, Kalman Bucy filter, Kalman filtering (8)
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	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	
EEE613	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	

EEE614	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 continuous and discrete signals and systems, sampling process. • CO2: To analyze LTI discrete time systems in time domain. • CO3: To understand and frequency response of continuous and discrete time signals and system. • CO4: To learn time frequency characterization of signal and systems • CO5: To get the knowledge of communication systems • CO6: To understand the concept of linear feedback system.
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 (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 (4) 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) Communication systems: Sinusoidal Amplitude Modulation, Demodulation sinusoidal AM, Discrete time Modulation (4) The Z-transform: Review, Analysis of LTI system in z-domain. (4) 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**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**1**

CO6	**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	
EEE615	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 circuits applicable to converters. (2) Applications: DC Drives, AC Drives, Power Conditioners and Uninterruptible Power Supplies, Power Line Disturbances, Power Conditioners, UPS. (6) Other Residential and Industrial Applications: Electronic ballast, Induction Heating, Electrical Welding, Static Circuit Breakers, Solid State Relays, HVDC Transmission, Static Var Compensators. Integration of Renewable Energy in Electric Power Systems. (12)
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="6">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>EEE616</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">EEE610 (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</td></tr>
</table>

	and crossover, comparisons among DE, PSO and GA, Examples, new 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

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	
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)

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	
EES652	POWER ELECTRONICS LABORATORY	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), EEC501 (ELECTRICAL MACHINES-II)		CT+EA					
Course Outcomes	• 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
Topics Covered	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 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
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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:

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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	
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: The Power system Laboratory includes the protection schemes and simulation related experiments. Facilities are available for over current, over voltage, directional, differential and distance relays including different numerical relays, Feeder Protection. Varieties of Power system Simulation packages like Load flow using MATLAB, EUROSTAG and MiPower are available. 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 MiCOM P442. 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. Over-current and Earth fault protection scheme for three phase system. 11. To study load flow and different dynamic events of the given network using EUROSTAG / Mi Power software 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:

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

Semester - VII						
Code	**Subject**	**L**	**T**	**S**	**C**	**H**
MSC731	**Principles of Management**	**3**	**0**	**0**	**3.0**	**3**
EEE710 --	**Depth Elective - 3**	**3**	**0**	**0**	**3.0**	**3**
EEE710 --	**Depth Elective - 4**	**3**	**0**	**0**	**3.0**	**3**
EEE710 --	**Depth Elective - 5**	**3**	**0**	**0**	**3.0**	**3**
YYO74*	**Open Elective - 3**	**3**	**0**	**0**	**3.0**	**3**
EES751	**Microprocessor and Microcontroller Laboratory**	**0**	**0**	**3**	**1.5**	**3**
EES752	**Advanced Power System Laboratory**	**0**	**0**	**3**	**1.5**	**3**
EES753	**Electrical machine Design Laboratory**	**0**	**0**	**3**	**1.5**	**3**
EES754	**Vocational Training / Summer Internship and Seminar**	**0**	**0**	**2**	**1.0**	**2**
EES755	**Project - I**	**0**	**0**	**3**	**1.0**	**3**
	TOTAL	**15**	**0**	**14**	**21.5**	**29**

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 MANAGEMENT**	PCR	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: To make budding engineers aware of various management functions required for any organization • CO2: 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 both in 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 **(8)** **UNIT II:** Quantitative tools and techniques used in management: Forecasting techniques, Decision analysis, PERT & CPM as controlling technique **(7)** **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:** Finance and Accounting: Basics of Financial management of an organization, Preparation of Final Accounts, Analysis of Financial statements, Cost Volume Profit (CVP) Analysis, An overview of financial market with special reference to India. **(12)**
Text Books, and/or reference material	Text Books: 1. Financial Management, 11th Edition, I M Pandey, Vikas Publishing House. 2. Marketing Management 15th Edition, Philip Kotler and Kelvin Keller, Pearson India 3. Management Principles, Processes, and practice, first edition, Anil Bhat and Arya Kumar, Oxford Higher education 4. Organizational Behavior,13 th edition, Stephen P Robbins, Pearson Prentice Hall India 5. Operations Management, 7th edition (Quality control, Forecasting), Buffa & Sarin, Willey

CO-PO mapping														
Course Code	**Course Title**	**COs**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
MSC731	**Principles of Management**	**CO1**									**3**	**2**	**2**	
		CO2				**2**					**2**	**2**		
		CO3				**2**					**3**	**2**		
		CO4							**1**		**3**			
		CO5				**2**					**2**	**2**	**2**	

2018 ONWARD UNDERGRADUATE ADMISSION BATCH

DEPTH ELECTIVE COURSE BASKETS

THE STUDENTS PRIMARILY WILL OPT FROM THE DEPTH ELECTIVE SUBJECT(S) THAT ARE OFFERED IN A PARTICULAR SEMESTER BY HIS/ HER OWN DEPARTMENT. HOWEVER, A STUDENT CAN OPT FOR DEPTH ELECTIVE SUBJECT(S) THAT ARE OFFERED BY OTHER DEPARTMENT IN A PARTICULAR SEMESTER, WITH THE PERMISSION/ CONSENT FROM HIS/ HER HEAD OF THE DEPARTMENT AND THE CONCERNED TEACHER OF THAT SUBJECT

Departmental Elective: SEVENTH SEMESTER

Subject Code	Subject Name
EEE710	Renewable Energy Systems
EEE711	Advanced Power Converters
EEE712	Generalized Theory of Electrical Machines
EEE713	Electrical Drives
EEE714	Power System Planning, Operation and Control
EEE715	Embedded Systems
EEE716	FACTS Device
EEE717	Generation & Utilization of Electrical Power
EEE718	Advanced Control Systems
EEE719	Microprocessor & Embedded Systems
EEE720	Digital Signal Processing
EEE721	Design of Flight Control Law
EEE722	Power system restructuring & deregulation

<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>EEE710</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="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">EEC01 (ELECTRICAL TECHNOLOGY)</td><td colspan="6">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</td></tr>
</table>

	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	
EEE711	ADVANCED POWER CONVERTERS	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC504(POWER ELECTRONICS), EEC502(CONTROL SYSTEMS)		CT+MT+EA					
Course Outcomes	• 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.
Topics Covered	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. (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)
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)

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

		(PEL)	(L)	(T)	(P)	Hours	
EEE712	GENERALIZED THEORY OF ELECTRICAL MACHINES	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC402 (ELECTRICAL MACHINES-1), EEC501 (ELECTRICAL MACHINES- II)		CT+MT+EA					
Course Outcomes	• 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						
Topics Covered	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)						
Text Books, and/or reference material	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: 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
CO1	2	2	2	2	2	1	1	1	1	1	1	1
CO2	2	3	3	3	3	2	1	1	1	1	2	2
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

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	
EEE 713	ELECTRICAL DRIVES	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC402 (ELECTRICAL MACHINES-1), EEC504 (POWER ELECTRONICS), EEC502 (CONTROL SYSTEMS), EEC 501 (ELECTRICAL MACHINES-II)		CT+MT+EA					

Course Outcomes	• 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
Topics Covered	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) 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)

<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>EEE714</td><td>POWER SYSTEM PLANNING, OPERATION AND CONTROL</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">EEC 401 (POWER SYSTEM-I), EEC 503 (POWER SYSTEM-II)</td><td colspan="5">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="6">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 and economic 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: understand different types of tariffs normally applicable for power system operation.</td></tr>
<tr><td>Topics Covered</td><td colspan="6">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)

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)

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)

Optimal Hydrothermal Scheduling: Classification of hydro plants, long range problem, short range problem, hydro model, equality and inequality constraints, transmission losses. (5)

Unit commitment: Definition, constraints in unit commitment, Methods available for unit commitment (priority list method & Dynamic programming). (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 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)

Protection against over voltages: voltage surge, causes of over voltages, Internal causes of over voltages, lightning, protection against lightning, earthing screen, overhead ground wire, lightning arrester, surge absorber. (4)</td></tr>
</table>

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. E.W. Kimbark, Power Systems Stability, Vol. I, II & III, Wiley Press Reference Books: Suggested Reference Books: 1. D.P. Kothari & I.J. Nagrath, Modern Power System Analysis, Tata Mc-Graw Hill 2. Subir Ray, Electrical Power Systems, PHI. 3. Hadi Sadaat, Power System Analysis, 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	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	1	2	2	2	1	1	0	0	0	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	
EEE715	EMBEDDED SYSTEMS	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC602(MICROPROCESSOR & MICROCONTROLLER)		CT+MT+EA					

