

# Curricula of B.E. Degree for 5<sup>th</sup> – 8<sup>th</sup> Semesters in Electrical Engineering (EE)

## Semester V (Third year) Curriculum Branch/Course: Electrical Engineering

Sl. No	Type of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1	Professional Core Course	PCC-EE 501	Power Systems – I (Apparatus and Modelling)	3	0	0	3	100
		PCC-EE 551	Power Systems Laboratory - I	0	0	2	1	100
2	Professional Core Course	PCC-EE 502	Control Systems	3	0	0	3	100
		PCC-EE 552	Control Systems Laboratory	0	0	2	1	100
3	Professional Core Course	PCC-EE 503	Microprocessors	3	0	0	3	100
		PCC-EE 553	Microprocessors Laboratory	0	0	2	1	100
4	Professional Elective Course <sup>#</sup>	PEC-EE 511	Professional Elective-I	3	0	0	3	100
5	Open Elective Course <sup>##</sup>	OEC-X* 521	Open Elective-I	3	0	0	3	100
6	Humanities and Social Sciences including Management courses	HSM-HU 501	Industrial Management & Entrepreneurship	3	0	0	3	100
7	Mandatory Course	**MC-HU 501	Constitution of India	3	0	0	0	100
8	Humanities and Social Sciences	HSM-HU 581	Grooming & Personality Development	0	0	2	1	100
<b>Total:</b>							<b>22</b>	<b>1000</b>

**\*\* Marks for this paper will not be reflected in total marks for the semester**

**\* X refers to offering codes such as M/EE/HU/ME/EC/EI/CSE**

### **#Professional Elective Course (PEC-EE 511)**

Sl. No	Paper code	Semester	Name of the paper
1	PEC-EE 511(a)	5th	Electrical Power Generation and Distribution
2	PEC-EE 511(b)	5th	Electrical Machine Design
3	PEC-EE 511(c)	5th	Synthesis of Electrical Circuits
4	PEC-EE 511(d)	5th	Data Structure and Algorithm

### **## Open Elective Course (OEC-X 521)**

Sl. No	Paper code	Semester	Name of the paper
1.	OEC-HU 521(a)	5th	Sanskrit for Technical Knowledge
2.	OEC-PH 521(b)	5th	Material Science
3.	OEC-EC 521(c)	5th	Bio Medical Electronics
4.	OEC-CSE 521(d)	5th	Introduction to Object Oriented Technology & Python
5.	OEC-EI 521(e)	5th	Optical Instrumentation

**Semester VI (Third year) Curriculum**  
**Branch/Course: Electrical Engineering**

Sl. No	Type of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1	Professional Core Course	PCC-EE 601	Power Systems – II (Operation and Control)	3	0	0	3	100
		PCC-EE 651	Power Systems Laboratory – II	0	0	2	1	100
2	Professional Core Course	PCC-EE 602	Measurement and Instrumentation	3	0	0	3	100
		PCC-EE 652	Measurement and Instrumentation Laboratory	0	0	2	1	100
3	Professional Core Course	PCC-EE 603	Electronics Design	2	0	0	2	100
		PCC-EE 653	Electronics Design Laboratory	0	0	2	1	100
4	Professional Elective Course <sup>#</sup>	PEC-EE 611	Professional Elective-II	3	0	0	3	100
5	Professional Elective Course <sup>#</sup>	PEC-EE 612	Professional Elective-III	3	0	0	3	100
6	Open Elective Course <sup>##</sup>	OEC-X* 621	Open Elective-II	3	0	0	3	100
7	Project and Internship	PROJ-EE 691	Term Paper Leading to Project Work	0	0	4	2	100
8.	Humanities and Social Sciences	HSM-HU 681	Group Discussion & Personal Interview	0	0	2	1	100
<b>Total:</b>							<b>23</b>	<b>1100</b>

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**#Professional Elective Course (PEC-EE 611)**

Sl. No	Paper code	Semester	Name of the paper
1	PEC-EE 611(a)	6th	Electrical Drives
2	PEC-EE 611(b)	6th	Line Commutated and Active Rectifiers
3	PEC-EE 611(c)	6th	Industrial Electrical Systems
4	PEC-EE 611(d)	6th	Electromagnetic Waves
5	PEC-EE 611(e)	6th	Computational Electromagnetics

**#Professional Elective Course (PEC-EE 612)**

Sl. No	Paper code	Semester	Name of the paper
1	PEC-EE 612(a)	6th	Digital Control Systems
2	PEC-EE 612(b)	6th	Advanced Control Engineering
3	PEC-EE 612(c)	6th	Digital Signal Processing
4	PEC-EE 612(d)	6th	Computer Architecture
5	PEC-EE 612(e)	6th	Lighting Calculation and Design

**## Open Elective Course (OEC-X 621)**

Sl. No	Paper code	Semester	Name of the paper
1.	OEC-HU 621(a)	6th	History of Science & Engineering in India
2.	OEC-HU 621 (b)	6th	Infrastructure Finance
3.	OEC-EC 621(c)	6th	Microprocessors & Its Applications
4.	OEC-EI 621 (d)	6th	Microprocessors & Its Programming
5.	OEC-M 621(e)	6th	Computational Methods

**Semester VII (Fourth year) Curriculum**  
**Branch/Course: Electrical Engineering**

Sl. No	Type of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1	Professional Elective Course <sup>#</sup>	PEC-EE 711	Professional Elective-IV	3	0	0	3	100
2	Professional Elective Course <sup>#</sup>	PEC-EE 712	Professional Elective-V	3	0	0	3	100
3	Open Elective Course <sup>##</sup>	OEC-X* 721	Open Elective-III	3	0	0	3	100
4	Open Elective Course <sup>##</sup>	OEC-X* 722	Open Elective-IV	3	0	0	3	100
5	Humanities and Social Sciences including Management courses	HSM-HU 703	Economics and Accountancy	2	0	0	2	100
6	Project and Internship	PROJ-INT 791	Internship	0	0	4	2	100
7	Project and Internship	PROJ-EE 792	Project Stage-I	0	0	4	2	100
<b>Total:</b>							<b>18</b>	<b>700</b>

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**#Professional Elective Course (PEC-EE 711)**

Sl. No	Paper code	Semester	Name of the paper
1	PEC-EE 711(a)	7th	High Voltage Engineering
2	PEC-EE 711(b)	7th	Electrical Energy Conservation and Auditing
3	PEC-EE 711(c)	7th	Wind and Solar Energy Systems
4	PEC-EE 711(d)	7th	Electrical and Hybrid Vehicles

**#Professional Elective Course (PEC-EE 712)**

Sl. No	Paper code	Semester	Name of the paper
1	PEC-EE 712(a)	7th	Power System Protection
2	PEC-EE 712(b)	7th	HVDC Transmission Systems
3	PEC-EE 712(c)	7th	Power Quality and FACTS
4	PEC-EE 712(d)	7th	Power System Dynamics and Control

**## Open Elective Course (OEC-X 721)**

Sl. No	Paper code	Semester	Name of the paper
1.	OEC-HU 721(a)	7th	Introduction to Comparative literature
2.	OEC-HU 721(b)	7th	Economic Policies in India
3.	OEC-M 721(c)	7th	Mathematical Formulation and Approximations
4.	OEC-HU 721(d)	7th	Soft Skills & Interpersonal Communication
5.	OEC-EI 721(e)	7th	MEMS
6.	OEC-EC 721(f)	7th	Nano Electronics

**## Open Elective Course (OEC-X 722)**

Sl. No	Paper code	Semester	Name of the paper
1.	OEC-EE 722(a)	7th	Renewable Energy
2.	OEC-ME 722(b)	7th	Modern Manufacturing Practice
3.	OEC-ME 722(c)	7th	Thermal Engineering & Fluid Machinery

**Semester VIII (Fourth year) Curriculum**  
**Branch/Course: Electrical Engineering**

Sl. No	Type of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1	Professional Elective Course <sup>#</sup>	PEC-EE 811	Professional Elective-VI	3	0	0	3	100
3	Open Elective Course <sup>##</sup>	OEC-X* 821	Open Elective-V	3	0	0	3	100
4	Open Elective Course <sup>##</sup>	OEC-X* 822	Open Elective-VI	3	0	0	3	100
7	Project and Internship	PROJ-EE 892	Project Stage-II	0	0	14	7	100
<b>Total:</b>							<b>16</b>	<b>400</b>

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**#Professional Elective Course (PEC-EE 811)**

Sl. No	Paper code	Semester	Name of the paper
1	PEC-EE 811(a)	8th	Advanced Electric Drives
2	PEC-EE 811(b)	8th	Utilization of Electrical Power

**## Open Elective Course (OEC-X 821)**

Sl. No	Paper code	Semester	Name of the paper
1.	OEC-M 821(a)	8th	Advanced Operations Research
2.	OEC-EE 821(b)	8th	Advanced Topics in Power Systems
3.	OEC-HU 821(c)	8th	Quality Control & Management
4.	OEC-HU 821(d)	8th	Cyber Law and Computer Ethics
5.	OEC-EC 821(e)	8th	Satellite Communication
6.	OEC-EE 821(f)	8th	Energy Audit & Management

**## Open Elective Course (OEC-X 822)**

Sl. No	Paper code	Semester	Name of the paper
1.	OEC-HU 822(a)	8th	Digital Marketing
2.	OEC-HU 822(b)	8th	Human Resource Development & Organizational Behavior
3.	OEC-EC 822(c)	8th	Machine Learning
4.	OEC-EI 822(d)	8th	Sensor Technology
5.	OEC-EE 822(e)	8th	Automotive Control & Robotics
6.	OEC-ME 822(f)	8th	Power Plant Engineering

