DIT UNIVERSITY
DEHRADUN

DETAILED COURSE STRUCTURE & SYLLABUS

OF

B. TECH – ELECTRICAL ENGINEERING (2022-25)
(FULLY FLEXIBLE CHOICE BASED CREDIT SYSTEM)

COURSE STRUCTURE & SYLLABUS OF B. TECH – ELECTRICAL ENGINEERING APPLICABLE FOR BATCH (2022-25)

Introduction

The Ministry of Human Resource Development (MHRD), Govt. of India, has initiated development of a New Education Policy (NEP) to bring out comprehensive reforms in the Indian education system.

The University Grants Commission (UGC) has subsequently initiated several steps to foster academic excellence through introduction of paradigm shift in learning and teaching pedagogy, innovation and improvement in course curricula, examination and education system.
While a majority of education institutions have started following the semester-based system of education, it has been observed that this new system is still producing graduates who lack knowledge, values, and skills and are not job ready professional. The reason for this lacking could be attributed to the rigidity of our program structures and lack of flexibility to have choices among core subject education, liberal arts, ability enhancement, skill development, etc., that is fundamental to overall development and employability of these graduates.

To make this possible, a fully flexible choice-based credit system (FFCBCS), a well-established internationally known system, is proposed. This fully flexible choice-based credit system allows students the flexibility to learn at their own pace, and register for both core subjects and a variety of courses from other areas, leading to holistic development of an individual. The FFCBCS will facilitate us to bench mark our programs with best international liberal arts based academic programs.

Advantages of the FFCBCS structure:

- Shift in focus from the teacher-centric to student-centric education. Student can curve out their program structure by choosing minimum number of credits from well-defined baskets.
- Student may undertake as many credits as they can cope with.
- FFCBCS allows students to choose courses from various baskets of inter-disciplinary, intra-disciplinary, skill oriented, ability enhancing, and from other disciplines.

Features unique to DIT University FFCBCS structure

1. A minimum of 150-160 credits has to be earned by a student to be eligible for an Under Graduate degree in Engineering. Each department will decide their total credits for each program, and it can vary across disciplines.
2. Courses are categorized into 11 baskets, and a student will have the option to choose courses in most baskets and earn **minimum number of credits** required in each basket for the award of his/her degree. For each basket, Engineering departments have the flexibility to identify course(s) which will be a core requirement for their program.
3. In certain disciplines, students may choose a **Specialization** by earning 21 credits of Discipline Elective courses towards a particular area of that discipline (intradisciplinary). In addition to this, brighter students will have the option to receive (a) a **Certificate** by earning additional 9 credits towards a particular area either inside or outside their discipline, or (b) **Minor** by earning additional 18 credits towards a particular area outside their discipline. Certificates and Minors can be earned through either University courses, or with MOOCs from providers as identified

by the University. Each department will design the structures and eligibility conditions for registration to its certificates or minor program, which may be reviewed annually, to keep the **Certificates** and **Minors** contemporary and relevant to latest changes.

4. An FFCBCS council may be formed comprising all HoDs and one representative each from respective departments. FFCBCS council will meet at the end of every semester after the completion of Board of Examination meeting to discuss and finalize course offerings by respective departments in the upcoming semester. FFCBCS council will be chaired by the Dean Academic Affairs.

5. To provide sufficient flexibility and room during the program for additional **Certificates**, **Specializations, and Minors**, 8-week summer semesters (Summer 1, Summer 2, and Summer 3) may have to run. Summer semesters are critical for implementing a fully flexible system. Each department will decide a priori which courses to offer in the summer semester and get them finalized at the FFCBCS council meeting.

6. Project based learning has to be incorporated as a core component of evaluation in each course, and depending on the level and type of the course, the project can be of several types - Study Oriented Project, Lab Oriented Project, Design Oriented Project, Computer Oriented Project, Projects of Organizational Aspects, Research Projects, or Entrepreneurship and Start Up Projects. A Capstone Project has been introduced in the 8th semester for all Bachelor of Technology students.

7. Courses under each basket may be updated on an annual basis.

8. Each student will be advised by a faculty advisor of his/her department for registration of courses from each basket in the beginning of semester, depending upon the availability of seats. A student advising centre may be formed where students will have access to department faculty advisers. Faculty advisers should have complete access to view individual student's academic transcript for advising purposes.

9. A student getting an F grade in a core course (departmental or otherwise) at the end of the semester will have to earn those credits by registering for the same course whenever it is offered in subsequent semesters. If the course is not a core course, the student may choose to register for any other course next semester in that basket as advised by the department faculty adviser. Additional fees for those number of credits may apply.

10. Students may opt for summer training/internships/industrial tours as advised by the department. However, these activities will not have credits.

Baskets of FFCBCS

11 baskets of courses have been identified to provide student comprehensive exposure to a large number of areas, leading to the holistic development of an individual. These baskets are as follows:

COURSE STRUCTURE & SYLLABUS OF B. TECH – ELECTRICAL ENGINEERING APPLICABLE FOR BATCH (2022-25)

1. **Language and Literature:** These include courses related to English or other popular languages worldwide, communication skills, and literature. These courses are of 3 credits each.
2. **Core Science:** These courses include science courses from the disciplines of Physics and Chemistry. These courses are of 5 credits each.
3. **Core Mathematics:** This basket includes courses from Mathematics department, crafted for engineering students. These courses are of 4 credits each.
4. **Engineering Sciences:** This basket includes introductory courses from various disciplines of Engineering designed to provide the student solid foundation to the domain of engineering. These courses are of 4 credits each.
5. **Discipline Core:** This basket includes compulsory courses in the discipline in which the student is admitted to the University. These courses are of 4 credits each.
6. **Discipline Elective:** This basket provides students courses other than discipline core, and are normally in certain specialized areas. These courses are of 3 credits each.
7. **Humanities and Liberal Arts:** This basket includes liberal arts courses in various disciplines like psychology, management, economics, etc., and are of 3 credits each.
8. **Skill Enhancement:** Courses in this basket are primarily hands-on and aims to allow students acquire skills required in certain disciplines that are currently in high demand in the job market. These courses are of 2 credits each.
9. **Ability Enhancement:** These courses aim to enhance knowledge and ability of an individual in certain required areas related to national and societal interest. Courses in this basket are of 2 credits each.
10. **Free Electives:** Student can register for any three courses outside their department of his/her choice. These courses can also be taken from MOOCs, and Courses in this basket are of 3 credits each.
11. **Capstone Project:** Capstone project is a semester long multifaceted experimental/research assignment that serves as a culminating academic and intellectual experience for students, taken in the last semester of study. It is of 12 credits and may be done groups of not more than three students, and in three modes as follows:

- **Mode A**: Project with a department faculty.
- **Mode B**: Project as part of Industry Internship arranged only by the career and placement service of the University. Students securing this assignment on their own will not be allowed, unless the project is secured at a well-known industry, and duly approved by the department. The department's decision in all such cases will be final.
- **Mode C**: Semester long project in an academic institute/lab of National/International Importance, secured by students on their own. The department's decision to allow in all such cases will be final.

A separate rule booklet will be released for implementation of Capstone Project.

COURSE STRUCTURE & SYLLABUS OF B. TECH – ELECTRICAL ENGINEERING APPLICABLE FOR BATCH (2022-25)

DIT UNIVERSITY FFCBCS CREDITS

Basket/Area	DIT Credits
Language and Literature (LL)	6
Core Sciences (CS)	10
Core Mathematics (CM)	12
Engineering Sciences (ES)	20
Discipline Core (DC)	48
Discipline Elective (DE)	21
Humanities and Social Sciences (HSS)	6
Skill Enhancement Courses (SEC)	8
Ability Enhancement Courses (AEC)	8
Free Electives (FE)	9
Projects (PRJ)	12
Total	**160**

Structure of the Undergraduate program in Electrical Engineering

Basket/Area	Min Credits To be taken	Credit per course	Courses
Language and Literature (LL) Core: Professional Communication Elective: Choose any 1 more LL course	6	3	2
Core Sciences (CS) Core: Wave & Optics and Introduction to Quantum Mechanics, Elective: Choose any one more Core science	10	5	2
Core Mathematics (CM) Core: Engineering Mathematics I, Engineering Mathematics II & Engineering Mathematics III Elective: None	12	4	3
Engineering Sciences (ES) Core: Programming for Problem Solving, Basic Electrical Engineering, Fundamentals of Electronics Engineering, Data Structures Elective: Choose any 1 more ES Course	20	4	5
Discipline Core (DC) Core: EM & WP, CAS, EMEC-I, ADE, M&I, EMEC-II, EPS, PSA, Control System, SGP, Electric Drives, Elective: None	48	4	12
Discipline Elective (DE) Core: None Elective: Choose 6 as per the prerequisites	21	3	7

Humanities and Social Sciences (HSS) Core: Principles of Management Elective: Choose any 1 HSS course	6	3	2
Skill Enhancement Courses (SEC) Core: None Elective: Choose any 2 SEC Course	8	2	4
Ability Enhancement Courses (AEC)	8	2	4
Free Electives (FE) Core: None Elective: Choose any 3 courses across University course offerings	9	3	3
Thesis Project (TP) Mode A: Project with a department faculty Mode B: Project as part of Industry Internship Mode C: Project in an academic institute/lab of National Importance. All Modes must be semester long	12	12	1
Total Credits	**160**		

COURSE STRUCTURE & SYLLABUS OF B. TECH – ELECTRICAL ENGINEERING APPLICABLE FOR BATCH (2022-25)

			Semester 1	**Credit**
S No.	**Basket**	**Course Code**	**Name of Courses**	**C**
1	CS	PYF105	Engineering Physics	5
2	CM	MAF101	Engineering Mathematics I	4
3	LL	LAF181	Professional Communication	3
4	ES	CSF101	Programming for Problem Solving	4
5	ES	EEF101	Basic Electrical Engineering	4
				Total 20
			Semester 2	**Credit**
S No.	**Basket**	**Course Code**	**Name of Courses**	**C**
1	CS	CHF102	Applied Engineering Chemistry	5
2	CM	MAF102	Engineering Mathematics II	4
3	ES	CSF102	Data Structures	4
4	ES	ECF101	Fundamentals of Electronics Engineering	4
5	ES	ECF142	Fundamental of Semiconductor Electronics	4
6	LL	LAF182	Indian English Literature	3
				Total 24
			Semester 3	**Credit**
S No.	**Basket**	**Course Code**	**Name of Courses**	**C**
1	DC	EEF201	Circuit Analysis & Synthesis	4
2	DC	EEF202	Electromechanical Energy Conversion - I	4
4	DC	ECF209	Analog & Digital Electronics	4
3	DE		Discipline Elective	3
5	CM	MAF201	Engineering Mathematics III	4
6	AEC		One course from Ability Enhancement	2
				Total 21
			Semester 4	**Credit**
S No.	**Basket**	**Course Code**	**Name of Courses**	**C**
1	DC	EEF203	Measurements & Instrumentation	4
2	DC	EEF204	Electromechanical Energy Conversion - II	4
3	DC	EEF205	Elements of Power System	4
4	DC	ECF205	Electromagnetic & Wave Propagation	4
5	AEC		One course from Ability Enhancement	2
6.	HSS		One course from Humanities and Liberal Arts	3

COURSE STRUCTURE & SYLLABUS OF B. TECH – ELECTRICAL ENGINEERING APPLICABLE FOR BATCH (2022-25)

				Total 21
			Semester 5	**Credit**
S No.	**Basket**	**Course Code**	**Name of Courses**	**C**
1	DC	EEF301	Power System Analysis	4
2	DC	EEF302	Control System	4
3	DE		Discipline Elective	3
4	DE		Discipline Elective	3
5	HSS		One course from Humanities and Liberal Arts	3
6	AEC		One course from Ability Enhancement	2
7	SEC		Skill Enhancement Course (Technical Training 1)	2
8	SEC		Skill Enhancement Course(VAT 1)	2
				Total 23
			Semester 6	**Credit**
S No.	**Basket**	**Course Code**	**Name of Courses**	**C**
1	DC	EEF303	Power Electronics	4
2	DC	EEF304	Switchgear and Protection	4
3	DE		Discipline Elective	3
4	DE		Discipline Elective	3
5	AEC		One course from Ability Enhancement	2
6	SEC		Skill Enhancement Course (Technical Training 2)	2
7	FE		Free Elective	3
				Total 21
			Semester 7	**Credit**
S No.	**Basket**	**Course Code**	**Name of Courses**	**C**
1	DC	EEF401	Electric Drives	4
2	DE		Discipline Elective	3
3	DE		Discipline Elective	3
4	FE		Free Elective	3
5	FE		Free Elective	3
6	SEC		Skill Enhancement Course(VAT 2)	2
				Total 18
			Semester 8	**Credit**
S No.	**Basket**	**Course Code**	**Name of Courses**	**C**
1	PR	UCF439	Project	12
Total 160 Credits				

COURSE STRUCTURE & SYLLABUS OF B. TECH – ELECTRICAL ENGINEERING APPLICABLE FOR BATCH (2022-25)

Course Baskets: University FFCBCS Baskets (other than DC/DE) for B. Tech Programs. A * against a course means it is a core course for all B. Tech students.

Course Code	FFCBCS Baskets (other than DC/DE)				
	Language and Literature (min 6 credits to be taken)	**Credits**			
	Name of Courses	**L**	**T**	**P**	**C**
LAF181	Professional Communication*	2	0	2	3
LAF182	Indian English Literature	3	0	0	3
LAF183	English Language Teaching	3	0	0	3
	Core Sciences (min 10 credits to be taken)				
	Name of Courses	**L**	**T**	**P**	**C**
CHF101	Engineering Chemistry (For CS/IT/EE/ECE)	3	1	2	5
CHF102	Applied Engineering Chemistry (for ME/CE/PE/EC/EE)*	3	1	2	5
PYF101	Wave & Optics and Introduction to Quantum Mechanics	3	1	2	5
PYF102	Introduction to Mechanics	3	1	2	5
PYF103	Electricity & Magnetism	3	1	2	5
PYF105	Engineering Physics* (Since 2022)	3	1	2	5
	Core Mathematics (min 12 credits to be taken)				
	Name of Courses	**L**	**T**	**P**	**C**
MAF101	Engineering Mathematics I *	3	1	0	4
MAF102	Engineering Mathematics II*	3	1	0	4
MAF201	Engineering Mathematics III (EE, ME, CE)	3	1	0	4
MAF202	Probability and Statistics (CSE, IT, ECE, PE)	3	1	0	4
	Engineering Sciences (min 20 credits to be taken)				
	Name of Courses	**L**	**T**	**P**	**C**
ECF101	Fundamental of Electronics Engineering.*	3	0	2	4
EEF101	Basic Electrical Engineering *	3	0	2	4
EEF143	Electrical and Electronics Engineering Practice (non EE/EECE)	3	0	2	4
MEF101	Thermodynamics	3	1	0	4
CSF101	Programming for Problem Solving*	3	0	2	4
CSF102	Data Structures*	3	0	2	4
MEF102	Engineering Graphics	2	0	4	4
MEF103	Engineering Mechanics	2	1	2	4
MEF201	Mechanical Engineering Materials	3	1	0	4
PEF204	Fluid Mechanics	3	0	2	4
EEF141	Electrical Engineering Materials	3	1	0	4

ECF142	Fundamental of Semiconductor Electronics	3	1	0	4
ECF144	Digital Electronics and Applications (non-EE/ECE, 2022-23 onwards)	3	0	2	4
	Skill Enhancement (min 8 credits to be taken)				
	Name of Courses	**L**	**T**	**P**	**C**
EEFXXX	Technical Training 1	0	0	4	2
EEFXXX	Technical Training 2	0	0	4	2
EEFXXX	Value Added Training 1	0	0	4	2
EEFXXX	Value Added Training 2	0	0	4	2
SWAYXXX	MOOCS Courses (as advised by the departments)	2	0	0	0
	Ability Enhancement (min 8 credits to be taken)				
	Name of Courses	**L**	**T**	**P**	**C**
CHF201	Environmental Science*	2	0	0	2
LAF285	Indian Constitution*	2	0	0	2
MEF483	Entrepreneurship and Start-ups*	0	0	4	2
UCF201	Aptitude and Soft Skills*	2	0	0	2
	Humanities and Liberal Arts (min 6 credits to be taken)				
	Name of Courses	**L**	**T**	**P**	**C**
LAF281	Introduction to Psychology	3	0	0	3
LAF381	Positive Psychology & Living	3	0	0	3
LAF481	Application of Psychology	3	0	0	3
LAF282	Human Values	3	0	0	3
LAF283	Literature, Language & Society	3	0	0	3
LAF284	Principles of Management	3	0	0	3
LAF482	Intellectual Property Rights	3	0	0	3
LAF382	Engineering Economics	3	0	0	3
	Free Electives (min 9 credits to be taken)				
	Name of Courses	**L**	**T**	**P**	**C**
ECF481	Analog Electronics (ECE)	2	0	2	3
ECF482	Cellular Communication Network (ECE)	2	0	2	3
ECF381	Microcontroller (ECE)	2	0	2	3
ECF382	Bio Medical Instrumentation (ECE)	2	0	2	3

ECF483	Digital Image processing (ECE)	2	0	2	3
CSF381	Software Project Management	3	0	0	3
CSF345	Introduction to Data Science	3	0	0	3
CSF482	Introduction to Cybersecurity	3	0	0	3
MEF381	Composites materials	3	0	0	3
MEF481	Total Quality Management	3	0	0	3
MEF482	Renewable Energy Sources	3	0	0	3
PEF 381	Carbon Capture and Sequestration	3	0	0	3
PEF 491	Polymer Technology	3	0	0	3
PEF 492	Health, Safety and Environment in Industry	3	0	0	3
CEF281	Properties of Materials	3	0	0	3
CEF382	Disaster Preparedness Planning & Management	3	0	0	3
CEF481	Environmental Management & Sustainability	3	0	0	3
CEF482	Natural Dynamics	3	0	0	3
CEF483	GIS	3	0	0	3
CEF484	Resource Dynamics and Economic Implications	3	0	0	3
	Project (12 credits)				
UCF439	Capstone Project	0	0	24	12

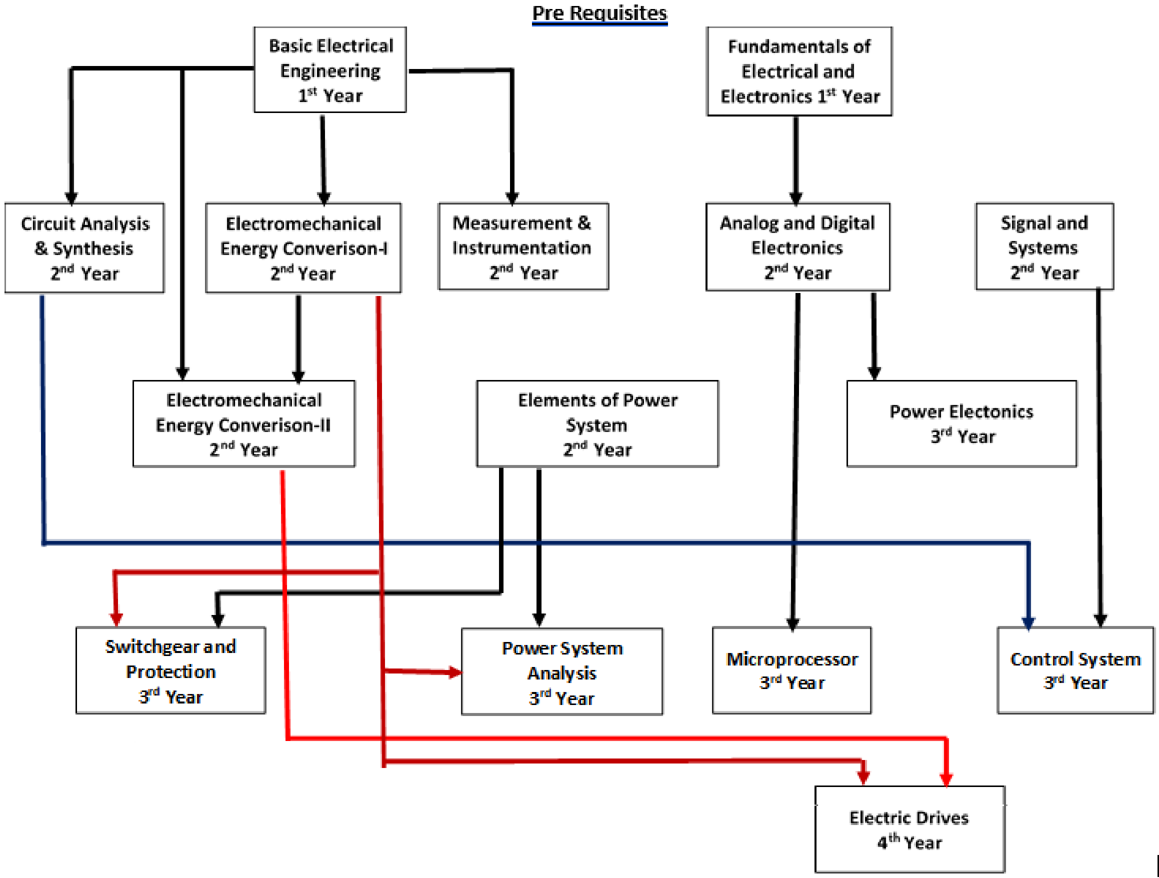
	Discipline Core (48 credits)					
	Name of Courses	**Pre-Requisite**				
ECF205	EM and WP	None	3	1	0	4
ECF209	Analog & Digital Electronics	None	3	0	2	4
EEF201	Circuit Analysis & Synthesis	None	3	0	2	4
EEF202	Electromechanical Energy Conversion - I	None	3	0	2	4
EEF203	Measurements & Instrumentation	None	3	0	2	4
EEF204	Electromechanical Energy Conversion - II	None	3	0	2	4
EEF205	Elements of Power System	None	3	0	2	4
EEF301	Power System Analysis	None	3	0	2	4
EEF302	Control System	None	3	0	2	4
EEF303	Power Electronics	None	3	0	2	4
EEF304	Switchgear and Protection	None	3	0	2	4
EEF401	Electric Drives	PE	3	0	2	4
	Discipline Electives (21 credits)					
	Name of Courses	**Pre-Requisite**				
EEF251	Signal & Systems	None	3	0	0	3
EEF241	IoT Sensors, Device & Components	None	3	0	0	3

ECF348	Biomedical Instrumentation	None	2	0	2	3
EEF341	Solar Thermal System	None	3	0	0	3
EEF342	Electrical Power Generation	None	3	0	0	3
EEF343	MATLAB for Engineers	None	1	0	4	3
EEF344	Wind and Solar Energy Systems	None	2	0	2	3
EEF345	Power Station Practice	None	3	0	0	3
EEF346	Special Electrical Machine	None	3	0	0	3
EEF347	Transducers and Instrumentation	None	2	0	2	3
EEF348	Industrial Electrical Systems	None	3	0	0	3
EEF357	Microprocessor	ADE	2	0	2	3
EEF358	Fundamentals of Electric and Hybrid Vehicles	None	3	0	0	3
EEF359	Power Electronics for EV	None	2	0	2	3
EEF349	Digital Control System	None	3	0	0	3
EEF367	Dynamic System Analysis	None	3	0	0	3
EEF351	Energy Management System	None	3	0	0	3
EEF352	Reliability Engineering	None	3	0	0	3
EEF353	Introduction to Artificial Intelligence	None	3	0	0	3
EEF354	Telemetry & Data Transmission	None	2	0	2	3
EEF355	New and Renewable Energy Sources	None	3	0	0	3
EEF356	Utilization of Electrical Energy & Traction	None	3	0	0	3
EEF368	Switching Power Supplies for EV	None	2	0	2	3
EEF361	Battery Management Systems	None	2	0	2	3
EEF362	EV Battery Charging System	None	2	0	2	3
EEF402	Electrical Machine Design	EMEC-I, EMEC-II	2	0	2	3
EEF441	Computer Methods in Power System Analysis	PSA	2	0	2	3
EEF442	Digital Simulation of Power System	PSA	3	0	0	3
EEF443	EHV A.C. & D.C. Transmission	None	3	0	0	3
EEF444	Electrical Energy Conservation and Auditing	None	3	0	0	3
EEF445	High Voltage Engineering	None	3	0	0	3
EEF446	Power System Deregulation	None	3	0	0	3
EEF447	Power System Operation & Control	None	3	0	0	3
EEF448	Power Quality	None	3	0	0	3
EEF449	Power Semiconductor Controllers	PE	3	0	0	3
EEF464	Digital Instrumentation Techniques	M&I, Transducers	3	0	0	3

EEF451	Instrumentation for Solar Energy System	M&I, Transducers	3	0	0	3
EEF452	Power System Stability	None	3	0	0	3
EEF453	Wind & Small Hydro Plant (SHP)Energy System	None	3	0	0	3
EEF455	Optimization Techniques	None	2	0	2	3
EEF456	Modern Control System	Control System	2	0	2	3
EEF457	ANN & Fuzzy Logic	None	2	0	2	3
EEF458	Solar PV System	None	3	0	0	3
EEF459	Basic Instrumentation & Process Control	None	3	0	0	3
EEF465	Automotive Electronics	None	3	0	0	3
EEF461	Computer Aided Modelling & Analysis of Electrical Machines	None	1	0	4	3
EEF462	Artificial Intelligence application in EV	None	3	0	0	3
EEF463	Smart Grid Interface of EV	None	3	0	0	3

SUBJECTS RELATED TO ELECTRICAL VEHICLE TECHNOLOGIES

	Discipline Electives					
	Name of Courses	**Pre-Requisite**				
EEF358	Fundamentals of Electric and Hybrid Vehicles	None	3	0	0	3
EEF359	Power Electronics for EV	None	2	0	2	3
EEF368	Switching Power Supplies for EV	None	2	0	2	3
EEF361	Battery Management Systems	None	2	0	2	3
EEF362	EV Battery Charging System	None	3	0	2	3
EEF465	Automotive Electronics	None	3	0	0	3
EEF461	Computer Aided Modeling & Analysis of Electrical Machines	None	1	0	4	3
EEF462	Artificial Intelligence application in EV	None	3	0	0	3
MEF202	Theory of machines	None	3	0	0	3
MEF345	Vehicle Body Engineering	None	3	0	0	3


Pre Requisites
Basic Electrical Engineering 1st Year
Fundamentals of Electrical and Electronics 1st Year
Circuit Analysis & Synthesis 2nd Year
Electromechanical Energy Converison-I 2nd Year
Measurement & Instrumentation 2nd Year
Analog and Digital Electronics 2nd Year
Signal and Systems 2nd Year
Electromechanical Energy Converison-II 2nd Year
Elements of Power System 2nd Year
Power Electonics 3rd Year
Switchgear and Protection 3rd Year
Power System Analysis 3rd Year
Microprocessor 3rd Year
Control System 3rd Year
Electric Drives 4th Year

PLAN OF ACTIONS FOR IMPLEMENTING FFCBCS EVERY SEMESTER

After release of Final Exam results, FFCBCS council meets to decide & finalize course offerings in each basket

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Courses are created in ERP and in LMS with required number of seats

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Registrar announces the date for Registration

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Students get advised and registers for courses in the Student Advising Centre

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List of students gets added in LMS

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Class Starts

COURSE STRUCTURE & SYLLABUS OF B. TECH – ELECTRICAL ENGINEERING APPLICABLE FOR BATCH (2022-25)

Department Offering the Course	**EECE**
Course Code	EEF101
Course Title	Basic Electrical Engineering
Credits (L:T:P:C)	3:0:1:4
Contact Hours (L:T:P)	3:0:2
Prerequisites (if any)	None
Course Basket	Engineering Science

Course Summary

To provide comprehensive idea about AC and D C circuit analysis, working principles and applications of basic machines in electrical engineering.

Course Objectives

To provide working knowledge for analysis of basic DC & AC circuits used in electrical & electronic devices.

To impart a basic knowledge of electrical quantities such as current, voltage, phasor diagram, power factor, power, energy and frequency.

To provide basic idea of power system, single phase and three phase systems.

To give an introductory idea about 1-phase transformers.

To explain working principle, construction, applications of DC and AC machines.

Course Outcomes

To understand and analyses AC & DC circuits.

To understand the behavior of circuit elements for single-phase circuits.

To understand the generation of three-phase power and operation of three-phase circuits.

To understand the construction and operation of transformers, DC generators and motors, induction motors, and synchronous generators.

Curriculum Content

Unit 1: D.C. Network Theory

Review of basic circuit theory concepts, Mesh and Nodal analysis, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Star – delta transformation, Magnetic Circuits.

