

COURSE: CRS PATTERN

Name of the Faculty: Technology and Engineering

Name of the Programme: Bachelor of Engineering- CRS Electrical Engineering

Mode of Learning: REGULAR

Semester Number (For Example 01,02,03, etc.):									01					
Maximum Courses/Papers for the present Semester:									11					
Minimum Courses/Papers for the present Semester:									11					
Maximum marks for the present Semester:									750					
Minimum marks for the present Semester:									00					
Total Credits for the present Semester:									23.5					
Sr. No.	Department (NAME OF THE DEPARTMENT WHICH IS TEACHING THE PAPER)	Type of Course Core/ Elective/ Foundation/ IDE/ Compulsory etc.	Title of Paper	Group (if any)	Hours of Teaching per week	Credit	Teaching Learning Method [TLM]	Assessment Method [AM]	Assessment Type [AT] UA/IA	UA Marks	IA Marks	Total Marks	Minimum marks for Passing	Remarks for Minimum /Maximum Course/Paper/Subject/ Selection
1	English	Foundation Compulsory	Communication Skills (ENG1002CS)	NA	02	02	Lecture	Theory	UA	50	--	50	20	UA=50
2	English	Foundation Compulsory	Communication Skills Lab (ENG1002LCS)	NA	01	0.5	Laboratory	Practical and Viva Voce	UA	50	--	50	20	UA=50
3	Applied Mathematics	Foundation Compulsory	Applied Mathematics-I-ELE (AMT1108CS)	NA	04	04	Lecture	Theory	UA	100	--	100	40	UA=100
4	Applied Physics	Foundation Compulsory	Applied Physics-I-ELE (APH1111CS)	NA	04	04	Lecture	Theory	UA	100	--	100	40	UA=100
5	Applied Physics	Foundation Compulsory	Applied Physics-I (TW, Practical and Viva)-ELE (APH1111LCS)	NA	02	01	Laboratory	Term Work, Practical & Viva	UA	50	--	50	20	UA=50
6	Civil Engineering	Foundation Compulsory	Fundamentals of Civil and Environmental Engineering-ELE (CVL1110CS)	NA	04	04	Lecture	Theory	UA	100	--	100	40	UA=100

7	Civil Engineering	Foundation Compulsory	Fundamentals of Civil and Environmental Engineering (TW, Practical and Viva)-ELE (CVL1110LCS)	NA	02	01	Laboratory	Term Work, Practical & Viva	UA	50	--	50	20	UA=50
8	Mechanical Engineering	Foundation Compulsory	Engineering Drawing-I-ELE (MEC1108CS)	NA	03	03	Lecture	Theory	UA	100	--	100	40	UA=100
9	Mechanical Engineering	Foundation Compulsory	Engineering Drawing-I (TW, Practical and Viva)-ELE (MEC1108LCS)	NA	04	02	Laboratory	Term Work, Practical & Viva	UA	50	--	50	20	UA=50
10	Mechanical Engineering	Foundation Compulsory	Workshop Practices-ELE (MEC1118LCS)	NA	04	02	Laboratory	Term Work, Practical & Viva	UA	100	--	100	40	UA=100
11	FTE	Foundation Compulsory	Universal Human Values-I (FTE1101CS)	NA	01 No Credit	00	Lecture	Theory	UA	--	--	--	--	Online - No Credit Course

Semester Number (For Example 01,02,03, etc.):						02									
Maximum Courses/Papers for the present Semester:						09									
Minimum Courses/Papers for the present Semester:						09									
Maximum marks for the present Semester:						750									
Minimum marks for the present Semester:						00									
Total Credits for the present Semester:						23									
Sr. No.	Department (NAME OF THE DEPARTMENT WHICH IS TEACHING THE PAPER)	Type of Course Core/ Elective/ Foundation/ IDE/ Compulsory etc.	Title of Paper	Group (if any)	Hours of Teaching per week	Credit	Teaching Learning Method [TLM]	Assessment Method [AM]	Assessment Type [AT] UA/ IA	UA Marks	IA Marks	Total Marks	Minimum marks for Passing	Remarks	
1	Applied mathematics	Foundation Compulsory	Applied Mathematics - II-ELE (AMT1213CS)	NA	04	04	Lecture	Theory	UA	100	--	100	40	UA=100	
2	Applied Mechanics	Foundation Compulsory	Engineering Mechanics-ELE (APM1214CS)	NA	04	04	Lecture	Theory	UA	100	--	100	40	UA=100	
3	Applied Mechanics	Foundation Compulsory	Engineering Mechanics (TW, Practical and Viva)-ELE (APM1214LCS)	NA	02	01	Laboratory	Term Work, Practical and Viva	UA	50	--	50	20	UA=50	
4	Electrical Engineering and Applied Mathematics	Core Compulsory	Programming and Simulations-ELE (ELE1209LCS)	NA	04	02	Laboratory	Term Work, Practical and Viva	UA	100	--	100	40	UA=100	
5	Electrical Engineering	Core Compulsory	Electrical Sciences-ELE (ELE1215CS)	NA	04	04	Lecture	Theory	UA	100	--	100	40	UA=100	
6	Electrical Engineering	Core Compulsory	Electrical Sciences (TW, Practical and Viva)-ELE (ELE1215LCS)	NA	02	01	Laboratory	Term Work, Practical and Viva	UA	50	--	50	20	UA=50	

7	Mechanical Engineering	Foundation Compulsory	Fundamentals of Mechanical Engineering-ELE (MEC1211CS)	NA	03	03	Lecture	Theory	UA	100	--	100	40	UA=100
8	Mechanical Engineering	Foundation Compulsory	Fundamentals of Mechanical Engineering (TW, Practical and Viva)-ELE (MEC1211LCS)	NA	02	01	Laboratory	Term Work, Practical and Viva	UA	50	--	50	20	UA=50
9	Metallurgical and Materials Engineering	Foundation Compulsory	Material Science-ELE (MME1202CS)	NA	03(03)	03	Lecture	Theory	UA	100	--	100	40	UA=100

Semester Number (For Example 01,02,03, etc.):						03								
Maximum Courses/Papers for the present Semester:						10								
Minimum Courses/Papers for the present Semester:						10								
Maximum marks for the present Semester:						800								
Minimum marks for the present Semester:						00								
Total Credits for the present Semester:						27								
Sr. No.	Department (NAME OF THE DEPARTMENT WHICH IS TEACHING THE PAPER)	Type of Course Core/ Elective/ Foundation/ IDE/ Compulsory etc.	Title of Paper	Group (if any)	Hours of Teaching per week	Credit	Teaching Learning Method [TLM]	Assessment Method [AM]	Assessment Type [AT] UA/IA	UA Marks	IA Marks	Total Marks	Minimum marks for Passing	Remarks for Minimum /Maximum Course/Paper/ Subject/ Selection
1	Electrical Engineering	Core Compulsory	Analog and Digital Electronics-ELE (ELE1324CS)	NA	04(04)	04	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30
2	Electrical Engineering	Core Compulsory	Analog and Digital Electronics (TW, Practical and Viva)-ELE (ELE1324LCS)	NA	02(01)	01	Laboratory	Term Work, Practical & Viva	UA	50	--	50	20	UA=50
3	Electrical Engineering	Core Compulsory	Electrical Machines-I-ELE (ELE1325CS)	NA	04	04	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30
4	Electrical Engineering	Core Compulsory	Electrical Machines-I (TW, Practical and Viva)-ELE (ELE1325LCS)	NA	02	01	Laboratory	Term Work, Practical & Viva	UA	50	--	50	20	UA=50

5	Electrical Engineering	Core Compulsory	Electrical Measurements and Instrumentation-ELE (ELE1334CS)	NA	04	04	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30
6	Electrical Engineering	Core Compulsory	Electrical Measurements and Instrumentation (TW, Practical and Viva)-ELE (ELE1334LCS)	NA	02	01	Laboratory	Term Work, Practical & Viva	UA	50	--	50	20	UA=50
7	Applied Mathematics	Foundation Compulsory	Applied Mathematics-III-ELE (AMT1313CS)	NA	04	04	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30
8	Electrical Engineering	Core Compulsory	Computational Techniques-ELE (ELE1331CS)	NA	04	04	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30
9	Electrical Engineering	Core Compulsory	Computational Techniques (TW, Practical and Viva)-ELE (ELE1331LCS)	NA	02	01	Laboratory	Term Work, Practical & Viva	UA	50	--	50	20	UA=50
10	Mechanical Engineering	Foundation Compulsory	Industrial Management and Economics-ELE (MEC1318CS)	NA	03	03	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30

Semester Number (For Example 01,02,03, etc.):								04							
Maximum Courses/Papers for the present Semester:								10							
Minimum Courses/Papers for the present Semester:								10							
Maximum marks for the present Semester:								800							
Minimum marks for the present Semester:								00							
Total Credits for the present Semester:								27							
Sr. No.	Department (NAME OF THE DEPARTMENT WHICH IS TEACHING THE PAPER)	Type of Course Core/ Elective/ Foundation/ IDE/ Compulsory etc.	Title of Paper	Group (if any)	Hours of Teaching per week	Credit	Teaching Learning Method [TLM]	Assessment Method [AM]	Assessment Type [AT] UA/IA	UA Marks	IA Marks	Total Marks	Minimum marks for Passing	Remarks	
1	Electrical Engineering	Core Compulsory	Signals & Systems-ELE (ELE1425CS)	NA	04	04	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30	
2	Electrical Engineering	Core Compulsory	Signals & Systems (TW, Practical and Viva)-ELE (ELE1425LCS)	NA	02	01	Laboratory	Term Work, Practical and Viva	UA	50	--	50	20	UA=50	
3	Electrical Engineering	Core Compulsory	Electrical Machines-II-ELE (ELE1427CS)	NA	04	04	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30	
4	Electrical Engineering	Core Compulsory	Electrical Machines-II (TW, Practical and Viva)-ELE (ELE1427LCS)	NA	02	01	Laboratory	Term Work, Practical and Viva	UA	50	--	50	20	UA=50	
5	Electrical Engineering	Core Compulsory	Electromagnetic Field Theory-ELE (ELE1428CS)	NA	04	04	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30	

6	Electrical Engineering	Core Compulsory	Network Analysis & Synthesis-ELE (ELE1429CS)	NA	04	04	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30
7	Electrical Engineering	Core Compulsory	Network Analysis & Synthesis (TW, Practical and Viva)-ELE (ELE1429LCS)	NA	02	01	Laboratory	Term Work, Practical and Viva	UA	50	--	50	20	UA=50
8	Electrical Engineering	Core Compulsory	Electronics and Communication Circuits-ELE (ELE1430CS)	NA	04	04	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30
9	Electrical Engineering	Core Compulsory	Electronics and Communication Circuits (TW, Practical and Viva)-ELE (ELE1430LCS)	NA	02	01	Laboratory	Term Work, Practical and Viva	UA	50	--	50	20	UA=50
10	FTE	Foundation Compulsory	Universal Human Values-II (FTExxxx)	NA	03	03	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30

