SCHEME OF INSTRUCTION AND SYLLABI

B.TECH DEGREE IN

Electrical Engineering

(Department of Electrical Engineering)

AS Per NEP2020

EFFECTIVE FROM 2022-2023

National Institute of Technology Delhi

(NIT DELHI)

Department of Electrical Engineering
National Institute of Technology Delhi

1.1 About the Department

Department of Electrical Engineering (EE), National Institute of Technology Delhi was established in 2010 under the ages of Ministry of Human Resource and Development (MHRD), Govt. of India. Currently it is offering one Undergraduate (B. Tech) course and one Postgraduate (M. Tech) courses in Power Electronics & Drives. The Department also offers PhD programme in relevant areas.The department is equipped with state-of-the-art facilities to carry out research work at all levels. The research focus of the department is in the area of power system reliability, power electronics, renewable energy systems, power systems, control/time delay systems, pattern recognition, image processing etc. The department also actively involved in multi-disciplinary research activities. The UG program is embraced by rigor and span to prepare a practicing engineer for a lifetime of creative work and ongoing technical learning. The department provides healthy & competitive environment for all round development of students leading to several remarkable achievements in GATE, CAT, GRE, TOEFEL, PSUs etc. The department has laboratories, equipped with latest equipment and software platforms, to impart state-of-the art technical knowledge. The department aims to setup new laboratories such as Green Energy Technologies, Digital Control & FPGA Design, Biometric etc. The Department has active collaborations with Institutes & research institutes in India and abroad.
The Department of EE has a blend of young as well as experienced dynamic faculty members and is committed to provide quality education and research in the field. Faculty members of the department have excellent academic & research credentials and published numerous peer reviewed journal articles/ papers, Books, Book Chapters etc. in diversified field and having adequate experience in advanced research. The department hopes to achieve the national goals and objectives of industrialization and self-reliance. As a result, it hopes to produce graduates with strong academic and practical background so that they can fit into the industry immediately upon graduation.

1.2 Vision

- To excel in education, research and development services in electrical engineering in tune with societal aspirations.

1.3 Mission

- Impart quality education to produce globally competent electrical engineers capable of extending technological services.
- To create entrepreneurial environment and industry interaction for mutual benefit.
- To be a global partner in training human resources in the field of power and energy systems.
- Nurture scientific temperament, professional ethics and industrial collaboration.

B. Tech. (Electrical Engineering)

2.1 Preamble

B. Tech. (Electrical Engineering) program offered at NIT Delhi isdesigned to equip students with a unique blend of skill sets that include:

- Strong theoretical foundation
- Predominantly practice-oriented approach with access to well-equipped and specialized laboratories, and supervised internship via the Practice School
- Hands-on technical training
- Life skills orientation
- Hard and soft skills
- Business perspective, along with emphasis on innovation and entrepreneurship

2.2 Salient Features

- Minimum Credits requirements for completion of B. Tech program is 160.
- The Curriculum is based on the guidelines of National Education Policy (NEP) – 2020.
- The curriculum has embedded the Multi Exit/ Multi Entry in the B. Tech program.
- There is provision of Major degree and Minor Degree for students.
- The curriculum is designed to meet the prevailing and ongoing industrial requirements.
- The curriculum includes Project based Education with Projects every year.
- The curriculum is flexible and offers Choice Based Credit System (CBCS).
- The curriculum inherits the Value based Education and offers Interdisciplinary/ Multidisciplinary Courses.
- The Curriculum offers Digital Pedagogy & Flipped Learning with adequate motivation for Entrepreneurship/ Startups.
- The curriculum aims the Holistic Development of the students.

2.3 Cardinal Mentions

- Students exiting after completing 1st Year, 2nd Year and 3rd Year will be awarded Certificate, Diploma and Advanced Diploma in Electrical Engineering respectively. A minimum Credit requirement for Certificate is 40 Credits, Diploma is 80 Credits and Advanced Diploma is 120 Credits respectively.

- The students can opt for Minor Degree across any specialization offered in the Institute from 5th Semester e.g. a student pursuing B. Tech. (Electrical Engineering) may opt for Minor Degrees offered by the different Departments in the Institute depending upon his/her interest.

- The students opting for Minor Degree will have to earn additional credits for the Minor Degree as per Institute norms which may vary from time to time.

2.4 Program Educational Objectives (PEOs)

PEO-1	Engineering Graduates will excel in Electrical fields both in theindustry and academics by analyzing the requirement technically and applying their knowledge in a professional manner.
PEO-2	Demonstrate multi-disciplinary knowledge and skills to analyze, interpret and create solutions to the real-life electrical engineering problems.
PEO-3	Apply the knowledge of electrical engineering to solve problems of social relevance pursue higher education and research.
PEO-4	Engage in lifelong learning, career enhancement and adopt to changing professional and societal needs.

2.5 Program Outcomes (POs)

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

2.6 Program Specific Objectives (PSOs)

PSO -1	Analysis, synthesis and design of electrical equipment and systems to enhance the quality of human life.
PSO -2	Development of innovative and environment – conscious technologies to sustain human life.

B. Tech. (Electrical Engineering) Semester wise Credit Structure

Sl. No.	**Courses**	**Credits**								**Total**
		1st Year		**2nd Year**		**3rd Year**		**4th Year**		
		1st Sem	**2nd Sem**	**3rd Sem**	**4th Sem**	**5th Sem**	**6th Sem**	**7th Sem**	**8th Sem**	
1	Program Core	4	7	7	15	16	5	8		62
2	Program Electives					3	3	6	3	15
3	Open Electives						3	3	3	9
4	Applied Sciences	9	5	4						18
5	Humanities	2					3			5
6	Summer Training & Project		1	1	1	1	2	3	14	23
7	Allied Engineering	5	7	8	4		4			28
Total		**20**	**20**	**20**	**20**	**20**	**20**	**20**	**20**	**160**

Teaching Scheme

Semester I

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	PHL 102	Electrical Engineering Materials	3	0	0	3
2.	EEB 102	Basic Electrical Engineering	3	0	2	4
3.	MEB 162	Engineering Visualization	3	0	2	4
4.	MAL 101	Advanced Calculus	3	1	0	4
5.	MEP 121	Product Design and Realization Laboratory	0	0	2	1
6.	HML 101	Communication Skills	2	0	0	2
7.	EVL 101	Environmental Sciences	2	0	0	2
	Total Credits		16	1	6	20

Semester II

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	MAL 153	Ordinary Differential Equation and Transforms	3	1	0	4
2.	EEL 151	Network Analysis	3	0	0	3
3.	CSB 181	Problem Solving and Computer Programming	3	0	2	4
4.	MEL 151	Engineering Mechanics	3	0	0	3
5.	EEB 152	Electrical Workshop	3	0	2	4
6.	EVP 102	Nature and Care	0	0	2	1
7.	EEP153	Project	0	0	2	1
	Total Credits		15	1	8	20

NOTE: Summer Training (6-8 Weeks) is mandatory for each student to continue the program and the evaluation will take place in the Semester-III.

Semester III

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	MAB 203	Numerical & Engineering Optimization Methods	3	0	2	4
2.	CSB 231	Data Structures	3	0	2	4
3.	EEL 201	Electro Magnetic Field Theory	3	1	0	4
4.	ECB 207	Electronic Devices and Circuits	3	0	2	4
5.	EEB 202	Signal & Systems	3	0	0	3
6	EEP 203	Summer Training -I	0	0	2	1
	Total Credits		15	1	8	20

Semester IV

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	EEB 251	Electrical Machines-I	3	0	2	4
2.	EEB 252	Control Systems	3	0	2	4
3.	EEL 253	Power Transmission and Distribution	3	0	0	3
4.	ECB 206	Digital Electronics and Logic Design	3	0	2	4
5.	EEB 254	Electrical Measurements	3	0	2	4
6.	EEP 255	Project	0	0	2	1
	Total Credits		15	0	10	20

NOTE: Summer Training (6-8 Weeks) is mandatory for each student to continue the program and the evaluation will take place in the Semester-V.

Semester V

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	EEB 301	Electrical Machines-II	3	0	2	4
2.	EEL 302	Power System Analysis	3	1	0	4
3.	EEL XXX	Elective-I	3	0	0	3
4.	EEB 303	Microprocessors and Microcontrollers	3	0	2	4
5.	EEB 304	Power Electronics	3	0	2	4
6.	EEP 305	Summer Training -II	-	-	-	1
	Total Credits		15	1	6	20

Semester VI

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	EEB 351	Electric Drives	3	0	2	4
2.	EEP 352	Electrical Simulation Lab	0	0	2	1
3.	CSB 310	Artificial Intelligence & Machine Learning	3	0	2	4
4.	HML 352	Engineering Economics and Accountancy	3	0	0	3
5.	EEL 3XX	Elective-II	3	0	0	3
6.		Open Elective-I	3	0	0	3
7.	EEP 353	Project	0	0	4	2
	Total Credits		15	0	10	20

NOTE: Summer Training (6-8 Weeks) is mandatory for each student to continue the program and the evaluation will take place in the Semester-VII.

Semester VII

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	EEL 401	HVDC & FACTS	3	0	0	3
2.	EEL 402	Switchgear & Protection	3	1	0	4
3	EEL 4XX	Elective-III	3	0	0	3
4	EEL 4XX	Elective-IV	3	0	0	3
5.		Open Elective-II	3	0	0	3
6.	EEP 403	Power System Lab	0	0	2	1
7.	EEP 404	Summer Training -III	0	0	2	1
8.	EEP 405	Project Work	0	0	4	2
	Total Credits		15	1	8	20

Semester VIII

Sl.No.	Course Code	Course Title	L	T	P	Credits
1	EEL 4XX	MOOCs (Program Elective-5)	3	0	0	3
2	XXX XXX	MOOCs (Open Elective-3)	3	0	0	3
3	EEP 451	Project Report	-	-	-	14
	Total Credits		6	0	0	20

Department Elective Courses of Specialization in Major Degree of Electrical Engineering

Bouquet 1 of Department Elective Courses
[Specialization in **Reliability Engineering** with B. Tech. (EE)]

Course Structure:

S. No.	Elective No.	Course Code	Course Name	L	T	P	Credits
1.	Elective 1	EEL 306	Reliability Distributions	3	0	0	3
2.	Elective 2	EEL 354	Reliability Modeling	3	0	0	3
3.	Elective 3	EEL 406	Design for Reliability	3	0	0	3
4.	Elective 4	EEL 407	Reliability Testing and Physics of Failure	3	0	0	3
5.	Elective 5	EEL 452	Power System Reliability	3	0	0	3

Bouquet 2 of Department Elective Courses
[Specialization in **Power Electronics** with B. Tech. (EE)]

Course Structure:

S. No	Elective No	Course Code	Course Name	L	T	P	Credits
1.	Elective 1	EEL 307	Solid State Power Controllers	3	0	0	3
2.	Elective 2	EEL 355	Switched Mode Power Conversion	3	0	0	3
3.	Elective 3	EEL 408	Special Electrical Machines	3	0	0	3
4.	Elective 4	EEL 409	DSP and its Application to Power Electronics	3	0	0	3
5.	Elective 5	EEL 453	Inverters and Resonant Pulse Converters	3	0	0	3
6.		EEL 454	Power Electronics For Renewable Energy Systems	3	0	0	3

Bouquet 3 of Department Elective Courses
[Specialization in **Renewable Energy Systems** with B. Tech. (EE)]

Course Structure:

S. No.	Elective No	Course Code	Course Name	L	T	P	Credits
1.	Elective 1	EEL 308	Solar Energy Technology	3	0	0	3
2.	Elective 2	EEL 356	Electric vehicles	3	0	0	3
3.	Elective 3	EEL 303	Energy Storage Systems	3	0	0	3
4.	Elective 4	EEL 410	Smart Grid	3	0	0	3
5.		EEL 411	Grid Integration of Renewable Energy	3	0	0	3
6.		EEL 412	Electrical Distribution System Analysis	3	0	0	3
7.	Elective 5	EEL 455	Wind Energy Conversion Systems	3	0	0	3
8.		EEL 456	IoT Applications in Renewable Energy Systems	3	0	0	3

Bouquet 4 of Department Elective Courses
[Specialization in **Instrumentation and Biomedical Signal Processing** with B. Tech. (EE)]

Course Structure:

S. No.	Elective No	Course Code	Course Name	L	T	P	Credits
1.	Elective 1	EEL 309	IoT and Advanced applications in healthcare	3	0	0	3
2.	Elective 2	EEL 357	Sensor design and system development	3	0	0	3
3.	Elective 3	EEL 413	Advanced Biomedical instrumentation	3	0	0	3
4.	Elective 4	EEL 414	Biomedical image processing	3	0	0	3
5.		EEL 415	Biomedical instruments and data interpretation				
6.		EEL 416	Optical Fibers	3	0	0	3
7.	Elective 5	EEL 458	Artificial intelligence in biomedicine and healthcare	3	0	0	3
8.		EEL 459	Virtual bio instrumentation	3	0	0	3

Bouquet 5 of Department Elective Courses
[Specialization in **Control and Automation** with B. Tech. (EE)]

Course Structure:

S. No.	Elective No.	Course Code	Course Name	L	T	P	Credits
1	Elective 1	EEL 310	Modern Control Systems	3	0	0	3
2	Elective 2	EEL 358	Digital Control Engineering	3	0	0	3
3	Elective 3	EEL 417	Control System Components	3	0	0	3
4	Elective 4	EEL 418	Automation and Robotics	3	0	0	3
5	Elective 5	EEL 460	Optimal Control	3	0	0	3
6		EEL 461	System Identification and Adaptive Control	3	0	0	3

Bouquet 6 of Department Elective Courses
[Specialization in **Power System Engineering** with B. Tech. (EE)]

Course Structure:

S. No.	Elective No.	Course Code	Course Name	L	T	P	Credits
1	Elective 1	EEL 311	Power System Deregulation	3	0	0	3
2	Elective 2	EEL 359	Power System Operation & Control	3	0	0	3
3	Elective 3	EEL 419	Modeling and Simulation of Modern Power Systems	3	0	0	3
4	Elective 4	EEL 420	Computer Applications in Power Systems	3	0	0	3
5	Elective 5	EEL 462	Power System Stability & Control	3	0	0	3

Course no: PHL 102	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of course				YES
Course Title	**Electrical Engineering Materials**			
Course Coordinator				
Course objectives:	To familiarize students with the properties of various types of electrical engineering materials			
POs				

Semester	**Autumn:**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

1.	Title	Materials for Electrical Engineering
	Author	B.M.Tareev
	Publisher	Higher School Pubishing House
	Edition	1st
2.	Title	Electronic Properties
	Author	R. Rose, L.A. Shepard and J. Wulff
	Publisher	Wiley Eastern Pvt. Ltd
	Edition	1st

Content

Magnetic Materials

Dia, Para, Ferro, anti-ferro and Ferri magnetic materials, soft and hard magnetic materials, tapes and films, magnetic anisotropy magnetostriction,effect of impurities, losses in magnetic materials.

Semiconductors

Silicon wafer preparation, different fabrication techniques involved in electronic chip in VLSI technology, conductivity of materials electrical and thermal conductivity of materials, bimetals high temperature materials, thermocouples, free electron theory of metals, factors affecting electric conductivity of metals, thermal conductivity of metals, heat developed in current carrying conductors, thermoelectric effect, super conductivity.

Dielectric Materials

Field vectors, polarization, Ferro electricity and Piezo electrics, behavior of polarization under impulse and frequency switching, dielectric loss, spontaneous polarization.

	Insulating Materials Electrical, mechanical and thermal properties of liquid, solid, fibrous insulating materials, glass, ceramic, mineral and plastic materials, relationships between structure and electrical, mechanical, thermal, chemical properties.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EEB 102	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	No	No
Type of Course	Theory			
Course Title	**Basic Electrical Engineering**			
Course Coordinator				
Course objectives:				
POs				
Semester	**Autumn: yes**		**Spring: Yes**	

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	2	4	36(L)+24(P)
Prerequisite course code as per proposed course numbers	Nil				
Equivalent course codes as per proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				

Text Books:		
1.	Title	Introduction to Electrical Engineering
	Author	Mulukutla S. Sarma
	Publisher	Oxford Press
	Edition	
2.	Title	Electrical Engineering Fundamentals
	Author	V. D. Toro
	Publisher	PHI
	Edition	2015
Reference Books:		
3.	Title	Basic Electrical Engineering
	Author	V.N. Mittle
	Publisher	McGraw Hill Education

	Edition	2017
4.	Title	Basic Electrical and Electronics Engineering
	Author	S.K. Bhattacharya
	Publisher	pearson
	Edition	2nd
Content	**FUNDAMENTALS OF DC CIRCUITS** Introduction to DC and AC circuits, Active and passive two terminal elements, Ohms law, Voltage-Current relations for resistor, inductor, capacitor, Kirchhoff's laws, Mesh analysis, Nodal analysis, Ideal sources – equivalent resistor, current division, voltage division, Star-Delta Transformation **MAGNETIC CIRCUITS** Introduction to magnetic circuits, analogy between electrical and magnetic circuit, Simple magnetic circuit with DC and AC excitations-Faraday's laws, induced emfs and inductances, magnetic leakages, B-H curve, hysteresis and eddy current loss, magnetic circuit calculations, mutual coupling **AC CIRCUITS** Sinusoids, Generation of AC, Average and RMS values, Form and peak factors, concept of phasor representation, J operator Analysis of R-L, R-C, R-L-C circuits Introduction to three phase systems - types of connections, relationship between line and phase values. **SINGLE- PHASE TRANSFORMER** Principle of operation, construction, emf equation, equivalent circuit, power losses, efficiency, introduction to auto transformer **ELECTRICAL MACHINES** Working principle, construction and applications of DC machines and AC machines. **POWER TRANSMISSION AND DISTRIBUTION** Concept of power transmission and power distribution. Low voltage distribution system (400 V and 230 V) for domestic, commercial, and small-scale industry through block diagrams only.	
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50% Lab: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading	

Course no: EEL 151	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	Yes
Type of course				YES
Course Title	**Network Analysis**			
Course Coordinator				
Course objectives:	To familiarize the students with the concepts of network analysis			
POs				

Semester	**Autumn:**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

1.	Title	Network Analysis
	Author	M.E. Van Valkenburg
	Publisher	PHI
	Edition	
2.	Title	Linear circuit Analysis: Time Domain, Phasor, and Laplace Transform Approaches
	Author	Decarlo & Lin
	Publisher	Oxford
	Edition	
3	Title	Network Analysis and Synthesis
	Author	F.F. Kuo
	Publisher	John Wiley and Sons
	Edition	
4	Title	Engineering Circuit Analysis
	Author	Hayt, Kemmerly & Durbin
	Publisher	Tata McGraw Hill Publishing Company Ltd
	Edition	

Content	
	Network Theorems: Superposition, Thevenin's theorem, Norton's theorem, maximum power transfer theorem, reciprocity theorem, Miller's theorem **Network Topology and Graph Theory:** Introductory concepts of network graphs, cut sets, loops, cut set and loop analysis

	Network Analysis in time Domain: Analysis of First and Second order circuits using differential equations **Transient response of networks using Laplace Transform:** Review of properties and applications of Laplace transform of complex waveform and transient response of R- L- C series, parallel, series-parallel circuits for all kinds of excitations **Two Port Networks:** z, y, h, g, ABCD, inverse ABCD parameters, their inter conversion, interconnection of two 2-port networks **Elements of Realizability:** Positive real functions; definition & properties, Foster's I and II, Cauer's I and II forms, Synthesis of LC, RC, RL Networks, image parameters and basics of two-port synthesis
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EEB 152	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	No	No
Type of Course	Theory			
Course Title	**Electrical Workshop**			
Course Coordinator				
Course objectives:				
POs				
Semester	**Autumn: yes**		**Spring: Yes**	

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	2	4	36(L)+24(P)
Prerequisite course code as per proposed course numbers	Nil				
Equivalent course codes as per proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				

Text Books:		
1.	Title	Electrical Installation Estimating & Costing
	Author	Gupta, J.B.
	Publisher	S. K. Kataria & Sons, New Delhi
	Edition	
2.	Title	Electrical Design, estimating & Costing
	Author	Raina, K. B. and Bhattacharya,S.K.
	Publisher	New Age International (p) Limited, New Delhi
	Edition	
Reference Books:		
3.	Title	I.E. rules for wiring, Electricity supply act-1948.
	Author	Bureau of Indian Standards
	Publisher	Electricity supply act-1948
	Edition	
4.	Title	Electrical Workshop: Safety, Commissioning, Maintenance & Testing of Electrical Equipment
	Author	R.P. Singh
	Publisher	wiley
	Edition	3rd

Content	**Electrical Wiring:** I.E. rules on electrical wiring. Types of domestic and industrial wirings. Study of wiring accessories e.g. switches, fuses, relays, MCB, ELCB, MCCB etc. Joints in electrical conductors. Measurement of conductor size using SWG and micrometer. Grading of cables and current ratings. Principle of laying out of domestic wiring. Voltage drop concept. PVC conduit and Casing capping wiring system. Different types of wiring - Power, control, Communication and entertainment wiring. Wiring circuits planning, permissible load in subcircuit and main circuit. Estimation of load, cable size, bill of material and cost. Inspection and testing of wiring installations. Special wiring circuit e.g. godown, tunnel and workshop etc. **Batteries and solar cell:** Chemical effect of electric current and Laws of electrolysis. Explanation of Anodes and cathodes. Types of cells, advantages / disadvantages and their applications. Lead acid cell: Principle of operation and components. Types of battery charging, Safety precautions, test equipment and maintenance. Grouping of cells for specified voltage and current. Principle and operation of solar cell. **Electrical Earthing:** Importance of Earthing. Plate earthing and pipe earthing methods and IEE regulations. Earth resistance by earth tester / megger. Earth leakage by ELCB and relay. **Electrical illumination:** Laws of Illuminations. Types of illumination system. Illumination factors, intensity of light. Type of lamps, advantages/ disadvantages and their applications. Calculations of lumens and efficiency. **Experiments:** 1. Make simple straight twist and rat-tail joints in single strand conductors, married and 'T' (Tee) joint in stranded conductors, Britannia straight and 'T' (Tee) joint in bare conductors, straight joint in different types of underground cables. 2. Measure insulation resistance of underground cable. 3. Determine the internal resistance of cell and make grouping of cells. 4. Carry out installation and maintenance of batteries. Determine total number of cells required for a given power requirement. 5. Plan work in compliance with solar panel installation norms. Combination of solar cells for given power requirement. Assemble and install solar panel. Check the functionality of solar panel. 6. Prepare and mount the energy meter board. Draw and wire up the consumers main board with ICDP switch and distribution fuse box. Draw and wire up a bank/hostel/jail in PVC conduit. 7. Identify the types of fuses their ratings and applications. Identify the parts of a relay, MCB & ELCB and check its operation.

