Course Curriculum (in light of NEP 2020) for B. Tech.

In

Electrical Engineering

(For students admitted in 2022-23 onwards)

National Institute of Technology
Arunachal Pradesh

P.O.: Jote, Dist.: Papumpare, Arunachal Pradesh, Pin–791113
www.nitap.ac.in

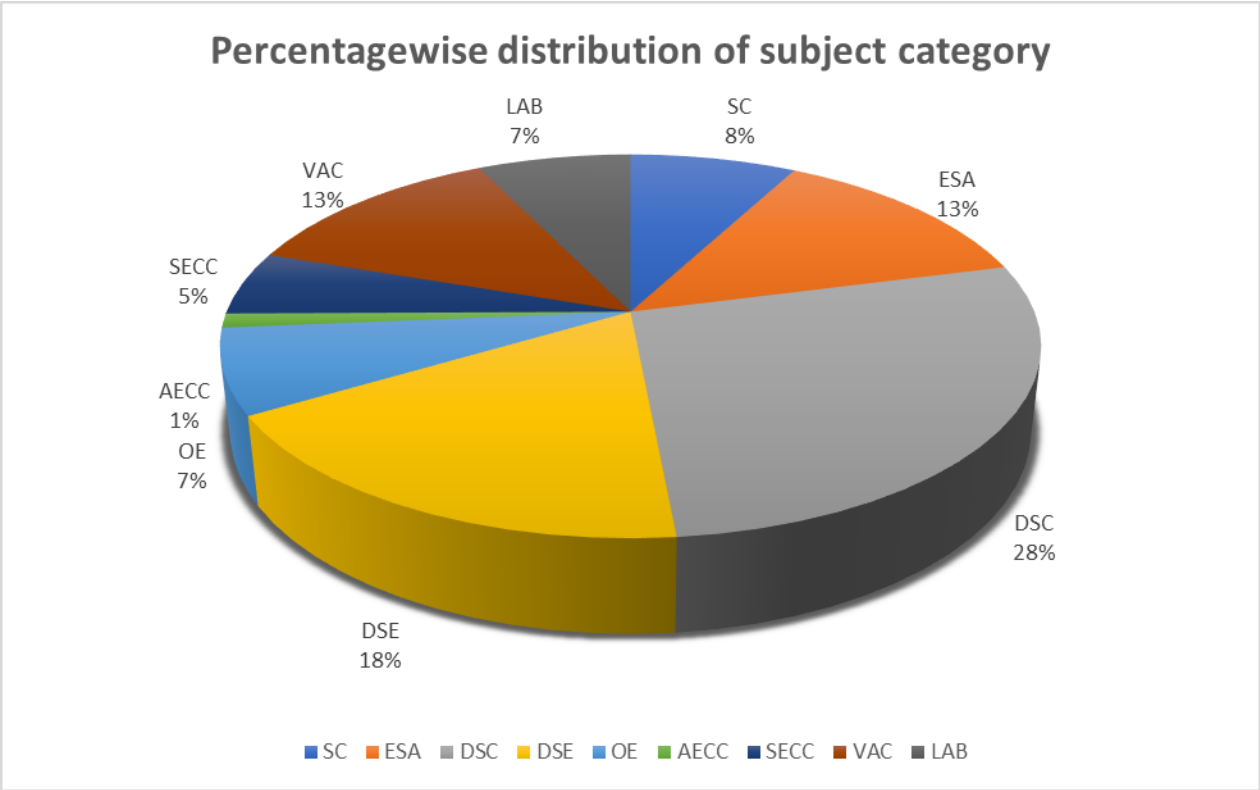
1.0 Semester wise Credit point distribution

Sl. No.	Year	Credit Point	
		ODD	EVEN
1	First	22	22
2	Second	21	21
3	Third	24	23
4	Fourth	20	17
Total Credit Point		**87**	**83**
		170	

1.1 Subject Category wise Credit point Distribution

Course Category	Sem-I	Sem-II	Sem-III	Sem-IV	Sem-V	Sem-VI	Sem-VII	Sem-VIII	Total Credit Point
Science Core (SC)	7	3	3	0	0	0	0	0	13
Engineering Science and Arts (ESA)	8	14	0	0	0	0	0	0	22
Departmental Specific Core (DSC)	4	3	9	9	9	9	3	0	46
Departmental Specific Elective (DSE)	0	0	3	3	3	6	9	6	30
Open Elective (OE)	0	0	3	3	3	3	3	0	15
Ability Enhancement Compulsory Course (AECC)	0	0	0	0	1	0	1	0	2
Skill Enhancement Compulsory Course (SECC)	3	0	0	3	3	0	0	0	9
Value Added Course (VAC)	0	2	0	0	2	2	4	11	21
Laboratory (LAB)	0	0	3	3	3	3	0	0	12
Total Credit Point	**22**	**22**	**21**	**21**	**24**	**23**	**20**	**17**	**170**

1.2 Subject Category wise Credit point Distribution (in percentage)



2.0 Course Structure

I[st] Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	BS-1101	SC1 - Engineering Mathematics-I	2	0	0	2
2	BS-1102	SC2 - Engineering Chemistry	2	0	0	2
3	BS-1103	SC3 - Engineering Physics	2	0	0	2
4	BT-1101	ESA1 - Biology for Engineers	2	0	0	2
5	EE-1101	DSC1 - Fundamentals of Electrical Engineering	3	0	0	3
6	MH-1101	SECC1 - Communication Skill	2	0	0	2
7	EE-1102	ESA2 - Basic of Electrical and Electronics Engineering	2	0	0	2
8	CS-1102	ESA3 - Coding Laboratory	0	0	4	2
9	EE-1103	ESA4 - Basic of Electrical and Electronics Engineering Laboratory	0	0	2	1
10	BS-1104	SC4 - Engineering Physics Laboratory	0	0	2	1
11	ME-1102	ESA5 - Engineering Drawing	0	0	2	1
12	EE-1104	DSC2 - Fundamentals of Electrical Engineering Laboratory	0	0	2	1

13	MH-1102	SECC2 - Language Laboratory	0	0	2	1
14	MH-1103	VAC1 - NSS/NCC/Yoga (Audit Pass)	0	0	0	0
Contact Hours			15	0	14	
Total Credits						22
IInd Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	BS-1201	SC5-Engineering Mathematics-II	2	0	0	2
2	CS-1201	ESA6-Programming and Data Structure	3	0	0	3
3	EC-1201	ESA7-Introduction to Digital engineering	2	0	0	2
4	MH-1201	ESA8-Introduction to Innovation and Creativity	2	0	0	2
5	ME-1201	ESA9-Engineering Mechanics	3	0	0	3
6	EE-1201	DSC3-Materials Science for Electrical Engineering	3	0	0	3
7	EE-1202	ESA10- System Design	2	0	0	2
8	ME-1204	ESA11-Workshop Practice-I	0	0	2	1
9	EE-1203	VAC2-Do It Yourself (DIY)/Industry Exposure	0	0	0	1
10	BS-1202	SC6- Engineering Chemistry Laboratory	0	0	2	1
11	CS-1202	ESA12-Programming and Data Structure Laboratory	0	0	2	1
12	MH-1202	VAC3-Gandhian Technology	0	0	2	1
Contact Hours			17	0	8	
Total Credits						22
IIIrd Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	BS-2101	SC7-Engineering Mathematics-III	3	0	0	3
2	EE-2101	DSC4-Electrical Circuit Analysis	3	0	0	3
3	EE-2102	DSC5-Electrical and Electronic Measurement	3	0	0	3
4	EC-2102	DSC6-Digital Logic Design	3	0	0	3
5	EE-210A	DSE1-Electromagnetic Field Theory	3	0	0	3
	EE–210B	DSE1-Electronic Circuits and Devices				
6	YY-210X	OE1*	3	0	0	3
7	EE-2103	Electrical Circuit Analysis Laboratory	0	0	2	1
8	EE-2104	Electrical and Electronic Measurement Laboratory	0	0	2	1
9	EC-2104	Digital Logic Design Laboratory	0	0	2	1
Contact Hours			18	0	6	
Total Credits						21
IVth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	EE-2201	DSC7-Electrical Machines-I	3	0	0	3
2	EC-2201	DSC8-Analog Circuits	3	0	0	3
3	EE-2202	DSC9-Power System -I	3	0	0	3

4	EC-220A	DSE2-Signals and Systems	3	0	0	3
	EE-220A	DSE2-Digital Signal Processing				
5	YY-220X	OE2*	3	0	0	3
6	MH-2201	SECC3-Entrepreneur Essential and Early Stage Start-up	3	0	0	3
7	EE-2203	Electrical Machine -I Laboratory	0	0	2	1
8	EE-2204	Power System -I Laboratory	0	0	2	1
9	EC-2204	Analog Circuits Laboratory	0	0	2	1
Contact Hours			18	0	6	
Total Credits						21

Vth Semester

Sl No	Course Code	Course Title	L	T	P	C
1	EE-3101	DSC10-Electrical Machines-II	3	0	0	3
2	EE-3102	DSC11-Power System - II	3	0	0	3
3	EE-3103	DSC12-Power Electronics	3	0	0	3
4	EC-310A	DSE3- Microprocessors and Interfacing	3	0	0	3
	EE-310A	DSE3- Embedded Systems				
5	YY-310X	OE3*	3	0	0	3
6	EE-3104	AECC1-Internship-I	0	0	0	1
7	MH-3101	SECC4-Engineering Economics	3	0	0	3
8	EE-3105	VAC4-Minor Project-I	0	0	4	2
9	EE-3106	Electrical Machines-II Laboratory	0	0	2	1
10	EE-3107	Power System-II Laboratory	0	0	2	1
11	EE-3108	Power Electronics Laboratory	0	0	2	1
Contact Hours			18	0	12	
Total Credits						24

VIth Semester

Sl No	Course Code	Course Title	L	T	P	C
1	EE-3201	DSC13-Electrical Drives	3	0	0	3
2	EE-3202	DSC14-Linear Control System	3	0	0	3
3	EE-3203	DSC15-Switchgear and Protection	3	0	0	3
4	EE-320A	DSE4-Utilization of Electrical Power	3	0	0	3
	EE-320B	DSE4:Energy Management and Auditing				
5	EE-321A	DSE5-Power System Operation and Control	3	0	0	3
	EE-321B	DSE5-HVAC Transmission Systems				
6	YY-320X	OE4*	3	0	0	3
7	EE-3204	VAC5-Minor Project-II	0	0	4	2
8	EE-3205	Electrical Drives Laboratory	0	0	2	1
9	EE-3206	Linear Control Systems Laboratory	0	0	2	1
10	EE-3207	Switchgear and Protection Laboratory	0	0	2	1

Contact Hours			18	0	10	
Total Credits						23
VIIth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	EE-4101	DSC16-Electrical Machine Design	3	0	0	3
2	EE-410A	DSE6-High Voltage Engineering	3	0	0	3
	EE-410B	DSE6-Advanced Control Systems				
	EE-410C	DSE6-Principles of Energy Conversion Systems				
3	EE-411A	DSE7-Renewable Energy Sources	3	0	0	3
	EE-411B	DSE7-Advanced Power Electronics				
	EE-411C	DSE7-Electrical Estimation and Costing				
4	EE-412A	DSE8-Power Plant Engineering	3	0	0	3
	EE-412B	DSE8-Distributed Generation				
	EE-412C	DSE8-Special Electrical Machines				
5	YY-410X	OE5*	3	0	0	3
6	EE-4102	AECC2-Internship-II	0	0	0	1
7	EE-4103	VAC6-Major Project-I	0	0	8	4
Contact Hours			15	0	6	
Total Credits						20
VIIIth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	EE-421A	DSE9-Grid Technology	3	0	0	3
	EE-421B	DSE9-Power Quality Improvements				
	EE-421C	DSE9-Load Forecasting				
	EE-421D	DSE9- SWAYAM COURSE				
2	EE-422A	DSE10-Internet of Things	3	0	0	3
	EE-422B	DSE10-Cloud Computing				
	EE-422C	DSE10-SWAYAM COURSE				
3	EE-4201	VAC7-Major Project-II	0	0	22	11
Contact Hours			6	0	12	
Total Credits						17

***The students of Dept. of EE have to choose a subject offered by other department as open elective.**

3.0 List of Department specific electives

DSE1	DSE2	DSE3	DSE4	DSE5	DSE6	DSE7	DSE8	DSE9	DSE10
EE-210A Electro magnetic Field Theory	EC-220A Signals and Systems	EC-310A Micro-processors and Inter facing	EE-320A Utilization of Electrical Power	EE-321A Power System Operation and Control	EE-410A High Voltage Engineer-ing	EE-411A Renewable Energy Sources	EE-412A Power Plant Engineer-ing	EE-421A Grid Techno-logy	EE-422A Internet of Things
EE–210B Electronic Circuits and Devices	EE-220A Digital Signal Process-ing	EE-310A Embedded Systems	EE-320B Energy Management and Auditing	EE-321B HVAC Trans-mission Systems	EE-410B Advanced Control Systems	EE-411B Advanced Power Electronics	EE-412B Distributed Generation	EE-421B Power Quality Improve-ments	EE-422B Cloud Computi ng
					EE-410C Principles of Energy Conversion Systems	EE-411C Electrical Estimation and Costing	EE-412C Special Electrical Machines	EE-421C Load Forecast-ing	

- **Students are urged to register for the electives given under DSE9 and DSE10 using the SWAYAM/NPTEL, etc. portal. Courses will be of completely student's choice and should be of at least of 12 weeks including tutorials which will be considered as 3 credit course.**

4.0 Open elective (offered by other departments)

- Students are free to choose any subjects of their interest offered as open electives by other department of the Institute.
- The total course has to be of 15 credits.
- During the beginning of the 3rd semester onwards, HoD of Department of Electrical Engineering will notify the specific subject offered as an open elective for other departments.

Open Electives (Offered by EE Dept. for other Departmental Students)

Sl No	Course Code	Course Title	L	T	P	C
1	EE-210X	OE1- Electrical Circuit Analysis	3	0	0	3
2	EE-220X	OE2- Power System	3	0	0	3
3	EE-310X	OE3- Electrical Machines	3	0	0	3
4	EE-320X	OE4-Linear Control System	3	0	0	3
5	EE-410X	OE5-Power Electronics	3	0	0	3
Contact Hours			15	0	0	15
Total Credits						15

5.0 Internship

- Internship - I: Student will go for internship during summer vacation (after 4th semester) for a period of 4 weeks. The assessment will be done on 5th semester
- Internship - II: Student will go for internship during summer vacation (after 6th semester) for a period of 4 weeks. The assessment will be done on 7th semester

6.0 Institute Vision

To transform into an acclaimed institution of higher learning with creation of an impact on the north eastern region in terms of innovation and entrepreneurship.

7.0 Institute Mission

1. To generate new knowledge through state-of-the-art academic program and research in multidisciplinary field.
2. To identify regional, Indian and global need to serve the society better.
3. To create an ambience to flourish new ideas, research and academic excellence to produce new leaders and innovators.
4. To collaborate with other academic, research institutes and industries for holistic growth of the students.
5. Utilization of available big resources to encourage entrepreneurship through formation of start-ups.

8.0 Departmental Vision

To excel in education, research and technological aspects of electrical engineering in accordance with the societal requirements.

9.0 Departmental Mission

- To impart state-of-the-art education and technological skills for producing globally competent electrical engineers with skilled ability to cater the needs of society.
- To enable industry oriented research and consultancy for providing solutions in energy sector.
- To enrich in the domain of sustainable technologies and progress to meet the rural demands.
- To nurture the temperament of engineering, human values and ethics and industrial collaboration.

10.0 Programme Outcomes (POs)

The students who have undergone B.Tech – Electrical Engineering programme will,	
PO1	Possess an ability to apply knowledge of mathematics and science in Electrical Engineering systems
PO2	Have an ability to provide solutions for Electrical Engineering problems by designing and conducting experiments, interpreting and analysing data, and reporting the results.
PO3	Be capable of comprehensive understanding of the entire range of electronic devices, analog and digital circuits with added state-of art knowledge on advanced electronic systems.
PO4	Possess knowledge and exposure on different power electronic circuits and drives for industrial applications.
PO5	Have an in-depth knowledge in transmission and distribution systems, power system analysis and protection systems to pursue a career in the power sector.
PO6	Possess a good knowledge in microprocessors/microcontrollers, data structures, computer programming and simulation software.
PO7	Be able to develop mathematical modelling, analysis and design of control systems and associated instrumentation for Electrical Engineering.
PO8	Be able to systematically carry out projects related to Electrical Engineering.
PO9	Have an ability to participate as members in various professional bodies as well as multidisciplinary design teams.
PO10	Be able to design and build renewable energy systems for developing clean energy and sustainable technologies.

PO11	Have confidence to apply engineering solutions with professional, ethical and social responsibilities.
PO12	Be able to excel in their professional endeavours through self-education.

11.0 Program Educational Objectives (PEOs)

PEO1	To train students into professional who can hold appropriate positions in the area of (i) Electrical Power (ii) Generation of electrical power by conventional and new energy resources for bulk use (iii) Power conditioning (iv) Utilization of power: Efficiency, Reliability, Conservation, Availability, Quality.(v) Transmission, Distribution and control (vi) Protection and safety (vii) Costing and audit (viii) System analysis (ix) Power electronics and controls (x) Linear control systems (xi) Data processing and computing (xii) Renewable energy (xiii) Electric Vehicles (xiv) Computational Intelligent Techniques.
PEO2	To train students for Engineering professions in various fields which include (i) Operation (ii) Maintenance (iii) Research and innovation (iv) Design (v) Manufacturing (vi) Services (vii) Testing (viii) Installation (ix) Planning (x) Academics (xi) Interdisciplinary (xii) Defence (xiii) Management (xiv) Entrepreneurship and to pursue higher studies in Core-Technical, Management, Software.
PEO3	To develop students with good human values and professional ethics to serve society through their core expertise and inculcate abilities for lifelong learning in the core area through fundamental domain knowledge and analytical skills.

12.0 Program Specific Outcomes (PSOs)

PSO1	Identify, formulate and analyse real-life electrical engineering problems by way of utilising the knowledge of mathematics, science and engineering principles.
PSO2	Design and develop sophisticated equipment and experimental systems for carrying out detailed investigation to multifaceted electrical engineering problems leading to reliable and feasible solutions for the same utilising all the available tools.
PSO3	Work as an electrical engineer who is capable of identifying solutions to various local and global problems faced by the society, up keeping a pollution free environment without compromising professional ethics and social values.

I[st] Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	BS-1101	SC1 - Engineering Mathematics-I	2	0	0	2
2	BS-1102	SC2 - Engineering Chemistry	2	0	0	2
3	BS-1103	SC3 - Engineering Physics	2	0	0	2
4	BT-1101	ESA1 - Biology for Engineers	2	0	0	2
5	EE-1101	DSC1 - Fundamentals of Electrical Engineering	3	0	0	3
6	MH-1101	SECC1 - Communication Skill	2	0	0	2
7	EE-1102	ESA2 - Basic of Electrical and Electronics Engineering	2	0	0	2
8	CS-1102	ESA3 - Coding Laboratory	0	0	4	2
9	EE-1103	ESA4 - Basic of Electrical and Electronics Engineering Laboratory	0	0	2	1
10	BS-1104	SC4 - Engineering Physics Laboratory	0	0	2	1
11	ME-1102	ESA5 - Engineering Drawing	0	0	2	1
12	EE-1104	DSC2 - Fundamentals of Electrical Engineering Laboratory	0	0	2	1
13	MH-1102	SECC2 - Language Laboratory	0	0	2	1
14	MH-1103	VAC1 - NSS/NCC/Yoga (Audit Pass)	0	0	0	0
Contact Hours			15	0	14	
Total Credits						22

Subject Name: Engineering Mathematics- I
Subject Code: BS 1101
Credit Value: 2 [P=0, T=0,L=2]

A. Course Objectives:

The course is designed to meet with the objectives of:

1. providing high quality education in pure and applied mathematics in order to prepare students for graduate studies or professional careers in mathematical sciences and related fields,
2. imparting theoretical knowledge and to develop computing skill to the students in the area of Science and Technology,
3. providing teaching and learning to make the students competent to their calculating ability, logical ability and decision-making ability,
4. giving students theoretical knowledge of Calculus, Algebra and the practical applications in the various fields of Science and Engineering,
5. apply their knowledge in modern industry or teaching, or secure acceptance in high-quality graduate program in Mathematics and other fields such as the field of quantitative /Mathematical finance, Mathematical computing, statistics and actuarial science.

B. Course Content:

Matrix Algebra: Basic concept of matrices & Determinant, Jacobi's theorem. Rank of a matrix, rank nullity theorem, Introduction to Vector space, Linear dependent and independent, System of homogeneous and non-homogeneous linear equations, Eigen values and Eigen vectors of a square matrix, Cayley-Hamilton theorem and its applications.

Differential Calculus: Higher order derivatives, Leibnitz's theorem and its application, Rolle's theorem and its application, Mean Value theorems–Lagrange & Cauchy and their application, Taylor's theorem and its application, Expansions of functions by Taylor's and Maclaurin's theorem. Partial Derivatives, Differential calculus for two variables.

Integral Calculus: Double and triple integrals and evaluation of area and volume, change of variables.

C. Text Books

1. Kreyszig E., Advanced Engineering Mathematics, John Wiley, 2010, 11th edition.
2. Grewal B. S., Higher Engineering Mathematics, Khanna Publishers, 2014, 43rd edition.
3. Marsden J., Tromba A. J. and Weinstein A., Basic Multivariable Calculus, Springer, India, Private Ltd, 2009.

D. Reference Books

1. Finney R. L. and Thomas G. B., Calculus and Analytical Geometry (Linear Algebra), Narosa Publishing House, 2021, 9th edition.
2. Hofmann K. M. and Kunze R., Linear Algebra, Prenticehall, 2015, 2nd edition,.
3. Bartle and Sherbart, Introduction to Real Analysis, Wiley, 2014, 4th edition.
4. Apostol T. M., Calculus,Vol I and II, John Wiley and Sons Ltd;, 2007, 2nd edition.
5. Stewart J., Transcendental Calculus, Cengage; 2014, 2nd edition,.
6. Mappa S. K., Higher Algebra, Shrat book House, 2014.
7. Mappa S. K., Real Analysis, Shrat book House, 2013, 7th edition.
8. Wylie C. R. and Barrett L. C., Advanced Engineering Mathematics, McGraw Hill, 1995.

E. Course Outcomes:

The outcomes of course are following:

1. Students will become more confident about their computing skill, logical skill and decision making skill,
2. Students will find various applications of calculus and algebra in the practical fields of science and engineering,
3. Students will become more competent to analyse mathematical and statistical problems, precisely define the key terms, and draw clear and reasonable conclusions,
4. Student will be able to explain the importance of mathematics and its techniques to solve real life problems and provide the limitations of such techniques and the validity of the results.

Subject Name: Engineering Chemistry
Subject Code: BS 1102
Credit Value: 2 [L=2, P=0, T=0]

A. Course Objectives:

1. To enable the students to acquire knowledge about basic chemistry and its technology.
2. To understand applicability of chemistry for engineering purposes.
3. To make them apply the knowledge of chemistry for analysis, evaluation and design system components or processes related to chemistry.

B. Course Content

Chemical thermo dynamics: first law, energy, enthalpy, Cp and Cv, second law, entropy, free energy, chemical kinetics: rate of elementary reactions, surface chemistry: surfactants and colloidal systems; electrochemistry: conductance, Kohlrausch's law, cell EMF.

Ligand, somerism, valence bond theory, valence shell electron pair repulsion theory, crystal field theory, molecular orbital theory, charge transfer transition, d-d transition, John-Teller effect, magnetic properties, bioinorganic chemistry.

Hybridization, inductive effect, resonance, hyper conjugation, carbocation, carbanion and free radicals, substitution and addition reactions, introduction to instrumental methods (IR, UV-vis, NMR and Mass-spectroscopy).

Polymers and materials: addition and condensation polymers, degree of polymerization, thermoplastic and thermosetting plastics, conducting polymers, nanomaterials and ceramics, nanocomposites, corrosion, explosive materials.

C. Text Books:

1. Morrison R. T., Boyd R. N. and Bhattacharjee S. K., Organic chemistry, Pearson education, New Delhi, 2010, 7th Ed.,.
2. Rakshit P.C., Physical chemistry, Sarat book distributors, Kolkata, 2004, 7th Ed.
3. Huheey J. E., Keiter E. A., Keiter R. L., Inorganic chemistry: principles of structure and reactivity, Pearson Education, New Delhi, 2009, 4th Ed..

D. Reference Books:

1. Ray B. C., Das S. N. and Biswas S., Engineering chemistry, New Central Book Agency, Kolkata, 2008.
2. Gowariker V. R, Viswanathan N. V and Sreedhar J., Polymer science, New Agency International, Kolkata, 2012.
3. Malik W. U., Tuli G. D. and Madan R. D., Selected topics in inorganic chemistry, S. Chand, New Delhi, 2012.

4. Ahluwalia V. K. and Parashar R. K., Organic reaction mechanisms,., Narosa publishing house, Kolkata, 2013, 4th Ed.

E. Course Outcomes:

After studying this course, students will be able to

1. acquire basic knowledge in engineering chemistry.
2. apply their knowledge for various technological and engineering issues.
3. select appropriate analysis, evaluation and methods for interpret the concern results.

Subject Code: BS-1103
Subject Name: Engineering Physics
Credit Point: 2 **(**L=2, T=0, P=0)

A. Course Objectives:
The course is designed to meet with the objectives of:

1. imparting theoretical & practical knowledge to the students in the area of engineering physics.
2. providing teaching and learning to make students acquainting with modern state-of-art of Engineering.
3. injecting the future scope and the research direction in the field of Physics with specific specialization.
4. making students competent to design & development of Engineering Physics.

B. Course Content:
Electricity and Magnetism:

Coulombs law in vector form, Electric field, Gauss's law (differential and integral form), Electric potential and energy, multipole expansion of electric potential, Boundary value problem (Poisson's Eqn. and Laplace's Eqn.). Dielectric, Polarization and Bound charges, Biot-Savart's law, Ampere's law (differential and integral form), Faraday's law of electromagnetic induction, Lenz's Law, Self and mutual Inductance, Maxwell'sfield equation in vacuum and matter.Wave solution of Electromagnetic waves.

Modern Physics and Quantum Mechanics:

Photo electric effect, Compton effect, Blackbody radiation (no derivations), Wave particle duality, two slit experiments, de-Broglie's hypothesis, Heisenberg's uncertainty principle, concept of wave function and wave packet**,** phase velocity and group velocity, Formulation of quantum mechanics and basic postulates, physical interpretation of wave function, Schrodinger's wave equation, Steady state of

Schrodinger's wave equation, One dimensional quantum problems:Free particle, particle in a box, particle in a step potential, harmonic oscillator.

C. **Text Books:**

1. Griffiths J. D, "Introduction to Electrodynamics," Pearson Education India Learning Private Limited, 2015, 4th edition.
2. Griffiths J. D, "Introduction to Quantum Mechanics," Pearson Education, 2015, 2nd edition,.
3. Beise, A., Mahajan, S. and Choudhury S. R., "Concepts of Modern Physics," McGraw-Hill Education, 2017, 7th edition.

D. Reference Books:

1. Krane K., "Modern Physics", Wiley, 2016.
2. Jackson, J. D. "Classical Electrodynamics", Wiley, 1998, 3rd edition.
3. Feynman R. P., Leighton R. B. and Matthew S., "The Feynman Lectures on Physics Vol. 1 to Vol. 3" The New Millennium Edition, 2012.

E. Course Outcomes:

Students successfully completing this module will be able to:

1. demonstrate competency and understanding of the basic concepts found in physics.
2. utilize the scientific method for formal investigation and to demonstrate competency with experimental methods that are used to discover and verify the concepts related to content knowledge.
3. engineering applications capability to understand advanced topics in engineering. apply quantum mechanics to engineering phenomena
4. identify formula and solve engineering problems.