Course Outcomes	• 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.
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. (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 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	
EEE716	FACTS DEVICE	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC401(POWERSYSTEMS-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	
EEE717	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)

Department of Electrical Engineering				
Course	Title of the course	Program Core	Total Number of contact hours	Credit

Code		(PCR) / Electives (PEL)	Lecture (L)	Tutorial (T)	Practical (P)	Total Hours	
EEE718	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)

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	
EEE719	MICROPROCESSOR AND EMBEDDED SYSTEMS	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	• CO 1: 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. (5) 8085 Architectures, Organizations and Pin out details, Instruction sets, Assembly language programming, Micro operations of instructions. (6) Memory Classification: ROM, EPROM, EEPROM, RAM, Memory Interfacing with 8085, Address decoding for Memory mapped I/O and I/O mapped I/O. (4) Various types of Interrupts. (2) Programmable Peripheral Devices and Interfacing with 8085: 8255, 8259, 8257, 8251, 8253, ADC, DAC and Practical Applications. (6) Microcontroller 89CX51/52 Series: Characteristics and Features, Overview of Architectures, and Peripherals, Timers, Counters, Serial communication, Digital I/O Ports. (5) 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. (5) ARM Architecture: Evolution, Characteristics and Features, Overview of architectures, Modes, Registers etc. (4) 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. (5)
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.

	4. 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	
EEE720	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	
EEE721	DESIGN OF FLIGHT CONTROL LAW	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
CONTROL SYSTEMS (EEC502)		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 surface for aircrafts and missile. • **CO2:** To understand the longitudinal & lateral dynamics of aircrafts & missile and to identify different modes along with the scope of improvement by designing control law. • **CO3:** To develop the concept of Static and Dynamic Stability. • **CO4:** To develop insight on margin criterion, the closed loop response specifications and their relationship with the stability and flying qualities of the aircrafts. • **CO5:** To design control law based on Classical Control Theory for Autopilots, Longitudinal and Lateral/directional dynamics to meet the desired margin and flying qualities criteria • **CO6:** 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, Overview of missile equation of motion (3) **Linearization of Equations of Motion:** Small Disturbance Theory and Linearization of Equations of Motion, Stability and Control Derivatives in brief (2) **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 (3) **Classical Design Techniques for Flight 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, Design for Aileron to Rudder interconnect gain, Concept of Autopilot design, Design of 2 Loop, 3 Loop Roll Autopilot for design (12) **Advanced Design Techniques for Flight Control:** Design of longitudinal and lateral Stability Augmentation System using Pole Placement, Linear Quadratic Regulator with Output feedback, Linear Quadratic Regulator with full state feedback, Designing Performance Index, Tracking a command (12)
Text Books, and/or reference material	Suggested Text Books: 1. Aircraft Control and Simulations by Stevens and Lewis, Wiley and Sons, 3rd Edn 2. Dynamics of Flight Stability and Control by Etkin and Reid, John Wiley & Sons, 3rd Edn Suggested Reference Books: 1. Flight Stability and Automatic Control by Nelson, WCB/McGraw-Hill, 2nd Edn 2. Introduction to Flight by Anderson, McGraw-Hill, 2nd Edn 3. Guided Weapon Control Systems by Garnell and East, 1st Edn, Pergamon Press, 1980 4. Missile Guidance and Control Systems by Siouris, 1st Edn, Springer Science & Business Media, 2004

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	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
CO6	2	3	3	2	3	2	3	1	3	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 722	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		CT+EA					

EEE 714: POWER SYSTEM PLANNING, OPERATION OF CONTROL SYSTEM AND STABILITY	
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– 3 (7th Semester)

Subject Code	Subject Name
EEO740	**Concept of Electrical Machines & Drives**
EEO741	**Biomedical Instrumentation**
EEO742	**Renewable Energy**
EEO743	**Flight control systems**

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	
EEO740	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))					
		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	
EEO741	BIOMEDICAL INSTRUMENTATION!	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: 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						
Topics Covered	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, Goldman 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)						

Text Books, and/or reference material	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:

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

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	
EEO742	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	
EEO743	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 surface. • **CO2:** To understand the longitudinal and lateral dynamics of aircrafts and to identify different modes along with the scope of their improvements by designing control law. • **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 relationship 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 • **CO6:** 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 (3) **Linearization of Equations of Motion:** Small Disturbance Theory and Linearization of Equations of Motion, Stability and Control Derivatives in brief (2)						

	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 (3) **Classical Design Techniques for Flight 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, Design for Aileron to Rudder interconnect gain, Concept of Autopilot design, Design of 2 Loop, 3 Loop Roll Autopilot (12) **Advanced Design Techniques for Flight Control:** Design of longitudinal and lateral Stability Augmentation System using Pole Placement, Linear Quadratic Regulator with Output feedback, Linear Quadratic Regulator with full state feedback, Designing Performance Index, Tracking a command (12)
Text Books, and/or reference material	Suggested Text Books: 3. Aircraft Control and Simulations by Stevens and Lewis, Wiley and Sons, 3rd Edn 4. Dynamics of Flight Stability and Control by Etkin and Reid, John Wiley & Sons, 3rd Edn Suggested Reference Books: 5. Flight Stability and Automatic Control by Nelson, WCB/McGraw-Hill, 2nd Edn 6. Introduction to Flight by Anderson, McGraw-Hill, 2nd Edn 7. Guided Weapon Control Systems by Garnell and East, 1st Edn Pergamon Press, 1980

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	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
CO6	2	3	3	2	3	2	3	1	3	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	
EES751	MICROPROCESSORS AND MICROCONTROLLERS LABORATORY	PCR	0	0	3	3	1.5
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	ADVANCED POWER SYSTEM LABORATORY	PCR	0	0	3	3	1.5
Pre-requisites		Course Assessment methods (Continuous (CT) and end assessment (EA))					
EEC401(POWERSYSTEMS-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	1.5
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 effects 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 predict correctly the expected performance of various general-purpose transformers and induction machines. • CO5: Students will be able use accepted national and international standards to select appropriate electrical machines to meet specified performance requirements.						

Topics Covered	Design of Transformer: Output equation, Optimum design, Design of core, Design of yoke, Window dimensions, Design of windings, Design of insulation, Overall dimensions. (12) Transformer Design Details: Resistance of winding, Leakage reactance of winding, Regulation and Efficiency, Temperature rise, Cooling. (9) 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. (21)
Text Books, and/or reference material	Text Books: 1. A. K. Sawhney & A. Chakrabarti, Electrical Machine Design, Dhanpat Rai & Co. Reference Books: 1. 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)

Semester - VIII						
Code	**Subject**	**L**	**T**	**S**	**C**	**H**
EEE810 --	**Depth Elective - 6**	**3**	**0**	**0**	**3.0**	**3**
YYO84*	**Open Elective - 4**	**3**	**0**	**0**	**3.0**	**3**
YYO85*	**Open Elective - 5**	**3**	**0**	**0**	**3.0**	**3**
EES851	**Project - II**	**0**	**0**	**15**	**5.0**	**15**
EES852	**Project Seminar**	**0**	**0**	**0**	**1.0**	**0**
EES853	**Viva Voce**	**0**	**0**	**0**	**1.0**	**0**
	TOTAL	**9**	**0**	**15**	**16.0**	**24**

2018 ONWARD UNDERGRADUATE ADMISSION BATCH

DEPTH ELECTIVE COURSE BASKETS

THE STUDENTS PRIMARILY WILL OPT FROM THE DEPTH ELECTIVE SUBJECT(S) THAT ARE OFFERED IN A PARTICULAR SEMESTER BY HIS/ HER OWN DEPARTMENT. HOWEVER, A STUDENT CAN OPT FOR DEPTH ELECTIVE SUBJECT(S) THAT ARE OFFERED BY OTHER DEPARTMENT IN A PARTICULAR SEMESTER, WITH THE PERMISSION/ CONSENT FROM HIS/ HER HEAD OF THE DEPARTMENT AND THE CONCERNED TEACHER OF THAT SUBJECT

Departmental Elective: EIGHTH SEMESTER

Subject Code	Subject Name
EEE810	Power System Transients & Power Quality
EEE811	Smart Grid
EEE812	Power system Reliability

<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>EEE 810</td><td>POWER SYSTEM TRANSIENTS & POWER QUALITY</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="6">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2">EEC 301 (NETWORK ANALYSIS AND SYNTHESIS)</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: 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.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">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)</td></tr>
</table>

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

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	
EEE811	SMART GRID	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC601 (ADVANCED POWER SYSTEMS), EEE714(POWER SYSTEM PLANNING, OPERATION OF CONTROL SYSTEM AND STABILITY)		CT+MT+EA					
Course Outcomes	• 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.						
Topics Covered	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) 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	
EEE812	Power system Reliability	PEL	3	0	0	3	3
Pre-requisites		Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))					
EEC401(POWERSYSTEMS-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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	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)

Open Elective: Basket– 4 (8th Semester)

Subject Code	Subject Name
EEO840	**Microgrid systems**
EEO841	**Biomedical Instrumentation**
EEO842	**Renewable Energy**
EEO843	**Digital Image Processing**

<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>EEO840</td><td>Microgrid 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="6">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2"></td><td colspan="6">CT+MT+EA</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">CO1: Acquire an idea about microgrid and its operations.
CO2: To learn the different components of the microgrid systems.
CO2: To study different types of microgrid and different control strategies.
CO3: To model and calculate different parameters of the renewable sources and the energy storage system of microgrid.
CO4: To learn different active and reactive power control strategies of microgrid.
CO5: To understand the future applications of microgrid and its role in the electrical ecosystem.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">Introduction: What is microgrid, advantage of microgrid over traditional systems, architecture of microgrid, operating modes of microgrid. (2L).
Components of microgrid: Local generation, different loads, storage system, converters, filters, monitoring and control system (4L).
Classification of microgrid: AC, DC, and hybrid microgrid, architecture and components of different microgrids, classification based on control strategies, centralized and decentralized control (5L).
Renewable sources: PV source, modelling of PV source, MPPT of PV source, different components of wind turbine, MPPT control of wind turbine, effect of uncertainty on PV and wind power (6L).
Energy storage system: Advantage of ESS, different type, integration of ESS, importance of storage system in microgrid (4L).
Microgrid power control: ABC/DQ, DQ/ABC transformation, centralized P-Q control, droop control, master-slave control, peer to peer control (6L).
Role of microgrid in future electricity ecosystem: Decarbonisation, digitalization, decentralization, load forecasting, load shedding, energy management. (7L).</td></tr>
<tr><td>Text Books, and/or Reference Material</td><td colspan="7">Text Book:
HANDBOOK ON MICROGRIDS FOR POWER QUALITY AND CONNECTIVITY– Asian Development Bank
Reference Book:
Microgrid Technologies– C.Sharmeela, P.Shivaraman, P.Sanjeevikumar (Wiley)</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	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)

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	
EEO841	BIOMEDICAL INSTRUMENTATION!	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: 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						
Topics Covered	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)						
Text Books, and/or reference material	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:						

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

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>EEO842</td><td>RENEWABLE ENERGY</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="6">Course Assessment methods (Continuous (CT), mid-term (MT) and end assessment (EA))</td></tr>
<tr><td colspan="2">EEC01 (ELECTRICAL TECHNOLOGY)</td><td colspan="6">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)

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	
EEO843	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)

Open Elective: Basket– 5 (8th Semester)

Subject Code	Subject Name
EEO850	**Soft Computing Techniques**
EEO851	**Embedded Systems and Applications**
EEO852	**Micro-Electro-Mechanical Systems**

<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>EEO850</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="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">EEE 610(NUMERICAL ANALYSIS)</td><td colspan="6">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</td></tr>
</table>

	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	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	
EEO851	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)

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<tr><td>Lecture (L)</td><td>Tutorial (T)</td><td>Practical (P)</td><td>Total Hours</td></tr>
<tr><td>EEO852</td><td>MICRO-ELECTROMECHANICAL SYSTEM</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">• 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.</td></tr>
<tr><td>Topics Covered</td><td colspan="7">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)</td></tr>
</table>

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

Correlation levels 1, 2 or 3 as defined below:

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