Semester Number (For Example 01,02,03, etc.):							05							
Maximum Courses/Papers for the present Semester:							09							
Minimum Courses/Papers for the present Semester:							09							
Maximum marks for the present Semester:							700							
Minimum marks for the present Semester:							00							
Total Credits for the present Semester:							24							
Sr. No.	Department (NAME OF THE DEPARTMENT WHICH IS TEACHING THE PAPER)	Type of Course Core/ Elective/ Foundation/ IDE/ Compulsory etc.	Title of Paper	Group (if any)	Hours of Teaching per week	Credit	Teaching Learning Method [TLM]	Assessment Method [AM]	Assessment Type [AT] UA/IA	UA Marks	IA Marks	Total Marks	Minimum marks for Passing	Remarks for Minimum /Maximum Course/Paper/Subject/ Selection
1	Electrical Engineering	Core Compulsory	Microprocessors & Microcontrollers (ELE1515CS)	NA	04	04	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30
2	Electrical Engineering	Core Compulsory	Microprocessors & Microcontrollers (TW, Practical and Viva) (ELE1515LCS)	NA	02	01	Laboratory	Term Work, Practical & Viva	UA	50	--	50	20	UA=50
3	Electrical Engineering	Core Compulsory	Control Systems Engineering (ELE1519CS)	NA	04	04	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30
4	Electrical Engineering	Core Compulsory	Control Systems Engineering (TW,	NA	02	01	Laboratory	Term Work,	UA	50	--	50	20	UA=50

			Practical and Viva) (ELE1519LCS)					Practical & Viva						
5	Electrical Engineering	Core Compulsory	High Voltage Engineering (ELE1513CS)	NA	04	04	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30
6	Electrical Engineering	Core Compulsory	High Voltage Engineering (TW, Practical and Viva) (ELE1513LCS)	NA	02	01	Laboratory	Term Work, Practical & Viva	UA	50	--	50	20	UA=50
7	Electrical Engineering	Core Compulsory	Power Systems-I (ELE1518CS)	NA	04	04	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30
8	Electrical Engineering	Core Compulsory	Electrical Machine Design (ELE1516CS)	NA	04	04	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30
9	Electrical Engineering	Core Compulsory	Electrical Machine Design (TW, Practical and Viva) (ELE1516LCS)	NA	02	01	Laboratory	Term Work, Practical & Viva	UA	50	--	50	20	UA=50

Semester Number (For Example 01,02,03, etc.):						06									
Maximum Courses/Papers for the present Semester:						09									
Minimum Courses/Papers for the present Semester:						09									
Maximum marks for the present Semester:						750									
Minimum marks for the present Semester:						00									
Total Credits for the present Semester:						26									
Sr. No.	Department (NAME OF THE DEPARTMENT WHICH IS TEACHING THE PAPER)	Type of Course Core/ Elective/ Foundation/ IDE/ Compulsory etc.	Title of Paper	Group (if any)	Hours of Teaching per week	Credit	Teaching Learning Method [TLM]	Assessment Method [AM]	Assessment Type [AT] UA/ IA	UA Marks	IA Marks	Total Marks	Minimum marks for Passing	Remarks for Minimum /Maximum Course/Paper/Subject/ Selection	
1	Electrical Engineering	Core Compulsory	Power Electronics (ELE1614CS)	NA	04	04	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30	
2	Electrical Engineering	Core Compulsory	Power Electronics (TW, Practical and Viva) (ELE1614LCS)	NA	02	01	Laboratory	Term Work, Practical and Viva	UA	50	--	50	20	UA=50	
3	Electrical Engineering	Core Compulsory	Utilization of Electrical Energy (ELE1624CS)	NA	04	04	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30	
4	Electrical Engineering	Core Compulsory	Utilization of Electrical Energy (TW, Practical and Viva) (ELE1624LCS)	NA	02	01	Laboratory	Term Work, Practical and Viva	UA	50	--	50	20	UA=50	
5	Electrical Engineering	Core Compulsory	Power System Switchgear (ELE1617CS)	NA	04	04	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30	
6	Electrical Engineering	Core Compulsory	Power Systems-II (ELE1615CS)	NA	04	04	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30	
7	Electrical Engineering	Core Elective	Elective-I (ELE....CS) Options:	NA	04	04	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30 Minimum & Maximum 01 Paper/Subject should be	

			(1) Electrical Safety and Energy Management (ELE1651DECS) (2) Engineering Optimization (ELE1652DECS)											Selected. Offered by the Department of Electrical Engineering
8	Other than Electrical Engineering	IDE Elective	Institute Elective (ELE.....CS)	NA	03	03	Lecture	Theory	UA & IA	70	30	100	40	UA=70 IA=30 Minimum & Maximum 01 Paper/Subject should be selected. The maximum and minimum number of students in each Institute Elective shall be 60 and 15, respectively. In an event when more than 60 students have opted for an Institute Elective, a merit list of students (based on the latest semester results) will be prepared and the first 60 students will be offered that Institute Elective.
9	Electrical Engineering	Core Compulsory	Electrical Workshop (TW, Practical and Viva) (ELE1625LCS)	NA	02	01	Laboratory	Term Work, Practical and Viva	UA	50	--	50	20	UA=50

Institute Elective

1. Advance statistical Software (AMT1682IECS)
2. Nanotechnology and its Applications (APH1681IECS)
3. Space Technology (APH1682IECS)
4. Fundamentals of Sustainable Building Design (ARC1681IECS)
5. Innovative Product Design and Development (ARC1682IECS)
6. Green Fuels (CHL1681IECS)
7. Plastic Waste Management (CHL1682IECS)
8. Python Programming (CSE1682IECS)

9. Circular Economy and Sustainable Development (CVL1681IECS)
10. Wireless communications and Networking (ELE1682IECS)
11. Robotics Engineering (MEC1682IECS)
12. Natural Resources for Textiles (TXC1681IECS)
13. Textile Materials and Sustainability (TXE1681IECS)
14. Functional Textiles (TXE1682IECS)
15. Water Conservation Concepts (WRE1681IECS)
16. Perspectives of Climate Change (WRE1682IECS)

Semester Number (For Example 01,02,03, etc.):					07									
Maximum Courses/Papers for the present Semester:					07									
Minimum Courses/Papers for the present Semester:					07									
Maximum marks for the present Semester:					550									
Minimum marks for the present Semester:					00									
Total Credits for the present Semester:					20									
Sr. No.	Department (NAME OF THE DEPARTMENT WHICH IS TEACHING THE PAPER)	Type of Course Core/ Elective/ Foundation/ IDE/ Compulsory etc.	Title of Paper	Group (if any)	Hours of Teaching per week [Credit*]	Teaching Learning Method [TLM]	Assessment Method [AM]	Assessment Type [AT] UA/IA	UA Marks	IA Marks	Total Marks	Minimum marks for Passing	Remarks for Minimum /Maximum Course/Paper/Subject/ Selection	
1	Electrical Engineering	Core Compulsory	Electrical Drives (ELE1716CS)	NA	04(04)	Lecture	Theory	UA	70	--	100	40	UA=70 IA=30	
								IA	--	30				
2	Electrical Engineering	Core Compulsory	Electrical Drives (TW, Practical and Viva) (ELE1716LCS)	NA	02(01)	Laboratory	Term Work, Practical & Viva	UA	50	--	50	20	UA=50	
								IA	--	--				
3	Electrical Engineering	Core Compulsory	Project Part – I (ELE1717LCS)	NA	10(05)	Project	Project	UA	100	--	100	40	UA=100	
								IA	--	--				
4	Electrical Engineering	Core Compulsory	Power System Protection (ELE1718CS)	NA	04(04)	Lecture	Theory	UA	70	--	100	40	UA=70 IA=30	
								IA	--	30				
5	Electrical Engineering	Core Compulsory	Power System Protection (TW, Practical and Viva) (ELE1718LCS)	NA	02(01)	Laboratory	Term Work, Practical & Viva	UA	50	--	50	20	UA=50	
								IA	--	--				

6	Electrical Engineering	Core Elective	Elective-I Options: (1) Advanced Electrical Machines (ELE1719DECS) (2) Computer Application to Power Systems (ELE1720DECS) (3) Artificial Intelligence (ELE1725DECS)	NA	04(04)	Lecture	Theory	UA	70	--	100	40	UA=70 IA=30 Out of three options in Elective-I, students can opt only one theory subject and it's respective laboratory
								IA	--	30			
7	Electrical Engineering	Core Elective	Elective-I Lab Options: (1) Advanced Electrical Machines (TW, Practical and Viva) (ELE1719LDECS) (2) Computer Application to Power Systems (TW, Practical and Viva) (ELE1720LDECS) (3) Artificial Intelligence (TW, Practical and Viva) (ELE1725LDECS)	NA	02(01)	Laboratory	Term Work, Practical & Viva	UA	50	--	50	20	UA=50
								IA	--	--			

Semester Number (For Example 01,02,03, etc.):					08								
Maximum Courses/Papers for the present Semester:					05								
Minimum Courses/Papers for the present Semester:					05								
Maximum marks for the present Semester:					500								
Minimum marks for the present Semester:					00								
Total Credits for the present Semester:					18.5								
Sr. No.	Department (NAME OF THE DEPARTMENT WHICH IS TEACHING THE PAPER)	Type of Course Core/ Elective/ Foundation/ IDE/ Compulsory etc.	Title of Paper	Group (if any)	Hours of Teaching per week [Credit*]	Teaching Learning Method [TLM]	Assessment Method [AM]	Assessment Type [AT] UA/ IA	UA Marks	IA Marks	Total Marks	Minimum marks for Passing	Remarks for Minimum /Maximum Course/Paper/Subject/ Selection
1	Electrical Engineering	Core Elective	Elective-III Options: (1) Digital Signal Processing (ELE....CS) (2) Industrial Automation (ELE1832DECSCS) (3) Embedded Systems (ELE....CS)	NA	04(04)	Lecture	Theory	UA	70	--	100	40	UA=70 IA=30 Out of three options in Elective-III, students can opt only one theory subject and it's respective laboratory
								IA	--	30			
2	Electrical Engineering	Core Elective	Elective-III Lab Options: (1) Digital Signal Processing (TW, Practical and Viva) (ELE....LCS) (2) Industrial Automation (TW, Practical and Viva) (ELE1832LDECS) (3) Embedded Systems (TW, Practical and Viva) (ELE....LCS)	NA	02(01)	Laboratory	Term Work, Practical & Viva	UA	50	--	50	20	UA=50
								IA	--	--			

3	Electrical Engineering	Core Elective	Elective-IV Options: (1) Flexible AC transmission System (ELE1827DECS) (2) Restructured Power System (ELE1825CS) (3) Power System Dynamics (ELE1828DECS)	NA	04(04)	Lecture	Theory	UA	70	--	100	40	UA=80 IA=20 Out of three options in Elective-IV, students can opt only one theory subject
								IA	--	30			
4	Electrical Engineering	Core Elective	Elective-V Options: 1) Testing and Commissioning of Electrical Equipment (ELE1829CS) 2) Microgrid and Grid Integration (ELE1830CS) 3) Power System Management and Planning (ELE1831CS)	NA	04(04)	Lecture	Theory	UA	70	--	100	40	UA=70 IA=30 Out of three options in Elective-II, students can opt only one theory subject
								IA	--	30			
5	Electrical Engineering	Core Compulsory	Project Part – II (ELE1820LCS)	NA	11(5.5)	Project	Project	UA	150	--	150	60	UA=150 Project Part – II is in continuation to Project Part – I.
								IA	--	--			

Bachelor of Engineering : Electrical Engineering

First Semester of BE I

(1) Communication Skills (Theory + Laboratory)

- **Strengthening Grammar** : Articles, Prepositions, Verbs, Tenses, Adjectives, Concord, Error Analysis
- **Developing Reading Skills** : Reading Comprehension: Developing Vocabulary through Derivation, Conversion and Compounding. From a seen/unseen passage write single and multiple sentence answers
- **Developing Writing Skills** : Paragraph Writing: Sentence linkers and supporting sentences. Identification and organization of paragraph types. Guided compositions. Writing Letters and Report. Technical report: Reporting workshop jobs- Carpentry, Fitting, Smithy, Tin Smithy Letter Writing: Letter seeking Permission and Request letter, Letter of Inquiry
- **Consolidating Speaking Skills** : Dialogue Rendering and Writing: Greeting and taking leave, Introducing self and others, Congratulating and Inviting. Expressing sympathy and offering condolences

(2) Applied Mathematics I (Theory)

- Calculus : Reorientation, Functions of one variable Application of derivatives, Curvature, Successive differentiation, Partial derivatives, Leibnitz rule for the nth order derivative of a function, Techniques of partial derivatives.
- Infinite Series: Sequence and their convergence , convergence and divergence of infinite series, Geometric series, P – Series ,Necessary condition for convergence, Comparison test, ratio test Absolute convergence and conditional convergence of alternating series, Maclaurin's & Taylor's expansion with reminder form, Indeterminate forms L'Hospital's rule
- Complex Numbers: Complex numbers & their geometrical representation, Complex numbers in polar form, Demoivre's theorem and its applications, Exponential, logarithmic, trigonometric & hyperbolic functions.
- Differential Equations Reorientation, Modeling of engineering systems pertaining to first order differential equations, Exact differential equations, integrating factors, Unified approach to first order ordinary differential equations, Equations of first order and higher degree.
- Linear differential equations of higher order with constant coefficients and with variable coefficients Models of higher order differential equations, Method of variation of parameters, Simultaneous linear differential equations Method of solution in series
- Bessel and Legendre's equations, Properties of Bessel functions Introduction to Legendre polynomials

(3) Applied Physics I (Theory + Laboratory)

- Electromagnetic Waves: Basic laws and equations. Application for devices and instrumentation, Microscopes, Telescopes and camera, Resolution and magnifications, Optical vibration and correction.

- LASER and Matter Waves: Fundamentals, Generation, Spontaneous and stimulated emission, conditions for lasing action, population inversion, Types and Engineering applications – Laser and electron beam machining and other instruments
- Sound Waves: Sound waves characteristic and properties, Velocity, frequency, wavelength, intensity, loudness (expression), timber, reflection, echo, reverberation. Sabine's formula, remedies over reverberation; Absorption of sound, absorbent materials; Criteria for good acoustics of a building; • Ultrasonic: Production of ultrasonic waves, Detection of ultrasonics; Engineering applications of Ultrasonics (Non-destructive testing, Infrasound – Seismology (concept only))
- Solar cells : Principle of working, conversion efficiency, Single, multi-junction solar cells, Photovoltaic system engineering, Thermo-photovoltaic generation in electricity, Concentration and storage of electrical energy, Photovoltaic – systems and applications
- Introduction to physics of Buildings :Heat transfer and air circulation in buildings, effects of thermal expansion

(4) Fundamentals of Civil and Environmental Engineering (Theory + Laboratory)

- Building Material : Stone - Introduction to stone – Uses of stone – Characteristics of good building stone – Availability, suitability and properties of different stone. Bricks - Comparison between stone work and brick work – Advantages of bricks – Characteristics of good brick – Standard test for brick along with field test for brick. Lime - Classification of Lime, Precautions in handling Lime. Cement - Basic ingredient of ordinary cement – Physical properties of cement – Field examinations of cement – Storing of cement and its uses. Timber - Introduction to timber – Importance of seasoning – Wood base product. Steel - Introduction – Use of different form of steel – Marketable forms of steel. Aggregates. Bitumen. FRP. Optical fiber. Plastic - Properties of plastics – Types and uses of plastic.
- Environmental Science and Sustainable Development : Introductory Environmental Engineering Terminology— Introduction to various types of pollution- Water and land pollution and remedial measures for control, water and wastewater quality criteria – Disposal of wastes – Air pollution and remedial for control – Ecology, Environmental Protection and legislation. Hydrologic cycle, Rain water harvesting, Green building, Solid waste management, Environment Impact Assessment, Basic environmental chemistry, Sustainable development – clean development mechanism, Global warming, Ozone layer depletion, Acid rain, and Climate change.
- Surveying and Leveling : Surveying - Introduction – Principle – Object of survey – Classification – Basic instruments of linear and angular measurements – chain, tape, Offsetting, Types of offsets, Ranging methods. Prismatic compass, Types of meridians, Types of bearings. Traverse survey: open and closed Examples based on compass. Leveling – Definitions – Computation of reduced levels– Introduction to contour, Methods of leveling and Examples on Level. Modern tools: Introduction to Theodolite, Total station – Introduction to GPS, GIS, Remote sensing.
- Building Construction : Building Construction & Infrastructures: Types of constructions – roads, pipelines, transmission lines – Typical details of load bearing and framed structures – Brief discussion and illustrational sketches of typical important building components – Foundation – Functions, Types of foundations such as Spread footing, Stepped footing, Isolated and Combined column footing, Raft, and Grillage foundation. Lintels– Function, Types of lintel. Flooring, Roofing. Mortar and concrete

specifications – Ingredients for mortar and concrete – classification of mortar and concrete – selection of mortar and its uses – precaution in using mortar – Pre-stressed concrete – grades of concrete, Internet of things for buildings, Hydropower plants.

(5) Engineering Drawing – I (Theory + Laboratory)

- Introduction to Engineering Curves: Introduction to conic sections, types of conic sections, eccentricity, construction of conic sections(parabola, ellipse , hyperbola) by different methods, Construction of involutes, construction of cycloid, epicycloid and hypocycloid, construction of spiral, construction of normal and tangent to all curves.
- Free hand sketches: Parts of screw thread and its types, conventional representation of threads, screwed fastening- types of nuts, bolts, set screws, locking arrangement of nuts, foundation bolts, riveted and welded joints, forms and proportions of rivet heads, representation of welded joints, shaft keys and couplings- types of keys, cotter joint, knuckle joint, double cotter/sleeve joint, types of couplings.
- Projection of Point and Line : Introduction to principal planes of projections, projections of points located with respect to reference planes (in different quadrants), Projection of Lines, Line parallel to reference planes, Line parallel to one reference plane and inclined to other reference plane, Line inclined to both the reference planes, Application of all variants
- Projection of Planes : Projection of Planes (Polygons, circle, semi-circle, ellipse etc.). Plane parallel to one reference plane and inclined to other, Plane inclined to both the reference plane, Concept of auxiliary plane method for projection of plane.
- Orthographic projection : Fundamental of projection along with classification, Projections from the pictorial view of the object on the principal planes for view from front, top and sides using first angle projection method and third angle projection method, full sectional view
- Isometric Projections and Isometric View or Drawing: Isometric Scale, Conversion of orthographic views into isometric projection, isometric view or drawing of objects

(6) Workshop Practices (Laboratory)

- Introduction to workshop facility: Introduction to different shops of the workshop, general safety guidelines, familiarization with workshop facility
- Carpentry Shop: Introduction to different tools of carpentry shop, understanding drawing of the job to be made, making of finished job as per drawing out of the given raw material of wood.
- Fitting Shop: Introduction to different tools of fitting shop, understating drawing of the job to be made, making of finished job as per drawing out of the given raw material.
- Smithy Shop: Introduction to different tools of smithy shop, understating drawing of the job to be made, making of finished job as per drawing out of the given raw material.
- Introduction to Machine Tools: Demonstration on different machine tools eg. Lathe machine, Shaping machine, Drilling machine, Grinding machine. Preparation of job by turning on lathe involving step turning and thread cutting.
- Metal Joining Processes: Introduction to different tools of welding shop, Demonstration of welding process, Preparation of welding job as per drawing, Introduction to other metal joining processes such as soldering, brazing and riveting
- Moulding Practice: Introduction to different tools of moulding shop, Demonstration of moulding process, Preparation of mould assembly as per pattern.

- Press Working: Demonstration of press working operations like blanking, punching, piercing etc.

(7) Universal Human Values I (Theory - Online)

- Introduction to UHV, Aspirations and Concerns, Self-management, Health
- Relationships
- Society, Natural Environment, Self-evaluation

Second Semester of BE I

(1) Applied Mathematics II (Theory)

- Partial Differentiation: Function of two variables – Definition, limit, continuity and partial derivatives, Chain rule, Euler's theorem, implicit functions differentials, Applications of partial derivatives (Tangent plane and normal line, approximation, maxima and minima, Lagrange's multiplier's method), Jacobians and transformations
- Vector Calculus: Reorientation, scalar and vector fields gradient of a scalar function, Directional derivative divergence and curl of a vector field and their applications
- Analytical Geometry: Reorientation, curvilinear coordinates (polar, cylindrical and spherical), cone, cylinder Conicoids, Surfaces and solids of revolutions
- Tangent planes and normal lines to above surfaces (by calculus method) Tracing of curves: Cardioid, cycloid, lemniscates, spiral, four leaved rose
- Rank of a matrix : solution of homogeneous and non – homogeneous systems of linear equations, Eigen values and eigen vectors of a matrix, Cayley – Hamilton theorem
- Laplace Transforms: Laplace transforms of elementary functions, inverse Laplace transforms, linearity property, first and second shifting theorem. Laplace transforms of derivatives and integrals, applications of Laplace transform in solving ordinary differential equations.

(2) Engineering Mechanics (Theory + Laboratory)

- Statics: Introduction, Forces and force system: Coplanar forces. Resultant of concurrent and non concurrent forces, Operations with couples. Graphical methods, Free body diagram. Support reactions, Equations of statics. Graphical methods. Forces in the members of simple trusses.
- Statics: Center of Gravity, Moment of Inertia: Centroids of lines and plane figures, Moment of inertia of plane figures. Transfer theorem. Product of inertia. C.G. of rigid bodies.
- Statics: Transmission of power : The wedge-the screw-the screw jacks, Simple lifting machines. Power transmission in belt drives. Gearings. Train of wheels. Epicyclic gearing.
- Strength and Elasticity of Materials: Simple stresses and strains: Hooke's law, Elastic limit. Ultimate stress. Factor of safety. Lateral strain. Poisson's ratio. Temperature stress. Simple shear. Proof stress. Elastic-moduli-relation, Principal stresses. Strain energy. Thin cylindrical and spherical shells: Analysis and design. Riveted and welded joints: Analysis and design. Determination of internal forces in beams and shafts. Shear force, Bending and/Twisting moment diagrams.

(3) Programming and Simulations (Laboratory)

- Simulation of Different types of Electrical Wiring in Applet circuit simulator
- Simulation of Electrical network theorems in Applet circuit simulator.
- Simulation of simple AC and DC electrical circuit in Applet circuit simulator.
- Different DC Circuits analysis in PSPICE.
- Steady state Analysis of R-L, R-C and R-L-C Series circuits in PSPICE.
- Modelling of Active and Passive Elements in ATP
- Simulation and Verification of Electrical Circuits for Steady State and Transient Condition under the applications of DC and AC Supply of low, power and high frequency
- Simulation and Verification of Electronics Circuits for Steady state condition
- Simulation of Electrical Wiring Concepts using ATP
- LaTeX Programming : Documentation
- LaTeX Programming : Beamer
- Programming and Simulation using Scilab
- Introduction to Programming and Simulation
- Basic Mathematical operation – I : Inbuilt commands/functions for some standard mathematical functions. Arithmetic operations on numbers and vectors.
- Basic Mathematical operation – II : Input of matrix. Inbuilt commands/functions on matrices. Arithmetic operations on Matrices.
- Graphical representation of Data –I (2-D plotting)
- Graphical representation of Data –II(3-D plotting)
- Data Analysis –I : Measure of central tendency
- Data Analysis –II : Measure of dispersion
- Introduction of Block Programming / Simulation
- Block Programming / Simulation for system of ODE
- Block Programming / Simulation for electrical circuits.
- Libre office calc – I : Introduction, Data representation using various Charts.
- Libre office calc – II : Use of Mathematical and Statistical tools.

(4) Electrical Sciences (Theory + Laboratory)

- Electrical circuit elements (R, L and C), voltage and current sources, Kirchhoff's current and voltage laws, analysis of simple circuits with dc excitation. Superposition, Thevenin and Norton Theorems. Time-domain analysis of first-order RL and RC circuits.
- Review of magnetic materials. Flux density. Intensity of magnetization. MMF. Permeability. Reluctance. Their relationships. Comparison with electric circuits. Calculation of amp. turns for series, parallel and series-parallel magnetic circuits containing air gaps. Effect of magnetic leakage and fringing. Review of Faraday's and Lenz's laws. Concept of self and mutual induction and their coefficients. Calculation of self and mutual inductance. Energy stored in magnetic field. Lifting power of an electromagnetic. Magnetization curve. Reversal of magnetization. Hysteresis and Eddy current losses.
- Alternating Voltages and Currents. RMS and Average values, Form factor and peak factor, vector representation of AC quantities.

- AC through R, L and C circuits, Series and Parallel circuits, Resonance, Q-factor, concept of active, reactive, apparent power and power factor.
- Three phase balanced circuits, voltage and current relations in star and delta connections.

(5) Fundamentals of Mechanical Engineering (Theory + Laboratory)

- Review of Thermodynamic System, Laws of Thermodynamics, Thermodynamic Cycle
- Transmission of Motion and Power : Machine and mechanisms, links, lower and higher pairs, four bar mechanism, slider crank mechanism and its inversions, Velocity and Acceleration of simple mechanism, Graphical and analytical method. Cam profiles for different kinds of motions, Balancing of rotating mass (simple cases) Flywheel
- Basic Elements of Mechanical Engineering : Steam Generation, Steam turbines, hydro turbines, wind turbines, Boilers, IC Engines, Pumps, Air compressors, Hydraulic/Pneumatic Equipment, Troubles, Refrigeration and Airconditioning system, Remedies and Safety related to all these elements.
- Mechanical Elements of Power Plant : Thermal Power Plant, Hydro Power Plant, Diesel Power Plant, Gas based Power Plant, Combined Cycle Power Plant

(6) Material Science (Theory)

- Introduction of Engineering Materials: Metallic Materials, Ceramic Material, Polymers, Composite and Nano-materials.
- Crystal Structure: Crystallography, Atomic structure and; Structure of crystalline solids; Lattices, unit cells; Crystal systems, Bravais lattices; Indexing of directions and planes, notations, Inter-planar spacings and angles, co-ordination number, packing factors stacking sequence in BCC, FCC and HCP.
- Mechanical Properties of Materials: Concepts of stress and strain, Stress- Strain diagrams; Properties obtained from the tensile test; Elastic deformation, Plastic deformation. Impact Testing & toughness behavior. Hardness of materials.
- Phase diagram: Gibbs phase rule, Binary phase diagram its types, solid solution – Hume Rothery Rules. Imperfections: Point defects, Line defects and surface defects – grain boundary, tilt boundary and twin boundary, Grain, Grain size number. Burgers vector and its representation.
- Ceramic Materials: Introduction, ceramic structures, silicate structures, Processing of ceramics; Properties, glasses; Composite Materials- Introduction, classification, metal-matrix, ceramic-matrix and polymer matrix composites.
- Corrosion: Types of corrosion – Dry and Wet corrosion, Electro chemical and oxidation (Chemical) corrosion. Corrosion prevention – anodic and cathodic protection & coatings
- Electrical & Electronic Materials: Intrinsic and Extrinsic Semi conductivity, Dielectric material, Piezo-electric materials. Magnetic Materials: Introduction, classification of magnetic materials, soft & hard magnetic materials.
- Advanced Materials: Nano Materials & its application, Metallic glasses, Super conducting material, optic fibers, smart materials.

First Semester of BE II

(1) Analog and Digital Electronics (Theory + Laboratory)

- Basics of Diode and Transistor, Diode Clipping circuits, Biasing of Transistors
- Transistor low frequency and High Frequency analysis for CE, CB and CC configuration
- Class A power amplifier with resistive load. Transformer coupled load. Drawbacks of class A. Power amplifier. Class B push-pull amplifiers. Selection of RL for maximum power output. Types of distortion in class B push-pull, its minimization, complementary symmetry and quasi-complementary symmetry. Class-B amplifier. Introduction to class-C amplifiers.
- Roman no. systems; weighted-positional systems and their conversions. Arithmetic operations. ASCII character set small keyboard switch matrix. 4-bit and 5-bit codes like 8421-EX.3, Gray, parity bit and their conversions.
- Boolean theorems and identities, logic gates AND, OR, NOT, NAND, NOR, EX-OR. Boolean expression SOP & POS form. Minimization of logic expression using K-maps. Use of Don't care conditions. Minimization using prime implicant table. There must be coverage of logic gates circuits. At least TTL, MOS & CMOS.
- Design of HA, HS, FA, FS, carry look ahead adder; 4 bit 8 bit adder, 8421 Adder/Sub. Ex-3 Adder/Sub, Parity bit generators and checkers, comparators, multipliers
- Design of multiplexers, demultiplexers, code converters, Decoders, Encoders.
- Sequential design using D, JK, T flip flops. Different types of flip flop, Synchronous counter Design, e.g shift counter, ring counter, twisted ring counter, Asynchronous sequential design of fundamental mode circuits and pulse mode circuits, Shift registers

(2) Electrical Machines - I (Theory + Laboratory)

- Electromechanical Energy conversion: Principles of electromechanical energy conversion, analysis of the devices & systems, Process of Energy Conversion, Designing and Optimizing techniques , Model development of electromechanical energy- conversion devices
- DC Machines : Construction details, Principles of Operation, Characteristics of different types of DC generators and DC motors, Armature Reaction and Commutation, Testing, Performance evaluation and applications of DC machines, Starting and Speed control of DC Motors
- Single phase transformer: Constructional features, working principle and types of transformers. Testing, performance evaluation and applications of various types of transformers, single phase auto- transformer. Parallel operation of transformers.
- Polyphase Transformer: Constructional features, working principle and types of polyphase transformers. Testing, performance evaluation and applications of various types of transformers, effect of saturation and harmonic analysis, three winding transformers, transformer connections, induction regulator.

(3) Electrical Measurements and Instrumentation (Theory + Laboratory)

- Measurement using Analog instruments and Measurement Systems: Significance of measurements, different types of measurements and instruments, their elements and

terms. Characteristics of instruments and measurement systems. Errors in measurement and their analysis. Units, systems of units, dimensions and standards. Different systems in analog instruments, types of Analog Instruments. Different types of galvanometers, ammeters, voltmeters, ohmmeters: Construction, working principles, analysis, advantages, disadvantages, applications, and Range of extensions by shunts and multipliers. DC and AC Potentiometers : Construction, operation, types, standardization and application

- Measurement of Resistance, Inductance and Capacitance : Different methods of measurement of resistance, measurement of low, medium and high resistance using DC measurement techniques and their analysis. Earth resistance measurement and localization of ground and short circuit faults. General form of AC bridges, detectors, measurement of self-inductance, mutual inductance, capacitance, and frequency using AC Bridges.
- Measurement of Miscellaneous Electrical Quantity and Magnetic Properties using Analog Instrumentation: Measurement of power and wattmeter, measurement of energy and industrial metering, measurement of phase and frequency, measurement of magnetic properties, measurement of current and voltage using instrument transformers.
- Digital Instruments: Basic concepts of digital instruments, signal conditioning and sampling concept in digital instruments, digital voltmeters, digital LCR meter, digital multimeter, digital tachometer. Transducers, Sensors and Measurement of Non-Electric Quantity: Classification, selection, construction, characteristics, working principle, types and applications of transducers and sensors. Measurement of pressure, temperature, flow, displacement, speed, force, torque, liquid level, humidity.

(4) Applied Mathematics III (Theory)

- Fourier Series and Fourier Transform: Fourier series of functions with arbitrary period, Fourier series of even and odd functions, Half range series. Fourier transform, Fourier sine and cosine transform.
- Multiple Integrals: Reorientation of concept of integrals, double and triple integrals, Evaluation techniques, Change of order of integration, Integrals in polar, cylindrical and spherical polar coordinates, transformation of multiple integrals.
- Vector Calculus: Line Integrals-Work done, Circulation, Surface integrals, Green's theorem, Stoke's theorem, Gauss divergence theorem.
- Second Order Partial Differential Equations: Formation and classification of PDE, Heat, wave, and Laplace equations & their solution by method of separation of variables and using Fourier series.
- Functions of Complex Variable: Limit, continuity and derivative of functions of a complex variable, C-R equations, analytic functions, and their applications: Harmonic, conjugate harmonic and potential functions, complex integration, line integrals, Cauchy integral theorem, and Cauchy integral formula.
- Power Series representation of $f(z)$: Taylor's series, Laurent's series, Singularities.

(5) Computational Techniques (Theory + Laboratory)

- Elements of C language: Data types, variables, operators, expressions, flow control schemes, Programs based on above, Simple statements, Decision making statements,

Looping statements, Nesting of control structures, break and continue, go to statement with programs.

- Advanced Features of C: Concepts of array, one and two dimensional arrays, declaration and initialization of arrays, string, string storage, Library string functions, Concepts of user defined functions, prototypes, definition of function, parameters, parameter passing, calling a function, recursive function, Macros, Pre-processing, Basics of pointers, pointer to pointer, pointer and array, pointer to array, array of pointers, functions returning a pointer, Basics of structure, structure members, accessing structure members, nested structures, array of structures, structure and functions, structures and pointers.
- Data Structure: Representation of Stacks & queues using arrays and linked list. Circular queues. Binary tree traversal methods. Sequential and binary searches insertion, selection, bubble, quick, shell, heap sorting.
- Numerical Methods: Introduction to numerical methods, Algorithm, Flow charts, Approximations and errors in numerical programming with examples, Introduction to iterative methods, approach and classification, Bisection method, algorithm, example and c program, False Position method, algorithm, example and c program, Newton Raphson method, convergence of numerical methods Secant method, algorithm, example and c program, Direct solution of linear equations, Solving simultaneous linear equations, Basic gauss elimination Method, Jacobi iteration method, algorithm, example and c program, Gauss Seidel Method, Gauss Jordan Method, L U Factorization Method, Numerical Integration, Newton cotes method, Trapezoidal rule, Simpson's 1/3rd Rule, Simpson's 3/8th Rule, Numerical solution of Ordinary differential Equations, Initial and Boundary value problems, Taylor series Method, Euler's Method, Runge Kutta Method. 2nd and 4th order, Matrix concepts, Matrix Inversion, example and c program, Eigen value and Eigen vectors.

(6) Industrial Management and Economics (Theory)

- Organization and Management: Introduction, Definition of Organization, Necessity of Organization, Essential Elements of a good Organization, Principles of Organization, Formal and Informal Organization, Advantages of good Organization, Organization Structure, Definitions of Management, Characteristics of Management, Levels of Management.
- Materials Management and Purchasing: Introduction, Definitions, Objectives of Materials Management, Functions of Materials Management, Importance of Materials Management, Scope of Materials Management, Organization of Materials Management, Factors Promoting Economies in Materials Management, Purchasing, Duties, Functions and Responsibilities of Purchasing Department, Methods of Purchasing, Purchasing Procedure.
- Personnel Management: Introduction, Definitions, Aims or Objectives of Personnel Management, Characteristics of Personnel Management, Functions/Scope of Personnel Management, Principles of Personnel Management, Manpower Planning, Sources of recruitment, Scientific Selection.
- Marketing Management: Introduction, Evolution of Marketing, Modern Concept of Marketing, Selling Concept Vs Marketing Concept, Marketing Functions, Marketing Mix, Product Mix and Product Line.

- Engineering Economics: Definition and Concept, Importance of Economics for Engineers, Wealth, Goods, Wants, Value and Price, Capital, Money, Income, Margins, Utility, Demand and Supply, Macro Economics and Micro Economics.
- Depreciation: Definition and Concept, Factors Affecting the Periodic Allocation of Depreciation, Classification of Depreciation, Methods of Calculating Depreciation
- Breakeven Analysis: Introduction, Assumption in Breakeven Analysis, Plotting the Breakeven Chart, Managerial Uses of Breakeven Chart, Limitations of Breakeven Chart Analysis.

Second Semester of BE II

(1) Signals & Systems (Theory + Laboratory)

- Introduction of Signals and Systems, Properties of Systems, Time-Domain Representations for Linear Time-Invariant Systems, correlation
- The Laplace transform, properties of Laplace transforms, Analysis and characterization of LTI systems using Laplace transforms
- Fourier Representations for periodic and aperiodic continuous time signals i.e. Fourier series and continuous time Fourier transforms, Sampling and reconstruction of signals, Energy Spectral Density, Power Spectral Density.
- The Z-transforms - ZT-IZT, Stability Criterion & ROC, Properties.
- Fourier Representations for Discrete-Time Periodic Signals and Discrete Time aperiodic signal - DTFT-IDTFT and properties, DFT-IDFT and properties

(2) Electrical Machines – II (Theory + Laboratory)

- ALTERNATORS: Constructional features, working principle, types of alternators. Testing and performance evaluation of alternators, synchronization of alternators with grid, capability curves.
- SYNCHRONOUS MOTORS: Constructional features, working principle, types of synchronous motors. Testing, performance evaluation and applications of synchronous motors, Methods of starting, effect of changing excitation, comparison between synchronous and induction motor.
- Induction Motors : Constructional features, working principle, types of induction motors. Production of rotating magnetic field, slip, frequency of rotor current, variation in rotor current. Equivalent circuit, torque-slip characteristics, starting, maximum and pullout torque, effect of change in supply voltage. Testing, performance evaluation and applications of induction motors. Circle Diagram, Starting and Speed control of Induction Motor, Double cage Induction Motor, Induction Motor as Induction Generator and Applications. Single Phase Induction Motors : Principle of working, types and applications of single phase induction motors.
- GENERALIZED MACHINE THEORY : Elements of generalized theory, Essentials & Conventions, Basic two pole machine, Transformer with movable secondary, Transformer and speed voltages in armature, Kron's primitive machine, Linear transformation in Electrical machines, Analysis of Electrical machines.

(3) Electromagnetic Field Theory (Theory)

- Vector Analysis : Vector Algebra, Coordinate Systems, Vector Calculus, Transformations
- Electrostatics Fields and Dielectrics : Electrostatic Fields, Dipole, Capacitance, Conductors, Dielectrics, Energy, Potentials, Electric Fields in Material and Space, Electrostatic Boundary Value Problems
- Magnetostatic Fields : Steady Magnetic Fields, Magnetic Forces, Magnetic Potentials, Materials and Devices
- Time Varying Fields and Maxwell's Equations : History of Electrical and Magnetic Effects, Maxwell's Equation in Steady field, Maxwell's Equation in Time Varying Fields, Displacement Current, Time varying Potentials, Time Harmonic Fields
- Electromagnetic Waves : Generation of Waves, Polarization of Waves, Wave Propagation in different medium, Reflection and Refraction of Waves , Interference of Waves, Waves in Space and Transmission Lines, Non-Linear Electromagnetic Effects
- Wave guides and Antenna : Transverse Electric Waves, Transverse Magnetic Waves, Wave guide, Wave guide Resonators, Radiation of Waves, Antenna and Its Characteristics, Impedance
- Electromagnetic Theory and Special Relativity : Galileian Relativity, Theory of Special Relativity, Lorentz Transformation, Electromagnetic Field Theory to Real World Application
- Computation of Fields : Idea for Computation of Fields, Field Plotting, Different methods of Computation of Fields like FDM, FEM, CSM, Moment Method, Field Computation in 1-Dimensional Region and 2-Dimensional Region

(4) Network Analysis & Synthesis (Theory + Laboratory)

- Two-port Networks: Network definitions, Principle of duality, Reduction of a complicated network, Conversions between T and π sections, The bridged- T network, The lattice network, Driving point impedance, transfer impedance, The parallel-T network. Definitions of different parameters and their equivalent circuits. Inter-conversion of parameters. Reciprocal and symmetrical networks. Different network structures (T, π , Ladder, Lattice, Bridged-T, Twin-T etc) and their parameters. Interconnection of two port Networks. Bartlett's Bisection theorem.
- Passive Filters: Impedance transformation-Transformation of impedances with tapped resonant circuits, Reactance L section for impedance transformation, Image impedances; reactance matching, Reactance T networks for impedance transformation. Fundamentals of filters. Various filter types and their responses – Constant-K, m-derived and Composite filters.
- Attenuators and Equalizers: Design and Analysis of symmetrical and asymmetrical attenuators. Equalizers- Inverse impedance, Constant resistance equalizers, Bridge T attenuation equalizers, Bridge T phase equalizer, Lattice attenuation equalizer, Lattice phase equalizer.
- Network Analysis using Laplace Transform: Application of LT to different RLC circuits and their responses for various excitations like dc, ac and exponential. LT of special signal waveforms – both periodic and non-periodic and their applications to obtaining different circuit responses.

- Network Functions: Network Functions of one port and two port network, Poles and Zeroes of network functions, Properties of driving point functions for RL, RC, LC networks and their Reactance Curves.
- Synthesis of One Port Network: Synthesis of RL, RC, LC networks using Foster and Cauer forms.
- Indefinite Admittance Matrix: Definitions, properties and reduction, applications of IAM.
- Graph Theory: Graph theory for networks – related definitions and matrices. Application of the same to solve different circuit examples.

(5) Electronics and Communication Circuits (Theory + Laboratory)

- Feedback concept, positive and negative feedback, advantage of negative feedback. Effect of negative feedback on different parameters of amplifier namely transfer gain, bandwidth, input and output resistances, harmonic and nonlinear distortion, signal to noise ratio etc. Classification of feedback amplifiers. Gain input and output resistance of a voltage series. Current series. Current shunt and voltage shunt type amplifiers.
- Review of differential amplifier, dual input concept. Inverting and non-inverting inputs, CMRR, OP Amp basics, standard values of different open loop parameters viz. voltage gain, input and output resistance, UGB, CMRR, Slew rate etc. of $\mu A - 741$ Op-Amp. Close loop configurations namely Inverting, non-inverting and differential with detail analysis. Measurement of open loop parameters, effect of Input offset voltage and input bias current, compensation circuits, different related definitions, viz. PSRR, voltage and current drift, full power band width, differential and common mode range. Applications: Adder, Subtractor, Instrumentation Amplifier, Active filter, classifications, first and second order Butterworth filters.
- Oscillators, basic concept, positive feedback, Barkhausen criteria for oscillations. R-C phase shift oscillator, Wien bridge oscillator, Crystal oscillators.
- Modulation, Different types of Modulation, comparison different types of modulation, advantages and disadvantages of the modulation. Amplitude Modulation (AM), Amplitude Modulation Index, Modulation for Sinusoidal AM, Frequency Spectrum for sinusoidal AM, Average Power for Sinusoidal AM, Effective Voltage and Current for Sinusoidal AM, Non sinusoidal modulation, relevant Examples. Double sideband suppressed Carrier(DSBSC) Modulation, Amplitude Modulator circuits Amplitude Demodulator Circuits, Distortion in demodulation like diagonal and negative clipping. Amplitude modulated transmitters, AM broadcast transmitters, AM receiver using a phase locked loop. Single sideband suppressed Carrier (SSBSC) Modulation Single sideband principles, Balanced modulators, integrated and circuit doubly balanced modulators. Diode mixer, doubly balanced ring modulator. Single Side Band generation using methods like (1) Balanced Modulator-Filter method (2) phasing method. Amplitude Modulation, Double sided full carrier system, Current, Voltage, Power, Efficiency of the Amplitude Modulation, Different methods of the Generation and Detection of AM signal. Double sided suppressed carrier system. Comparison of the DSBFC and DSBSC. Generation and Detection methods of the DSBSC.
- Angle Modulation: Frequency modulation (FM), Sinusoidal Frequency modulation, Comparison between Angle and Amplitude Modulation. Peak frequency deviation constant, modulation index for FM, Narrow band FM and Wide band FM. Effect of modulation index on bandwidth of FM, non sinusoidal modulation, Deviation ratio, Phase modulation(PM), Equivalence between PM and FM, Sinusoidal phase

modulation, Digital phase modulation. Angle modulator circuits like Varactor diode modulators and Transistors (JFET) modulators, FM transmission by methods like using (1) Reactance modulators and (2) indirect methods like Armstrong method. FM Broadcast, Angle modulation detectors like the Foster Seeley Discriminator, Ratio detector, Phase locked Loop detector.

- Introduction and Concepts of Pulse Modulation and Basic Pulse modulation like Pulse Amplitude Modulation, Pulse Position Modulation, Modulator and Demodulator of Pulse Modulation such as Pulse modulation, Amplitude Phase Keying, Frequency Phase Keying, Phase Shift Keying. Sampling, Different types of sampling, Nyquist Rate.

(6) Universal Human Values-II (Theory + Laboratory)

- Introduction to Value Education
- Harmony in the Human Being
- Harmony in the Family and Society
- Harmony in the Nature/Existence
- Implications of the Holistic Understanding

First Semester of BE III

(1) Microprocessors & Microcontrollers (Theory + Laboratory)

- Microprocessors & Microcontrollers: Basics of Microprocessors and its architecture. Different types of microcontrollers, Relative merits and demerits of microcontrollers. Microcontroller architecture, pin-out and associated signals. Instruction timing and execution for 8-bit microcontrollers. Interrupts, Handling Multiple Interrupts, Vectored Interrupts, Non Vectored Interrupts and Polled Interrupts, Pending Interrupts. Interrupt structure of 8051.
- Software Concepts: Assembly language programming, software development tools for program testing and development. Instruction set of 8051: Data transfer group, Arithmetic and logic group of instructions and Branch group of instructions. Simple programs based on these instructions. Viz. programs for time delays, counters. Bitwise instructions and their applications.
- Advanced Software Concepts: Stack, Handling stack; stack and subroutine group of instructions, subroutines and Interrupts handling programs. Features of assemblers, assembler directive, Relocation features, Macros.
- Applications of Microcontroller: Interfacing and Assembly language programs of external Peripheral Devices such as: Relays, Switches, Keys, Keyboard, ADC, DAC, 7 segment displays, LCD displays, LED, Sensors, non-volatile memory elements with 8051 microcontroller. Introduction to various motors, serial printers etc and their interfacing with 8051 using various protocols viz.: I2C, SPI, RS232/UART, RS422/RS485, MODBUS etc.
- Introduction to 8051-F340: Microcontroller and its advanced peripherals. C-programs based on peripherals.

(2) Control Systems Engineering (Theory + Laboratory)

- Background: History, recent trends and applications. Systems, Control Systems and their classifications. Open-loop and closed loop control systems.
- Modeling: Mathematical modeling of electrical, mechanical, electromechanical, thermal and hydraulic systems. Differential equations, transfer functions and state-space models. Linearization. Systems with transport lag. Block diagrams and signal-flow graphs. Computer simulation of control systems.
- Components: AC and DC Servomotors, Synchros, Gyroscopes, Valves, Gear-trains, Potentiometers and their models. Motion control systems – Servomechanisms.
- Time-response analysis and Design: Time response, Transient response, Steady-state response. Responses of first- and second-order systems to standard test signals and related specifications. Error Constants and Generalized Error Series. Sensitivity and Robustness. Solution of homogeneous and non-homogeneous state equations. Controllability and Observability. Design of P, PD, PI and PID controllers in time domain.
- Stability and Root Locus: Concept and definition – BIBO and Zero-input stability. Routh-Hurwitz criterion. Analysis of control systems using root locus plots. Design of P, PD, PI and PID controllers and Lag and Lead compensators using root locus.
- Frequency domain analysis and design: Nyquist stability criterion – Gain and Phase margins. Bode plots. Frequency domain specifications and their correlations with time response. M-N circles and Nichols chart. Lag and Lead compensator design using frequency response plots.

(3) High Voltage Engineering (Theory + Laboratory)

- Breakdown Mechanisms of Gaseous, Liquid, Solid, Vacuum and Composite Dielectrics: Introduction -Dielectrics-Properties of Dielectrics-Factors Affecting the Breakdown of Dielectric, Breakdown Mechanisms-Treatment of Dielectric-Different types of dielectrics-Applications of Dielectric
- Corona : Introduction -Phenomena of Corona & Corona Loss-Critical Disruptive Voltage-Causes of Corona-Effect of Corona-Advantages and Disadvantages of Corona-Factors Affecting Critical Disruptive Voltage and Corona Loss- Methods of Reducing Corona Loss- Radio Interference- Measurement of Radio Interference- Factors Affecting to Radio Interference- Methods to Reduce Radio Interference
- HVDC Transmission Systems: Introduction, Layout, Design Considerations, Working Principle, Comparison between HVAC and HVDC transmission system, Types, Control Strategies, Harmonics Generation, Filters, Multi-terminal HVDCTS, Advantages & Disadvantages, Faults, Protection System, Application
- Partial Discharge: Introduction, partial discharge detection and measurements, basic partial discharge (PD) circuit, PD currents, PD quantities, Digital PD instruments and measurements, acoustic emission technique and UHF Techniques for PD identification
- Transients in Power System: Introduction, Causes of Over Voltages and its Effect on Power System, Lightning Mechanism, Switching Surges and Temporary Over Voltages, Protection Against Over Voltages, Bewley Lattice Diagram, Insulation Coordination, Effect of Junctions and Terminations on Wave Propagation in Transmission Line.
- Generation of AC, DC and Impulse Wave : Introduction, High Voltage Generation, High Current Generation, Impulse Wave Generation

- Measurement of AC, DC and Impulse Wave: Introduction, High Voltage Measurement, high Current Measurement, Impulse Wave Measurement
- Testing of Power Apparatus and Components: Introduction, HV Testing of Electrical Apparatus, Definitions, Terms and Conditions, Test on Insulators, Cables, Transformers, Surge Arresters. HV and EHV Bushing Design, Selection, Quality Control, Maintenance and Diagnostic Testing, Biological and Environmental Aspects in EHV and UHV Line Design, Live Line Maintenance, Principles, Common Live Line Maintenance, Tools for Live Line Maintenance.
- Non-Destructive Testing of Insulation: Introduction, Dynamic Properties of Dielectric, Modelling of Dielectric Properties, DC Resistivity Measurement, Complex Permittivity, Dielectric Loss and Capacitance Measurement, Sweep Frequency Response Analysis, Dissolved Gas Analysis
- High Voltage System Earthing: Introduction, Need of Earthing, Types of Earthing, Earthing Design as per IEEE Std. 80

(4) Power Systems – I (Theory)

- Power System Network: Evolution of Power Systems, Basic structure, overhead and underground system, Comparison of AC & DC systems, High voltage for transmission
- Power Generation: Sources of electric energy, Conventional and Non Conventional electrical power generation
- Supply System and Distribution of Electric Power: Effect of voltage on transmission efficiency, Comparison of supply systems, Distribution systems
- Basics of Electrical Power Transmission: Mechanical Design of transmission lines, Insulators, Underground Cables
- Transmission Line Parameters: Resistance, Inductance, Capacitance of transmission lines
- Performance of Transmission Line: Types and Modeling of Transmission lines, Generalized circuit constants, Ferranti effect, Power flow, Power transfer capability, Compensation of a transmission line
- Load Characteristics: Load curves, Basic aspects pertaining to power plant operation, Tariff

(5) Electrical Machine Design (Theory + Laboratory)

- Design of Electromagnets and Instrument Transformer
- Design of Induction Machines
- Design of Synchronous Machine
- Design of Three Phase Transformers

Second Semester of BE III

(1) Power Electronics (Theory + Laboratory)

- Study of different types of conventional and modern semiconductor power switches like Power diodes, Power transistors, SCR, GTO, IGBT, MOSFET, MCT, Triac,

Diacetc – their Turn-on and Turn-off characteristics, triggering circuits, and protection, IC 555 and Its applications

- Principle and types of Cyclo-converters. Single-phase step-up and step-down cycloconverter using midpoint and bridge converters of different types.
- Phase-controlled rectifiers – single-phase/three-phase/six-phase/poly-phase for midpoint converters with and without freewheeling diode for R-L-E loads. Fully and Half-controlled Bridge converters (1-ph and 3-ph) for R-L-E load with and without freewheeling diode. Effect of source impedance on different types of converters. Dual Converters.
- Thyristor Commutation techniques. Choppers-Principle of operation, circuits for different types, operation, analysis and commutation. Load-commutated and multi-phase choppers.
- Principle and classification of inverters. Single- and Three-phase bridge VSSingle phase CSI, Series and parallel Resonant Inverters.
- Principle of AC voltage controller and its types. Study of Phase-controlled AC voltage regulator with different loads
- SMPS, UPS, DC drives, Battery chargers, AC drives, DC-DC Converters: Buck, Boost, Buck-Boost, Cuck etc.

(2) Utilization of Electrical Energy (Theory + Laboratory)

- POWER SUPPLY FOR ELECTRIC TRACTION: Electric Traction: System of traction types of traction. Methods of supplying power for electric traction. Speed time curves and mechanics of train movement. Tractive effects and Power output from driving axle. Energy output from driving axle. Various factors affecting energy consumption, Traction motor.
- HEATING-WELDING: Electrical heating and welding: Methods of transferring the heat. Methods of resistance heating. Resistance furnaces. Characteristics of induction heating. Induction furnaces. Dielectric heating. Arc furnace. Power supply and control of furnaces. Electric welding.
- ILLUMINATION: Various terms relating to illumination. Lighting schemes. Requirements. Design of lighting schemes. Different types of lamps
- TRANSMISSION AND DISTRIBUTION: Overview of Transmission and distribution planning, Bus bar scheme, Voltage drops and power loss calculations, Power factor improvement, Rural electrification.

(3) Power System Switchgear (Theory)

- Principles of circuit breaking: D.C. circuit breaking. A.C. circuit breaking. Current zero periods. A.C. Voltage and current waveform. Parallel capacitance. Restriking voltage. Transient recovery voltage. Current zero pauses. Current chopping. Capacitive current breaking. Inductive current breaking. Ideal circuit breaker. Circuit breaker ratings and specifications.
- Physics of arc phenomena: Initiations of the arc. Maintenance of the arc. Arc extinction. High resistance interruption. Low resistance of zero point extinction. Arc interruption theories. Arc extinction in oil, vacuum, air blast and SF6 gas. Use of a.c. network analysis and digital computer in fault calculation. Current limiting reactors.
- Circuit breakers: Air break circuit breakers-constructions. Arc extinction. Air break d.c. circuit breakers. Miniature construction. Arc quenching in ABCBs. Resistance

switching in ABCBs. Multibreak C.B.-Compressed air system for ABCBs. SF6 circuit breaker construction. Arc extinction. Single pressure buffer type. Double pressure dead tank type. SF6 insulator metal clad switchgear. Minimum oil circuit breaker (MOCB) and bulk oil circuit breaker. Vacuum C.B. construction. Arc extinction and rating.

- Switchgear Components : Bushings. Plain and dielectric bushings. Circuit breaker contacts. Current transformer construction and their of C.T. Protective and metering C.T.s. Ratings. Errors. Connections and specifications. Potential transformers construction and theory. Rating. Errors. Specifications. Connections of P.T.s. H.R.C. fuses-construction. Characteristics and their applications.

(4) Power Systems – II (Theory)

- System Modeling and the Per Unit System: Modeling of Power System Components, One-Line Diagram, Impedance and Reactance Diagram, Per Unit System and Computations
- Power Flow Analysis: Bus Admittance Matrix, Power Flow Equations, Load Flow Methods, Control of Power into a Network, Regulating Transformers, Energy Control Centres
- Economic Operation of Power Systems: Distribution of Load on Units within a Plant, Penalty Factors and Loss Coefficients, Distribution of Load Between Plants
- Symmetrical and Unsymmetrical Fault Analysis: Short Circuit Currents and the Reactances of Synchronous Machines, Application of Thevenin's Theorem, Faults on Systems, Symmetrical Components, Sequence Impedances and Sequence Networks, The Bus Impedance Matrix in Fault Calculations, Faults through Impedance
- Power System Stability: Steady State and Transient Stability, Swing Equation, Equal Area Criterion, Numerical Solution of the Swing Equation
- Power System Control: Basic Generator Control Loops, Automatic Voltage Control, Load Frequency Control

(5) Electrical Safety and Energy Management (Theory, Department Elective I)

- Electrical Safety, Shocks and Their Prevention: Definition of Current, Voltage and Resistance, safe limit of electrical parameter for human body, objectives of safety and security measures, Hazards associated with electric current and voltage, possibilities of getting electrical shock and its severity, medical treatment and analysis of electric shocks and its effects. Importance of earthing, pipe earthing, plate earthing, strip earthing, Chemical Earthing.
- Electrical Safety: in Residential, Commercial and Agricultural Installations: Wiring and fitting –Domestic appliances - multi-storied building –Temporary installations - Do's and Don'ts for safety in the use of domestic electrical appliances. Miniature Circuit Breaker and it's types, Residual Current Protective Devices, ELCB Vs RCCB, Safety requirements for renewable generating stations. Safety measures for operation and maintenance of generating station.
- Energy Audit: Definition, Need of Energy Audits, Types of Audit, procedures to follow, data and information analysis, Introduction to Data Analytics, Energy Audit Instruments Demand Side Management : Demand side management (DSM) fundamentals, Demand management through tariffs (TOD), Time of Use Tariff, Supply-side management (SSM), Impact of Power Factor on Electricity bills.

- Energy Conservation and Policies: Objective and Principles of Energy Conservation, Energy Management, Energy Efficiency Programs. BEE Star Label, Energy as a service, Energy Security, Salient features of Energy Conservation Act 2001 and the Energy Conservation (Amendment) act, 2010 and 2022, Introduction to ISO 50001-Energy Management.

(6) Engineering Optimization (Theory, Department Elective I)

- Introduction to Optimization: Introduction, Historical Development, Engineering Applications of Optimization, Statement of an Optimization Problem, Classification of Optimization Problems, Optimization Techniques
- Classical Optimization Techniques: Single-Variable Optimization, Multivariable Optimization with No Constraints, Multivariable Optimization with Equality & Inequality Constraints, Convex Programming Problem
- Linear Programming: Simplex Method, Duality in Linear Programming, Karmarkar's Interior Method, Quadratic Programming
- Nonlinear Programming: One-Dimensional Minimization Methods, Elimination Methods, Interpolation Methods, Unconstrained Optimization Techniques: DIRECT SEARCH METHODS, INDIRECT SEARCH (DESCENT) METHODS, Constrained Optimization Techniques: DIRECT METHODS, INDIRECT METHODS
- Dynamic Programming: Multistage Decision Processes, Concept of Suboptimization and Principle of Optimality, Computational Procedure in Dynamic Programming, Conversion of a Final Value Problem into an Initial Value Problem
- Integer Programming: Integer Linear and Non-linear Programming

(7) Institute Elective (Theory)

1. Advance statistical Software (AMT1682IECS)
2. Nanotechnology and its Applications (APH1681IECS)
3. Space Technology (APH1682IECS)
4. Fundamentals of Sustainable Building Design (ARC1681IECS)
5. Innovative Product Design and Development (ARC1682IECS)
6. Green Fuels (CHL1681IECS)
7. Plastic Waste Management (CHL1682IECS)
8. Python Programming (CSE1682IECS)
9. Circular Economy and Sustainable Development (CVL1681IECS)
10. Wireless communications and Networking (ELE1682IECS)
11. Robotics Engineering (MEC1682IECS)

12. Natural Resources for Textiles (TXC1681IECS)
13. Textile Materials and Sustainability (TXE1681IECS)
14. Functional Textiles (TXE1682IECS)
15. Water Conservation Concepts (WRE1681IECS)
16. Perspectives of Climate Change (WRE1682IECS)

(8) Electrical Workshop (Laboratory)

First Semester of BE IV

(1) Electrical Drives (Theory + Laboratory)

- Electric Drives: Concept of electric drives, advantages and parts of electric drives, Classification of electric drive, Characteristics of a.c. and d.c. motors from application point of view, Dynamic of electric drives-speed torque convention and multi quadrant operation, load torque.
- Operation of Motors: Starter for motors, overview of speed control for different motors, Electric breaking – Plugging, Rheostatic and regenerative braking, Rating and heating of motors, load equalization, Industrial application.
- Induction motor drives: Stator Voltage control- Rotor resistance control- Chopper control- Slip energy recovery schemes, V/f control, Cycloconverter fed motors, VSI & CSI fed motors- PWM drives, Field oriented control.
- Converter and chopper fed DC drives: Principle of phase control , Fundamental relations; Analysis of series and separately excited DC motor with single-phase and three-phase converters with waveforms, performance parameters and performance characteristics. Continuous and discontinuous mode, Current ripple, and its effect on performance; Operation with freewheeling diode, Dual converter fed DC drives. CHOPPER FED DC DRIVES : Introduction about chopper, control strategy, Class A, B, C, D and E chopper-controlled DC motor drive, performance analysis, Chopper based implementation of braking methods, Multi-phase chopper.

(2) Project Part I (Project)

(3) Power System Protection (Theory + Laboratory)

- Introduction to Power System Protection: The Philosophy of Protective Relaying, Purpose of protection, Causes and consequence of fault, types of faults, major components of power system that needs protection, basic tripping circuits, zones of protection, essential qualities of protection system, primary and backup protection, evolution of protective relay technology, classification of protective relays and protective schemes, auto reclosure, protective current and potential transformer, basic relay terminology, different types and working principle of electromagnetic relays and

their auxiliaries, thermal relays, advantages and disadvantages of electromagnetic relays.

- Over Current Protection: Different over current relay characteristics, relay settings, methods of discrimination, directional relay, different feeder protections, earth protection and protection scheme, combined phase fault and earth fault protection scheme, radial feeder relay coordination using definite time and IDMT relays, over current protection of interconnected systems
- Differential Relays and Apparatus Protection: Principle of differential protection, simple differential protection, difficulties with simple differential protection, percentage differential protection. Transformer Protection: Types of faults, gas-operated relay, leakage and over load protection, non-unit protection, problems in application of differential protection, biased differential protection against phase and earth faults, magnetizing inrush current, harmonic restraint relay, restricted earth fault protection, protection against inter-turn faults and over fluxing. Bus zone protection : Current differential protection, selection of CTs, biased differential protection, actual behaviour of normal and saturated protective CT, high impedance busbar differential scheme, supervisory relay, frame leakage protection, breaker backup protection, directional comparison, split-bus protection. Generator protection : Various faults and abnormal operating conditions, stator protection against phase, earth faults and inter-turn faults, rotor faults, protection against abnormal operating conditions. Motor protection : Various faults in induction motors, protection of small and large induction motors against abnormal operating conditions electrical and mechanical side, protection of synchronous motors.
- Distance Relays: Drawbacks of over current relay protection, introduction to distance protection, simple impedance relay, reactance relay, Mho relay, comparison between distance relay, Reach of distance relay, reasons for inaccuracy of distance relay reach, three stepped distance protection, complete distance protection of three phase transmission lines for phase fault and ground fault, Effect of Arc resistance, power swing, line length and source impedance on the performance of distance relay, different relay characteristics.
- Carrier Current and Pilot Relaying Protection: Wire pilot relaying, types and limitations of wire pilot relaying, Need of carrier current protection, working principle, various options for a carrier, phase comparison and directional comparison relaying.
- Testing of Relays: Acceptance tests, type tests, laboratory setup for testing of different types of relays.
- Static and Digital Relays: Static Relays : Need, essential components, advantages, disadvantages, classification of static relays, electronic circuits commonly used in static relays, basic concept of comparators, amplitude and phase comparators and their duality, different types of comparators, different static relay characteristics like over current, differential, distance relay, multi input comparator. Digital Relays : Introduction to computer relaying, Development and historical background, expected relay architecture, A-D converters, Anti –aliasing Filters, substation computer hierarchy Review of mathematical basis for protective relaying algorithms, phasor estimation using discrete fourier transform, Microprocessor based protection : over current relay. Distance relay, differential relay.

(4) Advanced Electrical Machines (Theory + Laboratory, Department Elective II)

- Parallel operation of two alternators, Effect of unequal voltage, distribution of loads, Time-period of oscillation, Maximum power output, Effect of varying mechanical Torque and excitation, Synchronous machine on infinite bus and effect of varying Excitation and driving torque, Significance of Short Circuit Ratio and Physical size And cost of the machine.
- Transient Analysis and transient torque, Sudden reactive loading and unloading, Transient analysis a qualitative approach, Reactances and time constants from equivalent circuits, Concepts of synchronous machine reactances, Measurement of reactances, Reactances and time constants from short circuit oscillogram, Transient power angle characteristics Phasor diagrams under Transient and Subtransient conditions, large Angular oscillations.
- Modelling of power system components like Generator, Prime Movers, Exciters, Transmission Line, Transformers and FACTS Devices.
- SPECIAL MACHINES: A.C. Commutator Machines, EMF equation, Torque equation, Performance and Characteristics of single phase AC series motor, Universal motor, Repulsion motor, Schrage motor. Brushless DC motor, Variable reluctance motor.

(5) Computer Application to Power Systems (Theory + Laboratory, Department Elective II)

- Development of algorithms and computer programs for solution of simultaneous equations. Direct methods of solution. Optimal re-ordering and application of sparsity. Iterative methods.
- Algorithms for formation of bus admittance and bus impedance matrices. Modification for changes in network. Handling of large system data. Application of sparsity. Short circuit studies of large system using bus impedance matrix. Development of computer programs.
- Planning of interconnected systems. Types of buses. 'State' and 'Control' variable. Development of algorithms for load flow solution of large system using Gauss Siedel, Newton Raphson, Decoupled and Fast-decoupled methods.
- Development of flowcharts and computer programs for load flow studies. Treatment of voltage control buses and regulating transformers. High speed reduced accuracy models for contingency analysis.
- Optimal dispatch strategy. General optimal load flow algorithm. Development of flowchart and computer program. Concepts of power system security analysis. Functions of modern energy control centers.
- Transient Stability studies of interconnected system. Representation of synchronous machines and loads. Solution techniques using modified Euler method. Development of computer programs.

(6) Artificial Intelligence (Theory + Laboratory, Department Elective II)

- Machine Intelligence and Modern AI: Machine Intelligence: Overview of different definitions of AI. History of AI - classical AI. Relationship of AI with computer science, Logic, power system, Robotics and Cybernetics. Modern AI: Agent based

conception – Agents and Environments. Classification of various agent types and their characteristics – Goal-based, Model-based and Learning agents. Classification of environments and their properties. PEAS description.

- Problem Solving Agents: Problem solving through searching – Uninformed and Informed search strategies. Constraint satisfaction problems
- Knowledge and Reasoning: Knowledge-based agents using Propositional and First-order logics. Knowledge Engineering in FOL. Introduction to Rule-based and knowledge-based reasoning.
- Fuzzy Logic: Concepts of Fuzzy sets, Fuzzy Membership functions, Defuzzification. Fuzzy rule-based systems. Basic FLC and its applications.
- Artificial Neural Networks: Basic concepts - model of an artificial neuron. Neural Network architectures – Single and Multi-layered Feed forward networks, Recurrent Networks. Back propagation Networks –Perceptron. Back propagation Learning
- Genetic Algorithm: Basic concepts – Canonical Genetic Algorithm (CGA). Comparison with other Optimization and search methods. Various aspects of CGA – Encoding, Fitness function, reproduction, Crossover, Mutation. Application of GA to optimization and search problems.

Second Semester of BE IV

(1) Digital Signal Processing (Theory + Laboratory, Department Elective III)

- Introduction to Discrete Time Systems and signals; Discrete time LTI systems, in context of - Linearity, Time variance, Causality, Stability, Recursion; Description by difference equations, System Function, Impulse response and frequency response
- Structures for Discrete Time Systems; Structures of filters : Direct Form 1 & 2, Parallel, Cascade, Canonic realizations, Lattice structures; Fixed-Point & Binary Floating-point Representation of numbers, Errors Resulting from Rounding and Truncation, Analysis of Finite word length effects, Quantization effects on Filter Coefficients in FIR Filters, Round-Off Effects in Digital Filters.
- Filtering of long data sequence using DFT-IDFT, circular convolution; Algorithms for efficient Computation of DFT , Radix-2 FFT algorithms
- Rational Z-Transforms, Concept of Poles and Zeros using Z-transform, Pole Location and Time-Domain Behavior of Causal Signals, System Function of a Linear Time-Invariant System, Analysis of Linear Time-Invariant Systems in the Z-Domain: Response of systems with Rational System Functions, Transient and Steady-State Responses, Causality and Stability criterion with respect to ROC and unit circle, Pole-Zero Cancellations, Multiple-Order Poles and Stability of Second-order systems
- Ideal filter characteristics, Eigen value , Eigen functions, geometrical evaluation of frequency response using Poles-zeros Frequency-Domain Characteristics of Linear Time-Invariant Systems, LTI Systems as Frequency-Selective Filters
- Design of Digital Filters, Design of FIR Filters, Design of IIR Filters from Analog Filters, Frequency Transformations: Frequency Transformations in the Analog & Digital Domain

(2) Industrial Automation (Theory + Laboratory, Department Elective III)

- Introduction to Automation and PLC Hardware: Automation – Definition, Need, Benefits, Different tools for automation history, architecture of industrial automation system. Block diagram and description of different parts of PLC. scan cycle etc. Memory – function & organisation of ROM & RAM. Input/ Output modules and their block diagram, description, typical wiring details, specifications. Sinking and sourcing connections & specifications. Relay and Isolated o/p modules. (Only description). PLC Programming Instruction Set and Applications: Different PLC programming languages (only introduction). I/O addressing of PLC, Relay type instructions - NO, NC, one shot, Latch, and Unlatch. Timer, Counter instructions. Comparison instructions – Equal, not equal, Greater, Greater than equal, Less, Less than equal. Data handling instructions – Move, Masked Move, and Limit test. Logical instructions – AND, OR, EX-OR, NOT.
- Simple programming examples using ladder programming language based on relay, timer, counter, logical, comparison, Data handling and miscellaneous instruction. Application based on above mentioned instruction set.
- Industry based control systems
- Two positioner, multiposition & floating control modes, P, PI, PD & PID modes, Analog & Digital Control modes, feed forward controllers, Cascade Controllers, proportional integral preview controller, Tuning of Controllers
- Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS. Programmable Automation Controllers
- Computer aided measurement and control systems
- Introduction of supervisory control and data acquisition (SCADA). Virtual Instrumentation, Industrial bus systems: network data communication, Hart communication, field buses: Modbus, Profibus, DeviceNet & control net, foundation fieldbus, industrial ethernet, IEEE1394 for industrial automation.

(3) Embedded Systems (Theory + Laboratory, Department Elective III)

- Introduction: Embedded systems overview, design challenge, processor technology, IC technology, Design Technology, Trade-offs. Custom single purpose processors: RT-level combinational logic, sequential logic (RT-level), custom single purpose processor design (RT-level) and optimization, Basic architecture, operation, Pipelining, Programmer's view, development environment. Finite state machines with data path model (FSMD), ASIPs, Selecting a microprocessor, General purpose processor design.
- Introduction to Advanced Microcontrollers: viz. 8051-F340 microcontroller architecture and its advanced peripherals. Assembly/Embedded C-programs based on peripherals. Data types of 8051 C, Interrupts and re-entrant functions, Mix C and assembly code, header files, Debug and Test embedded C program with Keil.
- Cortex M0 architecture and programming: Features, Block Diagram & Pin Diagram. System Memory MAP, System Manager controller Register MAP, System Timer, Clock controller (System Clock, Sys_tick & Freq. divider). Basic configuration, Functional description & register map of General Purpose I/O. Introduction of Embedded C & programs on Led Interfacing & Stepper motor interfacing. Timer Controller: Block Diagram, Functional description, Modes of operation, register map and programs LCD Interfacing: Programs of String display & Scrolling message. ADC: Block Diagram Functional description, Modes of operation, register map & programs.

NVIC: Timer Interrupts Programming, External Hardware Interrupts Programs of keyboard Matrix Interfacing & 7-Segment Led display multiplexing. PWM Generator, UART Controller & I2c Serial Interface Controller & Programs.

- Introduction to Cortex M7 microcontroller STM32F746: Enhanced Features, Block Diagram & Basic functions. Interfacing with MEM sensors, Accelerometer, Gyro.

(4) Flexible AC Transmission System (Theory, Department Elective IV)

- Introduction to FACTS & Compensation Techniques: Introduction to FACTS: Concept, necessity, types, benefits & applications, Power System Stability & Compensation: Power flow, voltage & reactive power control, stability issues, compensation techniques
- Series & Shunt Compensation and Filters: Series Compensation: Fixed Series Capacitors (FSC), Thyristor-Controlled Series Capacitor (TCSC), Static Synchronous Series Compensator (SSSC), Shunt Compensation: Static Var Compensator (SVC), Thyristor-Controlled Reactor (TCR), Thyristor-Switched Capacitor (TSC), Static Synchronous Compensator (STATCOM), Filters in FACTS: Passive & Active Power Filters, Harmonic Filtering Techniques, Hybrid Filters
- Advanced Controllers & Electric Spring Technology: Static Voltage and Phase Angle Regulators: Voltage control, thyristor-controlled voltage regulators, Unified Power Flow Controller (UPFC) & Interline Power Flow Controller (IPFC): Operation, modeling, applications, Electric Spring Technology: Concept, working principle, role in voltage stability and renewable energy integration, Comparison of Electric Springs with FACTS Controllers
- Applications, Case Studies & Environmental Impact: FACTS in modern power systems: Integration with renewable energy, Economic & environmental benefits of FACTS, Case studies of FACTS implementations in transmission systems

(5) Restructured Power System (Theory, Department Elective IV)

- Fundamentals of restructured power systems: Need for restructuring, market structures and participants, wholesale and retail competition
- Basic Concepts of Economics: Demand, Supply, Inverse Demand and Supply functions, Modeling the Consumers and producers, Elasticity of supply, market equilibrium
- Markets for Electrical Energy: Market mechanisms, Spot market
- Participating in markets for electricity: Participants' perspective, Perfect and imperfect competition, market power
- Transmission Networks and Electricity Markets: Centralized trading, transmission congestion – management and pricing, Nodal pricing, Financial Transmission Rights, Transmission pricing
- Ancillary Service Management: Types of ancillary services, Reactive power as an ancillary service, market-based mechanisms for ancillary services

(6) Power System Dynamics (Theory, Department Elective IV)

- Generator connected to Infinite Bus Small signal analysis. Linearization. Flux decay and Rotor-angle transfer functions. Closed loop analysis Root-locus diagrams. Small signal stability in presence of fast acting exciter voltage regulator, Further Topics on small signal analysis : State space representation. Linearization Analysis of stability. Eigen properties of state Matrix. Modal Matrices. Computation of eigen values & participation factor. Controllability & observability. Complex frequency. Eigen properties & transfer function. Illustration of application to single machine- infinite bus system.
- Transient stability of single and multi-machine system for large disturbances. Direct methods of transient stability analysis.
- Voltage Stability : Basic Concepts : Classification. Static & dynamic voltage stability P-V, Q-V curves.. Voltage collapse.
- Modelling of synchronous machines

(7) Testing and Commissioning of Electrical Equipment (Theory, Department Elective V)

- Installation of Electrical Equipment: Unloading of Electrical Equipment at Site, Inspection, Storage & Foundation of Electrical Equipment at site, Alignment of electrical machines, Tools/Instruments necessary for installation, Technical report, inspection, storage & handling of transformer, switchgear and motors.
- Transformers: Testing procedure for HV testing, Phase shifting/ phase group, Radio interference, Ratio Test , Load loss ,Separate source voltage testing ,Induced voltage testing , Impulse and Surge testing , Noise level and vibration testing , Short circuit withstand test ,Tan Delta test , Core insulation voltage test, Measurement of impedance ,Testing of auxiliaries and safety device , Oil testing , Classification of testing methods , Testing of bushing. DC and AC Resistance measurement, Temp. Rise test, Short circuit test, Dielectric test, Partial discharge, Insulation resistance testing. Polarity testing, Short time current rating, Impulse and surge testing, Determination of error and accuracy class, Power frequency voltage withstand test, over voltage inter-turn test. Determination of polarization index for transformer. Drying out procedure for transformer. Commissioning steps for transformer, Purification and Filtration Procedure, Overview of DGA, Sweep Frequency Analysis, Furan Analysis.
- DC Machines: Voltage drop test or bar to bar test, Load test, Open circuit and magnetizing test, Insulation resistance, Starting performance, Dielectric test. Swinburne's test, Hopkinson's test, Field test, Separation of losses in DC shunt machine. Temp. rise test and Heat run test Drying out process Commissioning steps for DC machines Troubleshooting and maintenance.
- Induction Motor: TESTING (3-PHASE and 1-PHASE): Hammer test, Testing against variation of voltage/current/frequency, Load test, NL and BR test, DC and AC, Resistance measurement, Insulation measurement, Starting test, Temp. Rise test, Slip measurement, HV test, Testing on auxiliaries, Vibration Test, Noise level test. Drying out methods / Polarization Index / Hot Temperature measurement Degree of protection (IP Grade) Commissioning steps for Induction motor, Heat Run Test. Commissioning of Induction Motor
- Synchronous Machine: Testing OC and SC test, Characteristics, Loss measurement, Temp. rise test , Over speed test , HV testing , Insulation resistance wave form interference , DC and AC Resistance of armature and field winding measurement , Dielectric testing on armature and field winding , Mechanical balance , Magnetic

balance , Current balance , Phase sequence , Harmonic analysis , reactance and time constant , Speed torque current , Vibration and noise measurement , SC test , Synchronizing circuit testing , Testing of voltage regulators , Excitation circuit testing, Voltage recovery test , Retardation test on load / no load .Drying out procedure Commissioning steps for synchronous machines Troubleshooting and maintenance, Natural Frequency Test.

- Substation Equipment: Bus bar Temp. Rise test, Rated short time current test, HV test, Power frequency voltage withstand test, Impulse / surge testing, Vibration. EARTHING: Earthing resistance measurement, Substation grid Earthing, Soil resistivity measurement. ISOLATOR TESTING: Temp. Resistance test, Short circuit test, charging current making and breaking test, Inductive current making and breaking test. CIRCUIT BREAKER: TESTING OF HV/LV CIRCUIT BREAKER: No load Mechanical Operation, Mechanical endurance test, Temp. Rise test, Impulse and surge testing, short time current test. Short circuit making and breaking test, Line Charging current making and breaking test, Cable charging and capacitor bank making and breaking test, Out of phase switching, Short line fault test, and Electrical and Mechanical endurance test for LT switch gear like MCB / MCCB / ELCB etc. C.T. and P.T. Testing, Relay testing, Coupling capacitors, Station Batteries for DC Supply, Fire Shifting Equipment. Testing and Commissioning of Lightning Arrestor, Substation Commissioning by Thermograph. Troubleshooting and maintenance of circuit breakers.
- Commissioning of Cable: De-rating of cable capacity, HV test, AC and DC Resistance check, Insulation resistance, Impedance measurement, Location finding technique for fault in underground cables (Murray loop test and Warley loop test), Testing of open circuit faults in cables. Line charging, loading and Dropping.
- Electrical Accidents & Safety Causes of electrical accidents, factors affecting severity of electrical shock & actions to be taken when a person gets attached to live parts, safety regulations & measures, Indian electricity supply act 1948-1956, Factory act 1948, substation shut down procedure, certificate of (i) requisition for shut down (ii) permit to work (iii) line clear certificate, instruction for the safety of persons working on a job with work permit, Fire extinguishers – types & its operations, fixed installation & portable devices.

(8) Microgrid and Grid Integration (Theory, Department Elective V)

- Introduction to Power Electronic Interface for Micro Grid: Conventional power generation, advantages and disadvantages, non-conventional energy source review; solar PV, wind energy, fuel cell, micro turbine and biomass, review of energy storing element. Need of power electronics interface, component and equipment for micro grid, type of power electronic converter; converter, rectifier, inverter, chopper, ac-ac converter, interface; pv, wind energy, fuel cell.
- Distributed Generation: Concept of distributed generation, topology, selection of sources, regulatory standard IEE 1547, DG installation classes, requirement for grid interconnection, security issue in DG ,implementation and limitation, islanding issue
- Micro Grid: Concept of microgrid, need and application of micro grid, formation of micro grid, typical structure and configuration of micro grid, ac-dc micro grid, power electronic interface in micro grid, modes of operation, control of micro grid; grid connected and islanding mode, active and reactive power control protection issue, anti-islanding scheme; passive, active and communication technique, regulatory standard,

difference between grid and micro grid, power quality and EMC in micro grid, and power quality issue of grid connected micro grid.

- Issues in Grid Integration of Distributed Energy Resources: Basic requirements of grid interconnections – operational parameters – voltage, frequency and THD limits – grid interfaces – inverter based DGs and rotary machines based DGs – reliability, stability and power quality issues on grid integration – impact of DGs on protective relaying and islanding issues in existing distribution grid.
- Integration of Energy Storage in Micro Grid: Modeling of Static Var Systems and their control, Modeling of different SVS Configurations, Design of controllers, Voltage Controller, Auxiliary Controller, Applications of SVS, Improvement of dynamic stability with SVS alone, SVS with generator excitation control, Enhancement of transient stability, Damping of torsional oscillations, SVS for dynamic reactive power support at HVDC terminals, Load compensation, Specifications of SVS

(9) Power System Management and Planning (Theory, Department Elective V)

- Load forecasting, problems facing electrical industries, technology options, and different techniques of load forecasting.
- State estimation in power system, weighted least square estimation, matrix formulation, state estimation of AC network, advanced topics, and applications
- Power quality problems – voltage sag, voltage swell, harmonics and mitigation techniques, power factor correction
- Single phase and three phase circuits power definition and various components in distribution systems

(10) Project Part II (Project)