Annexure-I: Common Open Elective Courses (OEC) List

Sl. No	Paper code	Sem.	Name of the paper
1.	OEC-HU 521(a)	5th	Sanskrit for Technical Knowledge
2.	OEC-PH 521(b)	5th	Material Science
3.	OEC-EC 521(c)	5th	Bio Medical Electronics
4.	OEC-CS/IT 521(d)	5th	Programming using Python
5.	OEC-HU 621(a)	6th	History of Science & Engineering in India
6.	OEC-HU 621 (b)	6th	Infrastructure Finance
7.	OEC-PH 621(c)	6th	Optoelectronics
8.	OEC-EC/EI 621(d)	6th	Microprocessors & Its Applications
9.	OEC-M 621(e)	6th	Computational Methods
10.	OEC-HU 721(a)	7th	Introduction to Comparative literature
11.	OEC-HU 721(b)	7th	Economic Policies in India
12.	OEC-M 721(c)	7th	Mathematical Formulation and Approximations
13.	OEC-HU 721(d)	7th	Soft Skills & Interpersonal Communication
14.	OEC-EI 721(e)	7th	MEMS
15.	OEC-EC 721(f)	7th	Nano Electronics
16.	OEC-EE 722(a)	7th	Renewable Energy
17.	OEC-ME 722(b)	7th	Modern Manufacturing Practice
18.	OEC-ME 722(c)	7th	Thermal Engineering & Fluid Machinery
19.	OEC-M 821(a)	8 <sup>th</sup>	Advanced Operations Research
20.	OEC-EE 821(b)	8 <sup>th</sup>	Advanced Topics in Power Systems
21.	OEC-CE 821©	8 <sup>th</sup>	Quality Control & Management
22.	OEC-HU 821(d)	8 <sup>th</sup>	Cyber Law and Computer Ethics
23.	OEC-EC 821(e)	8 <sup>th</sup>	Satellite Communication
24.	OEC-EE 821(f)	8 <sup>th</sup>	Energy Audit & Management
25.	OEC-HU 822(a)	8 <sup>th</sup>	Digital Marketing
26.	OEC-HU 822(b)	8 <sup>th</sup>	Human Resource Development & Organizational Behavior
27.	OEC-EC 822©	8 <sup>th</sup>	Machine Learning
28.	OEC-EI 822(d)	8 <sup>th</sup>	Sensor Technology
29.	OEC-EE 822(e)	8 <sup>th</sup>	Automotive Control & Robotics
30.	OEC-ME 822(f)	8 <sup>th</sup>	Power Plant Engineering

**Annexure-II: MOOCs (Massive Open Online Courses):**

The Curriculum for Bachelor of Engineering programme consists of total 160 credits in the entire 4 years programme in Electrical Engineering. A student will be eligible to get Under Graduate degree with Honours, if he/she completes an additional 20 credits during entire 4 years of time. These could be acquired through any online courses (MOOCs) (not offered in his/her entire 4-year syllabus) as per AICTE in consultation with his/her mentor if needed.

**List of MOOCs for EE**

No	List of Courses	Duration	Credit	Offered by
1.	Entrepreneurship in Emerging Economies	6 weeks	2	edX
2.	Programming, Data Structures and Algorithms using Python	8 weeks	2	NPTEL
3.	Introduction to Internet of Things	12Weeks	3	NPTEL

4.	IoT Programming and Big Data	5 weeks	2	edX
5.	Robotics: Aerial Robotics	6 weeks	2	Coursera
6.	Deep learning in Computer Vision	5 weeks	2	Coursera
7.	Natural Language Processing	12 weeks	3	Edx
8.	Embedded Systems	12 weeks	3	NPTEL
9.	Introduction to Industry 4.0 and Industrial Internet of Things	12 weeks	3	NPTEL
10.	IoT System Design: Software and Hardware Integration	4 weeks	2	edX
11.	Data Science with Python	10 weeks	3	edX
12.	Convolution Neural Network	4 weeks	1	Coursera
13.	Deep Learning	12 weeks	3	NPTEL
14.	AWS Fundamental: Going Cloud Native	5 weeks	2	Coursera
15.	Remote Sensing and Digital Image Processing of Satellite Data	8 weeks	2	NPTEL
16.	Leadership for Engineers	6 weeks	2	edX
17.	Fuzzy Sets, Logic and System Application	12 weeks	3	NPTEL
18.	Electronic Systems for Cancer Diagnostics	12 weeks	3	NPTEL
19.	Data Analytics with Python	12 weeks	3	NPTEL
20.	Optical Engineering	12 weeks	3	NPTEL
21.	Machine Learning	8 weeks	2	NPTEL
22.	Introduction to Machine Learning	12 weeks	3	NPTEL
23.	An Introduction to Artificial Intelligence	12 weeks	3	NPTEL
24.	Artificial Intelligence: Knowledge Representation and Reasoning	12 weeks	3	NPTEL
25.	Privacy and Security in Online Social Media	8 weeks	2	NPTEL
26.	Deep Learning	12 weeks	3	NPTEL
27.	Data Science for Engineers	8 weeks	2	NPTEL
28.	Embedded Systems Design	12 weeks	3	NPTEL
29.	Introduction to Internet of Things	12 weeks	3	NPTEL
30.	User-Centric Computing for Human-Computer Interaction	8 weeks	2	NPTEL
31.	VLSI Physical Design	12 weeks	3	NPTEL
32.	Hydraulic Engineering	12 weeks	3	NPTEL
33.	High Voltage Engineering	12 weeks	3	NPTEL
34.	Data Analysis and Presentation Skills: the PwC Approach Specialization	12 weeks	3	NPTEL
35.	Digital Signal Processing	12 weeks	3	NPTEL

36.	Electronics Equipment Integration and Prototype Building	12 weeks	3	NPTEL
37.	Advanced Power Electronics and Control	12 weeks	3	NPTEL
38.	Power Quality Improvement Technique	12 weeks	3	NPTEL
39.	Microwave Integrated Circuits	12 weeks	3	NPTEL
40.	VLSI Signal Processing	12 weeks	3	NPTEL
41.	CMOS Digital VLSI Design	12 weeks	3	NPTEL
42.	Principles of Digital Communication	6 weeks	2	Coursera
43.	Remote Sensing and GIS	6 weeks	2	Coursera
44.	Mathematical Methods and Techniques in Signal Processing	12 weeks	3	NPTEL
45.	Statistical Signal Processing	6 weeks	2	Coursera
46.	Multirate DSP	6 weeks	2	Coursera
47.	High Power Multilevel Converters – Analysis, Design and Operational Issues	12 weeks	3	NPTEL
48.	Power Management Integrated Circuits	12 weeks	3	NPTEL
49.	Nonlinear System Analysis	12 weeks	3	NPTEL
50.	Biomedical Signal Processing	12 weeks	3	NPTEL
51.	Electronic Systems for Cancer Diagnosis	12 weeks	3	NPTEL
52.	Fuzzy Sets, Logic and Systems & Applications	12 weeks	3	NPTEL
53.	Medical Image Analysis	12 weeks	3	NPTEL
54.	Electric Vehicles	12 weeks	3	NPTEL
55.	A brief Introduction to Micro-sensors	12 weeks	3	NPTEL
56.	Design and Simulation of Power Conversion using Open Source Tools	12 weeks	3	NPTEL
57.	Recent Advances in Transmission Insulator	8 weeks	2	NPTEL
58.	Data Analytics with Python	12 weeks	3	NPTEL
59.	Embedded System Design with ARM	12 weeks	3	NPTEL
60.	Real Time Operating System	6 weeks	2	edX
61.	Deep Learning	6 weeks	2	edX
62.	Introduction to scripting in Python	6 weeks	2	edX
63.	Introduction to Soft Computing	12 weeks	3	NPTEL
64.	Programming, Data Structures and Algorithms using Python	12 weeks	3	NPTEL
65.	Ethical Hacking	12 weeks	3	NPTEL
66.	Entrepreneurship in Emerging Economies	8 weeks	2	NPTEL

67.	Energy Efficiency, Acoustics and daylighting in Building	6 weeks	2	edX
68.	Big Data Analytics	12 weeks	3	NPTEL
69.	Robotics: Aerial Robotics	12 weeks	3	NPTEL
70.	Deep learning in Computer Vision	6 weeks	2	edX
71.	Process Automation & PLC	12 weeks	3	NPTEL
72.	Fuzzy Logic and Neural Networks	12 weeks	3	NPTEL
73.	Machine Analysis	12 weeks	3	NPTEL
74.	Switched Mode Power Conversion	12 weeks	3	NPTEL
75.	Electric Drives Systems	12 weeks	3	NPTEL
76.	Advanced Power Electronics Applications	12 weeks	3	NPTEL
77.	Mathematical Modeling and Analysis of Electrical Machines	12 weeks	3	NPTEL
78.	Embedded Systems	6 weeks	2	edX
79.	PIC Microcontroller and Applications	12 weeks	3	NPTEL
80.	Advanced Power Systems	12 weeks	3	NPTEL
81.	Special Electro-mechanical Devices	12 weeks	3	NPTEL
82.	Sliding Mode Control	12 weeks	3	NPTEL
83.	Electromagnetic Fields Applied to Electrical Machines	12 weeks	3	NPTEL
84.	Analysis and Control of Electric Drives	12 weeks	3	NPTEL
85.	Special Electrical Machines	12 weeks	3	NPTEL
86.	Power Electronic Converter-I	8 weeks	2	NPTEL
87.	Power Electronic Converter-II	8 weeks	2	NPTEL
88.	Digital Control Systems	12 weeks	3	NPTEL
89.	AI Applications in Power Electronics	12 weeks	3	NPTEL
90.	Advanced Protection of Power Apparatus and System	12 weeks	3	NPTEL
91.	CAD and Analysis of Electrical Machines	12 weeks	3	NPTEL
92.	Dynamics of Electric Machines	12 weeks	3	NPTEL
93.	Power Semiconductor Controlled Drives	8 weeks	2	NPTEL
94.	Special Operational and Design Features of Electrical Machines	12 weeks	3	NPTEL
95.	Electric Traction Systems	12 weeks	3	NPTEL
96.	Converter Applications	12 weeks	3	NPTEL
97.	Solar and Wind Power Technologies	8 weeks	2	NPTEL



98.	Control Techniques in Power Electronics	12 weeks	3	NPTEL
99.	Smart Grid	12 weeks	3	NPTEL
100.	Advanced Power System Stability	8 weeks	2	NPTEL
101.	Computer Architecture	4 weeks	2	Coursera
102.	Digital Systems: From Logic Gates to Processors	4 weeks	2	Coursera
103.	Development of Real-Time Systems	4 weeks	2	Coursera
104.	Sensors and Sensor Circuit Design	4 weeks	2	Coursera

*\* List is indicative only. Subject can be selected from the platform other than NPTEL with consultation of mentor.*

# Detailed syllabus of B.E. Degree for 5<sup>th</sup> – 8<sup>th</sup> Semesters in Electrical Engineering (EE)

## Semester V (Third year) Curriculum Branch/Course: Electrical Engineering

Sl. No	Type of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
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		PCC-EE 551	Power Systems Laboratory - I	0	0	2	1	100
2	Professional Core Course	PCC-EE 502	Control Systems	3	0	0	3	100
		PCC-EE 552	Control Systems Laboratory	0	0	2	1	100
3	Professional Core Course	PCC-EE 503	Microprocessors	3	0	0	3	100
		PCC-EE 553	Microprocessors Laboratory	0	0	2	1	100
4	Professional Elective Course <sup>#</sup>	PEC-EE 511	Professional Elective-I	3	0	0	3	100
5	Open Elective Course <sup>##</sup>	OEC-X* 521	Open Elective-I	3	0	0	3	100
6	Humanities and Social Sciences including Management courses	HSM-HU 501	Industrial Management & Entrepreneurship	3	0	0	3	100
7	Mandatory Course	**MC-HU 501	Constitution of India	3	0	0	0	100
8	Humanities and Social Sciences	HSM-HU 581	Grooming & Personality Development	0	0	2	1	100
<b>Total:</b>							<b>22</b>	<b>1000</b>

**\*\* Marks for this paper will not be reflected in total marks for the semester**

**\* X refers to offering codes such as M/EE/HU/ME/EC/EI/CSE**

### #Professional Elective Course (PEC-EE 511)

Sl. No	Paper code	Semester	Name of the paper
1	PEC-EE 511(a)	5th	Electrical Power Generation and Distribution
2	PEC-EE 511(b)	5th	Electrical Machine Design
3	PEC-EE 511(c)	5th	Synthesis of Electrical Circuits
4	PEC-EE 511(d)	5th	Data Structure and Algorithm

### ## Open Elective Course (OEC-X 521)

Sl. No	Paper code	Semester	Name of the paper
1.	OEC-HU 521(a)	5th	Sanskrit for Technical Knowledge
2.	OEC-PH 521(b)	5th	Material Science
3.	OEC-EC 521(c)	5th	Bio Medical Electronics
4.	OEC-CSE 521(d)	5th	Introduction to Object Oriented Technology & Python
5.	OEC-EI 521(e)	5th	Optical Instrumentation

**## Refer to the OEC booklet for detailed syllabus**

## Professional Core Courses

Course code	PCC-EE 501				
Category	Professional Core Course (PCC)				
Course title	Power System-I (Apparatus and Modeling)				
Scheme and Credits	L	T	P	Credits	Semester –V
	3	0	0	3	
Pre-requisites (if any)					

### Course Outcomes:

At the end of this course, students will have the ability to

- [1] Understand the concepts of power systems.
- [2] Understand the various power system components.
- [3] Evaluate per unit representation and line parameters for different types of transmission line in power system.
- [4] Evaluate line inductance and capacitance for transmission line conductors.
- [5] Understand the propagation of over-voltages and insulation coordination.

### Theory Syllabus:

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Basic Concepts:</b> Evolution of Power Systems and Present-Day Scenario. Structure of a power system, Generation: Conventional and Renewable Energy Sources. Distributed Energy Resources. Energy Storage. Transmission and Distribution Systems: Line diagrams, transmission and distribution voltage levels. Power flow through a line, power circle diagram, line charts, active power flow and voltage control in transmission system. Line load-ability and voltage dependence	<b>4L</b>
<b>2.</b>	<b>Power System Components:</b> <b>Transmission line structure-</b> Types of conductors, line supports – poles, towers, struts & Guy wires, sag and tension calculations, stringing chart, sag template. <b>Insulators</b> – Materials of insulators, types of insulators – Pin and Disc type – their applications, String efficiency, calculation of string efficiency, improvement of string efficiency. <b>Underground Cables</b> – Construction of cables, single and multicore cables, different types, capacitance of belted cables, dielectric loss in cables, heating of cables, Testing of cables	<b>12L</b>
<b>3.</b>	<b>Per-Unit representation of Power system:</b> Selection of base quantities, percent and per unit values, advantage of per unit system. <b>Line representation</b> – Representation of short, medium and long lines, Pai and T models. A, B, C, D constants of transmission lines and their measurement. Traveling wave interpretation of long line equations, tuned lines.	<b>7L</b>

<b>4.</b>	<b>Inductance of Transmission line conductors</b> – Resistance, Inductance, Capacitance and Conductance. Inductance of single-phase line, inductance of three phase line with symmetrical and unsymmetrical spacing, concept of GMD and GMR. <b>Capacitance of Transmission line conductors</b> – stranded conductors, bundle conductor and Double circuit lines. Capacitance of single-phase line, capacitance of three phase lines with symmetrical and unsymmetrical spacings, capacitance calculation for double circuit line and bundle conductor. Effect of earth on capacitance calculation. Skin effect and proximity effect.	<b>10L</b>
<b>5.</b>	<b>Over-voltages and Insulation Requirements:</b> Travelling wave equations, Reflection and refraction of travelling waves, Line terminations, Ladder diagram, Travelling waves in multi-conductor systems, Insulation Coordination. Propagation of Surges. Voltages produced by traveling surges. Bewley Diagrams.	<b>9L</b>
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Text/References Books:**

1. J. Grainger and W. D. Stevenson, “Power System Analysis”, McGraw Hill Education, 1994.
2. O. I. Elgerd, “Electric Energy Systems Theory”, McGraw Hill Education, 1995.
3. A. R. Bergen and V. Vittal, “Power System Analysis”, Pearson Education Inc., 1999.
4. D. P. Kothari and I. J. Nagrath, “Modern Power System Analysis”, McGraw Hill Education, 2003.
5. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, “Electric Power Systems”, Wiley, 2012.
6. P. K. Sadhu, S. Das, “Elements of Power Systems” CRC Press, Taylor & Francis Group, 2015.

**Laboratory Syllabus:**

<b>Course code</b>	<b>PCC-EE 551</b>				
<b>Category</b>	Professional Core Courses (PCC)				
<b>Course title</b>	<b>Power Systems – I Laboratory</b>				
<b>Scheme and Credits</b>	<b>L</b> 0	<b>T</b> 0	<b>P</b> 2	<b>Credits</b> 1	<b>Semester – V</b>
<b>Pre-requisites (if any)</b>					

Module	Detailed Description	Practical Period
1.	Determination of the generalized constants A, B, C, D of a long transmission line	4P
2.	Determination of Transmission parameters for T and $\Pi$ network	4P
3.	Dielectric strength test of insulating oil	4P
4.	Study of different types of insulators	4P
5.	Measurement of earth resistance by earth tester	4P
6.	Dielectric constant, tan delta, resistivity test of transformer oil.	8P
	Total:	28P
	Total Week Required:	14
	No. Of Week Reserved:	02

Course code	PCC-EE 502				
Category	Professional Core Course (PCC)				
Course title	Control Systems				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)					

**Course Outcomes: At the end of this course students will demonstrate the ability to**

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

### Theory Syllabus:

Unit	Detailed Description	Lecture/ Tutorial Period
1	<b>Introduction to control problem:</b> Industrial Control examples. Mathematical models of physical systems. Control hardware and their models. Transfer function models of linear time invariant systems. Feedback Control: Open-Loop and Closed-loop systems. Benefits of Feedback. Block diagram algebra.	4L
2.	<b>Time Response Analysis: Standard test signals:</b> Time response of first and second order systems for standard test inputs. Application of initial and final value theorem. Design specifications for second-order systems based on the time-response. Concept of Stability: Routh-Hurwitz Criteria. Relative Stability analysis. Root-Locus technique. Construction of Root-loci.	10L
3.	<b>Frequency-response analysis:</b> Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response.	10L

<b>4.</b>	<b>Introduction to Controller Design:</b> Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness of control systems. Root-loci method of feedback controller design. Design specifications in frequency-domain. Frequency domain methods of design. Application of Proportional, Integral and Derivative Controllers, Lead and Lag compensation in designs. Analog and Digital implementation of controllers.	<b>10L</b>
<b>5.</b>	<b>State variable Analysis:</b> Concepts of state variables. State space model. Diagonalization of State Matrix. Solution of state equations. Eigenvalues and Stability Analysis. Concept of controllability and observability. Pole-placement by state feedback. Discrete-time systems. Difference Equations. State-space models of linear discrete-time systems. Stability of linear discrete-time systems.	<b>8L</b>
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Text Book/ Reference Book:**

- [1] . M. Gopal, “Control Systems: Principles and Design”, McGraw Hill Education, 1997.
- [2] B. C. Kuo, “Automatic Control System”, Prentice Hall, 1995.
- [3] K. Ogata, “Modern Control Engineering”, Prentice Hall, 1991.
- [4] I. J. Nagrath and M. Gopal, “Control Systems Engineering”, New Age International, 2009.

**Laboratory Syllabus:**

Course code	PCC-EE552				
Category	Professional Core Course (PCC)				
Course title	Control Systems Laboratory				
Scheme and Credits	L	T	P	Credits	Semester – V
	0	0	2	1	
Pre-requisites (if any)					

<b>Module</b>	<b>Detailed Description</b>	<b>Practical Period</b>
1.	Familiarization with MATLAB control system tool box, MATLAB SIMULINK toolbox.	4P
2.	Determination of step response for first order & second order system with unity feedback on CRO & calculations of control system specifications like time constant, percentage peak overshoot, settling time etc. from the response.	4P
3.	Simulation of step response & impulse response for type-0, type-1 & type-2 system with unity feedback using MATLAB.	4P

4.	Determination of Root locus, Bode plot, Nyquist plot using MATLAB control system toolbox for 2nd order system & determination of different control system specifications from the plot.	4P
5.	Determination of PI, PD, and PID controller action of first order simulated process.	4P
6.	Determination of approximate transfer functions experimentally from the Bode plot.	4P
7.	Evaluation of steady state error, settling time, percentage peak overshoot, gain margin, phase margin with addition of lead compensator & by compensator in forward path transfer function for unity feedback control system using PSPICE or otherwise.	4P
	Total:	28P
	Total Week Required:	14
	No. Of Week Reserved:	02

Course code	PCC-EE503				
Category	Professional Core Course (PCC)				
Course title	Microprocessors				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)					

**Course Outcomes: At the end of this course students will demonstrate the ability to**

- Do assembly language programming.
- Do interfacing design of peripherals like I/O, A/D, D/A, timer etc.
- Develop systems using different microcontrollers

### **Theory Syllabus:**

<b>Unit</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
<b>1</b>	<b>Fundamentals of Microprocessors:</b> Fundamentals of Microprocessor Architecture. 8-bit Microprocessor and Microcontroller architecture, Comparison of 8-bit microcontrollers, 16-bit and 32-bit microcontrollers. Definition of embedded system and its characteristics, Role of microcontrollers in embedded Systems. Overview of the 8051 family.	<b>8L</b>
<b>2.</b>	<b>The 8051 Architecture:</b> Internal Block Diagram, CPU, ALU, address, data and control bus, working registers, SFRs, Clock and RESET circuits, Stack and Stack Pointer, Program Counter, I/O ports, Memory Structures, Data and Program Memory, Timing diagrams and Execution Cycles.	<b>8L</b>
<b>3.</b>	<b>Instruction Set and Programming:</b> Addressing modes: Introduction, Instruction syntax, Data types, Subroutines Immediate addressing, Register addressing, Direct addressing, Indirect addressing, Relative addressing, Indexed addressing, Bit inherent addressing, bit direct addressing. 8051 Instruction set, Instruction timings. Data transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Subroutine instructions, Bit manipulation instruction. Assembly language programs, C language programs. Assemblers and compilers. Programming and debugging tools.	<b>8L</b>

<b>4.</b>	<b>Memory and I/O Interfacing:</b> Memory and I/O expansion buses, control signals, memory wait states. Interfacing of peripheral devices such as General Purpose I/O, ADC, DAC, timers, counters, and memory devices.	<b>6L</b>
<b>5.</b>	<b>External Communication Interface:</b> Synchronous and Asynchronous Communication. RS232, SPI, I2C. Introduction and interfacing to protocols like Blue-tooth and Zig-bee.	<b>6L</b>
<b>6.</b>	<b>Applications:</b> LED, LCD and keyboard interfacing. Stepper motor interfacing, DC Motor interfacing, and sensor interfacing.	<b>6L</b>
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

#### Text / Reference Book:

- [1] M. A. Mazidi, J. G. Mazidi and R. D. McKinlay, "The 8051 Microcontroller and Embedded Systems: Using Assembly and C", Pearson Education, 2007.
- [2] K. J. Ayala, "8051 Microcontroller", Delmar Cengage Learning, 2004.
- [3] R. Kamal, "Embedded System", McGraw Hill Education, 2009.
- [4] R. S. Gaonkar, "Microprocessor Architecture: Programming and Applications with the 8085", Penram International Publishing, 1996
- [5] D. A. Patterson and J. H. Hennessy, "Computer Organization and Design: The Hardware/Software interface", Morgan Kaufman Publishers, 2013.
- [6] D. V. Hall, "Microprocessors & Interfacing", McGraw Hill Higher Education, 1991.

#### Laboratory Syllabus:

Course code	PCC-EE553				
Category	Professional Core Course (PCC)				
Course title	Microprocessor Laboratory				
Scheme and Credits	L	T	P	Credits	Semester – V
	0	0	2	1	
Pre-requisites (if any)					

<b>Module</b>	<b>Detailed Description</b>	<b>Practical Period</b>
1.	Familiarization with 8085 register level architecture and trainer kit components including the memory map. Familiarization with process of storing and viewing the contents of memory as well as registers.	3P
2.	Study of prewritten program on trainer kit using the basic instruction set (data transfer, load/store, arithmetic, logical operations).	3P
3.	Familiarization with 8085 simulators on PC. Study of prewritten program using basic instruction set (data transfer, load/store, arithmetic, logical operations).	3P
4.	Programming using kit/simulator: (a) Lookup table, (b) Copying a block of memory, (c) Shifting a block of memory, (d) Packing and unpacking of BCD numbers, (e) Addition of BCD number, (f) Binary to ASCII conversion, (g) String matching.	4P



5.	Program using subroutine calls and using IN/OUT instruction using 8255 PPI on the trainer kit, subroutine for delay, reading switch state and glowing LEDs accordingly, finding out frequency of pulse train, etc.	4P
6.	Interfacing any 8-bit latch (74LS373) with trainer kit as a peripheral mapped output port with absolute address decoding.	4P
7.	Interfacing with I/O module: (a) ADC, (b) Speed control of DC motor with DAC, (c) Keyboard, (d) Multi digit display with multiplexing, (e) Stepper motor.	4P
8.	Study of 8031/8051 Micro controller kit and writing program for the following task using the kit: (a) table look up, (b) basic arithmetic and logical operation, (c) interfacing of keyboard and stepper motor.	3P
	Total:	28P
	Total Week Required:	14
	No. Of Week Reserved:	02

### Professional Elective Courses

Course code	PEC-EE 511(a)				
Category	Professional Elective Course (PEC)				
Course title	Electrical Power Generation and Distribution				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)					

### Course Outcomes:

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

1. To understand the structure of Generation, transmission and distribution of Power system.
2. To understand the layout of Thermal station, Hydroelectric station and Nuclear power station.
3. To understand the Power distribution system and electrical wiring and installation.
4. To understand the Administrative aspect of electricity supply.

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
<b>1</b>	Structure of Power System – Generation, transmission and distribution. Power generating stations – different types. Steam power stations: Main parts and working, types of boilers and their characteristics. Characteristics of steam turbines and some introductory parts of alternators. Main flow circuits of steam power station. Power station auxiliaries, cooling system of alternators. Starting up and shut down procedures of thermal units Gas-turbine power stations- Main parts, plant layout and Bryton cycle operation. Combined cycle generation & Co-generation	11L

2	Nuclear power stations- Layout of nuclear power station, types of power reactors, main parts and control of reactors, nuclear waste disposal, radioactivity and hazards. Hydroelectric stations: Arrangement and location of hydroelectric stations, principles of working, types of turbines and their characteristics, Pumped storage plants Coordination of operation of different power stations. Substation - Classification of substations, Major equipment's in Substation, Busbar layouts	9L
3	Power distribution system: Primary and secondary distribution, types of conductors in distribution system, comparison of distribution systems. Distributor design, radial and ring main, current and voltage profiles along a distributor, economics of feeder design. Electrical wiring and installation - Domestic, commercial and industrial wiring, estimation of main, submain and subcircuit wiring. Earthing practice. Testing of installation. Special lighting connections. Conductors, Fuse and disconnecting devices.	12L
4	Administrative aspects of electricity supply- Development of power sector in India. Administrative set up and organizations in power sector.  Stages involved in power planning- load analysis, load management & load forecasting.  Legal aspects of electricity supply- Electricity acts, rules and codes. Standards followed in power supply, environmental and safety measures.	10L
<b>Total Lecture/Tutorial:</b>		<b>42L</b>
<b>Total Week Required:</b>		<b>14</b>
<b>No. Of Week Reserved:</b>		<b>02</b>

**Text/Reference Books:**

1. A Course on Power System by J.B.gupta, Kataria and Sons
2. Powerplant Technology by M.M.El-Wakil, McGraw Hill
3. Power Station Engineering & Economy by B.G.A. Skrotzki & W.A.Vopat, Tata McGraw Hill
4. A Course in Power Plant Engineering, by Arora & Domkundwar, Dhanpat Rai
5. Elements of Electrical Power Station Design, by M.V.Deshpande, Wheeler
6. Electric Power Distribution System Engineering, by Turan Gonen
7. Transmission & Distribution, by H.Cotton

Course code	PEC-EE 511(b)				
Category	Professional Elective Course (PEC)				
Course title	Electrical Machine Design				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)					

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

1. Understand the construction and performance characteristics of electrical machines.
2. Understand the various factors which influence the design: electrical, magnetic and thermal loading of electrical machines.
3. Understand the principles of electrical machine design and carry out a basic design of an AC machine.
4. Use software tools to do design calculations.

Unit	Detailed Description	Lecture/ Tutorial Period
1	<b>Introduction:</b> Major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines.	8L
2.	<b>Transformers:</b> Sizing of a transformer, main dimensions, kVA output for single- and three-phase transformers, window space factor, overall dimensions, operating characteristics, regulation, no load current, temperature rise in transformers, design of cooling tank, methods for cooling of transformers.	8L
3.	<b>Induction Motors:</b> Sizing of an induction motor, main dimensions, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, leakage reactance of poly-phase machines, magnetizing current, short circuit current, circle diagram, operating characteristics.	8L
4.	<b>Synchronous Machines:</b> Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of air gap length, design of rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo alternators, rotor design.	8L
5.	<b>Computer aided Design (CAD):</b> Limitations (assumptions) of traditional designs, need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation. Introduction to FEM based machine design. Introduction to complex structures of modern machines-PMSMs, BLDCs, SRM and claw-pole machines.	8L
	<b>Total:</b>	<b>40L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

Text Book:

1. A.K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 1970.
2. M.G. Say, "Theory & Performance & Design of A.C. Machines", ELBS London.
3. S. K. Sen, "Principles of Electrical Machine Design with computer programmes", Oxford and IBH Publishing, 2006.
4. K. L. Narang, "A Text Book of Electrical Engineering Drawings", Satya Prakashan, 1969.

5. A. Shanmugasundaram, G. Gangadharan and R. Palani, “Electrical Machine Design Data Book”, New Age International, 1979.
6. K. M. V. Murthy, “Computer Aided Design of Electrical Machines”, B.S. Publications, 2008.
7. Electrical machines and equipment design exercise examples using Ansoft’s Maxwell 2D machine design package.

Course code	PEC-EE 511(c)				
Category	Professional Elective Course (PEC)				
Course title	Synthesis of Electrical Circuits				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)					

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

- Understand the concepts of electrical network synthesis, their principles and practices.
- Learn how to synthesize an electrical network from a given impedance/admittance function.
- Design and synthesize practical attenuator networks.
- Design and synthesize practical passive filter networks.

<b>Unit</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
1	<b>Network Functions</b> Network function for one-port and two-port, calculation of network function for ladder and general networks, poles and zeros with restrictions for driving point functions and transform functions, time domain behavior from the pole zero plot, compensation network stability of active network, two-port parameters, stability by Routh-Harwitz criterion.	8L
2.	<b>Network Synthesis</b> Identification of network synthesis, Brune’s positive and real function (PRF), properties of PRF, testing of driving point functions, even and odd function, one terminal pair network driving point synthesis with LC elements, RC elements, Foster and Cauer form.	10L
3.	<b>Synthesis of two terminal and four terminal networks</b> Driving point impedance (first foster form), network realization of reactance functions, types of reactance functions, driving point admittance (second foster form), canonical networks, cauer networks, synthesis of four-terminal R-C and R-L networks.	8L
4.	<b>Attenuators and Equalisers</b> T, $\Pi$ , Bridged T, Lattice and L type attenuators, ladder Attenuator, amplitude and phase equalizer- Lattice and Bridged T, application of Attenuators and equalizers	6L
5.	<b>Filters</b> Mechanism of filter action, conditions of pass band and stop band, design of Prototype low pass, high pass, band pass and band stop sections (both T & $\Pi$ section), m-derived sections, modern filter design concepts.	10L

	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

Text/Reference Book:

1. "Introduction to Network Synthesis", Valkenburg, Van., PHI Pbs.
2. "Network Analysis And Synthesis", Wadhwa, C. L., New Age Pbs
3. "Circuit Theory", Chakrabarti, A., Dhanpat Rai and Co. (P) Ltd.
4. "Networks and Systems", Roy Chowdhury, D., New Age International (P) Limited.
5. "Networks and Systems", Hussain, A., CBS Publications.

Course code	PEC-EE 511(d)				
Category	Professional Elective Course (PEC)				
Course title	Data Structure & Algorithms				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)					

Course Outcomes:

1. For a given algorithm student will able to analyze the algorithms to determine the time and computation complexity and justify the correctness.
2. For a given Search problem (Linear Search and Binary Search) student will able to implement it.
3. For a given problem of Stacks, Queues and linked list student will able to implement it and analyze the same to determine the time and computation complexity.
4. Student will able to write an algorithm Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort and compare their performance in term of Space and Time complexity.
5. Student will able to implement Graph search and traversal algorithms and determine the time and computation complexity.

<b>Unit</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
1	<b>Introduction</b> Basic Terminologies: Elementary Data Organizations, Data Structure Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off. <b>Searching:</b> Linear Search and Binary Search Techniques and their complexity analysis.	8L
2.	<b>Stacks and Queues</b> ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation – corresponding algorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.	10L

3.	<b>Linked Lists</b> Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis. <b>Trees:</b> Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms and analysis.	12L
4.	<b>Sorting and Hashing</b> Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing. <b>Graph:</b> Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.	12L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

Text/Reference Book:

1. “Fundamentals of Data Structures”, Illustrated Edition by Ellis Horowitz, Sartaj Sahni, Computer Science Press.
2. “Algorithms, Data Structures, and Problem Solving with C++”, Illustrated Edition by Mark Allen Weiss, Addison-Wesley Publishing Company
3. “How to Solve it by Computer”, 2nd Impression by R. G. Dromey, Pearson Education.

#### Humanities and Social Sciences including Mandatory courses

Course Code	HSM-HU 501 (For Theory)				
Category	Humanities and Social Sciences including Management courses				
Course title	Industrial Management & Entrepreneurship (Theory)				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	3	
Pre-requisites (if any)					

#### Theory Syllabus:

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
<b>01.</b>	<b>Introduction:</b> Management: Its Nature, Purpose and Importance in Modern Organizations- Functions of Management- Types of Managerial Decisions-Information Processing -Importance of Ethics in Workplace-Basic idea about the Social Responsibility.	04L

02.	<b>Strategic management:</b> Business Mission, Vision, Formulation of objectives, Assessment of the external environment, Assessment of external competences, Strategic alternatives, portfolio analysis, methods, strategic choice.	06L
03.	<b>Leading-Human Factors and Motivation in Enterprises:</b> Maslow's Hierarchal' of Needs theory, Herzberg's Two factor theory, Mc Gregor's X Theory and Y Theory-Leadership: Trait Approaches-Leadership Behavior and Styles(overview), Group behavior, Stages in Group Development	05L
04.	<b>Human Resource Management:</b> Meaning of human Resource and Human Resource management, Understanding Human Behavior in Modern Organizations- Overall idea about the Operative Functions of Human Resource Management- Recruitment and Selection-Performance Appraisal-Training and Development-Compensation, Management-Employee Relations: Brief Overview of each of these, Industrial grievance Management.	05L
05.	<b>Marketing Management:</b> Marketing as a Concept and Process-Role of Marketing in Modern Organizations-Concept of Marketing Mix-Product, Product Mix and Product Line-Pricing: Meaning and Objectives-Basic idea about Promotion and Promotion Mix	05L
06.	<b>Financial Management:</b> Importance and Scope of Financial Management- Management of Working Capital- Dividend Policy- Capital Budgeting- Cost of capital & Capital Structure: functional ratios. Brief Overview of each of these	05L
07.	<b>Productivity, Operations Management and Total Quality Management:</b> Production and Operations Management: - -Productivity Problems and Measurement-Tools and Techniques for Improving Productivity- Basic Idea about Total Quality Management: Material handling, inventory control, JIT manufacturing, waste management.	07L
08.	<b>Entrepreneurship and Small Business:</b> Forms of Ownership, The Nature of Entrepreneurship -Entrepreneurial Scopes and Opportunities- - New Venture Creation: Developing Business Plan, Forms of ownership, Different forms of entrepreneurship, partnership ventures, creativity in entrepreneurship, need for financing of new ventures.	05L
	<b>Total</b>	<b>42L</b>
	<b>Total week required</b>	<b>14</b>
	<b>No. of week reserved</b>	<b>02</b>

**Books: Text and/or Reference:**

1. Essentials of Management: H. Koontz and H. Weihridr, Tata McGraw-Hill
2. S. P. Robbins and M. Coulter, Management; Prentice Hall India
3. J. R. Sdrermerhorn, Jr., Management, Wiley-India
4. J. A. F. Stoner, R. E. Freeman and D. R. Gilbert, Jt., Management, Prentice Hall
5. Management Theory and Practice by C B Gupta
6. Strategic Management and Business Policy by Azhar Kazmi
7. Principles of Management by Richard L. Daft,
8. Human Resource Management by Dr. S. S. Khanka
9. Production and Operations Management by S. Anil Kumar and Suresh,
10. Fundamentals of Entrepreneurship Development & Business Communication by P. Dhar
11. Discourses of Strategic Management by Dilip Roy

## Course Outcomes:

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

- Understand the concept of management and its different functions and how management concepts can be applied to practices as a member and leader in a team in a multidisciplinary environment to make management effective.
- Develop an understanding of professional, ethical, legal, and social issues and responsibilities of an industrial engineer to accomplish a common goal.
- Acquire certain knowledge about how to motivate people to work efficiently in industry.
- Make them possess the skill set required to make an appropriate staffing decision and to design, implement and evaluate training programs for the successful completion of a project.
- Know the dynamics of marketing in business and to apply theoretical marketing concepts to the practical situations like marketing research, marketing mixes and selling propositions etc.
- Know the concepts of financial management and how top management exercises financial control relating to capital structure, investment, dividend decisions etc.
- Make them understand management of manufacturing and production system and to use different techniques and tools to improve productivity.
- Instill some leadership and entrepreneurial and risk bearing attributes to enable them to start up their own ventures.

Course Code	MC-HU 501 (For Theory)				
Category	Mandatory Course (MC)				
Course title	Constitution of India				
Scheme and Credits	L	T	P	Credits	Semester – V
	3	0	0	0	
Pre-requisites (if any)					

## Theory Syllabus:

Module	Detailed Description	Lecture / Tutorial Period
01.	<b>Introduction and Basic Information about Indian Constitution</b> Constitution' meaning of the term, Indian Constitution: Sources and constitutional history, The Role of the Constituent Assembly. Features: Citizenship, Preamble and Salient features of the Constitution of India, Fundamental Rights and its Restriction and limitations in different Complex Situations, Fundamental Duties and its Scope and significance in Nation building, Directive Principles of State Policy (DPSP) & its present relevance in our society with examples.	08L
02.	<b>Union Government and its Administration</b> Structure of the Indian Union: Federalism, Centre-State relationship, President: Role, power and position, <i>Prime Minister</i> and Council of ministers, <i>Union</i> Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism.	08L
03.	<b>State Government and its Administration</b> Governor: Role and Position, Chief Minister State Cabinet, State Legislature, High Court and Subordinate Courts, Special Provisions (Article 370,371,371J) for some States. State Secretariat: Organization, Structure and Functions	08L



<b>04.</b>	<b>Constitutional Provisions/ Local Administration/Human Rights</b> Special Constitutional Provisions for SC & ST, OBC, Special Provision for Women, Children & Backward Classes. Institute and Bodies for the welfare of SC/ST/OBC and women.  District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Panchayati raj: Introduction, PRI: Zila Panchayat, Elected officials and their roles, CEO Zila Panchayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy  Human Rights/values – Meaning and Definitions, Legislative Specific Themes in Human Rights and Functions/ Roles of National Human Rights Commission of India. Human Rights (Amendment Act) 2006.	09L
<b>05</b>	<b>Elections, Amendments and Emergency Provisions</b>  Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning Elections, Electoral Process, and Election Commission of India, Election Laws. Amendments - Methods in Constitutional Amendments (How and Why) and Important Constitutional Amendments. Amendments - 7,9,10,12,42,44, 61, 73, 74, 75, 86, and 91, 94, 95,100,101,118 and some important Case Studies. Recent Amendments with explanation. Important Judgments with Explanation and its impact on society (from the list of Supreme Court Judgments). Emergency Provisions, types of Emergencies and its consequences.	09L
	<b>Total</b>	<b>42L</b>
	<b>Total week required</b>	<b>14</b>
	<b>No. of week reserved</b>	<b>02</b>

#### **Books: Text and/or Reference/Web Links and Video Lectures:**

- Durga Das Basu (DD Basu):** "Introduction to the Constitution on India", (Students Edition.) Prentice –Hall EEE, 19th / 20th Edn., (Latest Edition) or 2008.
- Shubham Singles, Charles E. Haries, and Et al :** "Constitution of India and Professional Ethics" by Cengage Learning India Private Limited, Latest Edition – 2018.
- M. Govindarajan, Natarajan, V. S. Senthil Kumar,** "Engineering Ethics", Prentice – Hall of India Pvt. Ltd. New Delhi, 2004
- M. V. Pylee,** "An Introduction to Constitution of India", Visas Publishing, 2002.
- Latest Publications of **NHRC - Indian Institute of Human Rights**, New Delhi.
- [www.unacademy.com/lesson/future-perfect-tense/YQ9NSNQZ](http://www.unacademy.com/lesson/future-perfect-tense/YQ9NSNQZ)
- <https://successesacademy>

#### **Course Outcomes:**

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

- Have general knowledge and legal literacy about Indian Constitution and thereby it helps to take up competitive examinations & to manage/face complex societal issues in society.
- Understand state and central policies (Union and State Executive), fundamental Rights & their duties.
- Understand Electoral Process, Amendments and special provisions in Constitution.
- Understand powers and functions of Municipalities, Panchayats and Co-operative Societies, with Human Rights and NHRC

Course Code	HSM-HU 581 (For Laboratory)				
Category	Humanities and Social Sciences including Management Courses				
Course Title	Grooming & Personality Development				
Scheme and credits	L	T	P	Credits	Semester—V
	0	0	2	1	
Pre-requisites (if any)	Basic knowledge of speaking and writing in English				

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture/Tutorial Period</b>
1.	<b>Self-Development Skills:</b> Introduction to personality; Self-Esteem and Self-Confidence; problem solving; Stress Management; Goal-Setting.	5L
2.	<b>Public Speaking:</b> Importance; Types, Mechanics; Pillars of Public Speaking; Overcoming fear of Public Speaking.	5L
3.	<b>Oral presentation and professional speaking:</b> Basics of English pronunciation public preparing for a speech.; Elements of effective presentations, Body language and use of voice during presentation; connecting with the audience during presentation; projecting a positive image while speaking; planning and preparing a model presentation; Organizing the presentation to suit the audience and content.	6L
4.	<b>Career Oriental Communication:</b> Design and Style applying for a job: Language and format of job application; Resume& bio-data.	5L
5.	<b>Job Interview:</b> Purpose and process, language and style to be used, types of interview question and how to answer them.	7L
	<b>Total</b>	<b>28L</b>
	<b>Total week required</b>	<b>14</b>
	<b>No. of week reserved</b>	<b>02</b>

#### **Text Books:**

1. Development and Soft Skills. Barun K. Mitra, Oxford University Press, New Delhi: 2016.
2. Personality Development: Rajiv K. Mishra, Transform Yourself. Rupa Publications, 2012.
3. Personality Development, Elizabeth B. Hurlock, McGraw Hill Education, 2017.

**Reference Books:**

1. Personality Development and Career Management. M. Onkar S. Chand Publication.
2. Managing Soft Skills for Personality Development. Ed. by B. N. Ghosh. McGraw Hill, India: 2012.

**Course outcomes:**

On completion of the course students will be able to:

- Groom themselves through the knowledge of personality development attributes – self-confidence, problem solving and stress management skills etc.
- Deliver confidently an organized, refined, professional and credible speech for better suit the audience.
- Acquire the basic concepts of English pronunciation and elements of effective presentations, body language and use of voice during presentation.
- Connect with the audience during presentation and exhibit the art of projecting a positive image while speaking and preparing a model presentation.
- Learn the effective language for writing job application, resume and bio-data.
- Familiar with common interview questions and the techniques to answer them.

**Semester VI (Third year) Curriculum**  
**Branch/Course: Electrical Engineering**

Sl. No	Type of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1	Professional Core Course	PCC-EE 601	Power Systems – II (Operation and Control)	3	0	0	3	100
		PCC-EE 651	Power Systems Laboratory – II	0	0	2	1	100
2	Professional Core Course	PCC-EE 602	Measurement and Instrumentation	3	0	0	3	100
		PCC-EE 652	Measurement and Instrumentation Laboratory	0	0	2	1	100
3	Professional Core Course	PCC-EE 603	Electronics Design	2	0	0	2	100
		PCC-EE 653	Electronics Design Laboratory	0	0	2	1	100
4	Professional Elective Course <sup>#</sup>	PEC-EE 611	Professional Elective-II	3	0	0	3	100
5	Professional Elective Course <sup>#</sup>	PEC-EE 612	Professional Elective-III	3	0	0	3	100
6	Open Elective Course <sup>##</sup>	OEC-X* 621	Open Elective-II	3	0	0	3	100
7	Project and Internship	PROJ-EE 691	Term Paper Leading to Project Work	0	0	4	2	100
8.	Humanities and Social Sciences	HSM-HU 681	Group Discussion & Personal Interview	0	0	2	1	100
<b>Total:</b>							<b>23</b>	<b>1100</b>

\* X refers to offering codes such as M/EE/HU/ME/EC/EI/CSE

**<sup>#</sup>Professional Elective Course (PEC-EE 611)**

Sl. No	Paper code	Semester	Name of the paper
1	PEC-EE 611(a)	6th	Electrical Drives
2	PEC-EE 611(b)	6th	Line Commutated and Active Rectifiers
3	PEC-EE 611(c)	6th	Industrial Electrical Systems
4	PEC-EE 611(d)	6th	Electromagnetic Waves
5	PEC-EE 611(e)	6th	Computational Electromagnetics

**<sup>#</sup>Professional Elective Course (PEC-EE 612)**

Sl. No	Paper code	Semester	Name of the paper
1	PEC-EE 612(a)	6th	Digital Control Systems
2	PEC-EE 612(b)	6th	Advanced Control Engineering
3	PEC-EE 612(c)	6th	Digital Signal Processing
4	PEC-EE 612(d)	6th	Computer Architecture
5	PEC-EE 612(e)	6th	Lighting Calculation and Design

**<sup>##</sup> Open Elective Course (OEC-X 621)**

Sl. No	Paper code	Semester	Name of the paper
1.	OEC-HU 621(a)	6th	History of Science & Engineering in India
2.	OEC-HU 621 (b)	6th	Infrastructure Finance
3.	OEC-EC 621(c)	6th	Microprocessors & Its Applications
4.	OEC-EI 621 (d)	6th	Microprocessors & Its Programming
5.	OEC-M 621(e)	6th	Computational Methods

**<sup>##</sup> Refer to the OEC booklet for detailed syllabus**

### Professional Core Courses

<b>Course code</b>	<b>PCC-EE 601</b>				
<b>Category</b>	Professional Core Course (PCC)				
<b>Course title</b>	<b>Power Systems – II (Operation and Control)</b>				
<b>Scheme and Credits</b>	<b>L</b> 3	<b>T</b> 0	<b>P</b> 0	<b>Credits</b> 3	<b>Semester –VI</b>
<b>Pre-requisites (if any)</b>					

#### Course Outcomes:

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

- Use numerical methods to analyze a power system in steady state.
- Understand stability constraints in a synchronous grid.
- Understand methods to control the voltage, frequency and power flow.
- Understand the monitoring and control of a power system.
- Understand the basics of power system economics.

#### Theory Syllabus:

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial</b>
1.	<b>Power Flow Analysis:</b> Review of the structure of a Power System and its components. Analysis of Power Flows: Formation of Bus Admittance Matrix. Real and reactive power balance equations at a node. Load and Generator Specifications. Application of numerical methods for solution of nonlinear algebraic equations – Gauss Seidel and Newton-Raphson methods for the solution of the power flow equations. Computational Issues in Large-scale Power Systems.	8L
2.	<b>Stability Constraints in synchronous grids:</b> Swing Equations of a synchronous machine connected to an infinite bus. Power angle curve. Description of the phenomena of loss of synchronism in a single-machine infinite bus system following a disturbance like a three—phase fault. Analysis using numerical integration of swing equations, Equal Area Criterion. Impact of stability constraints on Power System Operation. Effect of generation rescheduling and series compensation of transmission lines on stability.	8L
3.	<b>Load Frequency Control:</b> Turbines and Speed-Governors, Speed changer and main components of speed governing system, principle of operation, Frequency dependence of loads, effect of governor droop on load sharing among generators, dependence of load on frequency, system inertia. Modeling and analysis of single area load-frequency control, supplementary control, concept of control area. Automatic Generation Control.	9L

4.	<b>Power Systems Voltage Control:</b> Generation and absorption of reactive power by various components of a Power System. Basic concept of active and reactive power control of Synchronous generator. Interdependence of active power with frequency and reactive power with voltage and concept of decoupling, Role of excitation system, main & pilot exciters, description of different types of excitation systems, Voltage Regulators. Shunt Compensators, Static VAR compensators and STATCOMs.	9L
5.	<b>Power System Economics and Management:</b> Basic Pricing Principles: Generator Cost Curves, heat rate, incremental rate Utility Functions, Power Exchanges, Spot Pricing, economic load sharing among generating units, Demand Side-management, Transmission and Distributions charges, Ancillary Services. Regulatory framework.	8L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

#### Text/References Books:

1. J. Grainger and W. D. Stevenson, "Power System Analysis", McGraw Hill Education, 1994.
2. O. I. Elgerd, "Electric Energy Systems Theory", McGraw Hill Education, 1995.
3. A. R. Bergen and V. Vittal, "Power System Analysis", Pearson Education Inc., 1999.
4. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", McGraw Hill Education, 2003.
5. B. M. Weedy, B. J. Cory, N. Jenkins, J. Ekanayake and G. Strbac, "Electric Power Systems", Wiley, 2012.

#### Laboratory Syllabus:

Course code	PCC-EE 651				
Category	Professional Core Course (PCC)				
Course title	Power Systems – II Laboratory				
Scheme and Credits	L	T	P	Credits	Semester – VI
	0	0	2	1	
Pre-requisites (if any)					

Module	Detailed Description	Practical Period
1.	Study on (i) on load Time Delay Relay (ii) off load Time Delay Relay	3P
2.	Testing on (i) Under Voltage Relay and (ii) Earth Fault Relay	3P
3.	Study of Different Characteristics of Over Current Relay	3P
4.	Study of Different Characteristics of differential Relay	4P
5.	Study of VAR compensator	4P
6.	Study on AC load flow using Gauss-Seidel method	4P
7.	Study on AC load flow using Newton Raphson method.	4P
8.	Study on Economic load dispatch.	3P
	<b>Total:</b>	<b>28P</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

Course code	PCC-EE 602				
Category	Professional Core Course (PCC)				
Course title	Measurements and Instrumentation				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)					

#### Course Outcomes:

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

- Design and validate DC and AC bridges.
- Analyze the dynamic response and the calibration of few instruments.
- Learn about various measurement devices, their characteristics, their operation and their limitations.
- Understand applications of transducers.
- Understand operations of digital instruments.

#### Theory Syllabus:

Unit	Detailed Description	Lecture/ Tutorial Period
1	Concepts relating to Measurements: True value, Accuracy, Precision, Resolution, Drift, Hysteresis, Dead-band, Sensitivity, Errors in Measurements. Classification of electrical measuring instruments, general feature of indicating instruments: controlling, damping, balancing	4L

2	Galvanometer, dynamics, sensitivity, D'Arsonval galvanometer, Ballistic galvanometer, Vibration Galvanometer	4L
3	PMMC instrument, temperature compensation, rectifier type instrument, Moving iron instrument, errors and compensations	2L
4	Electrodynamometer type instrument, power measurement, low power factor wattmeter, wattmeter connections and errors	3L
5	Induction type energy meter: characteristics, errors and their compensation	2L
6	Extension of instrument range: shunt, multiplier, current transformer, potential transformer; testing and calibration of measuring instruments	2L
7	Kelvin double bridge, series and shunt type ohmmeter, megger, measurement of surface resistivity. Localization of cable faults. Murray and Varley Loop test.	4L
8	Measurement of inductances and capacitances, measurement of incremental inductances, inter-bridge transformer, residuals, errors in bridges, detectors	8L
9	Dc potentiometer: Weston normal cell, Vernier type, Kelvin-Verley slide, dual range, applications, phantom loading, ac potentiometer: polar type and co-ordinate type	4L
10	Transducers: RTD, thermistor, thermocouple, laws of thermocouple circuits, cold junction compensation, strain gauge	4L
11	Digital Multi-meter, True RMS meters, Clamp-on meters, CRO, Digital Storage Oscilloscope.	5L
	<b>Total</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

### Text/Reference Books

1. Electrical Measurement & Measuring Instrument: by Golding & Widdis
2. Electrical Measurement: by F. K. Harris
3. Electrical Measurement Analysis: by Ernest Frank
4. Alternating Current Bridge Networks: by Hague & Foord
5. Basic Electrical Measurement: by M. B. Stout
6. Electrical Measurement: by C. T. Baldwin

### Laboratory Syllabus:

Laboratory Syllabus:

Course code	PCC-EE 652				
Category	Professional Core Course (PCC)				
Course title	Measurement and Instrumentation Laboratory				
Scheme and Credits	L	T	P	Credits	Semester – VI
	0	0	2	1	
Pre-requisites (if any)					



Module	Detailed Description	Practical Period
1.	Instrument workshop- Study of construction of PMMC, Dynamometer, Electrothermal and Rectifier type instruments, Oscilloscope and Digital Multimeter	3P
2.	Calibration of moving iron and electrodynamic type ammeter/voltmeter by potentiometer	3P
3.	Calibration of dynamometer type Wattmeter by potentiometer	2P
4.	Calibration of A.C. energy meter	2P
5.	Measurement of resistivity of a material using Kelvin's Double Bridge	3P
6.	Measurement of Power using Instrument transformers	3P
7.	Measurement of Power in Polyphase circuits	3P
8.	Measurement of Frequency by Wien Bridge using Oscilloscope	3P
9.	Measurement of Inductance by Anderson Bridge	3P
10.	Measurement of Capacitance by De Sauty Bridge	3P
	<b>Total:</b>	<b>28P</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

Course code	PCC-EE 603				
Category	Professional Core Course (PCC)				
Course title	Electronics Design				
Scheme and Credits	L	T	P	Credits	Semester – VI
	2	0	0	2	
Pre-requisites (if any)					

### Course Outcomes:

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

1. Understand the practical issues related to practical implementation of applications using electronic circuits.
2. Choose appropriate components, software and hardware platforms.
3. Design a Printed Circuit Board, get it made and populate/solder it with components.
4. Work as a team with other students to implement an application.

**Theory Syllabus:**

Module	Detailed Description	Lecture/ Tutorial
1.	Basic concepts on measurements; Noise in electronic systems; Sensors and signal conditioning circuits;	7L
2.	Introduction to electronic instrumentation and PC based data acquisition;	7L
3.	Electronic system design, Analog system design, Interfacing of analog and digital systems, Embedded systems,	7L
4.	Electronic system design employing microcontrollers, CPLDs, and FPGAs, PCB design and layout; System assembly considerations.	7L
<b>Total Lecture/Tutorial:</b>		<b>28L</b>
<b>Total Week Required:</b>		<b>14</b>
<b>No. Of Week Reserved:</b>		<b>02</b>

**Text/References Books:**

1. A. S. Sedra and K. C. Smith, "Microelectronic circuits", Oxford University Press, 2007.
2. P. Horowitz and W. Hill, "The Art of Electronics", Cambridge University Press, 1997.
3. H.W.Ott, "Noise Reduction Techniques in Electronic Systems", Wiley, 1989.
4. W.C. Bosshart, "Printed Circuit Boards: Design and Technology", Tata McGraw Hill, 1983.
5. G.L. Ginsberg, "Printed Circuit Design", McGraw Hill, 1991.

**Laboratory Syllabus:**

Laboratory Syllabus

Course code	PCC-EE 653				
Category	Professional Core Course (PCC)				
Course title	Electronics Design Laboratory				
Scheme and Credits	L	T	P	Credits	Semester – VI
	0	0	2	1	
Pre-requisites (if any)					

Module	Detailed Description	Practical Period
1.	Introduction to electronic instrumentation and PC based data acquisition	4P
2.	Design and study of Electronic system	4P
3.	Design and study of analog system	4P
4.	Study of interfacing of analog and digital systems	4P
5.	Study of Embedded Systems	4P

6.	Electronic system design employing microcontrollers, CPLDs, and FPGAs, PCB design and layout	4P
7.	Group projects involving electronic hardware (Analog, Digital, mixed signal) leading to implementation of an application	4P
	<b>Total:</b>	<b>28P</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

### Professional Elective Courses

Course code	PEC-EE 611(a)				
Category	Professional Elective Course (PEC)				
Course title	Electrical Drives				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)					

**Course Outcomes:** At the end of this course students will demonstrate the ability to:

1. Understand the characteristics of dc motors and induction motors.
2. Understand the principles of speed-control of dc motors and induction motors.
3. Understand the power electronic converters used for dc motor and induction motor speed control.

Unit	Detailed Description	Lecture/ Tutorial Period
1	<b>DC motor characteristics:</b> Review of emf and torque equations of DC machine, review of torque speed characteristics of separately excited dc motor, change in torque-speed curve with armature voltage, example load torque-speed characteristics, operating point, armature voltage control for varying motor speed, flux weakening for high speed operation.	5L
2.	<b>Chopper fed DC drive:</b> Review of dc chopper and duty ratio control, chopper fed dc motor for speed control, steady state operation of a chopper fed drive, armature current waveform and ripple, calculation of losses in dc motor and chopper, efficiency of dc drive, smooth starting.	5L
3.	<b>Multi-quadrant DC drive:</b> Review of motoring and generating modes operation of a separately excited dc machine, four quadrant operation of dc machine; single-quadrant, two-quadrant and four-quadrant choppers; steady-state operation of multi-quadrant chopper fed dc drive, regenerative braking.	6L
4.	<b>Closed-loop control of DC Drive:</b> Control structure of DC drive, inner current loop and outer speed loop, dynamic model of dc motor – dynamic equations and transfer functions, modelling of chopper as gain with switching delay, plant transfer function, for controller design, current controller specification and design, speed controller specification and design.	7L

5.	<b>Induction motor characteristics:</b> Review of induction motor equivalent circuit and torque-speed characteristic, variation of torque-speed curve with (i) applied voltage, (ii) applied frequency and (iii) applied voltage and frequency, typical torque-speed curves of fan and pump loads, operating point, constant flux operation, flux weakening operation.	6L
6.	<b>Scalar control or constant V/f control of induction motor:</b> Review of three-phase voltage source inverter, generation of three-phase PWM signals, sinusoidal modulation, space vector theory, conventional space vector modulation; constant V/f control of induction motor, steady-state performance analysis based on equivalent circuit, speed drop with loading, slip regulation.	7L
7.	<b>Control of slip ring induction motor:</b> Impact of rotor resistance of the induction motor torque-speed curve, operation of slip-ring induction motor with external rotor resistance, starting torque, power electronic based rotor side control of slip ring motor, slip power recovery.	6L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

Text Book:

1. G. K. Dubey, "Power Semiconductor Controlled Drives", Prentice Hall, 1989.
2. R. Krishnan, "Electric Motor Drives: Modeling, Analysis and Control", Prentice Hall, 2001.
3. G. K. Dubey, "Fundamentals of Electrical Drives", CRC Press, 2002.
4. W. Leonhard, "Control of Electric Drives", Springer Science & Business Media, 2001.

Course code	PEC-EE 611(b)				
Category	Professional Elective Course (PEC)				
Course title	Line-Commutated and Active Rectifiers				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)					

### Course Outcomes:

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

1. Analyze controlled rectifier circuits.
2. Understand the operation of line-commutated rectifiers – 6 pulse and multi-pulse configurations.
3. Understand the operation of PWM rectifiers – operation in rectification and regeneration modes and lagging, leading and unity power factor mode.

<b>Unit</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
1	<b>Diode rectifiers with passive filtering:</b>  Half-wave diode rectifier with RL and RC loads; 1-phase full-wave diode rectifier with L, C and LC filter; 3-phase diode rectifier with L, C and LC filter; continuous and discontinuous conduction, input current wave shape, effect of source inductance; commutation overlap.	4L

2.	<b>DIODE CIRCUITS:</b> Ideal and piecewise linear models of diode, graphical analysis; Analysis and design of circuits-transient switching characteristics of diodes; Power supplies, surge studies, $I^2$ -t curve; Power supply filters. Clipper and Clamper circuits  Zener Diodes & Its applications, Buck and Boost converter, SMPS etc.	4L
3.	<b>BJT:</b> Transistor Biasing, bias stability, Compensation techniques, BJT biasing for integrated circuits, transistor as a switch, AC equivalent models (h-parameter, $\pi$ , T) of BJT, mid frequency and low frequency analysis of CE, CB and CC amplifier, high-frequency analysis of BJT amplifiers (Giacolletto model), Bode plots, transient switching characteristics of transistors. voltage, current, trans-resistance & trans- conductance amplifier.	12L
4.	<b>Single-phase ac-dc single-switch boost converter:</b> Review of dc-dc boost converter, power circuit of single-switch ac-dc converter, steady state analysis, unity power factor operation, closed-loop control structure	6L
5.	<b>Ac-dc bidirectional boost converter:</b> Review of 1-phase inverter and 3-phase inverter, power circuits of 1-phase and 3-phase ac-dc boost converter, steady state analysis, operation at leading, lagging and unity power factors. Rectification and regenerating modes. Phasor diagrams, closed-loop control structure.	6L
6.	<b>Isolated single-phase ac-dc fly back converter:</b> Dc-dc fly back converter, output voltage as a function of duty ratio and transformer turns ratio. Power circuit of ac-dc fly back converter, steady state analysis, unity power factor operation, closed loop control structure	10L
	<b>Total:</b>	<b>40L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

#### Text Book: Text/References Books:

1. G. De, "Principles of Thyristorised Converters", Oxford & IBH Publishing Co, 1988.
2. J.G. Kassakian, M. F. Schlecht and G. C. Verghese, "Principles of Power Electronics", AddisonWesley, 1991.
3. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.
4. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
5. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media,

Course code	PEC-EE 611(c)				
Category	Professional Elective Course (PEC)				
Course title	Industrial Electrical Systems				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)					

**Course Outcomes:** At the end of this course students will demonstrate the ability to:

1. Understand the electrical wiring systems for residential, commercial and industrial consumers, representing the systems with standard symbols and drawings, SLD.
2. Understand various components of industrial electrical systems.
3. Analyze and select the proper size of various electrical system components.

<b>Unit</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
1	<b>Electrical System Components:</b> 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	8L
2.	<b>Residential and Commercial Electrical Systems:</b> 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.	8L
3.	<b>Illumination Systems:</b> 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 premise, flood lighting.	6L
4.	<b>Industrial Electrical Systems I:</b> 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.	8L
5.	<b>Industrial Electrical Systems II:</b> DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.	6L
6.	<b>Industrial Electrical System Automation:</b> Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation.	6L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

Text Book:

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

Course code	PEC-EE 611(d)				
Category	Professional Elective Course (PEC)				
Course title	Electromagnetic waves				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)					

**Course Outcomes: At the end of this course students will demonstrate the ability to**

- 1) Analyze transmission lines and estimate voltage and current at any point on transmission line for different load conditions.
- 2) Provide solution to real life plane wave problems for various boundary conditions.
- 3) Analyse the field equations for the wave propagation in special cases such as lossy and low loss dielectric media.
- 4) Visualize TE and TM mode patterns of field distributions in a rectangular wave-guide.
- 5) Understand and analyse radiation by antennas.

Unit	Detailed Description	Lecture/ Tutorial Period
1.	<b>Maxwell's Equations:</b> Basic quantities of Electromagnetics, Basic laws of Electromagnetics: Gauss's law, Ampere's Circuital law, Faraday's law of Electromagnetic induction. Maxwell's equations, Surface charge and surface current, Boundary conditions at media interface.	7L
2.	<b>Uniform Plane Wave:</b> Homogeneous unbound medium, Wave equation for time harmonic fields, Solution of the wave equation, Uniform plane wave, Wave polarization, Wave propagation in conducting medium, Phase velocity of a wave, Power flow and Poynting vector.	7L
3.	<b>Plane Waves at Media Interface:</b> Plane wave in arbitrary direction, Plane wave at dielectric interface, Reflection and refraction of waves at dielectric interface, Total internal reflection, Wave polarization at media interface, Brewster angle, Fields and power flow at media interface, Lossy media interface, Reflection from conducting boundary.	7L
4.	<b>Waveguides:</b> Parallel plane waveguide: Transverse Electric (TE) mode, transverse Magnetic (TM) mode, Cut-off frequency, Phase velocity and dispersion. Transverse Electromagnetic (TEM) mode, Analysis of waveguide-general approach, Rectangular waveguides.	7L

5.	<b>Transmission Lines:</b> Introduction, Concept of distributed elements, Equations of voltage and current, standing waves and impedance transformation, Lossless and low loss transmission lines, Power transfer on a transmission line, Analysis of transmission line in terms of admittances, Transmission line calculations with the help of Smith chart, Applications of transmission line, Impedance matching using transmission lines.	7L
6.	<b>Antennas:</b> Radiation parameters of antenna, Potential functions, Solution for potential functions, Radiations from Hertz dipole, near field, far field, Total power radiated by a dipole, Radiation resistance and radiation pattern of Hertz dipole, Hertz dipole in receiving mode.	7L
	<b>Total:</b>	42L
	<b>Total Week Required:</b>	14
	<b>No. Of Week Reserved:</b>	02

### Text/Reference Books:

- [1] R. K. Shevgaonkar, “Electromagnetic Waves”, Tata McGraw Hill, 2005.
- [2] D. K. Cheng, “Field and Wave Electromagnetics”, Addison-Wesley, 1989.
- [3] M. N.O. Sadiku, “Elements of Electromagnetics”, Oxford University Press, 2007.
- [4] C. A. Balanis, “Advanced Engineering Electromagnetics”, John Wiley & Sons, 2012.
- [5] C. A. Balanis, “Antenna Theory: Analysis and Design”, John Wiley & Sons, 2005.

Course code	PEC-EE 611(e)				
Category	Professional Elective Course (PEC)				
Course title	Computational Electromagnetics				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)					

### Course Outcomes:

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

1. