Department: Electrical Engineering
Curriculum Structure & Syllabus

(Effective from 2021-22 admission batch)

1st Year 1st Semester								
Sl. No.	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
A. Theory								
1	BSC	CH101	Chemistry – I	3	0	0	3	3
2	BSC	M101	Mathematics – I	4	0	0	4	4
3	ESC	EE101	Basic Electrical Engineering	3	0	0	3	3
4	HSMC	HSMC101	Professional Communication	2	0	0	2	2
B. Practical								
5	BSC	CH191	Chemistry – I Laboratory	0	0	3	3	1.5
6	ESC	EE191	Basic Electrical Engineering Laboratory	0	0	3	3	1.5
7	ESC	ME192	Engineering Graphics and Design Laboratory	0	0	3	3	1.5
8	PROJ	PR191	Theme Based Project – I	0	0	1	1	0.5
9	PROJ	PR192	Skill Development – I: Soft Skill	0	0	1	1	0.5
C. Mandatory Activities / Courses								
10	MC	MC181	Induction Program	0	0	0	0	0
Total of Theory, Practical and Mandatory Activities / Courses							**23**	**17.5**

1st Year 2nd Semester								
Sl. No.	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
A. Theory								
1	BSC	PH201	Physics – I	3	0	0	3	3
2	BSC	M201	Mathematics – II	4	0	0	4	4
3	ESC	CS201	Programming for Problem Solving	3	0	0	3	3
B. Practical								
4	BSC	PH291	Physics – I Laboratory	0	0	3	3	1.5
5	HSMC	HSMC291	Professional Communication Laboratory	0	0	2	2	1
6	ESC	ME291	Workshop and Manufacturing Practices Laboratory	0	0	3	3	1.5
7	ESC	CS291	Programming for Problem Solving Laboratory	0	0	3	3	1.5
8	PROJ	PR291[1*]	Theme Based Project – II	0	0	1	1	0.5
9	PROJ	PR292	Skill Development – II: Life Skill	1	0	0	1	0.5
C. Mandatory Activities / Courses								
10	MC	MC281	NSS / Physical Activities / Meditation and Yoga / Photography / Nature Club	0	0	3	3	0
Total of Theory, Practical and Mandatory Activities / Courses							**26**	**16.5**

[1*] Technical Answers for Real World Problems (TARP).

2nd Year 3rd Semester								
Sl. No.	Category	Paper Code	Subject	Contact Hours/Week				Credit Points
				L	T	P	Total	
A. Theory								
1	BSC	EE(PH)301	Electromagnetic Fields	3	1	0	4	4
2	ESC	EE(ME)301	Engineering Mechanics	3	0	0	3	3
3	ESC	EE301	Electrical Circuit Analysis	3	0	0	3	3
4	PCC	EE302	Electrical and Electronic Measurement	2	0	0	2	2
5	PCC	EE303	Semiconductor Devices and Circuits	3	0	0	3	3
6	HSMC	HSMC302	Gender Culture and Development	2	0	0	2	2
B. Practical								
7	ESC	EE391	Electrical Circuit Analysis Laboratory	0	0	2	2	1
8	PCC	EE392	Electrical and Electronic Measurement Laboratory	0	0	3	3	1.5
9	PCC	EE393	Semiconductor Devices and Circuits Laboratory	0	0	2	2	1
10	ESC	EE394	Python Programming Laboratory	0	0	3	3	1.5
11	PROJ	PR391[2]	Theme Based Project – III	0	0	1	1	0.5
12	PROJ	PR392	Skill Development – III: Technical Seminar Presentation	1	0	0	1	0.5
C. Mandatory Activities / Courses								
13	MC	MC381	Learning an Art Form [Vocal or Instrumental, Dance, Painting, Clay Modeling, etc.] OR Environmental Protection Initiatives	0	0	0	3	0
Total of Theory, Practical and Mandatory Activities / Courses without MOOC Courses							**32**	**23**
D. MOOC Courses[3]**								
14	MOOC	HM301	MOOC Course – I	3	1	0	4	4

[2] Technical Answers for Real World Problems (TARP).

[3**] MOOC Courses for HONOURS / MINOR Degree are Program specific and to be taken from MOOC Basket.

Total of Theory, Practical and Mandatory Activities / Courses with MOOC Courses	**36**	**27**

2nd Year 4th Semester								
Sl. No.	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
A. Theory								
1	BSC	EE(M)401	Mathematics – III	3	0	0	3	3
2	PCC	EE401	Electrical Machines – I	3	0	0	3	3
3	PCC	EE402	Power Electronics	3	0	0	3	3
4	PCC	EE403	Analog and Digital Circuits	3	0	0	3	3
5	ESC	EE404	Data Structures and Algorithms	2	0	0	2	2
6	HSMC	HSMC403	Universal Human Values – II: Understanding Harmony	3	0	0	3	3
B. Practical								
7	PCC	EE491	Electrical Machines – I Laboratory	0	0	3	3	1.5
8	PCC	EE492	Power Electronics Laboratory	0	0	2	2	1
9	PCC	EE493	Analog and Digital Circuits Laboratory	0	0	2	2	1
10	ESC	EE494	Data Structures and Algorithms Laboratory	0	0	3	3	1.5
11	PROJ	PR491[4*]	Theme Based Project – IV	0	0	1	1	0.5
12	PROJ	PR492	Skill Development – IV: Soft Skill and Aptitude – I	1	0	0	1	0.5
C. Mandatory Activities / Courses								
13	MC	MC401	Environmental Science	3	0	0	3	0
Total of Theory, Practical and Mandatory Activities / Courses without MOOC Courses							**32**	**23**
D. MOOC Courses[5]**								
14	MOOC	HM401	MOOC Course – II	3	1	0	4	4
Total of Theory, Practical and Mandatory Activities / Courses with MOOC Courses							**36**	**27**

[4*] Technical Answers for Real World Problems (TARP).
[5**] MOOC Courses for HONOURS / MINOR Degree are Program specific and to be taken from MOOC Basket.

3rd Year 5th Semester								
Sl. No.	Category	Paper Code	Subject	Contact Hours/Week				Credit Points
				L	T	P	Total	
A. Theory								
1	HSMC	HSMC504	Economics for Engineers	2	0	0	2	2
2	PCC	EE501	Electrical Machines – II	3	0	0	3	3
3	PCC	EE502	Power Systems – I	3	0	0	3	3
4	PCC	EE503	Control Systems-I	3	0	0	3	3
5	OEC	EE504	A. Database Management System B. Computer Network C. Artificial Intelligence	3	0	0	3	3
6	PEC	EE505	A. Renewable Energy – I B. Line Commutated and Active Rectifiers C. Power Plant Engineering D. Engineering Optimization	3	0	0	3	3
B. Practical								
7	PCC	EE591	Electrical Machines – II Laboratory	0	0	3	3	1.5
8	PCC	EE592	Power Systems – I Laboratory	0	0	3	3	1.5
9	PCC	EE593	Control Systems – I Laboratory	0	0	2	2	1
10	OEC	EE594	A. Database Management System Laboratory B. Computer Network Laboratory C. Artificial Intelligence Laboratory	0	0	3	3	1.5
11	PROJ	PR 591	Minor Project – I	0	0	2	2	1
12	PROJ	PR 592	Skill Development – V: Soft Skill and Aptitude – II	1	0	0	1	0.5
C. Mandatory Activities / Courses								
13	MC	MC501	Intellectual Property Right	0	0	3	3	0
Total of Theory, Practical and Mandatory Activities / Courses without MOOC Courses							**34**	**24**
D. MOOC Courses[6]**								
14	MOOC	HM501	MOOC Course – III	3	1	0	4	4

[6**] MOOC Courses for HONOURS / MINOR Degree are Program specific and to be taken from MOOC Basket.

Total of Theory, Practical and Mandatory Activities / Courses with MOOC Courses	38	28

3rd Year 6th Semester								
Sl. No.	Category	Paper Code	Subject	Contact Hours/Week				Credit Points
				L	T	P	Total	
A. Theory								
1	HSMC	HSMC605	Principles of Management	2	0	0	2	2
2	PCC	EE601	Microprocessor and Microcontroller	3	0	0	3	3
3	PCC	EE602	Power Systems – II	3	0	0	3	3
4	PCC	EE603	Control Systems – II	3	0	0	3	3
5	OEC	EE604	A. Big Data Analytics B. Internet of Things C. Soft Computing	3	0	0	3	3
6	PEC	EE605	A. Renewable Energy – II B. Advanced Power Electronics C. Special Electric Machines D. Digital Signal Processing	3	0	0	3	3
B. Practical								
7	PCC	EE691	Microprocessor and Microcontroller Laboratory	0	0	3	3	1.5
8	PCC	EE692	Power System – II Laboratory	0	0	3	3	1.5
9	PCC	EE693	Control Systems – II Laboratory	0	0	3	3	1.5
10	PROJ	PR691[7*]	Electrical Workshop	0	0	2	2	1
11	PROJ	PR 692	Minor Project – II	0	0	2	2	1
12	PROJ	PR 693	Skill Development – VI: Soft Skill and Aptitude – III	1	0	0	1	0.5
C. Mandatory Activities / Courses								
13	MC	MC 601	Constitution of India	3	0	0	3	0
Total of Theory, Practical and Mandatory Activities / Courses without MOOC Courses							**34**	**24**
D. MOOC Courses[8]**								
14	MOOC	HM601	MOOC Course – IV	3	1	0	4	4

[7*] Students will initially see all the cutset models and prototypes of different electrical systems (Motor, Generator, Transformers, Transmission Lines, Solar Panels etc.) and prepare the data sheets and thereafter design their own.
[8**] MOOC Courses for HONOURS / MINOR Degree are Program specific and to be taken from MOOC Basket.

Total of Theory, Practical and Mandatory Activities / Courses with MOOC Courses	38	28

4th Year 7th Semester								
Sl. No.	Category	Paper Code	Subject	Contact Hours/Week				Credit Points
				L	T	P	Total	
A. Theory								
1	PCC	EE701	Electric Drives	2	0	0	2	2
2	PCC	EE702	Introduction to Smart Grid	3	0	0	3	3
3	PEC	EE703	A. Energy Conversion and Storage (Renewable Energy – III) B. Power Quality C. Design of Electric Apparatus D. Analog and Digital Communication	3	0	0	3	3
4	PEC	EE704	A. Distributed Generation and Microgrids B. FACTS and HVDC C. Electrical Energy Conservation and Auditing D. Embedded System Design	3	0	0	3	3
5	OEC	EE705	A. Data Science B. Cyber Security C. Machine Learning D. Smart and Nanomaterials for Electrical Engineering	3	0	0	3	3
B. Practical								
6	PCC	EE791	Electric Drives Laboratory	0	0	2	2	1
7	PCC	EE792	Computer-Aided Electrical Drawing Laboratory (AutoCAD / Automation Studio)	0	0	3	3	1.5
8	PROJ	PR791	Major Project – I	0	0	0	4	2
9	PROJ	PR792[9*]	Industrial Training / Internship	0	0	0	0	1
10	PROJ	PR793	Skill Development – VII: Seminar and Group Discussion	0	0	1	1	0.5
C. Mandatory Activities / Courses								
11	MC	MC781	Entrepreneurship and Innovation Skill	0	0	3	3	0
Total of Theory, Practical and Mandatory Activities / Courses without MOOC Courses							**27**	**20**

[9*] Collective Data from 3rd to 6th Semester (Summer / Winter Training during Semester Break and Internship should be done after 5th Semester or 6th Semester). All related certificates to be collected by the training/internship coordinator(s).

D. MOOC Courses[10**]								
12	MOOC	HM701	MOOC Course – V	3	1	0	4	4
Total of Theory, Practical and Mandatory Activities / Courses with MOOC Courses							**31**	**24**

4th Year 8th Semester								
Sl. No.	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
A. Theory								
1	PEC	EE801	A. Renewable Energy Management and sustainability B. Electrical and Hybrid Vehicles C. Finite Element analysis for Electrical Machines D. Robotics and Control	3	3	0	3	3
2	PEC	EE802	A. Restructured Power Systems B. High Voltage Engineering C. Illumination Engineering D. Power System Operation and Control	3	0	0	3	3
3	OEC	EE803	A. Bio-Medical Instrumentation B. Blockchain C. Image Processing D. 3D Printing and Design	2	0	0	2	2
B. Practical								
4	PROJ	PR891	Major Project – II	0	0	0	12	6
5	PROJ	PR892	Grand Viva	0	0	0	0	1
C. Mandatory Activities / Courses								
6	MC	MC801	Essence of Indian Knowledge Tradition	3	0	0	3	0
Total of Theory, Practical and Mandatory Activities / Courses without MOOC Courses							**24**	**15**

[10**] MOOC Courses for HONOURS / MINOR Degree are Program specific and to be taken from MOOC Basket.

Detailed Syllabus

1st Year 1st Semester								
Sl. No.	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
A. Theory								
1	BSC	CH101	Chemistry – I	3	0	0	3	3
2	BSC	M101	Mathematics – I	4	0	0	4	4
3	ESC	EE101	Basic Electrical Engineering	3	0	0	3	3
4	HSMC	HSMC101	Professional Communication	2	0	0	2	2
B. Practical								
5	BSC	CH191	Chemistry – I Laboratory	0	0	3	3	1.5
6	ESC	EE191	Basic Electrical Engineering Laboratory	0	0	3	3	1.5
7	ESC	ME192	Engineering Graphics and Design Laboratory	0	0	3	3	1.5
8	PROJ	PR191	Theme Based Project – I	0	0	1	1	0.5
9	PROJ	PR192	Skill Development – I: Soft Skill	0	0	1	1	0.5
C. Mandatory Activities / Courses								
10	MC	MC181	Induction Program	0	0	0	0	0
Total of Theory, Practical and Mandatory Activities / Courses							**23**	**17.5**

Course Name: Chemistry – I
Course Code: CH101
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: A basic knowledge in 10+2 science with chemistry.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Describe the fundamental properties of atoms & molecules, atomic structure and the periodicity of elements in the periodic table
- **CO2.** Apply fundamental concepts of thermodynamics in different engineering applications.
- **CO3.** Apply the knowledge of water quality parameters, corrosion control & polymers to different industries.
- **CO4.** Determine the structure of organic molecules using different spectroscopic techniques.
- **CO5.** Evaluate theoretical and practical aspects relating to the transfer of the production of chemical products from laboratories to the industrial scale, in accordance with environmental considerations.

CO-PO Mapping:

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

Course Content

Module 1: Inorganic Chemistry **9L**

a) Atomic structure:

Bohr's theory to hydrogen-like atoms and ions; spectrum of hydrogen atom. Quantum numbers, Introduction to the concept of atomic orbitals, diagrams of s, p and d orbitals, Pauli's exclusion principle, Hund's rule, exchange energy, Aufbau principle and its limitation, introduction to Schrodinger equation. 5L

b) Periodic properties:

Modern Periodic table, group trends and periodic trends in physical properties: electron affinity, electronegativity, polarizability, oxidation states, effective nuclear charges, penetration of orbitals, variations of s, p and d orbital energies of atoms. 4L

Module 2: Physical Chemistry **8L**

a) Use of free energy in chemical equilibria:
Thermodynamic functions: internal energy, enthalpy, entropy and free energy. 2nd Law of Thermodynamics, Estimations of entropy and free energies, Free energy and emf, Cell potentials, the Nernst equation and applications. 6L

b) Real Gases:
Reason for deviation of real gases from ideal behavior, Equations of state of real gases, Vander Waals' equation, pressure and volume correction, validity, critical state of gas. 2L

Module 3: Organic Chemistry 8L

a) Stereochemistry:
Representations of 3 dimensional structures, Chirality, optical activity, isomerism, structural isomerism, stereoisomers, enantiomers, diastereomers, configurations (D, L and cis trans), racemisation.
4L

b) Organic reactions:
Concepts of inductive effect, resonance, hyperconjugation, introduction to reactions involving substitution, addition, elimination, oxidation (Baeyer villiger oxidation), reduction (Clemmensen reduction, Wolff-Kishner reduction).
4L

Module 4: Industrial Chemistry 8L

a) Water:
Hardness, alkalinity, numerical. 2L

b) Corrosion:
Types of corrosion: wet and dry, preventive measures. 2L

c) Polymers:
Classification of polymers, conducting polymers, biodegradable polymers. 3L

d) Synthesis of a commonly used drug molecule:
Paracetamol, Aspirin
1L

Module 5: Spectroscopic techniques in Chemistry 3L
Electromagnetic radiation, Principles of spectroscopy, spectrophotometer, infrared spectroscopy, fingerprint region, functional group region, UV-VIS spectroscopy, 1H Nuclear magnetic resonance spectroscopy, chemical shift

Project Domain:
1. Application of Thermodynamics
2. Application of polymers in daily life
3. Nanomaterials and its applications
4. Determination of water quality parameters
5. Electronic storage devices
6. Managing E –wastes
7. Application of chemistry in core engineering
8. Application of spectroscopy in medical field
9. Applications of green chemistry
10. Merits of commercial organic products
11. Bioplastics
12. Any other related topics

Text Books:
1. A Text Book of Organic Chemistry, Arun Bahl & Arun Bahl

2. General & Inorganic Chemistry, P.K. Dutt
3. General & Inorganic Chemistry, Vol I, R.P. Sarkar
4. Physical Chemistry, P.C. Rakshit

Reference Books:

1. Chemistry: Principles and Applications, by M. J. Sienko and R. A. Plane.
2. Fundamentals of Molecular Spectroscopy, by C. N. Banwell
3. Engineering Chemistry (NPTEL Web-book), by B. L. Tembe, Kamaluddin and M. S. Krishnan
4. Physical Chemistry, by P. W. Atkins
5. Organic Chemistry: Structure and Function by K. P. C. Volhardt and N. E. Schore, 5th Edition http://bcs.whfreeman.com/vollhardtschore5e/default.asp

Course Name: Mathematics – I
Course Code: M101
Contact: 4L:0T:0P
Total Contact Hours: 48
Credit: 4

Prerequisite: The students to whom this course will be offered must have the concept of (10+2) standard matrix algebra, calculus and vector algebra.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Recall the properties and formula related to matrix algebra, differential calculus, multivariable calculus, vector calculus and infinite series.

CO2. Determine the solutions of the problems related to matrix algebra, differential calculus, multivariable calculus, vector calculus and infinite series.

CO3. Apply the appropriate mathematical tools of matrix algebra, differential calculus, multivariable calculus, vector calculus and infinite series for the solutions of the problems.

CO4. Analyze different engineering problems linked with matrix algebra, differential calculus, multivariable calculus, vector calculus.

CO-PO Mapping:

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

Course Content

Module 1: Matrix Algebra **11L**

Echelon form and Normal (Canonical) form of a matrix; Inverse and rank of a matrix; Consistency and inconsistency of system of linear equations, Solution of system of linear equations; Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton theorem.

Module 2: Differential Calculus and Infinite Series **10L**

Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; Concept of sequence and series, Tests for convergence of infinite series: Comparison test, D'Alembert's ratio

test, Raabe's test, Cauchy's root test, Leibnitz's Test, Power series; Taylor's series, Series for exponential, trigonometric and logarithm functions.

Module 3: Multivariable Calculus (Differentiation) 13L

Function of several variables, Concept of limit, continuity and differentiability; Partial derivatives, Total derivative and its application; Chain rules, Derivatives of implicit functions Euler's theorem on homogeneous function, Jacobian. Maxima and minima of functions of two variables, Method of Lagrange multipliers.

Module 4: Multivariable Calculus (Integration) 6L

Line Integral, Double Integral, Triple Integral,Change of order in multiple integrals, Change of variables in multiple integrals.

Module 5: Vector Calculus 8L

Gradient, Directional derivatives, Divergence, Curl, vector line integrals, vector surface integrals, vector volume integrals, Green's theorem, Gauss divergence theorem and Stokes' theorem.

Project Domain:

1. Study on eigenvalues and eigenvectors.
2. Study on convergence of infinite series.
3. Application of partial derivatives.
4. Application of vector calculus
5. Application of integral calculus.

Text Books:

1. Kreyszig, E., Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. Ramana, B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. Veerarajan, T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
5. Bali, N.P. and Goyal, M., A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
6. Samanta Guruprasad, A text book of Engineering Mathematics – I, New age International Publishers.

Reference Books:

1. Thomas, G.B. and Finney, R.L., Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
2. Apostol, M., Calculus, Volumes 1 and 2 (2nd Edition), Wiley Eastern, 1980.
3. Kumaresan, S., Linear Algebra - A Geometric approach, Prentice Hall of India, 2000.
4. Poole, D., Linear Algebra: A Modern Introduction, 2 nd Edition, Brooks/Cole, 2005.
5. Bronson, R., Schaum's Outline of Matrix Operations. 1988.
6. Piskunov, N., Differential and Integral Calculus, Vol. I & Vol. II, Mir Publishers, 1969.

Course Name: Basic Electrical Engineering
Course Code: EE101
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Basic 12th standard Physics and Mathematics, Concept of components of electric circuit.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand and analyze basic electric circuits
- **CO2.** Study the working principles of electrical machines.
- **CO3.** Introduce the components of low voltage electrical installations.
- **CO4.** Study the fundamentals of electrical Power systems and Control Systems.

CO-PO Mapping:

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

Course Content

Module 1: DC Circuits **8L**

Definition of electric circuit, linear circuit, non-linear circuit, bilateral circuit, unilateral circuit, Dependent source, node, branch, active and passive elements, Kirchhoff‘s laws, Source equivalence and conversion, Network Theorems - Superposition Theorem, Thevenin‘s Theorem, Norton Theorem, Maximum Power Transfer Theorem, Star-Delta Conversions.

Module 2: AC Fundamentals **8L**

Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor. Analysis of single-phase ac circuits consisting of R, L, C, RL, RC, RLC combinations (series and parallel), resonance. Three phase balanced circuits, voltage and current relations in star and delta connections.

Module 3: Electrical Machines 10L

a) **Transformer:** Magnetic materials, BH characteristics, ideal and practical transformer, equivalent circuit, losses in transformers, regulation and efficiency. Auto-transformer and three-phase transformer connections.

b) **Rotating Machines:**

i. **DC Machines:** Brief idea on constructional features, classifications, working principle of both motor and generator. Simple problems on Voltage equation.

ii. **Three-Phase Induction Motor:** Basic concept of three phase circuit and production of rotating magnetic field. Working principle of three-phase induction motor and torque-speed characteristics (concept only).

Module 4: Electrical Installations 3L

Earthing of Electrical Equipment, ideas of basic components – MCB, MCCB, ELCB, SFU, Megger. Types of Wires and Cables, Earthing.

Module 5: Fundamentals of Power Systems 5L

Generation of power: Block schematic representation of Thermal and nuclear power plants. Renewable energy sources: solar, wind, tidal and geothermal (Block diagram and working only- No Problems). Power transmission: Typical electrical power transmission scheme-need for high voltage transmission-(Derivation is not needed, No Problems). Power Distribution: substation equipments, primary and secondary transmission and distribution systems- feeder, service mains.

Module 6: Introduction to Control Systems 2L

Concept control systems, Objectives of control system, Types of control systems, Real examples of control systems.

Text Books:

1. P. Kothari & I. J. Nagrath, Basic Electrical Engineering, TMH.
2. V. Mittle & Arvind Mittal, Basic Electrical Engineering, TMH.
3. Ashfaq Hussain, Basic Electrical Engineering, Dhanpat Rai Publication.
4. Chakrabarti, Nath & Chanda, Basic Electrical Engineering, TMH.
5. C.L. Wadhwa, Basic Electrical Engineering, Pearson Education.

Reference Books:

1. E. Hughes, Electrical and Electronics Technology, Pearson, 2010.
2. V. D. Toro, Electrical Engineering Fundamentals, Prentice Hall India, 1989.

Course Name: Professional Communication
Course Code: HSMC101
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Basic (10+2) level of knowledge of English grammar, vocabulary reading and writing skills.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand about and use the modalities and nuances of communication in a workplace context.
- **CO2.** Understand about communicating across cultures and societies.
- **CO3.** Know about and apply the basic formats, templates of business and official communication.
- **CO4.** Know about and employ formal communication modes in meetings and reports.
- **CO5.** Know about and use objective and culturally neutral language in interpersonal and business communication.

CO-PO Mapping:

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

Course Content

Module 1: Verbal and Non-verbal communication **4L**

1.1. Definition, Relevance and Effective Usage
1.2. Components of Verbal Communication: Written and Oral Communication
1.3. Components of Non-verbal Communication: Kinesics, Proxemics, Chronemics, Haptics

Paralanguage
1.4. Barriers to Effective Communication

Module 2: Social Communication Essentials and Cross-Cultural Communication 6L
2.1. Communication in Society and the Workplace
2.2. Greetings, Courtesies and Socially Useful Language
2.3. Cultural Contexts: High Context and Low Context Cultures
2.4. Understanding Cultural Nuances and Stereotyping
2.5. Achieving Culturally Neutral Communication in Speech and Writing

Module 3: Meetings 4L
3.1. Meetings: Nature and Types
3.2. Conducting Meetings: Organization and Procedures
3.3. Meeting Coordination: Roles of Chairpersons and Members
3.4. Notice and Agenda for a Meeting
3.5. Preparing the Minutes of a Meeting (MOM)

Module 4: Report Writing 4L
4.1. Nature and Function of Reports
4.2. Types of Reports
4.3. Researching for a Business Report
4.4. Format, Language and Style
4.5. Report Documentation

Module 5: Employment Communication 6L
5.1. Writing Business Letters- (Enquiry, Order, Sales, Complaint, Adjustment, Job Application, Offer)
5.2. Preparing a CV or Rẽsumẽ
5.3. Creating a Digital/Online Profile – LinkedIn (Résumé/Video Profile)
5.4. Writing E-mails: types, convention, and etiquette
5.5. Memo, Notices and Circulars
5.6. Writing Technicalities—Paragraphing, Sentence Structure and Punctuation

Text Books & Reference Books:

1. Meenakshi Raman and Sangeetha Sharma, "Technical Communication", 3rd edition. New Delhi: Oxford University Press, 2015.
2. Mark Ibbotson, "Cambridge English for Engineering", Cambridge: Cambridge University Press, 2008.
3. Mark Ibbotson, "Professional English in Use: Engineering", Cambridge: Cambridge UP, 2009.
4. Lesikar et al., "Business Communication: Connecting in a Digital World", New Delhi: Tata McGraw-Hill, 2014.
5. John Seeley, "Writing Reports", Oxford: Oxford University Press, 2002.
6. Judith Leigh, "CVs and Job Applications", Oxford: Oxford University Press, 2002.
7. Judith Leigh, "Organizing and Participating in Meetings", Oxford: Oxford University Press, 2002.
8. Michael Swan, "Practical English Usage", Oxford: OUP, 1980.
9. Pickett, Laster and Staples, "Technical English: Writing, Reading & Speaking", 8th ed. London: Longman, 2001.
10. Diana Booher, "E-writing: 21st Century Tools for Effective Communication".

Links:

1. Purdue University's Online Writing Lab (OWL) – https://owl.purdue.edu/
2. Business English Pod-https://www.businessenglishpod.com/

Course Name: Chemistry – I Laboratory
Course Code: CH191
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: A basic knowledge in 10+2 science with chemistry.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Operate different types of instruments for estimation of small quantities chemicals used in industries and scientific and technical fields.
CO2. Analyze and determine the composition of liquid and solid samples working as an individual and also as a team member.
CO3. Analyze different parameters of water considering environmental issues.
CO4. Synthesize drug and polymer materials.
CO5. Design innovative experiments applying the fundamentals of chemistry.

CO-PO Mapping:

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

List of Experiments (Choice of 10-12 experiments from the following):

1. Determination of surface tension and viscosity
2. Thin layer chromatography
3. Determination of hardness of water
4. Determination of chloride content of water
5. Determination of the rate constant of a reaction
6. Determination of cell constant and conductometric tritration
7. pH metric titrations

8. Synthesis of a polymer/drug
9. Saponification/acid value of an oil
10. Chemical analysis of a salt
11. Chemical oscillations – Iodine clock reaction
12. Determination of the partition coefficient of a substance between two immiscible liquids
13. Adsorption of acetic acid by charcoal
14. Estimation of iron in Mohr's salt solution by permanganometry (Redox Titration)
15. Innovative experiments (any one)
    a. Synthesis of silver nano-particles
    b. Green synthesis

Course Name: Basic Electrical Engineering Laboratory
Course Code: EE191
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Basic Physics and applied physics, Basic Mathematics, Basic concept of Electric Circuit.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Identify and use common electrical components.
CO2. Develop electrical networks by physical connection of various components and analyze the circuit behaviour.
CO3. Apply and analyze the basic characteristics of transformers and electrical machines.

CO-PO Mapping:

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

List of Experiments:

1. Basic safety precautions – earthing, introduction to measuring instruments – Voltmeter, Ammeter, Multimeter, Wattmeter, Real life Resistor, Capacitor, Inductor.
2. Verification of Thevenin's and Norton's Theorem.
3. Verification of Superposition and Maximum Power Transfer Theorem.
4. Characteristics of Fluorescent, Tungsten and Carbon filament lamps.
5. Study of R-L-C series circuit.
6. Three-phase Power measurement with two wattmeter methods.
7. Demonstration of cut-out sections of machines: DC Machine (commutator-brush arrangement), Induction Machine (squirrel cage rotor).
8. Measurement of primary and secondary voltage and current of single-phase transformer –

Open Circuit and Short Circuit Test.
9. Starting, Reversing and speed control of DC shunt motor.
10. Torque-Speed characteristics of DC Machine.
11. Torque-Speed characteristics of Three-phase Induction Motor.
12. Test on single-phase Energy Meter.
13. Innovative experiments.

Course Name: Engineering Graphics and Design Laboratory
Course Code: EE191
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Basic knowledge of geometry.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Get introduced with Engineering Graphics and visual aspects of design.
CO2. Know and use common drafting tools with the knowledge of drafting standards.
CO3. Apply computer aided drafting techniques to represent line, surface or solid models in different Engineering viewpoints.
CO4. Produce part models; carry out assembly operation and show working procedure of a designed project work using animation.

CO-PO Mapping:

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

List of Drawings:

Traditional Engineering Graphics:
Principles of Engineering Graphics; Orthographic Projection; Descriptive Geometry; Drawing Principles; Isometric Projection; Surface Development; Perspective; Reading a Drawing; Sectional Views; Dimensioning and Tolerances; True Length, Angle; intersection, Shortest Distance.

Module 1: Introduction to Engineering Drawing

Principles of Engineering Graphics and their significance, Usage of Drawing instruments, lettering, Conic sections including Rectangular Hyperbola (General method only); Cycloid, Epicycloid and Involute; Scales – Plain, Diagonal and Vernier Scales.

Module 2: Orthographic and Isometric Projections
Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes on inclined Planes - Auxiliary Planes; Projection of Solids inclined to both the Planes- Auxiliary Views; Isometric Scale, Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa.

Module 3: Sections and Sectional Views of Right Angular Solids
Drawing sectional views of solids for Prism, Cylinder, Pyramid, Cone and project the true shape of the sectioned surface, Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw sectional orthographic views of objects from industry and dwellings (foundation to slab only).

Computer Graphics:
Engineering Graphics Software; -Spatial Transformations; Orthographic Projections; Model Viewing; Co-ordinate Systems; Multi-view Projection; Exploded Assembly; Model Viewing; Animation; Spatial Manipulation; Surface Modeling; Solid Modeling.

Module 4: Overview of Computer Graphics
Demonstration of CAD software [The Menu System, Toolbars (Standard, Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), Zooming methods, Select and erase objects].

Module 5: CAD Drawing, Customization, Annotations, layering
Set up of drawing page including scale settings, ISO and ANSI standards for dimensioning and tolerancing; Using various methods to draw straight lines, circles, applying dimensions and annotations to drawings; Setting up and use of Layers, changing line lengths (extend/lengthen); Drawing sectional views of solids; Drawing annotation, CAD modeling of parts and assemblies with animation, Parametric and nonparametric solid, surface and wireframe modeling, Part editing and printing documents.

Module 6: Demonstration of a simple team design project
Illustrating Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; Meshed topologies for engineering analysis and tool-path generation for component manufacture, use of solid-modeling software for creating associative models at the component and assembly levels.

Text Books:
1. Bhatt N.D., Panchal V.M. & Ingle P.R, (2014), Engineering Drawing, Charotar Publishing House
2. K. Venugopal, Engineering Drawing + AutoCAD, New Age International publishers

Reference Books:
1. Pradeep Jain, Ankita Maheswari, A.P. Gautam, Engineering Graphics & Design, Khanna Publishing House
2. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication.
3. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education

4. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers.

1st Year 2nd Semester								
Sl. No.	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
A. Theory								
1	BSC	PH201	Physics – I	3	0	0	3	3
2	BSC	M201	Mathematics – II	4	0	0	4	4
3	ESC	CS201	Programming for Problem Solving	3	0	0	3	3
B. Practical								
4	BSC	PH291	Physics – I Laboratory	0	0	3	3	1.5
5	HSMC	HSMC291	Professional Communication Laboratory	0	0	2	2	1
6	ESC	ME291	Workshop and Manufacturing Practices Laboratory	0	0	3	3	1.5
7	ESC	CS 291	Programming for Problem Solving Laboratory	0	0	3	3	1.5

8	PROJ	PR291[11*]	Theme Based Project – II	0	0	1	1	0.5
9	PROJ	PR292	Skill Development – II: Life Skill	1	0	0	1	0.5
C. Mandatory Activities / Courses								
10	MC	MC281	NSS / Physical Activities / Meditation and Yoga / Photography / Nature Club	0	0	3	3	0
Total of Theory, Practical and Mandatory Activities / Courses							**26**	**16.5**

Course Name: Physics – I
Course Code: PH201
Contact: 3L:0T:0P
Total Contact Hours: 39
Credit: 3

Prerequisite: Knowledge of Physics up to 12th standard.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Describe various types of oscillating systems, mechanical resonance and its electrical equivalence.
- **CO2.** Explain basic principles of Laser, Optical fibers and Polarization of light.
- **CO3.** Apply superposition principle to explain interference and diffraction, formation of Lissajous figures.
- **CO4.** Analyze different crystallographic structures according to their co-ordination number and packing factors, effect of various level of damping to an oscillating system.
- **CO5.** Justify the need of a quantum mechanics as remedy to overcome limitations imposed by classical physics and user to probability waves to represent microscopic systems.

CO-PO Mapping:

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

[11*] Technical Answers for Real World Problems (TARP).

Course Content

Module 1: Waves and Oscillations 5L

Simple Harmonic Motion (Recap), superposition of waves, damped harmonic motion-over damped, critically damped and under damped motion, energy decay, logarithmic decrement, force vibration and resonance (amplitude, velocity resonance), sharpness of resonance, quality factor, related numerical problems. 5L

Module 2: Classical Optics 12L

2.1. ***Interference of light:*** Huygens's principle, conditions of sustained interference, classification of interference, Newton's ring (qualitative descriptions of working principles and procedures-no deduction required). Engineering applications, related numerical problems. 4L

2.2. ***Diffraction of light****:* Fresnel and Fraunhofer class, Fraunhoffer diffraction of a single slit, double slit, multiple slits, intensity distributions, missing order, Rayleigh criterion (no deduction) and resolving power of grating and microscope (no deduction), related numerical problems. 4L

2.3. ***Polarization:*** Definition, Plane of polarization, Plane of vibration, Malus Law, Fundamental concepts of plane, circular & elliptical polarizations (only qualitative idea) with examples, Brewster's law, Double refraction: Ordinary and Extra ordinary rays, positive and negative crystal, Nicol's prism, Numerical problems. 4L

Module3: Quantum Mechanics – I 8L

3.1. ***Quantum Theory:*** Inadequacy of classical physics-concept of quantization of energy, particle concept of electromagnetic wave (example: photoelectric and Compton Effect; no derivation required, origin of modified and unmodified lines), wave particle duality; phase velocity and group velocity; de Broglie hypothesis; Davisson and Germer experiment. 4L

3.2. ***Quantum Mechanics 1:*** Concept of wave function, physical significance of wave function, probability interpretation; normalization of wave functions; uncertainty principle, relevant numerical problems. Introduction of Schrödinger wave equation (only statement). 4L

Module 4: Solid State Physics – I 3L

4.1. ***Crystal Structure:*** Structure of solids, amorphous and crystalline solids (definition and examples), lattice, basis, unit cell, Fundamental types of lattices – Bravais lattice, simple cubic, fcc and bcc lattices, Miller indices and miller planes, co-ordination number and atomic packing factor, Bragg's equation, applications, numerical problems. 3L

Module 5: Modern Optics – I 8L

5.1. ***Laser:*** Concepts of various emission and absorption processes, Einstein A and B coefficients and equations, working principle of laser, metastable state, population inversion, condition necessary for active laser action, optical resonator, illustrations of Ruby laser, He-Ne laser, Semiconductor laser, applications of laser, related numerical problems. 5L

5.2. ***Fibre Optics:*** Principle and propagation of light in optical fibers (Step index, Graded index, single and multiple modes) - Numerical aperture and Acceptance angle, Basic concept of losses in optical fiber, related numerical problems. 3L

Recommended Text Books:

a) Waves & Oscillations:

1. Sound – N. K. Bajaj (TMH)
2. Advanced Acoustics – D. P. Roy Chowdhury (Chayan Publisher)
3. Principles of Acoustics – B.Ghosh (Sridhar Publisher)
4. A text book of sound – M. Ghosh (S. Chand publishers)
5. A text book of Light – K.G. Mazumder & B.Ghoshs, (Book & Allied Publisher)
6. Physics of Oscillations and Waves – R.P. Singh
7. College Physics Vol. II – A.B. Gupta
8. Vibration, Waves and Acoustics – Chattopadhyay and Rakshit

b) Classical & Modern Optics:

1. A text book of Light – K.G. Mazumder & B.Ghoshs (Book & Allied Publisher)
2. A text book of Light – Brijlal & Subhramanium (S. Chand publishers)
3. Modern Optics – A. B. Gupta (Book & Allied Publisher)
4. Optics – Ajay Ghatak (TMH)
5. Optics – Hecht
6. Optics – R. Kar, Books Applied Publishers
7. Physical Optics Möler
8. Optics – F.A. Jenkins and H.E White

c) Quantum Mechanics – I:

1. Introduction to Quantum Mechanics – S. N. Ghoshal (Calcutta Book House)
2. Quantum Mechanics – Bagde and Singh (S. Chand Publishers)
3. Perspective of Quantum Mechanics – S. P. Kuilla (New Central Book Agency)
4. Quantum Mechanics – Binayak Datta Roy (S. Chand Publishers)
5. Quantum Mechanics – Bransden (Pearson Education Ltd.)
6. Perspective of Modern Physics – A. Beiser (TMH)
7. Quantum mechanics – A.K. Ghatak and S Lokenathan
8. Modern Physics – E.E. Anderson
9. Physics Volume 2 – Haliday, Resnick & Krane, Published by Wiley India

d) Solid State Physics – I:

1. Solid state physics – Puri & Babbar (S. Chand publishers)
2. Materials Science & Engineering – Kakani Kakani
3. Solid state physics – S. O. Pillai
4. Introduction to solid state physics – Kittel (TMH)
5. Solid State Physics and Electronics – A. B. Gupta and Nurul Islam (Book & Allied Publisher)
6. Problem in Solid state physics – S.O. Pillai (a. b.)

Text Books:

1. Refresher courses in physics (Vol. 1, Vol. 2 & Vol. 3) – C. L. Arora (S. Chand Publishers)
2. Basic Engineering Physics – Amal Chakraborty (Chaya Prakashani Pvt. Ltd.)
3. Perspective & Concept of Modern Physics – Arthur Baiser
4. Principles of engineering physics – Md. N Khan and S Panigrahi.
5. Basic Engineering Physics – Sujoy Bhattacharya, Saumen Pal (MG)
6. Engineering Physics (Vol. 1, Vol. 2) – S.P. Kuila (S. Chand Publishers)
7. Engineering Physics – A. S. Vasudeva

Project Domains:

1. Study of Superposition of waves: Lissajous figures.
2. Electrical analogue of mechanical vibrations: application to electrical circuit (LC and LCR circuits), Electrical and mechanical impedance, quality factor, complex representation and phasor diagram.
3. Study of N-slit diffractions
4. Optical Fibre & its applications: Study of losses, estimation of numerical aperture in practical problems.
5. Photonic nature of electromagnetic waves
6. Optical Rotation.

Course Name: Mathematics – II
Course Code: M201
Contact: 4L:0T:0P
Total Contact Hours: 48
Credit: 4

Prerequisite: The students to whom this course will be offered must have the concept of (10+2) calculus.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Recall the properties and formula related to ordinary differential equations, improper integral, Laplace transform and numerical techniques.

CO2. Determine the solutions of the problems related to ordinary differential equations, improper integral, Laplace transform and numerical techniques.

CO3. Apply appropriate mathematical tools of ordinary differential equations, improper integral, Laplace transform and numerical techniques for the solutions of the problems.

CO4. Analyze engineering problems by using differential equation, Laplace Transform and Numerical Methods.

CO-PO Mapping:

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

Course Content

Module 1: First Order Ordinary Differential Equations (ODE) 10L

Solution of first order and first degree ODE: Exact ODE, Rules for finding Integrating factors, Linear ODE, Bernoulli's equation, Solution of first order and higher degree ODE: solvable for p, solvable for y solvable for x and Clairaut's equation.

Module 2: Second Order Ordinary Differential Equations (ODE) 10L

Solution of second order ODE with constant coefficients: C.F. & P.I., Method of variation of parameters, Cauchy-Euler equations, Solution of simultaneous linear ODEs.

Module 3: Laplace Transform (LT) 14L

Improper integrals; Beta and Gamma functions and their properties.

Definition and existence of LT, LT of elementary functions, First and second shifting properties, Change of scale property, LT of t f (t) , LT of (f (t))/t, LT of derivatives of f (t), LT of integral of f(t), Evaluation of improper integrals using LT, LT of periodic and step functions, Inverse LT: Definition and its properties, Convolution theorem (statement only) and its application to the evaluation of inverse LT, Solution of linear ODE with constant coefficients (initial value problem) using LT.

Module 4: Numerical Methods 14L

Introduction to error analysis, Calculus of finite difference. Interpolation: Newton forward and backward interpolation, Lagrange's interpolation, Newton's divided difference interpolation formula. Numerical integration: Trapezoidal rule, Simpson's 1/3 rule, Weddle's rule. Numerical solution of ordinary differential equation: Euler method, Modified Euler method, Fourth order Runge-Kutta method.

Project Domains:

1. Mathematical modeling using ODE.
2. Application of ODE.
3. Application of Laplace Transform in different engineering branches.
4. Application of Numerical Methods in different engineering branches.

Text Books:

1. Kreyszig, E., Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. Ramana, B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
3. Veerarajan, T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Grewal, B.S., Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.
5. Bali, N.P. and Goyal, M., A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
6. Samanta Guruprasad, A text book of Engineering Mathematics-II, New age International Publishers
7. Mollah, S. A, Numerical Analysis and Computational Procedures, Books and Allied (P)

Ltd.

Reference Books:

1. Thomas, G.B. and Finney, R.L., Calculus and Analytic geometry, 9th Edition, Pearson, Reprint, 2002.
2. Boyce, W. E. and DiPrima, R. C., Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.
3. Ross, S. L., Differential Equations, 3rd Ed., Wiley India, 1984.
4. Piskunov, N., Differential and Integral Calculus, Vol. I & Vol. II, Mir Publishers, 1969.
5. Coddington, E. A., An Introduction to Ordinary Differential Equations, Prentice Hall, India, 1995.
6. Dey, Sukhendu, Gupta Sisir, Numerical Methods, McGraw Hill Education(India) Private Limited.
7. Jain, M. K., Iyengar, S. R. K., Jain, R. K., Numerical Methods, New age International Publishers.

Course Name: Programming for Problem Solving
Course Code: CS201
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Number system, Boolean Algebra.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the fundamental concept of Computer and mathematical knowledge and apply them in designing solution to engineering problem.
- **CO2.** Understand the basic concept of C programming and use of data types/operators/input/output function for developing and implementing complete program leading to solution of mathematical and engineering problem.
- **CO3.** Use conditional branching, iteration, recursion and formulate algorithms and programs in solving mathematical/ scientific/ engineering problem leading to lifelong learning.
- **CO4.** Understand the concept of arrays, pointers, file and dynamic memory allocation and

apply it for problem solving and also create new data types using structure, union and enum.

CO5. Understand how to decompose a problem into functions and assemble into a complete program by means of modular programming possibly as a team.

CO-PO Mapping:

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

Course Content

Module 1: Fundamentals of Computer **9L**

History of Computer, Generation of Computer, Classification of Computers, Basic structure of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output devices.

Number System: basic of Binary, Octal, Decimal and Hexadecimal number systems; Representation and interchanging of number in different number systems. Introduction to complements system, Representation of signed and unsigned numbers in singed magnitude singed 1's complement system and signed 2's complement system.

Arithmetic – Addition and Subtraction (using1'scomplementand2'scomplement).

Representation of Characters-ASCII Code

Basics of Compiler, Interpreter and Assembler

Problem solving – Basic concept of Algorithm. Representation of algorithm using flow chart and pseudo code. Some basic examples.

Module 2: Introduction to C Programming **5L**

Overview of Procedural vs Structural language; History of C Programming Language.

Variable and Data Types: The C characterse identifiers.

And keywords, data type & sizes, variable names, declaration, statements.

Operators & Expressions: Arithmetic operators, relational operators, logical operators, increment and decrementoperators, bitwiseoperators, assignmentoperators, conditionaloperators, specialoperators – typeconversion, C expressions, precedence and associativity.

Input and Output: Standard input and output, formatted output–print f, formatted input scan f.

Module 3: Branch and Loop **5L**

Branching: Concept of Statement and Blocks in C, Simple if, if -else, nested if-else and if-else ladder.

Switch Case: break andcontinue; switch-case, concept of goto and labels

Loops – while, for, do while

Module 4: Program Structures **4L**

Function: Basics of Functions, function types, function prototypes, formal and actual parameter, function calling, functions returning values, functions not returning values. Recursion and Recursive Function.

Storage Class in C: Storage Class-auto, external, static and register storage class, scope rules and life time of variables

C pre-processor: Pre-processing directive and macro, parameterized macro.

Module 5: Array and Pointer **7L**

Arrays: One dimensional arrays, Two-dimensional arrays, Passing an array to a function
Pointers: Pointers, Pointer andArray, Pointer and functions.
Strings: Character array and string, array of strings, Passing a string to a function, String related functions, Pointer and String.
Dynamic memory allocation: Malloc, calloc, realloc and free with example.

Module 6: Structures, Unions and Enum **3L**

Basic of structures, arrays of structures, structures and pointers, bit fields. Basics of union and enum, difference between structure and union.

Module 7: File in C **3L**

Files handling- opening and closing a file in different mode, formatted and unformatted files, Command line arguments, f open, f close, f get c, f put c, f print f, f scan f function.

Text Books:

1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.
2. KanetkarY. – LetusC, BPBPublication,15th Edition.

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.
2. K R Venugopal & S R Prasad – MASTERING C, TMH, 2nd Edition.

Course Name: Physics – I Laboratory
Course Code: PH291
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Knowledge of Physics up to 12th standard.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Demonstrate experiments allied to their theoretical concepts.
- **CO2.** Conduct experiments using LASER, Optical fiber, Torsional pendulum, Spectrometer.
- **CO3.** Participate as an individual and as a member or leader in groups in laboratory sessions actively.
- **CO4.** Analyze experimental data from graphical representations, and to communicate effectively them in Laboratory reports including innovative experiments.

CO5. Design solutions for real life challenges.

CO-PO Mapping:

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

List of Experiments:

General idea about Measurements and Errors (One Mandatory):

i. Error estimation using Slide calipers/ Screw-gauge/travelling microscope for one experiment.
ii. Proportional error calculation using Carrey Foster Bridge.

Any 6 to be performed from the following experiments

Experiments on Waves & Oscillations:

1. Study of Torsional oscillation of Torsional pendulum & determination of time using various load of the oscillator.
2. Determination of elastic moduli of different materials (Young's modulus /Rigidity modulus)
3. Determination of Q factor using LCR Circuit.
4. Calibration of an oscillator using Lissajous Figure.

Experiments on Classical Optics:

5. Determination of wavelength of light by Newton's ring method.
6. Determination of wavelength of light by Laser diffraction method.
7. To determine the angle of optical rotation of a polar solution using polarimeter

Experiments on Quantum Physics – I:

8. Determination of Planck's constant using photoelectric cell.
9. Verification of Bohr's atomic orbital theory through Frank-Hertz experiment.
10. Determination of Stefan's Constant

** In addition it is recommended that each student should carry out at least one experiment beyond the syllabus/one experiment as Innovative experiment

Probable experiments beyond the syllabus:

1. Determination of wavelength of light by Fresnel's bi-prism method (beyond the syllabus).
2. Study of dispersive power of material of a prism.
3. Study of viscosity using Poiseuille's capillary flow method/using Stoke's law.
4. Measurement of nodal and antipodal points along transmission wire and measurement of wavelength.
5. Any other experiment related to the theory.

Recommended Text Books for Physics I Lab:

Waves & Oscillations:

1. Vibration, Waves and Acoustics- Chattopadhyay and Rakshit

Classical & Modern Optics:

1. A text book of Light- K.G. Mazumder & B.Ghoshs (Book & Allied Publisher)

Quantum Mechanics – I:

1. Introduction to Quantum Mechanics-S. N. Ghoshal (Calcutta Book House)

Solid State Physics – I:

1. Solid State Physics and Electronics-A. B. Gupta and Nurul Islam (Book & Allied Publisher)

Text Books:

1. Practical Physics by Chatterjee & Rakshit (Book & Allied Publisher)
2. Practical Physics by K.G. Mazumder (New Central Publishing)
3. Practical Physics by R. K. Kar (Book & Allied Publisher)

Course Name: Professional Communication Laboratory
Course Code: HSMC291
Contact: 0L:0T:2P
Credit: 1

Prerequisite: Basic knowledge of LSRW skills.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Understand advanced skills of Technical Communication in English through

Language Laboratory.

CO2. Apply listening, speaking, reading and writing skills in societal and professional life.
CO3. Demonstrate the skills necessary to be a competent Interpersonal communicator.
CO4. Analyze communication behaviours.
CO5. Adapt to multifarious socio-economical and professional arenas with the help of effective communication and interpersonal skills.

CO-PO Mapping:

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

Course Content

Module 1: Introduction to the Language Lab
a. The Need for a Language Laboratory
b. Tasks in the Lab
c. Writing a Laboratory Note Book

Module 2: Active Listening
a. What is Active Listening?
b. Listening Sub-Skills—Predicting, Clarifying, Inferencing, Evaluating, Note-taking
c. Academic Listening vs Business Listening
d. Listening in Business Telephony
e. Study of Contextualized Examples based on Lab Recordings

Module 3: Speaking
a. Speaking—Accuracy and Fluency Parameters
b. Pronunciation Guide—Basics of Sound Scripting, Stress and Intonation
c. Fluency-focussed activities—JAM, Conversational Role Plays, Speaking using Picture/Audio Visual inputs
d. Accuracy-focussed activities—Identifying Minimal Pairs, Sound Mazes, Open and Closed Pair Drilling, Student Recordings (using software)
e. Group Discussion: Principles and Practice
f. Business Meetings and Sales Talks

Module 4: Lab Project Work
a. Making a brief Advertisement video (1-2 minutes)
b. Making a brief Business Documentary film (5-7 minutes)
c. Client interaction video (5-7 minutes)
d. Making a short video CV (1-2 minutes)

References:
1. IIT Mumbai, Preparatory Course in English syllabus
2. IIT Mumbai, Introduction to Linguistics syllabus
3. Sasikumar et al. A Course in Listening and Speaking. New Delhi: Foundation Books,

2005.
4. Tony Lynch, Study Listening. Cambridge: Cambridge UP, 2004.

Course Name: Workshop and Manufacturing Practices Laboratory
Course Code: ME291
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Higher Secondary with Mathematics, Physics and Chemistry.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Identify and operate various hand tools related to variety of manufacturing operations
- **CO2.** Safely fabricate simple components with their own hands.
- **CO3.** Get practical knowledge of the dimensional accuracies and tolerances applicable for different manufacturing processes.
- **CO4.** Produce small devices of their interest for project or research purpose.

CO-PO Mapping:

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

List of Experiments:

(i) Theoretical discussion & videos: 3P

1. Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods
2. Fitting operations & power tools
3. Carpentry
4. Welding (arc welding & gas welding), brazing
5. Electrical & Electronics
6. Metal casting
7. CNC machining, Additive manufacturing
8. Plastic moulding & Glass Cutting

(ii) Workshop Practice:

Module 1: Machine shop **6P**

Typical jobs that may be made in this practice module:

a. To make a pin from a mild steel rod in a lathe.
b. To make rectangular and vee slot in a block of cast iron or mild steel in a shaping and / or milling machine.

Module 2: Fitting shop **6P**

Typical jobs that may be made in this practice module:

a. To make a Gauge from MS plate.

Module 3: Carpentry **6P**

Typical jobs that may be made in this practice module:

a. To make wooden joints and/or a pattern or like.

Module 4: Welding shop (Arc welding 3P + gas welding 3P) **3P**

Typical jobs that may be made in this practice module:

a. ARC WELDING (3P): To join two thick (approx 5mm) MS plates by manual metalarcwelding.
b. GAS WELDING (3P): To join two thin mild steel plates or sheets by gas welding.

Module 5: Electrical & Electronics **3P**

a. House wiring, soft Soldering

Module 6: Smithy **3P**

Typical jobs that may be made in this practice module:

a. A simple job of making a square rod from a round bar or similar.

For further study (Optional)

Module 7: Casting **3P**

Typical jobs that may be made in this practice module:

a. One/ two green sand moulds to prepare, and a casting be demonstrated.

Module 8: Plastic moulding & Glass Cutting **3P**

Typical jobs that may be made in this practice module:

a. For plastic moulding, making at least one simple plastic component should be made.
b. At least one sample shape on glass should be made using laser cutting machine.

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Text Books:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
2. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGrawHill House, 2017.

Reference Books:

1. Gowri P., Hariharan and A. Suresh Babu, Manufacturing Technology – I, Pearson Education, 2008.
2. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
3. Kalpakjian S. and Steven S. Schmid, Manufacturing Engineering and Technology, 4th edition, Pearson Education India Edition, 2002.
4. Manufacturing Science by A. Ghosh and A.K. Mallick, Wiley Eastern.
5. Principles of Metal Cutting/Principles of Machine Tools by G.C. Sen and A. Bhattacharya, New Central Book Agency, Kolkata.

Course Name: Programming for Problem Solving Laboratory
Course Code: CS291
Contact: 0L:0T:3P

Credit: 1.5

Prerequisite: Number system, Boolean Algebra

Course Outcomes: After successful completion of the course, student will be able to

CO1. Understand and propose appropriate command or function in running system or developing program for engineering and mathematical problems depending on the platform used even in changed environment leading to their lifelong learning.

CO2. Identify and propose appropriate data type, arithmetic operators, input/output functions and also conditional statements in designing effective programs to solve complex engineering problem using modern tools.

CO3. Design and develop effective programs for engineering and mathematical problems using iterative statements as well as recursive functions using modular programming approach possibly as a team maintaining proper ethics of collaboration.

CO4. Explain and organize data in arrays, strings and structures and manipulate them through programs and also define pointers of different types and use them in defining self-referential structures and also to construct and use files for reading and writing to and from leading to solution of engineering and mathematical problem.

CO5. Prepare laboratory reports on interpretation of experimental results and analyze it for validating the same maintaining proper ethics of collaboration.

CO-PO Mapping:

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

List of Experiments:

Module 1: Familiarization with some basic commands of DOS and Linux. File handling and Directory structures, file permissions, creating and editing simple C program in different editor and IDE, compilation and execution of C program. Introduction to Code block.

Module 2: Problem based on

a) Basic data types
b) Different arithmetic operators.
c) Print f( ) and scan f( ) functions.

Module 3: Problem based on conditional statements using

a) if-else statements
b) different relational operators
c) different logical operators

Module 4: Problem based on

a) for loop
b) while loop
c) do-while loop

Module 5: Problem based on

a) How to write a menu driven program using switch-case statement
b) How to write a function and passing values to a function
c) How to write a recursive function.

Module 6: Problem based on
a) How to use array (both I-Dand2-D).
b) How to pass an array to a function.

Module 7: Problem based on manipulation of strings in different way.

Module 8: Problem based on
a) How to handle compound variables in C
b) How to handle file in C
c) How to use command line argument in C

Text Books:
1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
2. KanetkarY. – LetusC, BPB Publication, 15th Edition

Reference Books:
1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.
2. K R Venugopal & S R Prasad – MASTERING C, TMH, 2nd Edition

2nd Year 3rd Semester								
Sl. No.	Category	Paper Code	Subject	Contact Hours/Week				Credit Points
				L	T	P	Total	
A. Theory								
1	BSC	EE(PH)301	Electromagnetic Fields	3	1	0	4	4
2	ESC	EE(ME)301	Engineering Mechanics	3	0	0	3	3
3	ESC	EE301	Electrical Circuit Analysis	3	0	0	3	3
4	PCC	EE302	Electrical and Electronic Measurement	2	0	0	2	2
5	PCC	EE303	Semiconductor Devices and Circuits	3	0	0	3	3
6	HSMC	HSMC302	Gender Culture and Development	2	0	0	2	2
B. Practical								
7	ESC	EE391	Electrical Circuit Analysis Laboratory	0	0	2	2	1
8	PCC	EE392	Electrical and Electronic Measurement Laboratory	0	0	3	3	1.5
9	PCC	EE393	Semiconductor Devices and Circuits Laboratory	0	0	2	2	1
10	ESC	EE394	Python Programming Laboratory	0	0	3	3	1.5
11	PROJ	PR391[12*]	Theme Based Project – III	0	0	1	1	0.5
12	PROJ	PR392	Skill Development – III: Technical Seminar Presentation	1	0	0	1	0.5
C. Mandatory Activities / Courses								
13	MC	MC381	Learning an Art Form [Vocal or Instrumental, Dance, Painting, Clay Modeling, etc.] OR Environmental Protection Initiatives	0	0	0	3	0
Total of Theory, Practical and Mandatory Activities / Courses without MOOC Courses							**32**	**23**
D. MOOC Courses[13]**								
14	MOOC	HM301	MOOC Course – I	3	1	0	4	4
Total of Theory, Practical and Mandatory Activities / Courses with MOOC Courses							**36**	**27**

Course Name: Electromagnetic Fields
Course Code: EE(PH)301

[12*] Technical Answers for Real World Problems (TARP).
[13**] MOOC Courses for HONOURS / MINOR Degree are Program specific and to be taken from MOOC Basket.

Contact: 3L:1T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Knowledge of waves, equations, fields from 1st year Physics and Basic Electrical Engineeirng.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Explain electromagnetic wave propagation using fundamentals of electrostatics, magnetostatics and electromagnetic theory.
- **CO2.** Aapply vector calculus in problems of electrostatics and magnetostatics and attainment of electromagnetic wave equation.
- **CO3.** Analyze the physics of various kinds of electric and magnetic materials
- **CO4.** Justify the emergence of magnetic field under time varying electric field using Maxwell's 4th equation.

CO-PO Mapping:

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

Course Content

Module 1: Co-ordinate systems 3L

Cartesian coordinates, Circular cylindrical coordinates, Spherical coordinates and their transformation. Differential length, area and volume in different coordinate systems. Solution of problems**.**

Module 2: Vector Calculus 3L

Vector operators, Gradient, Divergence, Curl-Physical significance, Scalar and Vector field, Gauss's divergence theorem (statement only), Stoke's theorem (statement only), expression of gradient, divergence, curl in spherical and cylindrical coordinate system.

Module 3: Electrostatics 11L

3.01: Coulomb's law in vector form, Electrostatic field and its curl, Gauss's law in integral form and conversion into differential form, Electric potential and potential gradient, Concept of Electric dipole, flux lines and Energy density in electrostatic field, Equation of continuity, Extend to Poisson's & Laplace's equation, Application of Gauss's law. Application of Laplace's equation. Application to parallel plate, spherical and cylindrical capacitors (equivalent 1D problem). 7L

3.02: Concept of Polarization, the relation between D, E and P, Polarizability, Electronic, Ionic, Orientation & Space charge polarization (no derivation), behavior of Dielectric under alternating field (qualitative discussion only), Dielectric losses.
4L

Module 4: Magnetostatics 10L

4.01: Lorentz force (concept in Hall effect), Biot-Savart law (non-existence of magnetic monopole), Magnetic vector and scalar potential. Ampere's circuital law, force on a small current element placed in a magnetic field. force due to parallel and anti-parallel current carrying wire and definition of Ampere. Magnetic torque and moments, Magnetization in material, Magnetic boundary condition, Concept of Magnetic energy, Magnetostriction, Solution of problems.
6L

4.02: Relation between Magnetic Inducation, Magnetic field, Magnetization. Bohr magneton, susceptibility, Diamagnetism, Paramagnetism & Ferromagnetism-Hysteresis, Hard ferromagnets, Comparison and applications of permanent magnets (storage devices) and Soft ferromagnets (Permalloys, Ferrites etc.) 4L

Module 5: Time-varying field and Maxwell's equations 9L

5.01: Faraday's law-integral and differential form, Transformer and motional emf, Concept of displacement current, Maxwell's field equations with physical significance, Solution of problems. 4L

5.02: Wave equation in free space, transverse nature of electromagnetic wave.in conducting medium, Wave propagation in lossy dielectric, Plane waves in loss less dielectric, Plane wave in free space, Plane wave in good and dielectric conductor, Skin effect, Skin depth, Power and Poynting vector. Solution of problems.
5L

Text Books:

1. Vector analysis- Murray R Spigel (Schaum's outline)
2. Introduction to Electrodynamics- David J Griffiths (PHI learning Private Ltd.)
3. Barkley Physics course- E M Purcell (McGraw-Hill Book company)
4. Electromagnetic theory & Electrodynamics- Satya Prakash (Kedarnath Ramnath publication)
5. Electricity & Magnetism- D. Chattopadhyay & P.C. Rakshit (Central publication)
6. Electromagnetic field theory fundamentals, Guru &Hizroglu, 2nd edition, Cambridge University Press.
7. Electromagnetic with application, Krause, 5th Edition, TMH

Reference Books:

1. Electricity & Magnetism-B.Ghosh (Books & Allied Pub)
2. Elements of Electromagnetic Fields, S.P. Seth, Dhanpat Rai & Sons
3. Elements of Electromagnetic, Mathew N.O. Sadiku, 4th edition, Oxford University press.
4. Engineering Electromagnetic, W.H. Hyat& J.A. Buck, 7th Edition, TMH
5. Theory and problems of Electromagnetic, Edminister, 2nd Edition, TMH

Course Name: Engineering Mechanics
Course Code: EE(ME)301
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Basic Concept of Physics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** To understand representation of force, moments for drawing free-body diagrams and analyze friction-based systems in static condition
- **CO2.** To locate the centroid of an area and calculate the moment of inertia of a section.
- **CO3.** Apply of conservation of momentum & energy principle for particle dynamics and rigid body kinetics
- **CO4.** Understand and apply the concept of virtual work, rigid body dynamics and systems under vibration.

CO-PO Mapping:

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

Course Content

Module 1: Introduction to Engineering Mechanics 8L
Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Vector Mechanics- dot product, cross product, Problems

Module 2: Friction 4L
Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack, Problems.

Module 3: Basic Structural Analysis 4L
Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines, Problems.

Module 4: Centroid and Centre of Gravity 4L
Distributed Force: Centroid and Centre of Gravity; Centroids of a triangle, circular sector,

quadrilateral, etc., Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications, Problems.

Module 5: Moment of Inertia 4L

Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook, Problems.

Module 6: Virtual Work and Energy Method 3L

Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational), energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium, Problems.

Module 7: Review of particle dynamics 5L

rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2nd law (rectangular, path, and polar coordinates). Work-kinetic energy, power, potential energy. Impulse-momentum (linear, angular); Impact (Direct and oblique), Problems

Module 8: Introduction to Kinetics of Rigid Bodies 4L

Basic terms, general principles in dynamics; Types of motion, Instantaneous center of rotation in plane motion and simple problems; D'Alembert's principle and its applications in plane motion and connected bodies; Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation, Problems.

Text Books:

1. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall
2. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, – Dynamics, 9th Ed, Tata McGraw Hill
3. R.C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
4. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford University Press
5. Shanes and Rao (2006), Engineering Mechanics, Pearson Education,
6. Hibler and Gupta (2010), Engineering Mechanics (Statics, Dynamics) by Pearson Education

Reference Books:

1. Reddy Vijaykumar K. and K. Suresh Kumar (2010), Singer's Engineering Mechanics
2. Bansal R. K. (2010), A Text Book of Engineering Mechanics, Laxmi Publications
3. Khurmi R.S. (2010), Engineering Mechanics, S. Chand & Co.
4. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications

Course Name: Electrical Circuit Analysis
Course Code: EE301
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: The students to whom this course will be offered must have the concept of Basic electrical engineering, Laplace transform, First order ordinary differential equation and Second order ordinary differential equation.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the basic concepts of electric, magnetic and filter circuits.
- **CO2.** Synthesize different electrical circuits with network theorems.
- **CO3.** Apply advanced mathematical methods such as Laplace and Fourier transforms along with linear algebra and differential equations techniques for solving circuit problems.
- **CO4.** Analyze two port circuit behaviors.

CO-PO Mapping:

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

Course Content

Module 1: Network Theorems **6L**

KVL & KCL, Loop variable analysis, Node variable analysis, Superposition Theorem, Thevenin‘s Theorem, Norton‘s Theorem, Maximum Power Transfer Theorem, Millman‘s Theorem Solution of Problems with DC & AC sources.

Module 2: Coupled Circuits **4L**

Magnetic coupling, Polarity of coils, Polarity of induced voltage, Concept of Self and Mutual inductance, Coefficient of coupling, Modelling of coupled circuits, Solution of problems.

Module 3: Laplace Transform in Circuit Analysis **8L**

The Laplace’s transform, Initial value theorem and final value theorem, Transient phenomena of Electrical circuits (RL, RC, RLC) with the Laplace transform, Review of Laplace Transform, Analysis of electrical circuits using Laplace Transform for standard inputs, convolution integral, inverse Laplace transform, transformed network with initial conditions. Series and parallel resonances.

Module 4: Graph Theory **3L**

Concept of Tree, Branch, Tree link, Incidence Matrix, Cut Set Matrix, Tie Set Matrix, tieset, cutset matrices of electric circuits.

Module 5: Two Port Network **5L**

Open circuit Impedance & Short circuit Admittance parameter, Transmission parameter, Hybrid Parameter, Conditions of Reciprocity and Symmetry, Driving point impedance & Admittance. Solution of problems.

Module 6: Filter **4L**

Analysis and synthesis of Low pass, High pass, Band pass, Band reject, All pass filters (first and second order only) using operational amplifier.

Module 7: Fourier Series Analysis **6L**

Introduction, Periodic functions: Properties, Even & Odd functions: Properties, Special wave forms: Square wave, Half wave Rectifier, Full wave Rectifier, Saw-toothed wave, Triangular wave. Euler's Formulae for Fourier Series, Fourier Series for functions of period 2π, Dirichlet's conditions, Sum of Fourier series. Theorem for the convergence of Fourier Series (statement only). Fourier Series of a function with its Periodic extension. Half Range Fourier Series: Construction of Half range Sine Series, Construction of Half range Cosine Series. Parseval's identity (statement only).

Text Books:

1. Sudhakar, Circuits & Networks: Analysis & Synthesis, 2/e TMH
2. D. Roy Choudhury, Networks and Systems, New Age International Publications, 1998.
3. W. H. Hayt and J. E. Kemmerly, Engineering Circuit Analysis, McGraw Hill Education, 2013.
4. C. K. Alexander and M. N. O. Sadiku, Electric Circuits, McGraw Hill Education, 2004.
5. D. Chattopadhyay and P. C. Rakshit, Electrical Circuits.

Reference Books:

1. M. E. Van Valkenburg, Network Analysis, Prentice Hall, 2006.
2. K. V. V. Murthyand, M.S. Kamath, Basic Circuit Analysis, Jaico Publishers, 1999.
3. Sivanandam, Electric Circuits Analysis
4. V. K. Chandna, A Text Book of Network Theory & Circuit Analysis, Cyber Tech References.
5. Kuo F. F., Network Analysis & Synthesis, John Wiley & Sons.

Course Name: Electrical and Electronic Measurement
Course Code: EE302
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Concepts of Basic Electrical Engineering.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the operating principles of electrical and electronic measuring instruments.
- **CO2.** Identify and measure various physical parameters using appropriate measuring instruments.
- **CO3.** Measure various electrical parameters.
- **CO4.** Understand statistical data analysis and computerized data acquisition.

CO-PO Mapping:

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

Course Content

Module 1: Analog Measurement Systems **6L**

Instruments Characteristics:

Static Characteristics- Definition of accuracy, Precision, Resolution and sensitivity of analog and digital meters, classification of errors in measurement. Dynamic Characteristics- Speed of response, Band width. 2L

Analog Instruments:

Classification, General features, Construction, Principle of operation and torque equation of Moving coil and Moving iron, Electrodynamometer, Induction instruments, Electrostatic instruments, Extension of instrument ranges and multipliers. Disadvantages of shunt and multipliers. Galvanometer: Principle of operation, Advantage, Disadvantage, Error and Application. 4L

Module 2: Circuit Parameters, Voltage and Frequency **5L**

Measurement of resistance:

Measurement of medium resistance by using Wheatstone bridge, low resistance by using Kelvin double bridge. Other methods – Substitution method, Ammeter-Voltmeter method and Megger for

measurement of medium and high resistances. 3L

Measurement of inductance, capacitance and frequency:

Measurement of Inductance-Maxwell bridge and Anderson bridge, Measurement of Capacitance-Schering bridge and Anderson bridge, Measurement of Frequency-Wien bridge. 2L

Module 3: Electrical Power and Energy Measurement 6L

Instrument Transformer:

Use of Instrument transformers, Principle of operation of Current & Potential transformer, errors. 2L

Measurement of Power:

Principle of operation of Electro-dynamic & Induction type wattmeter. wattmeter errors. 2L

Measurement of Energy:

Basic circuit diagram and principle of operation, calibration and testing of energy meter. 2L

Module 4: Electronic Instruments 7L

Electronic Instruments:

Basic concept of analog Electronic Voltmeter, functional block diagram of Digital Voltmeter and Multimeter, working principle of digital frequency meter by using functional block diagram, True RMS meters, Clamp-on meters. 4L

Cathode Ray oscilloscope (CRO):

Basic working principle of Analog CRO using functional block diagram, concept of dual beam and dual trace CRO. Measurement of voltage, current, frequency & phase by CRO. Double beam CRO. Basic concept Digital Storage Oscilloscope. 3L

Text Books:

1. A course in Electrical & Electronic Measurements & Instrumentation, A.K. Sawhney, Dhanpat Rai & sons.
2. Electrical and Electronic Measurement & Instruments, J.B Gupta, S.K. Kataria & Sons.
3. Electronic Instruments, H.S. Kalsi, Tata Mc-Graw hill, 2nd Edition.
4. D.V.S. Moorthy, Transducers & Instrumentation", 2nd/e, Prentice Hall of India Pvt Ltd, 2010.

Reference Books:

1. Sensors & Transducers, D. Patranabis, PHI, 2nd edition.
2. Digital Instrumentation, A.J. Bouwens, Tata Mc-Graw hill.
3. Modern Electronic instrumentation & Measuring instruments, A.D. Heltric & W.C. Copper, Wheeler Publication.
4. Instrument transducers, H.K.P. Neubert, Oxford University press

Course Name: Semiconductor Devices and Circuits
Course Code: EE303
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Knowledge of Engineering Physics.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Apply the knowledge of solid state devices principles to analyze electronic circuits.
CO2. Understand amplifiers under different configurations and study their responses.
CO3. Analyze the high speed response of semiconducting devices.

CO-PO Mapping:

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

Course Content

Module 1: Semiconductor Device Physics **3L**
Semi-conductors, charge carriers, intrinsic and extrinsic semi-conductors, carrier generation, recombination, injection of carriers, Drift and diffusion, carrier mobility, conductivity.

Module 2: Diode Circuit Analysis **4L**
PN junction diode – Formation of Junction, Junction Capacitance, characteristics, Diode equations, Diode Circuits – Clipper and Clamper, rectifiers with and without filters, other multiple diode circuits, Regulated power supplies.

Module 3: Transistor DC Analysis **4L**
BJT Characteristics, current gains, h-parameters, MOSFET Characteristics, Load line and Operating point analysis, DC analysis and biasing of BJTs and MOSFETs.

Module 4: BJT Amplifiers **5L**
Small signal analysis of BJT amplifiers, Calculation of Gain, Input Impedance and Output

Impedance. Basic BJT amplifier Configurations (CE, CC and CB). Power Amplifiers.

Module 5: MOSFET Amplifiers 5L

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

Module 6: Frequency response 5L

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

Module 7: Feedback Amplifiers and Oscillators 5L

Basic concepts of feedback-Negative feedback advantages and types, Voltage/Current Series/Shunt, Positive feedback, Stability, Conditions for Oscillations RC and LC oscillators.

Module 8: Contemporary issues 5L

Text Books:

1. A.S.Sedra, K.C. Smith, “Microelectronic Circuits: Theory with Applications”, 6Ed, Oxford University Press, 2013.R. Krishnan, “Electric Motor Drives: Modeling, Analysis and Control”, PHI-India, 2005.

Reference Books:

1. D.A. Neamen, Electronic Circuits – Analysis and Design, 3Ed, McGraw Hill, 2011.
2. David A. Bell, “Electronic Devices and Circuits”, 5ed, Oxford University Press, 2008.
3. Behzad Razavi, Fundamentals of Microelectronics, 3Ed, Wiley, 2013
4. Ben Streetman, Sanjay Banerjee, Solid State Electronic Devices, 7ED, Pearson, 2014.

Course Name: Gender Culture and Development
Course Code: HSMC302
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: None.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Provide an analysis of the location of women in the processes of economic development; to understand what economic development is, the scales or levels at which it occurs, and the centrality of gender at every level.
- **CO2.** Examine theoretical and conceptual frameworks for that analysis.
- **CO3.** Reflect upon linkages between the global economy and the gendered macro and micro process of development and transitions from 'government' to 'governance.'
- **CO4.** Explain the usefulness of a rights based approach to gender justice.
- **CO5.** Provide basis for research, practical action and policy formulation and or evaluating for evaluating directions and strategies for social change from a gender perspective.

CO-PO Mapping:

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

Course Content

Module1: **4L**
Introduction to Gender, Definition of Gender, Basic Gender Concepts and Terminology, Exploring Attitudes towards Gender, Social Construction of Gender.

Module 2: **6L**
Gender Roles and Relations, Types of Gender Roles, Gender Roles and Relationships Matrix,

Gender-based Division and Valuation of Labour.

Module 3: **5L**

Gender Development Issues, Identifying Gender Issues, Gender Sensitive Language, Gender, Governance and Sustainable Development, Gender and Human Rights, Gender and Mainstreaming.

Module 4: **5L**

Gender-based Violence, The concept of violence, Types of Gender-based violence, The relationship between gender, development and violence, Gender-based violence from a human rights perspective.

Module 5: **4L**

Gender and Culture Gender and Film, Gender and Electronic Media, Gender and Advertisement, Gender and Popular Literature.

Text Books:

1. Beneria, Lourdes. (2004). Gender, Development, and Globalization: Economics as if All People Mattered. Roultedge Press. (GDGE)
2. Molyneux and Razavi. (2002). Gender Justice, Development and Rights. Oxford University Press (GJDR or WGD)
3. Visvanathan, Duggan,Wiegersma and Nisonoff. (2011). The Women, Gender and Development Reader. 2nd Edition. Zed Press (WGD)

Course Name: Electrical Circuit Analysis Laboratory
Course Code: EE391
Contact: 0L:0T:2P
Credit: 1

Prerequisite: Concepts of Basic Electrical Engineering.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Demonstrate transient analysis of electric circuits frequency response characteristics of Filter circuits.

CO2. Analyze electric circuits, signals and algorithms using mathematical tools.

CO-PO Mapping:

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

List of Experiments:

1. Familiarization with various MATLAB commands used in Electrical Engineering
2. Verification of Network theorems using hardware components/ software simulation using MATLAB/Pspice/ Multisim Software.
3. Verification of Series/Parallel Resonance circuit using MATLAB/ Pspice/ Multisim Software.
4. Transient response of R-L and R-C network: simulation with PSPICE/ MATLAB/ Hardware
5. Transient response of R-L C series and parallel circuit: Simulation with PSPICE/ MATLAB/ Hardware
6. Study the effect of inductance on step response of series RL circuit in MATLAB/ Hardware
7. Determination of Impedance(Z) and Admittance(Y) parameter of two port network: Simulation/ Hardware.
8. Frequency response of LP and HP filters: Simulation/ Hardware.
9. Frequency response of BP and BR filters: Simulation/ Hardware.

10. Amplitude and Phase spectrum analysis of different signals using MATLAB.
11. Innovative Experiments.

Course Name: Electrical and Electronic Measurement Laboratory
Course Code: EE392
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Concepts of different measuring system.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Conduct experiment to measure of Resistance, Inductance, Capacitance, Power and Energy.

CO-PO Mapping:

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

List of Experiments:

1. Measurement of power in polyphase circuit.
2. Measurement of power using instrument transformer.
3. Measurement of capacitance using Schering Bridge technique as well as LCR meter.
4. Calibration of Digital Energy Meter.
5. Testing of energy Meter
6. Measurement of capacitance using Anderson Bridge technique as well as LCR meter.
7. Measurement of low resistance using Kelvin Double bridge.
8. Measurement of high resistance and insulation resistance using Megger.
9. Current measurement using shunt, CT and Hall Sensor
10. Measurement of inductance by Maxwell bridge
11. Measurement of frequency by Wien Bridge.
12. Innovative Experiments (Software simulation by Multisim or Labview).

Course Name: Python Programming Laboratory
Course Code: EE394
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Basic knowledge of computers, basic knowledge of programming.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Apply programming concepts in designing solution.
- **CO2.** Analyze different dimensions of a problem and provide optimal solutions.
- **CO3.** Evaluate and analyze different solution based on Python programming features.
- **CO4.** Implement solutions of real-life problems in the field of Information Technology.

CO-PO Mapping:

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

List of Experiments:

Module 1: Introduction to Python
Installation of Python, Understanding the environment setup of python, Different phases for execution of python program, Basic features of Python, Major Application areas, Advantages and disadvantages.

Module 2: Variable and Functions
Values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and

use, flow of execution, parameters and arguments

Module 3: Control Structure
Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion;

Module 4: List Tuple String Packages
Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing – list comprehension; Strings, Concepts of packages

Module 5: Object Oriented Concepts
Defining class, creation of objects, Built in class, garbage collection, operator overloading, Inheritance.

Module 6: Exception Handling
Exception Handling, Assertion, except clause, try-finally, exception with arguments, raising exception, user defined exception.

Module 7: GUI Programming
Turtle Graphics, Writing GUI Programs,

Module 8: File Operations
File related modules in Python, File modes and permissions, Reading & Writing data from a file, Redirecting output streams to files, Working with directories, CSV files and Data Files

Module 9:
ODBC and Python, Working with Databases in MySQL, Working with Tables in MySQL, Working with SQLite Database

Module 10: Innovative Idea Development
Applying Python features for developing innovative projects

Text Books:
1. ‘Core Python Programming by R. Nageswara Rao
2. ‘Python Training Guide’, Mercury Learning & Information USA, BPB Publications, 2015.

Reference Books:
1. ‘Python for Education’, Ajith Kumar B. P., Inter University Accelerator Center, New Delhi, 2010.
2. ‘Python Cookbook: Recipes for Mastering Python 3’, 3rd Edition - David Beazley & Brian K. Jones, O'Reilly Media, Inc., 2013.

2nd Year 4th Semester								
Sl. No.	Category	Paper Code	Subject	Contact Hours/Week				Credit Points
				L	T	P	Total	
A. Theory								
1	BSC	EE(M)401	Mathematics – III	3	0	0	3	3
2	PCC	EE401	Electrical Machines – I	3	0	0	3	3
3	PCC	EE402	Power Electronics	3	0	0	3	3
4	PCC	EE403	Analog and Digital Circuits	3	0	0	3	3
5	ESC	EE404	Data Structures and Algorithms	2	0	0	2	2
6	HSMC	HSMC403	Universal Human Values – II: Understanding Harmony	3	0	0	3	3
B. Practical								
7	PCC	EE491	Electrical Machines – I Laboratory	0	0	3	3	1.5
8	PCC	EE492	Power Electronics Laboratory	0	0	2	2	1
9	PCC	EE493	Analog and Digital Circuits Laboratory	0	0	2	2	1
10	ESC	EE494	Data Structures and Algorithms Laboratory	0	0	3	3	1.5

11	PROJ	PR491[14*]	Theme Based Project – IV	0	0	1	1	0.5
12	PROJ	PR492	Skill Development – IV: Soft Skill and Aptitude – I	1	0	0	1	0.5
C. Mandatory Activities / Courses								
13	MC	MC401	Environmental Science	3	0	0	3	0
Total of Theory, Practical and Mandatory Activities / Courses without MOOC Courses							**32**	**23**
D. MOOC Courses[15]**								
14	MOOC	HM401	MOOC Course – II	3	1	0	4	4
Total of Theory, Practical and Mandatory Activities / Courses with MOOC Courses							**36**	**27**

Course Name: Mathematics – III
Course Code: EE(M)401
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: The students to whom this course will be offered must have the concept of (10+2) standard calculus, basic probability and differential equations.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Recall the underlying principle and properties of Fourier series, Fourier transform, probability distribution of a random variable, calculus of complex variable, and partial differential equation.

CO2. Exemplify the variables, functions, probability distribution and differential equations and find their distinctive measures using the underlying concept of Fourier series, Fourier transform, probability distribution of a random variable, calculus of complex variable, and partial differential equation.

CO3. Apply Cauchy's integral theorem and the residue theorem to find the value of complex integration, and compute the probability of real world uncertain phenomena by identifying probability distribution that fits the phenomena.

CO4. Solve partial differential equation using method of separation of variables.

CO5. Find the Fourier series and Fourier transform of functions by organizing understandings of underlying principles and also evaluate the integral using Parseval's identity.

CO-PO Mapping:

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

[14*] Technical Answers for Real World Problems (TARP).
[15**] MOOC Courses for HONOURS / MINOR Degree are Program specific and to be taken from MOOC Basket.

CO4	3	2	2	-	-	-	-	-	-	-	-	1

Course Content

Module 1: Fourier series and Fourier Transform 9L

Fourier series:

Dirichlet's Conditions; Euler's Formula for Fourier Series; Fourier Series for functions of period 2π; Sum of Fourier series (examples); Theorem for the convergence of Fourier series (statement only); Fourier series of a function with its periodic extension; Half range Fourier series: Construction of half range Sine series and half range Cosine Series; Parseval's identity (statement only) and related problems.

Fourier Transform:

Fourier Transform, Fourier Cosine Transforms, Fourier Sine Transforms (problems only); Properties of Fourier Transform: Linearity, Shifting, Change of Scale, Modulation (problems only); Fourier Transform of Derivatives (problems only); Convolution Theorem (statement only), Inverse of Fourier Transform (problems only).

Module 2: Probability Distributions 9L

Random Variable: Discrete and Continuous (definition & examples); Probability Distribution (definition & examples); Probability Mass Function, Probability Density Functionand Distribution Function for a single random variable only (definition, properties & related problems); Expectation, Varianceand Standard Deviation for a single random variable only (definition, properties & related problems); Binomial Distribution, Poisson Distribution, Binomial Approximation to Poisson Distribution and Normal Distribution (problems only), Mean, Variance and Standard Deviation of Binomial, Poisson and Normal Distribution (problems only).

Module 3: Calculus of Complex Variable 13L

Functions of a Complex Variable (definition and examples); Concept of Limit, Continuity and Differentiability (problems only); Analytic Functions (definition and examples); Cauchy-Riemann Equations (statement only& related problems); Sufficient condition for a function to be analytic (statement only & related problems).

Concept of Simple Curve, Closed Curve, Smooth Curve & Contour; Some elementary properties of complex integrals (problems only); Cauchy's Theorem (statement only & related problems); Cauchy's Integral Formula(statement only & related problems); Cauchy's Integral Formula for the derivative of an analytic function(statement only & related problems); Cauchy's Integral Formula for the successive derivatives of an analytic function (statement only & related problems); Taylor's series and Laurent's series (problems only).

Zero of an Analytic Function and its order (definition & related problems); Singularities of an Analytic Function: Isolated Singularity and Non-isolated Singularity (definition & related problems); Essential Singularities, Poles (Simple Pole and Pole of Order m) and Removable Singularities (definition & related problems); Determination of singularities and their nature (problems only); Residue (definition & examples); Determination of the residue of a given function; Cauchy's Residue theorem (statement only & related problems). Application of Residue.

Module 4: Partial Differential Equation (PDE) 5L

Solution of PDE: Method of Separation of Variables.

Solution of Initial Value & Boundary Value Problem: One Dimensional Wave Equation, One Dimensional Heat Equation, Two Dimensional Laplace Equation.

Project Domains:

1. Study of physical processes through PDE.
2. Application of calculus of complex variable in real world engineering problems.

3. Study of uncertainty in real world phenomena using probability distribution.
4. Application of Fourier series and Fourier transform in engineering problems.

Text Books:

1. Herman, R. L. An Introduction to Fourier Analysis, Chapman and Hall/CRC, 2016.
2. Grafakos, L. Classical Fourier Analysis, Springer, India, Private Ltd.
3. Das, N.G. Probability and Statistics; The McGraw Hill Companies.
4. Gupta, S. C. and Kapoor, V. K. Fundamentals of Mathematical Statistics, Sultan Chand & Sons.
5. Mathews, J. H. and Howell, R. W. Complex Analysis for Mathematics & Engineering, Jones & Bartlett Pub, 2006.
6. Chowdhury, B. Elements of Complex Analysis, New Age International, 1993.
7. Raisinghania, M. D. Advanced Ordinary & Partial Differential. Equation; S. Chand Publication.
8. Ross, S. L. Differential Equations, John Willey & Sons.
9. Grewal, B. S. Higher Engineering Mathematics, Khanna Pub.
10. Kreyszig, E. Advanced Engineering Mathematics, John Wiley & Sons, 2006.

Reference Books:

1. Gray, R. M. and Goodman, J. Fourier Transforms: An Introduction for Engineers, Springer, US, 1995.
2. Lipschutz & Lipson, Schaum's Outline in Probability (2ndEd), McGraw Hill Education.
3. Spiegel, M. R. Theory and Problems of Probability and Statistics (Schaum's Outline Series), McGraw Hill Book Co.
4. Goon, A.M., Gupta M .K. and Dasgupta, B. Fundamental of Statistics, The World Press Pvt. Ltd.
5. Soong, T. T. Fundamentals of Probability and Statistics for Engineers, John Wiley & Sons Inc, 2004.
6. Delampady, M. Probability & Statistics, Universities Press.
7. Spiegel, M. R. Theory and Problems of Complex Variables (Schaum's Outline Series), McGraw Hill Book Co.
8. Sneddon, I. N. Elements of Partial Differential Equations, McGraw Hill Book Co.

Course Name: Electrical Machines – I
Course Code: EE401
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Concept of Basic Electrical Engineering, Electrical Circuit Analysis.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Describe the concept of magnetic circuits.
CO2. Demonstrate the operation of different types of dc machines and its applications.
CO3. Analyse the connections of transformers and its applications.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	3	3	-	-	-	-	2	-	-	2	3	3
CO2	3	3	3	3	3		-	-	2	-	3	3
CO3	3	1	2	-	-	3	-	2	2	-	3	3

Course Content

Module 1: Magnetic Circuits **6L**

Review of magnetic circuits - MMF, flux, reluctance, inductance. Amperes' Law and Biot Savarts' Law. Visualization of magnetic fields produced by a bar magnet and a current carrying coil - through air and through a combination of iron and air. Review of magnetic hysteresis and magnetic circuits.

Module 2: Transformers **16L**

Construction and operation of single-phase transformers, equivalent circuit and phasor diagram,

voltage regulation, losses and efficiency. Per unit representation of single-phase transformers. Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses. Single-phase Auto transformer – Comparison of weight, copper loss with 2-winding transformer, equivalent circuit, applications. Three-phase transformer - construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers. Scott-connected transformer and open-delta connection – working principle, connection diagram, practical application. Effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current, Effect of unbalanced loading and neutral shifting - Tertiary windings. Tap-changing methods, Tap changers – Off load and On-load type. Special Transformer - Pulse transformer, Grounding transformer.

Module 3: DC Machines 14L

Single conductor generating and motoring action. DC machine construction and armature winding. Generated voltage and torque equation. OCC and Load characteristics of DC generators. Armature reaction and its minimization – Interpole and Compensating winding. Commutation method –concept of reactance voltage. Operating characteristics of DC motors. Starting, Braking and Speed Control techniques used for DC motors. Test on DC machines – Brake Test, Hopkinson's Test and Swinburne Test.

Text Books:

1. Electrical Machinery, P.S. Bhimra, 6th Edition, Khanna Publishers.
2. Electric machines, D.P. Kothari & I.J Nagrath, 3rd Edition, Tata Mc Graw-Hill Publishing Company Limited.
3. Electrical Machines, P.K. Mukherjee & S. Chakrabarty, Dhanpat Rai Publication.

Reference Books:

1. Electric Machinery & Transformers, Bhag S. Guru and H.R. Hiziroglu, 3rd Edition, Oxford University press.
2. Electrical Machines, R.K. Srivastava, Cengage Learning
3. Theory of Alternating Current Machinery, Alexander S Langsdorf, Tata Mc Graw Hill Edition.
4. The performance and Design of Alternating Current Machines, M. G. Say, CBS Publishers & Distributors.
5. Electric Machinery & transformer, Irving L Koskow, 2nd Edition, Prentice Hall India.

Course Name: Power Electronics
Course Code: EE402
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Concept of Basic Electronics, Electrical Circuit Analysis, Analog Electronics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Demonstrate the characteristics of different power electronic switches along with their turn-on, turn-off, triggering and protection circuits.
- **CO2.** Analyse various power converter circuits.
- **CO3.** Understand the use of power converters in commercial and industrial applications

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	3	2	1	-	-	-	-	-	-	-	-	-
CO2	2	3	2	-	-	-	-	-	-	-	-	-
CO3	2	-	2	2	1	-	-	-	-	-	-	-

Course Content

Module 1: Power Electronic Switching Devices 8L

Advances in Power Electronics Power Semiconductor Switches: Rectifier diodes, fast recovery diodes, Schottky barrier diode, BJT, Power MOSFET, SCR, TRIAC, IGBT, IGCT and GTO. Ratings, Static and Dynamic Characteristics, triggering and switching characteristics and cooling. SCR turn–on and turn-off methods, Triggering circuits, SCR Commutation circuits, SCR Series and

Parallel operation, Snubber Circuit.

Module 2: Uncontrolled and Controlled Rectifiers 8L

Single-Phase and Three-Phase Uncontrolled rectifiers.
Phase controlled Rectifiers: Principle of operation of single phase and three phase semi-controlled, full controlled converters with R, R-L and RLE loads. Effects of source inductance on the performance of converters. Performance parameters of converters, Dual converters, Solution of problems.

Module 3: DC-DC Converters 5L

Principle of operation, control strategies, Step up and Step down choppers, Buck, Boost, Buck - Boost Converters, Quadrant operation of DC DC converters.

Module 4: Inverters 8L

Inverters: Principle of operation of single phase inverter, 120o and 180° conduction mode of operation of three phase inverter, performance parameters of inverters, PWM techniques, sinusoidal PWM, modified Sinusoidal PWM - multiple PWM Voltage and Current Sources Inverter.

Module 5: Cycloconverters and AC Voltage Regulators 4L

AC Voltage Controllers, Single phase and three phase Cyclo-conveters.

Module 6: Applications 3L

UPS (Online and Offline), SMPS, Battery Chargers. Electric Vehicle, FACTS.

Text Books:

1. L. Umanand, Power Electronics: Essentials and Applications.
2. M. H. Rashid, Power Electronics, PHI/ Pearson Education.
3. P. S. Bhimra, Power Electronics, Khanna Publications.
4. K. Hari Babu: Power Electronics

Reference Books:

1. C.W. Lander, Power Electronics, McGraw Hill.
2. B. K. Bose, Modern Power Electronics, JAICO.
3. Mohan, N Undeland, TM & Robbins, WP- Power Electronics, John Wiley & Sons.

Course Name: Analog and Digital Circuits
Course Code: EE403
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Knowledge of Basic Electronics and Mathematics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the functional building blocks, characteristics and applications of Analog ICs.
- **CO2.** Understand effects of different feedback mechanism in amplifier circuit.
- **CO3.** Acquired knowledge about solving problems related to number systems conversions and Boolean algebra and design logic circuits using logic gates to their simplest forms using De Morgan's Theorems; Karnaugh Maps.
- **CO4.** Design of combinational circuits and sequential circuit.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	-	2	-	-	-	-	-	-	-	-	-	-
CO2	-	2	2	-	2	-	-	-	-	-	-	-
CO3	3	3	-	-	1	-	-	-	-	-	-	-
CO4	2	3	3	-	2	-	-	-	-	-	-	-

Course Content

Module 1: Operational Amplifier 2L

Ideal OPAMP, Differential amplifier, Constant current source, Level shifter, CMRR, Open & closed loop circuits, importance of feedback loop (positive & negative), inverting & non-inverting amplifiers.

Module 2: OPAMP Applications 5L

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

Module 3: Transistor Amplifier & Oscillators 5L

Biasing technique, Q-point & its Stability, Self Bias – CE configuration, Bias Compensation techniques, h-parameter model of transistors, Different coupling techniques, RC coupled amplifier, functions of all components, derivation of voltage gain, current gain, input impedance and output impedance, RC Oscillators-Phase shift and Wein bridge oscillators, LC Oscillator Colpitts and Hartley‘s oscillators.

Module 4: Timer and Power Supplies 4L

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

Module 5: Power amplifiers 2L

Class A, B, AB, C, Conversion efficiency.

Module 6: Digital Techniques 6L

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

Module 7: Combinational Circuit Design 6L

Half Adder, Full Addar, Encoder, Decoder, Multiplexer, De Multiplexer, Parity generator – Checker, Seven-segment display, Analysis and Design Procedure - Multiplexer, Decoder, Encoder, Design using programmable logic Devices.

Module 8: Sequential Circuit Design 5L

Flip Flops – SR, D, T and JK Flip-flops, Master slave Flip Flops, Counters, Shift Registers-SISO, SIPO, PISO, PIPO. Counters- synchronous, Counters- asynchronous, Design Examples.

Module 9: ADC and DAC 1L

Parameters of D/A & A/D Converters. Logic families – TTL their operation and specifications.

Text Books:

1. J. B. Gupta – Electronic Devices and circuits, S .K. KATARIA & SONS.
2. Gayakwad R. A. – OpAmps and Linear IC‘s, PHI
3. A. Anand Kumar – Fundamentals of Digital Circuits, PHI
4. A. K. Maini – Digital Electronics, Wiley-India

Reference Books:

1. Boylested & Nashelsky – Electronic Devices and Circuit Theory, Pearson/PHI.
2. Rashid – Microelectronic Circuits-Analysis and Design, Thomson (Cenage Learning)
3. D. Ray Chaudhuri – Digital Circuits-Vol-I & II, 2/e- Platinum Publishers

4. Floyed & Jain – Digital Fundamentals, Pearson press.

Course Name: Universal Human Values – II: Understanding Harmony
Course Code: HSMC403
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: None.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Develop holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
- **CO2.** Cultivate the harmony in the human being, family, society and nature/existence.
- **CO3.** Strengthen self-reflection.
- **CO4.** Build commitment and courage to act.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	3	2	1	-	2	1	-	-	-	2	3	3
CO2	3	2	-	1	3	2	-	1	2	-	3	3
CO3	3	2	2	-	2	3	1	-	2	1	3	3
CO4	3	1	-	2	-	-	-	2	-	3	3	3

Course Content

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education 8L

Self-Exploration–what is it? -Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration. Continuous Happiness and Prosperity- A look at basic Human Aspirations. Right understanding, Relationship and Physical Facility- the basic requirements for fulfillment of aspirations of every human being with their correct priority. Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario. Method to fulfill the above human aspirations: understanding and living in harmony at various levels. Practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking.

Module 2: Understanding Harmony in the Human Being – Harmony in Myself! 6L

Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer). Understanding the characteristics and activities of 'I' and harmony in 'I'. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail. Programs to ensure Sanyam and Health. Practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Ensuring health vs dealing with disease discussion.

Module 3: Understanding Harmony in the Family and Society - Harmony in Human-Human Relationship 7L

Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship. Understanding the meaning of Trust; Difference between intention and competence. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals. Visualizing a universal harmonious order in society – Undivided Society, Universal Order- from family to world family. Practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Elicit examples from students' lives.

Module 4: Understanding Harmony in the Nature and Existence – Whole existence as Coexistence 8L

Understanding the harmony in the Nature. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self- regulation in nature. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space. Holistic perception of harmony at all levels of existence. Practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of Technology etc.

Module 5: Implications of the above Holistic Understanding of Harmony on Professional Ethics 7L

Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in professional ethics:

a. Ability to utilize the professional competence for augmenting universal human order

b. Ability to identify the scope and characteristics of people- friendly and eco-friendly production systems
c. Ability to identify and develop appropriate technologies and management patterns for above production systems.
d. Case studies of typical holistic technologies, management models and production systems.

Strategy for transition from the present state to Universal Human Order:

e. At the level of individual: as socially and ecologically responsible engineers, technologists and managers
f. At the level of society: as mutually enriching institutions and organizations.
g. Practice Exercises and Case Studies in Practice (tutorial) Sessions to discuss the conduct as an engineer or scientist etc.

Text Books:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

Reference Books:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

Course Name: Electrical Machines – I Laboratory
Course Code: EE491
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Concept of Basic Electrical Engineering Laboratory, Electrical Measurement Laboratory.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Conduct different tests on Transformers and D.C. Machines.
CO2. Analyze the characteristics of Transformers, D.C. Machines.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	2	-	-	3	-	-	-	-	3	2	-	1
CO2	2	-	-	3	-	-	-	-	3	2	-	1

List of Experiment (At least *ten* experiments to be performed):

1. Heat-run test of a single-phase transformer.
2. Regulation and Efficiency of single-phase transformer by direct loading method.
3. Parallel operation of two single-phase transformer and find out the load sharing.

4. Efficiency of a single-phase transformer by Back-to-Back test.
5. Polarity test and vector grouping of a three-phase transformer.
6. Identification of different parts of a D.C. machine.
7. Voltage build-up of a D.C. shunt generator and find out critical resistance and critical speed.
8. Brake test of D.C. series motor.
9. Brake Test of D.C. shunt motor.
10. Swinburne test of a D.C. shunt motor.
11. Load test of Differentially Compound D.C. Motor
12. Innovative Experiments.

Course Name: Power Electronics Laboratory
Course Code: EE492
Contact: 0L:0T:2P
Credit: 1

Prerequisite: Concept of Basic Electronics, Electrical Circuit Analysis, Analog Electronics.

Course Outcomes: After successful completion of the course, student will be able to
CO1. Analyse the response of any power electronics devices.
CO2. Troubleshoot the operation of a power electronics circuit.
CO3. Choose suitable power electronic devices for any given application.
CO4. Know how to control and convert output signal as per requirements.
CO5. Develop any power electronics circuits as needed in operation.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	3	-	-	1	-	-	-	-	-	-	-	-
CO2	-	1	-	2	-	-	-	-	-	-	-	-

CO3	2	1	-	2	-	-	-	-	1	-	-	-
CO4	2	-	-	2	-	-	-	-	1	-	-	-
CO5	2	1	-	2	-	-	-	-	-	-	-	-

List of Experiment (At least *ten* experiments to be performed):

1. Study of the characteristics of an SCR.
2. Study of the characteristics of a TRIAC
3. Study of different triggering circuits of an SCR.
4. Study of the operation of a single phase full controlled bridge converter with R and R-L load.
5. Study of performance of single phase half controlled symmetrical and asymmetrical bridge converters.
6. Study of performance of three phase six pulse controlled bridge converters.
7. Study the performance of step down chopper.
8. Study the performance of step up chopper.
9. Study the performance of single-phase inverter with 180° conduction mode of operation.
10. Study of performance of single phase controlled converter with and without source inductance (Simulation).
11. Study of performance of step up and step down chopper with MOSFET, IGBT and GTO as switch (simulation).
12. Study of performance of single phase half controlled symmetrical and asymmetrical bridge converter (Simulation).
13. Study of performance of three phase controlled converter with R & R-L load (simulation).
14. Innovative Experiments.

Course Name: Data Structures and Algorithms Laboratory
Course Code: EE494
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Basic Mathematics, Programming language.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the concept of dynamic memory management, data types, basic data structures, and complexity analysis
- **CO2.** Introduce the concept of data structures through ADT.
- **CO3.** Choose the appropriate linear and non-linear data structure and algorithm design method for a specified application design.
- **CO4.** Analyze the complexity of the problems.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	3	2	1	-	-	-	-	-	-	-	-	-
CO2	2	3	1	3	-	-	-	-	-	-	-	--
CO3	3	3	3	3	2	-	-	-	2	-	-	3
CO4	3	2	1	3	2	-	-	-	-	-	-	1

List of Experiment:

1. Experiments should include but not limited to Implementation of array operations.
2. Stack and Queues: adding, deleting, elements circular Queue: Adding& deleting elements
3. Merging Problem:
4. Evaluation of expressions operations on Multiple stacks & queues:
5. Implementation of linked list: inserting, deleting, inverting a linked list
6. Implementation of stacks and queues
7. Using linked lists: Polynomial addition, Polynomial multiplication
8. Sparse Matrices: Multiplication, addition
9. Recursive and Non Recursive traversal Trees
10. Threaded binary tree traversal. AVL tree implementation
11. Application of Trees. Application of sorting and searching algorithms
12. Hash tables implementation: searching, inserting and deleting, searching and sorting techniques.
13. Innovative Experiments.

Text Books:

1. Data Structures Using C, by Reema Thereja, OXFORD Publications
2. Data Structures and Algorithms Using C by Amitava Nag and Joyti Prakash Singh, VIKASH Publication
3. Data Structures by S. Lipschutz.

Reference Books:

1. Data Structures Using C, by E. Balagurusamy E. Mc graw Hill)
2. Data Structures Using C and C++, by Moshe J. Augenstein, Aaron M. Tenenbaum

3rd Year 5th Semester								
Sl. No.	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
A. Theory								
1	HSMC	HSMC504	Economics for Engineers	2	0	0	2	2
2	PCC	EE501	Electrical Machines – II	3	0	0	3	3
3	PCC	EE502	Power Systems – I	3	0	0	3	3
4	PCC	EE503	Control Systems-I	3	0	0	3	3

5	OEC	EE504	D. Database Management System E. Computer Network F. Artificial Intelligence	3	0	0	3	3
6	PEC	EE505	E. Renewable Energy – I F. Line Commutated and Active Rectifiers G. Power Plant Engineering H. Engineering Optimization	3	0	0	3	3
B. Practical								
7	PCC	EE591	Electrical Machines – II Laboratory	0	0	3	3	1.5
8	PCC	EE592	Power Systems – I Laboratory	0	0	3	3	1.5
9	PCC	EE593	Control Systems – I Laboratory	0	0	2	2	1
10	OEC	EE594	D. Database Management System Laboratory E. Computer Network Laboratory F. Artificial Intelligence Laboratory	0	0	3	3	1.5
11	PROJ	PR591	Minor Project – I	0	0	2	2	1
12	PROJ	PR592	Skill Development – V: Soft Skill and Aptitude – II	1	0	0	1	0.5
C. Mandatory Activities / Courses								
13	MC	MC501	Intellectual Property Right	0	0	3	3	0
Total of Theory, Practical and Mandatory Activities / Courses without MOOC Courses							**34**	**24**
D. MOOC Courses[16]**								
14	MOOC	HM501	MOOC Course – III	3	1	0	4	4
Total of Theory, Practical and Mandatory Activities / Courses with MOOC Courses							**38**	**28**

Course Name: Electrical Machines – II
Course Code: EE501
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Knowledge of Physics up to B. Tech. 1st year Physics-I course and Electrical Machines – I.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Describe the concept of rotating magnetic fields.
CO2. Demonstrate the operation of AC Machines.
CO3. Analyse performance characteristics of ac machines.

CO-PO Mapping:

[16**] MOOC Courses for HONOURS / MINOR Degree are Program specific and to be taken from MOOC Basket.

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	3	2	2	-	-	-	-	-	-	-	-	2
CO2	3	3	2	3	2	-	-	-	-	-	-	3
CO3	3	3	3	3	2	-	-	-	2	-	-	3

Course Content

Module 1: Fundamentals of AC machine windings 4L

Physical arrangement of windings in stator, relationship between electrical and mechanical degree, single-turn coil – active portion and overhang; full-pitch coils, fractional pitched coils and its arrangement, factors pertaining to the windings.

Module 1: Induction Machines 13L

Induction motor as a transformer, Concept of rotating magnetic field, Power stages in 3-phase induction motor and their relation, torque-slip characteristics. Determination of equivalent circuit parameters, Separation of losses, Efficiency, Concept of Deep bar and Double cage rotor. Starting braking and speed control of three phase induction motor. Space harmonics: Crawling and Cogging, Industrial applications of 3-phase induction motor. Construction and operating principle of single-phase Induction Motor, Double-revolving field theory. Development of equivalent circuit, Determination of equivalent circuit parameters, Methods of starting using auxiliary winding, Selection of capacitor value during starting and running. Speed-Torque characteristics, Phasor diagram, Condition of Maximum torque. Application of single-phase motors. Brief idea on Induction Generator and Linear Induction Motor and its Applications.

Module 2: Synchronous Machines 15L

Construction of 3-phase Synchronous Machines, Advantages of Stationary armature and Rotating field system. Methods of excitation systems. Armature reaction at various p.f, concept of Synchronous reactance. Phasor diagrams of alternator at different p.f. loads. Open circuit characteristics, Short circuit characteristics and determination of synchronous reactance. Voltage regulation of alternator by synchronous impedance method. Two reaction theory, phasor diagram of salient pole generator at different loads. Power angle characteristics of Synchronous machines. Short circuit ratio (SCR) – concept and significance. Method of control of Active & Reactive Power of an alternator. Reasons and advantages of Parallel operation. Synchronization alternators and Load sharing. Methods of starting of Three-Phase Synchronous Motor. Effect of variation of excitation – V curves and inverted V curves. Hunting and its prevention. Applications of synchronous motor, Synchronous condenser.

Module 3: Fractional HP Machines 4L

Constructional features and performance characteristics of Universal Series Motors, Compensated and uncompensated motors. Principle and construction of switched reluctance motor, Permanent magnet machines, Brushless DC machines, Hysteresis motor, Stepper Motor.

Text Books:

1. Electrical Machines, Nagrath & Kothary, TMH
2. The performance and design of Alternating Current machines, M. G. Say, C.B.S Publishers & Distributors
3. Electrical Machinery, P.S. Bhimra, Khanna Publishers.
4. Electrical Machines, Ashfaq Husain, Dhanpat Rai & Co.
5. Electrical Machines, S.K.Bhattacharya, T.M.H Publishing Co. Ltd.

Reference Books:

1. Electrical Machines, Theory & Applications, M.N. Bandyopadhyay, PHI
2. Electrical Technology, H.Cotton, C.B.S. Publisher New Delhi
3. Electric Machinery & Transformes, Irving L. Kosow, PHI
4. Electric Machinery, A.E.Fitzgerald, Charles Kingsley, Jr. & Stephen D. Umans, 6th Edition, Tata McGraw Hill Edition.
5. Problems in Electrical Engineering, Parker smith, 9th Edition, CBS publishers & distributors.

Course Name: Power Systems – I
Course Code: EE502
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Concepts of basic electrical engineering, circuit theory and electrical machine.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Illustrate the concepts of power system components and its associated terms.
CO2. Classify different types of power generation.
CO3. Analyze performances of power system.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	3	2	1	1	3	2	2	-	-	-	-	1
CO2	3	2	2	2	1	3	3	-	-	-	2	3
CO3	2	3	3	3	2	3	2	-	-	-	2	3

Course Content

Module 1: Generation Transmission and Distribution 4L
Introduction to Thermal, Hydro-Electric, Nuclear, Solar and Wind Power Generation. Basic concept of electrical supply system. Introduction to Smart Grid.

Module 2: Mechanical Design of Overhead Transmission Line 6L
Design of Conductors, Line supports: Towers, Poles, Insulators: Types, Voltage distribution across a suspension insulator string, String efficiency, arching shield and rings, Methods of improving voltage distribution across Insulator strings, Electrical tests on line Insulators Sag, Tension and Clearance, Effect of Wind and Ice on Sag, Stringing Chart Dampers.

Module 3: Electrical Design of Overhead Transmission Line 8L
Choice of frequency, Choice of voltage, Types of conductors, Inductance and Capacitance of a single phase and three phases' symmetrical and unsymmetrical configurations. Skin Effect, Proximity Effect, Bundle conductors. Transposition. Concept of GMD and GMR. Influence of Earth on conductor capacitance.

Module 4: Corona 3L
Principle of Corona formation, Critical disruptive voltage, Visual critical corona discharge potential, Corona loss, advantages & disadvantages of Corona. Methods of reduction of Corona.

Module 5: Cables 5L
Types of cables, cable components, capacitance of single core and 3 core cables, dielectric stress, optimum cable thickness, grading, dielectric loss and loss angle.

Module 6: Performance of Lines 8L
Short, medium (nominal T, π) and long lines and their representation. Calculation of ABCD constants, Voltage regulation, Ferranti effect, Power equations and line compensation, Power Circle diagrams.

Module 7: Tariff 2L
Variable Load on Power Stations. Introduction of Tariff, different types of tariff. Indian Electricity Rule – 1956 and 2003: General Introduction.

Text Books:

1. Electrical Power System, Subir Roy, Prentice Hall
2. Power System Engineering, Nagrath & Kothery, TMH
3. Elements of Power System Analysis, C.L. Wadhwa, New Age International.
4. Electrical Power System, Ashfaq Hussain, CBS Publishers & Distributors
5. Principles of Power System, V. K. Mehta and Rohit Mehta, S. Chand.

Reference Books:

1. Electric Power Transmission & Distribution, S. Sivanagaraju, S. Satyanarayana, Pearson Education.
2. A Text book on Power System Engineering, Soni, Gupta, Bhatnagar & Chakrabarti, Dhanpat Rai & Co.

3. Power System Protection and Switchgear, Badri Ram, TMH
4. Electric Power Distribution System Engineering, 2nd Edition, T. Gonen, CRC Press.
5. www.powermin.nic.in/acts notification/pdf/ier1956.pdf.

Course Name: Control Systems – I
Course Code: EE503
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Concept of Basic Electrical Engineering, Circuit Theory and Engineering Mathematics.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Calculate mathematical model and transfer function of the physical systems.
CO2. Analyze the linear systems in time domain.

CO3. Illustrate the linear systems in frequency domain.
CO4. Design simple compensators and controllers for the given specifications.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	2	2	2	-	2	-	-	-	-	-	-	2
CO2	2	2	2	-	2	-	-	-	-	-	-	2
CO3	2	3	2	-	2	-	-	-	-	-	-	2
CO4	2	2	3	-	2	-	-	-	-	-	-	2

Course Content

Module 1: Systems and their Representations **6L**
Basic elements in control systems - open loop & closed loop - Transfer functions of mechanical, electrical and analogous systems. Block diagram reduction - signal flow graphs.

Module 2: Time Domain Analysis **6L**
Standard test signals, Time response of first and second order system, Time domain specifications, Steady state error, error constants, generalized error coefficient.

Module 3: Stability Analysis and Root Locus **6L**
Stability - concept and definition, Characteristic equation – Location of poles – Routh Hurwitz criterion - Root locus techniques: construction, properties and applications.

Module 4: Frequency Response Analysis **5L**
Bode plot - Polar plot - Correlation between frequency domain and time domain specifications.

Module 5: Stability in Frequency Domain **5L**
Relative stability, Gain margin, Phase margin, stability analysis using frequency response methods, Nyquist stability criterion.

Module 6: Control Systems Design **8L**
Introduction to design problem and philosophy. Introduction to time domain and frequency domain design specification and its physical relevance. Effect of gain on transient and steady state response. Effect of addition of pole on system performance. Effect of addition of zero on system response. Introduction to compensator. Design of Lag, lead lag-lead compensator in time domain & frequency domain using Bode plot. Design of P, PI, PD and PID controllers in time domain and frequency domain for first, second order systems.

Text Books:

1. Modern Control Engineering, K. Ogata, 4th Edition, Pearson Education.
2. Norman S. Nise, “Control System Engineering”, John Wiley & Sons, 6th Edition, 2011.
3. Benjamin C Kuo “Automatic Control System” John Wiley & Sons, 8th Edition, 2007.

Reference Books:

1. M. Gopal, “Control Systems-Principles And Design”, Tata McGraw Hill – 4th Edition, 2012.
2. R.C. Dorf & R.H. Bishop, “Modern Control Systems”, Pearson Education, 11th Edition, 2008.

3. I. J. Nagrath and M.Gopal," Control System Engineering", New Age International Publishers, 4th Edition, 2006.
4. Graham C. Goodwin, Stefan F. Graebe, Mario E. Sagado, "Control System Design", Prentice Hall, 2003.

Course Name: Database Management System
Course Code: EE504A
Contact: 3L:0T:0P
Total Contact Hours: 35
Credit: 3

Prerequisite: Mathematics, Data Structure, Operating System.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Understand Database Management System, explain fundamental elements of a database management system, compare the basic concepts of relational data model, entity-relationship model, file organization and use appropriate index structure.
CO2. Apply efficient query optimization techniques, suitable transaction management, concurrency control mechanism and recovery management techniques
CO3. Evaluate a database design and improve the design by normalization
CO4. Design entity-relationship diagrams to represent simple database application scenarios, translate entity-relationship diagrams into relational tables, populate a relational database and formulate SQL queries on the data.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	2	3	3	3	-	-	-	-	2	-	-	-
CO2	2	3	3	3	-	-	-	-	-	-	-	-
CO3	1	3	3	3	-	-	-	-	2	-	-	-
CO4	2	3	3	3	-	-	-	-	2	1	-	2

Course Content

Module 1: Introduction **2L**
Concept & Overview of DBMS, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS.

Module 2: Entity-Relationship Model **3L**
Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features.

Module 3: Relational Model **4L**
Structure of relational Databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations, Views, Modifications of the Database.

Module 4: SQL and Integrity Constraints **8L**
Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, assertions, views, Nested Sub queries, Database security application development using SQL, Stored procedures and triggers.

Module 5: Relational Database Design **8L**
Functional Dependency, Different anomalies in designing a Database., Normalization using functional dependencies, Decomposition, Boyce-Codd Normal Form, 3NF, Normalization using multi-valued dependencies, 4NF, 5NF.

Module 6: Internals of RDBMS **6L**
Physical data structures, Query optimization: join algorithm, statistics and cost bas optimization. Transaction processing, Concurrency control and Recovery Management: transaction model properties, state serializability, lock base protocols, two phase locking.

Module 6: File Organization & Index Structures **4L**
File & Record Concept, placing file records on Disk, Fixed and Variable sized Records, Types of Single-Level Index (primary, secondary, clustering), Multilevel Indexes, Dynamic Multilevel Indexes using B tree and B+ tree.
Text Books:

1. Henry F. Korth and Silberschatz Abraham, “Database System Concepts”, Mc.Graw Hill.
2. Elmasri Ramez and Novathe Shamkant, “Fundamentals of Database Systems”, Benjamin Cummings Publishing. Company.

Reference Books:

1. Raghu Ramakrishnan and Johannes Gehrke, Database Management Systems (3/e), McGraw Hill.
2. Peter Rob and Carlos Coronel, Database Systesm- Design, Implementation and Management (7/e), Cengage Learning.

Course Name: Computer Network
Course Code: EE504B
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Basic Digital Communication, Computer Architecture and Operating System.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the network model and architecture.
- **CO2.** Apply different networking concepts for implementing network solution.
- **CO3.** Analyze different networking functions and features for indentifying optimal solutions.
- **CO4.** Evaluate and implement routing algorithms for implanting solution for the real life problems.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	3	2	2	2	-	-	-	-	-	-	-	-
CO2	2	3	3	2	-	-	-	-	-	-	-	-
CO3	2	3	2	2	-	-	-	-	-	-	-	2
CO4	2	3	2	2	-	-	-	-	-	-	-	2

Course Content

Module 1: Overview of Data Communication and Networking 4L

Introduction; Data communications: components, data representation (ASCII, ISO etc.), direction of data flow (simplex, half duplex, full duplex); network criteria, physical structure (type of connection, topology), categories of network (LAN, MAN, WAN); Internet: brief history, Protocols and standards; Reference models: OSI and TCP/IP.

Module 2: Physical Level 5L

Overview of data (analog & digital), signal (analog & digital), transmission (analog & digital) & transmission media (guided & unguided); Circuit switching: time division & space division switch, TDM bus; Telephone Network.

Module 3: Data link Layer 8L

Types of errors, framing, error detection & correction methods; Flow control; Protocols: Stop & wait ARQ, GoBack- N ARQ, Selective repeat ARQ, HDLC; Point to Point Protocol, LCP, NCP, Token Ring; Reservation, Polling, Multiple access protocols: Pure ALOHA, Slotted ALOHA, CSMA, CSMA/CD, CSMA/CA Traditional Ethernet, fast Ethernet,

Module 4: Network Layer 7L

Internetworking & devices: Repeaters, Hubs, Bridges, Switches, Router, Gateway; Addressing: IP addressing, subnetting; Routing : techniques, Routing Protocols, ARP, IP, ICMP, IPV6.

Module 5: Transport Layer 6L

Process to Process delivery; UDP; TCP; Congestion Control: Open Loop, Closed Loop choke packets; Quality of service: techniques to improve QoS: Leaky bucket algorithm, Token bucket algorithm.

Module 6: Application Layer 6L

DNS, SMTP, SNMP, FTP, HTTPS, Firewalls, IP Filtering.

Text Books:

1. B. A. Forouzan – "Data Communications and Networking (5th Ed.)" – TMH
2. W. Stallings – "Data and Computer Communications (5th Ed.)" – PHI/ Pearson Education

Reference Books:

1. A. S. Tanenbaum – "Computer Networks (4th Ed.)" – Pearson Education/PHI
2. Black, Data & Computer Communication, PHI
3. Zheng & Akhtar, Network for Computer Scientists & Engineers, OUP

Course Name: Artificial Intelligence
Course Code: EE504C
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Basic concept of computer science and automation, Knowledge of programming

languages, Basic mathematical concept like calculus, probability, metrics and statistics.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Understand various AI search algorithms (uninformed, informed, heuristic, constraint satisfaction).

CO2. Apply facts, rules, and concepts of knowledge representation (logic-based, frame-based, semantic nets), inference and theorem proving.

CO3. Analyze working knowledge of reasoning in the presence of incomplete and/or uncertain information.

CO4. Evaluate and create knowledge representation, reasoning, and machine learning techniques for the solution of real-world problems.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	-	2	3	3	-	-	-	-	-	-	-	-
CO2	2	-	3	3	-	-	-	-	-	-	-	-
CO3	2	3	1	3	-	-	-	-	-	-	-	-
CO4	2	3	1	3	-	1	1	2	-	-	-	-

Course Content

Module 1: Introduction to Artificial Intelligence and Agent 3L

Foundations and History of Artificial Intelligence, Turing Test, Intelligent Agents – Agents and environment. Concept of Rationality, Nature of environments and Structure of agents.

Module 2: Searching and Problem Solving 12L

Problem solving agents - Problem formulation with suitable examples, searching for solutions, 8 puzzle problem, tower of Hanoi problem, water jugs problem, 8-queen problem, Data driven and goal driven search, Uninformed search strategies – Breadth-first search, Uniform-cost search, depth-first search, Depth-limited search, Uninformed search strategies Iterative deepening depth-first search, Bidirectional search, avoiding repeated states, Informed search strategies – Greedy best first search, A* search, Informed search strategies Memory-bounded heuristic search, Heuristic Functions, Constraint satisfaction problems.

Module 3: Game Playing 3L

Adversarial search, Mini-max, alpha-beta pruning.

Module 4: Knowledge Representation and Reasoning 10L

Building a Knowledge Base, Propositional logic, first order, script and frame, Logic, situation calculus. Theorem Proving in First Order Logic. Planning, partial order planning, Hierarchical Task network planning, Planning and acting in nondeterministic domains. Uncertain Knowledge and Reasoning, Probabilities, Bayesian Networks, Inference using full joint distribution, Independence, Bayes' rule and its use, Semantics of Bayesian Networks, Exact Inference in Bayesian networks, Dempster-Shafer-theory.

Module 5: Learning 5L

Learning from observation – Forms of learning, Inductive learning, Learning Decision trees, Knowledge in learning - Explanation based learning, Learning Decision Trees, Neural Networks Clustering concept, Reinforcement Learning – Introduction, Passive reinforcement Learning, Active Reinforcement Learning.

Module 6: Expert Systems **4L**

Introduction to Expert system, Expert System Design, Expert System Shell, Case Studies of Typical Expert Systems, PROLOG.

Text Books:

1. Fuzzy Logic with Engineering Applications, Timothy J. Ross, Willey.
2. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S.Rajasekaran, G. A. Vijayalakshami, PHI.
3. Genetic Algorithms: Search and Optimization, E. Goldberg

Reference Books:

1. Neuro-Fuzzy Systems, Chin Teng Lin, C. S. George Lee PHI.
2. Elements of Artificial Neural Network, Kishan Mehrotra, MIT Press.
3. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press.

Course Name: Renewable Energy – I
Course Code: EE505A
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Basic Electronics, Fundamental Concepts of Electrical Machines, Mathematics, Physics.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Identify the fundamental principle solar and wind power generation.
CO2. Classify different features of solar cells and wind generators.
CO3. Apply solar and wind power integration with existing network.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	3	-	-	-	3	-	-	-	-	-	1	1
CO2	3	3	2	2	2	-	-	-	-	-	2	2
CO3	3	3	2	-	2	-	-	-	-	-	-	-

Course Content

Module 1: Solar Radiation **5L**

The sun to earth transaction of solar energy, Study of wavelength of solar radiation spectra, Spectrum of electromagnetic radiation, Concept of extraterrestrial radiation, solar constant, air mass, beam, diffused and total solar radiation, Spectral distribution of solar spectrum, Solar geometry covering all parameter related to the position of the sun with respect to observer; Instruments for measurement of solar energy (Pyranometer/Pyrheliometer/ sunshine recorder/Lux meter), Depletion of solar radiation – absorption, scattering; beam radiation, diffuse and Global radiation; measurement of solar radiation; solar time – local apparent time (LAT) .

Module 2: Solar photovoltaic System **8L**

P-N junction, Space charge region, Energy band Diagram, P-N junction potential, width of depletion region, carrier movements and current densities, generation of photovoltage, light generated current, I-V equation of solar cells, Solar cell characteristics, Losses in solar cells, Design specification of solar cells, Types of solar cells, Solar PV module and array, Shading impact: Bypass diode, blocking diode, Maximum Power Point Tracking (MPPT) algorithms, Converter Control.

Module 3: Solar Thermal Power Generation **8L**

Principles of heat and mass transfer, Basic of Solar Thermal Conversion, Efficiency and Testing of flat plate collectors, Analysis of Parabolic trough, central receivers, parabolic dish collectors, Concept of solar pond, solar water heater, solar passive heating and cooling system, Solar industrial heating system, solar refrigeration and air conditioning, solar cookers, solar furnaces, solar green house, solar dryer, solar distillation.

Module 4: Introduction to Wind Power **8L**

History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind Turbine Aerodynamics, Wind Turbine Types and their construction, Major applications of Wind Power, Environmental Aspects of wind power, merits and demerits, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent-Magnet Synchronous Generators, Power electronics converters.

Module 5: Different configurations of Solar and Wind Power **7L**

Standalone PV system configurations (with different types of loads e.g. DC, with battery and DC, AC/DC, battery and AC/DC), Grid connected system without energy storage, Load characteristics, Applications of PV System: Direct coupled, Grid connected, Stand alone, Hybrid system, PV

System Economics. Constant Speed Constant Frequency (CSCF), Variable Speed Constant Frequency System (VSCF), Variable Speed Variable Frequency System (VSVF).

Text Books:

1. C. S. Solanki Solar Photovoltaics, PHI Learning, 2011
2. G. M. Masters, "Renewable and Efficient Electric Power Systems", John Wiley and Sons, 2004.
3. J N Roy, D.N Bose,Photo Voltaic Science And Technology, Cambridge University,Press (2018)
4. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill, 1984.
5. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems" John Wiley and Sons Ltd., 2006.

Reference Books:

1. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004.
2. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons, 1991.
3. Rao S. and B. B. Parulekar, Energy Technology, Khanna Publishers, 2005.

Course Name: Line Commutated and Active Rectifiers
Course Code: EE505B
Contact: 3L:0T:0P
Total Contact Hours: 36

Credit: 3

Prerequisite: Concept of Transformers and Power Electronic Converters.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Demonstrate different converters with/without filtering circuits.

CO2. Illustrate AC-DC rectification using PWM converters with improved power quality.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	3	3	-	-	-	-	-	-	-	-	-	2
CO2	3	3	-	-	-	-	-	-	-	-	-	2

Course Content

Module 1: Diode and Phase-Controlled Rectifiers with passive filtering 10L

single-phase full-wave diode rectifier with L, C and LC filter; 3-phase diode rectifier with L, C and LC filter; continuous and discontinuous conduction, input current waveshape. single-phase thyristor rectifier with L and LC filter; 3-phase thyristor rectifier with L and LC filter; continuous and discontinuous conduction, input current waveshape.

Module 2: Multi-Pulse converter 7L

Review of transformer phase shifting, generation of 6-phase AC voltage from 3-phase AC, 6-pulse converter and 12-pulse converters with inductive loads, steady state analysis, commutation overlap, notches during commutation.

Module 3: Single-phase AC-DC single-switch boost converter 5L

Review of DC-DC boost converter, power circuit of single-switch AC-DC converter, steady state analysis, unity power factor operation, closed-loop control structure.

Module 4: AC-DC bidirectional boost converter 7L

Review of 1-phase inverter and 3-phase inverter, power circuits of 1-phase and 3-phase ac-dc boost converter, steady state analysis, operation at leading, lagging and unity power factors, active power factor correction, Rectification and regenerating modes.

Module 5: Isolated single-phase AC-DC flyback converter 7L

DC-DC flyback converter, output voltage as a function of duty ratio and transformer turns ratio. Power circuit of AC-DC flyback converter, steady state analysis, power factor improvement.

Text Books:

1. G. De, ―Principles of Thyristorised Converters‖, Oxford & IBH Publishing Co, 1988.
2. J. G. Kassakian, M. F. Schlecht and G. C. Verghese, ―Principles of Power Electronics‖, Addison-Wesley, 1991.
3. L. Umanand, ―Power Electronics: Essentials and Applications‖, Wiley India, 2009.

Reference Books:

1. N. Mohan and T. M. Undeland, ―Power Electronics: Converters, Applications and Design‖, John Wiley & Sons, 2007.
2. R. W. Erickson and D. Maksimovic, ―Fundamentals of Power Electronics‖, Springer Science & Business Media, 2001.
3. Muhammad H. Rashid, -Power Electronics: Circuits, Devices, and Applications, Pearson,

2009.

Total Contact Hours: 36
Credit: 3

Prerequisite: Concept of Energy Conversion.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the principles of operation for different power plants.
- **CO2.** Understand the economics of operation for different power plants.
- **CO3.** Analyse the interconnection between different power plants.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	3
CO2	3	-	3	-	-	-	-	-	-	-	2	-
CO3	2	-	3	-	-	-	2	-	-	-	2	-

Course Content

Module 1: Basics of Power Generation 2L

Importance of electrical power in daily life, Different forms of energy, Comparison of different energy sources, Power crisis in India and Future Trend, Overview of method of electrical power generation.

Module 2: Coal Based Thermal Power Plants 8L

List of thermal power stations in the state with their capacities, basic Rankine cycle and its modifications, Selection of site for thermal power stations, Layout of modern coal power plant, Quality of fuel and its effect on quality of power generation, Operation of different components Super critical boilers, FBC boilers, Economizer, Air pre heater, Super-heaters and re-heaters, Steam turbines, Condensers, Spray ponds and cooling towers, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems, Merits and demerits of Thermal Power Plants.

Module 3: Nuclear Power Stations 6L

Basics of nuclear energy conversion, Selection of site for Nuclear Power plants, Block diagram and working of Nuclear Power station, Fuels used in Nuclear Power Station, subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants, Merits and demerits of Nuclear Power Plants, List of Nuclear power stations in state and county with their capacities.

Module 4: Hydro Power Stations 5L

Selection of site and classification of Hydroelectric Power Plants, Layout and working of Hydro Power Station, Types of Turbines and generators used, Pumped storage Power Plant, Merits and demerits of Hydro Power Station, List of Hydro Power stations with their capacities and number of units in the state.

Module 5: Gas Turbine Power Plants 3L

Selection of site for Gas Turbine Power Station, Fuels for gas turbine, Brayton cycle analysis and optimization, elements of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems, Merits, demerits and application Gas turbine power plants.

Module 6: Diesel Electric Power Stations 3L

Selection of site for Diesel Electric Power Station, Elements of diesel Electric power plants and their working, Operation, maintenance & trouble shooting, chart of diesel Electric plant, Merits, demerits and applications of diesel electric power stations, Performance and thermal efficiency of Diesel Electric Power Plant.

Module 7: Non-Conventional Energy Sources 3L

Types of non-conventional energy sources, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems.

Module 8: Economics of Power Generation 3L

Energy, economic and environmental issues, power tariffs, load distribution parameters, load curve, firm power, cold reserve, hot reserve, spinning reserve, capital and operating cost of different power plants, Factors affecting the cost of Generation, pollution control technologies including waste disposal options for coal and nuclear plants.

Module 9: Interconnected Power Systems 3L

Advantages of Interconnection, Base load and peak loads, load allocation among various types of power stations, Load sharing and transfer of load between power stations, Inter connection of power stations at state and national level.

Text Books:

1. P. K. Nag Power plant Engineering, Tata McGraw Hill.
2. T. C. Elliot, K. Chen and R. C. Swanekamp, Power Plant Engineering, 2nd ed., McGraw Hill, 1998.
3. M. M. El Wakil, Power Plant Technology, Tata McGraw Hill, 2010.
4. Arora and Domkundwar A course in Power Plant Engineering, Dhanpat Rai & Sons.

Reference Books:

1. Godfrey Boyle, Renewable Energy, Oxford University Press.
2. Soni, Gupta and Bhatnagar, A course in Electrical Power, Dhanpatrai & Sons.
3. Dr. S. L. Uppal, Electrical Power, Khanna Publishers.
4. Umesh Rathore, Energy Management, S.K.Katharia & Sons
5. K. K. Ramalingam, Power Plant Engineering, Scitech Publication (India) Pvt. Ltd.
6. S. P. Sukhatme, Solar Energy, Tata McGraw Hill Publishing Co. Ltd.
7. A. K. Raja, M. Dwibedi and A.P.Srivastava, Introduction to Non-conventional Energy sources, Scitech Publication (India) Pvt. Ltd.

Course Name: Engineering Optimization

Course Code: EE505C
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Engineering Mathematics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the fundamental concepts of engineering optimization.
- **CO2.** Design gradient based optimization method for various algorithms.
- **CO3.** Apply mathematics and science in engineering applications.
- **CO4.** Understand the genetic algorithm and PSO algorithm.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	1	3	2	-	1	-	-	-	1	-	-	1
CO3	1	3	3	-	1	-	-	-	1	-	-	1
CO4	-	-	-	3	2	-	-	-	-	-	-	2

Course Content

Module 1: Basic Concepts 3L
Introduction to Optimization: Engineering application of Optimization – Statement of an Optimization problem - Optimal Problem formulation – Classification of Optimization problem.

Module 2: Direct One Dimension, Gradient-Based and Newtonian Methods Search 9L
Classical Optimization Techniques: Single variable optimization, Multi-variable: Direct substitution method, Lagrange's method of multipliers, Karush-Kuhn-Tucker conditions.
Optimum design concepts: Definition of Global and Local optima – Optimality criteria.
Linear programming methods for optimum design: Review of Linear programming methods for optimum design – Post optimality analysis - Application of LPP models in design and manufacturing.

Module 3: Constrained and Unconstrained Optimization and Applications 12L
Optimization algorithms for solving unconstrained optimization problems – Gradient based method: Cauchy's steepest descent method, Newton's method, Conjugate gradient method.
Optimization algorithms for solving constrained optimization problems – direct methods, penalty function methods, steepest descent method.

Module 4: Modern methods of Optimization 12L
Genetic Algorithms, Simulated Annealing, Particle swam optimization, Use of MATLAB to solve optimization problems.

Book:

1. Rao S. S. - 'Engineering Optimization, Theory and Practice' - New Age International Publishers - 2012 - 4th Edition.

Course Name: Electrical Machines – II Laboratory
Course Code: EE591
Contact: 0L:0T:3P
Credit: 3

Prerequisite: Concepts of Electrical Machines - I.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Perform different tests on Three-Phase A.C. Generators, Synchronous Motors and Single-Phase Induction Motor.

CO2. Interpret the observed result using theoretical knowledge and hence calculate unknown parameters.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	3	-	-	3	-	-	-	-	3	2	-	-
CO2	2	-	-	3	-	-	-	-	3	2	-	-

List of Experiments (Maximum *Three* experiments to be conducted from each group):

Group A: Three-Phase Induction Machine

1. Separation of losses in three-phase Induction Motor.
2. Load test of a three-phase wound rotor Induction Motor
3. Speed control of three-phase Induction Motor by V/f constant.
4. To study the performance of Three-Phase Induction generator.
5. Circle diagram of a three-phase Induction Motor.

Group B: Synchronous Machine

6. To observe the effect of excitation and speed on induced e.m.f of a three-phase alternator and plot the O.C.C. of the alternator.
7. Determination of regulation of Synchronous machine by Synchronous Impedance method.
8. To determine the direct axis resistance [Xd] and quadrature reactance [Xq] of a 3-phase synchronous machine by slip test.
9. Parallel operation of three-phase Synchronous generators / existing supply system.
10. V-curve of Synchronous motor.

Group C: Low HP Motors

11. Identification of different types of low HP motors.
12. Determination of equivalent circuit parameters of a single-phase Induction motor.
13. Load test on single-phase Induction motor to obtain the performance characteristics.
14. To study the effect of capacitor on the starting and running condition of a Single-Phase Induction motor and to determine the method of reversing the direction of rotation.
15. Load Test on Universal Motor.

N.B. Other than above experiments, one innovative experiment has to be conducted in the laboratory.

Course Name: Power Systems – I Laboratory
Course Code: EE592
Contact: 0L:0T:3P
Credit: 3

Prerequisite: Concepts of Power System.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Demonstrate performance of transmission line and distribution line.
- **CO2.** Construct line support for a particular transmission line.
- **CO3.** Evaluate different methods of active and reactive power control.
- **CO4.** Solve the reliability of different components of transmission line and distribution line.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	3	3	2	1	-	2	-	-	-	-	2	2
CO2	2	-	3	1	-	-	-	-	-	-	2	3
CO3	2	3	-	3	-	-	-	-	-	-	2	2
CO4	2	3	-	3	-	-	-	-	-	-	2	2

List of Experiments:

1. Draw the schematic diagram of structure of power system and power transmission line and symbol of electrical equipment.
2. Simulation of DC distribution by network analyzer.
3. Measurement of earth resistance by earth-tester.
4. Measurement of dielectric strength of insulating oil.
5. Measurement of dielectric strength of solid insulating material.
6. Different parameter calculation by power circle diagram.
7. Study of different types of insulator.
8. Determination of the generalized constants A, B, C, D of long transmission line.
9. Active and reactive power control of alternator.
10. Study and analysis of an electrical transmission line circuit with the help of software.
11. Dielectric constant tan-delta, resistivity test of transformer oil.
12. Any innovative experiment according to knowledge of Power System – I.

Course Name: Database Management System Laboratory
Course Code: EE594A
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Knowledge about the basics of electronics and basic concepts in logic design, basic knowledge of data structure and programming concept.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Design and implement a database schema for a given problem-domain
- **CO2.** Create and maintain tables using PL/SQL Course Outcome
- **CO3.** Populate and query a database
- **CO4.** Application development using PL/SQL & front end tools

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	2	-	3	3	2	-	-	-	-	-	-	-
CO2	-	-	3	3	2	-	-	-	2	-	-	-
CO3	2	-	3	3	2	-	-	-	-	2	-	-
CO4	2	-	3	3	2	-	-	-	-	-	-	2

List of Experiments:

1. Study of Backend Tool – Oracle.
2. Data Definition Language (DDL) commands in RDBMS.
3. Data Manipulation Language (DML) and Data Control Language (DCL) commands in RDBMS.
4. High-level language extension with Cursors.
5. High level language extension with Triggers
6. Procedures and Functions.
7. Embedded SQL.
8. Database design using E-R model and Normalization.
9. Mini project (Application Development using Oracle and Visual Basic)
    i. Inventory Control System.
    ii. Material Requirement Processing
    iii. Hospital Management System
    iv. Railway Reservation System
    v. Personal Information System
    vi. Web Based User Identification System
    vii. Time-table Management System

Text Books:

1. ORACLE PL/SQL by example. Benjamin Rosenzweig, Elena Silvestrova, Pearson Education 3rd Edition.

Reference Books:

1. ORACLE DATA BASE LOG PL/SQL Programming SCOTT URMAN, Tata Mc- Graw

Hill.
2. SQL & PL/SQL for Oracle 10g, Black Book, Dr. P. S. Deshpande.

Course Name: Computer Network Laboratory
Course Code: EE594B
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Basic Computer Architecture and Operating System.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Understand and apply different network commands.
CO2. Analyze different networking functions and features for implementing optimal solutions.
CO3. Apply different networking concepts for implementing network solution.
CO4. Implement different network protocols.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	3	2	2	3	3	-	-	-	-	-	-	-
CO2	3	2	2	3	3	-	-	-	-	-	-	-
CO3	3	2	2	3	3	-	-	-	-	-	-	2
CO4	3	2	2	3	3	-	-	-	-	-	-	2

List of Experiments:

1. Familiarization with: Different networking cables, Different connectors, Hubs, Switches, Routers
2. NIC Installation & Configuration (Windows/Linux)
3. Understanding IP address, subnet etc, Connect the computers in Local Area Network.
4. Study of basic Network Configuration commands.
5. Configure a Network topology using packet tracer software
6. Link Layer Error Detection Mechanism (Cyclic Redundancy Check), Data Link Layer Error Control mechanism (Selective Repeat, Go Back N)
7. Implementation of Data Link Layer Flow Control Mechanism (Stop & Wait, Sliding Window), Data
8. Server Setup/Configuration: FTP, TELNET, NFS, DNS, Firewall.
9. TCP/UDP Socket Programming: Simple, TCP based, UDP based Multicast & Broadcast Sockets

Text Books:

1. B. A. Forouzan – "Data Communications and Networking (5th Ed.) " – TMH
2. W. Stallings – "Data and Computer Communications (5th Ed.)" – PHI/ Pearson Education

Reference Books:

1. A. S. Tanenbaum – "Computer Networks (4th Ed.)" – Pearson Education/PHI
2. Black, Data & Computer Communication, PHI
3. Zheng & Akhtar, Network for Computer Scientists & Engineers, OUP

Course Name: Artificial Intelligence Laboratory
Course Code: EE594C
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Knowledge of programming languages.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand and recognize various AI search algorithms and AI tools.
- **CO2.** Apply the fundamentals of knowledge representation, inference and theorem proving using AI tools.
- **CO3.** Analyze working knowledge of reasoning in the presence of incomplete and/or uncertain information.
- **CO4.** Evaluate and create knowledge representation, reasoning, and machine learning techniques for the solutions of real-world problems.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	2	-	-	-	-	-	-	-	-	-	-	1
CO2	-	3	-	-	-	-	-	-	-	-	-	1
CO3	1	-	3	-	-	-	-	-	-	-	-	1
CO4	-	3	-	2	-	-	-	-	-	-	-	1

List of Experiments:

A. Write the following programs using PROLOG

1. Study of PROLOG facts and rules.
2. Write a program to compute factorial of a number.
3. Write a program to compute GCD of two numbers.
4. Write a program to represent facts and rules.
5. Write a program to represent a family tree.
6. Write a program to diagnosis intelligently.
7. Write a program to check whether a given line segment is vertical or horizontal?
8. Write a program for list processing.

B. Write the following programs using PROLOG

1. Write a program to solve 8 queens problem
2. Solve any problem using depth first search.
3. Solve any problem using best first search.
4. Solve 8-puzzle problem using best first search
5. Solve Robot (traversal) problem using means End Analysis
6. Solve traveling salesman problem.

C. Write some programs on recent trend in AI (It may be recent real world problems)

Jupyter Notebook (iPython): Medical diagnosis. Design an Expert System

N.B. Projects assigned by instructor to model and solve real world problems.

Text Books:

1. Artificial Intelligence: A Modern Approach, Russell & Norvig, Prentice Hall.
2. Artificial Intelligence, Elain Rich and Kevin Knight, TMH.

Reference Books:

1. Prolog Programming for Artificial Intelligence Paperback by Ivan Bratko
2. Jacek M. Zurada, "Introduction to Artificial Neural Systems", PWS Publishers

3rd Year 6th Semester								
Sl. No.	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
A. Theory								
1	HSMC	HSMC605	Principles of Management	2	0	0	2	2
2	PCC	EE601	Microprocessor and Microcontroller	3	0	0	3	3
3	PCC	EE602	Power Systems – II	3	0	0	3	3
4	PCC	EE603	Control Systems – II	3	0	0	3	3
5	OEC	EE604	D. Bigdata Analytics E. Internet of Things F. Soft Computing	3	0	0	3	3
6	PEC	EE605	E. Renewable Energy – II F. Advanced Power Electronics G. Special Electric Machines H. Digital Signal Processing	3	0	0	3	3
B. Practical								
7	PCC	EE691	Microprocessor and Microcontroller Laboratory	0	0	3	3	1.5
8	PCC	EE692	Power System – II Laboratory	0	0	3	3	1.5
9	PCC	EE693	Control Systems – II Laboratory	0	0	3	3	1.5
10	PROJ	PR691[17*]	Electrical Workshop	0	0	2	2	1
11	PROJ	PR 692	Minor Project – II	0	0	2	2	1
12	PROJ	PR 693	Skill Development – VI: Soft Skill and Aptitude – III	1	0	0	1	0.5
C. Mandatory Activities / Courses								
13	MC	MC 601	Constitution of India	3	0	0	3	0
Total of Theory, Practical and Mandatory Activities / Courses without MOOC Courses							**34**	**24**

[17*] Students will initially see all the cutset models and prototypes of different electrical systems (Motor, Generator, Transformers, Transmission Lines, Solar Panels etc.) and prepare the data sheets and thereafter design their own.

D. MOOC Courses[18**]								
14	MOOC	HM601	MOOC Course – IV	3	1	0	4	4
Total of Theory, Practical and Mandatory Activities / Courses with MOOC Courses							**38**	**28**

Course Name: Microprocessor and Microcontroller
Course Code: EE601
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Knowledge in Digital Electronics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** To understand the hardware functionality of Intel 8051 and ARM
- **CO2.** To create the essential knowledge on operating modes of I/O ports, Timers/Counters, control registers and various types of interrupts of 8085,8086, 8051.
- **CO3.** To analyse various interfacing techniques with different supporting chips.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2		1	-	-	-	-	1	-	-	-
CO3	2	2	2	-	-	-	-	-	-	1	-	-

Course Content

Module 1: 8085 Microprocessor **4L**
8085 Architecture, Pin details, Familiarization of basic Instruction Set & Programming, addressing modes, Timing Diagram, memory segmentation, Interrupts & Direct Memory Access, Memory interfacing

Module 2: 8086 Microprocessor **5L**
8086 Architecture, Pin details timing diagram, instruction set, Familiarization of basic Instruction Set & Programming, addressing modes, Interrupts & Direct Memory Access, Memory interfacing.

Module 3: 8051 Microcontroller Architecture **4L**
Features of MCS51, Architecture of 8051, pin diagram, memory organization, external memory interfacing, register in MCS51 series.

Module 4: Instruction set of 8051 microcontroller **5L**
Addressing modes and instructions set, assembly programing, Parallel I/O interrupts ports, timer /counter and serial communication.

Module 5: Introduction to ARM Processor **4L**
Introduction to RISC processor – Comparison between CISC and RISC - Overview of ARM Architecture, Different modes of ARM processor, Program status register.

[18**] MOOC Courses for HONOURS / MINOR Degree are Program specific and to be taken from MOOC Basket.

Module 6: ARM Instruction Set **5L**

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

Module 7: Programming using ARM Processor **4L**

Solving a simple equation, generation of square wave form, Memory operations.

Module 8: Support IC chips **5L**

8255A: features, architecture, I/O addressing group A and group B controls operating modes, control word, example of determine the control word, interfacing with 8051 I/O devices interfacing with 8251 using 8255A.
8253: Pin diagram, block diagram, control word register, operational modes
8252 microcontroller: Block Diagram, Pin Details, Modes of operation, control word(s) format.

Text Books:

1. Andrew N Sloss, Dominic Symes , Chris Wright, " ARM System Developer's Guide.
2. Mohammad Ali Mazidi, Janice Gillispie Mazidi, " The 8051 Microcontroller and Embedded.
3. Microprocessor architecture, programming and application with 8085 – R. Gaonkar, Penram International.
4. The 8051 microcontroller and Embedded systems - Mazidi, Mazidi and McKinley, Pearson.

Reference Books:

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

Course Name: Control Systems – II
Course Code: EE603
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Any introductory course on Matrix Algebra, Calculus, Engineering Mechanics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Calculate mathematical model of linear-time-invariant systems using state- space representations.
- **CO2.** Analyze the nonlinear systems using appropriate methods.
- **CO3.** Illustrate discrete representation of LTI systems.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	2	3	2	-	2	-	-	-	-	-	-	2
CO2	2	3	2	-	2	-	-	-	-	-	-	2
CO3	2	3	2	-	2	-	-	-	-	-	-	2

Course Content

Module 1: State Variable Analysis **13L**

Introduction, Concepts of state, state variables and state model, Concept of State Equation for Dynamic Systems, state model for linear continuous-time systems, Non Uniqueness of State model, State Diagrams, Conversion of State variable model to transfer function, Conversion of transfer function to canonical state variable model, Diagonalization, Solution of state equations, State transition matrix – Properties and Computation, Eigenvalues and Stability Analysis, Concepts of Controllability and Observability, Pole placement by state feedback.

Module 2: Non-Linear Control Systems **13L**

Introduction to Non-Linear Systems: Introduction, Features of Linear and Non Linear Systems, Types of non-linearity, Common nonlinearities in control systems, Typical Examples, Concept of phase portraits – Singular points – Limit cycles.

Describing Function Analysis: Describing function fundamentals, Describing functions of common nonlinearities, Describing function analysis of nonlinear systems, Limit cycles, Stability of Oscillations

Lyapunov Stability Analysis: Stability Concepts, Equilibrium Points, BIBO and Asymptotic Stability, Lyapunov theory, Lyapunov's Direct method, Simple problem

Phase Plane Analysis: Construction of phase portrait, Concepts of phase plane analysis, Phase plane analysis of simple linear system and nonlinear system.

Module 3: Digital Control Systems 10L

Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modelling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent. Z-Transform and Inverse Z Transform for analyzing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane. Stability analysis by Jury test.

Text Books:

1. Katsuhiko Ogata, "Modern Control Engineering ", PHI Learning Pvt Ltd, 5th Edition, 2010.
2. Hassan K Khalil, "Nonlinear Control ", Pearson Prentice Hall, 1st Edition, 2014.
3. Gopal M : Digital Control and State Variable Methods, 2e, – TMH

Reference Books:

1. Goodwin, Control System Design, Pearson Education
2. Bandyopadhyaya, Control Engg. Theory and Practice, PHI
3. KuoB.C. : Digital Control System, Oxford University Press.
4. Houpis, C.H, Digital Control Systems, McGraw Hill International.
5. Ogata, K., Discrete Time Control Systems, Prentice Hall, 1995.

Course Name: Big Data Analytics
Course Code: EE604A
Contact: 3L:0T:0P
Total Contact Hours: 35
Credit: 3

Prerequisite: Basic knowledge in data storage and retrieval, Knowledge in Quantitative Aptitude and Statistics, Proficiency in Algorithms and Computer Programming Skills.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the fundamental concepts of big data and analytics
- **CO2.** Understand about clustering, classification and association techniques
- **CO3.** Summarize about stream computing.
- **CO4.** Summarize about the research that requires the integration of large amounts of data
- **CO5.** Summarize about tools and practices for working with big data

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	2	3	2	2	3	-	-	-	2	-	-	-
CO2	2	3	3	3	3	-	-	-	-	-	-	-
CO3	2	3	3	3	3	-	-	-	2	-	-	-
CO4	2	3	3	3	3	-	-	-	2	1	-	2
CO5	2	3	3	3	3	-	-	-	2	1	-	2

Course Content

Module 1: Introduction to Big Data **6L**

Evolution of Big data - Best Practices for Big Data Analytics – Big data characteristics - Validating - The Promotion of the Value of Big Data - Big Data Use Cases- Characteristics of Big Data Applications - Perception and Quantification of Value - Understanding Big Data Storage - A General Overview of High-Performance Architecture - HDFS - MapReduce and YARN - Map Reduce Programming Model

Module 2: Clustering and Classification **8L**

Advanced Analytical Theory and Methods: Overview of Clustering - K-means - Use Cases - Overview of the Method - Determining the Number of Clusters - Diagnostics - Reasons to Choose

and Cautions - Classification: Decision Trees - Overview of a Decision Tree - The General Algorithm - Decision Tree Algorithms - Evaluating a Decision Tree - Decision Trees in R - Naïve Bayes - Bayes‘ Theorem - Naïve Bayes Classifier.

Module 3: Association and Recommendation System 7L

Advanced Analytical Theory and Methods: Association Rules - Overview - Apriori Algorithm - Evaluation of Candidate Rules - Applications of Association Rules - Finding Association& finding similarity - Recommendation System: Collaborative Recommendation- Content Based Recommendation - Knowledge Based Recommendation- Hybrid Recommendation Approaches.

Module 4: Stream Memory 7L

Introduction to Streams Concepts – Stream Data Model and Architecture - Stream Computing, Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating moments – Counting oneness in a Window – Decaying Window – Real time Analytics Platform(RTAP) applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions. Using Graph Analytics for Big Data: Graph Analytics

Module 5: Nosql Data Management for Big Data and Visualization 7L

NoSQL Databases: Schema-less Models‖: Increasing Flexibility for Data Manipulation-Key Value Stores- Document Stores - Tabular Stores - Object Data Stores - Graph Databases Hive - Sharding –- Hbase – Analyzing big data with twitter - Big data for E-Commerce Big data for blogs - Review of Basic Data Analytic Methods using R.

Text Books:

1. Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press.
2. David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", Morgan Kaufmann/Elsevier Publishers.

Reference Books:

1. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley publishers.
2. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley Publishers.
3. Dietmar Jannach and Markus Zanker, "Recommender Systems: An Introduction", Cambridge University Press.
4. Kim H. Pries and Robert Dunnigan, "Big Data Analytics: A Practical Guide for Managers " CRC Press.
5. Jimmy Lin and Chris Dyer, "Data-Intensive Text Processing with MapReduce", Synthesis Lectures on Human Language Technologies, Vol. 3, No. 1, Pages 1-177, Morgan Claypool publishers, 2010.

Course Name: Internet of Things
Course Code: EE604B
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Operating System, Wireless Sensor Networks, Computer Networks, Cryptography, Communication Technology, Python Programming Language, and Cloud computing.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand the basic concepts of IoT and it's architectures.
- **CO2.** Analyze different issues in the domain of IoT and understand the practical applications of IoT.
- **CO3.** Evaluate and analyze different solution for the real life problems of IoT.
- **CO4.** Apply the concepts of IoT to design different smart tools.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	3	3	2	2	-	-	-	-	-	-	-	-
CO2	3	2	2	2	-	-	-	-	-	-	-	-
CO3	3	3	3	3	2	-	-	-	-	-	-	-
CO4	3	3	3	2	3	2	3	-	3	-	3	3

Course Content

Module 1: Wireless Sensor Network **4L**

Network and Communication aspects, Wireless medium access issues, MAC protocol, Routing protocols, Sensor deployment and Node discovery, Data aggregation and dissemination, Topology, Connectivity, Single-hop and Multi-hop communications.

Module 2: Fundamental of IoT **4L**

The Internet of Things, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Design challenges, Development challenges, Security challenges, Other challenges.

Module 3: IoT and M2M **5L**

Main design principles and needed capabilities, IoT architecture outline, standards, M2M and IoT Technology Fundamentals, Devices and gateways, Local and wide area networking, M2M Value Chains, IoT Value Chains, an emerging industrial structure for IoT, the international driven global value chain and global information monopolies. M2M to IoT Architectural Overview, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

Module 4: IoT Architecture **6L**

Introduction, Architecture Reference Model- Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

Module 5: IoT Privacy, Security and Governance **7L**

Introduction, Overview of Governance, Privacy and Security Issues, Access Control, Authentication and Authorization, Distributed trust in IoT, Secure Platform design, Smart Approach. Data Aggregation for the IoT in smart cities, Intrusion detection and prevention, Security attacks and functional threats.

Module 6: IoT Layers Architecture **6L**

PHY/MAC Layer - 3GPP MTC, IEEE 802.11, IEEE 802.15, Wireless HART, Z-Wave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7; Network Layer - IPv4, IPv6, 6LoWPAN, 6TiSCH, ND, DHCP, ICMP, RPL, CORPL, CARP ; Transport Layer - TCP, MPTCP, UDP, DCCP, SCTP TLS, DTLS; Session Layer - HTTP, CoAP, XMPP, AMQP, MQTT; Service Layer - oneM2M, ETSI M2M, OMA, BBF.

Module 7: IoT Applications for Value Creations **4L**

Introduction, IoT applications for industry: Future Factory Concepts, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Big Data and Serialization, IoT for Retailing Industry, Oil and Gas Industry, Real-time monitoring and control of processes - Deploying smart machines, smart sensors, and smart controllers with proprietary communication and Internet technologies, Remote control operation of energy consuming devices.

Text Books:

1. Internet of Things: Architecture and Design Principles, Raj Kamal, McGraw Hill Education; First edition.
2. Internet of Things fundamentals, David, Pearson Education.
3. Internet of Things by Tripathy and Anuradha, CRC Press.

Reference Books:

1. Getting Started With The Internet Of Things: Connecting Sensors and Microcontrollers to the Cloud, Cuno Pfister O'Reilly
2. Internet of Things (A Hands-on-Approach), Vijay Madisetti and ArshdeepBahga, Orient Blackswan Private Limited - New Delhi; First edition.

Course Name: Soft Computing
Course Code: EE604C
Contact: 3L:0T:0P
Total Contact Hours: 37
Credit: 3

Prerequisite: Mathematics, Set theory.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Understand importance of soft computing.
- **CO2.** Remember different soft computing techniques like Genetic Algorithms, Fuzzy Logic, Neural Networks and their combination.
- **CO3.** Implement algorithms based on soft computing.
- **CO4.** Apply soft computing techniques to solve engineering or real life problems.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	3	3	2	2	2	-	-	-	2	-	1	1
CO2	3	3	2	2	-	-	--	-	1	-	-	1
CO3	3	3	2	2	1	-		-	1	-	-	2
CO4	3	3	3	2	2	-	-	-	2	-	-	2

Course Content

Module 1: Introduction **4L**

Soft Computing. Difference between Hard and Soft computing, Requirement of Soft Computing, Major Areas of Soft Computing, Applications of Soft Computing.

Module 2: Fuzzy Systems **10L**

Fuzzy Set theory, Fuzzy versus Crisp set, Fuzzy Relation, Fuzzification, Min-max Composition, Defuzzification Method, Fuzzy Logic, Fuzzy Rule based systems, Fuzzy Decision Making, Fuzzy Control Systems, Fuzzy Classification.

Module 3: Genetic Algorithm **8L**

History of Genetic Algorithms (GA), Working Principle, Various Encoding methods, Fitness function, GA Operators- Reproduction, Crossover, Mutation, Convergence of GA, Bit wise operation in GA, Multi-level Optimization.

Module 4: Neural Networks 8L

Neural Network, Learning rules and various activation functions, Single layer Perceptrons, Back Propagation networks, Architecture of Back propagation(BP) Networks, Back propagation Learning, Variation of Standard Back propagation Neural Network, Introduction to Associative Memory, Adaptive Resonance theory and Self Organizing Map, Recent Applications.

Module 5: Multi-objective Optimization Problem Solving 4L

Concept of multi-objective optimization problems (MOOPs) and issues of solving them. Multi-Objective Evolutionary Algorithm (MOEA), some applications with MOEA.

Module 6: Hybrid Systems 3L

Introduction to Hybrid Systems, Neuro Fuzzy Hybrid Systems, Neuro-Genetic Hybrid Systems, Fuzzy-Genetic Hybrid Systems.

Text Books:

1. Fuzzy Logic with Engineering Applications, Timothy J. Ross, Willey.
2. Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis & Applications, S.Rajasekaran, G. A. Vijayalakshami, PHI.
3. Genetic Algorithms: Search and Optimization, E. Goldberg

Reference Books:

1. Neuro-Fuzzy Systems, Chin Teng Lin, C. S. George Lee PHI.
2. Elements of Artificial Neural Network, Kishan Mehrotra, MIT Press.
3. An Introduction to Genetic Algorithms, Melanie Mitchell, MIT Press.

Course Name: Renewable Energy – II
Course Code: EE605A
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Concept of energy conversion, Power system, Machine.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Obtain the basic knowledge of biomass energy conversion techniques and its types with waste into useful energy conversion.
- **CO2.** Obtain the knowledge of basic operating principles of tidal and wave energy to design an Ocean Thermal Energy Conversion (OTEC) plant.
- **CO3.** Understand the working principles of geothermal energy and fuel cell and its application along with estimation.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	3	3	-	-	-	-	3	-	-	-	-	3
CO2	3	-	3	-	2	2	2	-	2	-	2	-
CO3	2	2	3	-	-	3	2	-	-	-	2	-

Course Content

Module 1: Introduction to Renewable Energy Sources 4L

World energy resources - Indian energy scenario – Environmental aspects of energy utilization; review of conventional energy resources- Different form of nonconventional energy; Renewable energy resources and their importance – role of energy in economic development and social transformation.

Module 2: Biomass Energy 10L

Origin of biomass from different sources; Biomass resource assessment - Estimation of woody biomass, non woody biomass and wastes, ASTM standards. Bulk chemical properties - Moisture content, proximate and ultimate analyses, calorific value, and waste water analysis for solids; Anaerobic digestion, biogas production mechanism and technology, types of digesters, design of biogas plants, installation, operation and maintenance of biogas plants, biogas slurry utilization and management, biogas applications, cost benefit analysis of biogas for cooking, lighting, power generation applications, Feedstock for biogas, Microbial and biochemical aspects, operating parameters for biogas production. Kinetics and mechanism, Bio hydrogen production: hydrolysis, fermentation. Biodiesel production, different types of raw materials, non-edible oil-seeds, Pyrolysis, mechanism of trans esterification, fuel characteristics of biodiesel.

Module 3: Ocean and Tidal Energy 8L

Ocean energy resources, ocean energy routes; principles of ocean thermal energy conversion systems; principles of ocean wave energy conversion and tidal energy conversion; Ocean power generation: tidal energy estimation, components of tidal power plant, wave area of determining energy, mathematical analysis of wave energy, Wave energy conversion machine, Working principle –OTEC, Anderson closed cycle OTEC system, thermoelectric OTEC.

Module 4: Geothermal Energy 8L

Geothermal energy: Geothermal energy sources – types and potential principle of working and operation of different types of geothermal power generation- Direct and indirect uses of geothermal energy resources; geothermal energy conversion technologies; High temperature geothermal power plants; Environment impacts; Estimation of geothermal power –Future of geothermal energy.

Module 5: Fuel Cell 6L

Fuel cells – Principle of operation, classification and types of fuel cells – comparison on battery vs. fuel cell- Applications- Limitations and future prospect.

Text Books:

1. Kothari ,Renewable Energy Sources and Emerging Technologies, PHI, Eastern Economy
2. R.K.Rajpoot, Non-Conventional Energy Sources and Utilization, S. Chand Publication, New Delhi.
3. John Twidell and Tony Weir, Renewable Energy Resources, Second edition, Taylor & Francis, 2006.
4. Ronald Shaw, Wave Energy: A Design Challenge, Eills Horwood Ltd. Publishers, First Edition 1982.

Reference Books:

1. K.C. Khandelwal and S.S. Mahdi, Biogas Technology– A Practical Handbook, Tata McGrawHill, 1986.
2. Rai, G.D, Non-Conventional Energy Sources, Khanna Publishers, New Delhi
3. N. K. Bansal and M.K. Kleema, Renewable Sources of Energy and Conversion Systems
4. J. Twidell & T. Weir, Renewable Energy Resources, Taylor and Francis; 2006 (2nd ed)

Course Name: Advanced Power Electronics
Course Code: EE605B
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Concept of Power Electronics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Demonstrate conventional power converters suitable for different industrial and domestic applications.
- **CO2.** Demonstrate soft switched and resonant power converters suitable for power supply.
- **CO3.** Explain different power converters suitable for high voltage applications and power quality improvement.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	3	3	-	-	2	-	-	-	-	-	-	-
CO2	3	3	-	-	2	-	-	-	-	-	-	-
CO3	3	3	-	-	2	-	-	-	-	-	-	-

Course Content

Module 1: Advanced Switch Mode Power Converters 12L

Non Isolated DC – DC Converters: Linear Voltage Regulators, Review of Buck, Boost and Buck Boost converters, continuous, discontinuous and critical conduction mode conduction mode, Cuk converter, SEPIC converter.

Isolated DC – DC Converters: Full bridge dc-dc converter, Half-bridge converter, Forward converter, Flyback converter, Push-pull converter.

Module 2: Soft switching and Resonant Converters 12L

Introduction, Need for resonant converters, classification of resonant converters, series resonant converters, Parallel Resonant Converter, series-parallel resonant converter, load resonant converters, resonant switch converters, zero voltage and zero current switching resonant converters, Resonant converter comparison, Soft Switching Inverter, clamped voltage topologies.

Module 3: Multilevel Inverters 8L

Concept, types of multilevel inverters, diode-clamped, flying-capacitor (Three level configuration, Half bridge and full bridge Topology, Three Phase FC Converter), and cascaded multilevel inverters, SPWM and SVPWM techniques of multilevel inverter, applications, comparison.

Module 4: Matrix Converter 4L

Matrix Converter: Classic Matrix Converter, Sparse Matrix Converter, Z Souce Matrix Converter.

Text Books:

1. M. H. Rashid, ―Power Electronics: Circuits, Device and Applications‖, 2nd Ed. 1993, Prentice-Hall, Inc.
2. N. Mohan, T. M. Undeland, and W. P. Robbins, ―Power Electronics: Converters, Application and Design‖, 3rd. Ed., John Wiley, 2003

Reference Books:

1. M. Trzynadlowski, ―Introduction to Modern Power Electronics‖ John Wiley, 1998.

Course Name: Digital Signal Processing
Course Code: EE605D
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Concept of Circuit Theory, various signals and systems, Laplace Transform, Z-Transform, knowledge of arithmetic of complex numbers and elementary calculus.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Interpret the properties of discrete time signals in time domain and frequency domain.
- **CO2.** Demonstrate the transform- domain signal and analyze the frequency response.
- **CO3.** Design and implement IIR filtering operations with the real time constraints.
- **CO4.** Develop a FIR filter for specific digital signal applications.
- **CO5.** Explain finite word length effects and digital filters.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	2	2	-	-	-	-	-	-	-	-	-	2
CO2	2	3	3	-	2	-	-	-	-	-	-	-
CO3	3	1	3	3	1	-	2	-	-	-	-	2
CO4	2	2	3	3	3	-	2	-	-	-	-	-
CO5	3	3	2	2	3	-	2	-	-	-	-	2

Course Content

Module 1: Discrete-time Signals and Systems 6L

Concept of discrete-time signal, basic idea of sampling and reconstruction of signal, sampling theorem, sequences, periodic, energy, power, unit-sample, unit step, unit ramp and complex exponentials, arithmetic operations on sequences, impulse response, concept of convolution, graphical, analytical and overlap-add methods to compute convolution supported with examples properties of convolution, interconnection of LTI systems with physical interpretations, stability and causality conditions, recursive and non-recursive systems.

Module 2: Z-Transforms 4L

Definition, mapping between s-plane and Z-plane, unit circle, convergence and ROC, properties of Z-transform, Z-transform on sequences with examples and exercises, characteristic families of signals along with ROC, convolution, correlation and multiplication using Z-transform, initial value theorem, Perseval's relation, inverse Z-transform by contour integration, power series and partial fraction expansions with examples and exercises.

Module 3: Frequency Analysis of Signals and Systems 5L

DTFT- Frequency domain sampling - DFT-Properties-Frequency analysis of signals using DFT-FFT Algorithm-Radix-2 FFT algorithms-Applications of FFT.

Module 4: Theory and Design of Analog Filters 4L

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

Module 5: Design of IIR Digital Filters 4L

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

Module 6: Design of FIR Digital Filters 5L

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

Module 7: Realization of Digital Filters 4L

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

Module 8: Digital Signal Processors 4L

General-purpose digital signal processors - Fixed point and floating-point DSP - Finite word length effects - MAC, filter operation in different DSP architectures - typical implementation of DSP algorithms.

Text Books:

1. John G. Proakis, D.G. Manolakis and D.Sharma, "Digital Signal Processing Principles, Algorithms and Applications", 4th edition, Pearson Education, 2012.
2. Sanjit K. Mitra, "Digital Signal Processing", 4th edition, TMH, 2013.
3. P. Rameshbabu, "Digital Signal Processing", Scitech Publications (India).
4. S.Salivahanan, A.Vallabraj & C. Gnanapriya, "Digital Signal Processing", TMH Publishing Co.
5. A. Nagoor Kani, "Digital Signal Processing", McGraw Hill.

Reference Books:

1. Oppenhiem V.A.V and Schaffer R.W, "Discrete – time Signal Processing", 3rd edition, Pearson new international edition, 2014.
2. Sophocles J. Orfanidis, "Introduction to Signal Processing" 2nd edition, Prentice Hall, Inc,

2010.
3. Chi-Tsong Chen, "Digital Signal Processing; Spectral Computation and Filter Design", Oxford University Press.

Course Name: Power System – II Laboratory
Course Code: EE692
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Circuit Theory, Electrical Machines – I, Power System – I.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Demonstrate the performance of different types of relays.
- **CO2.** Determine polarity, ratio and magnetization characteristics of CT and PT.
- **CO3.** Demonstrate AC and DC load flow by simulation.
- **CO4.** Design different protection schemes for transformer, generator, motor and feeder by simulation.
- **CO5.** Determine economic load dispatch of a power plant.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2
CO1	3	-	-	3	-	-	-	-	3	-	-	3
CO2	3	-	-	3	-	-	-	-	3	-	-	3
CO3	3	-	-	3	3	-	-	-	3	-	-	3
CO4	3	-	-	3	3	-	-	-	3	-	-	3
CO5	3	-	-	3	-	-	-	-	3	-	-	3

List of Experiments:

1. Study on (i) on load Time Delay Relay (ii) off load Time Delay Relay

2. Polarity, Ratio and Magnetization Characteristics Test of CT & PT
3. Testing on (i) Under Voltage Relay and (ii) Earth Fault Relay
4. Study on D C Load Flow
5. Study of A C Load Flow Using Gauss – Seidel Method
6. Study of A C Load Flow Using Newton – Raphson Method
7. Study of IEEE 30, 57 bus Load Flow by Software Simulation (ETAP, MAT Lab or others)
8. Study on Economic Load Dispatch by software
9. Study of Transformer Protection by Simulation
10. Study of Generator Protection by Simulation
11. Study of Motor Protection by Micon Relay and Simulation.
12. Study of Different Characteristics of Over Current Relay.

Course Name: Electrical Workshop
Course Code: PR691
Contact: 0L:0T:2P
Credit: 1

Prerequisite: Concepts of Basic Electrical Engineering, Electric circuit, Measurements, Power electronics.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Implement the theoretical and practical knowledge and skills gained through various subjects/courses into an application suitable for a real practical working environment, preferably in an industrial environment.

CO2. Develop software packages or applications and implement these for the actual needs of the community/industry. Identify and contrast gap between the technological knowledge acquired through curriculum and the actual industrial need and to compensate it by acquiring additional knowledge as required.

CO3. Carry out cooperative learning through synchronous guided discussions within the class in key areas, asynchronous document sharing and discussions, as well as prepare collaborative edition of the final project report.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	3	2	1	-	-	-	-	-	1	-	2	-

CO2	-	-	3	-	2	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	3	-	-	-

List of Experiments:

Following are the suggestive areas of project work

1. Design and winding of small power transformers, Induction motor winding (squirrel cage type).
2. Speed control techniques using thyristor.
3. Battery design & its maintenance.
4. Energy management Techniques.
5. Dynamic models of Electrical machine.
6. Solar based cooker, lamp, water heater etc. & Solar operated vehicles.
7. Remote control operated Electrical devices.
8. Advanced energy meter.
9. Design of Illumination techniques using advanced luminaries etc.
10. Dynamic models of Electrical Machine.
11. PLC & Microprocessor based project.
12. Repair of electrical apparatus coil.
13. Wiring of relay circuits;
14. Computer maintenance
15. Any other related area found worth.

4th Year 7th Semester								
Sl. No.	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	
A. Theory								
1	PCC	EE701	Electric Drives	2	0	0	2	2
2	PCC	EE702	Introduction to Smart Grid	3	0	0	3	3
3	PEC	EE703	E. Energy Conversion and Storage (Renewable Energy – III) F. Power Quality G. Design of Electric Apparatus H. Analog and Digital Communication	3	0	0	3	3
4	PEC	EE704	E. Distributed Generation and Microgrids F. FACTS and HVDC G. Electrical Energy Conservation and Auditing H. Embedded System Design	3	0	0	3	3
5	OEC	EE705	E. Data Science F. Cyber Security G. Machine Learning	3	0	0	3	3

			H. Smart and Nanomaterials for Electrical Engineering					
B. Practical								
6	PCC	EE791	Electric Drives Laboratory	0	0	2	2	1
7	PCC	EE792	Computer-Aided Electrical Drawing Laboratory (AutoCAD / Automation Studio)	0	0	3	3	1.5
8	PROJ	PR791	Major Project – I	0	0	0	4	2
9	PROJ	PR792[19*]	Industrial Training / Internship	0	0	0	0	1
10	PROJ	PR793	Skill Development – VII: Seminar and Group Discussion	0	0	1	1	0.5
C. Mandatory Activities / Courses								
11	MC	MC781	Entrepreneurship and Innovation Skill	0	0	3	3	0
Total of Theory, Practical and Mandatory Activities / Courses without MOOC Courses							**26**	**19**
D. MOOC Courses[20]**								
12	MOOC	HM701	MOOC Course – V	3	1	0	4	4
Total of Theory, Practical and Mandatory Activities / Courses with MOOC Courses							**30**	**23**

Course Name: Electric Drives
Course Code: EE701
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Concept of Electrical Machines, and Power Electronics

Course Outcomes: After successful completion of the course, student will be able to

CO1. Understand the concept, characteristics, application fields and development trend of electric motor required for a Power Drives System

CO2. Understand different types of braking and speed-control of electric motors for various applications.

CO3. Analyze the converter fed motor under different torque/speed conditions.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	1	-	-	-	-	-	-	-	-	-	-	-
CO2	1	3	2	-	1	-	-	-	1	-	-	1
CO3	1	3	2	-	1	-	-	-	1	-	-	1

[19*] Collective Data from 3rd to 6th Semester (Summer / Winter Training during Semester Break and Internship should be done after 5th Semester or 6th Semester). All related certificates to be collected by the training/internship coordinator(s).
[20**] MOOC Courses for HONOURS / MINOR Degree are Program specific and to be taken from MOOC Basket.

Course Content

Module 1: Fundamental Concept of Electric Drive 2L
Definition and concept of electric drive and its block diagram, Concept of Multi-quadrant operation, concept of load torque.

Module 2: Electric Braking (concept only) 2L
Electric Braking of AC Drive (Induction motor drive and synchronous motor drive)

Module 3: Selection of motor power rating (concept only) 2L
Thermal model of motor for heating and cooling (equation and problems), classes of motor duty, determination of motor rating for continuous, short time and intermittent duty, Load equalization (concept only)

Module 4: DC Motor Drives 3L
Ward-Leonard System, Single phase and three phases controlled DC drives (two quadrant operation and steady state analysis), Dual converter control of DC drives. Two and Four quadrant dc motor drive.

Module 5: Induction Motor Drives 6L
Stator voltage control, V/f controlled induction motors, Slip power recovery, VSI (Full bridge inverter operation, constant slip speed control, constant air gap flux control, torque pulsation, control harmonics, flux weakening operation) and CSI fed induction motor drives, vector controlled induction motor drive

Module 6: Synchronous Motor Drives 6L
Synchronous machine variable speed drive, Variable frequency control, Sinusoidal SPM machine drives, synchronous reluctance machine drives, wound field synchronous motor drive, Load-commutated Synchronous Motor Drives, Model of PMSM.

Module 7: Stepper Motor and Energy conservation in drives 3L
Solar and battery powered drives, Stepper motor Drive, Energy Efficient operation and power factor improvement of drives.

Text Books:

1. G. K. Dubey, ―Fundamentals of Electrical Drives, Narosa, 2001.
2. R. Krishnan, ―Electric Motor Drives: Modeling, Analysis and Control, PHI-India, 2005.
3. N. K. De and P. K. Sen, ―Electric Drives, Prentice Hall of India Private Limited, 2006.
4. S. K. Pillai, ―A First Course on Electrical Drives, New Age International.
5. S. B. Dewan, G. R. Slemon and A. Straughen, ―Power Semiconductor Drives, John Wiley and Sons, New York 1984.

Reference Books:

1. G. K. Dubey, ―Power Semiconductor Controlled Drives‖, Prentice Hall international, New Jersey, 1989.
2. B. K. Bose, ―Modern Power Electronics and AC Drives, Pearson Education Asia, 2003.

Course Name: Introduction to Smart Grid
Course Code: EE702
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Concept of Power System and Power Electronics.

Course Outcomes: After successful completion of the course, student will be able to

- **CO1.** Describe the necessity and evolution of smart grid with policies.
- **CO2.** Apply theoretical concepts for analyzing the performance of the grid.
- **CO3.** Understand Smart Grid design, operation and control.
- **CO4.** Discuss on two-way power flow of distribution system.

CO-PO Mapping:

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	3	-	-	-	3	-	-	-	-	-	1	-
CO2	3	3	2	2	2	-	-	-	-	-	2	-
CO3	3	3	2	-	2	-	-	-	-	-	-	-
CO4	3	3	2	-	2	-	-	-	-	-	-	-

Course Content

Module 1: Smart Grid Architectural Designs 4L
Introduction. Evolution of electric Grid, Need for smart grid, difference between Conventional grid and smart grid, General View of the Smart Grid Market Drivers, Functions of Smart Grid Components, present development and international policies in smart grid.

Module 2: Smart Grid Communications and Measurement Technology 6L
Communication and Measurement, Monitoring, PMU, Smart Meters, and Measurements Technologies, Wide Area Monitoring Systems (WAMS), Phasor Measurement Units (PMU) , Smart Meters , Smart Appliances, Advanced Metering Infrastructure (AMI), Micro grid and Smart Grid Comparison.

Module 3: Performance Analysis Tools for Smart Grid Design 5L
Challenges to Load Flow in Smart Grid and Weaknesses of the Present Load Flow Methods, types, Load Flow State of the Art: Classical, Extended Formulations, and Algorithms, Congestion Management Effect, Load Flow for Smart Grid Design Contingency Studies for the Smart Grid.

Module 4: Information Security and Communication Technology for Smart Grid 6L
Data communication, switching techniques, communication channels, HAN, NAN, WAN, Bluetooth, Zigbee, GPS, Wi-Fi based communication, Wireless mesh network, Basic of cloud computing and cyber security for smart grid, Broadband over power line(BPL).

Module 5: Islanding & Smart Grid Protection 4L
Islanding Detection Techniques, Smart Grid Protection, Digital relays for Smart Grid Protection.

Module 6: Operation and control 5L
Modelling of Storage Devices, Modelling of DC Smart Grid components, Operation and control of DC Microgrid, Operation and control of AC Microgrid, Operation and control of AC-DC hybrid Microgrid.

Module 7: Smart Grid Case Study 5L
Simulation and Case study of AC Microgrid, Simulation and Case study of DC Microgrid, Simulation and Case Study of AC-DC Hybrid Microgrid, Demand side management of Smart Grid, Demand response analysis of Smart Grid.

Text Books:

1. James momoh, "Smart grid fundamentals of design and analysis, IEEE Press, a john wiley & sons, inc., publication, 2012.
2. Bernd M. Buchholz, Zbigniew Styczynski, Smart grid fundamentals and Technologies Electricity Networks, Springer, Heidelberg New York Dordrecht London, 2014.

Reference Books:

1. Janaka Ekanayake, Nick Jenkis, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Smard grid technology and applications, Wiley, 2012.
2. Stuart Borlase Smart grid: Infrastructure, Technology and solutions, CRC Press 2012.

Paper Name: Energy Conversion & Storage
Paper Code: EE703A
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Concept of Basic Electrical Principal and Renewable Energy

Course Outcomes: After successful completion of the course, student will be able to

CO1. Understand of energy storage and conversion technologies which are rapidly growing in necessity for large-scale integration of renewable energy.

CO2. Understanding of principles of operation of modern devices for electrochemical energy conversion and storage.

CO3. Understand the basic principles of Renewable Energy technology, Micro Fuel Cell Technology, Micro Fluid System and Battery Charger.

CO-PO Mapping:

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

CO3	1	2	-	-	-	-	-	-	-	-	-	-

Course Content

Module 1: Introduction 3L
Energy conversion process, indirect and direct energy conversion, Materials for light emitting diodes, Energy storage types, batteries advanced turbines-catalytic reactors-capacitors fuel cells. Power electronics for electric vehicle charging.

Module 2: Modern Energy Conversion Techniques 8L
Survey of modern sustainable technologies for electrochemical energy conversion and storage, Principles and mechanisms of electrochemical conversion (fuel cells, photo electrochemical devices), Principle of energy storage in modern sustainable devices (reversible batteries/accumulators, supercapacitors), Fundamental transport and reaction processes

Module 3: Overview of Typical Modern Storage Devices 7L
fuel cells, photoelectrochemical cells, batteries, supercapacitors, Advantages and disadvantages of current generation of alternative devices and outlook.

Module 4: Micro Fuel Cell Technology 6L
Micro-fuel cell technologies, integration and performance for micro-fuel cell systems -thin film and microfabrication methods - design methodologies - micro-fuel cell power sources.

Module 5: Hydrogen Storage Methods 4L
Hydrogen storage methods - metal hydrides - size effects - hydrogen storage capacity -hydrogen reaction kinetics - carbon-free cycle- gravimetric and volumetric storage capacities-hydriding/dehydriding kinetics -high enthalpy of formation - and thermal management during the hydriding reaction.

Module 6: Battery Charger 6L
Charging infrastructure, types of chargers, standards used for chargers, grid interaction of chargers; Difference between charging station and charging point; Inductive charging, Flash Charging; Charger protocols, OCPP, V2G, CHADEMO, Bharat Charger; Impact of charging on grid; Renewable energy integration to chargers; Application of IoT to charging infrastructure.

Text Books:

1. Martin A Green, “Solar cells: Operating principles, technology and system applications”, Prentice Hall Inc, Englewood Cliffs, 1981.
2. H J Moller, “Semiconductor for solar cells”, Artech House Inc, 1993.
3. J. Twidell and T. Weir, “Renewable Energy Resources”, E & F N Spon Ltd, 1986

Reference Books:

1. Linden, “Hand book of Batteries and fuel cells”, Mc Graw Hill, 1984.
2. Eastop T. D. and D. R. Croft, Energy Efficiency for Engineers & Technologists, Longman, 1990.
3. W. Vielstich, “Handbook of fuel cells: Fuel cell technology and applications”, Wiley, CRC Press, 2003.
4. Rao S. and B. B. Parulekar, Energy Technology, Khanna Publishers, 2005.

Paper Name: Power Quality
Paper Code: EE703B
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Power Electronics, Synchronous Machine, Power Systems.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Understand the basic concepts of power quality.
CO2. Understand the working principles of devices to improve power quality.
CO3. Describe power quality characteristics as per IEEE/IEC standards.
CO4. Understand voltage sag and interruption.
CO5. Describe methods to reduce over voltages.

CO-PO Mapping:

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

CO3	3	3	-	-	-	-	-	-	2	-	-	3
CO4	3	3	-	-	-	-	-	-	2	-	-	3
CO5	3	3	-	-	-	-	-	-	2	-	-	3

Course Content

Module 1: Introduction to Power Quality **6L**

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

Module 2: Voltage Sags and Interruptions **6L**

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

Module 3: Overvoltages **8L**

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

Module 4: Harmonics **6L**

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

Module 5: Power Quality Standards and Regulations **4L**

Standards - IEEE, IEC, ANSI, Limits and regulations on power quality in transmission and distribution network.

Module 6: Power Quality Monitoring and Survey **6L**

Monitoring Considerations - Historical Perspective of Power Quality Measuring Instruments-Power Quality Measurement Equipment-Assessment of Power Quality Measurement Data - Application of Intelligent Systems - Power Quality Monitoring Standards.

Text Books:

1. Roger C. Dugan, Mark F. McGranaghan, Surya Santoso “Electrical Power System Quality”, Tata Mcgraw-hill, New Delhi, 2012.
2. R. C. Dugan, “Electrical Power Systems Quality”, McGraw Hill Education, 2012.

Reference Books:

1. Mohammad A. S Masoum, Ewald F.Fuchs, “Power Quality in Power Systems and Electrical Machines”, Academic Press, Elsevier, 2015.
2. Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, “Power Quality: Problems and Mitigation Techniques”, John Wiley & sons Ltd, 2015.
3. T. J. E. Miller, “Reactive Power Control in Electric Systems”, John Wiley and Sons, New York, 1983.
4. G. T. Heydt, Electric Power Quality, Stars in a Circle Publications, 1991.

5. “Electric Power Quality" by Surajit Chattopadhyay, Madhuchhanda Mitra, Samarjit Sengupta, Springer, 2011.

Paper Name: Design of Electric Apparatus
Paper Code: EE703C
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Concept of Electromechanical energy conversion in Electrical Machines.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Determine electric and magnetic field strengths and their effects in and around electrical machinery, including effects of magnetic induction on moving parts.

CO2. Design stator and rotor parts of the d.c machines, Cage rotor Induction m/c, Wound rotor Induction m/c and Synchronous m/c and predict the performance of the corresponding machine using design values.

CO3. Design a transformer and estimates its performance as per the requirements and constraints specified.

CO4. Design a component or a product applying all the relevant standards with realistic constraints

CO-PO Mapping:

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

Course Content

Module 1: Magnetic Circuits and Cooling of Electrical Machines 5L

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

Module 2: D.C. Machines 6L

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

Module 3: Transformer 6L

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

Module 4: Squirrel Cage Induction Motors 5L

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

Module 5: Slip Ring Induction Motors 5L

Constructional details of slip ring motor – output equation – main dimensions – choice of specific loadings – design of stator – design of slip ring rotor – equivalent circuit parameters from designed data – losses and efficiency calculations. slip ring design - effect of skewing.

Module 6: Synchronous Machines & its Design 7L

Constructional details of cylindrical pole and salient pole alternators – output equation – choice of specific loadings – main dimensions – short circuit ratio.

Design of stator and rotor of cylindrical pole and salient pole Synchronous machines - design of field coil - performance calculation from designed data - introduction to computer aided design.

Module 7: Computer Aided Design 4L

Introduction to computer aided design.

Module 8: Contemporary issues 2L

Text Books:

1. A.K. Sawhney, 'A Course in Electrical Machine Design', Dhanpat Rai and Sons, New Delhi, 2012.
2. S.K. Sen, 'Principles of Electrical Machine Design with Computer Programmes', Oxford and IBH Publishing Co. Pvt Ltd., New Delhi, 2010.
3. R.K. Agarwal, 'Principles of Electrical Machine Design', S.K.Kataria and Sons, Delhi, 2012

Reference Books:

1. V.N. Mittle and A. Mittle, 'Design of Electrical Machines', Standard Publications and Distributors, Delhi, 2010.
2. M.V.Deshpande , "Design and Testing of Electrical Machines" Eastern Economy Edition, 2011.
3. Clayton and Hancock, "Performance and Design of Direct Current Machines", 2010.
4. M.G.Say, "Performance and Design of Alternating Current Machines" CBS Publisher, 3rd Edition 2010.
5. Kusik, "Computer aided design"

Paper Name: Distributed Generation and Microgrids
Paper Code: EE704A
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Power System-I& II, Power Electronics, Electrical Machines I &II, Renewable Energy - I &II.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Understanding comparative studies of the conventional and non- conventional power generation.
CO2. Analyse and design of distributed generation, installation and grid integration.
CO3. Design the dc and ac micro-grid.
CO4. Analyse power quality issues and control operation of micro grid.

CO-PO Mapping:

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

Course Content

Module 1: Architecture of Distributed Generations (DG) Technologies 6L

Introduction, Comparative study between conventional and non-conventional methods of power generation: energy crisis due to scarcity of fossil fuel & economic point of view, distributed generation (DG) overview and technology trend. Working principle, architecture, application of renewable DG technologies: solar PV, bio-energy, wind energy, hydroelectricity, tidal power, wave energy, geothermal energy etc.

Non-conventional technology based DGs: Fuel cells, CHP based micro turbine, IC engines, etc.Storage based DGs: Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants.

Module 2: Interconnection Issues and Standards of DG(s) 4L

Concept of distributed generations, topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations.

Module 3: Power Electronics and DG systems 8L

Relevance of power electronics in DG applications, Power quality requirements and source switching using SCR based static switches, Distribution system loading, line drop model, series voltage regulators and on line tap changers, power converter topologies, model and specifications for DG applications, issues filter designs, harmonic reduction, Control of DG inverters, phase locked loops, current control and DC voltage control for stand-alone and grid parallel operations. Protection of converters, power quality implication, acceptable ranges of voltage and frequency, reactive power compensation and active filtering.

Module 4: Impact of Grid Integration 4L

Requirements for grid interconnection, limits on operational parameters: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.

Module 5: Operation, Control and Modelling of Micro Grid 8L

Concept and definition of micro grid, review of sources of micro grids, typical structure and configuration of a micro grid, micro grid implementation in Indian and international scenario, AC and DC micro grids, Power Electronics interfaces in DC and AC micro grids, communication infrastructure, modes of operation and control of micro grid: grid connected and islanded mode operation, anti-islanding schemes. Control techniques for voltage, frequency, active and reactive power control of micro grid system, Computer aided Modelling of micro grid. Power quality issues in micro grids, regulatory standards, micro grid economics,

Module 6: Introduction to Reliability and Market Issues of Micro grid 3L

Power quality issue, THD reduction techniques, protection and stability analysis of micro grid, regulatory standards, introduction to micro grid reliability. Features of micro grid economy and market. LVDC Micro grid.

Module 7: Future Micro Grid 3L

Basic introduction of smart & future micro grid. IOT application and Machine learning applications in micro grid for controlling and mitigation problems of Islanding.

Text Books:

1. Renewable Energy- Power for a sustainable future, third edition, Edited by Godfrey Boyle, Oxford University Press, 2013.
2. Amirnaser Yezdani, and Reza Iravani, "Voltage Source Converters in Power Systems: Modeling, Control and Applications", IEEE John Wiley Publications, 2009.
3. Dorin Neacsu, "Power Switching Converters: Medium and High Power", CRC Press, Taylor & Francis, 2006. New Delhi.
4. Microgrids: Architectures and Control, Nikos Hatziargyriou (Editor), ISBN: 978-1-118-72068-4, 340 pages, December 2013, Wiley-IEEE Press
5. Microgrids and Active Distribution Networks, S. Chowdhury, S.P. Chowdhury and P. Crossley, The Institution of Engineering and Technology, London, U.K, 2009.
6. Technical literatures- research papers published in power system and power electronics.

Reference Books:

1. Amirnaser Yezdani, and Reza Iravani, "Voltage Source Converters in Power Systems: Modeling, Control and Applications", IEEE John Wiley Publications, 2009.
2. DorinNeacsu, "Power Switching Converters: Medium and High Power", CRC Press, Taylor & Francis, 2006.
3. Chetan Singh Solanki, "Solar Photo Voltaics", PHI learning Pvt. Ltd., New Delhi, 2009.
4. J.F. Manwell, J.G "Wind Energy Explained, Theory Design and Applications,". McGowan Wiley publication, 2nd Edition, 2009.
5. D. D. Hall and R. P. Grover, "Biomass Regenerable Energy", John Wiley, New York, 1987. 6. John Twidell and Tony Weir, "Renewable Energy Resources", Taylor and Francis Publications, Second Edition, 2006.

Paper Name: FACTS and HVDC
Paper Code: EE704B
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Concept of Power System, and Power Electronics.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Study the applications of FACTS Controllers in ac power flow.
CO2. Discuss the principles, operation and control of Series, Shunt and unified controller.
CO3. Explain the HVDC concepts, application of HVDC systems in bulk power transmission.
CO4. Classify the DC links and describe the operation of various MTDC systems.

CO-PO Mapping:

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

Course Content

Module 1: Introduction **6L**

Control of power flow in transmission lines, Application and classification of FACTS controllers. Introduction to HVDC transmission- Comparison between HVDC and HVAC systems.

Module 2: Shunt Compensation **6L**

Objectives of shunt compensation, Methods of controllable VAR generation, Static VAr Compensator (SVC), STATCOM.

Module 3: Series Compensation **7L**

Objectives of series compensation, GCSC, TSSC, TCSC and SSSC.

Module 4: Combined Controllers Compensation **6L**

Unified Power Flow Controller, Interline Power Flow Controller and Generalized Unified Power Flow Controller.

Module 5: HVDC Transmission **7L**

Introduction to CSI and VSI based HVDC Controllers, Converter control, Configuration of HVDC system, Recent Trends in HVDC transmission, HVDC systems in India. Case study

Module 6: DC Links **6L**

Types of DC links, Back to back HVDC connections. Multi-terminal HVDC systems.

Module 7: Contemporary issues. **2L**

Text Books:

1. Narain Hingorani & Lazzlo Gyugi “Understanding FACTS. Concepts & Technology of FACTS”, Standard publishers & distributors, 2001.
2. K. R. Padiyar, “FACTS Controllers in Power Ttransmission and Distribution”, New Age International Publishers, 2007.
3. K.R.Padiyar,"HVDC Power Transmission Systems “ New Academic Science , 2017
4. S. Kamaksahiah & V. Kamaraju, “HVDC Tramission”, T^ata McGraw Hill Education Pvt Ltd. 2011.

Reference Books:

1. R. Mohan Mathur, Rajiv.K.Varma, “Thyristor Based FACTS Controllers for Electrical Transmission systems” John Wiley and Sons, 2011.
2. Jos Arrillaga, Y. H. Liu, Neville R. Watson " Flexible Power Transmission: The HVDC Options”, Wiley 2007.

Paper Name: Electrical Energy Conservation and Auditing
Paper Code: EE704C
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisite: Concept of Electrical Machines, Power System and Power Electronics.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Learn about Energy Conservation and its benefits
CO2. Learn Life Cycle costing of Electrical Appliances
CO3. Learn about Energy auditing
CO4. Learn about Supply and Demand Side Management

CO5. Learn about the role of Smart Grid and Energy Control Centers.

CO-PO Mapping:

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

Course Content

Module 1: Energy Conservation and Environment 4L

Electricity Act 2003, Integrated Energy Policy. Energy and environment, Air pollution, Climate change, United Nations Framework Convention on climate change (UNFCCC), Montreal Protocol, Kyoto Protocol, Clean Development Mechanism (CDM), CDM methodology and Procedures, Sustainable development.

Module 2: 12L

Electrical Systems (5L): Supply & Demand Side, Economic operation, Input-Output curves, Electricity tariff types; Case Study 1;

Cogeneration (1L): Types and Schemes;

Energy auditing (5L): Load profiling; Case Study 2; Necessity of Energy audit, Types of energy audit, Energy audit instruments; Case Study 3; Energy Conservation Act-2001 and its features, Notification Under the act, Designated agencies, Schemes of Bureau of Energy Efficiency (BEE); Intervals of EA regulation;

Energy Economics (1L): Economic assessment and Economic methods for specific energy analysis; Case study 4

Module 3: 10L

Electric Motors & Energy Conservation (5L): Energy efficient controls and starting efficiency - Electric Motors; Energy efficient /high efficient Motors; Case study 5; Load Matching and selection of motors; Case Study 6; Variable speed drives; Case study 7; Pumps and Fans-Efficient Control strategies; Case study 8;

Electric loads & Energy conservation measures (5L): Air conditioning & Refrigeration, Cold storage-Types-Optimal operation-case study 9; Electric water heating-Geysers-Solar Water Heaters-Power Consumption in Compressors, Energy conservation measures; Electrolytic Process;

Module 4: Electrical Demand Side Management (DSM) 5L

Reactive Power management-Capacitor Sizing-Degree of Compensation; Case study 10; Peak Demand controls-Methodologies-Types of Industrial loads-Optimal Load scheduling -Case study 11; Lighting- Energy efficient light sources-Energy conservation in Lighting Schemes- Electronic ballast-Power quality issues-Luminaries, case study 12;

Module 5: 5L

Smart Grid Technologies in Energy Conservation (4L): Plug In Hybrid Electric Vehicles (PHEV); Microgrids; Home Energy Management Systems (HEMS); Electrical Energy Storage Technologies;

Computer Controls (1L): Hardware, Software-EMS

Text Books:

1. Leon K. Kirchmayer, "Economic Operation of power system", Wiley India Pvt Ltd, July 2010.
2. Timothy J. E. Miller, "Reactive power control in electric systems", Wiley edition, August 2010
3. Albert Thumann, P.W, Plant Engineers and Managers Guide to Energy Conservation" TWI Press Inc, Terre Haute, 9th edition, 2008
4. Turner, Wayne C., "Energy Management Handbook", Lilburn, The Fairmont Press, 2001
5. Anthony J. Pansini, Kenneth D. Smalling, "Guide to Electric Load Management", Pennwell Pub,1998
6. Albert Thumann, "Handbook of Energy Audits", Fairmont Pr; 5th edition,1998
7. Howard E. Jordan, "Energy-Efficient Electric Motors and Their Applications", Plenum Pub Corp; 2nd edition 1994

Reference Books:

1. Jean-Claude Sabonnadi Are, "Low emission power generation technologies and energy management", John Wiley & Sons, August 2010
2. Ursula Eicker, "Low energy cooling for sustainable buildings", John Wiley & Sons, August 2010
3. Francois, Leveque, "Transport pricing of electricity networks", Springer 2003.
4. Giovanni Petrecca, "Industrial Energy Management: Principles and Applications", The Kluwer international series -207,1999 Springer 2000.
5. Parasiliti F., P. Bertoldi, "Energy Efficiency in motor driven systems", Springer, 2003.
6. Donald R. W., "Energy Efficiency Manual", Energy Institute Press,2000
7. Petrecca, Giovanni, "Industrial Energy Management", Springer 1993
8. IEEE Bronze Book- "Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities", IEEE Inc, USA.,1985
9. NESCAP-Guide Book on Promotion of Sustainable Energy Consumption

Paper Name: Electrical Drives Laboratory
Paper Code: EE791
Contact: 0L:0T:2P
Credit: 1

Prerequisite: Concept of Electrical Machines and Power Electronics.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Apply power electronic converters for motor speed control.
CO2. Analyze the characteristics of electric motors for different type of loads.

CO-PO Mapping:

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

List of Experiments:

1. Study of Thyristor controlled DC Drive using Matlab/PSIM
2. Study of Chopper fed DC Drive using Matlab/PSIM
3. Study of AC Single phase motor-speed control using TRIAC.
4. Speed Control DC Motor Using BJT H- Bridge Simulation Using Matlab.
5. Three Phase Permanent Magnet Synchronous Motor Drive Simulation Using Matlab.
6. PWM Inverter fed three-phase Induction Motor control.
7. Three Phase Voltage Source Converter with Space Vector PWM simulation using Matlab/PSIM.
8. CSI fed Induction motor Drive analysis Matlab/PSIM
9. Study of V/f control operation of three-phase induction motor drive.
10. Study of permanent magnet synchronous motor drive fed by PWM Inverter.
11. Regenerative or Dynamic braking operation for DC Motor and AC Motor.
12. AC and DC Drive Applications using PLC.
13. Introduction to Industrial Automation.

Paper Name: Computer-Aided Electrical Drawing Laboratory
Paper Code: EE792
Contact: 0L:0T:3P
Credit: 1.5

Prerequisite: Basic Electrical Engineering, Fundamentals of static and dynamic machines, concepts of power systems.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Read electrical drawing for any system to understand the working of the system and its components.

CO2. Find the important points in the circuit diagrams or layout for troubleshooting and maintenance.
CO3. Use graphic software to draw the circuit for various types of electrical systems.

CO-PO Mapping:

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

List of Experiments (At least *ten* experiments to be performed):

1. Necessity and its application in Engineering Field and familiarization with designing software like AUTOCAD and Automation studio.
2. Awareness of different operating functions and command in AUTOCAD and Automation Studio.
3. To draw a sheet of electrical symbols for representation of Electrical machines, Equipment, accessories, switching and protection equipment.
4. Draw figures of different electrical equipment and simple electrical circuits (as instructed by the supervisor).
5. To draw different circuit combination of the experiments performed in machine and power system laboratories.
6. To draw the internal view of DC as well AC motors.
7. To draw the internal view of 3 phase transformer.
8. To draw the circuit of a simple layered power electronic circuit (as per the sample provided by the supervisor).
9. To draw a plan for simple power distribution system with 3 Alternators.
10. To draw electrical wiring with accessories on a single storied building (2 BHK) plan, showing Energy meter, Main switch, Distribution Board, Light points, Socket outlets etc.
11. Schematic diagram for a 3-phase induction motor control circuit operated with DOL starter at different location.
12. Complete wiring diagram of the previous drawing (showing overload and short circuit protection).
13. Innovative Experiments.

4th Year 8th Semester								
Sl. No.	**Category**	**Paper Code**	**Subject**	**Contact Hours/Week**				**Credit Points**
				L	**T**	**P**	**Total**	

A. Theory								
1	PEC	EE801	E. Renewable Energy Management and sustainability F. Electrical and Hybrid Vehicles G. Finite Element analysis for Electrical Machines H. Robotics and Control	3	3	0	3	3
2	PEC	EE802	E. Restructured Power Systems F. High Voltage Engineering G. Illumination Engineering H. Power System Operation and Control	3	0	0	3	3
3	OEC	EE803	E. Bio-Medical Instrumentation F. Blockchain G. Image Processing H. 3D Printing and Design	2	0	0	2	2
B. Practical								
4	PROJ	PR891	Major Project – II	0	0	0	12	6
5	PROJ	PR892	Grand Viva	0	0	0	0	1
C. Mandatory Activities / Courses								
6	MC	MC801	Essence of Indian Knowledge Tradition	3	0	0	3	0
Total of Theory, Practical and Mandatory Activities / Courses without MOOC Courses							**24**	**15**

Paper Name: Renewable Energy Management and sustainability
Paper Code: EE801A
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisites: Concept of Non-Conventional Energy, and Utilization of Electrical Energy.

Course Outcome: After successful completion of the course students will be able to

CO1. Ability to develop thorough understanding of Renewable energy resources like solar energy, wind energy, tidal energy etc.
CO2. Ability to apply skills and knowledge and demonstration of specialized competencies in Energy System Analysis, Renewable Energy Technology, Advanced Energy Technologies, Energy Management and Efficiency, etc.
CO3. Ability to develop and implement original and creative ideas to ensure qualitative Energy Management and Sustainable Development.

CO-PO Mapping:

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

Course Content

Module 1: Energy Scenario and Development **3L**
Overview of world energy scenario, India's energy scenario, Energy and development linkage, Energy Sources: classification of energy sources, Quality and concentration of energy sources.

Module 2: Major Energy Resources **7L**
Energy resources, Energy conversion processes and devices, Energy conversion plants, Conventional - Thermal, Hydro, Nuclear fission, and Non – conventional – Solar, Wind Biomass, Fuel cells, Magneto Hydrodynamics and Nuclear fusion, Energy from waste, Energy plantation.

Module 3: Energy Management **7L**
Definitions and significance of Energy Management, Objectives, Characterising of energy usage Energy Management program, Energy strategies and energy planning, Energy Audit – Types and Procedure, Optimum performance of existing facilities, Energy management control systems, Computer applications in Energy management.

Module 4: Energy Conservation Opportunities **7L**
Energy conservation, Principles, Energy economics, Energy conservation technologies, Cogeneration, Waste heat recovery, Combined cycle power generation, Heat Recuperators, Heat regenerators, Heat pipes, Heat pumps, Pinch Technology. ECOs in residential and commercial buildings, Energy Conservation Measures.

Module 5: Energy and the Environment **4L**
Environment and social concerns related to energy utilization, The greenhouse effect, Global Warming and its effect, Pollution, Acid Rains, Global Energy and environment Management.

Module 6: Sustainability Issues of energy use **8L**
Externalities, Future Energy Systems, Clean Energy Technologies, Socioeconomical aspects of Energy resources, Socio-economic impacts in Rural development, Poverty alleviation, Employment; Security of supply and use, Environmental and ethical concerns.

Text Books:

1. Rai G. D., Non-conventional Energy Sources, Khanna Publishers, 2011.
2. Doty S. and W. C. Turner, Energy Management Hand book, 7/e, Fairmont Press, 2009.
3. Rao S. and B. B. Parulekar, Energy Technology, Khanna Publishers, 2005.

Reference Books:

1. Amlan Chakrabarti, Energy Engineering and Management, Prentice Hall India, 2011.
2. Eastop T. D. and D. R. Croft, Energy Efficiency for Engineers & Technologists, Longman, 1990.
3. Albert Thumann P. E. and W. J. Younger, Handbook of Energy Audits, Fairmont Press, 2008.
4. Doty S. and W. C. Turner, Energy Management Hand book, 7/e, Fairmont Press, 2009.
5. Rao S. and B. B. Parulekar, Energy Technology, Khanna Publishers, 2005.

Paper Name: Electrical and Hybrid Vehicles
Paper Code: EE801B
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisites: Concept of Power Electronics.

Course Outcome: After successful completion of the course students will be able to

CO1. Explain basic terminologies associated with vehicle dynamics, schemes for energy storage and propulsion.

CO2. Demonstrate different drive train topologies and power converter topologies for EVs.

CO-PO Mapping:

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

Course Content

Module 1: Introduction **6L**

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies, HEV, Series HEV, Parallel HEV, FCEV.

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics.

Module 2: Vehicle Dynamics **4L**

Basic Power, Energy, Torque, Speed relationships, Gross vehicle weight, Aerodynamic Drag, Rolling resistance, Gradient resistance, traction power, traction force, concept of drive cycle.

Module 3: Electric and Hybrid Drive Trains **7L**

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency.

Module 4: Electric Propulsion unit **6L**

Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives.

Module 5: Energy Storage **6L**

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage, Fuel Cell based energy storage, Super Capacitor based energy storage, Flywheel based energy storage, Hybridization of different energy storage devices.

Module 6: Power Electronics for EVs **7L**

Basics of Electric vehicle charging infrastructure, Types of charging, V2G and G2V mode of operations, Their advantages and disadvantages, brief introduction to bidirectional power converters for EV battery charging – discharging.

Text Books:

1. Iqbal Hussain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press, Second Edition, 2011.
2. Mehrdad Ehsani, Yimin Gao, and Ali Emadi, "Modern Electric, Hybrid and Fuel Cell Vehicles: Fundamentals", CRC Press, 2010.

Reference Books:

1. Chris Mi, MA Masrur, and D W Gao, “Hybrid Electric Vehicles- Principles and Applications with Practical Perspectives”, Wiley, 2011.

Paper Name: Restructured Power System
Paper Code: EE802A
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisites: Engineering Mathematics, Fundamentals of Power System Operation.

Course Outcome: After successful completion of the course students will be able to

CO1. Understand the need for restructuring of Power Systems, discuss different market models, different stakeholders and market power.

CO2. Understand and generalize the functioning and planning activities of Independent System Operator (ISO) and to define ancillary services and understand reactive power as ancillary service.

CO3. Understand transmission open access pricing issues and congestion management, define transfer capability and estimate the transfer capability.

CO-PO Mapping:

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

Course Content

Module 1: Introduction to restructuring of power industry 4L

Introduction, Reasons for restructuring / deregulation of power industry, Understanding the restructuring process, Introduction to issues involved in deregulation, Reasons and objectives of deregulation of various power systems across the world.

Module 2: Power System Operation 8L

Introduction, need for operational reliability, value of reliability, cost of reliability, procuring reliability resources, operational issues, balancing resources, effect of generation from stochastic renewable sources, limits on power transfer, voltage control and reactive support, stability services, system restoration, market models, obtaining reliability resources, market for reliability resources, buying reliability resources, co-optimization of energy and reserve in a centralized electricity market, allocation of transmission capacity between energy and reserve, allocating the costs, who should pay for reserve, selling reliability resources.

Module 3: Transmission Congestion Management 6L

Introduction, Classification of congestion management methods, Calculation of ATC, Non-market methods, Market based methods, Nodal pricing, Price area congestion management, Capacity alleviation method.

Module 4: Pricing of transmission network usage and loss allocation 6L

Introduction to transmission pricing, Principles of transmission pricing, Classification of transmission pricing methods. Attributes of a perfectly competitive market, The firm's supply decision under perfect competition, Imperfect competition, Market power.

Module 5: Investing in Transmission 6L

Nature of transmission business, cost based transmission expansion, allocating the cost of transmission, optimal transmission capacity, effect of load fluctuation, load duration curve, the transmission demand function.

Text Books:

1. 1.Daniel Kirschen and Goran Strbac, “Fundamentals of Power System Economics”, John Wiley & Sons Ltd, 2004.
2. Jin Zhong, Power System Economics and Market Operations, CRC Press
3. Jeremy Lin Fernando H. Magnago, Electricity Markets Theories and Applications, IEEE Press, Wiley.

Reference Books:

1. Sally Hunt, “Making competition work in electricity”, John Wiley & Sons, Inc., 2002.
2. Kankar Bhattacharya, Jaap E. Daadler, Math H. J. Bollen, “Operation of Restructured Power Systems”, Kluwer Academic Pub., 2001.

Paper Name: Illumination Engineering
Paper Code: EE802C
Contact: 3L:0T:0P

Total Contact Hours: 36
Credit: 3

Prerequisites: Concept of Physics, Basic Electrical Engineering.

Course Outcome: After successful completion of the course students will be able to

CO1. Understand the fundamental concept of illumination and its measurements with different apparatus.
CO2. Understand the characteristics of various types of lamp with their accessories and their control circuits.
CO3. Apply the concept of different lighting scheme for interior and exterior lighting design.

CO-PO Mapping:

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

Course Content

Module 1: Fundamentals of Light **5L**

Types of illumination, Theory of gas discharge and production of light, Perception of light and colour, Radiation of energy, Electromagnetic radiation and Electromagnetic spectrum, Human eye as an optical system, Spectral sensitivity of human eye, Visual characteristics and Visual performance.

Module 2: Measurement of Light **7L**

Definition of luminous flux, Luminous intensity, Lumen, Candle power, Illumination, M.H.C.P, M.S.C.P, M.H.S.C.P, Lamp efficiency, Brightness or luminance, Photometry – Fundamentals of detector, Application of Polar Photometer and Goniophotometer, Calculation of luminance and illumination, Luxmeter, CIE standard source of illuminant, Colorimetry –Source colour and Object colour. Colorimetric instrument, Colour rendering index.

Module 3: Lamp, Accessories and Luminaries **9L**

Lamp materials – glass, filament, phosphor coating, ceramics, electrodes, gases, capping cement etc., Theory and basic properties of low and high pressure gas discharge. Theory of operation, Life, Characteristics and Application of - High and Low pressure sodium vapour, High and Low pressure mercury vapour, Metal halide, Fluorescent lamp, LED, LASER, Luminaire – Types of luminaire, Design consideration, Indian standard recommendation.

Module 4: Illumination Control and Control circuits **6L**

Purpose of lighting control in view of energy conservation, Operation of Electromagnetic and Electronic ballast and their comparison in light control, Function of Ignitor in lamps, Control circuits and operation of Fluorescent lamp circuit, Low pressure sodium vapour lamp circuit, High pressure sodium vapour lamp circuit.

Module 5: Interior Lighting **6L**

National standards of interior lighting calculation, Design considerations for interior lighting of Residential complex, Commercial complex, Industrial premises, Day lighting – Sky luminance pattern, Daylight factor, estimation of average daylight factor, window design considerations for

maximum day lighting, Application of daylight in interior lighting, Use of photocell, occupancy sensor in lighting controls, Concept of Isolux contour in lighting design.

Module 6: Exterior Lighting 3L

Lighting calculations of exterior lighting, Calculation of lighting and design considerations for exterior lighting of Road lighting, Flood lighting, Industrial complex, Commercial complex, Sports complex, National and CIE standards of exterior lighting calculation.

Text Books:

1. Generation, Distribution and Utilization of Electrical Energy, C.L. Wadha, New Age International Ltd.
2. Applied Illumination Engineering, Jack L. Lindsey, The Fairmont Press Inc.
3. Art and Science of Utilization of Electrical Energy, H. Partab, Dhanpat Rai & Sons.
4. Standard Hand Book for Electrical Engineers, Fink & Beaty, McGraw Hill International.

Reference Books:

1. Utilization of Electric Power, C.L. Wadha, New Age International Ltd.
2. Handbook of Applied Photometry, Casimer M Decusatis, Springer.
3. Light Engineering: Applied calculations, R.H. Simons, Robert Bean, Architectural Press.

Paper Name: Power System Operation and Control
Paper Code: EE802D
Contact: 3L:0T:0P
Total Contact Hours: 36
Credit: 3

Prerequisites: Engineering Mathematics, Basic Electrical Engineering, Power System.

Course Outcome: After successful completion of the course students will be able to

CO1. To get an overview of system operation and control.
CO2. To understand & model power-frequency dynamics and to design power-frequency controller.
CO3. To acquire knowledge on the reactive power-voltage and different methods of control for maintaining voltage profile against varying system load.
CO4. To Design SCADA and its application for real time operation.

CO-PO Mapping:

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

Course Content

Module 1: Introduction
5L
Power scenario in Indian grid – National and Regional load dispatching centers –necessity of voltage and frequency regulation - real power vs frequency and reactive power vs voltage control loops - system load variation, basic concepts of load dispatching, Basics of speed governing mechanisms and modeling - speed load characteristics - regulation of two generators in parallel

Module 2: Real Power - Frequency Control 7L
Load Frequency Control (LFC) of single area system-static and dynamic analysis of uncontrolled and controlled cases - LFC of two area system - tie line modeling - block diagram representation of two area system - static and dynamic analysis - tie line with frequency bias control

Module 3: Control of Voltage and Reactive Power
8L
Generation and absorption of reactive power - basics of reactive power control – Automatic Voltage Regulator (AVR) – brushless AC excitation system – block diagram representation of AVR loop - static and dynamic analysis, voltage drop in transmission line - methods of reactive power injection - tap changing transformer, SVC (TCR + TSC) and STATCOM for voltage control.

Module 4: Economic Operation of Power System
7L
Statement of economic dispatch problem - input and output characteristics of thermal plant - incremental cost curve - optimal operation of thermal units without and with transmission losses Unit Commitment (UC)- constraints on UC problem, solution of UC problem using priority list.

Module 5: Computer Control of Power Systems

9L

Need of computer control of power systems-concept of energy control centers and functions – PMU - system monitoring, data acquisition and controls - System hardware configurations - SCADA and EMS functions - state estimation problem – measurements and errors.

Text Books:

1. S. Sivinagaraju and G. Sreenivasan “Power System Operation and Control” Pearson Publications.
2. Abhijit Chakrabarti and Sunita Halder, “Power System Analysis Operation and Control”, PHI learning Pvt. Ltd., New Delhi, Third Edition, 2010.
3. Allen. J. Wood and Bruce F. Wollen Berg, ‘Power Generation, Operation and Control’, John Wiley & Sons, Inc., 2016

Reference Books:

1. Dr. K, Uma Rao “Power System Operation and Control”. Wiley Publications.
2. Olle. I. Elgerd, Patrick D.van der Puije “Electric Power Engineering”, McGraw Hill Education Pvt. Ltd., New Delhi, 34th reprint, 2010.
3. Yao-nan Yu “Electric Power System Dynamics”, Academic Press.

Paper Name: Bio-Medical Instrumentation
Paper Code: EE803A
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisites:

1. To have the basic knowledge about the principles behind sensors and transducers.
2. To have the knowledge about Operational Amplifiers.
3. To have the basic knowledge about the working principles of various measuring instruments.

Course Outcome: After successful completion of the course students will be able to

CO1. Understand the origin of bio potentials and its propagations
CO2. Understand the different types of electrodes and its placement for various recordings
CO3. Design bio amplifier for various physiological recordings
CO4. Analyze the different measurement techniques for non-physiological parameters

CO-PO Mapping:

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

Course Content

Module 1: Introduction **3L**

Introduction to biomedical instrumentation: Category of measurement, factors in making measurement, biometrics, problems encountered in measuring a living system.

Module 2: Bio potential Measurements **7L**

Bio potential Electrodes: Half-cell potential, offset voltage. Types of External, Internal and Microelectrodes. Electrochemical transducers. Potentiometric sensors, Ampero-metric sensors, Electro-Chemical gas sensors. Biosensors – Enzyme–based biosensors, immuno sensors, microbial sensors.

Module 3: Signal Conditioning Circuits **8L**

Need for bio-amplifier – single ended bio-amplifier, differential bio-amplifier, Impedance matching circuit, isolation amplifiers – transformer and optical isolation – isolated DC amplifier and AC carrier amplifier., Power line interference, Right leg driven ECG amplifier, Band pass filtering.

Module 4: Medical display devices and recorders **7L**

Basic requirements for the display and recording of biopotential signals. PMMC writing systems, General features of ink-jet, thermo-sensitive and optical recorders, Oscilloscopes- Medical, multi-beam & non-fade display systems.

Module 5: EEG **7L**

EEG- Block diagram & circuits, electrode placement, Evoked potentials and their measurement. EMG-Block diagram & circuits, electrode placement, Nerve conduction velocity determination, EMG stimulators.

Text Books:

1. Handbook of Biomedical Instrumentation by R. S. Khandpur, Tata McGraw Hill
2. Introduction to Biomedical Technology by J. J. Karr & J. M. Brown
3. Medical Instrumentation by J. G. Webste

Reference Books:

1. Biomedical Engineering Handbook by J. D. Bronzino
2. John G. Webster, Medical Instrumentation Application and Design, 4th edition, Wiley India Pvt Ltd,New Delhi, 2015.
3. Joseph J. Carr and John M. Brown, Introduction to Biomedical Equipment Technology, Pearson Education, 2004.
4. Myer Kutz, Standard Handbook of Biomedical Engineering and Design, McGraw Hill Publisher, 2003

Paper Name: Blockchain
Paper Code: EE803B
Contact: 2L:0T:0P
Total Contact Hours: 24
Credit: 2

Prerequisite: Distributed Systems, Computer Networks, Cryptography, Python Programming Language, and Cloud computing.

Course Outcome: After successful completion of the course students will be able to

CO1. Understand the basic concepts of blockchain and it's architectures.
CO2. Analyze different issues in the domain of blockchain and understand the practical applications of blockchain.
CO3. Evaluate and analyze different solutions for the real life problems related to the blockchain.
CO4. Apply the concepts of blockchain to design large scale distributed and secure data storage systems.

CO-PO Mapping:

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

Course Content

Module 1: Centralized versus Distributed Systems 6L
Client-Server Model, Distributed System, P2P Network Model, Distributed Database, Two General Problem in distributed database, Byzantine General problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete.

Module 2: Security, Trust and Privacy 6L
Confidentiality; Integrity; Availability; Authentication; Authorization; Access Control; Accounting; Non Repudiation, Symmetric Key and Asymmetric Key Cryptography, Hash function, Merkle tree hash, Digital Signatures – RSA, Schnorr, and ECDSA, Memory Hard Algorithm, Zero Knowledge Proof, User privacy.

Module 3: Fundamentals of Blockchain 6L
Introduction, Benefits over traditional distributed database, BlockchainNetwork, Data structure of block, Block construction and addition, Block mining mechanisms, Merkle Pa-tricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain policy, Real-time application of Blockchain, Soft & Hard Fork, Private, Public, and Consortium blockchain.

Module 4: Consensus algorithms in Blockchain 9L

Distributed Consensus, Nakamoto consensus, Proof ofWork (PoW), Proof of Stake (PoS), Proof of Burn (PoB), Delegated Proof of Stake (DPoS), Byzantine Fault Tolerance (BFT), Practical Byzantine Fault Tolerance (PBFT), Ripple Protocol Consensus Algorithm (RPCA), Difficulty Level, Sybil Attack, Energy utilization and alternate.

Module 5: Cryptocurrency and Blockchain Applications 9L

History, Distributed Ledger Technology (DLT),Bitcoin protocols - Mining strategy and rewards, Ethereum - Construction, DAO, Smart Contracts and Distributed Applications (Apps), GHOST, Vulnerability, Attacks, Sidechain, Namecoin, Stakeholders, Roots of Bitcoin, Legal Aspects - Cryptocurrency Exchange, Black Market and Global Economy, Application of Blockchain in Finance and Banking, Energy trading, Internet of Things (IoV, IoD, IIoT, Smart city, Smart Home, and so on), Medical Record Management System, Real estate business, Entertainment, Future scope of Blockchain.

Text Books:

1. Roger Wattenhofer, Distributed Ledger Technology: The Science of the Blockchain, Second Edition, 2017.
2. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryp-tocurrencyTechnologies: A Comprehensive Introduction, Princeton University Press, 2016.
3. Andreas M. Antonopoulos, Mastering Bitcoin: Unlocking Digital Cryptocurrencies, O'Reilly Publication House, 2014.

Reference Books:

1. Melanie Swan Blockchain: Blueprint for a new Economy, O'Reilly Publication House, 2015.
2. Andreas M. Antonopoulos and Dr. Gavin Wood, Mastering Ethereum Building Smart Contracts and DApps, O'Reilly Publication House, First Edition, 2018.

Paper Name: Image Processing
Paper Code: EE803C
Contact: 3L:0T:0P
Total Contact Hours: 30
Credit: 3

Prerequisite: Digital Signal Processing.

Course Outcomes: After successful completion of the course, student will be able to

CO1. Familiarize with Digital Image characteristics, its representation in different domain.
CO2. Analyze digital image enhancement techniques in spatial and frequency domain.
CO3. Aanalyze the performance of image compression, segmentation and security.
CO4. Aapply image processing algorithms in different applications and solve problems.

CO-PO Mapping:

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

Course Content

Module 1: Digital Imaging Fundamentals and Transform of Digital Images 8L

Digital Imaging Fundamentals: Basic idea of Digital image, Pixel, Mathematical operation of Digital Image, Sampling, Quantization, application of digital Image Processing.

Transform of Digital Images: Importance of Digital Image Transform, Fourier Transform of Digital Image (DFT), Inverse Fourier Transform (IDFT), Application of Digital Image Transform in different area

Module 2: Digital Image Enhancement 8L

Importance of Digital Image enhancement, enhancement in spatial and frequency domain, Bit plane slicing, Histogram, Histogram Equalization, Mean and Median filtering in Digital Images, Frequency domain filtering in Digital Images – LPF, HPF and BPF.

Module 3: Digital Image Compression 8L

Importance of Digital Image Compression, Types of Image Compression, example of lossless and lossy compression, Image compression standards, Compression in spatial domain, compression using Huffman coding, Filter Bank analysis Segmentation of Digital Images: Importance and applications of Image Segmentation, Thresholding, Segmentation based on Region Growing, Watershed algorithm. Edge detection in Digital Image Processing: Importance of Edge detection in Digital Image Processing, Types of Edge Detection, Mathematical Equation of each operator.

Module 4: Security in Digital Image Processing 6L

Importance of Digital Image Security, Watermarking, Image encryption in spatial and frequency domain, Steganography. Application of Artificial Intelligence/ Machine Learning in Image and Video Processing

Text Books:

1. Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing", Third Edition, Pearson Education,2010.
2. S. Annadurai, R. Shanmugalakshmi, "Fundamentals of Digital Image Processing", Pearson Education,2006
3. Digital Video processing, A Murat Tekalp, Prentice Hall

Reference Books:

1. Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using MATLAB", Third Edition Tata Mc Graw Hill Pvt. Ltd.,2011.
2. Anil Jain K. "Fundamentals of Digital Image Processing", PHI Learning Pvt. Ltd., 2011.
3. Willlliam K Pratt, "Digital Image Processing", John Willey,2002.
4. Malay K. Pakhira, "Digital Image Processing and Pattern Recognition", First Edition, PHI Learning Pvt. Ltd.,2011.