Unit 2: A.C. Circuits

Single Phase A.C.: Phasor representation of voltage and current, A.C. circuit behavior of resistance, inductance, capacitance & their combination in series and parallel, Power triangle, Power factor, Concept of series & parallel resonance.

Three Phase A.C.: Star – delta connections, Relation between line and phase quantities, three phase power and its measurement, what is 3 phase 4 wire and 3 phase 3 wire system.

Unit 3: Power System & Transformers

Single line diagram of simple power system.

Single phase Transformer: Principle of operation, Types of construction, Phasor diagram, Equivalent circuit, Efficiency and voltage regulation, O.C. and S.C. tests.

Unit 4: D.C. & Synchronous Machines

D.C. Machines: Construction and working principle of d.c. generator and d.c. motor, Types of d.c. machines, E.M.F. equation, Torque equation, characteristics, Losses and efficiency, Need of starter in d.c. motors.

Synchronous Machines: Construction and Principle of operation of Alternator and Synchronous Motor.

Unit- 5: Induction Motors

Three Phase Induction Motors: Principle of operation of 3-Ø induction motor, Types of 3-Ø induction motor, Need of starters in 3-Ø induction motors, Slip – torque characteristics

Single Phase Induction Motor: Principle of operation of single phase induction motor by double revolving field theory, Methods of starting of single phase induction motor.

TEXTBOOK(S)

V. Del Toro. “Principles of electrical Engineering”, Prentice hall International.

J. Nagrath, “Basic Electrical Engineering”, Tata Mc Graw Hill.

REFERENCE BOOKS

W.H. Hayt & J.E. Kemmerly, “Engineering circuit Analysis”, Mc Graw Hill.

H. Cotton, “Advanced Electrical Technology” Wheeler Publishing.

List of Experiments

1. Verification of Network Theorems.
2. Study of diode characteristics. Study of phenomenon of resonance in RLC series circuit.
3. Measurement of power in a three phase circuit by two wattmeter method.
4. Measurement of efficiency of a single phase transformer by load test.
5. Determination of parameters and losses in a single phase transformer by OC and SC test.
6. Study of characteristic of DC Motor.
7. Study of characteristic of AC Motor.
8. DC generator characteristics.
9. Speed control of dc shunt motor.
10. Study running and reversing of a three phase induction motor.
11. Study of a single phase energy meter.

Department Offering the Course	**EECE**
Course Code	ECF101
Course Title	Fundamental of Electronics Engineering
Credits (L:T:P:C)	3:0:1:4
Contact Hours (L:T:P)	3:0:2
Prerequisites (if any)	None
Course Basket	Engineering Science

Course Summary

This course is designed to serve as a first course in an undergraduate Electrical and Electronics & Communication Engineering (EECE) curriculum. The course introduces the fundamentals of electronics engineering. Topics covered include: Semiconductor theory; devices based on semiconductor materials like diodes, transistors; BJT and FET; Op-amp as linear integrated circuit with various applications. Design and lab exercises are also significant components of the course.

Course Objectives

After successfully studying this course, students will be able to understand the basic electronics engineering principles and abstractions on which the design of electronic systems is based. These include diodes and transistors models and operational amplifiers.

Student will be able to use these engineering abstractions to analyze and design simple electronic circuits.

Student will be able to formulate and solve the problems of electronic circuits and analyze their behaviour.

Course Outcomes

On successful completion of the course, students will be able to achieve the following:

Analyse circuits made up of linear and nonlinear elements. Specifically, analyse circuits containing resistors diodes and transistors such as rectifiers, clampers and clippers.

Determine the output produced by a circuit for a given set of inputs using diode,op-amp and transistors

Analyse the difference between bipolar and unipolar semiconductor devices and distinguish the designing difference and their parameters.

Study the regulators and their operations in various applications.

Curriculum Content

Unit 1: Semiconductor Diodes:

Semiconductor materials- intrinsic and extrinsic types, Ideal Diode, Terminal characteristics of diodes, p-n junction under open circuit condition, p-n junction under forward bias and reverse bias conditions, p-n junction in breakdown region, Diode small signal model, Zener diode and applications, Rectifier Circuits, Clipping and Clamping circuits

Unit 2: Bipolar Junction Transistors (BJTs):

Physical structure and operation modes, Active region operation of transistor, D.C. analysis of transistor circuits, Transistor as an amplifier, Biasing the BJT: fixed bias, emitter feedback bias, collector feedback bias and voltage divider bias, Basic BJT amplifier configuration: common emitter, common base and common collector amplifiers, Transistor as a switch: cut-off and saturation modes, High frequency model of BJT amplifier: Hybrid Models.

Unit 3: Field Effect Transistor (FET):
Junction Field-Effect Transistor (JFET). current-voltage characteristics
Enhancement-type MOSFET: structure and physical operation, current-voltage characteristics, Depletion-type MOSFET, D.C. operation of MOSFET circuits, Transfer characteristics, Shockley equation.

Unit 4: Operation Amplifier (Op-amps):
Ideal Op-amp, Differential amplifier: differential and common mode operation, common mode rejection ratio (CMRR), Practical op-amp circuits: inverting amplifier, non -inverting amplifier, weighted, summer, integrator, differentiator, other applications of op-amps: instrumentation Amplifier, Controlled Sources using Op-amp.

Unit- 5: Power Circuits and Systems:
Class A large signal amplifiers, second-harmonic distortion, Transformer coupled audio power amplifier, Class B amplifier, Class AB operation, Regulated power supplies, Series voltage regulator.

TEXTBOOK(S)

1. Millman J., Halkias C.C., Jit S., “Electronic Devices and Circuits”, Tata McGraw-Hill, 2nd 2007.
2. Boylstead R.L., Nashelsky L., “Electronic Devices and Circuit Theory”, Pearson, 10th 2009 Edition.

REFERENCE BOOKS

1. S. Shalivahanan, Electronics Devices & Circuits, Vikas Publication, 2nd Edition.2018
2. Ramakant A. Gayakwad, Op-Amp and Linear Integrated Circuits, Pearson Publications, 6th Edition.

List of Experiments

1. To identify and Study of the various component and Devices of electronics with their specification (CRO, Function Generator, Multimeter, Power Supply, resistor, capacitor, inductor, ICs, LED, potentiometer etc.)
2. To study the V-I characteristics of PN diode
3. To study the V-I characteristics Zener diode.
4. To find the efficiency of rectifiers and ripple factor of capacitive and non-capacitive half wave and full wave rectifier.
5. To Study and verify clipper and clamper with biased circuits.
6. To find the characteristics of CB and CE amplifiers.
7. Determine the characteristics of FET.
8. Verifications of all logics gates.

COURSE STRUCTURE & SYLLABUS OF B. TECH – ELECTRICAL ENGINEERING APPLICABLE FOR BATCH (2022-25)

Department Offering the Course	**EECE**
Course Code	EEF143
Course Title	Electrical And Electronics Engineering Practice(For Non EE/ECE)
Credits (L:T:P:C)	3:0:1:4
Contact Hours (L:T:P)	3:0:2
Prerequisites (if any)	None
Course Basket	Engineering Sciences

Course Summary

The course introduces the fundamentals of electronics and electrical engineering. In this syllabus the fundamentals of Circuits, semiconductors, Electronics devices and electrical machines would be studied by the students. The fundamental concepts of digital logic have been also included.

Course Objectives

To acknowledge students about charge, current, voltage and various circuit laws involved in analysis.

To provide students with the basic knowledge of operation and working different types of electrical machines and their application

To get acquaints student with fundamental knowledge of semiconductor devices their characteristics and modelling in different applications.

To provide students with the basic knowledge of digital logic.

Course Outcomes

On successful completion of the course, students will be able to achieve the following:

1. Fundamental knowledge about charge, current, voltage and various basic electric circuit laws.
2. DC circuit analysis and methods.
3. Basics of AC circuits elements and various methods involved.
4. Functioning of DC machines and its characteristics.
5. Fundamental theory of semiconductor devices, fermi level and concept of doping.
6. Basics of different types of transistor configuration, modelling and their application.
7. Basics of logics circuits.

Curriculum Content

UNIT 1 – DC Network Theorem

Review of basic circuit theory concepts, Mesh and Nodal analysis, Superposition theorem, Thevenin’s theorem, Norton’s theorem, Maximum power transfer theorem, Star – Delta transformation

UNIT 2 – AC Circuit’s and Fundamentals of Semiconductors

Single Phase AC: Phasor representation of voltage and current, AC circuit behaviour of Resistive, Inductive and Capacitive Load and their combination in series, Power triangle, Power factor. Introduction to three phase AC.

Fundamentals of semiconductors: Energy bands in semiconductors, Intrinsic and extrinsic semiconductors, Fermi level.

UNIT 3: Diode and Transistor Fundamental:
Diode circuits: Construction, Junction diode characteristics, Half and full wave rectifiers - Expression for efficiency, Zener Diode Characteristics and its application as voltage regulator.
Transistor circuits: Construction and characteristics of a transistor in CB, CE and CC modes - Relative merits. Construction and characteristics of JFET and MOSFET.

UNIT IV: Digital Logic:
Binary and Decimal Number systems, Boolean algebra, Basic Logic gates, Universal Logic gates and K-map up to 4 variables only.

UNIT V – Electrical Machines
Transformers: Principle of Operation and emf equation
DC Machines: Construction, working principle & characteristics
Induction & synchronous Machines: Principle of operation of 3 φ and 1 φ Induction Motor and synchronous machine.

TEXTBOOK(S)
1. Vincent Del Toro, "Principles of Electrical Engineering", Prentice Hall Publication.
2. Electronics Devices and Circuits, Millman and Halkias, Tata McGraw Hill, 4th ed.

REFERENCE BOOKS
1. I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill Publication.
2. Electronic Communication Systems, John Kennedy , Tata McGraw Hill, 4th ed.

List of Experiments
Verification of Network Theorems.
Measurement of efficiency of a single phase transformer by load test.
Determination of parameters and losses in a single phase transformer by OC and SC test.
Perform the polarity test on Transformer.
Study of characteristic of AC Motor.
Study of DC shunt and series generator characteristics.
Study the Speed control of dc shunt motor.
Study running and reversing of a three phase induction motor.
To identify and Study of the various component and Devices of electronics with their specification (CRO, Function Generator, Multimeter, Power Supply, resistor, capacitor, inductor, ICs, LED, potentiometer etc.)
To study the V-I characteristics of PN diode and Zener diode.
To find the efficiency of rectifiers and ripple factor of capacitive and non-capacitive half wave and full wave rectifier.
To Study and verify clipper and clamper with biased circuits.
To find the characteristics of CB and CE amplifiers.
Determine the characteristics of FET.
Verifications of all logics gates.

COURSE STRUCTURE & SYLLABUS OF B. TECH – ELECTRICAL ENGINEERING APPLICABLE FOR BATCH (2022-25)

Department Offering the Course	**EECE**
Course Code	EEF141
Course Title	Electrical Engineering Materials
Credits (L:T:P:C)	3:1:0:4
Contact Hours (L:T:P)	3:1:0
Prerequisites (if any)	None
Course Basket	Engineering Sciences

Course Summary

This course provides knowledge regarding the structure of different types of materials, to understand the factors affecting thermal and electrical conductivity of materials. To have understanding about different types of materials used in engineering and their applications.

Course Objectives

- In this course student will learn the Crystal structure of materials
- The student will learn about electron theory of materials
- The student will learn about thermal conductivity and study the material properties according to use in electrical equipment

Course Outcomes

- To have knowledge about the types of engineering materials.
- Various phenomena associated with different types of materials.
- Applications of these materials in different fields.

Curriculum Content

Unit 1 Crystal Structure of Materials: Bonds in solids, crystal structure, co-ordination number, atomic radius representation of plane distance b/w two planed packing factor, Miller Indices, Bragg's law and x-ray diffraction, structural Imperfections, crystal growth

Unit 2 Electrical Engineering Material: Electron theory of metals, factors affecting electrical resistance of materials, thermal conductivity of metals, heat developed in current carrying conductors, Half effect, Drift and Diffusion currents, continuity equation, thermoelectric effect, superconductivity and super conducting materials, optical properties of solids.

Unit 3 Magnetic Material: Origin of permanent magnetic dipoles in matters, Classification Diamagnetism, Paramagnetism, Ferromagnetism, Antiferromagnetism and Ferrimagnetism, magnetostriction, Properties of magnetic materials, soft and hard magnetic materials, permanent magnetic materials.

Unit 4 Dielectric Materials: Polarization and Dielectric constant, Dielectric constant of mono-atomic, Poly atomic gases and solids, frequency dependence of electronic and ionic polarizabilities, dipolar relaxation, dielectric loss, piezoelectricity, ferroelectric materials

Unit 5 Semiconductor Material and Devices: Properties of semiconductors, Conductivity of insulators, Metals and semiconductor in terms of energy bands, Intrinsic and Extrinsic semiconductors, Concentration of charge carriers, Hall effect, Drift and Diffusion current, semiconductor junction diode, Integrated circuits, semiconducting materials.

TEXTBOOK(S)

1. A.J. Dekker, "Electrical Engineering Materials", Prentice Hall of India
2. R. K. Rajput, "Electrical Engineering Materials", Laxmi Publications

REFERENCE BOOKS

1. Solymar, "Electrical Properties of Materials" Oxford University Press.
2. Ian P. Hones, "Material Science for Electrical & Electronic Engineering," Oxford University Press.
3. J. B. Gupta, "Electrical and Electronics Engineering Materials" Katson publishers

COURSE STRUCTURE & SYLLABUS OF B. TECH – ELECTRICAL ENGINEERING APPLICABLE FOR BATCH (2022-25)

Department Offering the Course	**EECE**
Course Code	ECF142
Course Title	Fundamental of Semiconductor Electronics
Credits (L:T:P:C)	3:1:0:4
Contact Hours (L:T:P)	3:1:0
Prerequisites (if any)	None
Course Basket	Engineering Science

Course Summary

Semiconductor Physics deals with concepts which are responsible for the majority of modern technology. These properties determine the material mechanical strength. Semiconductor Physics gives guidance to the principles of the circuits needed for modern electronic devices. It gives both the Transistor & the Semiconductor Chip.

Course Objectives

To provide an insight into the basic semiconductor concepts

To provide a sound understanding of current semiconductor devices and technology to appreciate its applications to electronics circuits and systems

Course Outcomes

On successful completion of the course, students will be having a good knowledge in semiconductor theory and electronic devices.

Curriculum Content

Unit 1: Elemental and compound semiconductors: Fermi-Dirac distribution, Fermi levels for Intrinsic and Extrinsic semiconductors, Dependence of fermi level on temperature, Equilibrium and steady state conditions, Equilibrium concentration of electrons and holes, Temperature dependence of carrier concentration.

Unit 2: Carrier transport in semiconductors: drift, conductivity and mobility, variation of mobility with temperature and doping, Excess carriers in semiconductors: Generation and recombination, mechanisms of excess carriers, diffusion,

Einstein relations, Continuity equations, Diffusion length

Unit 3: PN junctions: Contact potential, Electrical Field, Potential and Charge density at the junction, Energy band diagram, Minority carrier distribution, Ideal diode equation, Electron and hole component of current in forward biased p-n junction, piecewise linear model of a diode effect of temperature on V-I characteristics

Unit 4: Diode capacitances: switching transients, Electrical Breakdown in PN junctions, Zener and avalanche break down (abrupt PN junctions only), Tunnel Diode basics only, Metal Semiconductor contacts, Ohmic and Rectifying Contacts, current voltage characteristics

Unit- 5: BJT and MOSFET: current components, Minority carrier, distributions, basic parameters, Evaluation of terminal currents (based on physical dimensions),Transistor action, Base width modulation, Metal Insulator semiconductor devices: The ideal MOS capacitor, band diagrams at equilibrium, accumulation, depletion and inversion, surface potential, CV characteristics, threshold voltage MOSFET: Output characteristics, transfer characteristics, sub threshold characteristics, MOSFET scaling (basic concepts)

TEXTBOOK(S)

1. Ben G. Streetman and Sanjay Kumar Banerjee, Solid State Electronic Devices, Pearson, 6/e, 2010
2. Achuthan, K N Bhat, Fundamentals of Semiconductor Devices, 1e, McGraw Hill,2015

REFERENCE BOOKS

1. Tyagi M.S., Introduction to Semiconductor Materials and Devices, Wiley India, 5/e, 2008
2. Sze S.M., Physics of Semiconductor Devices, John Wiley, 3/e, 2005
3. Neamen, Semiconductor Physics and Devices, McGraw Hill, 4/e, 2012
4. Pierret, Semiconductor Devices Fundamentals, Pearson, 2006
5. Rita John, Solid State Devices, McGraw-Hill, 2014
6. Bhattacharya. Sharma, Solid State Electronic Devices, Oxford University Press, 2012
7. Dasgupta and Dasgupta , Semiconductor Devices : Modelling and Technology (PHI)

Department Offering the Course	**EECE**
Course Code	EEF201
Course Title	Circuit Analysis and Synthesis
Credits (L:T:P:C)	3:0:1:4
Contact Hours (L:T:P)	3:0:2
Prerequisites (if any)	None
Course Basket	Discipline Core

Course Summary

This course provides basic understanding of the different types of signals used with their mathematical representation, the application of tools like graph theory for analyzing electrical circuits, study about h parameters, ABCD parameters and other parameters for two port networks

Course Objectives

- To provide basic understanding of the different types of continuous time signals and systems and their mathematical representation.
- To provide knowledge of graph theory applicable for analysis of electrical circuits.
- The students will understand of different two port network parameters.

Course Outcomes

- An ability to design and analyze electrical circuits.
- An ability to control AC and DC circuits by using Basic Electrical devices.
- An ability to visualize and work on laboratory and multi-disciplinary tasks.

Curriculum Content

Unit I-Introduction to Continuous Time Signals and Systems:

Basic continuous time signals, unit step, unit ramp, unit impulse and periodic signals with their mathematical representation and characteristics. Waveform synthesis. Introduction to various types of systems, Causal and Non-causal, Stable and Unstable, Linear and Non-linear, Time invariant and Time varying systems.

Analogous System: Mechanical elements for translational and rotational systems, force-voltage and force- current analogy, torque-voltage and torque-current analogy.

Unit II-Graph Theory:

Graph of a Network, definitions, tree, co tree, link, basic loop and basic cut set, Incidence matrix, cut set matrix, Tie set matrix, Duality, Loop and Node methods of analysis.

Unit III-Network Theorems (Applications to Ac Networks) And Network Functions:

Review of KVL, KCL, Nodal & Mesh Analysis and network Theorems for DC, Super-position theorem, Thevenin’s theorem, Norton’s theorem, Maximum power transfer theorem. Network Functions: Concept of complex frequency, Transform impedances network functions of one port and two port networks, Concept of poles and zeros, Properties of driving point and transfer functions.

Unit IV-Two Port Networks:

Characterization of LTI two port networks; Z, Y, ABCD, A'B'C'D', g and h parameters, Reciprocity and symmetry, Inter-relationships between the parameters, Inter- connections of two port networks, Ladder and Lattice networks: T & Π representation.

Unit V-Network Synthesis:

Positive real function; definition and properties; properties of LC, RC and RL driving point functions, synthesis of LC, RC and RL driving point immittance functions using Foster and Cauer first and second forms.

TEXTBOOK(S)

1. William Hayt, Jack Kemmerly, Steven Durbin, "Engineering Circuit Analysis", Tata McGraw Hill, 8th Edition
2. Choudhary D. Roy, "Network & Systems", Wiley Eastern Ltd.

REFERENCE BOOKS

1. Kuo, "Network Analysis & Synthesis", Wiley India.
2. Jagan, "Network Analysis", B S Publication.
3. ME Van-Valkenberg; "Network Analysis", Prentice Hall of India

List of Experiments:

1. Verification of principle of superposition with dc and ac sources.
2. Verification of Thevenin's theorem with dc and ac sources.
3. Verification of Norton's theorem with dc and ac sources.
4. Verification of Maximum power transfer theorems in ac circuits.
5. Verification of cascade connection of 2, two -port networks.
6. To find Z and Y parameters of two-port network.
7. Time domain analysis of parallel RLC circuit using MULTI-SIM software.
8. To find current through and voltage across different elements of a given network using MULTI-SIM software.
9. Determination of transient response of current in RL circuit with step voltage input using MULTI-SIM software.
10. Determination of transient response of current in RC circuit with step voltage input using MULTI-SIM software.

List of two value added Experiments

1. Verification of superposition theorem using MULTI-SIM software.
2. Verification of reciprocity theorem using MULTI-SIM software.

Department Offering the Course	**EECE**
Course Code	EEF202
Course Title	Electromechanical Energy Conversion - I
Credits (L:T:P:C)	3:0:1:4
Contact Hours (L:T:P)	3:0:2
Prerequisites (if any)	None
Course Basket	Discipline Core

Course Summary

The course provides the basic understanding of electrical to mechanical energy conversion. The working of transformer, d.c. generators and d.c. motors, types of d.c. motors The course provided knowledge regarding the types of 3 phase transformers and phenomenon of harmonics in them

Course Objectives

- To empower students to understand the basics of electro mechanical energy conversion & transformer
- To empower students to understand the basics of d.c. machines
- To empower students to understand the basics of 3 phase transformers

Course Outcomes

- To familiarize students about dc machines, transformer, current, voltage and various circuit laws involved in analysis.
- To provide students with the basic knowledge of operation and working of DC machines & transformer and their application
- Acquire knowledge of various performance test on DC machines and Transformers.

Curriculum Content

Unit 1 Principles of Electro-Mechanical Energy Conversion

Introduction, Flow of Energy in Electromechanical Devices, Energy in magnetic systems (defining energy & Co- energy), Singly Excited Systems; determination of mechanical force, mechanical energy, torque equation, doubly excited Systems; Energy stored in magnetic field, electromagnetic torque, Generated emf in machines; torque in machines with cylindrical air gap.

Unit 2 D.C. Machines

Construction of DC Machines, Armature winding, Emf and torque equation Armature Reaction, Commutation, Interpoles and Compensating Windings, Performance Characteristics of D.C. generators.

Unit 3 D.C. Machines (Contd.)

Performance Characteristics of D.C. motors, Starting of D.C. motors; 3- point and 4-point starters, Speed control of D.C. motors: Field Control, armature control and Voltage Control (Ward Leonard method); Efficiency and Testing of D.C. machines (Hopkinson’s and Swinburne’s Test).

Unit 4 Single Phase Transformer

Phasor diagram, efficiency and voltage regulation, all day efficiency, Testing of Transformers: O.C. and S.C. tests, Sumpner's test, polarity test. Auto Transformer: Single phase and three phase auto transformers, volt-amp relationship, efficiency, merits & demerits and applications.

Unit 5 Three Phase Transformers

Construction, three phase transformer phasor groups and their connections, open delta connection, three phase to 2 phase (Scott connection), 6 phase or 12 phase connections, and their applications, parallel operation and load sharing of single phase and three phase transformers, excitation phenomenon and harmonics in transformers.

TEXTBOOK(S)

1. P. S. Bhimbra, "Electrical Machinery", Khanna publication.
2. I. J. Nagrath & D. P. Kothari, "Electrical Machines". Tata McGraw Hill

Reference Books

1. Charles Gross, Electric Machines, T & F, Delhi

List of Experiments

1. To obtain magnetization characteristics of a d.c. shunt generator.
2. To obtain external characteristics of a d.c. shunt generator and compound generator.
3. To obtain efficiency of a dc shunt machine using Swinburne's test.
4. To perform Hopkinson's test and determine losses and efficiency of DC machine.
5. To obtain speed-torque characteristics of a dc shunt motor.
6. To obtain speed control of dc shunt motor using (a) armature resistance control (b) field control.
7. To obtain speed control of dc separately excited motor using Conventional Ward-Leonard.
8. To study polarity and ratio test of single phase and 3-phase transformers.
9. To obtain equivalent circuit, efficiency and voltage regulation of a single phase transformer using O.C. and S.C. tests.

Value Added Experiments

- To obtain efficiency and voltage regulation of a single phase transformer by Sumpner's test.
- To obtain 3-phase to 2-phase conversion by Scott connection.
- To determine excitation phenomenon (B.H. loop) of single phase transformer using C.R.O.

Department Offering the Course	EECE
Course Code	ECF205
Course Title	Electromagnetic and Wave Propagation
Credits (L:T:P:C)	3:1:0:4
Contact Hours (L:T:P)	3:1:0
Prerequisites (if any)	None
Course Basket	Discipline Core

Course Summary

The course provides the basic understanding of electric and magnetic fields, the flow of power in the lines in the form of waves and the phenomenon associated with them

Course Objectives

- To understand the concept of electromagnetic field
- To understand the electromagnetic wave and their propagation
- To understand the transmission lines and wave guides.

Course Outcomes

- The students will understand the nature of electric field and magnetic field.
- The students will be able to analyse and solve the problems involving the electromagnetic waves.

Curriculum Content

Unit 1 Coordinate Systems and Transformation: Cartesian Coordinates, Circular Cylindrical Coordinates, Spherical Coordinates Vector Calculus: Differential Length, Area and Volume, Line Surface and Volume Integrals, Del Operator, Gradient of a Scalar, Divergence of a Vector and Divergence Theorem, Curl of a Vector and Stoke's Theorem, Laplacian of a Scalar.

Unit 2 Electromagnetic Wave Propagation: Faraday's Law, Electromotive Forces, Displacement Current, Derivation of Maxwell's Equations for Static and Time-Varying Fields, Differential and integral forms, concept of displacement current, Boundary conditions.

Unit 3 ELECTROMAGNETIC WAVE PROPAGATION APPLICATIONS: Electromagnetic Wave Propagation: Wave Propagation in Lossy Dielectrics, Plane Waves in Lossless Dielectrics, Plane Wave in Free Space, Plane Waves in Good Conductors, Power and The Poynting Vector, Reflection of a Plane Wave at Normal incidence.

Unit 4 Transmission Lines: Transmission Line Parameters, Transmission Line Equations, Input Impedance, Standing Wave Ratio and Power, Smith Chart, Some Applications of Transmission Lines, Low loss RF and UHF transmission lines, Distortion less condition. Transmission line charts-impedance matching

Unit 5 WAVEGUIDES: Introduction to Planar (Rectangular) Waveguides, Derivation of TE and TM Modes, TEM Mode, Impedance and characteristics impedances. Transmission line analogy for wave guides, Attenuation and factor of wave guides, Resonators.

TEXTBOOK(S)

1. M N O Sadiku, 'Elements of Electromagnetics'.
2. William Hayt, 'Engineering Electromagnetics', McGraw-Hill

REFERENCE BOOKS

1. John Kennedy, 'Electronic Communication Systems', Tata McGraw Hill, 4th edition.
2. K. D. Parsad, 'Electromagnetic Fields'.

Department Offering the Course	EECE
Course Code	ECF209
Course Title	Analog & Digital Electronics
Credits (L:T:P:C)	3:0:1:4
Contact Hours (L:T:P)	3:0:2
Prerequisites (if any)	None
Course Basket	Discipline Core

Course Summary

The course covers fundamentals of semiconductors like energy bands Fermi level, types of diodes and their characteristics. The construction and characteristics of various types of transistors like BJT, FET. The course provides basics of oscillators circuits, and fundamentals of digital circuits.

Course Objectives

- To Teach the basic concept of various Analog and Digital electronic devices, circuits and their application
- To develop ability among students for problem formulation, system design and solving skills
- To have basic knowledge of amplifiers and oscillators

Course Outcomes

- Students will be able to build analog and digital electronics circuits
- Students should be able to design and analyze amplifiers
- Students should be able to develop model and analyze oscillators

Curriculum Content

Unit 1 FUNDAMENTALS OF SEMICONDUCTORS AND DIODES: Review of energy bands in solids, Intrinsic and Extrinsic semiconductors, Fermi Level, Transport phenomenon in semiconductors: diffusion current, drift current, mobility, conductivity. The Hall Effect. Generation and recombination of carriers. Special Diodes- their characteristics and applications.

Unit 2 BJTs AND FETs: Construction and characteristics of transistor, Transistor biasing and stability factor analysis. Transistor application as an amplifier and as a switch. Types, construction and characteristics of JFET, Biasing of JFET. Construction and characteristics of Depletion and Enhancement types of MOSFET.

Unit 3 FEEDBACK AMPLIFIERS AND OSCILLATORS CIRCUITS: Introduction to positive and negative feedback: Negative feedback -current, voltage, Series and Shunt type. It's effect on input impedance, output impedance, voltage gain, current gain and bandwidth. Oscillators circuits: Frequency of oscillation and condition for sustained oscillations. Types of oscillator circuits-RC-phase shift, Wein-Bridge, Hartley, Clapp, Colpitt and Crystal Oscillators.

Unit 4 FUNDAMENTALS OF DIGITAL SYSTEMS: Combinational Logic Circuits: Review of logic gates and Boolean Algebra, Adder, Subtract or. Introduction to Multiplexers and DE multiplexers & Encoders and Decoders**.** Sequential Logic Circuits: Introduction to latches, Flip-flops, Registers and Counters.

Unit 5 OPERATIONAL AMPLIFIERS:
Introduction to Operational Amplifiers, Characteristics of an ideal op-amp, Inverting and Non-inverting amplifier, Application of op-amp as summer, differential amplifier, Integrator and Differentiator.

TEXTBOOK(S)

1. Boylstead and Neshelsky," Electronic Devices and Circuits", PHI
2. Jacob Millman & Christos C. Halkias," Integrated Electronics" Tata McGraw Hill, 1991.
3. Malvino & Leach, "Digital Principles and applications" Tata Mc. Graw Hill
4. R.A. Gayakwad "Op amps and Linear Integrated Circuits" Prentice Hall of India.

REFERENCE BOOKS

1. Taub & Schilling "Digital Electronics"- Tata Mc Graw Hill
2. Anil K. Maini, "Digital Electronics: Principles and Integrated circuits" Wiley India Ltd, 2008.
3. Millman, J. and Grabel A, "Microelectronics" Mc Graw Hill
4. S Salivahanan, N Suresh Kumar," Electronic Devices and Circuits", 3rd edition, McGraw Hill Publication

List of Experiments

1. To identify and Study of the various component and Devices of electronics with their specification (CRO, Function Generator, Multimeter, Power Supply, resistor, capacitor, inductor, ICs, LED, potentiometer etc.)
2. To study the V-I characteristics of PN diode and Zener Diode
3. To find the efficiency of rectifiers and ripple factor of capacitive and non-capacitive half wave and full wave rectifier.
4. To find the characteristics of CE Transistors.
5. To Study and verify oscillator circuits.
6. Implementation of All Logic Gates using Universal gates (NAND & NOR both).
7. To study operation of Adder / Subtractor
8. To study application of Operational Amplifier as summer integrator and voltage comparator

Value added experiments:

1. To study operation IC 555 based astable and monostable multibrators.
2. To study operation of (a) multiplexer using IC 74150 (b) demultiplexer using IC 74138.

Course Code	**EEF203**
Course Title	Measurements & Instrumentation
Credits (L:T:P:C)	3:0:1:4
Contact Hours (L:T:P)	3:0:2
Prerequisites (if any)	None
Course Basket	Discipline Core

Course Summary

The course provides knowledge regarding the different types of instruments used for measuring various electrical quantities like current, voltage, frequency, power factor etc. The course provides understanding of the construction and the working mechanism of these instruments. It also provides knowledge about the different types of bridges used for measuring parameters like inductance, capacitance and resistance.

Course Objectives

- To acquire knowledge regarding the use, measure and analyse the instruments.
- To be able to calculate all the parameters related to measurements.
- To develop an understanding about different instruments that are used for measurement purpose.
- To have knowledge about digital methods used for measurement of different quantities.

Course Outcomes

- Develop an understanding of construction and working of different measuring instruments
- Develop an understanding of construction and working of different AC and DC bridges and its applications
- Understanding about the measurement of active and passive parameters of Electrical Engineering.

Curriculum Content

Unit 1 Philosophy of Measurement: Methods of Measurement, Measurement System, Classification of instrument system, Characteristics of instruments & measurement system, Errors in measurement & its analysis, Standards. Analog Measurement of Electrical Quantities: Electrodynamic, Thermocouple, Electrostatic & Rectifier type Ammeters & Voltmeters, Electrodynamic Wattmeter, Three Phase Wattmeter, Power in three phase system, errors & remedies in wattmeter and energy meter

Unit 2 Instrument transformers: Instrument Transformer and their applications in the extension of instrument range, Introduction to measurement of speed, frequency and power factor.

Unit 3 Measurement of Parameters: Different methods of measuring low, medium and high resistances, measurement of inductance & capacitance with the help of AC Bridges, Q Meter
.

Unit 4 AC Potentiometer: Polar type & Co-ordinate type AC potentiometers, application of AC

Potentiometers in electrical measurement
Magnetic Measurement: Ballistic Galvanometer, flux meter, determination of hysteresis loop, Measurement of iron losses.

Unit 5 Digital Measurement of Electrical Quantities: Concept of digital measurement, block Diagram, Study of digital voltmeter, frequency meter Power Analyzer and Harmonics Analyzer; Electronic Multimeter.

TEXTBOOK(S)

1. E.W. Golding & F.C. Widdis, “Electrical Measurement &Measuring Instrument”, A.W. Wheeler & Co.Pvt. Ltd.
2. A.K. Sawhney, “Electrical & Electronic Measurement & Instrument”, Dhanpat Rai & Sons, India.

REFERENCE BOOKS

1. E.W. Golding & F.C. Widdis, “Electrical Measurement &Measuring Instrument”, A.W. Wheeler & Co.Pvt Ltd..
2. A.K. Sawhney ,“Electrical & Electronic Measurement & Instrument”, Dhanpat Rai & Sons , India .
3. W.D.Cooper, “Electronic Instrument & Measurement Technique”, Prentice Hall International.

List of Experiments

1. Calibration of ac voltmeter and ac ammeter
2. Measurement of phase difference and frequency of a sinusoidal ac voltage using C.R.O.
3. Measurement of low resistance by Kelvin’s double bridge
4. Measurement of voltage, current and resistance using dc potentiometer
5. Measurement of inductance by Maxwell’s bridge
6. Measurement of inductance by Hay’s bridge
7. Measurement of inductance by Anderson’s bridge
8. Measurement of capacitance by Owen’s bridge
9. Measurement of capacitance by De Sauty Bridge
10. Measurement of capacitance by Schering Bridge

Value added Experiments:

1. Measurement of power and power factor of a single phase inductive load and to study effect of capacitance connected across the load on the power factor
2. Measurement of form factor of a rectified sine wave and determine source of error if r. m. s. value is measured by a multi-meter
3. Study of Frequency and differential time counter

Department Offering the Course	EECE
Course Code	EEF204
Course Title	Electromechanical Energy Conversion- II
Credits (L:T:P:C)	3:0:1:4
Contact Hours (L:T:P)	3:0:2
Prerequisites (if any)	None
Course Basket	Discipline Core

Course Summary

The course provides advanced understanding of AC machines like synchronous generators, synchronous motors, induction motors and single phase motors of various types.

Course Objectives

- To empower students with the advanced understanding of AC machines.
- To empower students to have sufficient knowledge about synchronous machines.
- To empower students to have sufficient knowledge about induction machines

Course Outcomes

- Student becomes familiar with the elementary AC machines other than transformers
- To empower students with the advanced knowledge about principle of operation and applications of synchronous machines.
- To empower students with the advanced knowledge about principle of operation and applications of induction machines.

Curriculum Content

Unit 1 Synchronous Machine I:

Constructional features, Armature winding, EMF Equation, winding coefficients, equivalent circuit and phasor diagram, Armature reaction, working principle of synchronous generator, O. C. & S. C. tests, Voltage Regulation using Synchronous Impedance Method, MMF Method, Potier’s Triangle Method, Parallel Operation of synchronous generators, operation on infinite bus, synchronizing power and torque co-efficient

Unit 2 Synchronous Machine II:

Two Reaction Theory, Power flow equations of cylindrical and salient pole machines, operating characteristics Synchronous Motor: Working principle of synchronous motor, starting methods, Effect of varying field current at different loads, V-Curves, Hunting & damping, synchronous condenser.

Unit 3 Three phase Induction Machine – I:

Constructional features, rotating magnetic field, Principle of operation, Phasor diagram, equivalent circuit, torque and power equations, Torque- slip characteristics, no load & blocked rotor tests, efficiency, Induction generator

Unit 4 Three phase Induction Machine- II:
Starting, Deep bar and double cage rotors, Cogging & Crawling, Speed Control (with and without emf injection in rotor circuit.)

Unit 5 Single phase Induction Motor:
Double revolving field theory, Equivalent circuit, no load and blocked rotor tests, Starting methods, repulsion motor. AC Commutator Motors: Universal motor, stepper motors

TEXTBOOK(S)

1. P. S. Bhimbra, "Electrical Machinery", Khanna publication.
2. I. J. Nagrath & D. P. Kothari, "Electrical Machines". Tata McGraw Hill

REFERENCE BOOKS
Charles Gross, Electric Machines, T & F, Delhi

List of Experiments

1. To perform no load and blocked rotor tests on a three phase squirrel cage induction motor anddetermine equivalent circuit.
2. To perform load test on a three phase induction motor and draw:
(i) Torque -speed characteristics (ii) Power factor-line current characteristics
3. To perform no load & blocked rotor tests on 1- Ø induction motor and determine equivalent circuit.
4. To study speed control of three phase induction motor by keeping V/f ratio constant
5. To perform O.C. & S.C. tests on a 3-Ø alternator and determine voltage regulation at full load and at unity, 0.8 lagging and leading power factors by (i) EMF method (ii) MMF method.
6. To determine V-curves and inverted V-curves of a three phase synchronous motor.
7. To determine Xd and Xq of a three phase salient pole synchronous machine using the slip test and draw the power-angle curve.
8. To study synchronization of an alternator with the infinite bus by using: (i) dark lamp method (ii) two bright and one dark lamp method

Department Offering the Course	**EECE**
Course Code	EEF205
Course Title	Elements of Power System
Credits (L:T:P:C)	3:0:1:4
Contact Hours (L:T:P)	3:0:2
Prerequisites (if any)	None
Course Basket	Discipline Core

Course Summary

The course covers fundamentals of Single line diagram, Supply system, skin effect, Kelvin's law, Proximity effect, short, medium and long transmission lines, Ferranti effect, Surge impedance loading, Corona, insulators and their application, Potential distribution over a string of insulators. The course provides the knowledge of Mechanical Design of Transmission Lines, Grading of cables, Insulation resistance, Capacitance of single phase and three phase cables, Dielectric losses, Heating of cables.

Course Objectives

- To give an overview of power system and its various components and their importance.
- Calculation of line parameters, evaluation of line performance
- Mechanical aspects of overhead transmission line, underground cables, their constructional features

Course Outcomes

- The students should be able to know about the overhead and underground types of transmission systems,
- The students should be able to know about different mathematical models to represent different types of transmission lines and evaluate their performance.
- They should also be able to design an overhead transmission line including mechanical aspects.
- They will also know about different types of cables used in case of electrical power systems.

Curriculum Content

Unit 1 POWER SYSTEM COMPONENTS: Single line diagram of Power System, Supply system, Different types of supply system and their comparison, Transmission line configurations, Types of conductors, Skin effect, Kelvin's law, Proximity effect.

Unit 2 OVER HEAD TRANSMISSION LINES: Calculation of inductance and capacitance of single phase, three phase, single circuit, and double circuit transmission lines. Representation of short, medium and long transmission lines, Ferranti effect, Surge impedance loading

Unit 3 CORONA AND LINE Insulators: Corona formation, calculation of potential gradient, corona loss, factors affecting corona, Methods of reducing corona and interference. Electrostatic and electromagnetic interference with communication lines. Types of insulators and their application, Potential distribution over a string of insulators, Methods of equalizing the potential, String efficiency

Unit 4 Mechanical Design of Transmission Lines: Catenary curve, Calculation of sag & tension, Effects of wind and ice loading, Sag template, Vibration dampers, Types of towers and their design
Unit 5 Insulated Cables: Types of cables and their construction, Dielectric stress, Grading of cables, Insulation resistance, Capacitance of single phase and three phase cables, Dielectric losses, Heating of cables.

TEXTBOOK(S)

1. W.D. Stevenson, "Element of Power System Analysis", McGraw Hill, USA
2. C.L. Wadhwa, "Electrical Power Systems", New Age International Ltd., Third Edition
3. Ashfaq Husain, "Power System", CBS Publishers & Distributors, India
4. B.R. Gupta, "Power System Analysis & Design", S.Chand & Co, Third Edition
5. M.V. Deshpande, "Electrical Power System Design", Tata McGraw Hill

REFERENCE BOOKS

1. Soni, Gupta & Bhatnagar, "A Course in Electrical Power", Dhanpat Rai & Sons, India
2. S.L. Uppal, "Electric Power", Khanna Publishers
3. S.N. Singh, "Electric Power Generation, Transmission & Distribution", PHI, New Delhi

List of Experiments **MATLAB based**

1. To compute line parameters for a single phase transmission line
2. To compute line parameters for a three phase short transmission line
3. To compute line parameters for a three phase medium transmission line
4. To compute line parameters for a three phase long transmission line
5. Verification of Ferranti Effect for Different Length Transmission Lines
6. To calculate sag in case of transmission lines
7. To calculate voltage regulation of transmission line using MATLAB
8. To carry out modelling of 3 phase AC cable

COURSE STRUCTURE & SYLLABUS OF B. TECH – ELECTRICAL ENGINEERING APPLICABLE FOR BATCH (2022-25)

Department Offering the Course	**EECE**
Course Code	EEF251
Course Title	Signals and Systems
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

This course is the study of analog and digital signals, a topic that forms an integral part of engineering systems in many diverse areas, including signal processing, seismic data processing, communications, speech processing, image processing, defense electronics, consumer electronics, and consumer products.

Course Objectives

To develop basic knowledge of signals and systems and its properties in Continuous time and Discrete time domain along with sampling procedure. The course will develop understanding of the concepts and applications of Continuous Time and Discrete Time Fourier Series/Transforms and analyse signals and systems in time as well as frequency domain. To understand the concepts of Sampling and aliasing

Course Outcomes

On successful completion of the course, students will be able to achieve the following:

1. Classify various signals and systems (continuous and discrete) based on their properties.
2. Determine response of LTI systems using graphical or mathematical convolution.
3. Perform sampling of Continuous time signals using Nyquist criterion.

Curriculum Content

Unit 1: Time-Domain Analysis of Signals & LT I Systems:

Signals: Definition of Continuous Time (CT) and Discrete Time (DT) signals, Properties of CT & DT Signals, Operations on signals Systems: Types of Systems, Definition of CT & DT systems, system properties, Impulse response and the convolution integral and convolution summation, Properties of convolution, Analysis of LTI systems.

Unit 2: Frequency Domain Analysis of CT Signals and LTI Systems:

Fourier series (FS): Exponential FS and its properties, Continuous Time Fourier Transform (CTFT): Definition & Properties, Frequency Response of LTI systems.

Laplace Transform (LT): RoC, Properties and Applications. Relationship between Laplace transform and CTFT

Unit 3: Frequency Domain Analysis of DT Signals:

Sampling Theorem for Low Pass Signals, Nyquist Criterion, Aliasing, Discrete-Time Fourier Series, Discrete- Time Fourier Transform - Definition & Properties.

Unit 4: Frequency Domain Analysis of DT Systems:
Difference equation representation of I/O relationship, System properties in terms of the impulse response using DTFT, System response for complex-exponential inputs.

Unit- 5: Z-Transform:
Z-transform: Definition, existence and motivation, Evaluation of ZT, ROC and its Properties, Inverse ZT, Relationship between DTFT and z-transform, ZT Properties.

TEXTBOOK(S)

Signals and Systems, Oppenheim and Willsky with Nawab, 2nd Edition, Prentice Hall.

REFERENCE BOOKS

1. Linear Systems and Signals, B. P. Lathi, Oxford Press, 2nd Edition.
2. Signals and Systems, Tarun Kumar Rawat, 1st Edition, Oxford University Press, 2011
3. Signals and Systems, H P Hsu, Second Edition, Schaum’s Outlines, Mc Graw Hill Education

Department Offering the Course	**EECE**
Course Code	EEF301
Course Title	Power System Analysis
Credits (L:T:P:C)	3:0:1:4
Contact Hours (L:T:P)	3:0:2
Prerequisites (if any)	None
Course Basket	Discipline Core

Course Summary

The course covers fundamentals of Representation of power system components like synchronous machine, transformer, transmission line, Formation of bus admittance matrix by singular transformation, Formation of load flow problem, Gauss – Siedel and Newton – Raphson method of load flow analysis, Approximation of Newton – Raphson load flow analysis, Fast decoupled method, Fault analysis of symmetrical short circuit, Unsymmetrical short circuits, steady state and transient Stability of power systems, Swing equation, Equal area criteria, Solution of swing equation, Distribution System & Substations.

Course Objectives

- To introduce the concepts of Load flow analysis, bus impedance/admittance matrix,
- To introduce load flow problem formulation and solution techniques,
- To introduce fault analysis, steady state and transient stability analysis, load frequency and voltage control and different type of distribution systems.

Course Outcomes

- To solve load flow problems using per unit values systems.
- To develop power system network models.
- To formulate and solve load flow problems using various techniques as per the requirements of complexity, computational time and accuracy.
- To calculate power losses in power system and develop economic power system operation scheme.

Curriculum Content

Unit 1 Introduction: Representation of power system components like synchronous machine, transformer, transmission line. One-line diagram, Impedance and Reactance diagram, per unit system of calculation, Brief description of power system components like synchronous machine, transformer, busbar, transmission line and isolators.

Unit 2 Load Flow Analysis: Bus classifications, Formation of bus admittance matrix by singular transformation, Formation of load flow problem, Gauss – Siedel and Newton – Raphson method of load flow analysis, Approximation of Newton – Raphson load flow analysis, Fast decoupled method.

Unit 3 Fault analysis: Types of fault – shunt and series, Calculation of fault current and voltages for symmetrical short circuit, Symmetrical components, Sequence impedance, Unsymmetrical short circuits, Open conductor fault, Current limiting reactors

Unit 4 Stability Analysis: Introduction to steady state and transient Stability of power systems, Swing equation, Equal area criteria, Solution of swing equation, Methods of improving stability

Unit 5 Distribution System & Substations: Different types of distribution systems, Distribution from one and both ends, Ring mains, Unbalanced loading, 3 phase 4 wire and 3 phase 5 wire distribution system, Layout of distribution substation, Rural electrification and grounding.

TEXTBOOK(S)

1. W.D. Stevenson, "Element of Power System Analysis", McGraw Hill, USA
2. C.L. Wadhwa, "Electrical Power Systems", New Age International Ltd., Third Edition
3. Ashfaq Husain, "Power System", CBS Publishers & Distributors, India
4. B.R. Gupta, "Power System Analysis & Design", S. Chand & Co, Third Edition
5. M.V. Deshpande, "Electrical Power System Design", Tata McGraw Hill

REFERENCE BOOKS

1. Soni, Gupta & Bhatnagar, "A Course in Electrical Power", Dhanpat Rai & Sons, India
2. S. L. Uppal, "Electric Power", Khanna Publishers
3. S. N. Singh, "Electric Power Generation, Transmission & Distribution", PHI, New Delhi

List of Experiments **MATLAB Based**

1. Computation of Parameters and Modeling of Transmission Lines
2. Formation of Bus Admittance and Impedance Matrices
3. Solution of load flow and related problems using Gauss- Seidel Method.
4. Solution of load flow and related problems using Newton Raphson Method
5. Fault Analysis
6. Transient and Small Signal Stability Analysis: Single-Machine Infinite Bus System
7. Transient Stability Analysis of Multi machine Power Systems
8. Electromagnetic Transients in Power Systems

COURSE STRUCTURE & SYLLABUS OF B. TECH – ELECTRICAL ENGINEERING APPLICABLE FOR BATCH (2022-25)

Department Offering the Course	**EECE**
Course Code	EEF302
Course Title	Control System
Credits (L:T:P:C)	3:0:1:4
Contact Hours (L:T:P)	3:0:2
Prerequisites (if any)	None
Course Basket	Discipline Core

Course Summary

The course covers fundamentals of Control System, transfer functions, Block diagram algebra, Signal flow graph, Open loop & closed control, time response of first and second order systems, Constructional and working concept of ac servomotor, Routh-Hurwitz criteria, Root Locus Technique, Frequency response, polar and inverse polar plots, bode plots, Nyquist stability criterion, lag and lead-lag networks, design of closed loop systems.

Course Objectives

- To introduce the state variable representation of continuous and discrete data control systems, stability analysis and time response analysis using state model,
- The concepts of controllability and observability, basic concepts of digital control systems, their stability analysis,
- Use of state feedback for pole placement design, basic concepts and stability analysis of non-linear systems

Course Outcomes

- Possess in-depth knowledge of concepts from classical control theory, understand the concept of transfer function.
- Find out the time response of a given system and design of different basic controller (P, PI, PID)
- Understand the basic knowledge of servo & servomotor.
- Gain knowledge of finding out system stability in time and frequency domain.
- To draw different plots of control system and compensation design using these plots.

Curriculum Content

Unit 1 The Control System: Open loop & closed control; servomechanism, Physical examples. Transfer functions, Block diagram algebra, Signal flow graph, Mason's gain formula Reduction of parameter variation and effects of disturbance by using negative feedback

Unit 2 Time Response analysis: Standard test signals, time response of first and second order systems, time response specifications, steady state errors and error constants.
Controllers: Introduction to P, PI, & PID controller. performance indices

Unit 3 Control System Components: Constructional and working concept of ac servomotor, synchros and stepper motor.

Concept of Stability: Routh-Hurwitz criteria, Root Locus Technique
Unit 4 Frequency response Analysis: Frequency response, correlation between time and frequency responses, polar and inverse polar plots, bode plots: gain margin and phase margin**.**
Stability in Frequency Domain: NY Quist stability criterion, relative stability.

Unit 5 Introduction to Design: The design problem and preliminary considerations lead, lag and lead-lag networks, design of closed loop systems using compensation techniques in time domain and frequency domain.

TEXTBOOK(S)

1. I.J. Nagrath & Gopal, "Control System Engineering", 4th Edition, New age International.
2. K. Ogata, "Modern Control Engineering", Prentice Hall of India.

REFERENCE BOOKS

1. Norman S. Nise, Control System Engineering 4th edition, Wiley Publishing Co.
2. M. Gopal, "Control System; Principle and design", Tata McGraw Hill.
3. M. Gopal," Modern Control system", Tata McGraw Hill.
4. D. Roy Choudhary, "Modern Control Engineering", Prentice Hall of India.

List of Experiments

1. To determine response of first order and second order systems for step input for various values of constant 'K' using linear simulator unit and compare theoretical and practical results.
2. To study P, PI and PID temperature controller for an oven and compare their performance.
3. To study and calibrate temperature using resistance temperature detector (RTD)
4. To design Lag, Lead and Lag-Lead compensators using Bode plot.
5. To study DC position control system
6. To study synchro-transmitter and receiver and obtain output V/S input characteristics
7. To determine speed-torque characteristics of an ac servomotor.
8. To study performance of servo voltage stabilizer at various loads using load bank.
9. To study behaviour of separately excited dc motor in open loop and closed loop conditions at various loads.

Software based experiments (Use MATLAB, LABVIEW software etc.)

1. To determine time domain response of a second order system for step input and obtain performance parameters.
2. To convert transfer function of a system into state space form and vice-versa.
3. To plot root locus diagram of an open loop, transfer function & determine range of gain 'k' for stability. 4.To plot a Bode diagram of an open loop transfer function.

Department Offering the Course	**EECE**
Course Code	EEF303
Course Title	Power Electronics
Credits (L:T:P:C)	3:0:1:4
Contact Hours (L:T:P)	3:0:2
Prerequisites (if any)	None
Course Basket	Discipline Core

Course Summary

The course covers fundamentals of Power semiconductor devices such as Triacs, GTOs, MOSFETs and IGBTs, their characteristics, turn-on of SCR, gate characteristics, AC-DC Converters, DC - DC Converters, AC- AC and DC-AC Converters, three phase cyclo-converters, Single phase series resonant inverter; Single phase bridge inverters, Single phase and three phase current source inverters.

Course Objectives

- To introduce the basic concepts of power electronics,
- To introduce types of converters, their characteristics, turn-on of SCR, gate characteristics,
- To know about AC-DC Converters, DC - DC Converters, AC-AC and DC-AC Converters.

Course Outcomes

- Articulate the basics of power electronic devices
- Express the design and control of rectifiers, inverters.
- Design of power electronic converters in power control applications
- Ability to express characteristics of SCR, BJT, MOSFET and IGBT.
- Ability to express communication methods.
- Ability design AC voltage controller and Cyclo-Converter

Curriculum Content

Unit 1 Power semiconductor Devices: Power semiconductor devices their symbols and static characteristics; Characteristics and specifications of switches, types of power electronic circuits. Thyristor – Operation V- I characteristics, two transistor model; Triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation

Unit 2 Power Semiconductor Devices (Contd): Protection of devices; Series and parallel operation of thyristors; Commutation techniques of thyristor
DC-DC Converters: Principles of step-down and step-up chopper and their operation with R-L load; Classification of choppers

Unit 3 Phase Controlled Converters: Single phase half wave controlled rectifier with resistive and inductive loads, effect of freewheeling diode; Single phase fully controlled and half controlled bridge converters; Three phase half wave converters, three phase fully controlled and half controlled bridge converters; Effect of source impedance; Single phase and three phase dual converters.

Unit 4 AC Voltage Controllers: Principle of On-Off and phase controls; Single phase ac voltage controller with resistive and inductive loads; Three phase ac voltage controllers (various configurations and comparison) Cyclo Converters: Basic principle of operation, single phase to single phase, three phase to single phase and three phase to three phase cyclo converters, output voltage equation

Unit 5 Inverters: Single phase series resonant inverter; Single phase bridge inverters
Three phase bridge inverters: 1200 and 1800 mode of operation; Voltage control of inverters; Harmonics reduction techniques; Single phase and three phase current source inverters.

TEXTBOOK(S)

1. M.H. Rashid, “Power Electronics: Circuits, Devices & Applications”, Prentice Hall of India Ltd. 3rd Edition,
2. P.S.Bimbhra, “Power Electronics” Khanna Publication.
3. Umanand “Power Electronics” Wiley India.

REFERENCE BOOKS

1. P.C. Sen, “Power Electronics”, Mc Graw Hill
2. Dragan Maksimović and Robert Warren Erickson, “Fundamentals of Power Electronics”, Springer

List of Experiments

1. To study V-I characteristics of SCR and measure latching and holding currents.
2. To study UJT trigger circuit for half wave and full wave control.
3. To study single-phase half wave controlled rectified with (i) resistive load (ii) inductive load with and without freewheeling diode.
4. To study single phase (i) fully controlled (ii) half controlled bridge rectifiers with resistive & inductive loads.
5. To study three-phase fully/half controlled bridge rectifier with resistive and inductive loads.
6. To study single-phase ac voltage regulator with resistive and inductive loads.
7. To study single phase cyclo-converter
8. To study triggering of (i) IGBT (ii) MOSFET (iii) power transistor
9. To study operation of IGBT/MOSFET chopper circuit
10. To study MOSFET/IGBT based single-phase series-resonant inverter.

Software based experiments (PSPICE/MATLAB)

1. To obtain simulation of SCR and GTO thyristor.
2. To obtain simulation of Power Transistor and IGBT.
3. To obtain simulation of single phase full wave ac voltage controller and draw load voltage and load current waveforms for inductive load.

Department Offering the Course	**EECE**
Course Code	EEF304
Course Title	Switchgear and Protection
Credits (L:T:P:C)	3:0:1:4
Contact Hours (L:T:P)	3:0:2
Prerequisites (if any)	None
Course Basket	Discipline Core

Course Summary

The course provides the knowledge of PROTECTIVE Relays, different protection schemes, Relays, Circuit breakers, Arc Interruption Theory and Power System Transients, Power System Transients, Lightning arrestors, BIL and insulation coordination.

Course Objectives

- To introduce the basic concepts of different protection schemes,
- To introduce the basic concepts of Relays, Circuit breakers
- To introduce the basics of Arc Interruption Theory and Power System Transients.

Course Outcomes

- Learn the fundamental concept of different types of protective relays.
- Apply fundamental concepts of various protection schemes.
- Use different types of circuit breakers according to their principle of operation, characteristics, ratings and their duties.
- Become familiar with arc properties, their formation and extinction.
- Become familiar with Power System Transients, Lightning arrestors, BIL and insulation coordination.

Curriculum Content

Unit 1 PROTECTIVE Relays: Basic principles, types, Construction and characteristics of electromagnetic relays, Elements of static relays, Comparators, Basic principle of digital relays, Overcurrent, Earth fault and differential relays.

Unit 2 Protection Schemes: Protection of generators, transformers, transmission line, busbar and motors

Unit 3 Arc Interruption Theories: Formation and extinction of arc, properties of the arc, Restriking and recovery voltage, Methods and control devices for arc extinction, Current chopping, Resistance switching

Unit 4 Circuit breakers: Oil circuit breaker, Air blast circuit breaker, SF6 circuit breaker, Vacuum circuit breaker, Circuit breaker duties and ratings, Testing and maintenance of circuit breakers, HRC and other types of fuse, Isolators

Unit 5 Power System Transients: Overvoltage in the transmission lines, Fault clearance, Lightning and switching surges, Transmission, refraction and attenuation of surges. Ground wire, Sphere gaps, Lightning arrestors, BIL and insulation coordination, Grounding of power system.

TEXTBOOK(S)

1. Switchgear and protection Sunil S. Rao, Khanna Publishers
2. Power System Engg. Soni Gupta & Bhatnagar, Dhanpat Rai & Sons
3. A course in Electrical Power, C.L. Wadhawa, New Age International
4. Power system protection and switchgear, B. Ram, Wiley Eastern Ltd.

REFERENCE BOOKS

1. Power system protection & switchgear, Badriram & D.V. Vishwakarma, TMH
2. Switchgear & Protection, M.V. Deshpande, TMH

List of Experiments

1. To determine direct axis reactance (xd) and quadrature axis reactance (xq) of a salient pole alternator.
2. To determine negative and zero sequence reactances of an alternator.
3. To determine sub transient direct axis reactance (xd) and sub transient quadrature axis reactance (xq) of an alternator
4. To determine fault current for L-G, L-L, L-L-G and L-L-L faults at the terminals of an alternator at very low excitation
5. To study the IDMT over current relay and determine the time current characteristics
6. To study percentage differential relay
7. To study Impedance, MHO and Reactance type distance relays
8. To determine location of fault in a cable using cable fault locator
9. To study ferranty effect and voltage distribution in H.V. long transmission line using transmission line model.
10. To study operation of oil testing set.

Simulation Based Experiments (using MATLAB or any other software)

1. To determine transmission line performance.
2. To obtain steady state, transient and sub-transient short circuit currents in an alternator
3. To obtain formation of Y-bus and perform load flow analysis
4. To perform symmetrical fault analysis in a power system
5. To perform unsymmetrical fault analysis in a power system

Department Offering the Course	**EECE**
Course Code	EEF401
Course Title	Electric Drives
Credits (L:T:P:C)	3:0:1:4
Contact Hours (L:T:P)	3:0:2
Prerequisites (if any)	Power Electronics
Course Basket	Discipline Core

Course Summary

The course provides the knowledge of Electric Drives, Dynamics of motor-load combination; Steady state stability of Electric Drive; Load equalization, Selection of Motor Power rating, electric braking, braking of dc, three phase induction and synchronous motors, Power Electronic Control of DC Drives, Power Electronic Control of AC Drives, static frequency control scheme (VSI, CSI, and cyclo – converter based) static rotor resistance and slip power recovery control schemes.

Course Objectives

- To introduce the basic concepts of dc electric drives and ac electric drives
- To understand dc and ac electric drives closed-loop operation
- To understand dc and ac electric drives operation including microprocessor based arrangements.

Course Outcomes

- Apply the knowledge of drives and use them effectively.
- Suggest the particular type of AC drive system for an application.
- Suggest the particular type of DC drives system for an application.

Curriculum Content

Unit 1 Fundamentals of Electric Drive: Electric Drives and its parts, advantages of electric drives, classification of electric drives; Speed-torque conventions and multi-quadrant operations; Types of load, Load torque: components, nature and classification

Dynamics of Electric Drive: Dynamics of motor-load combination; Steady state stability of Electric Drive; Load equalization

Unit 2 Selection of Motor Power rating: Thermal model of motor for heating and cooling, classes of motor duty, determination of motor power rating for continuous duty, short time duty and intermittent duty.

Unit 3 Electric Braking: Purpose and types of electric braking, braking of dc, three phase induction and synchronous motors

Dynamics During Starting and Braking: Calculation of acceleration time and energy loss during starting of dc shunt and three phase induction motors, methods of reducing energy loss during starting; Energy relations during braking, dynamics during braking Special Drives: Switched Reluctance motor.

Unit 4 Power Electronic Control of DC Drives: Single phase and three phase controlled converter fed separately excited dc motor drives (continuous conduction only); dual converter fed separately excited dc motor drive; rectifier control of dc series motor; Chopper control of dc separately excited and dc series motor.

Unit 5 Power Electronic Control of AC Drives:
Three Phase Induction Motor Drive: Static Voltage control scheme, static frequency control scheme (VSI, CSI, and cyclo – converter based) static rotor resistance and slip power recovery control schemes.

TEXTBOOK(S)

1. G.K. Dubey, "Fundamentals of Electric Drives", Narosa publishing House.
2. V. Subrahmanyam, "Electric Drives: Concepts and Applications", Tata McGraw Hill.

REFERENCE BOOKS

1. M.Chilkin, "Electric Drives", Mir Publishers, Moscow.
2. Mohammed A. El-Sharkawi, "Fundamentals of Electric Drives", Thomson Asia Pvt. Ltd., Singapore.
3. N.K. De and Prashant K. Sen, "Electric Drives", Prentice Hall of India Ltd.
4. S.K. Pillai, "A First Course on Electric Drives", New Age International.

List of Experiments

1. To study speed control of separately excited dc motor by varying armature voltage using single-phase fully controlled bridge convertor.
2. To study speed control of separately excited dc motor by varying armature voltage using single-phase half controlled bridge convertor.
3. To study speed control of separately excited dc motor using single-phase dual converter (Static Ward- Leonard Control)
4. To study speed control of separately excited dc motor using MOSFET/IGBT chopper.
5. To study closed loop control of separately excited dc motor.
6. To study speed control of single-phase induction motor using single-phase ac voltage controller.
7. To study speed control of three-phase induction motor using three-phase ac voltage controller.
8. To study speed control of three-phase induction motor using three-phase current source inverter.
9. To study speed control of three-phase induction motor using three-phase voltage source inverter.

Simulation Based Experiments (using MATLAB or any other software)

1. To study starting transient response of separately excited dc motor.
2. To study speed control of separately excited dc motor using single phase fully/half controlled bridge converter in discontinuous and continuous current modes.
3. To study speed control of separately excited dc motor using chopper control in motoring and braking modes.

COURSE STRUCTURE & SYLLABUS OF B. TECH – ELECTRICAL ENGINEERING APPLICABLE FOR BATCH (2022-25)

Department Offering the Course	**EECE**
Course Code	EEF342
Course Title	Electrical Power Generation
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

This course provides basic knowledge about the different methods used for power generation like thermal power plants, hydroelectric power plants, gas turbine plants. The working of various components like economizer, boiler, turbine, types of turbine, to have understanding about power generation using non-conventional energy resources like solar energy and wind energy.

Course Objectives

- The objective of the course is that after studying this subject the student should become familiar with the different modes of electrical power generation, their advantages and limitations.
- He should also become aware of the various components and their working which are involved in the process of electrical power generation.
- He should have fair idea about energy generation and cost structure for revenue generation by energy

Course Outcomes

- The student will become familiar with the different modes of electrical power generation, their advantages and limitations.
- He will become aware of the various components and their working which are involved in the process of electrical power generation.
- He will have fair idea about energy generation and cost structure for revenue generation by energy

Curriculum Content

Unit 1 Introduction: Present energy scenario in India,

Power Plant Economics and Tariffs: Load curve, load duration curve, different factors related to plants and consumers, Cost of electrical energy, depreciation, generation cost, effect of Load factor on unit cost. Fixed and operating cost of different plants, role of load diversity in power system economy. Objectives and forms of Tariff including three-part tariff; Causes and effects of low power factor, advantages of power factor improvement, different methods for power factor improvements

Unit 2 Thermal Power Plant: Site selection, general layout and operation of plant, Rankine cycle, Function of pulverization, boiler, economizer, super heater, air pre-heater, ESP, turbine and pump. Classification of steam turbines, impulse and reaction turbines velocity diagrams

Gas Turbine Plant: Operational principle (Brayton cycle) of gas turbine plant & its efficiency, fuels, open and closed-cycle plants, regeneration, inter-cooling and reheating, role and applications, Diesel Plants: Diesel plant layout, components & their functions, its performance, role and applications

Unit 3 Nuclear Power Plant: Location, site selection, general layout and operation of plant. Brief description of different types of reactors, Moderator material, fissile materials, control of nuclear reactors, disposal of nuclear waste material, shielding.
Hydro Electric Plants: Classifications, location and site selection, detailed description of various components, general layout and operation of Plants, brief description of impulse, reaction, Kaplan and Francis turbines, advantages & disadvantages

Unit 4 Major Electrical Equipment in Power Plants: Differences between generators used in steam and hydro power plants, requirement of excitation systems, types of excitation systems
Cogeneration: Introduction, types of cycles and technologies, advantages and scope in India
Captive Generation: Introduction, advantages and constraints

Unit 5 Solar power plant: Working of solar power plant, Solar energy collectors, Photovoltaic cell, merits and limitations of solar power plant
Wind Energy: site selection for wind power plant, differences between horizontal and vertical axis turbines, power developed using wind turbine and its efficiency
Introduction to Geothermal energy, Ocean Energy and Tidal energy, Introduction to fuel cells.

TEXTBOOK(S)
B.R. Gupta, "Generation of Electrical Energy", S. Chand Publications

REFERENCE BOOKS
S. N. Singh, "Electric Power Generation: Transmission and Distribution", PHI Learning Pvt. Ltd

Department Offering the Course	**EECE**
Course Code	EEF457
Course Title	Ann & Fuzzy Logic
Credits (L:T:P:C)	2:0:1:3
Contact Hours (L:T:P)	2:0:2
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of Neural network architecture: Single layer and multilayer feed forward networks, single layer artificial neural networks, multilayer perceptron model, concept of fuzzy, Fuzzy sets and crisp sets, Fuzzy sets theory and operations, Membership functions, inference in fuzzy logic, fuzzy if then rules, fuzzifications & defuzzifications, fuzzy controller, Application of neural network.

Course Objectives

- To understand the fundamental theory and concepts of neural networks, Identify different neural network architectures, algorithms, applications and their limitations
- Understand appropriate learning rules for each of the architectures and learn several neural network paradigms and its applications.
- Comprehend the fuzzy logic and the concept of fuzziness involved in various systems and fuzzy set theory.
- Understand the concepts of fuzzy sets, knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic
- Reveal different applications of these models to solve engineering and other problem

Course Outcomes

- Understand the fundamentals of neural networks and identify different neural network architectures, algorithms, applications and their limitations
- Understand appropriate learning rules for each of the architectures
- Understand the fuzzy logic and the concept of fuzziness involved in various systems and fuzzy set theory.

Curriculum Content

Unit 1 Neural Networks-1(Introduction & Architecture): Neuron, biological neuron, Artificial Neuron and its model, activation functions, Neural network architecture: Single layer and multilayer feed forward networks, recurrent networks, and various learning techniques**.**

Unit 2 Back propagation networks Architecture: perceptron model, single layer artificial neural networks, multilayer perceptron model; back propagation algorithm, effects of learning coefficient; factors affecting back propagation training, applications.

Unit 3 Fuzzy Logic-I (Introduction): Basic concept of fuzzy, Fuzzy sets and crisp sets, Fuzzy sets theory and operations, Properties of fuzzy sets. Fuzzy and crisp relation.

Unit 4 Fuzzy Membership Functions, Rules: Membership functions, inference in fuzzy logic, fuzzy if then rules, fuzzifications & defuzzifications, fuzzy controller.

Unit 5 Application of Neural and fuzzy logic: Application of neural network, Neural Network approach in load flow study. Fuzzy logic application in industries.

TEXTBOOK(S)

1. S. Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI

REFERENCE BOOKS

1. Simon Haykins," Neural Networks" Prentice Hall of India
2. Moore, "Digital control devices", ISA press, 1986.
3. Kumar Satish, "Neural Networks", Tata Mc Graw Hill
4. Timothy J Ross, "Fuzzy Logic with Engineering Applications", McGraw Hill 1997

List of Experiments:

The instructor will give real time based problems each for neural networks and fuzzy logic controllers

Department Offering the Course	**EECE**
Course Code	EEF441
Course Title	Computer Methods in Power System Analysis
Credits (L:T:P:C)	2:0:1:3
Contact Hours (L:T:P)	2:0:2
Prerequisites (if any)	Power System Analysis
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of Power flow analysis – Gauss Siedel method, Newton Raphson method – DLF and FDLF method, Short Circuit Analysis, Methods of Load Forecasting, Power systems State estimation and various techniques like LSET & WLSET, The line power flow state estimation, real time and computer control of power system, SCADA & Energy Management Centers, Smart Grid.

Course Objectives

- To have knowledge about methods used for modeling of network and methods used for its analysis
- To study about methods used for short circuit analysis of a power system
- To study techniques used for forecasting of load both long term and short term

Course Outcomes

- A student is able to model a power system network and analyze it using different analysis methods
- A student is able to do short circuit analysis of a power system
- A student is able to do short circuit analysis and able to do load forecast both long term and short term

Curriculum Content

Unit 1 Network Modelling: - Impedance and Admittance representation. Power flow analysis – Gauss Siedel method, Newton Raphson method – DLF and FDLF method, DC Load flow, sparsity oriented programming, Optimal Power Flow Analysis

Unit 2 Short Circuit Analysis: - SCA of multi node system using bus impedance matrix, Z-bus building algorithm, asymmetrical fault analysis using Z-bus, development of voltage and current equations under asymmetrical fault using symmetrical components.

Unit 3 Load Forecasting Techniques: - Methods of Load Forecasting

Unit 4 Contingency Analysis: - Power Systems State estimation and various techniques like LSET & WLSET, The line power flow state estimation.

Unit 5 Computer Control of Power System: - Need of real time and computer control of power system, Operating states of power system, SCADA & Energy Management Centers, Smart Grid.

TEXTBOOK(S)

1. Glonn N. Stagg and Aimed H. El-abiad, "Computer Method in Power System Analysis", McGraw Hill, International edition 1988.
2. George L. Kusic, "Computer Aided Power System Analysis", Prentice Hall, 1986.

REFERENCE BOOKS

1. J. Arrillage, C.P. Amold and S. J. Harker, "Computer Modeling of Electrical Power Systems", John Wiley and Sons 1983.
2. Jos Arrillaga and Bruce Smith, "AC-DC Power System Analysis", IEE London UK, 1998.
3. L.P. Singh, "Advanced Power System Analysis and Dynamics", New Age International Ltd, New Delhi, 1992.
4. Hadi Sadat, "Power System Analysis", Tata McGraw Hill, New Delhi, 1999.
5. Mariesa Crow, "Computational methods for Electrical Power Systems", CRC press.

List of Experiments

1. To plot the daily load curve for the given data using MATLAB
2. Introduction to basics of Electrical Transients Analyser Program (ETAP)
3. Evaluate the value of voltages for a 4 bus system using node equations in MATLAB
4. Modeling and Load flow analysis of 5 bus system
5. Bus elimination of a 4 bus system using MATLAB
6. Application of Gauss-Siedel and Newton-Raphson method for load flow studies on a three bus system using MATLAB
7. Analysis of fault for a multibus system using bus impedance matrix
8. Load flow analysis using Gauss-Siedel and Newton-Raphson method for 5 bus system

Department Offering the Course	**EECE**
Course Code	EEF349
Course Title	Digital Control System
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of digital control system, discrete time signals, z-transform and inverse z-transform, modelling of sample-hold circuit, Design of Digital Control Algorithms, State Space Analysis and Design, Stability on the z-plane and Jury stability criterion, bilinear transformation, Routh stability criterion on rth plane. Lyapunov's Stability, Discrete Euler Lagrange equation, max. min. principle, optimality & Dynamic programming.

Course Objectives

- To introduce the state variable representation of continuous and discrete data control systems, stability analysis and time response analysis using state model,
- The concepts of controllability and observability, basic concepts of digital control systems, their stability analysis,
- Use of state feedback for pole placement design, basic concepts and stability analysis of non-linear systems

Course Outcomes

- Possess in-depth knowledge of concepts from classical control theory, understand the concept of transfer function.
- Find out the time response of a given system and design of different basic controller (P, PI, PID)
- Understand the basic knowledge of servo & servomotor.
- Gain knowledge of finding out system stability in time and frequency domain.
- To draw different plots of control system and compensation design using these plots.

Curriculum Content

Unit 1 Signal Processing in Digital Control Review of concepts of Laplace, Z-transform and signal & systems. Basic digital control system, advantages of digital control and implementation problems, basic discrete time signals, z-transform and inverse z-transform, modelling of sample-hold circuit., pulse transfer function, solution of difference equation by z-Transform method.

Unit 2 Design of Digital Control Algorithms Steady state accuracy, transient response and frequency response specifications, digital compensator design using frequency response plots and root locus plots.

Unit 3 State Space Analysis and Design: State space representation of digital control system, conversion of state variable models to transfer functions and vice versa, solution of state difference equations, controllability and observability, design of digital control system with state feedback.

Unit 4 Stability of Discrete System: Stability on the z-plane and Jury stability criterion, bilinear transformation, Routh stability criterion on rth plane. Lyapunov's Stability in the sense of Lyapunov, stability theorems for continuous and discrete systems, stability analysis using Lyapunov's method**.**
Unit 5 Optimal digital control: Discrete Euler Lagrange equation, max. min. principle, optimality & Dynamic programming, Different types of problem and their solutions.

TEXTBOOK(S)

1. B.C.Kuo, "Digital Control System", Saunders College Publishing.
2. M.Gopal, "Digital Control and State Variable Methods", Tata McGraw Hill.

REFERENCE BOOKS

1. J.R.Leigh, "Applied Digital Control", Prentice Hall, International
2. C.H. Houpis and G.B.Lamont, "Digital Control Systems: Theory, hardware, Software", Mc Graw Hill.

Department Offering the Course	EECE
Course Code	EEF442
Course Title	Digital Simulation of Power System
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	PSA
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of formation of network matrices – Y BUS, Y BR and Z LOOP, Z BUS building algorithms Short circuit studies using 3-phase Z BUS matrix, Simulation example, Automatic generation control (AGC), Reactive power compensation, static VAR systems, FACTS devices, Optimal power flow solution, Database for control: SCADA, State estimation.

Course Objectives

- The objectives of the course are to make the student understand the operation and control of a modern power system,
- To introduce various problems encountered in proper operation of the system and their mitigation.
- Students will learn how to analyze a large interconnected power system through digital simulation.

Course Outcomes

- To be able to model the power system for various studies.
- To analyze the system for different short circuit conditions.
- To be able to optimize the generation scheduling in a hydro-thermal mix including the effect of system losses and maintaining the desired operating conditions.
- To analyze large data, in an interconnected power system, obtained through SCADA and utilize them for state estimation, contingency analysis and security assessment

Curriculum Content

Unit 1 Network Matrices: Graph-theoretic approach for the formation of network matrices – Y BUS, Y BR and Z LOOP; Z BUS building algorithms, Simulation example.

Unit 2 Short Circuit Studies: Representation of 3-phase networks. Short circuit studies using 3-phase Z BUS matrix. Fault impedance and admittance matrices for various types of faults. Simulation example.

Unit 3 Power System Control: Automatic generation control (AGC). Voltage control methods. Reactive power compensation, static VAR systems, FACTS devices.

Unit 4 Optimal System Operation: Unit commitment. Optimal power flow solution, Hydro–Thermal load scheduling; short range and long range. Determination of Loss-Formula. Simulation example.

Unit 5 Computer Control and Automation: Database for control: SCADA, State estimation. Contingency analysis and power system security assessment. Modern energy control centres

TEXTBOOK(S)

1. Hadi Sadat: Power System Analysis; (McGraw Hill)

REFERENCE BOOKS

1. Nagrath and Kothari: Power System Analysis; 4th edition (TMH)
2. Grainger and Stevenson: Power System Analysis; (McGraw Hill)
3. El-Abiad and Stagg: Computer Methods in Power System Analysis; (McGraw Hill)
4. Wood and Wollenberg: Power Generation Operation and Control; Wiley, NY

Department Offering the Course	EECE
Course Code	EEF367
Course Title	Dynamic System Analysis
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of Control Concepts and Mathematical Modelling System, Relationship between State Model and Transfer Function, System Representation and Control Components Block Diagram Algebra, Time response of First Order and Second Order Systems, Frequency Response Analysis Correlation between Time and Frequency Response, Control System Design Cascade and Feedback Compensation.

Course Objectives

- To study the mathematical model of systems
- To study time response analysis
- To study the frequency analysis

Course Outcomes

- Apply the knowledge about the Automatic Control System to use them more effectively.
- Describe the State Space Analysis and use it for the stability analysis of the dynamic systems.
- Differentiate between types of controllers and design them for specific applications.
- Design Lag, Lead, Lag-Lead Compensator using Bode Plot and Root Locus techniques and suggest the relative stabilities of different dynamic systems.

Curriculum Content

Unit 1 Review of concepts of Laplace transform and signal & systems. Control Concepts and Mathematical Modelling System Concepts, Effect of Feedback, System Modelling, Transfer Function, Modelling of Different Types of Physical Systems, Analogy between the Elements of Different Types of Systems. State Variable Representation. Relationship between State Model and Transfer Function.

Unit 2 System Representation and Control Components Block Diagram Algebra. Signal Flow Graph and Mason's Gain Formula. State Diagram and Simulation. Introduction to Simulink. Working Principle and Control Applications of Synchros, Tach generator, Servomotor and Stepper Motor.

Unit 3 Time Response Analysis: Time response of First Order and Second Order Systems. Steady State Error and Error Coefficients. State Transition Matrix and Solution of State Equations. Concepts of Stability–Routh- Hurwitz Criterion of Stability. Root Locus Technique**.**

Unit 4 Frequency Response Analysis Correlation between Time and Frequency Response. Frequency Response of Second Order System. Bode Plots, Polar Plots, Nichols Chart and Nyquist Stability criterion – Gain Margin and Phase Margin.

Unit 5 Control System Design Cascade and Feedback Compensation – Design of Lag, Lead, Lag-Lead Compensator Using Bode Plot and Root Locus. Introduction to P, PI and PID Controllers and their Tuning.

TEXTBOOK(S)

1. Norman S. Nise, “Control Systems Engineering”, Wiley Eastern, 2007.
2. K. Ogata, “Modern Control Engineering”, Prentice Hall of India 2003.

REFERENCE BOOKS

B.C. Kuo, “Automatic Control Systems”, Prentice Hall of India, 2002.

Department Offering the Course	**EECE**
Course Code	EEF443
Course Title	EHV A.C. & D.C. Transmission
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of EHV AC & DC transmission systems, corona current, audible noise- generation, radio interference (RI), Extra High Voltage Testing, dc links, converter station, converter controls characteristics, firing angle control, current and excitation angle control, protection against over currents and over voltage, HVDC Circuit breakers, Smoothing reactors, generation of harmonics, ac and dc filters, multi –terminal dc systems.

Course Objectives

- Understand the need of EHV AC transmission and various issues related with it
- Reactive power management, Stability of AC and DC systems
- In depth converter analysis, faults, protections, harmonic considerations, grounding system

Course Outcomes

- Student will be able to demonstrate the knowledge of Power handling capacity of different Transmission systems
- Effect of Electrostatic and electromagnetic fields and corona due to EHVAC lines.
- Voltage control and current control systems for power flow controls in HVDC system.
- The knowledge of AC filters as well as DC filters and Reactive power compensation
- Overall knowledge about the HVDC system such as MTDC, protection and substation layout of HVDC power plant

Curriculum Content

Unit 1 Introduction: Need of EHV transmission, standard transmission voltage, comparison of EHV AC & DC transmission systems and their applications & limitations, surface voltage gradients in conductor, distribution of voltage gradients on sub-conductors, mechanical considerations of transmission lines, modern trends in EHV AC & DC transmission, Types of tower

Unit 2 EHV AC Transmission: Corona loss formulas, corona current, audible noise- generation and characteristics corona pulses their generation and properties, radio interference (RI) effects, over voltage due to switching, Ferro resonance, reduction of switching surges on EHV system.

Unit 3 Extra High Voltage Testing: Characteristics and generation of impulse voltage, generation of high AC and DC voltages, measurement of high voltage by sphere gaps and potential dividers. Consideration for Design of EHV Lines, Design factors under steady state limits, EHV line insulation design based upon transient over voltages. Effects of pollution on performance of EHV lines.

Unit 4 EHV DC Transmission-I: Types of dc links, converter station, choice of converter configuration and pulse number, effect of source inductance on operation of converters, principle of dc link control, converter controls characteristics, firing angle control, current and excitation angle control, power control, starting and stopping of dc link.

Unit 5 EHV DC Transmission- II: Converter faults, protection against over currents and over voltage, HVDC Circuit breakers, Smoothing reactors, generation of harmonics, ac and dc filters, multi –terminal dc systems (MTDC): Types, control, protection and application.

TEXTBOOK(S)

1. R.D. Begamudre, “Extra High Voltage AC Transmission Engineering “Wiley Eastern
2. K.R Padiyar,” HVDC power transmission System, Technology and System Reactions “new age international.

REFERENCE BOOKS

1. M.H Rashid,”Power Electronics: Circuit, Devices and Applications”, Prentice hall of India.
2. S. Rao, “EHV AC & HVDC Transmission Engineering and practice”, Khanna Publishers
3. J Arrillaga,” High Voltage Direct Current Transmission”, IFFE Power Engineering Series 6, Peter Peregrionus Ltd. London.
4. M.S Naidu & V.K Kamaraju “High Voltage Engineering”, Tata Mc Graw Hill.

Department Offering the Course	**EECE**
Course Code	EEF444
Course Title	Electrical Energy Conservation and Auditing
Credits (L:T:P:C)	3:0:0
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of the current energy scenario and importance of energy conservation, Energy Conservation Act-2001 and its features, various forms Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Energy management (audit) approach-understanding energy costs, bench marking, energy performance, Facility as an energy system, methods for preparing process flow, material and energy balance diagrams, Energy Efficiency in Electrical Systems Electrical system, Energy Efficiency in Industrial Systems.

Course Objectives

- To be able to understand the current energy scenario and importance of energy conservation.
- To be able to understand the concepts of energy management.
- To be able to understand the methods of improving energy efficiency in different electrical systems.

Course Outcomes

- Understand the current energy scenario and importance of energy conservation.
- Understand the concepts of energy management.
- Understand the methods of improving energy efficiency in different electrical systems.

Curriculum Content

Unit 1 Energy Scenario: Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, Energy Conservation Act-2001 and its features.

Unit 2 Basics of Energy and its various forms Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.

Unit 3 Energy Management & Audit: Definition, energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

Unit 4 Energy Efficiency in Electrical Systems Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

Unit 5 Energy Efficiency in Industrial Systems: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities in HVAC, Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation
opportunities., Cooling Tower: Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities, assessment of cooling towers. Energy Efficient Technologies in Electrical Systems

TEXTBOOK(S)

1. S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991.

REFERENCE BOOKS

1. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online)
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online)

Department Offering the Course	**EECE**
Course Code	EEF351
Course Title	Energy Management System
Credits (L:T:P:C)	3:0:0
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of SCADA and its Purpose and necessity, methods of data acquisition systems, commonly acquired data, transducers, RTUs, data concentrators, various communication channels, Supervisory and Control Functions, Regulatory functions, MAN-Machine Communication, mimic diagrams, report and printing facilities, SCADA system structure, real time operation system requirements, modularization of software programming languages, production control and load management economic dispatch, distributed centers and power pool management.

Course Objectives

- Understand the fundamentals of energy management functions
- Understand the economic analysis and system energy management for electrical system and equipment.
- Enhance the knowledge in SCADA, Multicontrol centres, system configuration

Course Outcomes

- To understand the fundamentals of energy management functions
- To understand the economic analysis and system energy management for electrical system and equipment.
- To have understanding of the concept of supervisory control and data acquisition.
- To familiarize the application of SCADA in power systems

Curriculum Content

Unit 1 SCADA: Purpose and necessity, general structure, data acquisition, transmission & monitoring. General power system hierarchical Structure. Overview of the methods of data acquisition systems, commonly acquired data, transducers, RTUs, data concentrators, various communication channels- cables, telephone lines, power line carrier, microwaves, fibre optical channels and satellites.

Unit 2 Supervisory and Control Functions: Data acquisitions, status indications, majored values, energy values, monitoring alarm and event application processing. Control Function: ON/ OFF control of lines, transformers, capacitors and applications in process in industry - valve, opening, closing etc.

Regulatory functions: Set points and feedback loops, time tagged data, disturbance data collection and analysis. Calculation and report preparation**.**

Unit 3 MAN-Machine Communication: Operator consoles and VDUs, displays, operator dialogues, alarm and event loggers, mimic diagrams, report and printing facilities.

Unit 4 Data basis- SCADA, EMS and network data basis. SCADA system structure- local system, communication system and central system. Configuration- NON-redundant- single processor, redundant dual processor. Multicontrol centers, system configuration.
Performance considerations: real time operation system requirements, modularization of software programming languages.

Unit 5 Energy Management Center: Functions performed at a centralized management center, production control and load management economic dispatch, distributed centers and power pool management.

TEXTBOOK(S)

1. Torsten Cergrell, " Power System Control Technology", Prentice Hall International.
2. George L Kusic "Computer Aided Power System Analysis", Prentice Hall of India,

Reference Books

1. A. J. Wood and B. Woolenberg, "Power Generation Operation and Control", John Wiley & Sons.
2. Sunil S Rao, "Switchgear Protection & Control System" Khanna Publishers 11 th Edition.

Department Offering the Course	EECE
Course Code	EEF343
Course Title	MATLAB for Engineers
Credits (L:T:P:C)	1:0:2:3
Contact Hours (L:T:P)	1:0:4
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of MATLAB environment Matrices Creating and Manipulating matrices, Matrix maths and Matrix functions, Simulink, M-file scripts Creating, saving and running an M-file, Applications Root finding, Data analysis, Statistical functions, Polynomials, Curve fitting, Interpolation, Ordinary differential equations, Integration and differentiation.

Course Objectives

- To aim at providing programming skills from basic level onwards using MATLAB software
- To aim at using MATLAB software for data acquisition, data analysis,
- To aim at using MATLAB software for graphical visualization, numerical analysis, algorithm development, signal processing and many other applications

Course Outcomes

- To be able to illustrate the direct connection between the theory and real-world applications encountered in the typical engineering and technology programs

Curriculum Content

Unit 1 Basics MATLAB environment, Variables, Basic data types, Relational and Logic operators, Conditional statements, Input and Output, Loops and branching.

Unit 2 Matrices Creating and Manipulating matrices, Matrix maths and Matrix functions, Colon operator, Linspace, Cross product, Dot product, Logical functions, Logical indexing, 3-dimensional arrays, Cell arrays, Structures, Plotting: 2-D and 3-D plots: Basic plots, subplots, Histograms, Bar graphs, Pie charts.

Unit 3 Simulink Introduction, Block diagram, Functions, Creating and working with models, Defining and managing signals, Running a simulation, analysing the results.

Unit 4 M-file scripts Creating, saving and running an M-file, Creating and running of a function, Function definition line, H1 and help text lines, Function body, Sub-functions, Nested functions, File I/O handling, M- file debugging.

Unit 5 Applications Root finding, Data analysis, Statistical functions, Polynomials, Curve fitting, Interpolation, Ordinary differential equations, Integration and differentiation, Signal processing applications, Circuit analysis applications, Control system applications.

TEXTBOOK(S)

1. D. Hanselman and B. Littlefield, Mastering Matlab 7, Pearson Education.

REFERENCE BOOKS

1. A. Gilat, Matlab: An Introduction with Applications, John Wiley and Sons, 2004.
2. Y. Kirani Singh and B.B. Chaudhari, Matlab Programming, Prentice Hall of India, 2007
3. Steven T Karris, Introduction to Simulink with Engineering Applications, 2nd edition, Orchard Publication, 2008.

Minimum 10 experiments to be performed based on contents with minimum two from each unit.

Department Offering the Course	**EECE**
Course Code	EEF445
Course Title	High Voltage Engineering
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of breakdown mechanisms of electric breakdown in liquids, gases, and solids, Generation of High direct Current Voltage, generation of impulse voltages generation of impulse currents, overvoltage's and their causes, importance of insulation coordination, measurement of partial discharges and loss tangent, high voltage testing and condition monitoring of power equipment's.

Course Objectives

- To introduce the basic concepts of high voltage engineering including mechanism of electrical breakdown in gases, liquids and solids,
- To understand high voltage ac/dc and impulse generation and measurement,
- To have knowledge about overvoltage's and their causes, importance of insulation coordination
- To understand measurement of partial discharges and loss tangent, high voltage testing and condition monitoring of power equipment's

Course Outcomes

- To analyze the breakdown mechanisms of electric breakdown in liquids, gases, and solids.
- To have understanding of fundamental concepts of high voltage AC, DC, and impulse generation.
- To be able to apply techniques for high voltage measurements and non-destructive test techniques in high voltage engineering.
- To become familiar with testing and condition monitoring of power equipments.

Curriculum Content

Unit 1 Introduction: Review of electromagnetic systems and basics of power systems

Break Down in Gases Ionization processes, Townsend's criterion, breakdown in electronegative gases, time lags for breakdown, streamer theory, Paschen's law, breakdown in non- uniform field, breakdown in vacuum.

Break Down in Liquid Dielectrics Classification of liquid dielectric, characteristics of liquid dielectric, breakdown in pure liquid and commercial liquid.

Break Down in Solid Dielectric Intrinsic breakdown, electromechanical breakdown, breakdown of solid, dielectric in practice, breakdown in composite dielectrics**.**

Unit 2 Generation of High Voltage and Currents: Generation of High direct Current Voltage, Generation of high voltage alternating voltages, generation of impulse voltages generation of impulse currents, tripping and control of impulse generators.

Unit 3 Measurement of High Voltage and Currents: Measurement of High direct Current Voltages, Measurement of High alternating & Impulse voltages, Measurement of High direct, alternating & Impulse Currents, Cathode ray Oscillographs for impulse voltage and current measurements.

Unit 4 Over Voltage Phenomenon & insulation Coordination: Lighting Phenomenon as natural cause for over voltage, over voltage due to switching surges and abnormal conditions, Principal of insulation coordination.

Unit 5 Non -Destructive Testing Measurement of direct current resistively, measurement of dielectric constant and loss factor, partial discharge measurements.
High voltage testing: Testing of insulator & bushing, testing of isolators and circuit breakers, testing of cables, testing of transformers, testing of surge arresters, radio interference measurements.

TEXTBOOK(S)

1. M.S. Naidu & V. Kamraju," High voltage Engineering, Tata Mc-Graw hill.

REFERENCE BOOKS

1. E Kuffel and W.S.Zacngal , High voltage Engineering:, Pergamum Press
2. M.P Churasia, High Voltage Engineering Khanna Publishers.
3. R.S. Jha," High voltage Engineering", Dhanpat Rai & Sons.
4. C.L. Wadhwa," High Voltage Engineering", Wiley Eastern Ltd.
5. Subir Ray." An Introduction to High Voltage Engineering" Prentice Hall of India.

Department Offering the Course	EECE
Course Code	EEF344
Course Title	Wind and Solar Energy Systems
Credits (L:T:P:C)	2:0:1:3
Contact Hours (L:T:P)	2:0:2
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, modern wind turbine technologies, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability, Solar photovoltaic, Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.

Course Objectives

- Understand the energy scenario and the consequent growth of the power generation from renewable energy sources.
- Understand the basic physics of wind and solar power generation.
- Understand the power electronic interfaces for wind and solar generation.
- Understand the issues related to the grid-integration of solar and wind energy systems.

Course Outcomes

- To be able to apply the concepts of renewable energy sources for electricity generation
- To be able to apply the concepts of grid integration with renewable sources
- To evaluate the options and estimate the energy generation through renewable sources

Curriculum Content

Unit 1 Physics of Wind Power: History of wind power, Indian and Global statistics, Wind physics, Betz limit, Tip speed ratio, stall and pitch control, Wind speed statistics-probability distributions, Wind speed and power-cumulative distribution functions.

Unit 2 Wind generator topologies: Review of modern wind turbine technologies, Fixed and Variable speed wind turbines, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent- Magnet Synchronous Generators, Power electronics converters. Generator-Converter configurations, Converter Control.

Unit 3 The Solar Resource: Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.

Solar photovoltaic: Technologies - Amorphous, monocrystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power Point Tracking (MPPT) algorithms. Converter Control.

Unit 4 Network Integration Issues: Overview of grid code technical requirements. Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behaviour during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.

Unit 5 Solar thermal power generation: Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.

TEXTBOOK(S)

1. T. Ackermann, “Wind Power in Power Systems”, John Wiley and Sons Ltd., 2005.
2. G. M. Masters, “Renewable and Efficient Electric Power Systems”, John Wiley and Sons, 2004.
3. S. P. Sukhatme, “Solar Energy: Principles of Thermal Collection and Storage”, McGraw Hill, 1984.
4. H. Siegfried and R. Waddington, “Grid integration of wind energy conversion systems” John Wiley and Sons Ltd., 2006.

REFERENCE BOOKS

1. G. N. Tiwari and M. K. Ghosal, “Renewable Energy Applications”, Narosa Publications, 2004.
2. J. A. Duffie and W. A. Beckman, “Solar Engineering of Thermal Processes”, John Wiley & Sons, 1991.

List of Experiments (MATLAB based)

1. Analysis of Solar Photovoltaic Panel Characteristics
2. Modelling of Solar Array
3. Design and Simulation of Solar PV Model
4. Solar cell modelling and study of characteristics
5. To study modelling of solar power converter
6. To study a grid connected PV array for high power rating
7. To study the effect of change in parameters of wind turbine on power output

COURSE STRUCTURE & SYLLABUS OF B. TECH – ELECTRICAL ENGINEERING APPLICABLE FOR BATCH (2022-25)

Department Offering the Course	**EECE**
Course Code	EEF455
Course Title	Optimization Techniques
Credits (L:T:P:C)	2:0:1:3
Contact Hours (L:T:P)	2:0:2
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of Linear Programming Model-Graphical Solution–Solving LPP Using Simplex Algorithm – Revised Simplex Method, Advancements in Linear Programming Techniques, Non- Linear Programming Techniques, Dynamic Programming Method.

Course Objectives

- To Introduce the Basic Concepts of Linear Programming
- To Educate On the Advancements in Linear Programming Techniques
- To Introduce Non-Linear Programming Techniques
- To Introduce the Interior Point Methods of Solving Problems
- To Introduce the Dynamic Programming Method

Course Outcomes

- To be able to solve linear optimization problems applicable to engineering based problems
- To be able to grasp the nuances of advanced techniques used in linear problem programming
- To be able to classify linear and nonlinear system from optimization point
- To apply the optimization techniques to practical problems faced in day to day scenario

Curriculum Content

Unit 1 LINEAR PROGRAMMING Introduction – Formulation of Linear Programming Model-Graphical Solution–Solving LPP Using Simplex Algorithm – Revised Simplex Method.

Unit 2 ADVANCES IN LPP Duality Theory- Dual Simplex Method – Sensitivity Analysis–-Transportation Problems– Assignment Problems-Traveling Sales Man Problem -Data Envelopment Analysis.

Unit 3 NON LINEAR PROGRAMMING Classification of Non Linear Programming – Lagrange Multiplier Method – Karush – Kuhn Tucker Conditions–Reduced Gradient Algorithms–Quadratic Programming Method – Penalty and Barrier Method.

Unit 4 INTERIOR POINT METHODS Karmarkar's Algorithm–Projection Scaling Method–Dual Affine Algorithm–Primal Affine Algorithm Barrier Algorithm.

Unit 5 DYNAMIC PROGRAMMING

Formulation of Multi Stage Decision Problem–Characteristics–Concept of Sub-Optimization and

The Principle of Optimality – Formulation of Dynamic Programming – Backward and Forward Recursion – Computational Procedure – Conversion of final Value Problem in to Initial Value Problems

TEXTBOOK(S)

1. Hillier and Lieberman “Introduction to Operations Research”, TMH, 2000.
2. R. Panneerselvam, “Operations Research”, PHI, 2006
3. Hamdy A. Taha, “Operations Research –An Introduction”, Prentice Hall India, 2003.

REFERENCE BOOKS

1. Philips, Ravindran and Solberg, “Operations Research”, John Wiley, 2002.
2. Ronald L. Rardin, “Optimization in Operation Research” Pearson Education Pvt. Ltd. New Delhi, 2005.

List of Experiments

1. Study of Introduction to MATLAB
2. Study of basic matrix operations
3. To solve linear equation
4. Solution of Linear equations for Underdetermined and Over determined cases.
5. Determination of Eigen values and Eigen vectors of a Square matrix.
6. Solution of Difference Equations.
7. Solution of Difference Equations using Euler Method.
8. Solution of differential equation using 4th order Runge- Kutta method.
9. Determination of roots of a polynomial.
10. Determination of polynomial using method of Least Square Curve Fitting.
11. Determination of polynomial fit, analyzing residuals, exponential fit and error bounds from the given data.
12. Determination of time response of an R-L-C circuit.

Department Offering the Course	**EECE**
Course Code	EEF446
Course Title	Power System Deregulation
Credits (L:T:P:C)	3:0:0
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of Electricity demand operation and reliability, energy policy and cost, competitive market for generation, Electricity Market and Management, multilateral transaction model, power exchange and ISO- functions and responsibilities, open transmission system operation and congestion management in open access transmission systems in normal operation, Predicting electricity costs, electricity cost derivation.

Course Objectives

- The objectives of the course are to make the student understand the concept of reliability,
- To make the student understand about energy policy, demand side management,
- To make the student understand about power exchange, trading arrangements and different pricing structure

Course Outcomes

- Use various models for electrical supply such as central pool model, independent model etc.
- Use benefits of deregulation for efficient energy management.
- Converse with the concept of power exchanges for trading arrangement.
- Converse with different pricing methods for various conditions.

Curriculum Content

Unit 1 General: Electricity demand operation and reliability, energy policy and cost, competitive market for generation, role of the existing power industry, renewable generation technologies, distributed generation, traditional central utility model, independent system operator (ISO), retail electric providers.

Unit 2 Electricity Market and Management: Wholesale electricity markets, characteristics, bidding market clearing and pricing, ISO models, market power evaluation, demand side management, distribution planning.

Unit 3 Power Pool: Role of the transmission provider, multilateral transaction model, power exchange and ISO- functions and responsibilities, classification of ISO types, trading arrangements, power pool, pool and bilateral contracts, multilateral traders.

Unit 4 Electricity Pricing-I: Transmission pricing in open access system, rolled in pricing methods, marginal pricing methods, zonal pricing, embedded cost recovery, open transmission system operation and congestion management in open access transmission systems in normal operation.

Unit 5 Electricity Pricing-II: Predicting electricity costs, electricity cost derivation, electricity pricing of inter provincial power market, transmission policy.

TEXTBOOK(S)

1. L.L. Loi: Power System Restructuring and Deregulation-Trading, Performance and Information Technology, John Wiley & Sons.

REFERENCE BOOKS

1. C.S. Frd, C.C Michael, D.T Richard and E.B. Roger: Spot Pricing of Electricity, Kluwer Academic Publishers
2. I. Marija, G. Francisco and F. Lester: Power System Restructuring: Engineering and Economics, Kluwer Academic Publishers

Department Offering the Course	**EECE**
Course Code	EEF352
Course Title	Reliability Engineering
Credits (L:T:P:C)	3:0:0
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

The aim of the course is to provide students with knowledge in concepts, methodology, and tools of reliability engineering. On completion of the course, the students should be able to construct models for the estimation and improvement of reliability parameters of manufactured products and components**.**

Course Objectives

- To provide students with knowledge in concepts of reliability engineering
- To provide students with knowledge of methodology used to assess reliability engineering
- To provide tools of assessing reliability engineering.

Course Outcomes

- The student should have knowledge in concepts of reliability engineering
- The student should have knowledge of methodology used to assess reliability engineering
- The student should have knowledge of tools used for assessing reliability engineering.

Curriculum Content

Unit 1 Introduction: Definition of reliability, types of failures, definition and factors influencing system effectiveness, various parameters of system effectiveness.

Unit 2 Reliability Mathematics: Definition of probability, laws of probability, conditional probability, Bay's theorem; various distributions; data collection, recovery of data, data analysis procedures, empirical reliability calculations

Unit 3 Reliability: Types of system- series, parallel, series parallel, stand by and complex; development of logic diagram, methods of reliability evaluation; cut set and tie-set methods, matrix methods event trees and fault trees methods, reliability evaluation using probability distributions, Markov method, frequency and duration method.

Unit 4 Reliability Improvements: Methods of reliability improvement, component redundancy, system redundancy, types of redundancies-series, parallel, series - parallel, stand by and hybrid, effect of maintenance.

Unit 5 Reliability Testing: Life testing, requirements, methods, test planning, data reporting system, data reduction and analysis, reliability test standards.

TEXTBOOK(S)

1. R.Billintan & R.N. Allan,"Reliability Evaluation of Engineering and Systems", Plenum Press.

REFERENCE BOOKS

1. K.C. Kapoor & L.R. Lamberson,"Reliability in Engineering and Design", John Wiley and Sons.
2. S.K. Sinha & B.K. Kale, "Life Testing and Reliability Estimation", Wiley Eastern Ltd.
3. M.L. Shooman, "Probabilistic Reliability, An Engineering Approach", McGraw Hill.
4. G.H. Sandler, "System Reliability Engineering", Prentice Hall.

Department Offering the Course	**EECE**
Course Code	EEF447
Course Title	Power System Operation & Control
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of optimization techniques used in the power system and Load Frequency Control (LFC), Hydrothermal scheduling, reactive power control, governing system in Turbine models, different FACT controllers.

Course Objectives

- To provide students the knowledge of optimization techniques used in the power system and Load Frequency Control (LFC).
- To provide a solid foundation in mathematical and engineering fundamentals required to control the governing system in Turbine models.
- To provide the knowledge of Hydrothermal scheduling, reactive power control.

Course Outcomes

- To make students understand Economic operation of power system and importance of LFC control.
- To allow students discuss about thermal and hydro power plants operation in meeting the load demand optimally.
- To improve student's ability in solving problems (numerical problems at present)
- Ability to discuss single area load frequency control and two area load frequency control.
- Ability to model and design turbine and Automatic controller

Curriculum Content

Unit 1 Introduction: Structure of power system, power system control center, level decomposition in power system, power system security, various operational stages of power system, power system voltage stability, introduction to SCADA

Unit 2 ECONOMIC operation: Concept and problems of unit commitment, input output characteristics of thermal and hydroplants, system constraints, Optimal operation of thermal units without and with transmission losses, penalty factor, incremental transmission loss, transmission loss formula (without derivation), hydrothermal scheduling long and short terms, concept of optimal power flow

Unit 3 Load frequency control: Concept of load frequency control, load frequency control of signal area system: turbine speed governing system and modelling, block diagram representation of single area system, steady state analysis, dynamic response control area concept, P-I control, load frequency Control and economic dispatch control. Load frequency control of two area system tie line power modelling, block diagram representation of two area system,

Unit 4 AUTOMATIC voltage control: Schematic diagram and block diagram representation, Different type of excitation system & their controllers. Concept of voltage control, methods of voltage control, control by tap changing transformer. Shunt compensation, series compensation, phase angle compensation

Unit 5 Fact Devices: Concept and objectives of facts controllers, Introduction to different FACT controllers like TCR, FC-TCR, TSC, SVC, STATCOM, TSSC, TCSC, SSSC, TC-PAR, UPFC

TEXTBOOK(S)

1. D.P. Kothari & I.J. Nagrath, "Modern Power System Analysis" Tata Mc Graw Hill, 3rd edition.
2. P.S.R. Murty, "Operation and Control in Power Systems" B.S. publications

REFERENCE BOOKS

1. N.G. Hingorani & I. Gyugyi, "Understanding Facts “Concepts and Technology of Flexible AC Transmission Systems", IEEE Press Publications
2. A.J. Wood & B.F. Wollenburg, "Power Generation, Operation and Control ", John Wiley & Sons
3. O.J. Elgerd,"Electric Energy System Theory”, Tata Mc Graw Hill.
4. P. Kundur, "Power System Stability and Control”, Mc Graw Hill.
5. M.H. Rashid, "Power Electronics: Circuits, Devices and Applications "Prentice Hall of India”, 3rd edition.

Department Offering the Course	**EECE**
Course Code	EEF356
Course Title	Utilization of Electrical Energy & Traction
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

- The course provides the knowledge of various types of electrical heating and electrical welding applications, fundamentals of refrigeration, air conditioning and illumination engineering, types of electric traction systems and the fundamentals related to electric traction, electric drives and their control mechanisms specially when used in electric traction.

Course Objectives

- To introduce the fundamentals of various types of electrical heating and electrical welding applications.
- To introduce the fundamentals of refrigeration, air conditioning and illumination engineering
- To have knowledge about the types of electric traction systems and the fundamentals related to electric traction
- To have knowledge about the types of electric drives and their control mechanisms specially when used in electric traction

Course Outcomes

- Have the knowledge of various types of methods used for heating and welding
- A student should be able to select a suitable heating method depending on types of material to be heated
- Have proper knowledge of different welding methods and electroplating.
- Electroplating and its applications
- A student should be able to design the lighting system for various applications.
- Have understanding of Different types of traction systems particularly electric traction system, types of services and their characteristic

Curriculum Content

Unit 1 Electric Heating: Advantage & methods of electric heating, Resistance heating, Electric arc heating, Induction heating, Dielectric heating

Unit 2 Electric Welding: Electric arc welding, electric resistance welding, Electric Welding control, **Electrolyte Process:** Principal of Electro deposition, laws of Electrolysis, application Electrolysis**.**

Unit 3 Illumination: Various definition, laws of Illumination, requirement of good lighting, Design of indoor lighting & outdoor lighting system.

Refrigeration and Air Conditioning: Refrigeration system, domestic Refrigerator, water cooler, Types of Air conditioning, Window air conditioner

Unit 4 Electric Traction – I : Types of electric traction, system of track electrification, Traction mechanics- types of services, speed time curve and its simplification, average and schedule speeds, Tractive effort specific energy consumption, mechanics of train movement, coefficient of adhesion and its influence

Unit 5 Electric Traction – II: Salient features of traction drives, Series-parallel control of dc traction drives (bridge traction) and energy saving, Power Electronic control of dc & ac traction drives, Diesel electric traction.

TEXTBOOK(S)

1. H. Pratab." Art & Science of Electric Energy's" Dhanpat Rai & Sons.
2. G.K. Dubey," Fundamentals of electric drives" Narosa Publishing House.

Reference Books

1. H. Pratab." Modern electric traction" Dhanpat Rai & Sons.
2. C.L. Wadhwa," Generation, Distribution and Utilization of Electrical Energy "New Age International Publishers.

Department Offering the Course	**EECE**
Course Code	EEF456
Course Title	Modern Control System
Credits (L:T:P:C)	2:0:1:3
Contact Hours (L:T:P)	2:0:2
Prerequisites (if any)	Control System
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of discrete data systems, concepts of controllability and observability, stability methods, State Space analysis, Non-linear System & Linearization.

Course Objectives

- To study about discrete data systems
- To study state space analysis involving concepts of controllability and observability
- To study different types of stability methods

Course Outcomes

- To have understanding of discrete data systems
- To have understanding and be able to carry out state space analysis involving concepts of controllability and observability
- To be able to analyse different types of stability method

Curriculum Content

Unit 1 Discrete Data Systems: Introduction to discrete time systems, sample and hold circuits, pulse transfer function, representation by differential equations and its solution using z-transform and inverse-z transforms, analysis of LTI systems, unit circle concepts.

Unit 2 State Space analysis: State equations for dynamic systems, State equations using phase, physical and canonical variables, realization of transfer matrices, Solution of state equation, concepts of controllability, observability, Controllability and Observability tests.

Unit 3 Non-linear System & Linearization: Introduction to non-linear system and their state variable representation. Linearization, describing function of various non-linearities. Stability analysis using describing function.

Unit 4 Stability: Liapunov's method, generation of Liapunov's function, Popov's criteria, design of state observers and controllers, adaptive control systems, model reference.

Unit 5 Optimal Control: Introduction, formation of optimal control problems, calculus of variation, minimization of functions, constrained optimization, dynamic programming, performance index, optimality principles, Hamilton – Jacobian equation, linear quadratic problem, Ricatti II equation and its solution, solution of two-point boundary value problem

TEXTBOOK(S)

1. K. Ogata, "Modern Control Engineering", Prentice Hall of India.
2. M. Gopal, "Modern Control System", Wiley Eastern.
3. Stefani, Shahain, Savant, Hostetter, “Design of feedback control system”, oxford university press

REFERENCE BOOKS

1. B.D.O. Anderson and IB. Moore, " Optimal Control System: Linear Quadratic Methods", Prenctice Hall International.
2. U. Itkis, "Control System of Variable Structure", John Wiley and Sons.
3. H. Kwakemaok and R. Sivan, "Linear Optimal Control System", Wiley Interscience**.**

List of Experiments

1. To convert a given system of 2nd order from transfer function model to state space model
2. To convert a 3rd order system from transfer function model to state space model
3. To check the controllability of a given system
4. To check the observability of a given system
5. To assess the stability of a 2nd order system using Liapunovs method
6. To assess the stability of a 2nd order system using Popov’s method
7. To solve problems based on constrained optimization
8. To solve problems based on two-point boundary problems

Department Offering the Course	**EECE**
Course Code	EEF345
Course Title	Power Station Practice
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of loads, demand factor, group diversity factor and peak diversity factor, load curve, load duration curve, load factor, capacity factor and utilization factor, base load and peak load stations, operating and spinning reserves, load forecasting, tariff form , Coordinated operation of different types of power plants, hydrothermal scheduling: short term and long term, exciters and automatic voltage regulators (AVR), bus bar arrangements, Substation Layout of EHV substation, brief description of various equipment's.

Course Objectives

- The course has been designed to fulfil the requirement of power industry.
- The course aims to provide basic fundamentals of economics involved with power generation
- The course aims to provide basic fundamentals of techniques used for optimization of generation cost.

Course Outcomes

- Understanding the economics of power generation.
- Apply design of various new technologies to optimize the economical relations.
- Formulate and solve coordination problem of power system plants.

9. **Curriculum Content**

Unit 1 Economics of Generation: Types of loads, demand factor, group diversity factor and peak diversity factor, load curve, load duration curve, load factor, capacity factor and utilization factor, base load and peak load stations, operating and spinning reserves, load forecasting, capital cost of power plants, depreciation, annual fixed and operating charges.

Unit 2 Tariff and Power Factor Improvement General tariff form and different types of tariffs, Tariff option for DSM. Causes and effect of low power factor, necessity of improvement and use of power factor improvement devices.

Unit 3 Coordinated Operation of Power Plants Advantages of Coordinated operation of different types of power plants, hydrothermal scheduling: short term and long term. Coordination of various types of power plant.

Unit 4 Electrical Equipment's in Power Plants Governors for hydro and thermal generators, excitation systems; exciters and automatic voltage regulators (AVR), bus bar arrangements.

Unit 5 EHV Substation Layout of EHV substation, brief description of various equipments used in EHV substations, testing and maintenance of EHV substations equipments. Gas insulated substations (GIS).

TEXTBOOK(S)

1. B.R. Gupta, Generation of Electrical Energy, (Euresia Publishing House).
2. M.V. Deshpande, Elements of Electrical Power Station Design, (Wheeler Publishing House).

REFERENCE BOOKS

1. S. Rao, Electrical Substation-Engineering and Practice, (Khanna).
2. S.N. Singh, Electric Power Generation, Transmission and Distribution (PHI).

Department Offering the Course	EECE
Course Code	EEF348
Course Title	Industrial Electrical Systems
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of electrical wiring systems for various applications, components of industrial electrical systems, Illumination Systems, HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, LT Breakers, MCB and other LT panel components, DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Selection of UPS and Battery Banks.

Course Objectives

- To be able to understand the electrical wiring systems for various applications
- To be able to understand various components of industrial electrical systems.
- To be able to analyze and select the proper size of various electrical system components.

Course Outcomes

- Understand the electrical wiring systems for residential, commercial and industrial consumers, representing the systems with standard symbols and drawings, SLD.
- Understand various components of industrial electrical systems.
- Analyze and select the proper size of various electrical system components.
- To be able to design an illumination scheme for a given building, workshop etc.

Curriculum Content

Unit 1 Electrical System Components: LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices

Unit 2 Residential and Commercial Electrical Systems: Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.

Unit 3 Illumination Systems Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like

CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.

Unit 4 Industrial Electrical Systems I: HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.

Unit 5 Industrial Electrical Systems II: DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Selection of UPS and Battery Banks.
Industrial Electrical System Automation: Study of basic PLC, advantages of process automation, PLC based
control system design, Panel Metering and Introduction to SCADA system for distribution automation.

TEXTBOOK(S)

1. L. Uppal and G. C. Garg, "Electrical Wiring, Estimating & Costing", Khanna publishers, 2008.
2. K. B. Raina, "Electrical Design, Estimating & Costing", New age International, 2007.

REFERENCE BOOKS

1. S. Singh and R.D. Singh, "Electrical estimating and costing", Dhanpat Rai and Co., 1997.
2. Web site for IS Standards.
3. H. Joshi, "Residential Commercial and Industrial Systems", McGraw Hill Education, 2008.

Department Offering the Course	**EECE**
Course Code	EEF346
Course Title	Special Electrical Machines
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

This course provides knowledge regarding the construction and working of special electrical machines like deep bar induction motors, switched reluctance motors stepper motors, permanent magnet motors and commutator motors. It provides information about working of linear induction motors and their applications.

Course Objectives

- To study regarding construction working and purpose of special 3 phase a.c. machines
- To study working and characteristics of servomotors
- To study working, construction and applications of special ac and dc motor

Course Outcomes

- Able to distinguish between normal types of motors and special types of motors
- Understand the working of servomotors, stepper motors reluctance motors
- Understand and able to select the suitable motor for the type of load

Curriculum Content

Unit 1 Poly-phase AC Machines: Construction and performance of double cage and deep bar three phase induction motors; e.m.f. injection in rotor circuit of slip ring induction motor, concept of constant torque and constant power controls, static slip power recovery control schemes (constant torque and constant power), Introduction to multiphase machines.

Unit 2 Single phase Induction Motors: Construction, starting characteristics and applications of split phase, capacitor start, capacitor run, capacitor start, capacitor-run and shaded pole motors. Two Phase AC Servomotors: Construction, torque-speed characteristics, performance and applications

Unit 3 Stepper Motors: Principle of operation, variable reluctance, permanent magnet and hybrid stepper motors, characteristics, drive circuits and applications.
Switched Reluctance Motors: Construction; principle of operation; torque production, modes of operation, drive circuits

Unit 4 Permanent Magnet Machines: Types of permanent magnets and their magnetization characteristics, demagnetizing effect, permanent magnet dc motors, sinusoidal PM ac motors, brushless dc motors and their important features and applications, PCB motors. Single phase synchronous motor; construction, operating principle and characteristics of reluctance and hysteresis motors; introduction to permanent magnet generators.

Unit 5 Single Phase Commutator Motors: Construction, principle of operation, characteristics of universal and repulsion motors; Linear Induction Motors. Construction, principle of operation, Linear force, and applications

Textbook(s)

1. P.S. Bimbhra "Generalized Theory of Electrical Machines" Khanna Publishers.
2. P.C. Sen "Principles of Electrical Machines and Power Electronics" John willey & Sons, 2001

Reference Books

1. G. K. Dubey "Fundamentals of Electric Drives" Narosa Publishing House, 2001
2. Cyril G. Veinott "Fractional and Sub-fractional horse power electric motors" McGraw Hill International, 1987
3. M.G. Say "Alternating current Machines", Pitman & Sons

Department Offering the Course	**EECE**
Course Code	EEF448
Course Title	Power Quality
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of power quality disturbances, and their causes, detrimental effects and solutions, sag and swell, short duration/long duration voltage variations, voltage imbalance, waveform distortion, voltage fluctuations, power frequency variation, Poor load power factor, loads containing harmonics, notching in load voltage, DC offset in loads, unbalanced loads, disturbance in supply voltage, harmonic distortion: IEEE, IEC, EN, NORSOK, 2-pulse, 6-pulse and 12-pulse converter configurations, Effect of Harmonics, Elimination/Suppression of Harmonics.

Course Objectives

- Learn to distinguish between the various categories of power quality problems.
- Understand the root of the power quality problems in industry and their impact on performance and economics.
- Learn to apply appropriate solution techniques for power quality mitigation based on the type of problem

Course Outcomes

- Understand the definition of power quality disturbances, and their causes, detrimental effects and solutions;
- Understand the causes of power quality problems and relate them to equipment.
- To introduce the harmonic sources, passive filters, active filters and standards.
- To know the power quality monitoring method, equipment's and develop the ability to analyse the measured data

Curriculum Content

Unit 1 Power Quality Terms and Definitions: Introduction, transients, sag and swell, short duration/long duration voltage variations, voltage imbalance, waveform distortion, voltage fluctuations, power frequency variation.

Power Quality Problems: Poor load power factor, loads containing harmonics, notching in load voltage, DC offset in loads, unbalanced loads, disturbance in supply voltage

Unit 2 Fundamentals of Harmonics: Representation of harmonics, waveform, harmonic power, measures of harmonic distortion; current and voltage limits of harmonic distortion: IEEE, IEC, EN, NORSOK

Causes of Harmonics: 2-pulse, 6-pulse and 12-pulse converter configurations, input current waveforms and their harmonic spectrum; Input supply harmonics of AC regulator, integral cycle control, cycloconverter, transformer, rotating machines, ARC furnace, TV and battery charger.

Unit 3 Effect of Harmonics: Parallel and series resonance, effect of harmonics on static power plant- transmission lines, transformers, capacitor banks, rotating machines, harmonic interference with ripple control systems, power system protection, consumer equipments and communication systems, power measurement.

Unit 4 Elimination/Suppression of Harmonics: High power factor converter, multi-pulse converters using transformer connections (Delta, polygon)
Passive Filters: Types of passive filters, single tuned and high pass filters, filer design criteria, double tuned filters, damped filters and their design.

Unit 5 Active Power filters: Compensation principle, classification of active filters by objective, systems configuration, power circuit and control strategy.
Shunt Active Filter: Single phase active filter, principle of operation, expression for compensating current, concept of constant capacitor voltage control; Three phase active filter: Operation, analysis and modeling; Instantaneous reactive power theory
Three phase series active filters: Principle of operation, analysis and modeling.
Other Techniques: Unified power quality conditioner, voltage source and current configurations, principle of operation for sag, swell and flicker control

TEXTBOOK(S)

1. Roger. C. Dugan, Mark. F. McGranagham, Surya Santoso, H.Wayne Beaty, ‘Electrical Power Systems Quality’ McGraw Hill, 2003. (For Chapters1,2,3, 4 and 5)

REFERENCE BOOKS

1. G.T. Heydt, 'Electric Power Quality', 2nd Edition. (West Lafayette, IN, Stars in a Circle Publications, 1994). (For Chapter 1, 2, 3 and 5)
2. M.H.J Bollen, ‘Understanding Power Quality Problems: Voltage Sags and Interruptions’, (New York: IEEE Press, 1999). (For Chapters 1, 2, 3 and 5)
3. J. Arrillaga, N.R. Watson, S. Chen, 'Power System Quality Assessment', (NewYork: Wiley, 1999

Department Offering the Course	**EECE**
Course Code	EEF449
Course Title	Power Semiconductor Controllers
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	Power Electronics
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of power conditioners, uninterruptible power supplies; dc power supplies: comparison of linear and switched-mode power supplies, Analysis and simulation of Power Electronic Circuits, Recent advances in power devices, Three-phase ac regulators, multiple converters, application of different converters in solar and wind energy systems.

Course Objectives

- To give the exposure to types of power supplies
- To give the exposure to types of resonant converter used in real world applications
- To analyse and gain knowledge about practical exposure and applications of different power electronic controllers.

Course Outcomes

- A student will have exposure to types of power supplies
- A student will have exposure to types of resonant converter used in real world applications
- A student will be able to analyse and gain knowledge about practical exposure and applications of different power electronic controllers

Curriculum Content

Unit 1 Power Supplies: Introduction, ac power supplies: power quality, power supply protection, power conditioners, uninterruptible power supplies; dc power supplies: comparison of linear and switched-mode power supplies, dc to dc converters with electrical isolation: forward, push-pull and bridge converter, SMPS.

Unit 2 Resonant Converters: Switched-mode inductive current switching, significance of ZVS and ZCS, classification of resonant converters, series and parallel load resonant converters, Class-E converters, ZCS/ZVS resonant switch converters and their switch configurations, resonant dc link converters and their circuit configurations.

Unit 3 Analysis and simulation of Power Electronic Circuits: Analysis of simple power electronic circuits with RL, RC and RLC type loads and dc / sinusoidal sources; performance of transformers for high frequency applications, computer simulation of power electronic devices and systems.

Unit 4 Recent Power Semiconductor Devices: Recent advances in power devices and their relative merits, power modules, protection of devices and converters, heat management.

Unit 5 Applications of Different Controllers: Three-phase ac regulators, multiple converters, application of different converters in solar and wind energy systems as well as in dispersed generation, current trends in power electronics.

TEXTBOOK(S)

1. M. H. Rashid (Editor), Power Electronics Handbook, Academic Press, California.

REFERENCE BOOKS

1. N. Mohan, T.M.Undeland and W.P. Robins, Power Electronics, John Wiley, Singapore, 3rd ed.
2. M. H. Rashid, Power Electronics, PHI Learning, 3rd ed, New Delhi.
3. G.K. Dubey et al, Thyristorised Power Controllers, New Age International, New Delhi.

Department Offering the Course	EECE
Course Code	EEF353
Course Title	Introduction to Artificial Intelligence
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of AI; Foundations of AI, History of AI; Problem solving; Problem-solving agents; Searching for solutions; Fuzzy theory, Search Strategies, Knowledge based agents; Logic; Propositional and Predicate logic; Reasoning patterns in propositional logic, Functional anatomy of neuron; Artificial neuron models; Neural network architectures; Activation functions; Rationale and basics of learning; Learning rules, Supervised and Unsupervised Networks.

Course Objectives

- To become familiar with new technologies like AI being used in electrical engineering
- To become familiar with uses of AI in Electrical Engineering

Course Outcomes

- To have a basic idea about the concept of AI and its working
- To be able to apply AI for electrical engineering

Curriculum Content

Unit I Introduction to Artificial Intelligence (AI) and Fuzzy Logic: Introduction to AI; Foundations of AI; History of AI; Problem solving; Problem-solving agents; Searching for solutions; Fuzzy theory: Set- theoretic operations, Member function formulation and parameterization, Fuzzy Rules, Relations and Reasoning.

Unit II Search Strategies: Uninformed Search Strategies: Breadth-first search, Depth-first search, Depth-limited search, Bidirectional search; Informed search strategies: Greedy best-first search, A* search, Memory-bounded heuristic search; Local Search algorithms: Hill climbing search, Simulated annealing search; Adversarial search: Minimax algorithm, alpha-beta pruning.

Unit III Knowledge and Reasoning: Knowledge based agents; Logic; Propositional and Predicate logic; Reasoning patterns in propositional logic; First-order logic: Syntax and semantics, Models for first- order logic, Inference rules; Rule based systems: Forward and backward reasoning.

Unit IV Neural Network Fundamentals: Functional anatomy of neuron; Artificial neuron models; Neural network architectures; Activation functions; Rationale and basics of learning; Learning rules.

Unit V Supervised and Unsupervised Networks: Perceptrons; Perceptrons convergence theorem; Mutilayer Perceptrons; Single layer networks; Limitations of single layer network; Multi-layer Networks; Back propagation algorithm; Radial basis function Networks; Self-organizing networks.

TEXTBOOK(S)

1. Stuart Russell and Peter Norvig Artificial Intelligence: A Modern Approach, 2 nd edition, Prentice Hall of India, 2004.
2. D W Patterson Introduction to Artificial Intelligence and Expert Systems, Prentice Hall of India, 1998.

REFERENCE BOOKS

1. Simon Haykin Neural Networks: A Comprehensive Foundation, 2nd edition, Pearson Education, 2004
2. Satish Kumar Neural Networks: A Classroom Approach, Tata McGraw Hill, 2004
3. Timothy J Ross Fuzzy Logic with Engineering Applications, McGraw Hill Inc, 2001.
4. J.S.R. Jang, C.T. Sun and E. Mizutani Neuro-Fuzzy and Soft Computing, PHI, 2004

Department Offering the Course	**EECE**
Course Code	EEF347
Course Title	Transducers and Instrumentation
Credits (L:T:P:C)	2:0:1:3
Contact Hours (L:T:P)	2:0:2
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of Identification, classification construction, working principle and application of various transducers used for Displacement measurement, Temperature measurement, Level measurement, and Miscellaneous measurement, Thermal Sensors, Pressure Sensors, Opto-Electronic Sensors, Measurements of Liquid Level, Measurement of Humidity, Measurement of pH value, Sound measurement of using Microphone, ultrasonic sensors, Measurement of Nuclear Radiations: Geiger Muller Tube, Scintillation detectors, MEMS Sensors.

Course Objectives

- To make students understand the Identification, classification construction, working principle and application of various transducers used for Displacement measurement, Temperature measurement, Level measurement, and Miscellaneous measurement
- To make the students learn the selection procedure, applications and comparative study of various Transducers
- To understand the role of the various elements of a measurement system and to specify and evaluate a measurement system for a given application
- To make the students evaluate the technological and physical limitations of a specific sensor and propose a suitable sensor for a given measurement situation

Course Outcomes

- Able to understand Working principles of sensors and transducers.
- Able to take Measurement of physical quantities like displacement, temperature, pressure, etc.
- Able to understand the Applications of various transducers used in industry.
- Able to analyze smart sensors for their relevant applications

Curriculum Content

Unit 1 Transducers: Definition, principle of sensing & transduction, classification, Static and Dynamic characteristics. Mechanical and Electro-mechanical sensors: Resistive Transducers – potentio-metric type (linear and logarithmic), Strain gauge- resistive and semiconductor type, rosettes. Inductive sensors - Reluctance type, Mutual inductance, LVDT: Construction, material, I/O curve, applications, RVDT, Hall Effect Sensor. Capacitive transducers - variable distance-parallel plate type, variable area- parallel plate, cylindrical type, and variable dielectric constant type. Piezoelectric element: piezoelectric effect, materials**.**

Unit 2 Thermal Sensors: Classification, Bimetallic Thermometer, Resistance thermometer (RTD), Thermistors, Thermocouples – Principle of working, Thermoelectric Laws, Radiation Pyrometers, Optical Pyrometers, Pyrometers, Liquid Crystal Thermometer, Digital Thermometer.

Unit 3 Pressure Sensors: Types, Manometers, Bourdon Tube – C Type, spiral type, Helical Type, Bellows, Diaphragms, Pressure Measurement using: LVDT, Potentiometer, Photoelectric Transducer.

Unit 4 Opto-Electronic Sensors: Photo-emissive transducer, Photo-Conductive Transducer, Photo-Voltaic Transducer, Applications of Photo Diode and Photo Transistors as transducers, Optical encoders, Stroboscope, Fibre Optic Sensors.

Unit 5 Miscellaneous Measurements: Measurements of Liquid Level, Measurement of Humidity, Measurement of pH value, Sound measurement of using Microphone, ultrasonic sensors, Measurement of Nuclear Radiations: Geiger Muller Tube, Scintillation detectors, MEMS Sensors, Introduction to Smart Sensors.

TEXTBOOK(S)

1. D. Patranabis, “Sensors and Transducers,” 2nd edition, Prentice Hall of India Private Limited
2. Ian R. Sinclair, “Sensors & Transducers”, 3rd Edition, Newnes Publications.
3. E.O. Doebelin and Dhanesh N Manik, “Measurement Systems,” 6th Edition, McGraw Hill Education, India

REFERENCE BOOKS

1. B.C. Nakra & K. Chaudhry, “Instrumentation, Measurement and Analysis”, Tata Mc Graw Hill 2nd Edition.
2. A.K. Sawhney and Puneet Sawhney, “Mechanical Measurements & Instrumentation & Control,” Dhanpat Rai & Co., India
3. D.V.S. Murthy, “Transducers and Instrumentation,” Prentice Hall of India Private Limited (2003).

List of Experiments

1. Measurement of unknown resistance with the help of a dc potentiometer.
2. To determine the characteristics of LVDT
3. To determine the characteristics of RVDT.
4. Measurement of strain using strain gauge.
5. Measurement of load using strain gauge based load cell.
6. Temperature measurement using thermocouple.
7. Temperature measurement using RTD.
8. Pressure measurement using Bourdon Tube.
9. Measurement of speed using Stroboscope/optical encoder.
10. Displacement measurement using IR Sensor.

Department Offering the Course	**EECE**
Course Code	EEF464
Course Title	Digital Instrumentation Techniques
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	Measurements & Instrumentation, Transducers
Course Basket	Discipline Elective

Course Summary

This course provides knowledge about the digital techniques used for measuring and analysing various electrical and non-electrical signals. This course provides knowledge of Data Acquisition & Processing Techniques, Analysis & Record of Signals and Realization of Digital Instruments in Process Control

Course Objectives

To introduce the concepts of digital techniques for measurement, signal conditioning, acquisition, analyzing, recording and displaying for electrical/non-electrical signals.

Course Outcomes

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

1. Know the use of digital counting techniques and working of various digital instruments for measurement of electrical quantities.
2. Apply measurement, signal conditioning, acquisition, and know the digital hardware configurations for the above processes.
3. Analyze continuous and logic signals using various analyzers in time as well as frequency domain, and logging signal.
4. Apply various schemes for the measurement of non-electrical quantities using digital measurement methods and displaying techniques.

Curriculum Content

Unit-I Digital Measurement of Electrical Quantities

Resolution, Sensitivity, Loading effect of digital instrument, Counters & Registers, Digital voltmeters, Digital Multimeter, Digital methods for the measurement of power and energy, Digital LCR meter, Low and high frequency measurement

Unit –II Data Acquisition & Processing Techniques

Introduction to digital signal processing, Implementation of ADC and types, Implementation of DAC and types

Distortions in ADC & DAC, signal conditioning, DAQ hardware configuration, DFT, FCT, DCT, realization in digital circuits

Unit –III Analysis & Record of Signals

Digital Oscilloscope, types, bandwidth, Spectrum analyzer, types of spectrum analyzers, Logic analyzer, types, triggering, Data logging: local & remote acquisition

Unit –IV Realization of Digital Instruments in Process Control
Transducers for non-electrical quantities, multiplexing of transducers, Digital Encoders & Decoders, Measurement schemes for various non-electrical quantities, display devices, drivers and multiplexers

TEXTBOOK(S)

1. T. S. Rathore, "Digital measurement Techniques," CRC Press, 2003.
2. Thomas L. Floyd, "Digital Fundamentals", 11th edition, Pearson, 2014.
3. H. S. Kalsi, "Electronic instrumentation," Tata McGraw-Hill Education, 2004.

REFERENCE BOOKS

1. Klaas B. Klaassen, "Electronic measurement and instrumentation, "Cambridge University Press," 2006
2. David A. Bell, "Electronic instrumentation and measurements," OUP Canada, 2nd edition, 2006.
3. A. J. Bouwens, "Digital Instrumentation," McGraw-Hill, 1984.
4. 7. Relevant journals/ Magazines / IEEE Transaction papers.

Department Offering the Course	**EECE**
Course Code	EEF458
Course Title	Solar PV System
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

This course provides knowledge about the types of solar PV modules and arrays. The criteria and analysis of performance of solar modules as well their interconnections, It provides knowledge about the components which are the part of PV modules, about batteries and DC-DC converters. It also provides information about the types of solar PV power system their design and installation.

Course Objectives

To study and analyze the components, design and installation of the solar PV systems.

Course Outcomes

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

1. Classify different types of solar PV modules required and learn their performance index.
2. Analyze the different components of solar PV system.
3. Analyze different types of Solar PV Power System.
4. Design a suitable solar PV power system.

Curriculum Content

Unit- 1: Solar PV Modules and Arrays

Introduction to PV System, Solar PV Module- Selecting criteria and performance analysis, Module interconnections, Solar PV Array- Design and assembly, Solar PV array characteristics and output conditioning

Unit- 2: Solar PV System and Components

Solar Inverter – Its characteristics and performance analysis, Batteries - Its characteristics and performance analysis, DC-DC converters and Maximum Power Point Tracking, Protection Devices and Switchgear assemblies, Balance of System Components

Unit- 3: Solar PV Power System

Types of SPV power systems, Grid connected power systems, Remote area power systems, Specific purpose Photovoltaic systems: Space – Marine –Telecommunication – water pumping – refrigeration etc.

Unit- 4: Power system design and installations

Power considerations and system design- Array integration, electrical integration, utility integration, Inspection and commissioning, Distributed power generation, Hybrid systems

TEXTBOOK(S)

1. Photovoltaic Systems, 2nd Edition, by James P. Dunlop, Publisher: American, Technical Publishers, Inc. 2010

REFERENCE BOOKS

1. Photovoltaics: Design and Installation Manual, by Solar Energy International, Publisher- New Society Publishers, (2004).
2. C. S. Solanki, Solar Photovoltaic Technology and Systems, PHI

Department Offering the Course	**EECE**
Course Code	EEF451
Course Title	Instrumentation for Solar Energy System
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	Measurements & Instrumentation, Transducers
Course Basket	Discipline Elective

Course Summary

This course provides knowledge about the types and characteristics of instruments. It provides knowledge about the instruments used for the measurements of various parameters related to solar thermal system, about path finder, abut solar simulators. It also provides knowledge about interconnection and metering

Course Objectives

To study the working principle of various instruments and control devices used in Solar PV systems.

Course Outcomes

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

1. Classify different types of instruments required and learn their performance index.
2. Analyze the instruments required for solar thermal system.
3. Analyze the instruments required for solar PV system.
4. Design a suitable metering system for solar PV system.

Curriculum Content

Unit- 1: Characteristics of Instruments

Classification of instruments, Characteristics–Static and dynamics, Systematic and random errors -Statistical analysis –Uncertainty, Selection and reliability, Intelligent instruments -Physical variables -Error reduction.

Unit- 2: Instrument for Solar Thermal System

Measurement of temperature, pressure and flow, Data logging and acquisition, Sensors for heat flow measurements, Heat flux meters, Instruments for analysing Flat plate collectors

Unit- 3: Instruments for solar PV System

Instruments for Solar radiation, Solar pathfinder/ sun eye, Instruments for analysing PV performance Solar Simulators, Instruments for analysing battery performance

Unit- 4: Interconnection and metering

Interconnection and metering – Deciding factors, Gross Metering – Grid Tied LT and HT, Gross metering using 1 meter, 2 meters and for multiple buildings, Net metering – Grid Tied LT and HT, Net metering using 1 meter, 2 meters and for multiple buildings

TEXTBOOK(S)

1. Raman.C. S, Sharma. G.R, Mani. V.S.V, "Instrumentation Devices and Systems", Tata McGraw-Hill.

REFERENCE BOOKS

1. Doeblin, "Measurement System Application and Design", McGraw-Hill, 2010.
2. 3. Morris. A.S, "Principles of Measurements and Instrumentation", Prentice Hall of India, 2009

COURSE STRUCTURE & SYLLABUS OF B. TECH – ELECTRICAL ENGINEERING APPLICABLE FOR BATCH (2022-25)

Department Offering the Course	**EECE**
Course Code	EEF341
Course Title	Solar Thermal Systems
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

This course provides knowledge regarding solar radiation measurement methods, about analysing the performance of solar thermal collectors, use of solar energy for distillation, drying, cooking, heating and cooling in buildings and power generation

Course Objectives

To impart knowledge of measurement and prediction of solar radiation; performance analysis of solar thermal systems for domestic and industrial applications.

Course Outcomes

After successful completion of this course, the students will be able to:

1. Predict direct and diffuse radiation on different dates, times and locations.
2. Apply solar radiation measurement methods.
3. Analyse the performance of solar thermal collectors.
4. Use solar energy for distillation, drying, cooking, heating and cooling in buildings and power generation

Curriculum Content Unit I: Solar Radiation

Solar Radiation: Extra-terrestrial and terrestrial solar radiation, Solar Time, Solar radiation geometry, Radiation on inclined surface, Solar radiation data, Measurement of solar radiation, Empirical Equations for estimation of solar radiation

Unit II: Flat Plate Collectors

Flat plate collectors; Basic energy balance equation, Transmissivity of the cover system, Transmissivity- absorptivity product, Overall loss coefficient and heat transfer correlations, Useful energy collection in liquid flat plate collector, collector efficiency factor, Collector heat removal factor, efficiency of flat plate collector, Effect of various parameters on performance of plat plate collectors, selective coatings, etc., Transient analysis of flat plate collectors , Testing procedure of flat plate collectors

Unit III: Solar Air Heater

Solar air heater; types and applications, Performance analysis of conventional air heater, Solar water heating system, Concentrating collectors; types and applications, Solar distillation, Thermal analysis of solar still, Solar dryers; types and applications

Unit IV: Solar Cooking

Solar cooking; Testing procedure of solar cooker, Solar thermal power generation, Solar thermal energy storage; types, analysis of liquid storage tank, Active and passive heating & cooling of buildings

TEXTBOOK(S)

1. Solar Engineering of Thermal Processes by Duffie & Beckman; Willey & Sons.
2. Principles of Solar Engineering by Goswami, Kreider & Kreith; Taylor & Francis.

REFERENCE BOOKS

1. Solar Energy: Principles Thermal collection and Storage by S.P. Sukhatme and J.K.Nayak, Tata McGraw Hill.
2. Solar Heating and Cooling: Active and Passive Design by Kreider & Kreith, Hemisphere Publishing Corporation.
3. Solar Energy: Fundamentals, Design, Modelling and Applications by G. N. Tiwari, Narosa Publising

Department Offering the Course	EECE
Course Code	EEF452
Course Title	Power System Stability
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

This course knowledge about the types of stability, solutions of swing equation for both a single machine and a multi machine system for stability studies. It provides understanding of the both small single stability analysis, transient stability, sub synchronous and torsional oscillations, voltage collapse, static and dynamic analysis of voltage stability.

Course Objectives

The goal of the course is to make the student understand the transient as well as small signal stability for single and multi-machine system and voltage stability of power systems.

Course Outcomes

After successful completion of this course students will be able to:

1. Understand the concepts of different type of stability problems in power systems.
2. Analyse single and multi-machine systems for transient stability.
3. Understand the enhancement of small signal stability using power system stabilizer and FACTS controllers.
4. Analyse voltage stability problems.

Curriculum Content

Unit I Review of Stability Concept:

Definition, Broad classification, Various modes of small signal oscillations, Rotor dynamics and Swing equation, Power angle equation, equal area criterion, Solution of Swing equation of a single and multimachine system: Modified Euler, R-K 4th Order Methods.

Unit II Small signal stability analysis

Small signal stability analysis of a single machine infinite bus system (i) Generator represented by the classical model (ii) Effect of synchronous machine field circuit dynamics including excitation and Power System

Stabilizer (PSS), Small signal stability analysis of multi-machine systems: Eigen value and time domain analysis. Improvement of Small signal stability using FACTS devices.

Unit III Transient stability analysis, Sub-synchronous and Torsional Oscillations

Transient stability analysis of multi-machine systems- digital simulation. Direct method of stability analysis of a single and multi-machine systems using Lyapunav energy function. Methods of enhancing transient stability Introduction, Subsynchronous resonance (SSR) Theory, Classification of SSR, Torsional Oscillations/Interaction with power system control, Computation of Torsional Natural frequencies of shaft system, Countermeasures to SSR.

Unit IV Voltage stability

Basic concept of voltage stability, Voltage Collapse, Transmission system characteristics of radial system, P-V and Q-V curves methods, Criteria for assessing voltage stability, Static analysis and Dynamic analysis.

TEXTBOOK(S)

1. P. Kundur Power System Stability and Control, Mc - Graw Hill.
2. K. R. Padiyar, Power System Dynamics, Stability & Control, Interline Publishers, Bangalore.

REFERENCE BOOKS

1. P. Saur and M. A. Pai, Power System Dynamics & Stability, Prentice Hall
2. G.W. Stagg & A.H. Al-Abiad, Computer Methods in Power System, Mc - Graw Hill.
3. Jan Machowski and others, Power System Dynamics Stability and Control
4. 6. C.W.Taylor. Power System Voltage Stability

Department Offering the Course	**EECE**
Course Code	EEF453
Course Title	Wind and Small Hydro Power (SHP) Energy Systems
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

This course provides knowledge about types of wind energy systems, horizontal axis and vertical axis wind turbines, mini micro hydroelectric power plants and their control strategies

Course Objectives

To introduce fundamentals of wind and small hydro energy system and their technologies used to harness usable energy from wind and hydro energy sources.

Course Outcomes

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

1. Identify wind energy systems.
2. Understand the mechanism of extraction of power from wind energy resources.
3. Understand the various components of hydro power plants.
4. Understand the marketing issues and control strategies of stand-alone and hybrid energy systems.

Curriculum Content Unit-I Introduction

Introduction of wind energy systems, General theories of wind machines, Basic laws and concepts of aerodynamics, Micro-siting

Unit-II Wind Power Extraction

Description and performance of the horizontal-axis wind machines, Description and performance of the vertical-axis wind machines, Blade design, Generation of electricity by wind machines, case studies, Electrical and pitch controller design

Unit-III Hydro Power Plants

Overview of micro, mini and small hydro, Site selection and civil works, Penstocks and turbines, Speed and voltage regulation

Unit-IV

Control Strategies of Wind, Hydro and Hybrid Power Systems, Investment issues, load management and tariff collection, Distribution and marketing issues, case studies, Wind and hydro based stand-alone/hybrid power systems, Control of hybrid power systems, Wind diesel hybrid systems

TEXTBOOK(S)

1. B. H. Khan, “Conventional Energy Source” Second Edition, Tata McGraw Hill, 2009

REFERENCE BOOKS

1. J.W. Twidell & A.D. Weir, Renewable Energy Resources, (ELBS / E. & F.N. Spon., London).
2. Djamila Rekioua, Wind power electric systems, Modeling, Simulation and Control. Springer,
3. Qiuwei Wu, Yuanzhang Sun, “Modeling and control of wind power”, John Wiley and Sons, pub.

Department Offering the Course	EECE
Course Code	EEF354
Course Title	Telemetry and Data Transmission
Credits (L:T:P:C)	2:0:1:3
Contact Hours (L:T:P)	2:0:2
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

This subject provides knowledge about Data Formats, DM code converters, PSK, QPSK, FSK, Sensors, Signal conditioners, Multiplexing- high level and low level, ADC- range and resolution, Word Format, Frame format, Frame synchronizer codes, R. F. links, X24, RS 422, RS423, RS 232C interfaces, Multiplexing techniques in telecontrol, Industrial telecontrol

Course Objectives

- To study about various digital modulation techniques
- To study about data handling and data reception systems
- To study about various control systems used and the types of command system
- To study about telemetry systems

Course Outcomes

On successful completion of the course, students will be able to achieve the following:

- To have knowledge about data sampling and digital modulation techniques used
- To have knowledge and understanding of requirements for data handling and data analysis
- To have knowledge about the techniques to be used for data transmission using various technique

Curriculum Content

Unit 1 Sampling Fundamentals: Introduction to sampling theorem and sampling process, convolution, computing minimum sampling rate. Alising Errors.

Digital Modulation Techniques: Review of PCM, DPCM, Methods of binary data transmission, Data Formats, DM code converters, PSK, QPSK, FSK, probability of error, phase ambiguity resolution and differential encoding, error detection, error correction, error correction codes.

Unit 2 Data Handling System: Block schematic, Sensors, Signal conditioners, Multiplexing- high level and low level, ADC- range and resolution, Word Format, Frame format, Frame synchronizer codes, R. F. links, X24, RS 422, RS423, RS 232C interfaces, Multi terminal configuration, Multiplier & Concentrator, Data Modems, Data transmission over telephone lines.

Unit 3 Data Reception Systems: Bit synchronizers, frame synchronizers, sub frame synchronizers, PLL, Display systems.

Unit 4 Remote Control: Communication based processing control systems, pipelines, Operational security systems components, Pipeline control, Power system control, Programmable controllers

for factory automation.
Command: Tone command system, Tone digital command system, ON/OFF command and data commands.

Unit 5 Aerospace Telemetry: Signal formation and conversion, Multiplexing techniques in tele control, Industrial tele control installations, reliability in tele control installations**.**

List of Experiments

1. To plot the Characteristics of Strain gauge
2. To plot the Characteristics of load cell
3. To plot the Characteristics of thermistor
4. To plot the Characteristics of RTD
5. To plot the Characteristics of Thermocouple
6. To study the Loading effect of Potentiometer
7. To plot the Characteristics of Synchros
8. To plot the Characteristics of LVDT
9. To plot the Characteristics of Piezo-electric transducer

TEXTBOOK(S)

1. Patranabis," Telemetry Principles: Tata McGraw Hill.
2. Schweber," Data Communication "McGraw Hill.

REFERENCE BOOKS

1. Berder & Menjewlse," Telemetry Systems

Department Offering the Course	**EECE**
Course Code	ECF348
Course Title	Biomedical Instrumentation
Credits (L:T:P:C)	2:0:1:3
Contact Hours (L:T:P)	2:0:2
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

This course introduces the students to the various technical details of the different biomedical Instrumentation systems aiming to make them aware of the principles and concepts involved

Course Objectives

- Requirement of bio-medical and its application
- Concept of bio-potential electrodes and measurements related to them.
- Concepts of bio-transducers and measurements related to them.
- Concept of bio-medical instruments and their uses.

Course Outcomes

On successful completion of the course, students will be able to achieve the following: The course provides an understanding of:

- Bio-medical instruments and measurements.
- Principle of working of bio-medical transducers.
- Skills to use modern bio-medical tools and equipment for measurements related to human body.

Curriculum Content

Unit 1: Anatomy and Physiology:

Basic Cell Functions, Origin of Bio-potentials, Electrical Activity of Cells, components of man Instrument system, types of bio-medical stems, design factors and limitations of biomedical instruments, terms and transducers to various physiological events.

Unit 2: Bio-Potential Electrode:

Types of bio-potential electrodes., Electrode-Electrolyte interface, half-cell potential, Polarization-polarisable and non- polarisable electrodes, Ag/AgCl electrodes, Electrode circuit model; Electrode and Skin interface and motion artifact. Body surface recording electrodes for ECG, EMG, EEG. Electrodes standards.

Unit 3: Bio-Transducer:

Transduction Principles: Resistive Transducers Strain Gauge- types, construction, selection materials, Gauge factor, Bridge circuit, Temperature compensation. Strain Gauge Type Blood pressure transducers. Thermo resistive transducer, Inductive Transducers, Capacitive Transducer Piezoelectric Transducer Bio Potential Measurement.

Unit 4: Biomedical Instrumentation Cardiac Measurement:

Cardiovascular System, Heart Structure, Cardiac Cycle, ECG Theory, ECG Electrodes, Electrocardiograph, Indicator dilution methods; Measurement of continuous Cardiac output derived from aortic pressure waveforms, cardiac Arrhythmias; Phonocardiogram, Measurement of heart rate, Blood pressure, Temperature, Respiration rate, Blood Flow meters.

Unit- 5: Biotelemetry and Electrical Safety:

Bio-telemetry design, single channel bio telemetry transmitter and receiver system based on AM, FM and, pulse modulation. Significance of Electrical Danger, physiological effect of current, ground shock Hazards.

TEXTBOOK(S)

1. Joseph J. Carr & John. M. Brown, 'Introduction to Biomedical Equipment technology'

REFERENCE BOOKS

1. J.G. Webster, 'Medical instrumentation application and design', Houghton Miffin Co., Boston USA. 2.Mohan Murali H, 'Monograph on Biomedical engineering', O.U. Press 1985.
2. Geddes L. A. & L. E. Baker, 'Principles of Applied Biomedical Instrumentation', Wiley, 1989.
3. Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer, 'Biomedical Instrumentations and Measurements' (2^{nd} edition), PHI, 1991.
4. R.S. Khandpur, 'Handbook of Biomedical Instrumentation', McGraw Hill.

List of Experiments

1. Pulse measurement
2. Heartbeat measurement
3. Automatic BP measurement
4. Heart sound study using electronics stethoscope
5. ECG measurement
6. Following experiments to be done on the breadboard
7. Design of low noise and low frequency amplifier for biomedical application
8. Design of Instrumentation amplifier
9. Construction of chopper amplifier
10. Two Value Added Experiments to be added by Instructor

COURSE STRUCTURE & SYLLABUS OF B. TECH – ELECTRICAL ENGINEERING APPLICABLE FOR BATCH (2022-25)

Department Offering the Course	**EECE**
Course Code	EEF459
Course Title	Basic Instrumentation and Process Control
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

This course provides knowledge about types of transducers, their classifications, strain gauges, LVDT, RVDT, Thermistors, Opto-electronic transducers, measurement of force, pressure, temperature. It provides knowledge about types of telemetry systems.

Course Objectives

- To make students understand the construction, working principle and application of various transducers used for flow measurement, strain measurement, pressure and vacuum measurement, force, torque and power measurement
- To develop an understanding about the different types of telemetry systems used and types of instruments required for display and recording of the data to be transmitted
- Understand about components, characteristics of various control processes used and their modes of operation

Course Outcomes

- Identify the appropriate instruments for measurement of different quantities.
- Ability to analyse, formulate and select suitable sensor for the given industrial applications
- Ability to analyse various control processes used and their modes of operation.

Curriculum Content

Unit 1 Transducer – I: Definition, advantages of electrical transducers, classification, characteristics, factors affecting the choice of transducers, Potentiometers, Strain guages, Resistance thermometer, Thermistors, Thermocouples, LVDT, RVDT

Unit 2 Transducer – II: Capacitive, Piezoelectric Hall effect and opto electronic transducers. Measurement of Motion, Force pressure, temperature, flow and liquid level.

Unit 3 Telemetry: General telemetry system, land line & radio frequency telemetering system, transmission channels and media, receiver & transmitter. Data Acquisition System: Analog data acquisition system, Digital data acquisition system, Modern digital data acquisition system.

Unit 4 Telemetry: General telemetry system, land line & radio frequency telemetering system, transmission channels and media, receiver & transmitter. Data Acquisition System: Analog data acquisition system, Digital data acquisition system, Modern digital data acquisition system.

Unit 5 Display Devices and Recorders: Display devices, storage oscilloscope, spectrum analyser, strip chart & x-y recorders, magnetic tape & digital tape recorders.

Process Control: Principle, elements of process control system, process characteristics, proportional (P), integral (I), Derivative (D), PI, PD and PID control modes. Electronic, Pneumatic & digital controllers.

TEXTBOOK(S)

1. A.K.Sawhney, "Advanced Measurements & Instrumentation", Dhanpat Rai & Sons
2. B.C. Nakra & K.Chaudhry, "Instrumentation, Measurement and Analysis", Tata Mc Graw Hill 2nd Edition.
3. Curtis Johns, "Process Control Instrumentation Technology", Prentice Hall

REFERENCE BOOKS

1. E.O. Decblin, "Measurement System – Application & design", Mc Graw Hill.
2. W.D. Cooper and A.P. Beltried, "Electronics Instrumentation and Measurement Techniques" Prentice Hall International
3. Rajendra Prasad,"Electronic Measurement and Instrumentation Khanna Publisher
4. M.M.S. Anand, "Electronic Instruments and Instrumentation Technology" PHI Learning.

Department Offering the Course	**EECE**
Course Code	Eef355
Course Title	New and Renewable Energy Sources
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (If Any)	None
Course Basket	Discipline Elective

Course Summary

This course provides knowledge about different types of energy resources like solar, wind, biomass, MHD

Course Objectives

- To introduce fundamentals of various renewable energy source
- To introduce fundamentals of technologies used to harness usable energy from solar, wind,
- To introduce fundamentals of technologies used to harness usable energy from ocean and Biomass energy sources

Course Outcomes

- Able to identify renewable energy sources.
- Able to understand the mechanism of solar, wind and ocean energy sources.
- Able to demonstrate the understanding of various technologies involved in power generation from renewable energy sources.

Curriculum Content

Unit 1 Introduction: Energy resources and their classification, oil crisis of late 20th century and its impacts on energy planning, consumption trend of primary energy sources, world energy future, energy audit and energy conservation, energy storage.

Unit 2 Solar Energy Conversion: Solar resources, passage through atmosphere, solar thermal energy conversion: solar energy collectors, solar thermal power plant, solar PV conversion: solar PV cell, V-I characteristics, MPPT, Solar PV power plant and applications.

Unit 3 Biomass Energy Conversion: Usable forms of Bio Mass, Biomass energy resources, biomass energy conversion technologies, ethanol blended petrol and diesel, biogas plants. Energy farming.

Unit 4 Wind Energy Conversion: Wind Power: Energy estimation, Power extraction, lift and drag forces, horizontal axis wind turbine, vertical axis wind turbine, wind energy conversion and control schemes, environmental aspects.

Unit 5 Other Alternate Energy Sources/Technologies: Geothermal Energy: geothermal fields, types, geothermal energy generation systems, ocean tidal energy systems, fuel cell: basic operation and classification, principle of MHD generation, output voltage and power, environmental aspects.

TEXTBOOK(S)

1. B.H. Khan, Non-conventional Energy Resources, 2nd edition, 2009.

REFERENCE BOOKS

1. G.D. Rai, Non-Conventional Sources of Energy, (Khanna Publishers).
2. J.W. Twidell & A.D. Weir, Renewable Energy Resources, (ELBS / E. & F.N. Spoon., London).
3. Godfrey Boyle, Renewable Energy, Oxford, 2nd edition 2010

Department Offering the Course	**EECE**
Course Code	EEF465
Course Title	Automotive Electronics
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (If Any)	None
Course Basket	Discipline Elective

Course Summary

This course will provide knowledge about batteries and their working principle, about the ignition system of automobiles, electronics being used currently in automobiles.

Course Objectives

- To understand the starting methods of a vehicle.
- To know the functioning of ignition systems and use of electronics for controlling purpose.
- To understand the use of sensors and actuators in the automotive unit.

Course Outcomes

After completion of this course the student will:

- To understand the Fundamentals of automotive electronics.
- To understand the needs of Sensors for various automotive applications.
- To have an overview of electrical and electronic systems used in vehicles.
- To understand Electronic fuel injection and ignition systems
- To know the important of actuators and control system in Automobiles.

Curriculum Content

UNIT I: Power Source and Starting Methods for Automotive Unit

Batteries: Principles and construction of lead-acid battery, characteristics of battery, rating capacity and efficiency of batteries, various tests on battery condition, charging methods, constructional aspect of alkaline battery.

Starting System: Condition at starting. Behaviour of starter during starting, series motor and its characteristics, principle &construction of starter motor, working of different starter drive units, care and maintenance of starter motor, starter Switches.

Unit II: Ignition systems and Lighting System & Accessories:

Ignition Systems: Types, construction & working of battery coil and magneto ignition systems, relative merits, centrifugal and vacuum advance mechanisms, types and construction of spark plugs, electronic ignition systems.

Lighting System & Accessories: Insulated & earth return systems, positive & negative earth systems. Details of head light & side light, headlight dazzling & preventive methods, electrical fuel-pump, Speedometer, fuel, oil & temperature gauges, Horn, wiper system.

Unit III: Automotive Electronics:

Current trends in modern automobiles Open and close loop Systems-Components for electronic engine management, electronic management of chassis system, vehicle motion control

Unit IV: Sensors and Actuators:

Basic sensor arrangement, Types of sensors such As-Oxygen sensors, Crank angle position Sensors-Fuel metering/vehicle speed sensor and detonation sensor- Altitude sensor, flow sensor, throttle position sensors. Solenoids, stepper motors, and relays

Electronic Fuel Injection and Ignition Systems: Introduction, feedback carburettor systems. Throttle body injection and multi-port or point fuel injection, fuel injection systems, Injection system controls, Advantages of electronic ignition systems: Types of solid-state ignition systems and their principle of operation, Contact less electronic ignition system, and electronic spark timing control.

Unit V: Digital Engine Control System:

Digital Engine Control System: Open loop and closed loop control Systems-Engine cranking and warm up control- Acceleration enrichment- Deceleration leaning and idle speed control, distributor less ignition- Integrated engine control systems, Exhaust mission control engineering, electronic dashboard instruments- On-board diagnosis system, security and warning system.

TEXTBOOK(S)

1. Judge. A.W, 'Modern Electrical Equipment of Automobiles', Chapman & Hall, London, 1992.
2. William B. Ribbens, 'Understanding Automotive Electronics', 5th Edition, Butterworth, Heinemann Woburn, 1998.

REFERENCE BOOKS

1. Vinal. G.W., 'Storage Batteries', John Wiley & Sons Inc., New York, 1985.
2. Robert Bosch,'Automotive Hand Book', Bently Publishers, 1997.

COURSE STRUCTURE & SYLLABUS OF B. TECH – ELECTRICAL ENGINEERING APPLICABLE FOR BATCH (2022-25)

Department Offering the Course	**EECE**
Course Code	EEF402
Course Title	Electrical Machine Design
Credits (L:T:P:C)	2:0:1:3
Contact Hours (L:T:P)	2:0:2
Prerequisites (if any)	EMEC-I, EMEC-II
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of design the transformers and analysis design the induction motors, design the synchronous machines and dc machines.

Course Objectives

- To study and design the transformers and analyse them
- To study and design the induction motors
- To study and design the synchronous machines and dc machines

Course Outcomes

- Students will be able to learn the applications of transformer and induction motor and application regarding representation using piece wise linearization and least square error method.
- Students will be able to formulate the mathematical modelling of transformer design, output equation, design dimension of core and yoke.
- Students will be able to learn the fundamentals of electrical circuits and thermal circuits of cooling method.
- Students will be able to learn the basics of induction motor stator design, electrical and magnetic loading, types and design of winding

Curriculum Content

Unit 1 Introduction Standards & standardization, Classification of insulating materials. Modes of heat dissipation & temperature rise-time curves. Methods of cooling ventilation (induced & forced, radial & axial), direct cooling & quantity of cooling medium.

Unit 2 Design of Transformer Output equation design of core, yoke and windings, overall dimensions, Computation of no load current to voltage regulation, efficiency and cooling system designs.

Unit 3 Design of Synchronous Machines Output equations of synchronous machines, specific electric and magnetic loadings, separation of main dimensions, Rotor design, Design of field system. Estimation of performance from design data. Flow chart for design of three phase synchronous generators

Unit 4 Design of Induction Machines Output equations, specific electric and magnetic loadings, factors affecting size of rotating machines, separation of main dimensions, selection of frame size, Rotor design of three phase induction motors. Circle diagram, Estimation of performance from design data. Flow chart for design of three phase induction motors

Unit 5 Design of DC Machines & Computer Aided Design Output equation, Main dimensions, Design of armature, commutator, flow chart for design of dc machines.
Philosophy of computer aided design, advantages and limitations. Computer aided design approaches analysis-, synthesis and hybrid methods.

TEXTBOOK(S)

1. A.K. Sawhney, “Electrical Machine Design”, Dhanpat Rai & Sons.
2. S. K. Sen, “Principles of Electrical Machine Design with Computer Programmes”, Oxford & IBH Pub. Company

REFERENCE BOOKS

1. M.G. Say, “Alternating Current Machines”, Pitman Publishing Company Ltd.
2. A.E. Clayton, “The Performance and Design of DC Machines”, Pitman Publishing Company Ltd.
3. H. Cotton, “Advanced Electrical Technology” Wheeler Publishing.

List of Experiments Design using MATLAB/Simulink/C

1. Design of a single phase transformer for distribution
2. Design of a three phase distribution transformer
3. Design of a three phase power transformer
4. Design of a d.c. machine
5. Design of a synchronous generator
6. Design of a synchronous motor.

Department Offering the Course	EECE
Course Code	EEF457
Course Title	Ann & Fuzzy Logic
Credits (L:T:P:C)	2:0:1:3
Contact Hours (L:T:P)	2:0:2
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

The course provides the knowledge of Neural network architecture: Single layer and multilayer feed forward networks, single layer artificial neural networks, multilayer perceptron model, concept of fuzzy, Fuzzy sets and crisp sets, Fuzzy sets theory and operations, Membership functions, inference in fuzzy logic, fuzzy if then rules, fuzzifications & defuzzifications, fuzzy controller, Application of neural network.

Course Objectives

- To understand the fundamental theory and concepts of neural networks, Identify different neural network architectures, algorithms, applications and their limitations
- Understand appropriate learning rules for each of the architectures and learn several neural network paradigms and its applications.
- Comprehend the fuzzy logic and the concept of fuzziness involved in various systems and fuzzy set theory.
- Understand the concepts of fuzzy sets, knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic
- Reveal different applications of these models to solve engineering and other problem

Course Outcomes

- Understand the fundamentals of neural networks and identify different neural network architectures, algorithms, applications and their limitations
- Understand appropriate learning rules for each of the architectures
- Understand the fuzzy logic and the concept of fuzziness involved in various systems and fuzzy set theory.

Curriculum Content

Unit 1 Neural Networks-1(Introduction & Architecture): Neuron, biological neuron, Artificial Neuron and its model, activation functions, Neural network architecture: Single layer and multilayer feed forward networks, recurrent networks, and various learning techniques**.**

Unit 2 Back propagation networks Architecture: perceptron model, single layer artificial neural networks, multilayer perceptron model; back propagation algorithm, effects of learning coefficient; factors affecting back propagation training, applications.

Unit 3 Fuzzy Logic-I (Introduction): Basic concept of fuzzy, Fuzzy sets and crisp sets, Fuzzy sets theory and operations, Properties of fuzzy sets. Fuzzy and crisp relation.

Unit 4 Fuzzy Membership Functions, Rules: Membership functions, inference in fuzzy logic, fuzzy if then rules, fuzzifications & defuzzifications, fuzzy controller.

Unit 5 Application of Neural and fuzzy logic: Application of neural network, Neural Network approach in load flow study. Fuzzy logic application in industries.

TEXTBOOK(S)

1. S. Rajasekaran and G.A.V.Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI

REFERENCE BOOKS

1. Simon Haykins," Neural Networks" Prentice Hall of India
2. Moore, "Digital control devices", ISA press, 1986.
3. Kumar Satish, "Neural Networks", Tata Mc Graw Hill
4. Timothy J Ross, "Fuzzy Logic with Engineering Applications", McGraw Hill 1997

List of Experiments:

The instructor will give real time based problems each for neural networks and fuzzy logic controllers

COURSE STRUCTURE & SYLLABUS OF B. TECH – ELECTRICAL ENGINEERING APPLICABLE FOR BATCH (2022-25)

Department Offering the Course	**EECE**
Course Code	EEF462
Course Title	Artificial Intelligence Application in EV
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

To provide comprehensive idea about ANN, deep learning, Fuzzy Logic and its application in electrical engineering.

Course Objectives

To locate soft commanding methodologies, such as artificial neural networks, deep learning, and Fuzzy logic.
To observe the concepts of feed forward neural networks and about feedback neural networks.
To practice the concept of fuzziness involved in various systems and comprehensive knowledge of fuzzy logic control and to design the fuzzy control

Course Outcomes

Understand how the soft computing techniques can be used for solving the problems of power electronics and motor drives.
Design of ANN based systems for function approximation in signal estimation for vector drives.
Design of Fuzzy based systems for load frequency control in power systems.
Develop and evaluate control systems required in operations of power electronics equipment

Ccurriculum Content

Unit 1: Introduction

The AI Problems, The Underlying Assumption, what is an AI Techniques, Difference between soft computing techniques and hard computing systems. Expert systems brief history of ANN and Fuzzy Logic.

Unit 2: Artificial Neural Network

Introduction, History of neural network research, Basic concepts of Neural Networks, Human brain, Model of Artificial Neuron, Neural Network architectures, Perceptron, Single layer feed forward Network, Multi-layer feed forward network, Recurrent networks (RNN), Feedback networks and Radial Basis Function Networks Characteristics of NN, Learning Methods, LMS and Back Propagation Algorithm, training Examples of models Advances in Neural networks

Unit 3: Deep Learning

Convolution Neural Network (CNN): Neuron in human vision, Shortcoming of feature, election, Filters and feature maps, Full Description of Convolution neural network (CNN), Max pooling.

Principal component analysis Auto-encoder: Architecture, Sparsity. Long short term memory units in RNN

Unit 4: Fuzzy Logic

Introduction, Comparison between Fuzzy and crisp logic, Fuzzy sets, Membership function, Basic fuzzy set operations, Properties of Fuzzy set, fuzzy relations, Fuzzy interference system, Mamdani, Sugeno, Fuzzy rule based system, Defuzzification methods, Fuzzy Neural Networks

Unit- 5: Applications

ANN in space vector PWM wave synthesis for 2-level and multi-level converters. Static feedback signals estimation for a vector drive, space vector PWM for a two-level voltage-fed inverter and voltage model flux vector estimation. Model referencing adaptive control (MRAC) of ac drives, drift-free flux estimation of drives. Fuzzy logic based control replacing PID controller Neuro-fuzzy control of drives.

TEXTBOOK(S)

1. Neural Networks, Fuzzy logic and Genetic Algorithms by S. Rajasekaran, G. A. Vijayalakshmi Pai PHI publication,
2. Principles of Soft computing, Wiley, 2nd Edition, S. N. Deepa and S. Sivanandam. 3. Introduction to Neural Networks using MATLAB 6.0, McGraw Hill Education, S. Sivanandam, S. Sumathi, S. N. Deepa.
3. Neural Network: A Comprehensive Foundation, second edition, Pearson Prentice Hall, Simon Haykin.

REFERENCE BOOKS

1. Deep learning with python: A Hands-on Introduction, Apress, Nikhil Ketkar
2. Fundamentals of Deep Learning, O' Reilly, Nikhil Baduma Nicholas Locasio.
3. Artificial intelligence techniques in power systems by KEVIN WARWICK, ARTHUR EKWUE RAJ AGRAWA

List of Experiments

1. Introduction to MATLAB and various tool boxes.
2. Use of MATLAB tool box for ANN.
3. Use of MATLAB tool box for Fuzzy Logic.
4. Use of MATLAB tool box for Optimization.
5. Use of MATLAB Programming for implementing NN.
6. Use of MATLAB Programming for generating different types of activation functions in ANN
7. Use of MATLAB Programming for training and testing of ANN.
8. Use of MATLAB for load forecasting using ANN
9. Use of MATLAB to get familiar with the deep learning toolbox.
10. Use of MATLAB to train a test of the load forecasting with the
11. MATLAB program for generating different types of Fuzzy membership functions.
12. Use of MATLAB for DTC control using fuzzy logic approach.

Recommendation

1. Use MATLAB as software package to implement ANN for applications.
2. Suggest MOOC course: NPTEL on Deep Learning, Machine Learning, Data Analysis, and Soft computing.
3. B. K. Bose, "Neural network applications in power electronics and drives", Distinguished Lecture in Texas A&M University, College Station, Texas, November 12, 2001.

Department Offering the Course	**EECE**
Course Code	EEF361
Course Title	Battery Management Systems
Credits (L:T:P:C)	2:0:1:3
Contact Hours (L:T:P)	2:0:2
Prerequisites (if any)	None
Course Basket	DE

Course Summary

A battery management system (BMS) is any electronic system that manages a rechargeable battery (cell or battery pack), such as by protecting the battery from operating outside its safe operating area monitoring its state, calculating secondary data, reporting that data, controlling its environment, authenticating it and / or balancing it

Course Objectives

The objective of this course is to introduce learner to batteries, its parameters, modelling and charging requirements. The course will help learner to develop battery management algorithms for batteries

Course Outcomes

- Interpret the role of battery management system
- Identify the requirements of Battery Management System
- Interpret the concept associated with battery charging / discharging process
- Calculate the various parameters of battery and battery pack
- Design the model of battery pack

Ccurriculum Content

Unit 1: Introduction:

Introduction to Battery Management System, Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithium-ion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging

Unit 2: Battery Management System Requirement:

Introduction and BMS functionality, Battery pack topology, BMS
Functionality, Voltage Sensing, Temperature Sensing, Current Sensing, BMS Functionality, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Communication Interface, Range estimation, State-of charge estimation, Cell total energy and cell total power,

Unit 3: Battery State of Charge and State of Health Estimation, Cell Balancing: Battery state of charge estimation (SOC), voltage-based methods to estimate SOC, Model-based state estimation, Battery Health Estimation, Lithium-ion aging: Negative electrode, Lithium ion aging: Positive electrode, Cell
Balancing, Causes of imbalance, Circuits for balancing

Unit 4: Modelling and Simulation:

Equivalent-circuit models (ECMs), Physics-based models (PBMs), Empirical modelling approach, Physics-based modelling approach, simulating an electric vehicle, Vehicle range calculations, Simulating constant power and voltage, Simulating battery packs

Unit- 5: Design of battery BMS:

Design principles of battery BMS, Effect of distance, load, and force on battery life and BMS, energy balancing with multi-battery system**.**

TEXTBOOK(S)

1. Plett, Gregory L. Battery management systems, Volume I: Battery modeling. Artech House, 2015.
2. Plett, Gregory L. Battery management systems, Volume II: Equivalent-circuit methods. Artech House, 2015.

REFERENCE BOOKS

1. Bergveld, H.J., Kruijt, W.S., Notten, P.H.L “Battery Management Systems -Design by Modelling” Philips Research Book Series 2002.
2. Davide Andrea,” Battery Management Systems for Large Lithium-ion Battery Packs” Artech House, 2010
3. Pop, Valer, et al. Battery management systems: Accurate state-of-charge indication for battery-powered applications. Vol. 9. Springer Science & Business Media, 2008.

List of Experiments

1. To model a lead-acid battery cell using the Simscape™
2. Observe the charging and discharging process, and plot graph of charging/load current, SOC, temperature, DOC, and terminal voltage.
3. To analyse the effect of temperature on the performance of a Lithium-Ion battery model
4. To simulate and plot the result of temperature, SOC, current, and terminal voltage for the HV Battery Charge/Discharge using realistic DC-link current profile, which originates from a dynamic driving cycle
5. To study Lithium Battery Cell - One RC-Branch Equivalent Circuit and it’s simulation
6. To simulate Ni-MH Battery Model with the DC machine and show the charging and discharging process using DC machine.
7. To simulate Lithium-Ion (LiFePO4) Battery and analyse the effect of DOD and discharge rate on battery ageing considering 1000 h simulation time

Department Offering the Course	EECE
Course Code	EEF461
Course Title	Computer Aided Modelling and Analysis of Electrical Machine
Credits (L:T:P:C)	1:0:2:3
Contact Hours (L:T:P)	1:0:4
Prerequisites (if any)	None
Course Basket	DE

Course Summary
To provide comprehensive idea about Computer aided modelling of Electrical Machines.

Course Objectives
The objective of this course is to introduce learner and dynamic modelling of electrical machine and implement computer-based model of machine

Course Outcomes
- Develop mathematical model of different electrical machine.
- Design mathematical model of machine in software tool
- Analyse the generalised performance of machine in software
- Analyse the performance of machine under various dynamics condition

Ccurriculum Content

Unit 1: Principles of Electromagnetic Energy Conversion:
Basics of magnetic circuits, General expression of stored magnetic energy, co-energy and force/torque, example using single and doubly excited system.

Unit 2: Reference Frame Theory
Transformation of variables, three phase to two phase transformation, Static and rotating reference frames, transformation relationships, examples using static symmetrical three phase R, R-L, R-L-L and R-L-C circuits, application of reference frame theory to three phases symmetrical induction, synchronous machines and advance machine.

Unit 3 Modelling of Induction Machines:
Voltage equation in machine variables, flux-linkage equation in machine variables, torque equation in machine variable, voltage equation in arbitrary reference frame, flux-linkage equation in arbitrary reverence frame, torque equation in arbitrary reference frame, dynamic dq equivalent circuit of induction machine, per unit representation of induction machine model, analysis of steady-state operation, free acceleration characteristics, computer simulation of induction machine in arbitrary reference frame.

Unit 4: Modelling of Permanent Magnet Synchronous Machines
Construction and operating principle, Surface permanent magnet and interior permanent magnet machines, real-time model of a two-phase PMSM, transformation to rotor reference frames, three-phase to two-phase transformation, unbalanced operation, zero sequence inductance derivation, power equivalence, electromagnetic torque, steady-state torque characteristics, models in flux linkages, equivalent circuits

Unit- 5: Permanent Magnet Brushless DC Motor:
Construction and operating principle, PM Brushless DC Machine, Modelling of PM Brushless DC Motor, Normalized System Equations, The PMBLDC Motor Drive Scheme

TEXTBOOK(S)

1. Paul C. Krause, Oleg Wasynczuk and Scott D. Sudhoff, “Analysis of Electric Machinery and Drive Systems”, John Wiley & Sons, New York, 2004.
2. Charles Kingsley,Jr., A.E. Fitzgerald, Stephen D.Umans “Electric Machinery”, Tata McGraw Hill, Fifth Edition, 1992.
3. ONG, Chee-Mun, "Dynamic Simulation of Electric Machinery using MATLAB", Prentice Hall PTR
4. Generalized theory of electrical machines by P S Bimbhra, 5th edition, Khanna Publishers Delhi
5. R. Krishnan, “Electric Motor & Drives: Modeling, Analysis and Control”, Prentice Hall of India, 2001.

REFERENCE BOOKS

1. Ned Mohan, “Advanced electrical drives Analysis, Control and Modeling using Simulink”,MNPERE, Minneapolis, USA, 2001.
2. C.V.Jones, “The Unified Theory of Electrical Machines”, Butterworth, London, 1967.
3. Miller, T.J.E. “Brushless permanent magnet and reluctance motor drives” Clarendon Press, Oxford, 1989.
4. O'Simmons and Kelly, "Introduction to Generalized Machine Theory". McGraw-Hill, 1968
5. Hancock, "Matrix Analysis of Electric Machinery". Pergamon, Oxford, U.K., 1964 11. Mrittunjay Bhattacharyya, "Electrical Machines: Modelling and Analysis" Prentice Hall 12. J. Meisel, “Principles of Electromechanical Energy Conversion” McGraw Hill, 1966.

List of Experiments

1. Modelling and simulation of variable frequency oscillator in MATLAB
2. Modelling and simulation of series-parallel RLC circuit
3. To implement change of variables (3 – φ to 2 – φ) in MATLAB simulation
4. To implement change of variables (2 – φ to 3 – φ) in MATLAB simulation
5. To implement flux equation of induction machine in arbitrary reference frame in MATLAB simulation.
6. To implement current equation of induction machine in arbitrary reference frame in MATLAB simulation
7. To implement torque equations of induction machine in arbitrary reference frame variable in
8. MATLAB
9. To simulate and observe free acceleration characteristics of induction machine
10. To observe dynamic performance of induction machine during sudden changes in load torque
11. Simulation of BLDC motor
12. Analyze the dynamic performance of PMSM

Department Offering the Course	**EECE**
Course Code	EEF362
Course Title	EV Battery Charging System
Credits (L:T:P:C)	2:0:1:3
Contact Hours (L:T:P)	2:0:2
Prerequisites (if any)	None
Course Basket	DE

Course Summary

To provide comprehensive idea about an **electric-vehicle battery** (EVB) used to power the electric motors of a battery electric vehicle (BEV) or hybrid electric vehicle (HEV) and its charging system.

Course Objectives

Main objective of subject is to introduce major parts of electric vehicle system, its parameters and types.

Course Outcomes

- Elaborate various grind connected converter for EV battery charging.
- Analyse impact of battery charging converter on power system.
- Analyse the operation of various resonant converters for EV charging system.
- Develop battery charger for an EV

Ccurriculum Content

Unit 1: LLC Resonant Converters:

Overview of series, parallel and series-parallel resonance converter, Half bridge LLC resonant converter: topology, operation and control, Full bridge LLC resonant converter: topology, operation and control, design of LLC resonant converter.

Unit 2: Dual Active Bridge (DAB) Converter:

Basic Principle of DAB Converters, Control of Voltage-Fed DAB Converters, Control of Current-Fed DAB Converters, Key Issues, Unified Boundary Trapezoidal Modulation Control, A Current-Fed Dual Active Bridge DC–DC Converter Using Dual PWM Plus Double Phase Shifted Control.

Unit 3: Wireless Power Transfer (WPT) for Electric Vehicles (EVs):

Basics of WPT Technology, Modelling the WPT System, WPT for EV Charging, Design Challenges and Optimization Candidates, Optimization of Resonator Design, Future Directions and Trends

Unit 4: Battery Charger Impact on Grid:

1-phase fully controlled converter, 3-phase fully controlled converter, 1 phase PWM AC-DC converter, strategy used for power factor correction, Harmonics Impact, Harmonics Compensation, Current Demand Impact and current demand minimization.

Unit- 5: Charging Infrastructures:

Introduction, Understanding charging economics, Commercial charging and pricing models, Load managements for large scale EV integration.

TEXTBOOK(S)

1. James Larminie Oxford Brookes University, Oxford, UKJohn Lowry Acenti Designs Ltd., UK,Electric Vehicle Technology Explained
2. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001
3. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
4. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

REFERENCE BOOKS

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.
2. Chris Mi, M. Abul Masrur, David Wenzhong Gao, Hybrid Electric Vehicles Principles and Applications with Practical Perspectives, Wiley Publication, 2011.
3. Sumedha Rajakaruna, Farhad Shahnia, Arindam Ghosh, Plug in Electric Vehicle in Smart Grids, Springer Singapore Heidelberg New York Dordrecht London
4. Deshang Sha, Guo Xu, HFrequency Isolated Bidirectional Dual Active Bridge DC–DC Converters with Wide Voltage Gain, Springer Nature Singapore Pte Ltd. 2019.

List of Experiments

1. Simulation of Battery Charging by using non isolated DC – DC converter
2. Simulation of Battery Charging by using AC – DC converter
3. Simulation of Ultracapacitor Charging and Discharging
4. Simulation of Battery Charging using Isolated DC – DC Converter
5. Simulation of Battery Charging in regeneration mode using AC - DC converter.
6. Simulation of battery charging system to analyse its impact on power system.
7. Simulate dual active bridge converter for battery charging.
8. Simulate full bridge LLC resonant converter for EV Battery.
9. Simulate half bridge LLC resonant converter for EV Battery.

COURSE STRUCTURE & SYLLABUS OF B. TECH – ELECTRICAL ENGINEERING APPLICABLE FOR BATCH (2022-25)

Department Offering the Course	EECE
Course Code	EEF357
Course Title	Microprocessor
Credits (L:T:P:C)	2:0:1:3
Contact Hours (L:T:P)	2:0:2
Prerequisites (if any)	Digital system Design
Course Basket	Discipline Elective

Course Summary

This course will introduce to the students about the elementary knowledge of microprocessor. Thisexplain that how microprocessor interact with the peripherals like memory and input/output devices? Students are able to learn the basic programming skills of assembly language.

Course Objectives

1. The student will learn how the hardware and software components of a microprocessor-based system work together to implement system-level features and integrating digital devices into microprocessor based systems;
2. The student will learn the operating principles of, and gain hands-on experience with, common microprocessor peripherals such as timers, USART, and PPI; role of CPU, registers, and modes of operation of 8085 and 8086 microprocessors.
3. Learning Microprocessor instruction sets and learning assembly-programming styles, structured assembly language programming.

Course Outcomes

On successful completion of the course, students will be able to achieve the following:

The course provides an understanding of: Identify the basic element and functions of microprocessor.

1. Describe the architecture of microprocessor and its peripheral devices.
2. Demonstrate fundamental understanding on the operation between the microprocessor and itsinterfacing devices.
3. Apply the programming techniques in developing the assembly language program for microprocessor application.
4. An ability to design microprocessors based system, components or process as per needs andspecifications

Curriculum Contents

Unit 1 Evolution of Microprocessors, history of computers, Introduction to Microprocessor, Microprocessor systems with bus organization, Microprocessor Architecture & Operations, Tristate devices, buffers, encoder, decoder, latches, Memory devices: Semiconductor memory organization, Category of memory, I/O Device.

Unit 2 Register organization, 8085 Microprocessor Architecture, Address, Data and Control Buses, Pin Functions, Demultiplexing of Buses, Generation of Control Signals, Timing diagrams: Instruction Cycle, Machine Cycles, T- States, Concept of Address line and Memory interfacing, Address Decoding and Memory Interfacing.

Unit 3

Classification of Instructions, Addressing Modes, 8085 Instruction Set, Instruction And Data Formats, Writing assembly language programs, Programming techniques: looping, counting and indexing, Stack & Subroutines, Developing Counters And Time Delay Routines, Code Conversion, BCD Arithmetic And 16-Bit Data Operations. The 8085 Interrupts, 8085 vector interrupts.

Unit 4

Memory interfacing, I/O interfacing – memory mapped and peripheral mapped I/O Programmable Interfacing Devices Like 8255A PPI, 8253/8254 Timer, 8259A PIT, 8237 DMA Controller, and Serial I/O Concepts 8251A USART. Interfacing of above chips with 8085, Programming them In Different Modes.

Unit 5

Architecture of 8086, block diagram, register set, flags, Queuing, concept of segmentation, Pin description, operating modes, addressing modes.

TEXTBOOK(S)

1. Microprocessor Architecture, Programming, and Applications with the 8085 Ramesh S. Gaonkar – Penram International
2. Microcomputers and Microprocessors: The 8080, 8085 and Z-80 Programming, Interfacing and Troubleshooting John E. Uffenbeck.

REFERENCE BOOKS

1. Microprocessor and Microcontroller fundamentals. The 8085 and 8051 Hardware and Software William Kleitz

List of Experiments

1. To perform 8-bit arithmetic operations between two numbers stored at consecutive memory locations: addition, subtraction, multiplication, division.
2. To perform 16-bit arithmetic operations between two numbers stored at consecutive memory locations: addition, subtraction, multiplication, division.
3. To find the largest and smallest element in an array. Also find the sum of elementsin an array.
4. Generation of Fibonacci series in 8085 in hexadecimal sequence.
5. Write and execute the program for finding even and odd numbers.
6. To sort the given number in the ascending and descending order using 8085microprocessors.
7. Code conversion: decimal number to hexadecimal, hexadecimal number todecimal.
8. To add two 8 bit BCD numbers stored at consecutive memory locations.
9. To subtract two 8 bit BCD numbers stored at consecutive memory locations.
10. To interface programmable peripheral interface 8255 with 8085 and study itscharacteristics in mode0, mode1 and BSR mode.

Value added Experiments:

1. To interface 8253 Interface board to 8085 mp and verify the operation of 8253 in sixdifferent modes.
2. To interface a stepper motor with 8051 microcontrollers and operate it.

Teaching and Learning Strategy

All materials (ppts, assignments, labs, etc.) will be uploaded in Moodle/MS Team.

Department Offering the Course	**EECE**
Course Code	EEF358
Course Title	Fundamentals of Electric and Hybrid Vehicles
Credits (L: T:P:C)	3:0:0:3
Contact Hours (L: T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	DE

Course Summary

To provide comprehensive idea of basic of conventional electric and vehicles

Course Objectives

The course introduces basic aspects of Electric and Hybrid Vehicle systems such as their configuration, energy storage devices, electric propulsion systems and parameters associated with such systems.

Course Outcomes

- Differentiate among different types of Electric and Hybrid Vehicles and their configurations.
- Decide suitable electric propulsion system for EV and HEV.
- Determine the rating of energy source requirement of EV and HEV.
- Analyze the role of auxiliaries in Electric and Hybrid Vehicles.

Curriculum Content

Unit 1: Introduction to Electric Vehicles:

Evolution of Electric Vehicles, EV configurations - Fixed and variable gearing, Single- and multiple-motor drives, In-wheel drives, Parameters of EV systems - Weight and size parameters, Force parameters, Energy parameters, Performance parameters

Unit 2: Hybrid EV systems:

HEV configurations - Series hybrid system, Parallel hybrid system, Series-parallel hybrid system, Complex hybrid system, Power flow control in Series hybrid system, Parallel hybrid system, Series-parallel hybrid system, Complex hybrid system, Case Study

Unit 3: Electric Propulsion Systems:

DC motor drives, Induction motor drives, Permanent-magnet motor drives, Switched reluctance motor drives and their role in EV and HEV systems. Performance study of electrical propulsion system with respect to application.

Unit 4: Energy Sources in EV and HEV systems:

Electrochemical Batteries – Terminology, Specific Energy, Specific Power, Energy Efficiency in Lead-Acid Batteries, nicked based batteries, Lithium based batteries, Requirement of Ultra capacitors – Features, Principle of operation and Performance of UC, High Speed Flywheels – Operating Principles, Power capacity, Flywheel technologies, Hybrid Energy Storage Systems, Fuel Cell – Principle of Operation and Performance

Unit 5: EV Auxiliary Systems:
Battery characteristics and chargers, Battery indication, Temperature control unit, Power Steering Unit, Auxiliary Power Supply, Navigation system

TEXT BOOKS

1. C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001
2. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.

REFERENCE BOOKS

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2nd edition, 2009.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Recommendation:

- https://nptel.ac.in/courses/108/103/108103009/
- https://www.edx.org/course/electric-cars-technology
- https://www.youtube.com/channel/UC5PK4aUlSYMfnEjig_fdGsg

COURSE STRUCTURE & SYLLABUS OF B. TECH – ELECTRICAL ENGINEERING APPLICABLE FOR BATCH (2022-25)

Department Offering the Course	**EECE**
Course Code	EEF359
Course Title	Power Electronics for EV
Credits (L:T:P:C)	2:0:1:3
Contact Hours (L:T:P)	2:0:2
Prerequisites (if any)	Non
Course Basket	Discipline Elective

Course Summary

The course covers fundamentals of Power semiconductor devices such as Triacs, GTOs, MOSFETs and IGBTs, their characteristics, turn-on of SCR, gate characteristics, AC-DC Converters, DC - DC Converters, AC- AC and DC-AC Converters, three phase cyclo-converters, Single phase series resonant inverter; Single phase bridge inverters, Single phase and three phase current source inverters.

Course Objectives

- To introduce the basic concepts of power electronics,
- To introduce types of converters, their characteristics, turn-on of SCR, gate characteristics,
- To know about AC-DC Converters, DC - DC Converters, AC-AC and DC-AC Converters.

Course Outcomes

- Articulate the basics of power electronic devices
- Express the design and control of rectifiers, inverters.
- Design of power electronic converters in power control applications
- Ability to express characteristics of SCR, BJT, MOSFET and IGBT.
- Ability to express communication methods.
- Ability design AC voltage controller and Cyclo-Converter

Curriculum Content

Unit 1 Power semiconductor Devices: Power semiconductor devices their symbols and static characteristics; Characteristics and specifications of switches, types of power electronic circuits. Thyristor – Operation V- I characteristics, two transistor model; Triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation

Unit 2 Power Semiconductor Devices (Contd): Protection of devices; Series and parallel operation of thyristors; Commutation techniques of thyristor

DC-DC Converters: Principles of step-down and step-up chopper and their operation with R-L load; Classification of choppers

Unit 3 Phase Controlled Converters: Single phase half wave controlled rectifier with resistive and inductive loads, effect of freewheeling diode; Single phase fully controlled and half controlled bridge converters; Three phase half wave converters, three phase fully controlled and half controlled bridge converters; Effect of source impedance; Single phase and three phase dual converters.

Unit 4 AC Voltage Controllers: Principle of On-Off and phase controls; Single phase ac voltage controller with resistive and inductive loads; Three phase ac voltage controllers (various configurations and comparison) Cyclo Converters: Basic principle of operation, single phase to single phase, three phase to single phase and three phase to three phase cyclo converters, output voltage equation

Unit 5 Inverters: Single phase series resonant inverter; Single phase bridge inverters
Three phase bridge inverters: 1200 and 1800 mode of operation; Voltage control of inverters; Harmonics reduction techniques; Single phase and three phase current source inverters.

TEXTBOOK(S)

1. M.H. Rashid, "Power Electronics: Circuits, Devices & Applications", Prentice Hall of India Ltd. 3rd Edition,
2. P.S.Bimbhra, "Power Electronics" Khanna Publication.
3. Umanand "Power Electronics" Wiley India.

REFERENCE BOOKS

1. P.C. Sen, "Power Electronics", Mc Graw Hill
2. Dragan Maksimović and Robert Warren Erickson, "Fundamentals of Power Electronics", Springer

List of Experiments

1. To study V-I characteristics of SCR and measure latching and holding currents.
2. To study UJT trigger circuit for half wave and full wave control.
3. To study single-phase half wave controlled rectified with (i) resistive load (ii) inductive load with and without freewheeling diode.
4. To study single phase (i) fully controlled (ii) half controlled bridge rectifiers with resistive & inductive loads.
5. To study three-phase fully/half controlled bridge rectifier with resistive and inductive loads.
6. To study single-phase ac voltage regulator with resistive and inductive loads.
7. To study single phase cyclo-converter
8. To study triggering of (i) IGBT (ii) MOSFET (iii) power transistor
9. To study operation of IGBT/MOSFET chopper circuit
10. To study MOSFET/IGBT based single-phase series-resonant inverter.

Software based experiments (PSPICE/MATLAB)

1. To obtain simulation of SCR and GTO thyristor.
2. To obtain simulation of Power Transistor and IGBT.
3. To obtain simulation of single phase full wave ac voltage controller and draw load voltage and load current waveforms for inductive load.

Department Offering the Course	**EECE**
Course Code	EEF241
Course Title	IoT Sensors, Devices and Components
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	Discipline Elective

Course Summary

To provide comprehensive idea IoT sensors, devices, and Components used in real world.

Course Objectives

- To understand basic terminology and concepts of IOT, Sensors, Devices & Components.
- To Understand IoT structure, application areas and technologies involved
- To attain knowledge on the application and examples.
- To Understand technological challenges faced by IoT devices

Course Outcomes

- Aware of IoT Sensors & Devices.
- Understand the Application of sensors, devices & components,
- Understand design issues

Curriculum Content

Unit 1: Introduction:

Internet of Things Promises–Definition– Scope–Sensors for IoT Applications–Structure of IoT– IoT Device.

Unit 2: SEVEN GENERATIONS OF IOT SENSORS TO APPEAR:

Industrial sensors – Description & Characteristics–First Generation – Description & Characteristics-Advanced Generation – Description & Characteristics–Integrated IoT Sensors – Description & Characteristics–Polytronics Systems – Description & Characteristics–Sensors' Swarm – Descriptior Characteristics–Printed Electronics – Description & Characteristics–IoT Generation Roadmap

Unit 3: IOT Sensors & Devices:

Sensors – to sense Gas, Humidity, Moisture, Leaks, Levels, Motion, Temperature, Acceleration, Til Force, Load, Torque, Strain, Proximity Device – Google Home Voice Controller

Unit 4: TECHNOLOGICAL ANALYSIS:

Wireless Sensor Structure–Energy Storage Module–Power Management Module–RF Module–Sens Module

Unit- 5: Evolution of Social IoT World: Security Issues and Research Challenges:

Social Networking Popularity, Evolution of IoT and Technologies, On Emergence of Social IoT, Sec Issues and Research Challenges

TEXTBOOK(S)

1. Peter Waher, 'Learning Internet of Things', Packt Publishing, 2015
2. N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.
3. Ricardo Armentano, Robin Singh Bhadoria, Parag Chatterjee, Ganesh Chandra Deka, “The Internet of Things: Foundation for Smart Cities, eHealth, and Ubiquitous Computing”, CRC, Published October 10, 2017, 1st Edition
4. BK Tripathy, J Anuradha “Internet of Things (IoT): Technologies, Applications, Challenges and Solutions”, CRC, Published

REFERENCE BOOKS

1. Dr. Guillaume Girardin, Antoine Bonnabel, Dr. Eric Mounier, 'Technologies & Sensors for the Internet of Things Businesses & Market Trends 2014 - 2024’, Yole Développement Copyrights ,2014
2. Cuno Pfister "Getting Started with The Internet of Things: Connecting Sensors and Microcontrollers to the Cloud", Shroff; First edition (2011)
3. Daniel Kellmereit, &, Daniel Obodovski, "The Silent Intelligence: The Internet of Things ", Lightning Source Inc; 1 edition (15 April 2014)

Department Offering the Course	EECE
Course Code	EEF463
Course Title	Smart Grid Interface of EV
Credits (L:T:P:C)	3:0:0:3
Contact Hours (L:T:P)	3:0:0
Prerequisites (if any)	None
Course Basket	DE

Course Summary
To provide detail idea about grid integration of electric vehicles and its effects on/off battery board charging.

Course Objectives
The objective of the course is to study the possible methods of integration of Electric Vehicle in smart grid networks and its effect on the system.

Course Outcomes
- Determine the role of PEV as source in smart grid
- Analyze Impact of EV on smart grid
- Assess the performance of EV parking lot on smart distribution system
- Evaluate the role of EV as ancillary service

Curriculum Contents
Unit 1: Introduction to smart grid and PEV:
Introduction to smart grid and micro grid, Impact of PEVs on Distributed Energy Resources in the Smart Grid, V2G Technology and PEVs Charging Infrastructures

Unit 2: Impact of EV and V2G on the Smart Grid and Renewable Energy Systems
Types of Electric Vehicles, Motor Vehicle Ownership and EV Migration, Impact of Estimated EVs on Electrical Network, Impact on Drivers and the Smart Grid, Standardization and Plug-and-Play

Unit 3: Power Conversion Technology in the Smart Grid and EV
Impacts of EV Penetration on Grid Power Profile, Requirements of Its Control and Monitoring, Hybrid EV Powertrain Architectures, Control, Monitoring and Management Strategies of EV, V2G Communication System, System model of EV, Case study of three phase fault and its impact

Unit 4: Planning, Control, and Management Strategies for Parking Lots for PEVs
Introduction to PEV Charging Facility, Long-Term Planning for PEV Parking Lots, Control and Management of PEV Parking Lots - stages of implementation

Unit 5: PEV as ancillary service in Smart grid
Introduction to Ancillary Services, PEV Charger Optimization, PEV as ancillary source, Control Strategies for PEVs to Follow the Individual Operation Values, Systems and
Control Algorithm for Smart PEV Chargers, Avoiding the Harmonic Propagation Within the Grid, Case study

TEXTBOOK(S)

1. Lu, J. and Hossain, J., 2015. Vehicle-to-grid: linking electric vehicles to the smart grid. Institution of Engineering and Technology.
2. Rajakaruna, S., Shahnia, F. and Ghosh, A. eds., 2014. Plug in Electric Vehicles in Smart Grids: Integration Techniques. Springer.

REFERENCE BOOKS

1. Rajakaruna, S., Shahnia, F. and Ghosh, A. eds., 2014. Plug in electric vehicles in smart grids: charging strategies. Springer.
2. Salman, S.K., 2017. Introduction to the Smart Grid: Concepts, Technologies and Evolution (Vol. 94). IET.

Department Offering the Course	**EECE**
Course Code	EEF368
Course Title	Switching Power Supplies for EV
Credits (L: T:P:C)	2:0:1:3
Contact Hours (L: T:P)	2:0:2
Prerequisites (if any)	None
Course Basket	DE

Course Summary

To provide detail description of converter design and implementation required for electric vehicles

Course Objectives

The student is expected with both the design and control of dc-dc converters at the end of the course.

Course Outcomes

- Analyse an equivalent circuit model of switched mode power supply for steady-state analysis.
- Design of magnetic components (i.e., inductor and transformer) for converters used in power supply.
- Compare the operation of resonance switching power converters with traditional converters.
- Develop feedback controller to regulate DC output of power supply and obtain it frequency response.
- Analyse the performance of SMPS with various input filters.

Curriculum Content

Unit 1: Introduction to Non-isolated and isolated dc-dc converter:

Buck Converter, Boost Converter, Buck-Boost Converter, Cuk Converter, SEPIC converters. Continuous conduction mode and discontinuous conduction mode analysis. Non-idealities in the SMPS, Fly back Converter, Forward Converter, Push-Pull Converter, Half bridge Converter and Full Bridge Converter topologies.

Unit 2: Resonant Converters:

Classification of Resonant Converters, Basic Resonant Circuit Concepts, Load- Resonant Converters, Resonant-Switch Converters, Zero-Voltage-Switching, Clamped-Voltage Topologies, Resonant-Dc-Link Inverters with Zero-Voltage Switching's, High-Frequency-Link Integral-Half-Cycle Converters.

Unit 3: Reactive Elements in Power Electronic Systems:

Introduction, Electromagnetics, Design of Inductor, Design of Transformer, Capacitors for Power Electronic Application, Types of Capacitors

Unit 4: Modelling and control of SMPS:

Introduction, Duty cycle and current model control, canonical model of the converter, Averaged Model of the Converter, Generalized State Space Model of the Converter, Dynamic Model of Converters Operating in DCM.

TEXT BOOKS

1. L. Umanand, “Power Electronics Essentials and Applications”, Wiley India Ltd., 2009.
2. V. Ramanarayanan, Switched Mode Power Conversion, 2007.
3. Abraham Pressman, Switching Power Supply Design, McGraw Hill.
4. Ned Mohan, Tore M. Undeland and William P. Robbins, “Power Electronics – Converters, Applications and Design”, John Willey & sons, Inc., 3rd ed., 2003.

REFERENCE BOOKS

1. Keith H Billings - Switch mode power supply handbook – 1st edition 1989 Mc-Graw hill Publishing Company.
2. Sanjaya Maniktala - Switching power supplies A to Z. – 1st edition 2006, Elsevier Inc.
3. Daniel M Mitchell: DC-DC Switching Regulator Analysis. McGraw Hill Publishing Company.
4. Otmar Kilgenstein: Switched Mode Power Supplies in Practice. John Wiley and Sons.

List of Experiments

1. To study single-phase half wave controlled rectified with (i) resistive load (ii) inductive load with and without freewheeling diode.
2. To study single phase (i) fully controlled (ii) half-controlled bridge rectifiers with resistive & inductive loads.
3. To study three-phase fully/half-controlled bridge rectifier with resistive and inductive loads.
4. To study single-phase ac voltage regulator with resistive and inductive loads.
5. To study single phase cyclo-converter
6. To study operation DC-DC chopper circuit
7. To study MOSFET/IGBT based single-phase series-resonant inverter.