	8. Estimate the cost of material for wiring in PVC channel for an office room having 2 lamps, 1 Fan, one 6A socket outlet and wire up. 9. Estimate the requirement for conduit wiring (3 phase) and wire up. Estimate the materials and wire up the lighting circuit for a godown. Estimate the materials and wire up a lighting circuit for a corridor in conduit. 10. Test, locate the fault and repair a domestic wiring installation. 11. Install the pipe and plate earthing and test it. Measure the earth electrode resistance using earth tester. Carry out earth resistance improvement.
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50% Lab: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading

Course no: **EEL 201**	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	N	Y	N
Type of course	Core			
Course Title	**Electromagnetic Field Theory**			
Course Coordinator				
Course objectives:	To learn the fundamental concepts applied in Electrostatics, Magnetostatics, Time-varying fields and Electromagnetic Waves. To apply the principles of Electromagnetic Field Theory for the design and analysis of Power Transmission lines.			
POs				

Semester	**Autumn:** Yes		**Spring**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	**3**	**1**	**0**	**4**	**36(L) + 12(T)**
Prerequisite course code as per proposed course numbers	NA				
Prerequisite credits	NA				
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed	--				

course numbers				

Text Books:		
1.	Title	Principles of Electromagnetics
	Author	Mathew N. O. Sadiku
	Publisher	Oxford University Press Inc.
	Edition	
2.	Title	Electromagnetism – Theory and Applications
	Author	AshutoshPramanik
	Publisher	PHI.
	Edition	
3.	Title	Engineering Electromagnetics
	Author	W H Hayt, J A Buck
	Publisher	McGraw Hill Education
	Edition	
Reference Book:		
1.	Title	Theory and Problems of Electromagnetics
	Author	Joseph. A.Edminister
	Publisher	Tata McGraw Hill
	Edition	Second edition
2.	Title	Electromagnetics with Applications
	Author	Kraus and Fleish
	Publisher	
	Edition	McGraw Hill International Editions, Fifth Edition, 1999

Content

Introduction

Vector Algebra, Cartesian, Cylindrical and Spherical Co-ordinate System. Transformation of Variables from Cartesian to Cylindrical and Spherical Coordinate System and Vice-Versa, Gradient, Divergence and Curl, Divergence Theory, Stoke's Theorem.

Electrostatics

Coulomb's Law – Electric field intensity – Field due to point and continuous charges – Gauss's lawand application – Electric potential – Electric field and equipotential plots – Electric field in freespace, conductors, dielectric -Dielectric polarization - Dielectric strength - Electric field in multipledielectrics – Boundary conditions, Poisson's and Laplace's equations – Capacitance- Energy

	Magnetostatics Lorentz Law of force, magnetic field intensity – Biot–savart Law - Ampere's Law – Magnetic field dueto straight conductors, circular loop, infinite sheet of current – Magnetic flux density (B) – B in freespace, conductor, magnetic materials – Magnetization – Magnetic field in multiple media –Boundaryconditions – Scalar and vector potential – Magnetic force – Torque – Inductance – Energy density –Magnetic circuits. **Electro-Magnetic Waves** Generation – Electro Magnetic Wave equations – Wave parameters; velocity, intrinsic impedance, propagation constant – Waves in free space, lossy and lossless dielectrics, conductors-skin depth, Skin Effect, Proximity Effect, Poynting vector – Plane wave reflection and refraction – Transmission lines–Line equations – Input impedances – Standing wave ratio.
Curse Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EEB 202	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of course	Other Engg. Core			
Course Title	**Electronic Devices and Circuits**			
Course Coordinator				
Course objectives:	To make the Students i. familiar with the structure of basic electronic devices. ii. exposed to the operation and applications of electronic devices.			
POs				

Semester	**Autumn:** Yes		**Spring:** Yes		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	**3**	**0**	**2**	**4**	**36(L) + 24(P)**
Prerequisite course code as per proposed course numbers	NA				
Prerequisite credits	NA				
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	--				

Text Books:		
1.	Title	Electronic Devices and Circuits
	Author	David A. Bell
	Publisher	Prentice Hall of India
	Edition	
2.	Title	Microelectronic Circuits
	Author	Sedra and smith
	Publisher	Oxford University Press
	Edition	2004
3.	Title	Electronic Devices and Circuit theory

	Author	Robert L.Boylestad
	Publisher	Pearson Education
	Edition	11 edition (2015)
4.	Title	Integrated Electronics
	Author	Millman&Halkias
	Publisher	McGraw Hill Education
	Edition	3 edition (2010)
Reference Book:		
1.	Title	Electronic Devices
	Author	Floyd
	Publisher	Pearson Asia
	Edition	9th Edition, 2012.

Content

Diodes

Review of semiconductors, p-n junction, forward and reverse biased junction, equivalent circuits; Applications - rectifier, clipper, clamper, voltage doubler, transfer characteristics; Zener diode; Power supply, filter, zener regulator; Special purpose diodes.

Bipolar Junction transistors

npn and pnp transistors, input and output characteristics - cut-off, saturation and active regions; CE, CB and CC configurations, small signal model, BJT as amplifier; Biasing circuits; Stability analysis, DC and AC equivalent circuits. Small-signal Analysis:h-parameter model of BJT, analysis of BJT amplifier circuits, cascaded amplifiers, frequency response of RC coupled amplifier.

Power Amplifiers

DC and AC load lines; Class A operation; Class B operation, push-pull circuit; Biasing circuits, Class C amplifier; Current source

Field Effect Transistors

Operating characteristic, transductance, JFET as amplifier, biasing circuits; Applications.

Active Filters & Oscillators:

Advantages of active filters, classification of filters, response characteristics of butter worth, Chebyshev, causal filters, first order and second order butter worth filters- low pass and high pass types. Band pass & band reject filters. Oscillator principles, types of oscillators - phase shift, wein bridge & quadrature, square wave, triangular wave and saw tooth wave generators, voltage-controlled oscillator.

Barkhausen criterion, damped oscillation in LC circuits; Harmonic oscillators- RC-phase shift oscillator, transistor phase shift oscillator; Tuned oscillator- Colpitts oscillator, Hartley oscillator; Crystal oscillator

	Operational Amplifiers: The basic operational amplifier & its characteristics, Block diagram representation of OP-AMP, Power supply requirements of an OP-AMP, Evolution of OP-AMP. **Voltage Regulators** Zener voltage regulator, emitter follower regulator, series voltage regulator, IC regulator **Laboratory Experiments:** 1. Ripple And Regulation Characteristics Of Full Wave And Half Wave With Filters (C,L,Lc,Clc) 2. Clippers and Clampers 3. Half Wave and Full Wave Voltage Doubler, Tripler. 4. BJT Characteristics NPN & PNP (CB, CC And CE). 5. Biasing Circuits Of BJT 6. Amplifier Class A,B,AB By Using BJT 7. FET Characteristics (N & P Channel) 8. MOSFET Characteristics (N & P Channel) 9. RC Phase Shift Oscillators by Using BJT 10. Operational Amplifiers Characteristics 11. Zener Diode &IC Voltage Regulator 12. Series & Emitter Follower Voltage Regulator
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50% Lab: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading

Course no: **EEB 202**	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of Course	Theory		**Core Engineering Course**	
Course Title	**SIGNALS AND SYSTEMS**			
Course Coordinator				
Course objectives:	Coverage of continuous and discrete-time signals and systems, their properties and representations and methods those are necessary for the analysis of continuous and discrete-time signals and systems. Knowledge of time-domain representation and analysis concepts as they relate to difference equations, impulse response and convolution, etc. Knowledge of frequency-domain representation and analysis concepts using Fourier Analysis tools, Z-transform. Mathematical and computational skills needed in application areas like communication, signal processing and control, which will be taught in other courses			
POs				
Semester	**Autumn: Yes**		**Spring: No**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	None				
Prerequisite Credits	None				
Equivalent course codes as per proposed course and old course	None				
Overlap course codes as per proposed course numbers	None				

Text Books:		
1.	Title	Signals and Systems

	Author	Alan V. Oppenheim, Alan S. Willsky with S. Hamid Nawab
	Publisher	PHI Publications
	Edition	
2.	Title	Principles of Linear Systems and Signals
	Author	B.P. Lathi
	Publisher	Oxford University Press Publications
	Edition	
3.	Title	Signals and Systems
	Author	Simon Haykin
	Publisher	John Wiley and Sons Publications
	Edition	
Content	**CLASSIFICATION OF SIGNALS AND SYSTEMS** Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids_ sampling and quantization, Classification of signals — Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals — Classification of systems- CT systems and DT systems- — Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable. **ANALYSIS OF CONTINUOUS TIME SIGNALS** Fourier series for periodic signals — Fourier Transform — properties- Laplace Transforms and properties **LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS** Impulse response — convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems — Systems connected in series / parallel. **ANALYSIS OF DISCRETE TIME SIGNALS** Baseband signal Sampling — Fourier Transform of discrete time signals (DTFT) — Properties of DTFT — Z Transform & Properties **LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS** Impulse response — Difference Equations- Convolution sum- Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: EEB 251	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of course	Core			
Course Title	**Electrical Machines-I**			
Course Coordinator				
Course objectives:	To develop basic concepts of Transformers and DC machines. Understand their constructional details, working principles, operating characteristics, operational issues and practical applications. Understand the fundamental concepts of electro-mechanical energy conversion			
POs				

Semester	**Autumn:**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	**3**	**0**	**2**	**4**	**36(L) + 24(P)**
Prerequisite course code as per proposed course numbers	NA				
Prerequisite credits	NA				
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	---				

Text Books:		
1.	Title	Electrical Machines with MATLAB
	Author	Turan Gonen
	Publisher	CRC Press
	Edition	2nd
2.	Title	Performance & Design of Direct Current Machines
	Author	A.E. Clayton and N.N. Hancock
	Publisher	CBS

	Edition	3rd
3	Title	The Performance And Design Of Alternating Current Machines
	Author	SAY M.G.
	Publisher	CBS
	Edition	3rd
Reference Book:		
1.	Title	Theory of AC Machinery
	Author	A.S.Langsdorf
	Publisher	Tata McGraw Hill
	Edition	
2.	Title	Electric Machinery
	Author	A.E.Fitzerald, C.Kingsley and S.D.Umans
	Publisher	Tata McGraw Hill
	Edition	

Content

Transformers

Construction, theory and operation, E.M.F. equation, phasor diagram, ideal transformer, equivalent circuit, open and short circuit tests, back to back test, voltage regulation and efficiency, per-unit transformer values, application, auto-transformers, three winding transformer, parallel operation of single phase and three phase transformers, three phase transformer connections, phasor groups, three phase to two phase and six phase conversion.

Basic Concepts of Rotating Electrical Machines

Constructional details of various rotating machines, introduction to lap and wave windings, EMF generation, effect of chording and distribution of winding on EMF, Harmonics in generated emf, MMF produced by distributed winding.

DC Machines

Construction, types of dc machine, EMF equation, armature reaction, commutation, interpoles and compensating windings, characteristics of dc generators, voltage build up, DC motor: principle, torque of dc machine, types of dc motors, characteristics of dc motor, speed control of dc motor, three point starter, four point starter, Ward-Leonard system, Swinburne's test, Hopkinson's test, braking of dc

	motor, losses and efficiency, applications of DC motors. **Electrical Machines – I Laboratory:** Determination of open circuit characteristic of D.C. machine, determination of load characteristics of D.C. generators, speed control of D.C. motors using armature control and field control methods, brake test on D.C. shunt motor & Swinburne's test, fields test on two identical D.C. series machines, retardation test on D.C. machines to determine moment of Inertia, Hopkinson test on two identical D.C. machines, O.C. and S.C. tests on single phase transformer, load test on single phase transformer, Sumpners test on two single phase transformers, Scott connection of single phase transformers, separation of no load losses of a single phase transformer.
Curse Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50% Lab: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading

Course no: EEB 252	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of course	Core			
Course Title	**Control Systems**			
Course Coordinator				
Course objectives:	This is a first course on feedback control of dynamic systems. It provides basic concepts and principles of modelling, analysis and controller design for continuous linear time-invariant systems with techniques including roots locus and frequency response methods. Laboratory experiments are designed so that the theory learnt in the class can be applied to real physical systems.			
POs				

Semester	**Autumn:**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	**3**	**0**	**2**	**4**	**36(L) + 24(P)**
Prerequisite course code as per proposed course numbers	NA				
Prerequisite credits	NA				
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	--				

Text Books:		
1.	Title	Control Systems Engineering
	Author	I.J. Nagarath& M. Gopal
	Publisher	New Age Pub. Company
	Edition	
2.	Title	Automatic Control Systems
	Author	B.C. Kuo
	Publisher	PHI

	Edition	
3.	Title	Modern Control Engineering
	Author	Kotsuhiko Ogata
	Publisher	Prentice Hall of India
	Edition	

Content	**Introduction** Concepts of control systems, open loop and closed loop control systems and their differences, different examples of control systems. **Mathematical Modelling and Transfer Function of Physical Systems** Mathematical modeling of electrical and mechanical systems, transfer function of DC servo motor, AC servo motor, block diagram representation of systems considering electrical systems as examples, block diagram reduction technique and signal flow graph, mason's gain formula. **Time Response Analysis** Standard test signals, time response of first order systems, characteristic equation of feedback control systems, transient response of second order systems, time domain specifications, steady state response, steady state errors and error constants, effects of proportional derivative, proportional integral systems. **Stability Analysis in S-Domain** The concept of stability- Routh's stability criterion, absolute, relative, conditional and bounded input, bounded output stability, limitations of Routh's stability. **Root Locus Technique** The root locus concept, construction of root loci, effects of adding poles and zeros to G(s)H(s) on the root loci. **Frequency Response Analysis** Introduction, frequency domain specifications, bode diagrams-determination of frequency domain specifications and transfer function from the bode diagram, phase margin and gain margin, stability analysis from bode plots, polar plot, nyquist plots, stability analysis. **Classical Control Design Techniques** Compensation techniques – Lag, Lead, Lead-Lag controllers design in frequency domain, PID controllers.
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50% Lab: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory foroverall grading

Course no: EEL 253	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	No
Type of Course	Theory			
Course Title	**Power Transmission and Distribution**			
Course Coordinator				
Course objectives:	To familiarize students with the infrastructure of power systems and to introduce the design aspects of power system distribution and transmission.			
POs				
Semester	**Autumn: yes**		**Spring: Yes**	

Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36(L)
Prerequisite course code as per proposed course numbers	Nil				
Equivalent course codes as per proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				

Text Books:		
1.	Title	Power System Analysis & Design.
	Author	J. D. Glover, M. S. Sharma, T. J. Overbye
	Publisher	Cengage
	Edition	
2.	Title	A Text Book on Power System Engineering
	Author	M. L. Soni, P. V. Gupta, U. S. Bhatnagar and A. Chakraborti
	Publisher	Dhanpat Rai & Co. Pvt. Ltd
	Edition	
3.	Title	Generation Distribution and Utilization of Electrical Power,., 2005.
	Author	C. L. Wadhwa
	Publisher	New Age International Ltd
	Edition	
4.	Title	Power System Analysis
	Author	J. J. Grainger and W. D.Stevenson
	Publisher	McGraw-Hill International Book Company
	Edition	2008
5.	Title	Electrical Power Distribution Systems by Turan Gonen,
	Author	Turan Gonen
	Publisher	Mc. Graw-hill
	Edition	
Content	**Introduction:** General Structure of Electrical Power System- Introduction to Power System, Generation, Transmission, Distribution and Utilization- Overview	

	Single Line Diagram representation. **Transmission of Electrical Power:** Brief introduction to AC and DC transmission systems. AC Transmission line parameters: Types of conductors – ACSR, Bundled and Stranded conductors- Skin Effect- Calculation of inductance and capacitance for single phase and three phase, Single and double circuit lines, Concept of GMR & GMD, Symmetrical and asymmetrical conductor configuration with and without transposition. Effect of ground on Capacitance. **Performance of AC transmission line:** Short, Medium and Long lines and their exact equivalent circuits- Nominal-T, Nominal-π. Regulation and Efficiency of transmission lines. Long transmission line-Rigorous solution. A, B, C, D parameters of transmission lines. Surge impedance and Surge impedance loading - Wavelengths and Velocity of propagation, Ferranti effect. **Mechanical design of transmission lines:** Overhead line insulators: Types of Insulators, String efficiency and methods for improvement. Phenomenon of corona, Factors affecting corona. **Distribution of Electric power:** Classification of distribution systems, DC and AC distribution systems, Underground and Overhead Distribution Systems. Design considerations of distribution feeders: Radial and loop, Primary feeders, Voltage levels, Feeder loading.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECB 206	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	NO	NO	NO	NO
Type of course	**Other Engineering Courses**			
Course Title	**DIGITAL ELECTRONICS & LOGIC DESIGN**			
Course Coordinator				
Course objectives:	This course is aimed to provide an introduction to digital logic design and its ability to understand number system representations, binary codes, binary arithmetic and Boolean algebra, its axioms and theorems, and its relevance to digital logic design. It also introduces combinational circuits, synchronous sequential logic and Asynchronous sequential logic.			
POs				

Semester	**Autumn:**		**Spring: Yes**		
IV	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total teaching hours**
Contact Hours	3	0	2	4	36(L) + 24(P)
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1	Title	Digital Design
	Author	Mano, M. Morris
	Publisher	Pearson Education
	Edition	Third Edition, 2002
Reference Book:		
1	Title	Digital Fundamentals
	Author	Floyd, Thomas L.
	Publisher	Pearson Education, Singapore
	Edition	Seventh Edition, 2002
2	Title	Digital Electronics
	Author	Gothmann, William H.
	Publisher	PHI, New Delhi
	Edition	Second Edition 2000
3	Title	Jain, R.P.
	Author	Modern Digital Electronics
	Publisher	TMH, New Delhi

	Edition	Third Edition 2003
Content	**Number system and codes:** Analog versus digital, merits of digital system, number systems, base conversions, complements of numbers weighted and unweighted codes and error detecting and correcting codes, Alpha numeric code (ASCII), Error detecting and correcting codes. **Switching algebra and switching functions:** Boolean algebra, postulates, theorems and switching algebra, completely and incompletely specified switching functions, Representation of Boolean functions in sum of products form and product of sums form, minimization of Boolean functions using Karnaugh map and Quine McCluskey methods. Problem solving. **Combinational logic circuits:** Logic gates, Logic gates operation using discrete components, Universal Logic gates, Logic design of combinational circuits: adders, Code converters, Comparators, multiplexers, de-multiplexers, encoders, decoders, buffers, tri-state buffers. **Logic Families:** Transistor as an inverter/switch. Classification of logic families and their developments. TTL NAND gate analysis, ECL and CMOS logic family. Comparison TTL CMOS and ECL logic families. **Flip-Flops:** RS Flip flop, Clocked RS flip-flop, JK flip-flop, T-flip-flop, JK flip-flops and M/S JK flip flop, Conversion of flip-flops. **Registers:** Buffer Register, Controlled buffer register, Shift Registers (Left shift and Right shift register), Universal shift register: SISO, SIPO, PISO, PIPO, Ring counter and twisted ring counter **Counters:** Design of Asynchronous and Synchronous counters. **Comparators & Converters:** Basic comparator & its characteristics, zero crossing detector, voltage limiters, clippers & clampers, small signal half wave & full wave rectifiers, absolute value detectors, sample and hold circuit.	
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50% Lab: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading	

Course no: EEB 254	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of course	Core			
Course Title	**Electrical Measurements**			
Course Coordinator				
Course objectives:	To impart knowledge of principles of measurement of electrical quantities, construction and operating principles of electrical instruments, their static and dynamic characteristics, and errors in measurement.			
POs				

Semester	**Autumn:** Yes		**Spring**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	**3**	**0**	**2**	**4**	**36(L) + 24(P)**
Prerequisite course code as per proposed course numbers	NA				
Prerequisite credits	NA				
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	---				

Text Books:

1.	Title	Electronic Instrumentation and Measurement Techniques
	Author	W.D. Cooper & A.D. Helfrick
	Publisher	Prentice-Hall India
	Edition	
2.	Title	Electrical Measurement & Measuring Instruments
	Author	E.W. Golding
	Publisher	WhELLer Publishing
	Edition	
3.	Title	A Course in Electrical & Electronic Measurements and Instrumentation

	Author	A.K.Sawhney
	Publisher	Dhanpat Rai
	Edition	19th

Content	**Errors and Accuracy** Static error, static calibration, error calibration curve, limiting errors, relative limiting errors, types of errors- gross errors, systematic errors, random (residual) errors, accuracy and precision, static sensitivity, linearity, hysteresis, threshold, dead time, resolution of instrument, loading effects, introduction to measurement standards. **Ammeters and Voltmeters, Wattmeters:** Introduction, D'Arsonval galvanometer, moving iron & moving coil instruments, electrodynamometer, electrostatic instruments, induction type energy-meter, wattmeter. **Resistance Measurements** Methods of measurement of low, medium and high resistance, measurement of earth resistance, localization of cable faults by Murray and Varley loop test. **Inductance and Capacitance Measurements** Measurement of inductance and capacitance by A.C. Bridge methods, Q-factor and dissipation factor, sources of errors in bridge circuits, methods of reducing bridge errors, Wagner Earthing Device. **Measurement of Power Factor and Frequency** Single phase, three phase Electrodynamometer type power factor meters, moving iron power factor meters, types of frequency meter, mechanical resonance type, electrical resonance type, ratio meter type and Weston frequency meter. **Potentiometers** Basic D.C. potentiometer circuit, modern form of D.C. potentiometer, measurement of voltage, current, resistance and calibration of voltmeter & ammeter using D.C. potentiometer, volt ratio box, A.C. potentiometers and their applications. **Instrument Transformers** Introduction, use of Instrument transformers, ratios, basic constructional features of C.T. and P.T., ratio and phase angle errors, reduction of errors.
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50% Lab: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading

Course no: EEB 301	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	Theory and Practical			
Course Title	**Electrical Machines - II**			
Course Coordinator				
Course objectives:	To develop the basic understanding of ac rotating electrical machines. Familiarize with constructional details, working principles, operating characteristics, operational issues and practical applications of single-phase &three-phase Induction Machines and Synchronous Machines.			
POs				
Semester	**Autumn:** YES		**Spring:** NO	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	**3**	**0**	**2**	**4**	**36(L) + 24(P)**
Prerequisite course code as per proposed course numbers	**EEB 251**				
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	--				

1.	Title	Electric Machinery
	Author	A.E.Fitzerald, C.Kingsley and S.D.Umans
	Publisher	Tata McGraw Hill
	Edition	
2.	Title	Theory of AC Machinery
	Author	A.S.Langsdorf
	Publisher	Tata McGraw Hill
	Edition	

Content	**Polyphase Induction Machines** Theory of three phase induction motors, principle of operation, slip, equivalent circuits, expression for torque, full load torque, maximum torque, starting torque and output power, torque-slip and torque-speed characteristics, circle diagram, no load and blocked rotor test, dELP bar cage and double cage induction motor, starting of induction motors, speed control of induction motor, cogging &crawling, induction generators.

	Single Phase Induction Motors Principle of operation on the basis of double revolving field theory, equivalent circuit **Synchronous Machines** Types of exciters for synchronous machines, flux and MMF phasor diagrams for cylindrical rotor synchronous machines, armature reaction, open and short circuit characteristics, leakage reactance, synchronous reactance, phasor diagram under loaded conditions, operating characteristics of alternators and their ratings, predetermination of regulation by EMF and potier triangle methods for non-salient pole alternators, steady state power flow equations, power angle characteristics, constant excitation and constant power output, circle diagram for synchronous machines, two reaction theory for salient pole alternators and pre-determination for regulation, slip test, V curves, hunting and its suppression, starting of synchronous motor, synchronous condenser. **Parallel Operation of Alternators** Synchronization of alternators by dark lamp method, parallel operation of alternators, alternator on infinite bus bar, effect of change of excitation and prime mover inputs. **Electrical Machines – II Laboratory** Determination of equivalent circuit parameters of three phase induction motor, Brake test on 3-phase induction motor, circle diagram of 3-phase induction motor, speed control of 3-phase induction motor, single phase operation of 3-phase induction motor, regulation of 3-phase alternator by Z.P.F. method, parallel operation of alternators, determination of V and inverted V curves of 3-phase synchronous machine, characteristics of 3-phase Schrage motor, no load and load characteristics of an amplidyne, determination of equivalent circuit parameters of single phase induction motor.
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50% Lab: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading

Course no: EEL 302	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	No	No
Type of Course	Theory			
Course Title	**Power System Analysis**			
Course Coordinator				
Course objectives:	To familiarize the students with the techniques for analyzing a power system during normal operation and abnormal conditions.			
POs				
Semester	**Autumn: yes**		**Spring: Yes**	

Contact Hours	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
Contact Hours	3	1	0	4	36(L)+12(T)
Prerequisite course code as per proposed course numbers	Nil				
Equivalent course codes as per proposed course and old course	Nil				
Overlap course codes as per proposed course numbers	Nil				

Text Books:		
1.	Title	Power System Analysis
	Author	H.Saadat
	Publisher	Tata McGraw-Hill Publishing Company Limited
	Edition	2008
2.	Title	Computer Techniques in Power System Analysis
	Author	M. A.Pai
	Publisher	Tata McGraw-Hill Publishing Company Limited
	Edition	2nd Ed.,2008
3.	Title	Reactive Power Control in Electric Systems
	Author	T. J. E.Miller
	Publisher	John Wiley and Sons
	Edition	2010
4.	Title	Power System Analysis
	Author	J. J. Grainger and W. D.Stevenson
	Publisher	McGraw-Hill International Book Company
	Edition	2008
5.	Title	Power System Analysis and Design
	Author	J. D. Glover and M. S.Sarma
	Publisher	Cengage Learning
	Edition	4th Ed.

Content	**Per Unit Representation of Power Systems:** The one-line diagram, impedance and reactance diagrams, per unit quantities, changing the base of per unit quantities, advantages of per unit system. **Load flow analysis:** Numerical techniques for solving algebraic equations, matrix representation of the power system, load flow equations, application of Gauss-Seidel method for solving load flow equations, application of Newton-Raphson method for solving

	load flow equations, fast decoupled solution for load flow equations. **Economic load dispatch:** Introduction to constrained optimization, optimal scheduling of generators, network loss modelling. **Short circuit analysis:** System representation for short circuit analysis, balanced short circuit analysis, Significance of positive, negative and zero sequence components, sequence impedances and sequence networks, fault calculations, single line to ground fault, line to line fault, double line to ground fault, three phase faults **Stability analysis:** Basic concept of stability, Classification of stability, Swing equation, power angle equation, synchronizing power coefficient, basic concepts of steady state, dynamic and transient stability, equal area criterion, solution of the swing equation.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EEB 303	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**Yes**	**No**
Type of Course	Theory and Practical			
Course Title	**Microprocessors and Micro Controllers**			
Course Coordinator				
Course objectives:	To introduce the 8086 microprocessors and their interfacing, Develop assembly level programs on the 8051 and PIC 18F-microcontroller platforms.			
POs				
Semester	**Autumn:** Yes		**Spring:** No	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	**3**	**0**	**2**	**4**	**36(L) + 24(P)**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	--				

Text Books:		
1.	Title	Microprocessors and Interfacing
	Author	Douglas V. Hall, SSSP Rao
	Publisher	Mc Graw Hill

	Edition	3rd Edition, 2012
2.	Title	Advanced Microprocessor and Peripherals
	Author	Ray A.K., Bhurchandi K.M
	Publisher	McGraw Hill Education Publications
	Edition	3rd Edition, 2017.
3.	Title	The 8051 Microcontroller
	Author	Kenneth J Ayala
	Publisher	Cengage Learning Publications
	Edition	3rdEdition, 2007
Content	**Introduction:** Overview of the course, Functional elements of a microprocessor, overview of architecture of a general-purpose microprocessor. **8086 Microprocessor:** Internal Architecture of 8086, BIU and EU- Registers in of 8086- Memory segmentation- Addressing modes-register related and memory related- Instruction formats, Instruction set of 8086- Assembler directives, Tutorial- Problems on assembly language programming- Pin diagram of 8086, Modes of operation- Timing diagrams of typical instructions- Fundamentals of I/O data transfer, Polling, Handshaking, interrupts-Steps in an interrupt process, Interrupt structure in 8086 **Fundamentals of interfacing peripheral chips**: Interfacing memory & I/O devices- Interfacing I/O- Programmable peripheral interface-8255, Modes of operation of 8255, Interfacing examples with 8255- Interfacing 8254 timer, Interfacing Digital to analog converters, Analog to Digital converters- Interfacing USART 8251. **8051 Microcontroller:** 8051 architecture, memory organization, addressing modes & port structure, external memory access, counters and timers, Interrupts, serial communication, Microcontroller instructions, moving data, logical operations, arithmetic operations, jump and call instructions – subroutines - Interrupts and returns. Microcontroller programming – Assembly Language Programming, timer and counter programming, Interrupt programmingInterfacing examples. **PIC Microcontrollers (PIC 18F):** Introduction - Architecture – Memory organization – Assembly Language Programming and programming with Embedded C – simulation using Integrated Development Environment (IDE) - Programming of I/O ports – Addressing modes. Bank switching – Look-up Table and Table processing – Timers and its programming – Interrupt sources- analog-to-digital converter (ADC) module-Brown-out-reset (BOR), Power on-reset (POR), Capture/Compare/PWM modules, USART, Master Synchronous Serial Port (MSSP) Module -Interfacing examples. **Advanced Microprocessors:** Multi-User/Multi-Tasking Operating System, Memory **Laboratory:** Experiments follow the contents of the course covered during the lectures.	

Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50% Lab: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading

Course no: EEB 304	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**Yes**	**No**
Type of Course	Theory and Practical			
Course Title	**Power Electronics**			
Course Coordinator				
Course objectives:	The course aims at familiarizing the students with the operating characteristics of semiconductor devices, triggering circuits and their applications for power control. The course also deals with the detailed analysis and operation of power controllers.			
POs				
Semester	**Autumn:** No		**Spring:** Yes	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	**3**	**0**	**2**	**4**	**36(L) + 24(P)**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	--				

Text Books:		
1.	Title	Modern Power Electronics

	Author	B. K. Bose
	Publisher	IEEE Press
	Edition	
2.	Title	Power Electronics-Circuits, Devices & Applications
	Author	M.H. Rashid
	Publisher	Pearson Education
	Edition	
Content	**Characteristics of Various Solid State Devices** Introduction, power semiconductor devices: power diode, power transistor, MOSFET, Thyristor & its two-transistor model, Triac, Gate turn off thyristor (GTO), insulated gate bipolar transistor (IGBT), comparison of switching power devices, turn on & turn off characteristics, driver circuits. **AC to DC Converters** Commutation, single phase and three phase bridge rectifiers, semi controlled & fully controlled rectifiers, dual converters, effect of load and source inductance. **DC to DC Converters** Principle of operation, control strategies, step-up, step-down choppers, types of chopper circuits, steady state analysis, multiphase chopper. **DC to AC Inverters** Voltage source inverters, single phase inverter, three phase inverter, harmonic reduction techniques and PWM techniques, current source inverter. **AC to AC Converters** Single phase & 3-phase AC voltage controllers using thyristors , phase control and integral cycle control, AC choppers, single phase cyclo-converters, applications, effects of harmonics. **Power Electronics Laboratory:** Study of characteristics of power semiconductor switching devices (SCR, Triac, MOSFET, IGBT), Study of two-pulse fully controlled rectifier, feeding R, RL and RLC (DC-motor) loads, Study of a six-pulse half controlled rectifier feeding R, RL and RLE loads, Study of a six-pulse fully controlled rectifier feeding R and RL loads- Closed-loop control of a six-pulse fully controlled rectifier, Study of a 1-phase inverter with square wave, quasi-square wave and SPWM control, Speed control of induction motor with V/f control method using 3-phase inverter, Open –loop control of a separately excited DC motor drive with a 6-phase fully controlled rectifier, Study of characteristics of a class –D commutated thyristorized step-down chopper, Study of AC chopper with R and RL loads to achieve power control, Study of performance of a PWM controlled AC-DC converter, Study of performance of a 1-phase cyclo-converter.	
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50% Lab: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading	

Course no: EEB 351	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of course	Theory and Practical			
Course Title	**Electrical Drives**			
Course Coordinator				
Course objectives:	To understand basic of DC/AC electrical drives, their speed control and braking techniques			
POs				

Semester	**Autumn:** Yes		**Spring**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	**3**	**0**	**2**	**4**	**36(L) + 24(P)**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	---				

Text Books:

1.	Title	Fundamentals of Electrical Drives
	Author	G. K. Dubey
	Publisher	Alpha Science International, Ltd
	Edition	2nd Ed.
2.	Title	Power electronic control of AC motors
	Author	J. M. D. Murphy and F. G. Turnbull
	Publisher	Pergamon press
	Edition	1st Ed. and Revised
3.	Title	Electric Drives
	Author	Ion Boldea and S. A. Nasar
	Publisher	CRC press
	Edition	3rd Ed.

Content

Introduction

Electrical drives, advantages of electrical drives, parts of electrical drives – electrical motors, power modulators, sources, control unit.

Dynamics of Load System

Fundamental torque equations, speed torque conventions and multiquadrant operation, equivalent values of drive parameters – loads with rotational motion and translational motion, measurement of moment of inertia – reduced voltage and retardation test on induction motor, components of load torques, nature and classification of load torques, calculation of time and energy loss in transient operations, steady state stability, load equalisation.

	Control Aspects and Sensing Modes of operation, speed control and drives classifications, closed loop control of drives – current limit control, Torque control, speed control, speed sensing, current sensing, phase locked loop control, closed loop position control. **Rating and Heating of Motors** Thermal model, classes of duty, determination of motor rating – continuous duty, short time duty, intermittent duty. **DC Motor Drives** DC motor and their performance, starting, braking, transient analysis, speed control, methods of armature voltage control, ward Leonard drives, transformer and uncontrolled rectifier control, 1-phase controlled and semi controlled rectifier fed DC motor, 3- phase half controlled, semi controlled and fully controlled rectifier fed DC motor drive, chopper-controlled DC motor drive. **Induction Motor Drive** Three phase induction motor analysis and performance, starting, speed control and braking, stator voltage control, variable frequency control, VSI and CSI control, rotor resistance control, pole amplitude modulation, slip power recovery – Scherbius and Kramer drive. **Laboratory:** Measurement of Moment of Inertia of a 3-phase induction motor using retardation Test, To perform rheostatic braking of a DC Shunt motor and observe the impact of increasing resistance on braking time, To perform counter-current braking of a DC – Shunt type motor and observe the impact of plugging resistance on braking time, To validate armature and flux control of a DC – shunt type motor using rheostats, To validate two-quadrant operation of a DC – shunt type motor using Ward-Leonard Method of speed control, To validate the speed control of a DC-shunt type motor by using DC-DC chopper circuit, To perform DC-dynamic braking of a 3-phase induction motor and observe the impact of DC current on braking time, To perform counter-current braking of a 3-phase induction motor and observe the impact of braking resistance on braking time, To validate V/F control of a 3-phase induction motor using 3-phase Voltage Source Inverter, To perform speed control of a 3-phase slip-ring Induction motor by rotor resistance variation.
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50% Lab: Continuous Evaluation 50% End Semester 50% 60% weightage to theory and 40 % weightage to laboratory for overall grading

Course no: EEL 401	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of course	Theory			
Course Title	**HVDC & Flexible AC Transmission Systems**			
Course Coordinator				
Course objectives:	To provide an in-depth understanding of different aspects of high voltage direct current power transmission system. To familiarize students with FACTS devices, their control techniques and applications.			
POs				

Semester	**Autumn:** No		**Spring:** Yes		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Teaching Hours**
Contact Hours	**3**	**0**	**0**	**3**	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

1.	Title	HVDC Power Transmission Systems–Technology and System Interactions
	Author	K.R.Padiyar
	Publisher	New Age International Publishers
	Edition	3rd Ed.
2.	Title	Understanding FACTS–Concepts and Technology of Flexible AC Transmission Systems
	Author	Narain G.Honorani, Laszlo Gyugyi
	Publisher	Wiley-IEEE Press
	Edition	2nd Ed.

Content

HVDC Transmission

Introduction, comparison of ac and HVDC, economic & terminal equipment of HVDC transmission systems: types of HVDC Links, apparatus required for HVDC System, comparison of AC & DC transmission, application of DC transmission system, planning & modern trends in D. C. transmission.

HVDC Transmission Analysis

HVDC converters, pulse number, analysis with and without overlap, converter bridge characteristics, characteristics of 6 Pulse & 12 Pulse converters.

HVDC System Control

Principles of dc link control, starting and stopping of dc link, power control, harmonics & filters, introduction- generation of harmonics types, power flow analysis in ac/dc systems.

	Flexible AC Transmission Systems (FACTS) Concept of FACTS, flow of power in an ac system, dynamic stability consideration- basic types of FACTS controllers, shunt compensator: SVC & STATCOM - objectives of shunt compensation- methods of controllable VAR generation- switching converter type VAR generators-basic operating principle and control approaches, static series compensators -GCSC,TSSC,TCSC & SSSC - objectives of series compensator, variable impedance type series compensators- basic operating control schemes- power angle characteristics, control range and VA rating- external control.
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: EEL 402	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**		**DE (Y/N)**
	No	**No**	**Yes**		**No**
Type of Course	Theory				
Course Title	**Switchgear and Protection**				
Course Coordinator					
Course objectives:	To introduce the concept and necessity of protection in generation and transmission, and applications of switchgears including internal operation of different types of circuit breakers.				
POs					
Semester	**Autumn:** No		**Spring:** Yes		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	**3**	**0**	**0**	**3**	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite Credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	--				
Text Books:					
1.	Title	Fundamentals of power system protection			

	Author	Y. G. Paithankar and S. R. Bhide
	Publisher	Prentice Hall
	Edition	
2.	Title	Switchgear and Power System Protection
	Author	Ravindra P.Singh
	Publisher	PHI Learning Private Ltd
	Edition	
3.	Title	Power System Protection and Switchgear
	Author	Badri Ram, D N Vishwakarma
	Publisher	TMH
	Edition	

Content

Introduction:

fuse characteristics, types of fuses, application of HRC fuses, discrimination Overvoltage Protection and Insulation Coordination: Over voltage due to arcing ground and Peterson coil, lightning, horn gaps, surge diverters, rod gaps, expulsion type lightning arrester, valve type lightning arrester, ground wires, ground rods, counter poise, surge absorbers, insulation coordination, volt-time curves.

Protective Relays:

Evolution of protective relays, zones of protection, primary and backup protection, essential qualities of protection, classification of protective relays and schemes, current transformers, potential transformers, basic relay terminology.

Operating Principles of Protective Relays:

Electromagnetic relays, thermal relays, static relays, Amplitude and Phase comparators, Duality between AC and PC, Static amplitude comparator, integrating and instantaneous comparators, static phase comparators, coincidence type of phase comparator, introduction to microprocessor based protective relays.

Over-current Protection:

Time-current characteristics, current setting, over current protective schemes, directional relay, protection of parallel feeders, protection of ring mains, Phase fault and earth fault protection, Combined earth fault and phase fault protective scheme, Directional earth fault relay.

Distance Protection:

Impedance relay, reactance relay, MHO relay, input quantities for various types of distance relays, Effect of arc resistance, Effect of power swings, effect of line length and source impedance on the performance of distance relays, selection of distance relays, MHO relay with blinders, Reduction of measuring units, switched distance schemes, auto re-closing.

Pilot Relaying Schemes:

Wire Pilot protection, Carrier current protection.

AC Machines and Bus Zone Protection:

Protection of Generators, Protection of transformers, Bus-zone protection, frame leakage protection.

	Static Relays: Static over current relays, static directional relay, static differential relay, static distance relays, and Multi input comparators, concept of Quadrilateral and Elliptical relay characteristics. **Circuit Breakers:** Introduction, arcing in circuit breakers, arc interruption theories, re-striking and recovery voltage, resistance switching, current chopping, interruption of capacitive current, oil circuit breaker, air blast circuit breakers, SF6 circuit breaker, operating mechanism, selection of circuit breakers, high voltage d.c. breakers, ratings of circuit breakers.
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester 50%