Subject Code: BT1101
Subject Name: ESA1-Biology for Engineers
Credit Point: 2 (L=2, T=0, P=0)

A. Course Objectives:

1. Imparting knowledge on the origin of Earth and life forms on Earth, appreciating importance of biological diversity and understanding biomolecules being the main component of life.
2. Understanding "Cell" – the basic UNIT in different life forms, and structure and function of different organelles in living organisms.
3. Imparting knowledge on nutrient uptake and assimilation, and metabolism in living organisms, providing knowledge on Bioenergetics of living cells, different organelles involved in electron transport systems, nervous, digestive and immune systems in animals.

4. Imparting knowledge on immunity of the body and various advanced applications derived out of the natural systems.
5. Imparting knowledge on DNA as a genetic material and various advanced technology derived out of it for variety of applications.
6. Imparting knowledge on interference of biological systems in various machines, structures, process and instrumentation.
7. Motivating young minds to utilise their interdisciplinary knowledge to become a thinker in innovation of effective ideas for solving problems related to biological systems

B. Course Content:

Origin of Life: theories of origin of life, Classification of various forms of life (virus, bacteria, fungi, plantae, Animalia)
Nutrients and Bioenergetics: Essential nutrients (carbohydrates proteins, lipids, nucleic acids, minerals, vitamins), Bioenergetics; basics of aerobic and anaerobic glycolysis and citric acid cycle.
Cell: Cell concept, prokaryotic and eukaryotic cell, cell organelles and their functions, Cell division: Mitosis and meiosis, Cancer biology.
Genes and Chromosomes: Principles of inheritance, Mendelian Genetics, Discovery of DNA as genetic material, DNA mutation and effects, Basics of Genetic engineering and its applications.
Immunology: Immune systems and cell types.

C. Text Books:

1. H. Lodish, A. Berk, C. A. Kaiser, M. Krieger, A. Bretscher, H. Ploegh, K. C. Martin,
2. M. Yaffe, A. Amon, Molecular Cell Biology, 9th Edition, Macmillan Learning, 2021.
3. L. Nelson and M. M. Cox, Lehninger Principles of Biochemistry, 7th Edition, W. H. Freeman, 2017.
4. N. A. Campbell, J. B. Reece, Biology, 6th Edition, *Pearson,* 2002.
5. A.Wen, J. Punt and A. S. Stranford, Kuby Immunology, 7th Edition, W.H. Freeman, 2013.

D. Reference Books:

1. J. M. Berg, J. L. Tymoczko, L. Stryer, Biochemistry, 5th Edition, W. H. Freeman & Co Ltd, 2002.
2. P. S. Verma and V. K. Agarwal, Cell Biology, Genetics, Molecular Biology, Evolution and Ecology: Evolution and Ecology, 2006 Edition, S. Chand Publishing, 2006.
3. K. Sharma, Immunology: An Introductory Textbook, 2nd Edition, New Age International Private Limited, 2021.
4. Karp, J. Iwasa and W. Marshall, Karp's Cell and Molecular Biology, 9th Edition, John Wiley & Sons, 2020.

E. Course Outcomes:

1. Students will understand the characteristics of living organisms; appreciate the importance of diversity of life and their interaction with the environment.
2. Students will be able to explain the interrelationship between biomolecules and the living system, and influences of biomolecules upon the structure and function of intracellular components.
3. Students will have a broad knowledge on Bioenergetics of living cells; and a brief on important biological systems of animal.
4. Students will learn different functions of cell organelles, cell types and various positive and negative functional implications, development of new tools and kits from the knowledge of natural system.
5. Students will learn the basis of inheritance and introduction to technological aspects and varied applications and advanced tools to tackle medical complications
6. Students will learn the interference of biological systems in various machines, structures, process and instrumentation
7. Students will develop keen interest in applying basic engineering skills to solving problems related to biological systems through their concepts in biology

Subject Code: EE-1101
Subject Name: Fundamentals of Electrical Engineering
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To understand the structure and properties of different type of electrical circuits, networks and sources.
2. To apply different mathematical tools & techniques for analysing electrical networks.
3. To apply circuit analysis techniques to simplify electrical networks.
4. To solve problems of electrical circuits.

B. Course Content:

Electrical Machines: Concepts of AC and DC Machines, Basic Working Principles and types. Characteristics of Electrical Machines. Power Systems: Concepts of Generation, Transmission and Distribution. Single Line Diagram. Switchgear and Protection: Brief idea of Electrical Protection Systems, Insulators, Lightning Arrestors, Circuit Breakers, Isolators and Electromagnetic Relays.

Control Systems: Concepts of open-loop and closed loop control systems, transfer function, time response analysis. Electrical and Electronic Measurements: Calibrations of Instruments, PMMC and PMMI Instruments, Error Calculations. Power Electronics: Fundamentals of Power Electronic Switches, Working Principles and Characteristics. Basic concepts of Converters.

C. Text Books:

1. Theraja B.L., Theraja A.K., A Textbook of Electrical Technology, Vol 1 -4, S. Chand, 24th Edition, 2008.
2. Wadwa C. L., Electrical Power Systems, New Age Publications.

D. Reference Books:

1. Rajendra Prasad., Fundamentals of Electrical Engineering. Prentice Hall of India Pvt Limited, 3rd Edition, 2009
2. Wadhwa.C.L., Basic Electrical Engineering, New Age International (P) Limited, 2nd Edition, 2006.

E. Course Outcomes:

After completion of this course, the learners will be able to

1. describe different type of networks, sources and signals with examples.
2. explain different network theorems, coupled circuit and tools for solution of networks.
3. apply network theorems and different tools to solve network problems.

Subject Code: MH-1101
Subject Name: Communication skills
Credit Point: 2 (L=2, T=0, P=0)

A. Course Objectives:

The course is designed to meet the following objectives:

1. To increase the student's ability to improve and utilize the skills necessary to be competent communicator.
2. To enhance the students' linguistic understanding of his or her own communication behaviour.
3. To improve the students' communication skills in both social and professional contexts.
4. To enhance language proficiency and thereby the employability of budding engineers and technologists.

B. Course Content:

Fundamentals of Communication-Concept and Meaning, Process of Communication, Communication Channels, Importance of Communication, Role of Cross-cultural Communication, Communication Cycle, Objectives and Barriers of Communication(linguistic and semantic, psychological, physical, mechanical, cultural), Importance of Audience and Purpose, Types of Communication, Styles of Communication, Verbal and Nonverbal Communication, Comparing General Communication and Technical Communication, Role of Communication in Technology, Persuasive Skills, Negotiation Skills, Language Skills (listening, speaking, reading, writing),Listening-Types of Listening, Writing-Writing Formal Letters, Résumés, Reports, User Manuals, Emails and Blogs, Essentials of Grammar- Sentence

Formation, Common Errors and Misappropriations, Note Making, Oral and Poster Presentation Skills, Interview Skills and Etiquette, Language Usage in Social Media.

C. Text Books:

1. Salaria, R.S. and Kul Bhushun Kumar, Effective Communication Skills, Khanna Publishing, 2022.
2. Edwards, Vanessa Van. Cues: Master the Secret Language of Charismatic Communication, Penguin, 2022.
3. Kumar, Sanjay and Pushp Lata, Communication Skills: Workbook, Oxford University Press (OUP), 2018.
4. Mitra, Barun K. Personality Development and Soft Skills, Oxford University Press(OUP), 2016.

D. Reference Books:

1. Kumar, Sanjay and Pushpa Lata, English Language and Communication Skills for Engineers (as per AICTE Syllabus), Oxford University Press (OUP), 2018.
2. Raman, Meenakshi and Sangeeta Sharma, Technical Communication: Principles and Practice, Oxford University Press (OUP), 2017.
3. Quirk, Randolph, Sidney Greenbaum, Geoffrey Leech, Jan Svartvik. A Comprehensive Grammar of the English Language, Pearson Education India, 2010.

E. Course Outcomes:

By the end of this course you will be able to:

1. Display competence in oral, written, and visual communication.
2. Apply communication theories in various speech acts.
3. Practice the effective way of communication with good personality traits and etiquette.
4. Understand the process of communication and its effect on giving and receiving information.

Subject Code: EE-1102
Subject Name: Basic of Electrical and Electronics Engineering
Credit Point: 2 (L=2, T=0, P=0)

A. Course Objectives:

1. To understand the structure and properties of different type of electrical circuits, networks and sources.
2. To apply different mathematical tools & techniques for analysing electrical networks.
3. To apply circuit analysis techniques to simplify electrical networks.
4. To solve problems of electrical circuits.

B. Course Content:

Network Theorems: Formulation of network equations, Source transformation, Loop variable analysis, Node variable analysis. Superposition, Thevenin's, Norton's & Maximum power

transfer theorem and its application in three phase unbalanced circuit analysis. Solution of Problems with DC & AC sources.

Coupled circuits: 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.

AC Fundamentals: RMS Values, Average Values, Peak Factor, Crest Factor, Resonance. Power in purely resistive, inductive, capacitive, RL, RC and RLC Circuits.

Number Systems: Decimal, Binary, Octal, Hexadecimal systems, conversion of a number from one base to another, complements of number systems and its addition and subtraction, Introduction to logic gates.

Boolean Algebra: Theorems and operations, Boolean expressions and truth tables, Duality and inversion, multiplying out and factoring expressions, Exclusive-OR and equivalence operations, Positive and negative logic.

C. Text Books:

1. Theraja B. L., Theraja A.K., A Textbook of Electrical Technology Vol 1, Shree Hari Publications, 2021.
2. Morris Mano M., Digital Logic and Computer Design, Pearson Education India, First Edition, 2016.

D. Reference Books:

1. Kumar Anand, Fundamentals of Digital Circuits, Prentice Hall, 3rd Edition, 2014.
2. Salivahanan.S., Pravin Kumar.S., Digital Electronics, Vikas Publiashing House, First Edition, 2011.

E. Course Outcomes:

After completion of this course, the learners will be able to

1. describe different type of networks, sources and signals with examples.
2. explain different network theorems, coupled circuit and tools for solution of networks.
3. apply network theorems and different tools to solve network problems.
4. select suitable techniques of network analysis for efficient solution.
5. estimate parameters of two-port networks.

Subject Code: CS1102
Subject Name: Coding Laboratory
Credit Point: 2 (L=0, T=0, P=4)

A. Course Objectives:

1. The student will gain a thorough understanding of the fundamentals of C programming.
2. A student can code, compile and test C programs.
3. Could take Systems programming or Advanced C programming course.

4. Although this course does not deal with object-oriented programming methodology, it will assist the student build the required foundations to undertake a course in OOP.

B. Course Content:

Introduction: The von Neumann architecture, machine language, assembly language, high level programming languages, compiler, interpreter, loader, linker, text editors, operating systems, flowchart.

C Fundamentals: Introduction to C, Data types, Constants and variable declaration, Scope, Storage classes, Data input and output functions, Sample programs.

Operators & Expressions: Arithmetic, Relational, Logical, Bitwise operators, Conditional, Assignment, Library functions.

Decision making: Simple If statement, if-else statement, nested if else statement, Switch statement, nested switch, the operator, goto statement.

Decision making & branching: while statement, do-while statement, for statement.

Array: Declaration, Initialization and processing One-dimension array, Two-dimension array and multi dimension array and their operations.

String & pointer: String: Operation on String without using library function and using library function. Pointer: Declaration of pointer variables, accessing the variable by using pointer, pointer increment and decrement operator, pointer and array

Functions: Basic functions, function type, function with no argument & no return value, function with no argument but return value, function with argument & return value, Storage class identifier, Call by reference, Recursive function. Pointer to function.

Structure & Union: Defining a structure, accessing of structure variable, structure and array, array within structure. Nested structure, structure & functions, Pointer & structure, Unions, Enum.

File management system: Advantage of using file, Open, close, read, write in the files, Operation on files.

Dynamic memory Allocation: use of malloc, calloc, realloc, free. Library functions, Implementation of Linked list and their various operations.

The pre-processor: macro statements.

C. Text Books:

1. Kerninghan and Ritchie, The 'C' programming language, 2nd Edition, Pearson, 2008.
2. Yashavant P. Kanetkar, Let Us C: Authentic guide to C programming language, 15th edition, BPB, 2021.
3. Balaguruswamy, Programming In ANSI C, 8th Edition, Tata McGraw-Hill Education, 2019

D. Reference Books:

1. Zed A. Shaw, Learn C the Hard Way: Pratical Exercises on Computational Subjects You Keep Avoiding (Like C), 2015.
2. Deepali Srivastava and S.K Srivastava, C in Depth, BPB Publication, 2017.
3. Griffiths David and Dawn Griffiths, Head First C, A Brain Friendly Guide, 2012.
4. Grey Perry and Dean Miller, C Programming Absolute Beginner's Guide, 3rd Edition, 2013.

E. Course Outcomes:

1. Understand the basic terminology used in computer programming.
2. Write, compile and debug programs in C language in different operating systems.
3. Design programs involving decision structures, loops and functions.
4. Use and apply the dynamics of memory by the use of pointers in engineering applications.
5. Use and apply the differences between structure oriented and function oriented programming in programming applications.

Subject Code: EE-1103
Subject Name: Basic of Electrical and Electronics Engineering Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course Objectives:

1. To understand the structure and properties of different type of electrical circuits, networks and sources.
2. To apply different mathematical tools & techniques for analysing electrical networks.
3. To apply circuit analysis techniques to simplify electrical networks.
4. To solve problems of electrical circuits.

B. List of Practical:

1. V-I Characteristics of Carbon and Tungsten filament lamp.
2. V-I Characteristics of Fluorescence Lamp.
3. V-I Characteristics of RLC Series Circuit.
4. V-I Characteristics of RLC Parallel Circuit.
5. Verification of truth tables of different logic and universal gates.
6. Implementation of logic gates with the help of universal gates.

C. Course Outcomes:

After completion of this course, the learners will be able to

1. describe different type of networks, sources and signals with examples.
2. explain different network theorems, coupled circuit and tools for solution of networks.
3. apply network theorems and different tools to solve network problems.
4. select suitable techniques of network analysis for efficient solution.
5. estimate parameters of two-port networks.
6. design of filter circuits.

Subject Name: Engineering Physics Laboratory
Subject Code: BS 1104
Credit Value: 1 [P=2, T=0, L=0]

A. Course Objectives:

The course is designed to meet with the objectives of:

1. imparting theoretical & practical knowledge to the students in the area of engineering physics.
2. student will have exposure to various experimental skills which is very essential for an engineering student.
3. to gain practical knowledge by applying the experimental methods to correlate with the physics theory.
4. to develop intellectual communication skills and discuss the basic principles of scientific concepts in a group.
5. to learn the usage of various areas of physics like electricity and magnetism systems for various measurements.
6. apply the analytical techniques and graphical analysis to the experimental data.

B. List of Experiments:

1. Determination of Planck's constant using photocell.
2. Verification of Stefan's radiation law.
3. Verification of Bohr's atomic orbital theory through Frank-Hertz experiment.
4. Verification of Biot-Savart's law.
5. Charging and discharging of capacitor using RC circuit
6. Hall Effect.
7. To determine e/m ratio

C. Reference Books:

1. C. L. Arora, "Practical Physics", S. Chand Publications, 2010.
2. G. L. Squires, "Practical Physics", Cambridge University Press, 2014.

D. Course Outcomes:

Students successfully completing this module will be able to:

1. apply the various procedures and techniques for the experiments.
2. develop basic communication skills through working in groups in performing the laboratory experiments and by interpreting the results.
3. understand principle, concept, working and application of new technology and comparison of results with theoretical calculations.
4. gain knowledge of new concept in the solution of practical oriented problems and to understand more deep knowledge about the solution to theoretical problems.
5. understand measurement technology, usage of new instruments and real time applications in engineering studies.

Subject Code: ME-1102
Subject Name: Engineering Drawing
Credit Value: 1 [L = 0, T = 0, P = 2]

A. Course Objectives:

The course is design to meet with the following objectives:

1. Increase ability to understand Engineering Drawing.
2. Learn to sketch and take field dimensions.
3. Learn to take data and transform it into graphic drawings.
4. Learn basic Auto Cad skills.
5. Learn basic engineering drawing formats.
6. Prepare the student for future Engineering positions.

B. Course Content:

Indian standards: Sheet layout, type of lines and their representations, scales.

Principles of orthographic projection (multi view drawing): 1st and 3rd angle projection.

Projections: Points, lines, surfaces and solids.

Projection of sections and intersections of solids: Isometric projection.

Use of drafting software

C. Reference Books:

1. Dhananjay, A. J., "Engineering Drawing", 1st Ed., 2017, TMH.
2. Bhatt, N.D. and Panchal, V.M., "Engineering Drawing", 43rd ed., 2014, Charotar Publishing House Pvt.Ltd.
3. Venugopal, K. and Prabhu,V. R., "Engineering Graphics", 15th Ed., 2018, New Age International Pvt. Ltd.

D. Course Outcomes:

Upon completion of the subject student's ability to**:**

1. Understand orthographic projections and sections.
2. Basic understanding of Indian standards of Engineering drawing.
3. Develop engineering drawings by projection techniques.
4. Utilise AutoCAD towards developments of drawings.

Subject Code: EE-1104
Subject Name: Fundamentals of Electrical Engineering Laboratory
Credit Point: 1 (L=0, T=0, P=2)

A. Course Objectives:

1. To understand the structure and properties of different type of electrical circuits, networks and sources.
2. To apply different mathematical tools & techniques for analysing electrical networks.
3. To apply circuit analysis techniques to simplify electrical networks.
4. To solve problems of electrical circuits.

B. List of Practical:

1. Study of Electrical Laboratory Measuring Instruments: PMMI.
2. Study of Electrical Laboratory Measuring Instruments: PMMC.
3. Study of Electrical Machine Components: DC Machines.
4. Study of Electrical Machine Components: AC Machines
5. Study of Power System Components.
6. Study of Power System Protection Equipment.
7. Design of open loop and closed loop control system models.
8. Study of Power Electronic Components.

C. Course Outcomes:

After completion of this course, the learners will be able to

1. describe different type of networks, sources and signals with examples.
2. explain different network theorems, coupled circuit and tools for solution of networks.
3. apply network theorems and different tools to solve network problems.

Subject Code: MH-1102
Subject Name: Language Laboratory
Credit Point: 1 (L=0, T=0, P=2)

A. Course Objectives:

The course is designed to meet the following objectives:

1. To facilitate computer-assisted multi-media instruction enabling individualized and independent language learning
2. To sensitize students to the nuances of English speech sounds, word accent, intonation and rhythm
3. To bring about a consistent accent and intelligibility in students' pronunciation of English by providing an opportunity for practice in speaking
4. To improve the fluency of students in spoken English and neutralize their mother tongue influence
5. To train students to use language appropriately for public speaking and interviews

B. Course Content:

Basics of Phonetics, Speech Sounds – Vowels and Consonants, Word Stress and Rhythm, Accent, Intonation, Phonetics Drills, Developing Effective Listening Skills- Listening Comprehension Drills, Speaking - Conversations, Dialogues, and Debates, Role Play, Situational Dialogues, Expressions in Various Situations, Making Requests and Seeking Permissions, Formal Presentations. Telephone Etiquette, Building Advanced Vocabulary and English Grammar Exercises.

C. Text Books:

1. Words Worth English Language Software
2. Kumar, Rajesh, English Language Communication Skills: Lab Manual Cum Workbook with CD, Cengage Learning India, 2014

D. Reference Books:

1. Jones, Daniel. English Pronouncing Dictionary, Cambridge University Press, 2011.
2. Bansal, R. K. & J. B. Harrison. Spoken English with CD, Orient Blackswan, 2013.

E. Course Outcomes:

By the end of this course, you will be able to:

1. Understand of nuances of English language through audio - visual experience and group activities.
2. Reach the neutral intelligibility.
3. Attain the clarity and confidence to enhance their employability skills.
4. Express themselves fluently and appropriately in social and professional contexts.

II[nd] Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	BS-1201	SC5-Engineering Mathematics-II	2	0	0	2
2	CS-1201	ESA6-Programming and Data Structure	3	0	0	3
3	EC-1201	ESA7-Introduction to Digital engineering	2	0	0	2
4	MH-1201	ESA8-Introduction to Innovation and Creativity	2	0	0	2
5	ME-1201	ESA9-Engineering Mechanics	3	0	0	3
6	EE-1201	DSC3-Materials Science for Electrical Engineering	3	0	0	3
7	EE-1202	ESA10- System Design	2	0	0	2
8	ME-1204	ESA11-Workshop Practice-I	0	0	2	1
9	EE-1203	VAC2-Do It Yourself (DIY)/Industry Exposure	0	0	0	1
10	BS-1202	SC6-Basic Science Laboratory-II	0	0	2	1
11	CS-1202	ESA12-Programming and Data Structure Laboratory	0	0	2	1
12	MH-1202	VAC3-Gandhian Technology	0	0	2	1
Contact Hours			17	0	8	
Total Credits						22

Subject Name: Engineering Mathematics- II
Subject Code: BS 1201
Credit Value: 2 [P=0, T=0, L=2]

A. Course objectives:

The course is designed to meet the following objectives:

1. imparting theoretical knowledge to the students about three and more dimensional objects in space and to improve their capability of visualizing of objects in space.
2. Making student competent enough to construct a differential equation/mathematical modeling for every real life situation with its solution.
3. Giving students theoretical knowledge of vectors with the flavour of Calculus.
4. Introduce the concepts of Laplace and Fourier transforms and its application to the solution of differential equations (ODE &PDE) to the students.

B. Course Content:

Vector Calculus: Basics of vector calculus, Line integral, Surface integral and Volume integral, Path independence, Fundamental theorem of Calculus, Green's, Gauss' and Stokes' theorems (without proofs) and their simple applications.

Ordinary Differential Equations: First order ODEs, Higher order linear differential equation with constant coefficients, Euler's homogeneous equation, Series solutions of linear differential equations with variable coefficients (Ordinary point).

Partial Differential Equations: Basic of PDEs (order, degree, Linear, Non-Linear, homogeneous, non-homogeneous), Classification of 2[nd] Order PDEs; boundary and initial value

problems (Dirichlet and Neumann type) involving wave equation, D'Alembert method, heat conduction equation, Laplace's equations and solutions by method of separation of variables (Cartesian coordinates).

C. Text Books:

1. Kreyszig E., Advanced Engineering Mathematics, John Wiley, 2010, 11th edition.
2. Ross S. L., Ordinary Differential Equation, Wiley and Sons Ltd., 2010, 3rd edition.
3. Farlow S. J., Partial Differential Equation for Scientists and Engineers, Dover Publications, 1993, 1st edition.

D. Reference Books:

1. Boyce and Diprima R. C., Elementary Differential Equations and Boundary value Problems, Wiley publications, 2009, 9th edition.
2. Sneddon I. N., Elements of Partial Differential Equations, Dover Publications Inc., 2013, 2nd edition.
3. Alan Jeffrey, Advanced Engineering Mathematics, Academic Press,1st edition, 2001.
4. Earl Coddington, Norman Levinson, Introduction to Ordinary Differential Equations McGraw Hill Education; 1st edition, 2017.

E. Course Outcomes:

Upon completion of the subject:

1. Students will have strong visualizing capability in their mind about any object.
2. Students are so trained that they will recognize various real life situation/problem and able to solve them by constructing a differential equation/ mathematical model.
3. Students will be able to find the Laplace representation as transforms of functions of one/two variable.

Subject Code: CS - 1201
Subject Name: Programming and Data Structure
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. Designing principles of algorithms and data structures
2. Learning efficiency and scaling of algorithms
3. Learning essential algorithms in computing
4. Understanding generic data structures for common problems

B. Course Content:

Performance of algorithms: Basic concepts, Mathematical Background, Complexity Analysis, space and time complexity, asymptotic notations, Types of Date Structure.

Linear Data Structures: Arrays: one dimensional, multi-dimensional, Sparse Matrix, Elementary Operations

Stacks: Representation, elementary operations and applications such as infix to postfix, postfix evaluation, parenthesis matching

Queues: Simple queue, circular queue, de-queue, elementary operations and applications.

Linked lists: Linear, circular and doubly linked lists, elementary operations and applications such as polynomial manipulation

Non-Linear Data Structures: Trees: Binary tree representation, tree traversal, complete binary tree, heap, binary search tree, height balanced trees like AVL tree and 2-3 tree, tries, red-black tree, B-tree, B+ tree, m-way Search tree, other operations and applications of trees

Graphs: representation, Adjacency list, graph traversal, path matrix, connected components, topological sort, Spanning tree, BFS, DFS.

Sorting and Searching:
Sorting: Selection sort, bubble sort, quick sort, merge sort, heap sort, insertion sort, selection sort, radix sort.
Searching: linear and binary search,
Hashing: hash tables, hash functions, and open addressing.

File structures: Introduction, data file types, file organization, file access methods.

C. Text Books:

1. Lipschutz S., Data Structure, McGraw Hill Education, 2014.
2. Deshpande P.S., Kakde O.G., C & Data Structures, Charles River Media, 2004.
3. Balagurusamy E., Data Structures Using C, McGraw Hill Education, 2017.
4. Srivastava S.K., Srivastava D., Data Structures Through C In Depth, BPB Publications, 2004.

D. Reference Books:

1. Drozdek A., Data Structures and Algorithms in C++, Cengage Learning, 2012.
2. Radhakrishnan M., Srinivasan V., Data Structures Using C, BPB Publications, 2008.
3. Gupta P., Aggarwal V., Varshney M., Data Structure Using C, Laxmi Publications, 2011.
4. Aho A.V., Hopperoft J.E., UIlman J.D., Data Structures and Algorithms, Pearson, 1998.
5. Tanenbaum A.M., Data Structures using C, Pearson Education, 2009.
6. Agarwal A., Data structure Through C, Cyber Tech Publications, 2005.
7. Bandyopadhyay S.K., Data Structures Using C, Pearson Education India, 2009.
8. Thareja R., Data Structures Using C, Oxford University Press, 2011.

E. Course Outcomes:

After successfully completion of this module students will be able to:

1. Assess performance efficiency of sequential algorithms.
2. Design data structures to enable algorithms and design sequential algorithms for performance.
3. Implement designing algorithms and corresponding data structures using object oriented programming languages.
4. Demonstrate deployment of essential data structures such as lists, stacks, queues, and trees.

Subject Code: EC-1201
Subject Name: Introduction to Digital Engineering
Credit Value: 2 (L = 2, T = 0, P = 0)

A. Course Objectives

The objective of the course is:

1. Understand different digital technology used in everyday life.
2. Work with electrical circuits in cascaded form and implementation in real world.

B. Course Content

Introduction- What is *digital* (analog vs. digital)? What is *technology*? History of Computing/Internet
Hardware – from electricity to hardware to software
Binary Arithmetic- Boolean Logic
Computer Architecture- Quantum computing
IoT - Introduction to principles and uses- BIG DATA - Introduction to principles and uses
VR/AR - Introduction to principles and uses
AI - Introduction to principles and uses
Blockchain - Introduction to principles and uses
Databases and mySQL queries
Networking Protocols
Introduction to Data Analytics, Machine Learning, Security, Quantum Technology and Cyber Physical System (CPS)
Careers in Digital Technologies
Ethics and the Future of Computing
Model based analysis; Data driven analysis

C. Text Books

1. Marr, "Tech Trends in Practice: The 25 Technologies that are Driving the 4th Industrial Revolution", Wiley, 2020.

D. Reference Books

1. Goel, "Computer Fundamentals", Pearson, 2010.

E. Course Outcomes

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

1. Understand basic fundamentals of different digital techniques
2. Understand the fundamentals of AI, Blockchain and its use
3. Understand different network protocols.

Subject Code: MH-1201
Subject Name: Introduction to Innovation and Creativity (3-0-0-3)
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

The course is designed to meet the objectives of:

1. To involve themselves in the innovation and creative activities
2. Starting innovative practices in their entrepreneurial activities.
3. Developing their skills on the traits that they want to carry forward.
4. Starting activities based on the search of new ideas.

B. Course Content:

Introduction to innovation and creativity, opportunity identification: the search for new idea, entrepreneurial imagination and creativity, The role of creative thinking, Components of creativity, Indication of creativity, Developing your creativity, the creative thinking process, Two approaches to creative problem-solving, the most common idea killers, Arenas in which people are creative, the creative climate, Innovation and entrepreneur, the innovation process, types of innovation, Proof of Concept(PoC), product development, the major misconceptions of innovation, principles of innovation, Methods to initiate ventures, creating new ventures: new-new approach & new-old approach, ways to develop personal creativity: recognise relationships, develop a functional perspective, use your brains, and eliminate muddling mind –sets, design thinking, design innovation, technological innovation and designing entrepreneurship, creative design. Case study on startup/unicon

C. Text Books:

1. Donald F. Kuratko, Entrepreneurship: Theory, Process, Practice Cengage Learning 2017
2. Cynthia, L. Greene, Entrepreneurship Ideas in Action. Thomson Asia Pvt. Ltd., Singapore. 2004

D. Reference Books:

1. Barringer Entrepreneurship: Successfully Launching New Ventures, Pearson Education Publishing 2015
2. Timmons, Jerry A., and Spinelli, Stephen, 2009. New Venture Creation: Entrepreneurship for the 21st Century, 8th Edition, Boston, MA: IrwinMcGraw-Hill
3. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2001

E. Programme Outcomes:

1. Start their venture more scientifically.
2. Start their venture by linking with the all the stakeholders.
3. Enable to identify various opportunity mapping
4. Explore many possibility of generating new idea leading to enterprise.

Subject Code: ME-1201
Subject Name: Engineering Mechanics
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

The course is designed to meet with the following objectives:

1. Ability to utilise scalar and vector analytical techniques for analysing forces in statically determinate structures.
2. Ability to apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple, practical problems.
3. Student gets a basic idea of Centre of gravity, moment of inertia, mass moment of inertia, friction.

B. Course Content:

Forces and Moments: Force, moment and couple, wrench, equivalent force and moment, forces in space equilibrium, FBD, general equations of equilibrium-Lami's theorem, analysis of forces in truss and frames, brief introduction to vector approach.

Friction: Introduction to dry friction, laws of friction, friction of simple machines, inclined planes, screw jacks, clutch, and collar pivot bearing (uniform wear and uniform pressure assumptions).

Centre of gravity and moment of inertia: Centre of gravity, volume and composite bodies, area moment of inertia and mass moment of inertia for plane figures and bodies.

Virtual work and energy method: Virtual displacement; principle of virtual work; applications of virtual work principle to machines.

Kinematics of particle: Introduction, rectilinear motion, plane curvilinear motion, rectangular coordinates (x-y), normal and tangential coordinates (r-θ).

Kinetics of particle: Review of force, mass, acceleration, work and energy, impulse, momentum, linear impulse and linear momentum, angular impulse and angular momentum, impact, central-force and motion, and relative motion,

Kinetics of system of particles: Introduction, generalized Newton's second law, work-energy, impulse-momentum, conservation of energy and momentum, steady mass flow, variable mass.

Plane kinematics of rigid bodies: Introduction, rotation, absolute motion, relative velocity, instantaneous center of zero velocity, relative acceleration, motion relative to rotating axes.

Plane kinetics of rigid bodies: Introduction, general equation of motion, translation, fixed axis rotation, general plane motion, work energy relations, acceleration from work-energy, virtual work, impulse-momentum equation.

C. Text Books:

1. Timoshenko S. and Young D.H., "Engineering Mechanics", 5th Ed., 2017, MGH.
2. Beer and Johnston, "Vector Mechanics for Engineers: Statics and Dynamics", 10th Ed., 2012, TMGH.

D. Reference Books:

1. Meriam, J. L. and Kraige, L. G., "Engineering Mechanics, Volume 1: Statics", 8th Ed., 2017, Wiley.
2. Meriam, J. L. and Kraige, L. G., "Engineering Mechanics, Volume 2: Dynamics", 5th Ed., 2006, Wiley.
3. Shames, I. H. and Rao,G. K., "Engineering Mechanics: Statics and Dynamics'", 4thEd., 2006, Pearson.
4. Nelson A., "Engineering Mechanics: Statics and Dynamics", 1st Ed., 2017, TMGH.

E. Course Outcomes:

Upon completion of the subject, students should have the knowledge of:

1. Basic understanding of different type of forces, moments and resolving them.
2. Evaluation of centre of gravity, moment of inertia and mass moment of inertia for various figures & bodies.
3. Apply principles of kinematics, kinetics and effects of friction for solving problems.

Subject Code: EE 1201
Subject Name: Materials Science for Electrical Engineering
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To impart knowledge in field of materials science.
2. To make students aware of applications of materials science in field of Electrical Engineering.
3. To discuss the properties of materials used in manufacturing of various Electrical equipment.

B. Course Content:

Conducting Materials: Conductivity- dependence on temperature and composition – Materials for electrical applications such as resistance, machines, solders etc.

Semiconductor Materials: Concept, materials and properties. Basic ideas of Compound semiconductors, amorphous and organic semiconductors- applications.
Dielectrics: Introduction to Dielectric polarization and classification –Clausius Mosotti relation- Behaviour of dielectric in static and alternating fields.

Insulating materials and classification- properties- Common insulating materials used in electrical apparatus-Inorganic, organic, liquid and gaseous insulators- capacitor materials- Electro-negative gases- properties and application of SF6 gas and its mixtures with nitrogen
Ferro electricity.

Dielectric Breakdown: Mechanism of breakdown in gases, liquids and solids –basic theories including Townsend's criterion, Streamer mechanism, suspended particle theory, intrinsic breakdown, electro-mechanical breakdown- Factors influencing Ageing of insulators- Application of vacuum insulation- Breakdown in high vacuum-Basics of treatment and testing of transformer oil.

Magnetic Materials: Origin of permanent magnetic dipoles- Classification of magnetic materials -Curie-Weiss law- Properties and application of iron, alloys of iron- Hard and soft magnetic materials– Ferrites- Magnetic materials used in electrical machines, instruments and relays.

Superconductor Materials: -Basic Concept- types characteristics- applications Solar Energy Materials: Photo thermal conversion- Solar selective coatings for enhanced solar thermal energy collection –Photovoltaic conversion – Solar cells -Silicon, Cadmium sulphide and Gallium arsenic – Organic solar cells.

Modern Techniques for materials studies: Optical microscopy – Electron microscopy – Photo electron spectroscopy – Atomic absorption spectroscopy – Introduction to Biomaterials and Nanomaterials

C. Text Books:

1. Dekker A.J: Electrical Engineering Materials, Prentice Hall of India.
2. Mittal G. K.: Electrical Engineering Material Science. Khanna Publishers.

D. Reference Books:

1. Tareev, Electrical Engineering Materials, Mir Publications
2. Meinal A.B and Meinal M. P., Applied Solar Energy – An Introduction, Addisos Wesley
3. Nasser E., Fundamentals of Gaseous Ionization and Plasma Electronics, Wiley Series in Plasma Physics, 1971
4. Naidu M. S. and V. Kamaraju, High Voltage Engineering, Tata McGraw Hill, 2004
5. Indulkar O. S &Thiruvegadam S., An Introduction to electrical Engineering Materials, S.Chand
6. Agnihotri O. P and Gupta B. K, Solar selective Surface, John wiley
7. Seth. S.P and Gupta P. V, A Course in Electrical Engineering Materials, Dhanpathrai

E. Course Outcomes:

After the completion of the course student will be able to:

1. describe the characteristics of conducting and semiconducting materials
2. classify magnetic materials and describe different laws related to them
3. classify and describe different insulators and to explain the behaviour of dielectrics in static and alternating fields
4. describe the mechanisms of breakdown in solids, liquids and gases
5. classify and describe solar energy materials and superconducting materials
6. gain knowledge in the modern techniques for material studies

Subject Code: EE-1202
Subject Name: System Design
Credit Point: 2 (L=2, T=0, P=0)

A. Course Objectives:

1. To inculcate the domain knowledge in the concept of systems and its stages
2. To be known of various types of systems related to the product development
3. To be aware of the operation of system engineering responsibilities and skills

B. Course Content:

1. Basic concept of system level input & output with qualities, properties, characteristics, functions, behaviours & performances
2. **System Engineering Major Process flow** (Concepts of Interdisciplinary design, integration, complex systems and life cycles
3. **System Engineering Stages**

a. Analysis of base level Requirement and appropriate Management.
b. Functional Analytics, Interpretation and Allocation of inference.
c. Design Synthesis.
d. Systems Analysis and Control.
e. Verification.
f. Conclusion

4. **System Engineering Types (concept of product system, service system, enterprise system and system of systems)**
5. **Systems Engineering responsibilities**

a. Management and monitoring of all installed systems and infrastructure.
b. Installation, configuration, testing and maintaining operating systems, application software and system management tools.
c. Ensure the highest levels of quality standards on systems and infrastructure.

6. **System Engineering Skill** (for analysis, problem solving, and conflict resolution)

a. Communication skill
b. Interpersonal skill
c. Project management skill
d. Governance skills

Under System Development Process

1. Life cycle Planning and Life Cycle integration
2. System Development Life Cycle Phasing (planning, analysis, design, development, testing, implementation, and maintenance)
3. Industrial System Engineering (Quality Function Deployment, Product Planning, Design Planning, Production & Operational Planning, Planning for Quality Control & Assurance, Whole Value chain concept)

Under System Engineering Management

1. Management of complex systems over their life cycles

C. Reference Books:

1. Systems engineering principles and practice book by Alexander Kossiakoff
2. Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities by INCOSE
3. Handbook of Systems Engineering and Management Book by Andrew P. Sage and William B. Rouse
4. A Practical Guide to SysML: The Systems Modeling Language Book by Alan Moore, Rick Steiner, and Sanford Friedenthal

D. Course Outcomes:

Student will be known of the,

1. Fundamental concept and operation of system design
2. Various stages of system design and the responsibilities and skills of system engineering
3. Process of System Development and System Management

Subject Code: ME-1204
Subject Name: Workshop Practice-I
Credit Point: 1 (L=0, T=0, P=2)

A. Course Objectives:

1. Students able to understand different tool &equipment for work shop practice.
2. Students acquire skills for the preparation of different Carpentry/fitting/welding models.
3. Students able to understand the safety precaution in the workshop
4. Student acquires skills of Application orientated tasks.

B. Course Content:

Introduction and demonstration: Introduction to various shops/ sections and workshop layouts, safety norms to be followed in a workshop should be conveyed to students.

Carpentry shop: Introduction of tools and operations, types of woods & their applications, types of carpentry hardware and their uses, carpentry joints, carpentry operations such as marking, sawing, planning, chiseling, grooving, boring, joining, types of woods and carpentry hardware.

Fitting shop: Introduction of tools and operations, types of marking tools and their uses, types of fitting cutting tool and their uses, fitting operations such as chipping, filing, scraping, grinding, sawing, marking, drilling, tapping.

Metal joining shop: Introduction of tools, types of welding joint, arc welding, gas welding, gas cutting.

Machine shop: Introduction of machine tools and operations, demonstrations of basic machine tools like lathe, shaper, drilling, milling machine and CNC with basic operations and uses.

List of workshop practices:

1. Hands on practice and job making in carpentry.
2. Hands on practice and job making in fitting.
3. Hands on practice and job making in welding.
4. Demonstrate the operations of machine shop.

C. Text Books:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Media promoters and publishers private limited, Mumbai, Vol. I 2008 and Vol. II 2010.
2. Raghuvanshi B.S., Workshop Technology Vol. I & II, Dhanpath Rai & Sons. 2017.
3. Bawa H S., Workshop Practices, Tata McGraw-Hill, 2009.

D. Reference Books:

1. John K.C., Mechanical Workshop Practice. 2nd Edition, PHI, 2010.
2. Kannaiah P. and Narayana K.L., Workshop Manual, 2nd Edition, Scitech publishers, 2009.

E. Course Outcomes:

1. Study and practice on machine tools and their operation
2. Select the appropriate tools required for specific operation.
3. Practice on manufacturing of components using workshop trades including fitting, carpentry, foundry and welding
4. Identify and apply suitable tools for machining processes including turning, facing, thread cutting and tapping

Subject Code: EE-1203
Subject Name: Do It Yourself (DIY)/ Industry Exposure
Credit Point: 1 (L=0, T=0, P=0)

A. Course Objectives:

The course is designed to meet with the objectives of:

1. To inculcate in the mind of students the real meaning of electrification,
2. Calculation of various internal / external wiring parameters,
3. To give practical knowledge, on building wirings.

B. Course Content:

Single Phase and Three Phase Systems: designing and costing of conductors and equipment.
Concepts of domestic wirings: Casing-caping wiring, conduit wiring, domestic wiring for MIBT (Medium Improvised Building Type), SPT (Semi Permanent Building Type) and RCC

(Reinforced Cement Concrete). Wiring of multi-storeyed building, wiring of commercial building.

Design of LT (Low Tension) Poles, Earthing of buildings and transformers.

C. Text Books:

1. Uppal S.L., Electrical Wiring Estimating and Costing, Khanna Publishers, 3rd Edition, 2017.
2. Wadhwa, C.L., Electric Power Systems, Wiley Eastern Limited, 6th Edition, 2018.

D. Reference Books:

1. V.K Mehta., Rohit Mehta, Principles of Power System, S.Chand Publishers, 3rd Edition, 2013
2. Schedule of rates, Delhi, DGSN, Arunachal Pradesh, and Power Department, 2021

E. Course Outcomes:

Students successfully completing this module will be able to:

1. acquainted with the internal and external wiring estimates,
2. acquainted with the methods of designing of innovative wiring system,
3. substantially prepared to learn about special techniques of estimations.

Subject Name: Engineering Chemistry Laboratory
Subject Code: BS 1202
Credit Value: 1 [L=0, P=2, T=0]

A. Course Objectives:

1. To enable the students to acquire knowledge about chemistry practical and its technological importance towards research works.
2. To understand applicability of chemistry for engineering and research purposes.
3. To make them apply the knowledge of fundamental chemistry for design system components or processes and researches considering the public health and safety, and the cultural, societal, and environmental considerations.

B. Course Content:

1. Determination of the concentration of NaOH solution.
2. Standardization of $KMnO_4$ solution by Mohr's salt.
3. Estimation of hardness of water using EDTA titration.
4. Conductometric titration for

a) Determination of the strength of a given HCl solution by titration against a standard NaOH solution.
b) Analysis of a mixture of strong and weak acid by strong base.

5. Estimation of available chlorine in bleaching powder.
6. Determination of pH value of the solution by digital pH meter and pH paper.

C. Reference Books:

1. M. V. Basaveswara Rao, Laboratory Mannual for Engineering and Physical Chemistry, Studium Press (India) PVT. Ltd. 2013.
2. Vogel Arthur Israel, Vogel's Qualitative Inorganic Analysis, Publisher: Pearson Education Limited, ISBN: 9780582218666, 0582218667

D. Course Outcomes:

After studying this course, students will be able to

1. an ability to function on research areas in multidisciplinary subjects.
2. design economically, environmental friendly and new methods of synthesis for various needful products.
3. a knowledge of titration for various kinds of acid-base for new experimental aspects.

Subject Code: CS-1202
Subject Name: Multimedia and Web Design
Credit Point: 3 (L=1, T=0, P=4)

A. Course Objectives:

1. Students will understand multimedia in respect to many application including business, schools, home, education, and virtual reality.
2. Students will understand the hardware and software needed to create projects using creativity and organization to create them.
3. Student will develop multimedia skills understanding the principal players of individual players in multimedia teams in developing projects.
4. Students will learn the cost involved in multimedia planning, designing, and producing.

B. Course Content:

Coding Basics: Intro to HTML Syntax: The HTML, head, title, & body tags, Headings, paragraphs, & lists, The strong & em tags, The doctype, The lang attribute, The meta tag & the unicode character set, Coding Links: Absolute & Relative URLs, Anchor tags & hrefs, Linking to other websites, Linking to pages within a website, Opening a link in a new browser window/tab, Adding Images, The break tag, The image tag & source attribute, Using the width, height, & alt attributes, Using horizontal rules

Intro to Cascading Style Sheets (CSS): CSS Class Selectors The class attribute CSS class selectors The span tag CSS opacity Div Tags, ID Selectors, & Basic Page Formatting Dividing up content with the div tag Assigning IDs to divs Setting width & max-width CSS background-color Adding padding inside a div Centering content CSS borders CSS shorthand & the DRY principle Using Browser Developer Tools Opening the DevTools in Chrome Editing HTML in the DevTools Elements panel Enabling, disabling, & editing CSS in the DevTools Using DevTools to fine-tune your CSS Hexadecimal shorthand HTML5 Semantic Elements & Validating HTML The outline algorithm The header, nav, aside, & footer elements

Understanding articles & sections The main element The figure & figcaption elements Checking for errors: validating your code

Basics of web-programming Programming: Client-side scripting: JAVASCRIPT, Overview of Java, JAVA Applet

PHP: Concept of PHP, features of PHP, other equivalent tools – JSP, PHP Including PHP in web page, **Data types, Variables,** Operator precedence Built In Functions., **String Manipulation Functions, Time & Date Functions, Arrays, Conditional statements, Loops, User Defined Functions,** Global Variables, Elements of $_SERVER, PHP Forms, Text Files, Other Features: PHP File Upload, Cookies, Sessions (start, modify and destroy), Error Handling

C. Text Books:

1. Richardson T., and Thies C., Multimedia Web Design and Development, Mercury Learning and Information, 2013.
2. Steinmetz R., Multimedia: Computing Communications & Applications, Pearson Education India, 2002.

D. Reference Books:

1. Xavier C, "Web Technology & Design New Age Publication.
2. Andleigh K. Prabhat., Thakrar K., Multimedia Systems Design 1st Edition, Pearson, 2015.
3. Maidasani Dinesh., Multimedia Applications and Web Designing, Laxmi Publications, 2008.

E. Course Outcomes:

1. Ability to develop proficiency in Webpage Development and website management
2. Ability to develop proficiency in creating dynamic Web Interface
3. Ability to write server and client sides scripts and manage websites
4. Ability to design a web page using Image, Audio and Video editing tools
5. Ability to understand the basic concepts of Open Source Standards and Open Source software.

Subject Code:MH-1202
Subject Name: Gandhian Philosophy and Technology
Credit Point:1 (L=0, T=0, P=2)

A. Course Objectives:

The course is designed to meet the following objectives:

1. To understand the life style and significance of M. K. Gandhi in modern world
2. To introduce Gandhian Thought as an academic discipline to students
3. To convey the importance of Gandhian Values in different walks of life
4. To create awareness about the significance of Gandhian Thought for Academics and life in general, in students and common stakeholder through workshop and related activities done by Gandhi Study Center

B. Course Content:

Ethics in Gandhian Thought : Socio- Political and Economic Thoughts of Gandhiji, Gandhian methods for Global Peace, Gandhian Development, Mahatma Gandhi's Perspectives on Technology. Participating practical oriented activities done by GSC/ Technology-attributes/innovation/activities of Gandhian way of life styles/Gandhian economics, Indian cottage industry and its improvement, Inclusive growth and through sustainable development.

C. Text Books:

1. Gandhi, Gopal krishna, Mohandas Karamchand Gandhi: Restless as Mercury, My Life as a Young Man, Aleph Book Company, 2021.
2. Beitzel, Terry and et al. Reflections on Mahatma Gandhi: The Global Perspectives, Rawat Publications, India, 2021.
3. Gandhi, M.K. The story of my experiments with truth (an autobiography), Navajivan Publishing House, 1927.

D. Reference Books:

1. Awasthi, R.K. Technological Transformation and Relevance of Gandhi in Modern India, IJSW online, Retrieved May 2022.
2. Talwar, Sushant. Mahatma and machines: Understanding Gandhi's thoughts on modern technology, https://www.timesnownews.com/, 2019.
3. Kothari,L. S. Science and Technology in India: What Can We Learn From Gandhi?, Source: International Seminar on Gandhi And The Twenty First Century, (January 30-February 4, 1998) New Delhi- Wardha.
4. Ram K.Vepa, New Technology: A Gandhian Concept, Gandhi Book House New Delhi, 1975

E. Course Outcomes:

By the end of this course, you will be able to:

1. Understand how a simple thought changes the world
2. Identify the various barriers and challenges faced in India and try to solve from Gandhian perspectives
3. Dedicate your ideas to poor people and transform technology among people
4. Aware of the economic and social equality and relationship with peace

III[rd] Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	BS-2101	SC7-Engineering Mathematics-III	3	0	0	3
2	EE-2101	DSC4-Electrical Circuit Analysis	3	0	0	3
3	EE-2102	DSC5-Electrical and Electronic Measurement	3	0	0	3
4	EC-2102	DSC6-Digital Logic Design	3	0	0	3
5	EE-210A EE–210B	DSE1-Electromagnetic Field Theory DSE1-Electronic Circuits and Devices	3	0	0	3
6	YY-210X	OE1*	3	0	0	3
7	EE-2103	Electrical Circuit Analysis Laboratory	0	0	2	1
8	EE-2104	Electrical and Electronic Measurement Laboratory	0	0	2	1
9	EC-2104	Digital Logic Design Laboratory	0	0	2	1
Contact Hours			18	0	6	
Total Credits						21

Subject Name: Engineering Mathematics- III
Subject Code: BS 2101
CreditValue:3 [P=0, T=0, L=3]

A. Course objectives:

The course is designed to meet the objectives of:

1. imparting theoretical knowledge and practical application to the students in the area of Stochastic Process,
2. introducing the basic notions of probability theory and develops them to the stage where one can begin to use probabilistic ideas in statistical inference and modeling, and the study of stochastic processes,
3. providing confidence to students in manipulating and drawing conclusions from data and provide them with a critical frame work for evaluating study designs and results,
4. injecting future scope and the research directions in the field of stochastic process.

B. Course Content:

Probability: Random Experiment, Sample space; Events; Probability of events, Frequency Definition of probability; Axiomatic definition of probability; Finite sample spaces, Probability of Non-disjoint events (Theorems). Conditional probability; General Multiplication Theorem; Independent events; Bayes'theorem and related problems.

Random variables: Probability mass function; Probability density function and distribution function. Distributions: Binomial, Poisson, Uniform, Exponential, Normal, t and $\chi 2$. Expectation and Variance (t and $\chi 2$ excluded); Moment generating function; Transformation of random variables (One variable); Central limit theorem (Statement only).

Basic Statistics: Measures of Central tendency: Moments, skew-ness and Kurtosis – Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters

for these three distributions, Correlation and regression– Rank correlation.

Statistics: Population; Sample; Statistic; Estimation of parameters (consistent and unbiased); Sampling distribution of sample mean and sample variance (proof not required).

Estimation: Maximum likelihood estimate of statistical parameters (Binomial, Poisson and Normal distribution). Interval estimation (Normal distribution). Testing of hypothesis and $\chi 2$ goodness of fit.

Curve fitting: Linear and Nonlinear

C. Text Books

1. Rohatgi V. K. and Saleh A K. Md E., An Introduction to Probability and Statistics,Willy, 2008, 2nd edition.
2. Gupta S. C., & Kapoor V. K., Fundamental of Mathematical Statistics, Sultan Chand &Sons, 2014.

D. Reference Books

1. Ross S. M., Introduction to Probability Models, Academic Press, 2014, 14th edition.
1. Cramer H., Random Variables and Probability Distributions, Cambridge University Press, 2014, Revised ed.
2. Spiegel M. R., Probability and Statistics, McGraw-Hill, 2017, 3rdedition.
3. Mayer P. L., Introductory Probability and Statistical Applications, Oxford & IBH, 1970, 2nd ed.
4. Feller W., An Introduction to Probability Theory and Its applications, Vol I, John Wiley and Sons, 2008, 3rd edition.
5. Chung K. L., A course of Probability Theory, Academic Press, 2000, 3rd edition.

E. Course Outcomes:

Upon Completion of the subjects:

1. Students will add new interactive activities to fill gaps that we have identified by analyzing student log data and by gathering input from other college professors on where students typically have difficulties,
2. Students will add new simulation-style activities to the course in Inference and Probability, Student s will be able to take up prospective research assignments.

Subject Code: EE-2101
Subject Name: Electrical Circuit Analysis
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objective:

The course has been designed to make students:

1. understand the calculations of electrical circuits / networks.
2. work with electrical circuits in cascaded form and implementation in real world.

B. Course Content:

Basic Concepts of Electrical Circuits, Circuit Concepts – R-L-C parameters – Voltage and Current sources – Independent and dependent sources-Source transformation – Voltage – Current relationship for passive elements (for different input signals-square, ramp, saw tooth, triangular); Kirchhoff's laws – network reduction techniques – series, parallel, series parallel, star-to-delta or delta-to- star transformation, Nodal analysis, Mesh analysis, Super node and Super mesh for D.C. Excitations Single Phase A.C Circuits: R.M.S and Average values and form factor for different periodic wave forms,– Concept of Reactance, Impedance, Susceptance and Admittance – Phase and Phase difference– concept of power factor, Real and Reactive powers – J-notation, Complex and Polar forms of representation, Complex power. Steady state analysis of R, L and C (in series, parallel and series parallel combinations) with sinusoidal excitation; Transient analysis of different electrical circuits with and without initial conditions; Solution using Laplace Transforms, Fourier analysis of different types of input signals Locus Diagrams and Resonance: Locus diagrams – series R-L, R-C, R-L-C and parallel combination with variation of various parameters – Resonance – series, parallel circuits, concept of band width and Q factor. Magnetic Circuits: Magnetic Circuits – Faraday's laws of electromagnetic induction – concept of self and mutual inductance – dot convention – coefficient of coupling – composite magnetic circuit - Analysis of series and parallel magnetic circuits.

Network Topology: Definitions – Graph – Tree, Basic cutest and Basic Tie-set matrices for planar networks– Loop and Nodal methods of analysis of Networks with independent voltage and current sources - Dualityand Dual networks.

Network Theorems:

Tellegen's, Superposition, Reciprocity, Thevenin's, Norton's, Maximum Power Transfer, Millman's and Compensation theorems for D.C. and A.C. excitations. Three phase unbalanced circuits.

C. Text Books:

1. M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2006.
2. D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1998.

D. Reference Books:

1. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, 2013.
2. C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education, 2004.
3. K. V. V. Murthy and M. S. Kamath, "Basic Circuit Analysis", Jaico Publishers, 1999.

E. Course Outcomes:

At the end of this course, students will demonstrate the ability to:

1. apply network theorems for the analysis of electrical circuits.
2. obtain the transient and steady-state response of electrical circuits.
3. analyse circuits in the sinusoidal steady-state (single-phase and three-phase).
4. analyse two port circuit behavior.

Subject Code: EE-2102
Subject Name: DSC5-Electrical and Electronic Measurement
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

After completion of this course, students will be able to –

1. Identify various types of electronic instrument suitable for specific measurement.
2. Classify various errors present in measuring instruments.
3. Understand construction, working principle and types of oscilloscopes.
4. Comprehend different types of signal generators and analyzers, their construction and operation.
5. Describe the working principle, selection criteria and applications of various transducers used in measurement systems.

B. Course Content:

Introduction- Basics of Measurements: Accuracy, Precision, resolution, reliability, repeatability, validity, Errors and their analysis, Standards of measurement, calibration of instruments.

Bridge Measurements: AC bridges: Applications and conditions for balance, Maxwell's bridge, Hay's bridge, Schering bridge, Wien's bridge, De Sauty's bridge, Shielding of bridges, Insulation testing, Ground resistance measurement, Varley and Murray loop test.

Measurement of Resistance: Wheatstone's bridge, sensitivity, limitations. Kelvin's double bridge. Earth resistance measurement by fall of potential method and by using Megger.

Electromechanical Indicating Instruments: PMMC galvanometer, Ohmmeter, Electrodynamometer, Moving iron meter, Rectifier and thermo-instruments, Comparison of various types of indicating instruments.

Extension of Instrument Ranges: Desirable features of ammeters and voltmeters. Shunts and multipliers. Construction and theory of instrument transformers, Desirable characterises, Errors of CT and PT. Turns compensation, Illustrative examples, Silsbee's method of testing CT.

Magnetic measurements: Introduction, measurement of flux/ flux density, magnetising force and leakage factor.

Power and Energy Measurement: Electrodynamometer type of wattmeter and power factor meter, Power in poly phase system: two wattmeter method, Single-phase induction and Electronic energy meters.

Instrument Transformers: Current and Voltage transformers, Constructional features, Ratio and Phase angle errors.

Oscilloscopes: - Cathode Ray Tube, Vertical and Horizontal Deflection Systems, Delay lines, Probes and Transducers, Specification of an Oscilloscope. Oscilloscope measurement Techniques, Special Oscilloscopes, Storage Oscilloscope, Sampling Oscilloscope.

Electronic Instruments: Electronic multimeter, Digital voltmeters, General characteristics ramp type voltmeter, Quantization error, Digital frequency meter/Timer, Q meter and its applications, Distortion meter, Wavemeter and Spectrum Analyser.

Display Devices: - LED, LCD, Power quality analyzer, Applications of expert systems for power quality monitoring, Net Metering and data logger.

Digital Data Acquisition System: Interfacing transducers to Electronics Control and Measuring System. Instrumentation Amplifier, Isolation Amplifier. An Introduction to Computer-Controlled Test Systems.IEEE488 GPIB Bus.

Recording Devices: Introduction, Strip chart recorders, Galvanometer recorders, Null balance recorders, Potentiometer type recorders, Bridge type recorders, LVDT type recorders, Circular chart and XY recorders. Digital tape recording, Ultraviolet recorders. Electro Cardio Graph (ECG)

C. Text Books:

1. Shawney A.K., "Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai and Sons, 2018
2. Kalsi H. S., "Electronic Instrumentation", Tata McGraw Hill, 2007.
3. Nakra C. & Chaudhary K.K., "Instrumentation Measurement and Analysis", Tata McGraw Hill, 2003.
4. Patranabis. D, "Sensors & Transducers", PHI, 2010
5. Gupta J. B., "A Course in Electronics and Electrical Measurements and Instrumentation", S.K. Kataria & Sons, 2015

D. Reference Books

1. Golding E. W. and Widdis F. C., "Electrical Measurements and Measuring Instruments", Pitman, 2003.
2. Helfrick A. D. and Cooper W. D., "Modern Electronic Instrumentation and Measurement Techniques", Prentice Hall of India, 2007.
3. Bernard Oliver and John Cage., "Electronic Measurements and Instrumentation", Tata McGraw Hill, 2017.

E. Course Outcomes:

1. **understand** the concept of measurement different electrical and non-electrical parameters.
2. **select** a suitable measuring instrument for field specific applications.
3. **compare** different measuring instruments and analyse their errors in measurement of a specific quantity.
4. **discuss** the concepts in digital measurement and data acquisition system.
5. **explain** basic principle, working, characteristics and applications of the various measuring instruments and transducers.

Subject Code: EC-2102
Subject Name: Digital Logic Design
Credit Value: 3 (L = 3, T = 0, P = 0)

A. Course Objectives:

The course is designed to meet the following objectives:

1. To build a solid foundation about Boolean algebra
2. To study Digital Logic Gates and Circuits
3. To provide a clear foundation of Modern Digital Systems

B. Course Content:

Minimization techniques: Minterms and maxterms expressions. Algebraic method, Karnaugh maps (including 5 and 6 variables), Quine-McCluskey method, Multi-output circuits, Multi-level circuits, Design of circuits with universal gates.

Codes: BCD, Excess- 3, Gray, ASCII, EBCDIC.

Combinational circuits: Arithmetic circuits: adders and subtractor-ripple carry adders, Carry look ahead adders, Adder cum subtractor, BCD Adder and Subtractor, Comparator, Decoder, Encoder, Priority encoder, MUX/DEMUX and their structures, logic using ROM array, Applications of MSI designs.

Sequential circuits: Latches and Flip-Flops: SR latch, SR Flip-Flop, JK Flip-Flop, D Flip-Flop, T Flip-Flop, Flip-Flops with preset and clear inputs, Triggering methods and their circuits, Conversion of one type of flip flop to another, Excitation table, Applications of Flip Flops. Difference between synchronous and asynchronous circuits.

Shift Registers: Right shift, Left shift, Bidirectional, SISO, SIPO, PISO, PIPO, Universal shift registers.

Counters: Operation; up counter, Down counter, up/down counter, mod n counters, other types of Counters: Ring counter, Johnson counter, BCD counter.

Finite State Machines: Mealy & Moore types, Basic design steps, Design of counters using sequential circuit approach.

Asynchronous sequential circuits: Analysis and synthesis, State reduction and state assignment, Hazards.

Introduction to digital logic families: Characteristics, Basic working of TTL NAND gate, ECL gate and CMOS logic gate, Memory Devices: types of memories, RAM BJT cell and MOS RAM cells, Organization of a RAM

ADC & DAC: Analog and digital data conversions, D/A converter: Specifications, Weighted resistor type, R-2R ladder type, Voltage mode and current mode R-2R Ladder types, Switches for D/A converters, High speed sample-and-hold circuits, A/D Converters: Specifications, Flash type, Successive approximation type, Single slope type, Dual slope type, A/D converter using voltage-to-time conversion, Over-sampling A/D converters.

C. Text Books

1. Malvino & Leach, "Digital Principles and Applications", Tata McGraw Hill, 2010.
2. M. Morris Mano, "Digital Logic Design", Prentice Hall, 2018.

D. Reference Books

1. C. H. Roth (Jr.), "Fundamentals of Logic Design", Cengage Engineering, 2013.
2. R L Morris & J R Miller, "Designing with TTL Integrated Circuits", McGraw Hill, 1971.
3. R. P. Jain, "Modern Digital Electronics", Tata McGraw Hill, 2009.
4. Anand Kumar, "Fundamentals of Digital Circuits", Prentice Hall, 2014.
5. J Crowe & B. Hayes-Gill, "Introduction to Digital Electronics", Butterworth-Heinemann, 1998.

E. Course Outcomes

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

1. Design and analyse combinational and sequential logic circuits.
2. Optimize combinational and sequential logic circuits
3. Analyse a memory cell and apply for organizing larger memories

Subject Code: EE-210A
Subject Name: Electromagnetic Field Theory
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

This course is design to meet the objectives of:

1. imparting theoretical & practical knowledge to students in the area of Electromagnetic Field Theory,
2. providing teaching and learning to make students acquainting with modern state-of –art ofElectromagnetic propagation,
3. injecting the future scope and the research direction in the field of Electromagnetisms,
4. making students competent to design & development of Electromagnetisms.

B. Course Content:

Review of vector algebra- Rectangular, cylindrical and spherical, Curvilinear coordinates,

Line, surface and volume integrals, Gradient, Divergence, Curl, Divergence theorem, Stoke's theorem.

Coulomb's Law – Electric flux and flux density, Gauss's law and applications. Poisson's and Laplace equations and their solutions. Electric Current: Charge conservation and continuity equation–conductivity and Ohm's law.

Lorentz force, magnetic field intensity (H) – Biot–Savart's Law - Ampere's Circuit Law – H due to straight conductors, circular loop, infinite sheet of current, Magnetic flux density (B) – B in free space, conductor, magnetic materials – Magnetization, Magnetic field in multiple media –Boundary conditions, scalar and vector potential, Poisson's Equation, Magnetic force, Torque, Inductance, Energy density, Applications.

Faraday's law – Displacement current.

Maxwell's equations (differential and integral form) – Relation between field theory and circuit theory, wave equation, Wave parameters; velocity, intrinsic impedance, propagation constant – Waves in free space, lossy, lossless dielectrics and conductors- skin depth, Flow of energy and Poynting vector, Plane wave reflection and refraction: linear, elliptic and circular polarization, reflection coefficient and standing wave ratio, Brewster's angle. Transmission Lines; Concept of Lumped parameters and Distributed parameters. Line Parameters, Transmission line equations and solutions, Physical significance of the solutions, Propagation constant, Characteristic Impedance; Wavelength; Velocity of Propagation; Distortion-less, lossy, lossless Line, Reflection and Transmission coefficients; Standing Waves, VSWR, Input Impedance, Smith Chart - Applications; Load Matching Techniques / Quarter wave Matching.

Waves between parallel planes, TE and TM waves, Characteristics of TE and TM waves, TEM waves, Velocities of propagation, Attenuation in parallel plane guides, Wave impedance, Electric field and current flow within the conductor.

C. Text Books:

1. Mathew N. O. Sadiku, 'Principles of Electromagnetics', 6th Edition, Oxford University Press Inc.Asian edition, 2015.
2. William H. Hayt and John A. Buck, 'Engineering Electromagnetics', McGraw Hill Special Indianedition, 2014

D. Reference Books:

1. Kraus and Fleish, 'Electromagnetics with Applications', McGraw Hill International Editions, FifthEdition, 2010.
2. V. V. Sarwate, 'Electromagnetic fields and waves', First Edition, Newage Publishers, 1993.
3. P. Tewari, 'Engineering Electromagnetics - Theory, Problems and Applications', Second Edition,Khanna Publishers.
4. S. P. Ghosh, Lipika Datta, 'Electromagnetic Field Theory', First Edition, McGraw Hill,Education(India) Private Limited, 2012.

E. Course Outcome:

At the end of this course, students will demonstrate the ability to:

1. understand calculations of electric and magnetic fields in space in some selected

geometries withboundary conditions.
2. perform calculations of stationery and time-dependent electrical currents in selected circuitscontaining resistors, capacitors, and inductors.
3. analyse for the operational principles of common electrical devices.

Subject Code: EE-210B
Subject Name: Electronic Circuits and Devices
Credit Point: 3 [L=3, T=0, P=0]

A. Course Objectives:

The course is designed:

1. To enable the students to build a solid foundation on the basic electronic elements, circuits and devices, which includes junction theory, electrons, holes, diodes and transistors?

2. To make the students to study the characteristics and hence functions & performance parameters of basic electronics devices,

3. To enhance in building different circuits using different combinations of different diodes and transistors,

4. To understand the measurement parameters and criteria of circuits likes rectifiers, bias circuits, amplifiers.

B. Course Content:

Junction Theory: Conduction in solids. Pure and doped semiconductor, Metal Semiconductor Junction, Concept of holes, Electron and hole mobility, Band Diagram, Ohmic & rectifying effects, Depletion & capacitance effects, Semiconductor-semiconductor junction, p=n junction, homo & hetero junction, Equilibrium band diagram, Potential diagrams of p-n junction. **p-n diodes:** p-n junction diodes, diode mechanism & I-V characteristics, biased p-n diode, Schottky diode, Avalanche and Zener effect, Zener diode and its I-V characteristics, Degeneration, Large doping, Tunnel diode & its I-V characteristics, Backward diode, Equivalent circuits of diodes, Half wave and Full wave rectifier circuits, clipping and clamping circuits. **Transistors Theory and Circuits:** Metal-insulator-semiconductor junctions, Band diagram, n-p-n and p-n-p junctions (bipolar junction transistor/BJT), transistors characteristics: Emitter, Collector and Base terminals, I-V characteristics, transfer characteristics, input-output characteristics, current /voltage gain, mutual conductance, transfer resistance (trans resistance & trans-conductance). **Biasing and Stability of transistors'**: bias circuits in different modes - Self Bias-CE, CB, CC, Compensation techniques, Low and High frequency model of transistor. T and Π models & parameters, Voltage & current amplifier. Audio and Radio Amplifier, Power amplifiers – Class A, B, AB, C, Push pull & Tuned amplifier. Analysis of the amplifiers circuits with gain, input & output resistance, power dissipation & stability.

C. Text Books:

1. Millman & Halkias, "Integrated Electronics", Tata McGraw Hill, New Delhi, 3rd Edition, 2002.
2. Simon.M.Sze & Yiming Li, "Physics of Semiconductor Devices", Wiley India Ltd, 4th Edition, 2021

3. Chattopadhyaya, Rakhist, Saha and Porkait, "Foundation of Electronics", Prentice Hall of India, New Delhi, 2ndEdition, 2014.
4. Ralph.J.Smith, "Electronics: Circuits & Devices", John Wiley & Sons Ltd, 3rd Edition, 1991.

D. Reference Books:

1. Manis Mukherjee, "Foundation of Electronics Devices" Prentice Hall of India, New Delhi, 2nd Edition, 2009
2. Donald.A.Neaman, "Semiconductor Physics & Devices: Basic principles", Tata McGraw Hill, New Delhi,3rd Edition, 2011
3. Paul Horowitz & Winfield Hill, "The Art of Electronics", Cambridge University Press, 2nd Edition, 1989
4. Ben.G.Streetman and Sanjay Kumar Banerjee, "Solid State Electronic Devices", Prentice Hall, 5th Edition, 1999.

E. Course Outcomes:

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

1. Have clear understanding & utilization of semiconductor devices & fabrication,
2. Design and develop different electronic circuits made of different diodes and transistors,
3. Measure the device performances to apply in particular systems.

Subject Code: EE-2103
Subject Name: Electrical Circuit Analysis Laboratory
Credit Point: 1 (L=0, T=0, P=2)

A. Course Objective:

The course has been designed to make students:

1. work with electrical circuits in laboratory and apply theoretical knowledge of networks into practice.
2. familiar with devices used in electrical circuit analysis.

B. Course Content:

1. Verification of KVL and KCL (Simulation using MATLAB and Hardware)
2. Mesh Analysis (Simulation using MATLAB and Hardware)
3. Nodal Analysis (Simulation using MATLAB and Hardware)
4. Verification of Superposition Theorem (Simulation using MATLAB and Hardware)
5. Verification of Reciprocity Theorem (Simulation using MATLAB and Hardware)
6. Verification of Maximum Power Transfer Theorem (Simulation using MATLAB and Hardware)
7. Verification of Thevenin's Theorem (Simulation using MATLAB and Hardware)
8. Verification of Norton's Theorem (Simulation using MATLAB and Hardware)
9. Verification of Compensation Theorem (Simulation using MATLAB and Hardware)
10. Verification of Millman's Theorem (Simulation using MATLAB and Hardware)
11. Verification of Series and Parallel Resonance (Simulation using MATLAB and Hardware)
12. Determination of Self, Mutual Inductance and Coefficient of Coupling

C. Course Outcome:

At the end of this course, students will demonstrate the ability to:

1. apply fundamental laws to electric circuits.
2. select suitable instrument for measurement of electrical quantities.
3. verify basic network theorems to solve complex circuits.
4. demonstrate performance improvement by power factor correction.
5. compare resonance characteristics of series and parallel RLC circuits and determine resonantfrequency.
6. design of filter to reduce ripple in rectifier circuits

Subject Code: EE2104
Subject Name: Electrical and Electronic Measurement Laboratory
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course Objectives:

1. Help understanding basic principles of Electrical measurements and measuring instruments.
2. Classify various errors present in measuring instruments.
3. Identify Electrical measuring instruments.
4. Comprehend different types of signal generators and analysers, their construction and operation.
5. Describe the working principle, selection criteria and applications of various transducers used in measurement systems.

B. Course Content:

1. Measurement of low resistance by Kelvin's Double Bridge method.
2. Study of Galvanometer and determination of sensitivity and galvanometer constants.
3. Measurement of capacitance and loss angle of capacitor using Schering bridge.
4. Measurement of unknown inductance by Maxwell's inductance and capacitance bridge.
5. Measurement of inductance and Q-factor using Owen bridge.
6. To measure value of unknown inductance using LCR meter.
7. Measurement of ratio and phase angle errors of instrument transformers
8. Calibration of voltmeters and ammeters using potentiometer.
9. Measurement of power and power factor in a three phase AC circuit by two-wattmeter method.
10. Demonstration of Function generator by understanding different waveform.
11. To demonstrate usage of DSO for steady state periodic waveforms produced by a function generator.
12. To measure high resistance and insulation resistance using Megger.

C. Course Outcomes:

At the end of this course, students will

1. demonstrate the ability to extend the range and calibrate electro mechanical instruments

2. Apply AC and DC bridges for measurement of electrical parameters like resistance, inductance and capacitance.
3. Prepare the specifications of required measurement systems to be used for measurement of parameters for a specified application.
4. Comprehend the basics of Display Devices.
5. Explain basic principle, working, characteristics and applications of the various measuring instruments and transducers.

Subject Code: EC-2104
Subject Name: Digital Logic Design Laboratory
Credit Value: 1 (L = 0, T = 0, P = 2)

A. Course Objectives

The objective of the course is:

1. To build a solid foundation about Boolean algebra
2. To study the applications of Digital Logic Gates and Circuits

B. Course Content

1. Verification of truth tables of different logic and universal gates.
2. Design and verification of adder subtractor circuits using universal gates.
3. Minimize the following logic system with SOP/POS by tabular technique & implement the circuit.
4. SOP: $f(A,B,C,D) = m_0 + m_1 + m_2 + m_3 + m_5 + m_6 + m_{10} + m_{13} + m_{15}$
5. POS: $f(X,Y,Z) = M_0.M_1.M_3.M_7$
6. Design Gray to Binary and Binary to Gray code Converter & test the circuit.
7. Verification of the truth table of the Multiplexer / Demultiplexer.
8. Design and test of flip-flops using NOR/NAND gates.
9. Verification of 3-bit synchronous / asynchronous up / down counter.
10. Basic GATEs implementation in HDL
11. Design and implementation of 3-bit synchronous up/down counter in HDL.
12. Construction and verification of 4-bit ripple counter and Mod-10 / Mod-12Ripple counters using JK flip-flop in HDL.

C. Text Books

1. Malvino & Leach, “Digital Principles and Applications”, Tata McGraw Hill, 2010.
2. Morris Mano, “Digital Logic Design”, Prentice Hall, 2018.

D. Reference Books

1. H. Roth (Jr.), “Fundamentals of Logic design”, Cengage Engineering, 2013.
2. R L Morris & J R Miller, “Designing with TTL Integrated Circuits”, McGraw Hill, 1971.
3. R. P. Jain, “Modern Digital Electronics”, Tata McGraw Hill, 2009.
4. Anand Kumar, “Fundamentals of Digital Circuits”, Prentice Hall, 2014.
5. J Crowe & B. Hayes-Gill, “Introduction to Digital Electronics”, Butterworth-Heinemann, 1998.

E. Course Outcomes

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

1. Design and analyse combinational and sequential logic circuits.
2. Optimize combinational and sequential logic circuits

IVth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	EE-2201	DSC7-Electrical Machines-I	3	0	0	3
2	EC-2201	DSC8-Analog Circuits	3	0	0	3
3	EE-2202	DSC9-Power System -I	3	0	0	3
4	EC-220A EE-220A	DSE2-Signals and Systems DSE2-Digital Signal Processing	3	0	0	3
5	YY-220X	OE2*	3	0	0	3
6	MH-2201	SECC3-Entrepreneur Essential and Early Stage Start-up	3	0	0	3
7	EE-2203	Electrical Machine -I Laboratory	0	0	2	1
8	EE-2204	Power System -I Laboratory	0	0	2	1
9	EC-2204	Analog Circuits Laboratory	0	0	2	1
Contact Hours			18	0	6	
Total Credits						21

Subject Code: EE-2201
Subject Name: Electrical Machines-I
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

The course is designed to:

1. acquire knowledge about the fundamental principles and classification of electromagnetic machines.
2. acquire knowledge about the constructional details and principle of operation of dc machines.
3. acquire knowledge about the working of dc machines as generators and motors.
4. acquire knowledge about the constructional details, principle of operation, testing and applications of transformers.

B. Course Content:

Magnetic fields and magnetic circuits Review of magnetic circuits - MMF, flux, reluctance, inductance; review of Ampere Law and Biot Savart 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; influence of highly permeable materials on the magnetic flux lines.

Electromagnetic force and torque: B-H curve of magnetic materials; flux-linkage vs current characteristic of magnetic circuits; linear and nonlinear magnetic circuits; energy stored in the magnetic circuit; force as a partial derivative of stored energy with respect to position of a moving element; torque as a partial derivative of stored energy with respect to angular position of a rotating element. Examples -galvanometer coil, relay contact, lifting magnet, rotating element with eccentricity or saliency.

DC machines: Basic construction of a DC machine, magnetic structure - stator yoke, stator poles, pole-faces or shoes, air gap and armature core, visualization of magnetic field produced by the field winding excitation with armature winding open, air gap flux density distribution, flux per pole, induced EMF in an armature coil. Armature winding and commutation – Elementary armature coil and commutator, lap and wave windings, construction of commutator, linear commutation Derivation of back EMF equation, armature MMF wave, derivation of torque equation, armature reaction, air gap flux density distribution with armature reaction.

DC machine - motoring and generation: Armature circuit equation for motoring and generation, Types of field excitations – separately excited, shunt and series. Open circuit characteristic of separately excited DC generator, back EMF with armature reaction, voltage build-up in a shunt generator, critical field resistance and critical speed. V-I characteristics and torque-speed characteristics of separately excited, shunt and series motors. Speed control through armature voltage. Losses, load testing andback-to-back testing of DC machines.

Transformers: Principle, construction and operation of single-phase transformers, equivalent circuit, phasor diagram, voltage regulation, losses and efficiency Testing - open circuit and short circuit tests, polarity test, back-to-back test, separation of hysteresis and eddy current losses Three-phase transformer - construction, types of connection and their comparative features, Parallel operation of single-phase and three-phase transformers, Autotransformers - construction, principle, applications and comparison with two winding transformer, Magnetizing current, effect of nonlinear B-H curve of magnetic core material, harmonics in magnetization current, Phase conversion - Scott connection, three-phase to six-phase conversion, Tap-changing transformers - No-load and on-load tap-changing of transformers, Three-winding transformers. Cooling of transformers.

C. Text Books:

1. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 2013.
2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2004.

D. Reference Books:

1. M. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.
2. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
3. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.

E. Course Outcome:

At the end of this course, students will demonstrate the ability to:

1. understand the concepts of magnetic circuits.
2. understand the operation of dc machines.
3. analyse the differences in operation of different dc machine configurations.
4. analyse single phase and three phase transformers circuits.

Subject Code: EC-2201
Subject Name: Analog Circuits
Credit Value: 3 (L = 3, T = 0, P = 0)

A. Course Objectives

The objective of the course is:

1. To make the students understand the fundamentals of electronic circuits.
2. To train them to use the basic in important applications like Feedback network, oscillator and power amplifier

B. Course Content

Wave-shaping Circuits: Linear wave shaping circuits, RC high pass and low pass circuits with phase and frequency analysis, RC integrator and differentiator circuits, Piece-wise linear model of diode, Nonlinear wave shaping circuits, Rectifier, Series-shunt and two-level diode clipper circuits, Clamping circuits

Transistor Biasing and Thermal Stabilization: Need for biasing, Operating point, Load line analysis, Biasing methods, Stabilization against V_{BE}, Ic, and β, Stability factors, (S, S', S"), Bias compensation, Thermal runaway, Thermal stability, FET biasing methods and analysis.

Transistor Amplifiers & Frequency Response: Basic amplifier circuit, small signal analysis, Hybrid parameters, Phase splitter, low frequency and high frequency response amplifiers, Miller's theorem, Cascade/Cascade amplifiers

Power Amplifiers: Amplifier terms, two load lines, Class-A & Class-B operation, Class-B push pull emitter follower, Biasing class B/AB Amplifiers, Class B/AB driver, Class-C operation, Class-D operation.

Feedback Amplifier: Introduction, Basic concepts of feedback, Effect of negative feedback, Different topologies, Method of identifying feedback topology and feedback factor, Stability of feedback amplifier, Frequency response of the feedback amplifiers.

Oscillators: Conditions for oscillations, RC and LC type oscillators, Crystal oscillators, Frequency and amplitude stability of oscillators, Generalized analysis of LC oscillators, Quartz, Hartley, Colpitts, RC-phase shift and Wien-bridge oscillators.

C. Text Books

1. Millman and Halkias, Integrated Electronics, TMH, 2nd Edition, 2010
2. Salivahanan, Kumar, “Electronics Devices & Circuits”, Tata McGraw Hill

D. Reference Books

1. S. Sedra & K.C. Smith, “Microelectronic Circuits (5/e)”, Oxford, 2004.
2. L. Schilling & C. Belove, “Electronic Circuits: Discrete and Integrated”, (3/e), McGraw Hill, 1989.

E. Course Outcomes

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

1. Apply the knowledge of basic BJT and diode-based circuits
2. Characterize wave shaping circuits
3. Analyze the characteristics of oscillators, power amplifiers and feedback circuit
4. Design of test circuits for real time applications.

Subject Code: EE-2202
Subject Name: Power System -I
Credit Point: 3 [L=3, T=0, P=0]

A. Course Objectives:

The course is designed to:

1. impart the knowledge of generation of electricity based on conventional and non-conventional sources
2. enable the students to do analysis of different types of distribution systems and its design
3. make students capable of analysis of mechanical and electrical design aspects of transmission system

B. Course Content:

General layout of a typical coal fired power station, hydroelectric power station, nuclear power station, their components and working principles. Comparison of different methods of power generation. Introduction to solar and wind energy systems. **Overhead Transmission Line:** Choice of Voltage, Types of Conductors, Inductance and Capacitance of Single Phase and Three Phase symmetrical and unsymmetrical configurations, Bundle conductors, Transposition, Concept of GMD and GMR. Overhead line construction: Line supports, Towers, Poles, Sag, Tension and Clearance, Effect of Wind and Ice on Sag, Dampers.

Performance of lines: Short, medium (nominal π, T) and long lines and their representation. A, B, C, D constants, voltage regulation, Ferranti Effect, **Insulators:** Types, string Insulator efficiency and methods of its improvement. Corona: Principle of Corona formation, Critical disruptive voltage, Visual critical corona discharge potential, Corona loss, advantages and disadvantages of Corona, methods of reduction of Corona. **Distribution System:** Feeders and Distributors, radial and loop systems. Underground Cables: Types of cables, capacitance of single core and 3 core cables, dielectric stress, optimum cable thickness, grading, dielectric loss and loss angle.

C. Text Books:

1. Debapriya Das, Electrical Power Systems, New Age International Private Limited, 2016.
2. Grainger John, J. and Stevenson, Jr. W.D., "Power System Analysis", McGraw Hill, 2011.
3. Harder Edwin.I, "Fundamentals of Energy Production", John Wiley and Sons, 2008.
4. Deshpande, M.V., "Elements of Electric Power Station Design", A.H. Wheeler and Company, Ald 1979.
5. Wadhwa, C.L.,"Electric Power Systems", 6th Edition, Wiley Eastern Limited,2018.

D. Reference Books:

1. Nagrath,I.J. and Kothari, D.P., "Power System Engineering", Tata McGraw Hill, 1995
2. Electric Transmission and Distribution Reference Book", Westing house Electric Corporation: East Pittsburg, Pa, 1964.
3. BurkeJames,J.,"PowerDistributionEngineering;FundamentalsandApplications"MarcelDekk.,1996.
4. Hadi Saadat, "Power System Analysis", Tata McGraw Hill Edition, 2008.

E. Course Outcomes:

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

1. understand the various power generations
2. categorize transmission lines based on operational length and modelling techniques,
3. solve the problems complex network based on per unit system,
4. work on distribution networks and solve problems such as using bundle conductors.

Subject Code: EC-220A
Subject Name: Signals and Systems
Credit Value: 3 (L = 3, T = 0, P = 0)

A. Course Objectives

The objective of the course is:

1. Understanding the fundamental characteristics of signals and systems.
2. Understanding signals and systems in terms of both the time and transform domains, taking advantage of the complementary insights and tools that these different perspectives provide.
3. Analyze the spectral characteristics of signals using Fourier analysis.
4. development of the mathematical skills to solve problems involving convolution, filtering, modulation and sampling

B. Course Content

Signal and Systems: Introduction, Operations on signals, Classification of signals, Classification of systems, System model- input output description

Time Domain Analysis of Continuous Time Systems: Introduction, Convolution, System response to internal conditions - Zero input response, Unit impulse response, System response to external input- Zero state response, Classical solution of differential equations, System stability.

Continuous Time Signal Analysis - The Fourier Series: Periodic signal representation by trigonometric Fourier series, Existence and convergence of the Fourier series, Exponential Fourier series, properties, LTIC system response to periodic inputs

Continuous Time Signal Analysis - The Fourier Transform: Aperiodic signal representation by Fourier integral, Properties of FT, Transforms of some useful function, Frequency response of LTIC system.

Continuous Time System Analysis Using the Laplace Transform: Laplace transform, Relation to FT, Properties of Laplace transform, Solution of differential equations, Unilateral Laplace transform: Properties of the unilateral Laplace transform.

Sampling: Sampling theorem, Signal reconstruction.

Discrete Time System Analysis Using the Z-Transform: Discrete-time signals and systems, Z-transform (BZT & UZT) and its properties, Analysis of LTI systems using Z – transform.

C. Text Books

1. A. V. Oppenheim, A. Willsky, S. Hamid Nawab, "Signals and Systems (2/e)", Pearson 2000.
2. S. Haykin and B.Van Veen "Signals and Systems, Wiley, 2012.

D. Reference Books

1. S. S. Soliman & M. D. Srinath, "Continuous and Discrete Signals and Systems", Prentice- Hall, 1998.
2. M.Mandal and A.Asif, "Continuous and Discrete Time Signals and Systems, Cambridge, 2007.

E. Course Outcomes

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

1. Analyse the spectral characteristics of continuous-time periodic and a periodic signal using Fourier analysis.
2. Classify systems based on their properties and determine the response of LSI system using convolution.
3. Analyze system properties based on impulse response and Fourier analysis.
4. Apply the Laplace transform and Z- transform for analyze of continuous-time and discrete-time signals and systems.
5. Understand the process of sampling and the effects of under sampling

Subject Code: EE-220A
Subject Name: Digital Signal Processing
Credit Point: 1 **(**L=0, T=0, P=2)

A. Course Objectives

1. To understand the basic concept of frequency in continuous-time and discrete-time signals
2. To understand various transformation algorithm related to signals and systems

B. Course Content:

Introduction: Review of signals and systems, Concept of frequency in continuous-time and discrete-time signals, Analog to digital conversion.

Discrete time signals and systems: Discrete time signals, Discrete time systems, Analysis of discrete time linear time invariant systems, Convolution, Discrete time systems described by differential equations, Implementation of discrete time systems, Correlation of discrete time signals.

Discrete Time Fourier Transform (DTFT): DTFT **and its** Properties

Discrete Fourier Transform: Frequency domain sampling, Properties of DFT, Linear filtering methods based on DFT **Efficient computation of the DFT:** FFT algorithms, Linear filtering, Approach tocomputation of the DFT.

Implementation of Discrete-Time System: FIR system, IIR system

Design of Digital Filters: Design of FIR filters Design of IIR filters from analog filters,Frequency transformations.

C. Text Books

1. J.G.Proakis, D.G. Manolakis, "Digital Signal Processing", (4/e) Pearson, 2007.
2. A.V.Oppenheim & R.W.Schafer, "Discrete Time Signal processing", (2/e), PearsonEducation, 2003.
3. S.K.Mitra, "Digital Signal Processing (3/e)", Tata McGraw Hill, 2006

D. Reference Books

1. Ramesh Babu, "Digital Signal Processing", Scitech Publications (India) Pvt. Ltd.
2. P.S.R.Diniz, E.A.B.da Silva and S.L.Netto, "Digital Signal Processing", Cambridge,2002.
3. E.C.Ifeachor & B.W.Jervis, "Digital Signal Processing", (2/e), Pearson Education, 2002.
4. J.R.Johnson, "Introduction to Digital Signal Processing", Prentice-Hall, 1989

E. Course Outcomes

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

1. Classify different signals and systems and perform time domain analysis of LTIDTS.
2. Compute Convolution, Correlation of the signals.
3. Find DFT of a given signal through Fast Fourier Transform Techniques.
4. Design FIR and IIR type digital filters.
5. Identify filter structures and evaluate the coefficient quantization effects.

Subject Code: MH-2201
Subject Name: Entrepreneur Essential and Early-stage Start-up
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

The course is designed to meet the objectives of:

1. To involve themselves in the business activities
2. Starting innovative practices in their entrepreneurial activities.
3. Developing their skills on the traits that they want to carry forward.

B. Course Content:

Introduction to Entrepreneurship Meaning, Role of Entrepreneur, Entrepreneur Process: different approaches, Qualities of successful Entrepreneur, Functions of an Entrepreneur, Types of Entrepreneur, Issues & Problems Entrepreneurial Practices, Motivation for becoming an Entrepreneur. SME Concept, its role, status, prospects and policies for promotion of SMEs. Importance of Entrepreneurship: innovations, Qualities of successful Entrepreneur, Functions of an Entrepreneur, Types of Entrepreneurs, Issues & Problems Entrepreneurial Practices. Identifying and Assessing the Idea, Identifying Target Segment & Market Sizing, Analysing Environment & Competitive Advantage, Choosing the right legal structure, Permits, Registrations & Compliances, Components of a Business Plan, Creating an Effective B-Plan Part, Valuation, Investor pitch. Importance of Entrepreneurship: Entrepreneurship and Innovations, Converting Innovation to Economic Value which includes, Growth Strategies, value position, Market Segments, Value Chain Structure, Revenue Model, Contribution of Entrepreneurs: Towards R&D, creates Wealth of Nation & Self prospect with Challenge. Characteristics of Entrepreneurship idea generation techniques, Concept of product development, Business plan, Strategic Plan, issues and opportunity of early stage start-up etc.

C. Text Books:

1. Donald F. Kuratko, Entrepreneurship: Theory, Process, Practice Cengage Learning 2017
2. Desai, Vasant, Small Scale Industries and Entrepreneurship. Himalaya Publishing House, Delhi.2008
3. Kaulgud, Aruna Entrepreneurship Management. Vikas Publishing House, Delhi.2003
4. Cynthia, L. Greene. Entrepreneurship Ideas in Action. Thomson Asia Pvt. Ltd., Singapore. 2004

D. Reference Books:

1. Barringer Entrepreneurship: Successfully Launching New Ventures, Pearson Education Publishing 2015
2. Timmons, Jerry A., and Spinelli, Stephen, New Venture Creation: Entrepreneurship for the 21st Century, 8th Edition, Boston, MA: Irwin McGraw-Hill 2009.
3. Hisrich, Entrepreneurship, Tata McGraw Hill, New Delhi, 2001

E. Course Outcomes:

1. Start the venture more scientifically.
2. Start the venture by linking with the financial institutions.
3. Seeking for a start-up idea
4. To be an entrepreneurs

Subject Code: EE-2203
Subject Name: Electrical Machines-I Laboratory
Credit Point: 1 (L=0, T=0, P=2)

A. Course Objectives:

The course is designed to:

1. acquire knowledge about the fundamental principles and classification of electromagnetic machines.
2. acquire knowledge about the constructional details and principle of operation of dc machines.
3. acquire knowledge about the working of dc machines as generators and motors.
4. acquire knowledge about the constructional details, principle of operation, testing and applications of transformers.

B. List of Practical:

1. Open Circuit Characteristics of a DC Shunt Generator.
2. Characteristics of a separately excited D.C Generator.
3. Characteristics of a D.C shunt motor
4. Speed control of a D.C motor.
5. Characteristics of a compound D.C generator (short shunt).
6. Measurement of the speed of a D.C series motor as a function of load torque.
7. Equivalent circuit of a single-phase transformer.
8. Predetermination of efficiency of a DC motor (Swinburn's test)
9. Testing the efficiency of a DC motor |(Hopkinson's test)
10. Retardation (Run-Down) test on a DC shunt motor (to find the stray losses)
11. Separation of Core Losses

C. Course Outcome:

At the end of this course, students will demonstrate the ability to:

a. construct the equivalent circuit of transformers and predetermine the characteristics
b. analyse the performance characteristics of DC machines and Transformers
c. implement speed control of DC Machines
d. realize three phase transformer connections

Subject Code: EE-2204
Subject Name: Power System -I Laboratory
Credit Point: 1 [L=0, T=0, P=2]

A. Course Objectives:

The course is designed to:

1. impart the knowledge of generation of electricity based on conventional and non-conventional sources
2. enable the students to do analysis of different types of distribution systems and its design
3. make students capable of analysis of mechanical and electrical design aspects of

transmission system

B. List of Practical:

1. Demonstration of various parts of TLS (Transmission line simulator) and it's working.
2. PU modelling of the given transmission line on given base value.
3. Calculating simulator impedance values to model the given transmission line.
4. Ferranti effect in the given line using TLS.
5. Calculating surge impedance of the given transmission line.
6. Estimating loading capability of the line and voltage regulation at given power factor.
7. Calculating shunt capacitive compensation to improve receiving end voltage and power factor.

C. Text Books:

1. Debapriya Das, Electrical Power Systems, New Age International Private Limited, 2016.
2. Grainger John, J. and Stevenson, Jr. W.D., "Power System Analysis", McGraw Hill, 2011.
3. Harder Edwin.I, "Fundamentals of Energy Production", John Wiley and Sons, 2008.
4. Deshpande, M.V., "Elements of Electric Power Station Design", A.H. Wheeler and Company, Ald 1979. Wadhwa, C.L.,"Electric Power Systems", 6th Edition, Wiley Eastern Limited,2018.

D. Reference Books:

1. Nagrath,I.J. and Kothari, D.P., "Power System Engineering", Tata McGraw Hill, 1995
2. Electric Transmission and Distribution Reference Book", Westing house Electric Corporation: East Pittsburg, Pa, 1964.
3. BurkeJames,J.,"PowerDistributionEngineering;FundamentalsandApplications"MarcelDekk.,1996.

E. Course Outcomes:

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

1. understand the various power generations
2. categorize transmission lines based on operational length and modelling techniques,
3. solve the problems complex network based on per unit system,
4. work on distribution networks and solve problems such as using bundle conductors.

Subject Code: EC-2204
Subject Name: Analog Circuits Laboratory
Credit Value: 1 (L = 0, T = 0, P = 2)

A. Course Objectives:

The objective of the course is:

1. To make the students understand the fundamentals of electronic circuits.
2. To train them to use the basic in important applications like Feedback network, oscillator and power amplifier

B. Course Content:

1. Study and Implement RC Low Pass and High Pass Filter Circuits.
2. Study and Implement RC Integrator / Differentiator Circuits.
3. Study and Implement BJT/FET biasing methods.
4. Study and Implement RC-Phase shift and wien-bridge oscillator.
5. Study and Implement Class A/B/AB/C amplifier
6. Study and Implement push pull amplifier

C. Text Books

1. Malvino and D. Bates, Electronic Principles, McGraw-Hill, 2015
2. Horowitz and W. Hill, The Art of Electronics, Cambridge University Press, 2015.
3. Millman and A. Grabel, Micro Electronics, TMH, 2nd Edition, 2009.

D. Reference Books

1. S. Sedra & K.C.Smith, "Microelectronic Circuits (5/e)", Oxford, 2004.
2. L. Schilling & C. Belove, "Electronic Circuits: Discrete and Integrated", (3/e), McGraw Hill, 1989.
3. K.V. Ramanan, "Functional Electronics", Tata McGraw Hill ,1984

E. Course Outcomes

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

1. Design and implement filters
2. Design and implement integrators and differentiators.
3. Design and implement oscillators, power amplifiers and feedback circuit

Vth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	EE-3101	DSC10-Electrical Machines-II	3	0	0	3
2	EE-3102	DSC11-Power System - II	3	0	0	3
3	EE-3103	DSC12-Power Electronics	3	0	0	3
4	EC-310A EE-310A	DSE3- Microprocessors and Interfacing DSE3- Embedded Systems	3	0	0	3
5	YY-310X	OE3*	3	0	0	3
6	EE-3104	AECC1-Internship-I	0	0	0	1
7	MH-3101	SECC4-Engineering Economics	3	0	0	3
8	EE-3105	VAC4-Minor Project-I	0	0	4	2
9	EE-3106	Electrical Machines-II Laboratory	0	0	2	1
10	EE-3107	Power System-II Laboratory	0	0	2	1
11	EE-3108	Power Electronics Laboratory	0	0	2	1
Contact Hours			18	0	12	
Total Credits						24

Subject Code: EE-3101
Subject Name: Electrical Machines-II
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

The course is designed to:

1. study construction and operation of AC Electrical Machines,
2. calculation of machine parameters and modelling,
3. brief study of special electrical motors (PMBL), etc.,
4. introduce theory of machine control and practical applications.

B. Course Content:

Fundamentals of AC machine windings: Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single turn coil - active portion and overhang; full-pitch coils, concentrated winding, distributed winding, winding axis, 3D visualization of the above winding types, Air-gap MMF distribution with fixed current through winding - concentrated and distributed, Sinusoidally distributed winding, winding distribution factor

Pulsating and revolving magnetic fields: Constant magnetic field, pulsating magnetic field - alternating current in windings with spatial displacement, Magnetic field produced by a single winding - fixed current and alternating current Pulsating fields produced by spatially displaced windings, Windings spatially shifted by 90degrees, Addition of pulsating magnetic fields, three windings spatially shifted by 120degrees (carrying three-phase balanced currents), revolving magnetic field.

Induction Machines: Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly-Fed Induction Machines.

Single-phase induction motors: Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications

Synchronous machines: Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine – two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.

C. Text Books:

1. E. Fitzgerald and C. Kingsley, "Electric Machinery", McGraw Hill Education, 2013.
2. G. Say, "Performance and design of AC machines", CBS Publishers, 2002.

D. Reference Books:

1. P. S. Bimbhra, "Electrical Machinery", Khanna Publishers, 2011.
2. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 2010.
3. A. S. Langsdorf, "Alternating current machines", McGraw Hill Education, 1984.
4. P. C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley and Sons,
   2007.

E. Course Outcome:

At the end of this course, students will demonstrate the ability to:

1. understand the concepts of rotating magnetic fields.
2. understand the operation of ac machines.
3. analyse performance characteristics of ac machines.

Subject Code: EE-3102
Subject Name: Power System -II
Credit Point: 3 [L=3, T=0, P=0]

A. Course Objectives:

The course is designed to:

1. introduce students to the concepts of performance of power system under various faults, like LG, LLG, LLL, LLLG etc. and their effects on power system, Single line diagram for fault analysis, tools for analysing faults in power system, Symmetrical components,

Unsymmetrical faults, PU system, Positive, Negative and Zero sequences components, Z bus formation,

2. analysis the power system under various faults. And to solve this power system constraint which are the tools to make use of. Solving faults problems has become a new challenged to power Engineers,
3. introduce the advent of powerful symmetrical components has become very useful tools to solve these constrains. Recognizing the importance of concepts of fault analysis in power system, this module is can be introduced in the Electrical Engineering curriculum

B. Course Content:

Introduction to protective devices: Different types of electromagnetic relays, Circuit Breakers, Isolators, Lightning arrestors.

Nature of Faults in Electrical systems: Symmetrical fault: Short circuit of a synchronous machine with no load and load, Symmetrical components transformation. Sequence impedance and sequence network of power system, synchronous machine, transmission lines and transformers. Representation of sequence network of power system. **Unsymmetrical faults:** Single line to ground, line to line, double line to ground fault.

Power system dynamics: Steady state stability, transient stability, equal area criterion, swing equation, multi-machine stability concept.

Tariff: Guiding Principle of Tariff, different types of tariff. Indian Electricity Rules-2003 – General Introduction.

C. Text Books:

1. Debapriya Das, Electrical Power Systems, New Age International Private Limited, 2016.
2. Grainger John, J. and Stevenson, Jr. W.D., "Power System Analysis", McGraw Hill, 2011.
3. Harder Edwin.I, "Fundamentals of Energy Production", John Wiley and Sons, 2008.
4. Hadi Saadat, "Power System Analysis", Tata McGraw Hill Edition, 2008.
5. Wadhwa, C.L.,"Electric Power Systems", 6th Edition, Wiley Eastern Limited,2018.

D. Reference Books:

1. Nagrath,I.J. and Kothari, D.P., "Power System Engineering", Tata McGraw Hill, 1995
2. Electric Transmission and Distribution Reference Book", Westing house Electric Corporation: East Pittsburg, Pa, 1964.
3. BurkeJames,J.,"PowerDistributionEngineering;FundamentalsandApplications"MarcelDekk.,1996.

E. Course Outcomes:

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

1. do fault Analysis, this is the study of methods for solving problems of number of faults in power system,
2. know analysis of symmetrical components and per unit system and their implementation in solving power system faults.
3. knowledge of load flow studies, system dynamics and Electricity Rules

Subject Code: EE-3103
Subject Name: DSC12-Power Electronics
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To introduce students to the basic theory of power semiconductor devices and passive components, their practical applications in power electronics.
2. Understand advanced topics of different types of Power Converters.
3. To familiarize students to the principle of operation, design and synthesis of different power conversion circuits and their applications.
4. To familiarize students to the principle of operation, design and synthesis of different power conversion circuits and their applications.

B. Course Content:

Power semiconductor devices:

Introduction: Concept of Power Electronics, scope and applications, desired Characteristics of controllable switches Power semiconductor switches and their characteristics: Power Diode, Power BJT, Power MOSFET, IGBT, SCR, TRIAC, GTO.

Thyristor: Rating and protection, Methods of SCR commutation, Gate Drive Circuit, Series and Parallel operation.

DC-DC Converters:

Introduction, Control Strategies, Buck converter, Boost Converter, Buck-Boost converter, Analysis of buck converter, Special Types of DC-DC converters-CUK and SEPIC converter, Switched Mode power Supply (SMPS).

Phase Controlled Converters:

Single phase half wave-controlled rectifier with various loads, Effect of freewheeling diode. Single phase fully controlled and half controlled bridge converters with various loads. Performance Parameters of single phase uncontrolled and controlled converters. Three phase half wave converters, three phases fully controlled and half controlled bridge converters, Effect of source impedance, Single phase and three phase dual converters.

AC Voltage Controllers:

Principle of On-Off and phase controls, Single phase ac voltage controller with resistive and inductive loads, sequence control, Introduction to Matrix converter. **Cyclo-Converters:**

Basic principle of operation, single phase to single phase, three phases to single phase output voltage equation

Inverters:

Single phase and Three phase bridge inverters, VSI, CSI, Voltage control of single-phase inverters, Series and Parallel inverter-Analysis of basic series inverter, Modified series inverter, Half bridge series inverter, PWM Techniques, Introduction to Multi level inverter.

Applications:

Speed control of AC and DC motors. HVDC transmission. Static circuit breaker, UPS, static VAR controller.

C. Text Books:

1. M.H. Rashid, "Power Electronics: Circuits, Devices and Applications", Pearson India, 4th Edition, 2018.
2. P.S. Bhimbra, "Power Electronics", Khanna Publishers, 2010.
3. Ned Mohan, T. M. Undeland and W. P. Robbins, "Power Electronics: Converters, Applications and Design", Wiley India Ltd, 2018.
4. D.W. Hart, "Power Electronics", Tata McGraw Hill edition 2014.
5. P.C. Sen, "Power Electronics", McGraw Hill Education (India) Pvt. Ltd.
6. M.S. Jamil Asghar, "Power Electronics", Prentice Hall of India Ltd., 2004

D. Reference Books:

1. B.W. Williams, "Power Electronics, Devices Drivers and Application" Wiley New York, 1987.
2. R. Pelley, "Thyristor Phase controlled converters and cyclo-converters", Wiley Inter science, 1971.
3. R. Hnatek, "Design of Solid-State Power Supplies", Van Nostrand Reinhold New York 1989.
4. Kenjo, "Power Electronics for the Microprocessor Age", Oxford University Press New York 1990.
5. Bausiere, F. Labrique and G. Seguier, "Power Electronics Converters: DC-DC Conversion", Springer-Verlag, 1993.

E. Course Outcomes:

At the end of this course, students will demonstrate the ability to:

1. relate basic semiconductor physics to properties of power devices, and combine circuit mathematics and characteristics of linear and non-linear devices.
2. compare the performance of basic power semiconductor devices any analyse their circuit performance.
3. analyse and identify power converters for particular system application.
4. recognize the role of power electronics in different renewable energy applications and their importance in different emerging research areas.
5. Identify the critical areas in application levels and derive typical alternative solutions, select suitable power converters to control Electrical Motors and other industry grade apparatus.

Subject Code: EC-310A
Subject Name: Microprocessor and Interfacing
Credit Value: 3 (L = 3, T = 0, P = 0)

A. Course Objectives

1. To introduce students to basic concepts of microprocessor
2. To give a knowledge on Assembly Level Language.
3. To introduce interfacing of peripheral with microprocessor.

B. Course Content

Introduction: Microcomputer structure and operation, 8086 microprocessor family, Overview, Architecture of processor 8085 and 8086.

Assembly Language Programming: Programming development steps, Constructing machine development codes for 8085 and 8086 instructions, Assembly language program development tools.

Strings, Procedure and Macros: String instructions, Writing and using procedures, writing and using assembler macros

Instruction Description and Assembler Directives: Instruction descriptions, Assembler directives systems connections, Timing and troubleshooting: Basic 8086 microcomputer systems connections, Logic analyzer to observe microprocessor bus signals, Troubleshooting simple 8086-based microcomputer.

Peripheral Interfacing Applications: Basic interfacing concepts, Memory / IO interfacing, non-programmable peripheral interface, 8255 programmable peripheral interface, Interfacing display, Keyboards, 8279 programmable keyboard / display interface, 8253/54 programmable timer, DMA controller, Interrupt controller, ADC and DAC interfacing, 8086 interrupts and types, 8259A priority interrupt controller, Software interrupt applications.

Memories, Coprocessors and EDA Tools: 8086 maximum mode and DMA data transfer, Interfacing and refreshing dynamic RAMs, Coprocessor - 8087 Math coprocessor, Computer based design and development tools.

C. Text Books

1. Sunil Mathur, "Microprocessor 8085 and its Interfacing", PHI.
2. Sunil Mathur, "Microprocessor 8086: Architecture, Programming and Interfacing", PHI.
3. Gaonkar R. S., "Microprocessor Architecture, Programming and Applications with 8085", Penram International.

D. Reference Books

1. Ram B., "Fundamental of Microprocessor & Microcomputers", Dhanpat Rai Publications.
2. Leventhal Lance, "Introduction to Microprocessor - Software, Hardware and Programming", PHI.
3. Mathur A. P., "Introduction to Microprocessor", Tata McGraw-Hill.
4. Short K. L., "Microprocessor and Programming Logic", Pearson Education.
5. Hall D., "Microprocessor and Interfacing", Tata McGraw-Hill.

E. Course Outcomes

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

1. Students will have the thorough understanding of the evolution of microprocessor
2. Students will get to know the interfacing knowledge to get a kick start in embedded world.
3. Students will get the idea of doing lively embedded design projects.

Subject Code: EE310A
Subject Name: Embedded Systems
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives

The course has been designed:

1. analysis, optimization, and implementation of embedded systems,
2. enabling the students to adapt to a changing environment with the widespread use of embedded systems,

B. Course Content:

Introduction to Embedded Systems Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.

Typical Embedded System: Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the Type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface: Onboard and External Communication Interfaces.

Embedded Firmware: Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages.

RTOS Based Embedded System Design: Operating System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling. Task Communication: Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/Synchronization Issues, Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.

C. Text Books:

1. Embedded Systems - Raj Kamal, TMH.
2. Embedded System Design - Frank Vahid, Tony Givargis, John Wiley.
3. Embedded Systems – Lyla, Pearson, 2013

D. Reference Books:

1. An Embedded Software Primer - David E. Simon, Pearson Education.
2. Introduction to Embedded Systems - Shibu K.V, Mc Graw Hill

E. Course Outcome:

At the end of this course, students will:

1. obtain the knowledge, skills and capabilities necessary for immediate employment in developing embedded systems,
2. as participants in embedded development teams,
3. as effective participants such as robotics, mechatronics in a multidisciplinary team

Subject Code: MH-3101
Subject Name: Engineering Economics
Credit Point: 3 (L=3, T=0, P=0)

A. Course objectives:

The course is design to meet the following objectives:

1. Learn the fundamentals of Engineering Economics
2. Understand and use of Economic concepts in making business decision
3. Use economic information to manage the organization
4. Use economic tools with respect to acceptance or rejection of investment proposals
5. Know the current issues relating to economic environment

B. Course content:

Basics of Economics: Basic Concepts, Scope, Importance and definitions, Relevant to Managerial Economics-Factors Influencing Managerial Decision — Managerial economics and other disciplines, Relation between Science, Engineering, Technology and Economics Demand Analysis : Managerial Decisions-Meaning-Types—Determinants, Demand Functions,Demand Elasticity, Demand Forecasting Methods, Accuracy of Forecasting Cost concept :Costs Concepts-Accounting Cost and Economic Cost determinants of Cost, Cost —Output Relationship, Break Even Analysis- Meaning, Assumption, Uses and Limitation, Break Even Point (BEP)- Meaning, Determinants of Break Even Point- Break Even Charts, linear approach (Simple numerical problems to be solved). Market Structure and Product Pricing :Perfect and Imperfect Market Structures. Conditions of Perfect Competition. Price of a Product under demand and supply forces. Equilibrium Price. Pricing under Monopoly and Monopolistic Competition. Pricing under Oligopoly. Kinked Demand Curve. Discriminating Prices. Inflation, Business cycle, Nation alI income: Inflation- meaning, feature, Types, causes, Effects of Inflation, Measures to Control Inflation. Business Cycle - Features of Business Cycle, Causes of Business Cycle, Types of Business Cycle, Theories of Business Cycle, Impacts/ Effects of Business Cycle, Measures to Control Business cycle, National Income & Current Issues- Concepts of National Income, Factors Determining Level (Size)of National Income, Methods of Measurement of National Income, Choice of Methods of National Income, Importance of Measurement of National Income, Difficulties in Measuring National Income.

C. Text Books:

1. Park, S. Chan, Fundamentals of Engineering Economics, Fourth Edition, Pearson New York, 2019
2. Yates, J.K. Engineering Economics, 1st Edition, CRC Press, Boca Raton, 2016.
3. Brajesh Kumar, Zahid A.Khan, Arshad N. Siddiquee, Mustufa H. Abidi , Principles of Engineering Economics with Applications, Cambridge University Press; 2nd edition 2018
4. Singh, Seema, Economics for Engineering Students, Second Edition. I.K. International Publishing House, Delhi, 2014.

D. Reference Books:

1. Panneer Selvam, Engineering Economics, Second Edition, New Delhi, PHI Learning Private Limited,2013.
2. Pravin Kumar, Fundamentals of Engineering Economics, New Delhi, John, and Wile y ,2012.
3. Gupta , G.S. Managerial Economics, Joel Dean, Englewood Cliffs, N.J.: Prentice-. Hall, 2011
4. Diwedi, D.N., Managerial Economics, New Delhi, Pearson Education India,2012. 5. Varshney, S.C., Managerial Economics, New Delhi Sultan Chand & Sons, 2010

E. Course outcomes:

1. Learn the fundamentals of Engineering Economics.
2. Understand and use of Economic concepts in making business decision.
3. Use economic information to manage the organization.
4. Use economic tools with respect to acceptance or rejection of investment proposals.
5. Know the recent trends relating to economic environment.

Subject Code: EE-3106
Subject Name: Electrical Machines -II Laboratory
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

The course is designed to:

1. study construction and operation of AC Electrical Machines,
2. calculation of machine parameters and modelling,
3. brief study of special electrical motors (PMBL), etc.,
4. introduce theory of machine control and practical applications.

B. Course Content:

1. Different methods of starting of 3 phase squirrel cage Induction motor and their comparison [D.O.L, Auto transformer and Star-Delta].
2. Speed control of 3 phase squirrel cage induction motor by different methods and their comparison [voltage control and frequency control].
3. Speed control of three phase slip ring Induction motor by rotor resistance control.
4. Determination of regulation of Synchronous machine by Potier reactance method.
5. Determination of regulation of an Alternator by Synchronous Impedance method.
6. Determination of equivalent circuit parameters of a single-phase Induction motor.
7. Load test on single phase slip ring induction motor to obtain the performance characteristics
8. Determination of direct axis reactance [X_d] and quadrature axis reactance [X_q] of three phase synchronous machine by slip test.
9. Performance characteristics of wound rotor induction motor by direct loading.

C. Course Outcome:

At the end of this course, students will demonstrate the ability to:

1. construct the equivalent circuit of induction motors and predetermine the characteristics
2. analyze the performance characteristics of synchronous and asynchronous machines.
3. control asynchronous motors
4. demonstrate the connection of synchronous and asynchronous machines to infinite bus bar.

Subject Code: EE-3107
Subject Name: Power System -II Laboratory
Credit Point: 1 [L=0, T=0, P=2]

A. Course Objectives:

The course is designed to:

1. introduce students to the concepts of performance of power system under various faults, like LG, LLG, LLL, LLLG etc. and their effects on power system, Single line diagram for fault analysis, tools for analysing faults in power system, Symmetrical components, Unsymmetrical faults, PU system, Positive, Negative and Zero sequences components, Z bus formation,
2. analysis the power system under various faults. And to solve this power system constraint which are the tools to make use of. Solving faults problems has become a new challenged to power Engineers,
3. introduce the advent of powerful symmetrical components has become very useful tools to solve these constrains. Recognizing the importance of concepts of fault analysis in power system, this module is can be introduced in the Electrical Engineering curriculum

B. Course Content:

1. Demonstration of various parts of TLS (Transmission line simulator) and it's working.
2. PU modelling of the given transmission line on given base value.
3. Calculating simulator impedance values to model the given transmission line.
4. Ferranti effect in the given line using TLS.
5. Calculating surge impedance of the given transmission line.
6. Estimating loading capability of the line and voltage regulation at given power factor.

C. Text Books:

1. Debapriya Das, Electrical Power Systems, New Age International Private Limited, 2016.
2. Grainger John, J. and Stevenson, Jr. W.D., "Power System Analysis", McGraw Hill, 2011.
3. Harder Edwin.I, "Fundamentals of Energy Production", John Wiley and Sons, 2008.
4. Deshpande, M.V., "Elements of Electric Power Station Design", A.H. Wheeler and Company, Ald 1979.
5. Wadhwa, C.L.,"Electric Power Systems", 6th Edition, Wiley Eastern Limited,2018.

D. Reference Books:

1. Nagrath,I.J. and Kothari, D.P., "Power System Engineering", Tata McGraw Hill, 1995
2. Electric Transmission and Distribution Reference Book", Westing house Electric Corporation: East Pittsburg, Pa, 1964.
3. BurkeJames,J.,"PowerDistributionEngineering;FundamentalsandApplications"MarcelDekk.,1996.

E. Course Outcomes:

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

1. Understand the various types of ASCR used for power transmission,
2. know various parameters of transmission line
3. understand and observed Ferranti effects in transmission line
4. knowledge of load flow studies, system dynamics

Subject Code: EE-3108
Subject Name: Power Electronics Laboratory
Credit Point: 1 (L=0, T=0, P=2)

A. Course Objectives:

1. Understand advanced topics of power electronics.
2. To familiarize students to the principle of operation, design and synthesis of different power conversion circuits and their applications.
3. Acquire knowledge of power quality mitigation devices.
4. To familiarize students to the principle of operation, design and synthesis of different power conversion circuits and their applications.

B. Course Content:

1. Study of IGBT, MOSFET, BJT switching characteristics.
2. Triggering circuits for SCR, MOSFET, IGBT, BJT & UJT.
3. Experimental Evaluation of Class-A, Class-B, Class-C, Class-D and Class-E commutation of thyristor.
4. Experimental Evaluation of Step-Up chopper circuit.
5. Experimental Evaluation of Step-Down Chopper circuit.
6. Experimental Evaluation of Voltage commutated chopper circuit.
7. Experimental Evaluation of Single-phase full phase-controlled rectifier with R Load, R-L Load and RLE load.
8. Experimental Evaluation of Single-phase full bridge Inverter.
9. Experimental Evaluation of Current source inverter circuit.
10. Experimental Evaluation of single-phase AC voltage controller.
11. Experimental Evaluation of single phase PWM control.
12. Experimental Evaluation of single phase cyclo-converter.

C. Course Outcomes:

1. identify different simulation and analytical soft-wares for power electronics application
2. analyse simulation results and do effective documentation.

3. develop skills for designing, simulating and developing hard-wares for power electronic circuits.
4. acquire expertise in usage of modern power electronic hardware and software tools.
5. recognize the role power electronics play in the improvement of energy usage efficiency and the applications of power electronics in emerging areas.

VIth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	EE-3201	DSC13-Electrical Drives	3	0	0	3
2	EE-3202	DSC14-Linear Control System	3	0	0	3
3	EE-3203	DSC15-Switchgear and Protection	3	0	0	3
4	EE-320A EE-320B	DSE4-Utilization of Electrical Power DSE4:Energy Management and Auditing	3	0	0	3
5	EE-321A EE-321B	DSE5-Power System Operation and Control DSE5-HVAC Transmission Systems	3	0	0	3
6	YY-320X	OE4*	3	0	0	3
7	EE-3204	VAC5-Minor Project-II	0	0	4	2
8	EE-3205	Electrical Drives Laboratory	0	0	2	1
9	EE-3206	Linear Control Systems Laboratory	0	0	2	1
10	EE-3207	Switchgear and Protection Laboratory	0	0	2	1
Contact Hours			18	0	10	
Total Credits						23

Subject Code: EE-3201
Subject Name: DSC13-Electrical Drives
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To expose students to the operation, application and control of power conversion systems employing electric drive to cater to industrial needs.
2. To familiarize the operation principles, and design of starting, braking, and speed control arrangements for electric motors and their applications.
3. To provide strong foundation to asses performance of different industrial drives considering issues such as, energy efficiency, power quality, economic justification, environmental issues, and practical viabilities.

B. Course Content:

Fundamentals of Electric Drive:
Electric Drives and its parts, advantages of electric drives Classification of electric drives Speed-torque conventions and multi-quadrant operations Constant torque and constant power operation Types of load Load torque: components, nature and classification**.**

Dynamics of Electric Drive:
Dynamics of motor-load combination Steady state stability of Electric Drive Transient stability of electric Drive.

Selection of Motor Power rating:
Thermal model of motor for heating and cooling, classes of motor duty, determination of motor power rating for continuous duty, short time duty and intermittent duty. Load equalization.

Electric Braking:
Purpose and types of electric braking, braking of DC, three phase induction and synchronous motors Dynamics During Starting and Braking: Calculation of acceleration time and energy loss during starting of DC shunt and three phase induction motors, methods of reducing energy loss during starting. Energy relations during braking, dynamics during braking.

Power Electronic Control of DC Drives:
Single phase and three phase controlled converter fed separately excited DC motor drives (continuous conduction only), dual converter fed separately excited DC motor drive, rectifier control of DC series motor. Supply harmonics, power factor and ripples in motor current Chopper control of separately excited DC motor and DC series motor.

Power Electronic Control of AC Drives:
Three Phase induction Motor Drive: Static Voltage control scheme, static frequency control scheme (VSI, CSI, and cyclo – converter based) static rotor resistance and slip power recovery control schemes.

Three Phase Synchronous motor: Variable frequency control, Self Control, Voltage source inverter fed synchronous motor drive, Vector control.

Special Drives: Switched Reluctance motor, Brushless dc motor. Selection of motor for particular applications. Introduction to Solar and Battery Powered Drive.

Industrial application: Drive consideration for Textile mills, Steel rolling mills, Cement mills, Paper mills, Machine tools. Cranes & hoist drives.

C. Text Books:

1. G.K. Dubey, "Fundamentals of Electric Drives", Narosa publishing House, 2010.
2. S.K. Pillai, "A First Course on Electric Drives", New Age International, 2015.
3. B.N. Sarkar, "Fundamental of Industrial Drives", Prentice Hall of India Ltd, 2010.
4. Subrahmanyam, "Electric Drives: Concepts and Applications", Tata McGraw Hill, 2018.

D. Reference Books:

1. Chilkin, "Electric Drives",Mir Publishers, Moscow, 2008.
2. Mohammed A. El-Sharkawi, "Fundamentals of Electric Drives", Thomson Asia, Pvt. Ltd. Singapore, 2008.
3. N.K. De and Prashant K. Sen, "Electric Drives", Prentice Hall of India Ltd, 2005.
4. Bose K Bimal, "Modern Power Electronics & AC Drives", Prentice Hall of India Ltd, 2001.

E. Course Outcomes:

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

1. Understand the various drive mechanisms and methods for energy conservation.
2. Apply power electronic converters to control the speed of DC motors and induction motors.
3. Evaluate the motor and power converter for a specific application.
4. Develop closed loop control strategies of drives
5. Design and justify new control and power conversion schemes for implementing alternative solutions considering the critical and contemporary issues.

Subject Code: EE-3202
Subject Name: Linear Control Systems
Credit Point: 3 [L=3, T=0, P=0]

A. Course Objectives:

The course is designed:

1. To enable the students to carry out mathematical modelling of any given physical systems and thereby to analyse the time response and frequency response of the considered systems.
2. To impart knowledge on stability of systems and to control the systems.
3. To inculcate skill on the design of controllers and feedback modelling with state variable analysis.

B. Course Content:

Introduction to Systems: Mathematical models of physical systems - Control hardware and their models - Transfer Function models of linear time-invariant systems – Industrial Control examples. **Feedback Control:** Open-Loop and Closed-loop systems. Benefits of Feedback. Block diagram algebra. **Standard test signals:** Time response of first and second order systems for standard test inputs - Application of initial and final value theorem. Design specifications for second-order systems based on the time-response. **Concept of Stability**: Routh-Hurwitz Criteria. Relative Stability analysis. Root-Locus technique. Construction of Root-loci. **Frequency response analysis:** Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin - closed-loop frequency response. Root-loci method of feedback controller design. Design specifications in frequency domain. **Design of Controllers and Compensators:** Application of Proportional, Integral and Derivative Controllers - Lead and Lag compensation in designs - Analog and Digital implementation of controllers. **State Variable Analysis:** Concepts of state variables - State space model - Diagonalization of State Matrix - Solution of state equations - Eigenvalues and Stability Analysis - Concept of controllability and observability. **Design in State Space Analysis:** Pole-placement by state feedback. Discrete-time systems. Difference Equations. State-space models of linear discrete-time systems. Stability of linear discrete-time systems. Performance Indices. Regulator problem, Tracking Problem. Nonlinear system–Basic concepts and analysis.

C. Text Books:

1. Norman.S.Nise, “Control Systems Engineering”, Wiley India Edition, 2018.
2. M. Gopal, “Control Systems: Principles and Design”, McGraw Hill Education, 4th Edition, 2012.
3. Farid Golnarghi & Benjamin. C. Kuo, “Automatic Control System”, McGraw Hill Education, 1st Edition, 2018.

D. Reference Books:

1. Katsuhiko Ogata, “Modern Control Engineering”, Pearson Education India, 5th Edition, 2015.
2. Richard.C.Dorf & Robert.H.Bishop, “Modern Control Systems”, Pearson Education India, 15th Edition, 2013.

3. S.N.Sivanandam & S.N.Deepa, "Problems & Solutions in Control System Engineering", Jaico Publishing House, 1st Edition, 2005.

E. Course Outcomes:

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

1. Understand the modelling of linear-time-invariant systems using transfer function and state-space representations.
2. Understand the concept of stability and its assessment for linear-time invariant systems.
3. Design simple feedback controllers and compensators
4. Model state variable design-based controllers

Subject Code: EE-3203
Subject Name: Switchgear and Protection
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

The course is designed to meet with the objectives of:

1. fundamentals of protection equipment used in power systems, concept of primary and backup relaying,
2. Imparting theoretical and practical knowledge of modern switchgear and current trends in protective relaying,
3. Constructional Features and testing methodologies of AC and DC Circuit breakers.

B. Course Content:

Introduction:

Requirement of circuit breakers, characteristics of an electric arc, principle of AC and DC arc interruption, Recovery voltage, re-striking voltage and effect of current asymmetry upon them, current chopping, resistance switching.

Protection Schemes: Need for protective systems, Component of protective systems, Zones of protection, Importance of protective relaying for power systems, fundamental requirements of a good protection scheme–Primary and Back-up Relaying and Instruments Transformers.

Circuit Breakers:

Types of AC and DC circuit breakers in general, oil circuit breaker, plain break and controlled break, minimum oil circuit breaker, air blast circuit breaker, vacuum and SF6 circuit breaker, introduction to miniature case circuit breaker and moulded case circuit breaker, Calculation of fault MVA for symmetrical short circuits and determination of circuit breaker capacity, circuit breaker ratings.

Substation and Earthing:

Types of substations, arrangement of circuit breakers, isolators and bus bars, limiting reactors in power system, Methods of neutral grounding (solid earthing, resistance earthing and Peterson coil earthing and its effects on fault conditions). H.R.C, Fuse, its construction, capacity and characteristics.

Protective Devices:
Philosophy of protection, requirement of ideal protective scheme, definition of different terms in protective systems, Basic elements in protective scheme, Construction and Principle of operations of Electromagnetic type, induction type: over current, directional, distance relays.

Alternator Protection:
Different types of faults, differential protection with biasing, restricted earth fault protection, negative sequence protection, automatic field suppression and neutral circuit breakers.

Transformer Protection:
Buchholz relay, Biased differential protection, restricted earth fault protection, harmonic restraint, protection of combined alternator and transformer.

Bus Bar Protection: Differential scheme for both phase and line faults, frame leakage scheme, introduction to digital protective relay and microprocessor based relays.

Feeder protection:
Time graded protection: radial, parallel and ring feeders; over current and earth fault protection, calculation of graded time setting, split core protection of feeders, carrier current protection and introduction to microwave pilot system, arrangement of relay contacts.

Pilot Wire Protection:
Circulating current differential protection (Merz-Price protection), Biased or percentage differential protection scheme, opposed (balanced) voltage differential protection system, Translay scheme; static relays.

Protection Against Surges: Ground wire, Surge diverters: rod gap, horn gap lighting arresters; surge absorbers.

C. Text Books:

1. Rao Sunil S., Switchgear Protection and Power Systems, Khanna Publishers, 2009.
2. B Rabindranath and M Chander Power System Protection and Switchgear by, Wiley Eastern (1977)

D. Reference Books:

1. Gupta, J. B. "A Course in Power Systems", ,S. K. Kataria and Sons Publishers and Distributors, 2009.
2. Warrington, Van "Principles of Relaying", Y. G. Paithankar. TMH, 2009.
3. Y. G. Paithankar, S. R. Bhide, Fundamentals of Power System Protection", 2nd edition, Prentice Hall of India Private Limited, New Delhi, 2011.
4. Badri Ram and D N Vishwakarma "Power system Protection and Switchgear", Tata McGraw Hill, 2nd reprint 2012
5. N.Veerappan and S R Krishnamurthy, "Power system Switchgear and Protection", S Chand Publication, Revised edition 2013.

E. Course Outcomes:

1. Know the basics of the switchgears and current chopping phenomenon.
2. Understand the working principles of different types of Circuit Breakers.
3. Understand the requirements of substations and earthing mechanism.
4. Know the philosophy of protection, construction and operation of protective devices in power system.

Subject Code: EE 320A
Subject Name: Utilization of Electrical Power
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

The subject aims to provide the student of electrical engineering with:

1. Understanding of selection of drives for industrial application.
2. Understanding the heating and welding methods for industrial applications.
3. Understanding of the concepts of Electrolysis processes and illumination engineering.
4. Understanding of electric traction system and drives.
5. To focus on the recent illumination practices adopted.

B. Course Content:

Traction: System of Traction Electrification, Train movement and energy consumption (Speed-time curves, Crest speed, Average speed and Schedule speed), Tractive effort, Factors affecting energy consumption (Dead weight, Acceleration weight and Adhesion weight), Protective devices.

Electric Traction motor and their control: Starting, breaking with special emphasis on power electronic controllers, Current collector, Interference with telecommunication circuit. A brief outline of linear Induction motor principle in Traction.

Illumination: Laws of illumination, Polar cuvees, Photometry, Integrating sphere, Types of Lamps: Conventional and Energy Efficient, Basic principle of Light control, Different lighting scheme and their design methods, Flood and Street lighting.

Heating: Types of heating, Resistance heating, Induction heating, Arc furnace, Dielectric heating, Microwave heating.

Welding: Resistance welding, Arc welding, Ultrasonic welding, Electron bean welding, Laser beam welding, Requirement for good welding, Power supplies for different welding schemes.

C. Text Books:

1. Wadha C. L., Generation, "Distribution and Utilization of electrical energy", New Age International Ltd.
2. Partab H., "Art and Science of Utilization of Electrical Energy", Dhanpat Rai and Sons.

D. Reference Books:

1. Openshaw E. and Taylor, "Utilization of Electric Energy", Orient Longman.
2. Sahdev S.K., "Utilization of electrical energy and traction", New Age International.
3. Sivanagaraju K., "Electric Energy: Generation, Utilization and Conservation", Pearson Publications.

E. Course Outcomes:

At the end of this course, students will demonstrate the ability to:

1. understand different utilities of electric energy.

2. analyze an industrial process like electrochemical, welding, heating etc.
3. design suitable lighting scheme for a particular application.
4. select a suitable motor for electric traction and hybrid vehicles.

Subject Code: EE 320B
Subject Name: Energy Management and Auditing
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To enable the students to understand the concept of energy management and energy management opportunities
2. To understand the different methods used to control peak demand
3. To know energy auditing procedure
4. To understand the different methods used for the economic analysis of energy projects

B. Course Content:

General principles of Energy management and Energy management planning. Peak Demand controls, Methodologies, Types of Industrial Loads, Optimal Load Scheduling-Case studies.
Energy management opportunities in Lighting and Motors. Electrolytic Process and Electric heating, Case studies.

Types of boilers, Combustion in boilers, Performances evaluation, Feed water treatment, Blow down, Energy conservation opportunities in boiler. Properties of steam, Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Identifying opportunities for energy savings.

Classification, General fuel economy measures in furnaces, Excess air, Heat Distribution, Temperature control, Draft control, Waste heat recovery.
HVAC system: Coefficient of performance, Capacity, Factors affecting Refrigeration and Air conditioning system performance and savings opportunities. Classification and Advantages of Waste Heat Recovery system, analysis of waste heat recovery for Energy saving opportunities
Energy audit -Definition, Need, Types of energy audit, Energy audit Instruments. Cogeneration-Types and Schemes, Optimal operation of cogeneration plants- Case study.

Computer aided energy management. Economic analysis methods-cash flow model, time value of money, evaluation of proposals, pay-back method, average rate of return method, internal rate of return method, present value method, life cycle costing approach, Case studies.

C. Text Books:

1. Albert Thumann, William J. Younger, Handbook of Energy Audits, CRC Press.
2. Charles M. Gottschalk, Industrial energy conservation, John Wiley & Sons.

D. Reference Books:

1. Craig B. Smith, Energy management principles, Pergamon Press. 4. D. Yogi Goswami, Frank Kreith, Energy Management and Conservation Handbook, CRC Press, 2007
2. G.G. Rajan, Optimizing energy efficiencies in industry -, Tata McGraw Hill, Pub. Co., 2001.
3. IEEE recommended practice for energy management in industrial and commercial facilities,
4. IEEE std 739 - 1995 (Bronze book).
5. M Jayaraju and Premlet, Introduction to Energy Conservation and Management, Phasor Books, 2008
6. Paul O'Callaghan, Energy management, McGraw Hill Book Co.
7. Wayne C. Turner, Energy management Hand Book - - The Fairmount Press, Inc.

E. Course Outcomes:

At the end of this course, students will demonstrate the ability to:

1. understand the different methods used to reduce energy consumption
2. design energy efficient electrical systems
3. perform energy audit of electrical installations
4. select proper methodologies for energy management and auditing

Subject Code: EE 321A
Subject Name: Power System Operation and Control
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. to have an overview of power system operation and control,
2. model power frequency dynamics to design power frequency controllers, model reactive power-voltage interaction and the control actions to be implemented for maintaining voltage profile against varying system load

B. Course Content:

Introduction- Load Flow Analysis and Static Load flow equation:
Sparse matrix techniques, Bus admittance matrix, Bus classification, Gauss Siedel, Newton Raphson and fast decoupled Load flow methods.

Economic Operation of Power Systems:
Input-output characteristics of thermal and hydel power plants, Incremental fuel cost (IFC) curve, Constraints in economic operation of power system, Introduction to dynamic programming, Unit commitment using dynamic programming method, Distribution of loads between units within a plant, Distribution of loads between plants, Transmission loss equation, Classical Economic dispatch with losses, Optimal unit commitment problems and their solutions.

Voltage and Load Frequency Control:
Introduction to control of active and reactive power flow, control of voltage, Excitation systems. Introduction to Load Frequency Control and Automatic generation control, Single area and modelling of AGC, Concept of multi area AGC.

State Estimation:
Static as well as dynamic Deregulation: What is deregulation? Background to deregulation and current situation, Benefits of a competitive electricity market.

C. Text Books:

1. Abhijit Chakrabarti, and Sunita Halder, Power System Analysis, Operation and Control, India: Prentice Hall.
2. D.P. Kothari, and I.J.Nagrath, Modern Power System Analysis, India, Tata McGraw Hill, 3rd edition.

D. Reference Books:

1. O.I.Elegard, Electric Energy Systems Theory, An Introduction, India: Tata McGraw Hill, 2nd edition.
2. Mahalanabis, A.K., Kothari, D.P. and Ahson, S.I., "Computer Aided Power System analysis and Control", TMH, New Delhi, 1988.
3. Indulkar, C.S. and Kothari D.P., "Power System Transients: A Statistical Approach", Prentice Hall of India, New Delhi, 1996.

E. Course outcomes:

1. Students will be adequately trained to become Operation Engineers in field of Process Control,
2. Students will be skilled theoretically about designing and operation of control systems employed in various industries,
3. Students will be substantially prepared to take up prospective research assignments

Subject Code: EE 321B
Subject Name: HVAC Transmission Systems
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

The objectives of the course are to make students:

1. know the importance of compensation in transmission lines and the concepts of FACTS devices.
2. illustrate the design, modelling and applications of SVC.
3. learn the operation, modes, modelling and applications of TCSC.
4. study the principle, characteristics, modelling and applications of STATCOM and SSSC.
5. summarize about the importance in coordination of FACTS controllers

B. Course Content:

FACTS Concepts: Transmission line inter connections, Power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basictypes of FACTS controllers, benefits from FACTS controllers.

Voltage Source Converters: Single phase three phase full wave bridge converters, transformer connections for 12, 24 and 48 pulse operation. Three level voltage source

converters, pulse width modulation converter, basic concept of current source Converters, comparison of current sourceconverters with voltage Source converters.
Static Shunt Compensation: Objectives of shunt compensation, midpoint voltage regulation, voltage instability prevention, improvement of transient stability, Power oscillation damping, Methods of controllable var generation, variable impedance type static var generators, switching converter type var generators, hybrid var generators.
SVC and STATCOM: The regulation and slope transfer function and dynamic performance, transient Stability enhancement and power oscillation damping, operating point control and summary of compensator control.
Static Series Compensation: Concept of series capacitive Compensation, improvement of transient stability, power oscillation damping, Functional requirements, GTO Thyristor controlled series capacitor (GSC), Thyristor switched series capacitor (TSSC) and Thyristor controlled series capacitor (TCSC), control schemes for GSC, TSSC and TCSC.

C. Text Books:

1. Mathur M., Rajiv R., Varma K., "Thyristor–Based Facts Controllers for Electrical Transmission Systems", Wiley Publishers.
2. John A. T., "Flexible AC Transmission System", IEEE Press.

D. Reference Books:

1. Hingorani N. G., Gyugyl L., "Understanding FACTS Concepts and Technology of Flexible AC Transmission System", Wiley Publishers.
2. Bergen A. R., "Power Systems Analysis", Pearson Publications.
3. Padiyar K. R., "FACTs Controller in Power Transmission and Distribution", New Age International.

E. Course Outcomes:

At end of this course, students will demonstrate the ability to:

1. understand load ability of the transmission line.
2. emphasize the importance of the voltage and reactive power control in electrical systems
3. state different compensation techniques through facts devices
4. analyse the real and reactive power flow and control in transmission lines

Subject Code: EE-3205
Subject Name: Electrical Drives Laboratory
Credit Point: 1 (L=0, T=0, P=2)

A. Course Objectives:

1. To impart knowledge on Performance of the fundamental control practices associated with AC and DC machines (starting, reversing, braking, plugging, etc.) using power electronics
2. To familiarize the operation principles, and design of starting, braking, and speed control arrangements for electric motors and their applications.

3. To impart industry oriented learning.
4. To evaluate the use of computer-based analysis tools to review the major classes of machines and their physical basis for operation

B. Course Content:

1. Study of thysistor controlled DC Drive.
2. Study of Chopper fed DC Drive.
3. Study of AC Single phase motor-speed control using TRIAC.
4. PWM Inverter fed 3 phase Induction Motor control using PSPICE / MATLAB / PSIM Software.
5. VSI / CSI fed Induction motor Drive analysis using MATLAB/DSPICE/PSIM Software.
6. Study of V/f control operation of 3-Phase induction motor drive.
7. Study of permanent magnet synchronous motor drive fed by PWM Inverter using Software.
8. Regenerative / Dynamic braking operation for DC Motor - Study using software.
9. Regenerative / Dynamic braking operation of AC motor - study is using software PC/PLC based AC/DC motor control operation.
10. Speed control of permanent magnet synchronous motor using FPGA spartan 6 controller.

C. Course Outcomes:

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

1. Set up control strategies to synthesize the voltages in dc and ac motor drives.
2. Develop testing and experimental procedures applying basic knowledge in electronics, electrical circuit analysis, electrical machines, microprocessors, and programmable logic controllers.
3. An ability to use standard methods to determine accurate modeling/simulation parameters for various general-purpose electrical machines and power electronics devices required for designing a system and solve drives related problems
4. Estimate constraints, uncertainties and risks of the system (social, environmental, business, safety issues etc.)
5. Combine the use of computer-based simulation tools relevant to electrical Drives with practical laboratory experimentation.

Subject Code: EE-3206
Subject Name: Linear Control System Laboratory
Credit Point: 1 [L=0, T=0, P=2]

A. Course Objectives:

The course is designed:

1. To enable the students to carry out mathematical modelling, time response and frequency response analysis of the considered systems.
2. To test the stability of systems and to understand their performance characteristics.

3. To design controllers and compensators for the systems to meet desired specifications.
4. To perform feedback controller modelling using state variable analysis.

B. Course Content:

1. Familiarization with MATLAB- control system tool box, MATLAB- Simulink tool box.
2. Determination of step response for first order and second order system with unity feedback and calculations of control system specifications like time constant, % peak overshoot, settling time etc., from the response.
3. Simulation of step response and impulse response for Type-0, Type-1 and Type –2 system with unity feedback using MATLAB and PSPICE.
4. Determination of root locus, Bode- Plot, Nyquist Plot Using MATLAB- control system toolbox for 2nd order system and determination of different control system specifications from the plot.
5. Determination of PI, PD and PID controller action of first order simulated process.
6. Determinations of approximate transfer function experimentally from the Bode plot.
7. Evaluation of steady state error, setting time, percentage peak overshoot, gain margin, phase margin with addition of lead.
8. Design of Compensators and including it in forward path transfer function for unity feedback control system using PSPICE modelling or otherwise.
9. Conversion of transfer function model into state space form and analysing controllability and observability.
10. A practical position control system and determination of control system specifications for variations in the system parameters.

C. Course Outcomes:

At the end of this laboratory course, a student will be able to:

1. Perform modelling of linear-time-invariant systems using transfer function and state-space representations.
2. Analyse the system in time domain and frequency domain and attain the respective performance specifications.
3. Test the stability of systems and thereby perform system design
4. Design simple feedback controllers and compensators for the given physical systems
5. Model state variable design-based controllers

Subject Code: EE-3207
Subject Name: Switchgear and Protection Laboratory
Credit Point: 1 [L=0, T=0, P=2]

A. Course Objectives:

The course is designed to meet with the objectives of:

1. fundamentals of protection equipment used in power systems, concept of primary and backup relaying,

2. Imparting theoretical and practical knowledge of modern switchgear and current trends in protective relaying,
3. Constructional Features and testing methodologies of AC and DC Circuit breakers.

B. Course Content:

1. Determination of drop out factor of an instantaneous over current relay.
2. Determination of operating characteristics of IDMT relay.
3. Determination of operating characteristics of differential relay.
4. Study and operation of gas actuated protective relay.
5. Study of Static Over current relay
6. Determination of transmission line parameters using MATLAB
7. Analysis of power system faults (Symmetrical & Asymmetrical) using MATLAB
8. Study of SF6 circuit breaker
9. Protection Simulation study of Generator, Transformer, motor and feeder.
10. Determination of dielectric Strength of transformer oil.

C. Course Outcomes:

1. Know the basics of the switchgears and current chopping phenomenon.
2. Understand the working principles of different types of Circuit Breakers.
3. Understand the requirements of substations and earthing mechanism.
4. Know the philosophy of protection, construction and operation of protective devices in power system.

VIIth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	EE-4101	DSC16-Electrical Machine Design	3	0	0	3
2	EE-410A EE-410B EE-410C	DSE6-High Voltage Engineering DSE6-Advanced Control Systems DSE6-Principles of Energy Conversion Systems	3	0	0	3
3	EE-411A EE-411B EE-411C	DSE7-Renewable Energy Sources DSE7-Advanced Power Electronics DSE7-Electrical Estimation and Costing	3	0	0	3
4	EE-412A EE-412B EE-412C	DSE8-Power Plant Engineering DSE8-Distributed Generation DSE8-Special Electrical Machines	3	0	0	3
5	YY-410X	OE5*	3	0	0	3
6	EE-4102	AECC2-Internship-II	0	0	0	1
7	EE-4103	VAC6-Major Project-I	0	0	8	4
Contact Hours			15	0	4	
Total Credits						20

Subject Code: EE- 4101
Subject Name: Electrical Machine Design
Credit Point: 3 [L=3, T=0, P=0]

A. Course Objectives:

The course is designed:

1. To teach the fundamentals of electrical machine design
2. To impart the skill required for the students to design an electrical machine on his own by understanding all the constraints and the required parameter specifications
3. To inculcate them on the analytical computations required for designing a machine
4. To familiarize them on the various cooling methods and design constraints of electrical machineries

B. Course Content:

Major considerations in Electrical Machine Design: Electrical Engineering Materials – Space factor – Choice of Specific Electrical and Magnetic loadings - Thermal considerations - Heat flow – Temperature rise - Rating of machines – Standard specifications.

DC Machines: Output Equations – Main Dimensions - Magnetic circuit calculations – Carter's Coefficient – Net length of Iron –Real and Apparent flux densities – Selection of number of poles – Design of Armature – Design of commutator and brushes – performance prediction using design values. **Transformers:** Output Equations – Main Dimensions - KVA output for single and three phase transformers – Window space factor – Overall dimensions – Operating characteristics – Regulation – No load current – Temperature rise in Transformers – Design of Tank - Methods of cooling of Transformers. **Induction Motors**: Output equation of Induction

motor – Main dimensions – Length of air gap- Rules for selecting rotor slots of squirrel cage machines – Design of rotor bars and slots – Design of end rings – Design of wound rotor - Magnetic leakage calculations – Leakage reactance of polyphase machines- Magnetizing current - Short circuit current – Circle diagram - Operating characteristics. **Synchronous Machines:** Output equations – choice of loadings – Design of salient pole machines – Short circuit ratio – shape of pole face – Armature design – Armature parameters – Estimation of air gap length – Design of rotor –Design of damper winding – Determination of full load field mmf – Design of field winding – Design of turbo alternators – Rotor design.

C. Text Books:

1. A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Co (P) Limited, New Delhi, 2016.
2. S. K. Sen, "Principles of Electrical Machine Designs with Computer Programs", Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 2006.

D. Reference Books:

1. P.S.Bimbhra, "Electrical Machinery", Khanna Publishers, 7th Edition, 2021.
2. D. P. Kothari & I.J.Nagrath, "Electric Machines", McGraw Hill Education, 5th Edition 2017.
3. P. C. Sen, "Principles of Electric Machines and Power Electronics", John Wiley and Sons, 3rd Edition, 2013.

E. Course Outcomes:

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

1. Study mmf calculation and thermal rating of various types of electrical machines.
2. Design armature and field systems for D.C. machines.
3. Design core, yoke, windings and cooling systems of transformers.
4. Design stator and rotor of induction machines.
5. Design stator and rotor of synchronous machines and study their thermal behaviour.

Subject Code: EE 410A
Subject Name: High Voltage Engineering
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

By the end of the course students should be able to:

1. understand the generation and measurement of high voltages
2. understand electric fields and field stress control around high voltage systems
3. understand the phenomena involved in non-destructive insulation and testing as well as over voltages in power systems.

B. Course Content:

Breakdown Phenomena: Breakdown of Gases: Charge multiplication, Secondary emission, Townsend Theory, Streamer Theory, Paschen's Law, Determination of Minimum breakdown voltage, Breakdown in non-uniform field, Effect of polarity on corona inception

and break down voltage. Partial Discharge: definition and development in solid dielectric. Break Down of Solids: Intrinsic breakdown, Electromechanical breakdown, Thermal breakdown, Streamer Breakdown. Breakdown of Liquid: Intrinsic Break down, Cavitation Theory, Suspended particle Theory.

Lightning Phenomena: Electrification of cloud, Development of Lightning Stroke, lightning induced over voltage, direct stroke, indirect stroke. Protection of Electrical Apparatus against over voltage: Lightning Arrestors, Valve Type, Metal Oxide arresters, Expulsion type. Effect of location of lightning arresters on protection of transformer. Protection of substation, Earth wire. Insulation Coordination: Basic Insulation level. Basic Impulse level, Switching Impulse level. Volt time characteristics of protective devices, Determination of Basic Impulse level of substation equipment.

Generation of High Voltage: Generation of high AC voltage by testing transformer, cascaded transformer, series resonant circuit, single stage and multi stage. Advantages of Series Resonant Circuit in testing of cables. Generation of DC high voltage: Cockcroft Walton doubler and multistage circuit. Definition of Impulse Voltage as per Indian Standard Specification, Wave front and wave tail time, Generation of Impulse Voltage, Multistage impulse generator, triggering of Impulse Generator.

Measurement of High Voltage: Sphere gap voltmeter: AC, DC and impulse, high voltage measurement as per Indian Standard Specifications. Resistance and Capacitance Potential dividers, Peak voltmeters for measurement of high AC voltage in conjunction with capacitance dividers. Capacitance Voltage Transformer, Rotating Voltmeter for the measurement of DC high voltage, Electrostatic Voltmeter High Voltage testing: Testing as per Indian Standard Specifications: Power frequency withstand, induced over voltage and impulse test on transformers, Power frequency wet withstand test and impulse test on insulators.

C. Text Books:

1. Kuffel E., Zaengl W. S., “High Voltage Engineering Fundamentals”, Pergamon press, Oxford.
2. Naidu M. S. and Kamraju V., “High Voltage Engineering”, Tata McGraw Hill.

D. Reference Books:

1. Wadhwa C. L., “High Voltage Engineering”, New Age International.
2. Roy S., “An introduction to High Voltage Engineering”, Prentice Hall of India.
3. Hadad S. and Warene K., “Advances in High Voltage Engineering”, IET.

E. Course Outcomes:

At end of this course, students will demonstrate the ability to:

1. understand and formulate equations for uniform and non-uniform electric field and electric field in different geometric boundaries.
2. analyze the breakdown behaviour of gas, liquid and solid dielectric materials.
3. illustrate the circuits for generation and measurement of high voltage ac, dc and impulse

4. discuss the non-destructive test techniques for measuring dielectric properties
5. investigate measures for testing of power apparatus used in high voltage applications.
6. assess the standard specifications for high voltage testing procedures.

Subject Code: EE- 410B
Subject Name: Advanced Control Systems
Credit Point: 3 [L=3, T=0, P=0]

A. Course Objectives:

The course is designed:

1. To elucidate the students on the basic concepts of state variable analysis, its transformation and determining solutions of the state equations
2. To make students understand the concept of nonlinear control, Internal Model Control and Optimal Control.
3. To study the stability analysis of non-linear systems.

B. Course Content:

State variable model of continuous dynamic systems: Converting higher order linear differential equations into state variable (SV) form - Obtaining SV model from transfer functions - Obtaining characteristic equation and transfer functions from SV model -Obtaining SV equations directly for R-L-C and spring-mass-dashpot systems. **Concept and properties associated with state equations**: Linear Transformations on state variables -Canonical forms of SV equations - Companion forms. **Solutions of state equations**: state transition matrix, properties of state transition matrix - Derivation of transfer function from state model, diagonalization, Eigen values, Eigen vectors, generalized Eigen vectors - Controllability and observability. **State variable controller design:** Linear State variable feedback controller - the pole placement techniques - stability improvement by state feedback, necessary and sufficient conditions for arbitrary pole placement - state regulator design, and design of state observer, Controllers - P, PI, PID. **Introduction to non-linear systems:** Block diagram and state variable representations - Behaviour of non-linear systems - common physical non linearity-saturation, friction, backlash, dead zone, relay, multi variable non-linearity -Phase plane analysis of Non-linear second order systems - Methods of obtaining phase plane trajectories by graphical method – isoclines method - Qualitative analysis of simple control systems by phase plane methods. Describing Function method - Limit cycles in non-linear systems. Prediction of limit cycles using describing function. **Stability concepts for nonlinear systems**: BIBO vs. State stability - Lyapunov's definition - Asymptotic stability, Global asymptotic stability - The first and second methods of Lyapunov methods to analyse non- linear systems.

C. Text Books:

1. Katsuhiko Ogata, "Modern Control Engineering", Pearson Education India, 5th Edition, 2015.
2. Richard.C.Dorf & Robert.H.Bishop, "Modern Control Systems", Pearson Education India, 15th Edition, 2013.

D. Reference Books:

1. Graham.C.Goodwin, "Control System Design", Pearson Education, 2015.
2. Gopal M, "Modern Control System Theory", New Age International Private Limited, 4th Edition, 2021.
3. Mohandas K.P., "Modern Control Engineering", Sanguine Technical Publishers, 2nd Edition, 2016.
4. Roy Choudhury, "Modern Control Systems", New Age International, 2005.

E. Course Outcomes:

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

1. Represent the time-invariant systems in state space form as well as analyse, whether the system is stabilizable, controllable, observable and detectable.
2. Design state feedback controller and state observers
3. Use the techniques such as describing function, Lyapunov Stability, Popov's Stability Criterion and Circle Criterion to assess the stability of certain class of non-linear system.
4. Describe non-linear behaviours such as Limit cycles, input multiplicity and output multiplicity.

Subject Code: EE 410C
Subject Name: Principles of Energy Conversion Systems
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. The course extends the theoretical base of various subjects to power generation technologies. In a multi-disciplinary approach,
2. it covers practical aspects of power system planning, system level design, equipment features and environmental aspects.
3. Thermal, nuclear, combined cycle, hydro and renewable power plants are covered in the syllabus.

B. Course Content:

Introduction:

Introduction to power system and technologies, Demand variation and forecasting. Grid features, Siting and costing.

Diesel generators:

System, equipment and layout.

Fossil-fuelled steam power plants:

boiler and accessories. Turbine and accessories, feed cycle equipment, generator. **Combined cycle power plants**:

gas turbine, heat recovery boiler.

Nuclear power:

nuclear reactions, fuel, moderator and coolant, Neutron life cycle. Light water, heavy water, gas cooled and fast reactors.

Hydroelectric plants:
features and siting, Pelton, Francis, Kaplan and propeller turbines construction, mini and micro turbines.

Renewable energy:
solar, geothermal, wind, biomass, ocean, fuel cells, unique features of decentralized systems, Co-generation systems, Environmental issues, sustainability and future scenarios.

C. **Text Books:**

1. BEI International, Hambling, P., (Ed.), Modern Power Station Practice: Nuclear Turbines, and Associated Plant, Pergamon Press, 1992.
2. Drbal, L. F., Boston, P. G., Westra, K. L., Black and Veatch, Power Plant Engineering, Kluwer Academic, 1995.
3. Elliott, T. C., Chen, K., and Swanekamp, R., Standard Handbook of Power Plant Engineering, McGraw-Hill Professional, 2nd ed., 1997.

D. Reference Books:

1. El-Wakil, M. M., Power Plant Technology, McGraw-Hill, 1984.
2. Jog, M., Hydro-electric and Pumped Storage Plants, John Wiley, 1989.
3. Fritz, J. J., Small and Mini Hydropower Systems, McGraw-Hill, 1984.
4. Central Board for Irrigation and Power (CPIB), India, Design and Construction Features of Selected Dams in India, 1983.
5. Borbely, Anne-Marie, and Kreider, Jan J., (Eds.), Distributed Generation: The Paradigm for the New Millennium, CRC Press, 2003.
6. Larminie, J., and Dicks, A., Fuel Cell Systems Explained, John Wiley, 2003.
7. Vielstich, W., Lamm, A., and Gasteiger, H., Handbook of Fuel Cells: Fundamentals, Technology, Applications, John Wiley, 2003.
8. Appleby, A. J., and Foulkes, F. R. Fuel Cell Handbook, van Nostrand Reinhold, 1996.
9. Harrison, R., Hau, E., and Snel, H., Large Wind Turbines: Design and Economics, John Wiley, 2001.
10. Bejan, Adrian, Advanced Engineering Thermodynamics, Interscience, 1997 Patents and catalogues related to various equipment

E.Course outcomes:

1. Understanding of renewable energy sources
2. Knowledge of working principle of various energy systems
3. Capability to carry out basic design of renewable energy systems

Subject Code: EE 411A
Subject Name: Renewable Energy Sources
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To explain the concepts of Non-renewable and renewable energy systems
2. To outline utilization of renewable energy sources for both domestic and industrial applications

3. To analyse the environmental and cost economics of renewable energy sources in comparison with fossil fuels.

B. Course Content:

Introduction to Energy Sources:

Energy Sources & their Availability, Renewable Energy Sources & their Prospects.

Solar Energy:

Solar Radiation, its computation and measurement. Solar Energy Collectors, Solar Thermal Energy Applications. Storage of Solar Energy, Solar Photovoltaic Technology, Solar cell configurations, voltage developed by solar cell, photo current and load current, solar cell performance, test specifications for photo voltaic systems.

Wind Energy:

Basic Principles of Wind Energy Conversion. Wind energy estimation, site selection, components and classification of wind energy conversion systems, their advantages and disadvantages. Wind Machines Generating Systems, Energy Storage, Applications of Wind Energy, Interconnected systems.

Bio Energy:

Biomass Conversion Technologies, Biogas generation, Biomass as a source of energy, Applications of Biomass plants, Problems of Biogas plants. Biogas for Biomass, Characteristics of Biogas plants, Thermal Gasification of Biomass. Other Non-**Conventional Energy Sources:**

Geothermal Energy – Resources and Harnessing Processes and its Applications. Ocean Energy-Ocean Thermal Energy Conversion (OTEC), Tidal Energy, Wave Energy, Magneto Hydro Dynamic Power Generation- Principles, MHD Systems. Thermo Nuclear fusion energy – Nuclear fusion and Reactions, its requirements. Grid integration of RES, Energy storage system, Micro-grid.

C. Text Books:

1. Rai G.D: Non-Conventional Energy Sources, Khanna Publishers.
2. Begamudre R. D: Energy Conversion Systems, New Age International Publishers.

D. Reference Books:

1. M.V.R. Koteswara Rao, “Energy Resources: Conventional & Non-Conventional” BSP Publications,2006.
2. D.S. Chauhan,”Non-conventional Energy Resources” New Age International.
3. C.S. Solanki, “Renewal Energy Technologies: A Practical Guide for Beginners” PHI Learning.
4. Peter Auer, "Advances in Energy System and Technology". Vol. 1 & II Edited by Academic Press.
5. Odfrey Boyle,“Renewable Energy Power For A Sustainable Future”, Oxford University Press.
6. Raja etal, “Introduction to Non-Conventional Energy Resources” Scitech Publications.
7. John Twideu and Tony Weir, “Renewal Energy Resources” BSP Publications, 2006.

E. Course outcomes:

1. Understanding of renewable energy sources
2. Knowledge of working principle of various energy systems

3. Capability to carry out basic design of renewable energy systems

Subject Code: EE-411B
Subject Name: DSE7-Advanced Power Electronics
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To expose students to the operation, application and control of power conversion systems employing electric drive to cater to industrial needs.
2. To familiarize the operation principles, and design of starting, braking, and speed control arrangements for electric motors and their applications.
3. To provide strong foundation to asses performance of different industrial drives considering issues such as, energy efficiency, power quality, economic justification, environmental issues, and practical viabilities.

B. Course Content:

Switching Voltage Regulators

Introduction; Linear power supply (voltage regulators); Switching voltage regulators; Review of basic dc-dc voltage regulator configurations -Buck, Boost, Buck-Boost converters and their analysis for continuous and discontinuous mode; Other converter configurations like Flyback converter, Forward converter, Half bridge, Full bridge configurations, Push-pull converter, C'uk converter, Sepic Converter; Design criteria for SMPS; Multi-output switch mode regulator

Resonant Converters

Introduction, Need of resonant converters, Classification of resonant converters, Load resonant converters, Resonant switch converters, zero-voltage switching dc-dc converters, zero current switching dc-dc converters, clamped voltage topologies

Multi-level converters

Need for multi-level inverters, Concept of multi-level, Topologies for multi-level: Diode Clamped, Flying capacitor and Cascaded H-bridge multilevel Converters configurations; Features and relative comparison of these configurations applications, Introduction to carrier based PWM technique for multi-level converters

Multi-pulse Converters

Concept of multi-pulse, Configurations for m-pulse (m=12,18,24 ….) converters, Different phase shifting transformer (Y-?1, Y-?2, Y-Z1 and Y-Z2) configurations for multi-pulse converters, Applications

HVDC Transmission

Introduction, Operation of 12-pulse converter as receiving and sending terminals of HVDC system, Equipment required for HVDC System and their significance, Comparison of AC and DC transmission, Control of HVDC transmission

FACTS devices

Importance of reactive power compensation, Flow of power in AC system and conventional control mechanisms, Definition of Flexible ac Transmission Systems (FACTS) and brief description, possible benefits from FACTS, Thyristor- Controlled Reactor (TCR), Fixed Capacitor-Thyristor-Controlled Reactor (FC-TCR), Thyristor-Switched capacitor and Reactor, Thyristor-Switched capacitor-Thyristor-Controlled Reactor (TSCTCR), STATCOM configuration and operating principle, Static characteristics of SVC and STATCOM Comparison of SVC and STATCOM, Principle of series compensation, Introduction to Static Synchronous Series Compensator, Advantages and limitation of SSSC, Introduction to UPFC and operating principle

C. Text Books:

1. M.H. Rashid, "Power Electronics: Circuits, Devices and Applications", Pearson India, 4th Edition, 2018.
2. Ned Mohan, T. M. Undeland and W. P. Robbins, "Power Electronics: Converters, Applications and Design", Wiley India Ltd, 2018.
3. D.W. Hart, "Power Electronics", Tata McGraw Hill edition 2014.
4. M.S. Jamil Asghar, "Power Electronics", Prentice Hall of India Ltd., 2004

D. Reference Books:

1. B.W. Williams, "Power Electronics, Devices Drivers and Application" Wiley New York, 1987.
2. B. R. Pelley, "Thyristor Phase controlled converters and cyclo-converters", Wiley Inter science, 1971.
3. R. Hnatek, "Design of Solid-State Power Supplies", Van Nostrand Reinhold New York 1989.
4. T. Kenjo, "Power Electronics for the Microprocessor Age", Oxford University Press New York 1990.
5. R. Bausiere, F. Labrique and G. Seguier, "Power Electronics Converters: DC-DC Conversion", Springer-Verlag, 1993.

E. Course Outcomes:

At the end of this course, students will demonstrate the ability to:

1. Evaluate different dc-dc voltage regulators
2. Simulate and analyze resonant converters
3. Select appropriate phase shifting converter for a multi-pulse converter
4. Evaluate various multi-level inverter configurations
5. Compare various FACTS devices for VAR compensation

Subject Code: EE-411C
Subject Name: Electrical Estimation and Costing
Credit Point: 3 [L=3, T=0, P=0]

A. Course Objectives:

The course is designed to meet with the objectives of:

1. to inculcate in the mind of students the real meaning of electrification,
2. calculation of various internal / external wiring parameters,
3. to give practical knowledge, on building wirings.

B. Course Content:

Tools: - Screw drivers, Pliers, drilling machine, electrical symbols etc. Wires and wire splicing, sizes of wire, casing capping fitting, conduit pipe, GI and PVC. Lighting accessories - fitting of switches, plugs, Isolators, MCB box, MCB switches, main switch, change over, control panel, switch boards, Bulbs, fans, florescent tubes, Compact Florescent lamp (CFL), LED. Protective devices - Main features of a good protective devices.

Estimating and conductor size calculation:- Introduction, Price catalogue, Schedules of rates, Labour rates. Current carrying capacity, segregation for circuits, Conductor sizes for domestic wiring, Conductor size calculation for UG cables and OH lines. Sizes of LT/HT poles.

Internal wiring:-Type of wirings, Casing capping wiring, wooden beat wiring and PVC/GI conduit wirings. Earthing, Recognition of building plan for wiring, Estimation for T-I,T-II,T-III,T-IV buildings, estimation of G+2, G+3.

External Electrification:- Poles, and other components like cross arms, disc insulators, conductors, etc. Service connection- Its type and estimation using SR. Estimation for LT distribution and street light fittings. Extracts from Indian Electricity Amendment rules 1972/1956. Estimates for 11 kV feeders and substations.

C. Text Books:

1. Electrical wiring, Estimating and costing, by S.L. Uppal, 2011
2. Electrical wiring, Estimating and costing, by K.B. Bhatia.2008
3. Hadi Saadat, "Power System Analysis", Tata McGraw Hill Edition, 2008.
4. Wadhwa, C.L.,"Electric Power Systems", 6th Edition, Wiley Eastern Limited,2018.

D. Reference Books:

1. Principal of Power System, by V.K Mehta., 2013
2. Schedule of rates, Delhi, DGSN, Arunachal Pradesh, and Power Department, 2021

E. Course Outcomes:

Students successfully completing this module will be able to:

1. be well acquainted with the internal and external wiring estimates,
2. be well acquainted with the methods of designing of innovative wiring system,
3. be substantially prepared to learn about special techniques of estimations.

Subject Code: EE-412A
Subject Name: Power Plant Engineering
Credit Point: 3 [L=3, T=0, P=0]

A. Course Objectives:

The course is designed to meet with the objectives of:

1. students will become familiar with power plant systems, terms and definitions and basic power plant engineering design calculations,
2. students will become familiar with the proper design and application of power plant related equipment,
3. Students will become familiar with methods of diagnosing and correcting equipment mis-operation or misapplication,
4. students will become familiar with recognized standards utilized in the design and operation of power plant equipment,
5. students will prepare and present topical issues relevant to power plant design and operations.

B. Course Content:

Introduction:

Layout of Steam, Hydel, Diesel, MHD, Nuclear and Gas Turbine Power Plants-Combined Power Cycles– Comparison and Selection, Load Duration Curves. Steam Boilers and Cycles– High Pressure and Super Critical Boilers–Fluidised Bed Boiler

Steam Power plant:

Different systems of thermal power plant: fuel, air and flue gas systems, pulverisers, Condensate and feedwater system, Construction and functioning of condenser, deaerator and closed feed water heaters, HP - LP By-pass systems, Auxiliary Steam System, Turbine gland steam system. Cooling water system, Cooling Towers—principle of operation and types, Ash handling, electrostatic precipitators.

Nuclear and Hydro power plant:

Nuclear Energy–Fission, Fusion Reaction, Types of Reactors, pressurized water reactor, Boiling Water Reactor, Waste Disposal and safety. Hydel Power Plant–Essential Elements, Selection of Turbines, Governing of Turbines-Micro Hydel developments. Fast Breeder Reactor.

Diesel and Gas turbine Plant:

Types of Diesel Plants, Components, Selection of Engine Type, Fundamental concept of gas turbine control and monitoring system, Applications Gas Turbine Power Plant–Fuels-Gas Turbine Material–Open and Closed Cycles–Reheating–Regeneration and Intercooling–Combined Cycle.

Other power plants and Economy:

Geothermal–OTEC–Tidal- Pumped storage- Solar thermal central receiver system. Cost of Electric Energy– Fixed and operating Costs–Energy Rates–Types of Tariffs–Economics of load sharing, comparison of economics of various power plants

C. Text Books:

1. EI-Wakil M.M, "Power Plant Technology", McGraw-Hill 1984.
2. AroraS.C and Domkund war S, "A course in Power Plant Engineering", Dhanpatrai, 2001.

3. Nag P.K, "Power plant Engineering", Tata McGraw-Hill, 1998.
4. G.R. Nagpal, "Power Plant Engineering", Hanna Publishers, 1998.

D. Reference Books:

1. K.K.Ramalingam, "Power Plant Engineering", Scitech Publications, 2002.
2. G.D.Rai, "Introduction to Power Plant Technology", Khanna Publishers, 1995.
3. R.K. Rajput, "Power Plant Engineering", Laxmi Publications, 1995.
4. Frank D.Graham, "Power Plant Engineers Guide", D.B. Taraporevala Sons & Co, New Delhi, 1993.
5. T.Morse Frederick, "Power Plant Engineering", Prentice Hall of India, 1998

E. Course outcomes:

1. Students will be adequately trained to become Power Plant Engineers,
2. Students will be skilled theoretically and practically design of various power plant, operation, maintenance and repairing works.
3. Students will be substantially prepared to take up prospective research assignments.

Subject Code: EE-412B
Subject Name: Distributed Generation
Credit Point: 3 [L=3, T=0, P=0]

A. Course Objectives:

1. To illustrate the concept of distributed generation
2. To analyze the impact of grid integration.
3. To study concept of Microgrid and its configuration

B. Course Contents:

Conventional power generation: advantages and disadvantages, Energy crises, Non - conventional energy (NCE) resources: review of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources.

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. Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants.

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.

Concept and definition of microgrid, microgrid drivers and benefits, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids.

Modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques, microgrid communication

infrastructure, Power quality issues in microgrids, regulatory standards, Microgrid economics, Introduction to smart microgrids.

C. Text 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

D. Reference Books:

1. Chetan Singh Solanki, "Solar Photo Voltaics", , PHI learning Pvt. Ltd., New Delhi, 2009.
2. J.F. Manwell, J.G "Wind Energy Explained, Theory Design and Applications,". McGowan Wiley publication, 2ndEdition, 2009.
3. D. Hall and R. P. Grover, "Biomass Regenerable Energy", , John Wiley, New York, 1987.
4. John Twidell and Tony Weir, "Renewable Energy Resources", Taylor and Francis Publications, Second Edition, 2006.

E. Course Outcomes:

1. Review the conventional power generation
2. Analyze the concept of distributed generation and installation
3. Design the grid integration system with conventional and non-conventional energy sources
4. Design the dc and ac micro gridCO5: Analyze power quality issues and control operation of micro grid

Subject Code: EE-412C
Subject Name: Special Electrical Machines
Credit Point: 3 [L=3, T=0, P=0]

A. Course Objectives:

The course is design to:

1. to familiarize students with the concepts of electric drives, study DC Drives, study AC Drives.
2. provide in-depth knowledge of power converters fed AC and AC drives in open and closed loop,
3. control of different AC and DC Drives.

B. Course Content:

Synchronous Reluctance Motors: Constructional features –Types–Axial and radial air gap motors– Operating principle–Reluctance–phasor diagram- Characteristics–Vernier motor.

Stepping Motors: Constructional features–Principle of operation –Variable reluctance motor– Hybridmotor–Single and multi-stack configurations –Theory of torque predictions – Linear and non-linear analysis–Characteristics–Drive circuits.

Switched Reluctance Motors: Constructional features–Principle of operation–Torque prediction–Power controllers–Non-linear analysis–Microprocessor based control-Characteristics–Computer control.

Permanent Magnet Brushless D.C. Motors: Principle of operation–Types–Magnetic circuit analysis– EMF and torqueequations–Power controllers–Motor characteristics and control. Permanent Magnet Synchronous Motors: Principle of operation–EMF and torque equations–Reactance–Phasor diagram–Power Controllers-Converter-Volt-ampere requirements–Torque speed characteristics- Microprocessor based control.

C. Text Books:

1. S.K. Pillai, "A first course on Electrical Drives", New Age International Publication.
2. G.K. Dubey, "Fundamental of Electrical Drives", New Age International Publication.

D. Reference Books:

1. Krishnan and B. K. Bose, "Electric motor Drives, Pearson Education. Modern power Electronics and AC drives", Prentice Hall of India.
2. K. Dubey, "Power Semiconductor Controlled Drives", Prentice Hall of India.
3. V. Subrahmanyam, "Electric Drives", Tata McGraw Hill.

E. Course Outcome:

At end of this course, students will demonstrate the ability to:

1. identify the application of Special electric machines.
2. understand the operating principle of various Special electric machines.
3. analyze the properties of different magnetic materials for permanent magnet machines.
4. choose a suitable permanent magnet material for special purpose machine.
5. develop a control circuit for SRM/BLDC motors.

VIIIth Semester						
Sl No	**Course Code**	**Course Title**	**L**	**T**	**P**	**C**
1	EE-421A EE-421B EE-421C EE-421D	DSE9-Grid Technology DSE9-Power Quality Improvements DSE9-Load Forecasting DSE9-SWAYAM Course	3	0	0	3
2	EE-422A EE-422B EE-422C	DSE10-Internet of Things DSE10-Cloud Computing DSE10-SWAYAM Course	3	0	0	3
3	EE-4201	VAC7-Major Project-II	0	0	22	11
Contact Hours			6	0	11	
Total Credits						17

Subject Code: EE-421A
Subject Name: Grid Technology
Credit Point: 3 [L=3, T=0, P=0]

A. Course Objectives:

1. To provide an in-depth knowledge on smart grid architectures and the integration of renewable energy sources with smart grids.
2. To inculcate the concept of machine learning and artificial intelligence models with the grids and finding solutions for load dispatch problems.
3. To present an idea on the importance and design of electric vehicle technology
4. To elucidate on the communication modes and the smart grids.

B. Course Contents:

Introduction to Smart Grid: Basics of power systems, definition of smart grid, need for smart grid, smart grid domain, enablers of smart grid, smart grid priority areas, regulatory challenges, smart-grid activities in India.Smart Grid Architecture: Smart grid architecture, standards-policies, smart-grid control layer and elements, network architectures, IP-based systems, power line communications, supervisory control and data acquisition system, advanced metering infrastructure. The fundamental components of Smart Grid designs, Transmission Automation, Distribution Automation, Renewable IntegrationTools and Techniques for Smart Grid: Computational Techniques –Static and Dynamic Optimization Techniques for power applications such as Economic load dispatch –Computational Intelligence Techniques -Evolutionary Algorithms in power system –Artificial Intelligence techniques and applications in power system. Distribution Generation Technologies: Introduction to Distribution Energy Sources, Renewable Energy Technologies –Microgrids –Storage Technologies –Electric Vehicles and plug –in hybrids – Design of Electric Vehicles - Environmental impact and Climate Change –Economic Issues.

Communication Technologies in Smart Grid: Introductionto Communication Technology, Two Way Digital Communications Paradigm, Synchro-Phasor Measurement Units (PMUs) –

Wide Area Measurement Systems (WAMS)-Introduction to Internet of things (IoT)-Applications of IoT in Smart GridSmart-cities: Smart city pilot projects, essential elements of smart cities, active distribution networks, microgrids, distribution system automation, Reliability and resiliency studies, decentralized operation of power network.

C. Text Books:

1. Smart Grids, Infrastructure, Technology and Solutions, S. Borlase, CRC Press, 2013, 1st Edition.
2. Renewable and Efficient Electric Power System, G. Masters, Wiley–IEEE Press, 2013, 2nd Edition.

D. Reference Books:

1. Synchronized Phasor Measurements and their Applications, A.G. Phadke and J.S. Thorp, Springer, 2017, 2nd Edition.
2. Wind Power in Power Systems, T. Ackermann, Hoboken, N J, USA, John Wiley, 2012, 2nd Edition.

E. Course Outcomes:

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

1. Understand the features of Smart Grid
2. Assess the role of automation and digitization in Transmission and Distribution
3. Analyse Smart grids and Distributed energy resources (DER) with evolutionary algorithms
4. Investigate operation and the importance of data acquisition devices and their location for Voltage and Frequency control.

Subject Code: EE-421B
Subject Name: Power Quality Improvements
Credit Point: 3 [L=3, T=0, P=0]

A. Course Objectives:

The course is designed to meet with the objectives of:

1. to inculcate in the mind of students the real meaning of electrification,
2. calculation of various internal / external wiring parameters,
3. to give practical knowledge, on building wirings.

B. Course Content:

Introduction of the Power Quality problem, Terms used in Power Quality: Definition, Bad power, Good power, Voltage, Voltage sag – definition, causes of voltage sag, voltage sag magnitude, and monitoring, theoretical calculation of voltage sag magnitude, Sag, Swell, Surges, Harmonics, Long Interruptions, Short interruptions, over voltages, under voltages, spikes, voltage fluctuations, Transients, Interruption, overview of power quality phenomenon, Remedies to improve power quality, power quality monitoring. Sources for Electric Power Quality problem in power system: poor load power factor, Non-linear and unbalanced loads

Overview of mitigation methods – from fault to trip, reducing the number of faults, reducing the fault clearing time changing the power system, installing mitigation equipment, improving equipment immunity, different events and mitigation methods. System equipment interface – voltage source converter, series voltage controller, shunt controller, combined shunt and series controller.

C. Text Books:

1. Roger.C.Dugan, Mark.F.McGranagham, Surya Santoso, H.Wayne Beaty, "Electrical Power Systems Quality", McGraw Hill, 2003.
2. Jos Arrillaga, Neville R. Watson, " Power System Harmonics"- John Wiley & Sons, 2003.
3. G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications, 1994(2nd edition).
4. Arindam Ghosh "Power Quality Enhancement Using Custom Power Devices", Kluwer Academic Publishers, 2002.

D. Reference Books:

1. "Understanding Power Quality Problems" by Math H J Bollen. IEEE Press.2019
2. David D. Shipp and William S. Vilcheck, "Power Quality and Line Considerations for Variable Speed AC Drives", IEEE Transactions on Industry Applications, Vol. 32, March / April – 1996

E. Course Outcomes:

Students on successful completion this module will be able to:

CO1: differentiate and explain the various power quality issues and its sources,

CO2: students will be well acquainted with the methods of designing of converters for improving power quality issues,

CO3: students will be substantially prepared to learn about harmonics, its sources and remedies.

Subject Code: EE-421C
Subject Name: Load Forecasting
Credit Point: 3 [L=3, T=0, P=0]

A. Course Objectives:

1. To study power system stability and reliability.
2. To overcome the stability problem for complex and large capacity units.
3. Classification of stability on the basis of nature of perturbation and evaluation time.
4. To understand how to analyse the stability of a power system, how to improve the stability and finally how to prevent system becoming unstable.

B. Course Contents:

Generation Control Loops, AVR Loop, Performance and Response, Automatic Generation Control of Single Area and Multi Area Systems, Static and Dynamic Response of AGC Loops, Economic Dispatch and AGC. Transient Stability Problem, Modeling Of Synchronous Machine, Loads, Network, Excitation and Systems, Turbine And Governing Systems, Trapezoidal Rule Of Numerical Integration Technique For Transient Stability Analysis, Data For Transient Stability

Studies, Transient Stability Enhancement Methods
Low Frequency Oscillations, Power System Model For Low Frequency Oscillation Studies, Improvement Of System Damping With Supplementary Excitation Control, Introduction To Sub Synchronous Resonance and Countermeasures.

Voltage Stability Problem, Real And Reactive Power Flow In Long Transmission Lines, Effect Of ULTC And Load Characteristics On Voltage Stability, Voltage Stability Limit, Voltage Stability Assessment Using PV Curves, Voltage Collapse Proximity Indices, Voltage Stability Improvement MethodsContingency analysis ZBUS Method in Contingency Analysis, Adding and Removing Multiple Lines, Piecewise Solution of Interconnected Systems, Analysis of Single Contingencies, Analysis of Multiple Contingencies, Contingency Analysis of DC Model, System Reduction for Contingency and Fault Studies.

Introduction to power system security. System state classification, Load Forecasting & State Estimation: Estimation of average, periodic, stochastic components of load, basic idea of state estimation of power system. State estimation in power systems Security analysis. Machine learning models – Fundamentals and Algorithms – Load forecasting using machine learning models.

C. Text books:

1. Electric Energy System Theory: An Introduction.O.I. Elgard, .II Edition, McGraw Hill, New York, 1982.
2. Power Generation, Operation And Control., A.J. Wood, B.F. Wollenberg, .John Wiley And Sons, New York, 1984, 2nd Edition: 1996.

D. Reference Books:

1. Computer Modeling Of Electrical Power Systems.,J. Arrilaga, C.P. Arnold, B.J. Harker, Wiley, New York, 1983.
2. Power System Engineering, I.J. Nagrath, O.P. Kothari, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994.
3. Electric Power System Dynamics,Yao-Nan-Yu,
4. Power System Stability andControl.P. Kundur McGraw Hill, New York, 1994.

E. Course Outcomes:

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

1. Understand facts, concepts and classification of stability on the basis of perturbation and economical aspect of energy exchange.
2. Analyze the characteristics of synchronous alternator under small and large disturbances.
3. Understand the apply knowledge of electrical subjects for solving stability problem and use method for enhancing stability
4. Understand and analyze the voltage stability problems and methods of improving voltage stability.

Subject Code: EE- 422A
Subject Name: Internet of Things
Credit Point: 3 [L=3, T=0, P=0]

A. Course Objectives:

The course is designed to:

1. Understand the concepts of IoT Architectures.
2. Learn about various IOT-related protocols
3. Build simple IoT Systems using Arduino and Raspberry Pi.
4. Understand data analytics and cloud in the context of IoT
5. Develop IoT infrastructure for smart applications

B. Course Content:

IoT fundamentals: Evolution of Internet of Things - Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack -– Fog, Edge and Cloud in IoT. **Things in IoT:** Sensors, Actuators and Smart Objects – IoT Hardware platforms – Arduino/Raspberry Pi. **IoT connectivity Technologies:** Connecting Smart Objects - IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 1901.2a, 802.11ah and LoRaWAN. **Network Layer:** Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6LoRouting over Low Power and Lossy Networks (RPL). **Transport Layer:** Application Transport Methods: Application Layer Not Present, Supervisory Control and Data Acquisition (SCADA). **Application Layer and Cloud Services:** Application Layer Protocols: CoAP and MQTT – Service discovery – mDNS - Cloud and Fog Topologies – Cloud services model – Fog Computing. **Applications in IoT:** Smart appliances and applications: Autonomous cars – Connected cars – Smart Home appliances– Smart speakers –Smart energy.

C. Text Books:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017.

D. Reference Books:

1. Perry Lea,” Internet of things for architects”, Packt Publishing, 1st Edition,2018
2. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier Science Publishers, 1st Edition ,2014.
3. Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things – Key applications and Protocols”, Wiley, 2nd Edition, 2012.
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011 Edition.
5. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on-Approach”, Universities Press, 1st Edition ,2015

E. Course Outcomes:

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

1. Explain the concept and architecture of IoT.
2. Choose the right sensors and actuators for an application.
3. Analyze various protocols for IoT.
4. Apply data analytics and use cloud/fog offerings related to IoT.
5. Analyze applications of IoT in real time scenario
6. Design an IoT based smart system using open hardware platforms and open cloud offerings.

Subject Code: EE- 422B
Subject Name: Cloud Computing
Credit Point: 3 [L=3, T=0, P=0]

A. Course Objectives:

The course is designed:

1. To learn the concepts of cloud computing
2. To provide an in-depth knowledge of the cloud computing fundamentals, technologies, applications and implementations.
3. To shed light on the security issues in cloud computing.
4. To appreciate the emergence of the next generation computing paradigm based on cloud.

B. Course Content:

Introduction to Cloud Computing: Roots of Cloud Computing -;System Models for Distributed and Cloud Computing-Layers and Types of Clouds -Desired Features of a Cloud -Cloud Infrastructure Management -Infrastructure as a Service Providers -Platform as a Service Providers -Challenges and Risks-Architectural Design of Compute and Storage Clouds. **Service-Oriented Architecture for Cloud:** -SOAP, REST and Systems of Systems - Services and Web Services-Event Driven SOA -SOA Communication. **Open Source Cloud Platforms:** Features of Cloud platforms- Overview of various open-source platforms –Eucalyptus and OpenNebula-Insight into OpenStack Architecture and Components. **Cloud Security:** Cloud Security Defense Strategies-Securing the Cloud & Data-Distributed Intrusion and Anomaly Detection-Data and Software Protection Techniques-Data Security in the Cloud -The Current State of Data Security in the Cloud -Cloud Computing and Data Security Risk -The Cloud, Digital Identity, and Data Security -Establishing Identity in Cloud. **Cloud Platforms in Industry:** Parallel Programming Paradigm -Apache Hadoop and Map-Reduce -MapReduce Programming Model. **Cloud Management:** Administrating the Clouds – Management Responsibilities & lifecycle Management-Distributed Management of Virtual Infrastructures.

C. Text Books:

1. Kai Hwang, Geoffrey C Fox and Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
2. Barrie Sosinky,"Cloud Computing Bible", Wiley Publishing Inc,2011
3. Buyya R., Broberg J. and Goscinski A., "Cloud Computing: Principles and Paradigm", First Edition, John Wiley & Sons, 2011.

D. Reference Books:

1. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi,"Mastering the Cloud Computing", Morgan Kaufmann,2013
2. John W. Rittinghouse and James F. Ransome, "Cloud Computing: Implementation "Management, and Security", CRC Press, 2016.
3. David Bernstein, "Containers and Cloud: From LXC to Docker to Kubernetes", IEEE Cloud Computing, Volume: 1 , Issue: 3 , 2014.

E. Course Outcomes:

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

1. Articulate the main concepts, key technologies, strengths and limitations of cloud computing.
2. Learn the key and enabling technologies that help in the development of cloud.
3. Develop the ability to understand and use the architecture of compute and storage cloud, service and delivery models.
4. Discuss the core issues of cloud computing such as resource management and security.

Open Electives

(Offered by Dept. of EE for other Departmental Students)

Sl No	Course Code	Course Title	L	T	P	C
1	EE-210X	OE1- Electrical Circuit Analysis	3	0	0	3
2	EE-220X	OE2- Power System	3	0	0	3
3	EE-310X	OE3- Electrical Machines	3	0	0	3
4	EE-320X	OE4-Linear Control System	3	0	0	3
5	EE-410X	OE5-Power Electronics	3	0	0	3
Contact Hours			15	0	0	15
Total Credits						15

Subject Code: EE-210X
Subject Name: Electrical Circuit Analysis
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objective:

The course has been designed to make students:

1. understand the calculations of electrical circuits / networks.
2. work with electrical circuits in cascaded form and implementation in real world.

B. Course Content:

Basic Concepts of Electrical Circuits, Circuit Concepts – R-L-C parameters – Voltage and Current sources – Independent and dependent sources-Source transformation – Voltage – Current relationship for passive elements (for different input signals-square, ramp, saw tooth, triangular); Kirchhoff's laws – network reduction techniques – series, parallel, series parallel, star-to-delta or delta-to- star transformation, Nodal analysis, Mesh analysis, Super node and Super mesh for D.C. Excitations Single Phase A.C Circuits: R.M.S and Average values and form factor for different periodic wave forms,– Concept of Reactance, Impedance, Susceptance and Admittance – Phase and Phase difference– concept of power factor, Real and Reactive powers – J-notation, Complex and Polar forms of representation, Complex power. Steady state analysis of R, L and C (in series, parallel and series parallel combinations) with sinusoidal excitation; Transient analysis of different electrical circuits with and without initial conditions; Solution using Laplace Transforms, Fourier analysis of different types of input signals Locus Diagrams and Resonance: Locus diagrams – series R-L, R-C, R-L-C and parallel combination with variation of various parameters – Resonance – series, parallel circuits, concept of band width and Q factor. Magnetic Circuits: Magnetic

Circuits – Faraday's laws of electromagnetic induction – concept of self and mutual inductance – dot convention – coefficient of coupling – composite magnetic circuit - Analysis of series and parallel magnetic circuits.

Network Topology: Definitions – Graph – Tree, Basic cutest and Basic Tie-set matrices for planar networks
– Loop and Nodal methods of analysis of Networks with independent voltage and current sources - Dualityand Dual networks.

Network Theorems:
Tellegen's, Superposition, Reciprocity, Thevenin's, Norton's, Maximum Power Transfer, Millman's and Compensation theorems for D.C. and A.C. excitations. Three phase unbalanced circuits

C. Text Books:

1. M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2006.
2. D. Roy Choudhury, "Networks and Systems", New Age International Publications, 1998.

D. Reference Books:

1. W. H. Hayt and J. E. Kemmerly, "Engineering Circuit Analysis", McGraw Hill Education, 2013.
2. C. K. Alexander and M. N. O. Sadiku, "Electric Circuits", McGraw Hill Education,2004.
3. K. V. V. Murthy and M. S. Kamath, "Basic Circuit Analysis", Jaico Publishers, 1999.

E. Course Outcome:

At the end of this course, students will demonstrate the ability to:

1. apply network theorems for the analysis of electrical circuits.
2. obtain the transient and steady-state response of electrical circuits.
3. analyse circuits in the sinusoidal steady-state (single-phase and three-phase).
4. analyse two port circuit behaviour.

Subject Code: EE-220X
Subject Name: Power System
Credit Point: 3 [L=3, T=0, P=0]

A. Course Objectives:

The course is designed to:

1. impart the knowledge of generation of electricity based on conventional and non-conventional sources
2. enable the students to do analysis of different types of distribution systems and its design
3. make students capable of analysis of mechanical and electrical design aspects of transmission system

B. Course Content:

Power system definition, Energy sources, and General layout of a typical coal fired power station, hydroelectric power station, nuclear power station, their components and working principles. Introduction to solar and wind energy systems. **Overhead Transmission Line:** Voltages, currents, Single Phase and Three Phase symmetrical and unsymmetrical configurations, Bundle conductors, Transposition, Line supports, Towers, Poles, Sag, Tension and Clearance, Effect of Wind and Ice on Sag, Dampers.

Performance of lines: Short, medium (nominal π, T) and long lines and their representation. A, B, C, D constants, voltage regulation, Ferranti Effect. **Insulators:** Types, string Insulator efficiency and methods of its improvement. Corona: Principle of Corona formation, Corona loss, advantages and disadvantages of Corona, methods of reduction of Corona. **Distribution System:** Feeders and Distributors, radial and loop systems.

C. Text Books:

1. Debapriya Das, Electrical Power Systems, New Age International Private Limited, 2016.
2. Grainger John, J. and Stevenson, Jr. W.D., "Power System Analysis", McGraw Hill, 2011.
3. Harder Edwin.I, "Fundamentals of Energy Production", John Wiley and Sons, 2008.
4. Deshpande, M.V., "Elements of Electric Power Station Design", A.H. Wheeler and Company, Ald 1979.
5. Wadhwa, C.L.,"Electric Power Systems", 6th Edition, Wiley Eastern Limited,2018.

D. Reference Books:

1. Nagrath,I.J. and Kothari, D.P., "Power System Engineering", Tata McGraw Hill, 1995
2. Electric Transmission and Distribution Reference Book", Westing house Electric Corporation: East Pittsburg, Pa, 1964.
3. BurkeJames,J.,"PowerDistributionEngineering;FundamentalsandApplications"MarcelDekk.,1996.

E. Course Outcomes:

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

1. Understand the various power generations
2. categorize transmission lines based on operational length and modelling techniques,
3. solve the problems complex network based on per unit system,
4. work on distribution networks and solve problems such as using bundle conductors.

Subject Code: EE-310X
Subject Name: Electrical Machines
Credit Point: 3 **(**L=3, T=0, P=0)

A. Course Objectives:

1. To study transformer construction, operation, various tests, efficiency and voltage regulation.
2. To study about DC machines, operation, performance, applications, recent advancements.
3. To study induction motor operation, find efficiency and speed regulation.
4. To study of synchronous machine and its applications.

B. Course Content:

Transformers: Operating principle, classification, construction, emf equation, phasordiagrams, equivalent circuit model, losses & efficiency, voltage regulation, frequency response, polarity test, autotransformers, three-phase transformer connections, impedance matching, isolation & instrument transformers.

D.C. Machines:Operating principle, generator & motor action, construction, types of excitation, emf & torque equations, power stages & efficiency. Commutation & Armature Reaction, characteristics & application of d.c generators, starting & speed control of d.c motors, characteristics & applications of d.c motors, electric braking.Design of D.C Machines: Output equation, Main dimensions, Armature design, Armature windings, Design of commutator and brushes, Design of Field systems, Design of interlopes.

Induction Machines:Three-phase induction motors. Principle of operation, construction, types. Rotating magnetic field, emf equation of an AC Machine, torque developed in an induction motor, equivalent circuit model, torque-speed characteristics, starting & speed control. Single phase induction motors, starting, application.

Synchronous Machines:Construction, types & operating principle of synchronous generator, A.C armature windings, equivalent circuit, phasor diagrams, voltage regulation, parallel operation, synchronization, Power Angle characteristics, effect of field excitation change.Synchronous Motor, principle, starting, hunting, damper windings.Special Purpose Motors: Stepper Motor, Universal Motor, shaded-pole Motor.

C. Text Books:

1. Fitzgerald, Kingslay, Umans “Electric Machinery”, Tata McGraw-Hill.
2. Chapman, “Electric Machinery Fundamentals”, McGraw-Hill Higher Education.
3. Nagrath and Kothari, “Electric Machines”, Tata McGraw-Hill.

D. Reference Books:

1. Guru, Hiziroglu, Electric Machinery and Transformer, Oxford University press.
2. P.S.Bimbhra, Electric Machinery, Khanna Publishers.

3. Vincent Deltoro, Basic Electric Machines, Prentice Hall.

E. Course Outcomes:

At the end of this course, students will demonstrate the ability to:

1. construct the equivalent circuit of induction motors and predetermine the characteristics
2. analyze the performance characteristics of synchronous and asynchronous machines.
3. control asynchronous motors
4. demonstrate the connection of synchronous and asynchronous machines to infinite bus bar.

Subject Code: EE-320X
Subject Name: Linear Control System
Credit Point: 3 [L=3, T=0, P=0]

A. Course Objectives:

The course is designed:

1. To enable the students to carry out mathematical modelling of any given physical systems.
2. To analyse the time response and frequency response of the considered systems.
3. To impart knowledge on stability of systems and to control the systems and perform design of controllers and compensators.

B. Course Content:

Introduction to Systems: Mathematical models of physical systems - Control hardware and their models - Transfer Function models of linear time-invariant systems – Industrial Control examples. **Feedback Control:** Open-Loop and Closed-loop systems. Benefits of Feedback. Block diagram algebra. **Standard test signals:** Time response of first and second order systems for standard test inputs - Application of initial and final value theorem. Design specifications for second-order systems based on the time-response.

Concept of Stability: Routh-Hurwitz Criteria. Relative Stability analysis. Root-Locus technique. Construction of Root-loci.

Frequency response analysis: Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin - closed-loop frequency response. Root-loci method of feedback controller design. Design specifications in frequency domain.

Design of Controllers and Compensators: Application of Proportional, Integral and Derivative Controllers - Lead and Lag compensation in designs - Analog and Digital implementation of controllers.

C. Text Books:

1. Norman.S.Nise, "Control Systems Engineering", Wiley India Edition, 2018.

2. M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, 4th Edition, 2012.

3. Farid Golnarghi & Benjamin. C. Kuo, "Automatic Control System", McGraw Hill Education, 1st Edition, 2018.

D. Reference Books:

1. Katsuhiko Ogata, "Modern Control Engineering", Pearson Education India, 5th Edition, 2015.
2. Richard.C.Dorf & Robert.H.Bishop, "Modern Control Systems", Pearson Education India, 15th Edition, 2013.
3. S.N.Sivanandam & S.N.Deepa, "Problems & Solutions in Control System Engineering", Jaico Publishing House, 1st Edition, 2005.

E. Course Outcomes:

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

1. Understand the modelling of linear-time-invariant systems using transfer function and state-space representations.
2. Understand the concept of stability and its assessment for linear-time invariant systems.
3. Design simple feedback controllers and compensators

Subject Code: EE-410X
Subject Name: Power Electronics
Credit Point: 3 (L=3, T=0, P=0)

A. Course Objectives:

1. To introduce students to the basic theory of power semiconductor devices and passive components, their practical applications in power electronics.
2. Understand advanced topics of different types of Power Converters.
3. To familiarize students to the principle of operation, design and synthesis of different power conversion circuits and their applications.
4. To familiarize students to the principle of operation, design and synthesis of different power conversion circuits and their applications.

B. Course Content:

Power semiconductor devices:

Introduction: Concept of Power Electronics, scope and applications, desired Characteristics of controllable switches Power semiconductor switches and their characteristics: Power Diode, Power BJT, Power MOSFET, IGBT, SCR, TRIAC, GTO.

Thyristor: Rating and protection, Methods of SCR commutation, Gate Drive Circuit, Series and Parallel operation.

DC-DC Converters:

Introduction, Control Strategies, Buck converter, Boost Converter, Buck-Boost converter, Analysis of buck converter, Different types of other DC-DC converters and their application.

Phase Controlled Converters:

Single phase half wave-controlled rectifier with various loads, Effect of freewheeling diode. Single phase fully controlled and half controlled bridge converters with various loads. Performance Parameters of single phase uncontrolled and controlled converters. Three phase half

wave converters, three phases fully controlled and half controlled bridge converters, Effect of source impedance, Single phase and three phase dual converters.

AC Voltage Controllers:

Principle of On-Off and phase controls, Single phase ac voltage controller with resistive and inductive loads, sequence control, Introduction to Matrix converter. **Cyclo-Converters:**

Basic principle of operation, single phase to single phase, three phases to single phase output voltage equation

Inverters:

Single phase and Three phase bridge inverters, VSI, CSI, Voltage control of single-phase inverters, Series and Parallel inverter-Analysis of basic series inverter, Modified series inverter, Half bridge series inverter, PWM Techniques, Introduction to Multi level inverter.

C. Text Books:

1. M.H. Rashid, "Power Electronics: Circuits, Devices and Applications", Pearson India, 4th Edition, 2018.
2. P.S. Bhimbra, "Power Electronics", Khanna Publishers, 2010.
3. Ned Mohan, T. M. Undeland and W. P. Robbins, "Power Electronics: Converters, Applications and Design", Wiley India Ltd, 2018.
4. D.W. Hart, "Power Electronics", Tata McGraw Hill edition 2014.
5. P.C. Sen, "Power Electronics", McGraw Hill Education (India) Pvt. Ltd.
6. M.S. Jamil Asghar, "Power Electronics", Prentice Hall of India Ltd., 2004

D. Reference Books:

1. B.W. Williams, "Power Electronics, Devices Drivers and Application" Wiley New York, 1987.
2. R. Pelley, "Thyristor Phase controlled converters and cyclo-converters", Wiley Inter science, 1971.
3. R. Hnatek, "Design of Solid-State Power Supplies", Van Nostrand Reinhold New York 1989.
4. T. Kenjo, "Power Electronics for the Microprocessor Age", Oxford University Press New York 1990.
5. Bausiere, F. Labrique and G. Seguier, "Power Electronics Converters: DC-DC Conversion", Springer-Verlag, 1993.

E. Course Outcomes:

At the end of this course, students will demonstrate the ability to:

1. relate basic semiconductor physics to properties of power devices, and combine circuit mathematics and characteristics of linear and non-linear devices.
2. compare the performance of basic power semiconductor devices any analyse their circuit performance.
3. analyse and identify power converters for particular system application.
4. recognize the role of power electronics in different renewable energy applications and their importance in different emerging research areas.
5. Identify the critical areas in application levels and derive typical alternative solutions, select suitable power converters to control Electrical Motors and other industry grade apparatus.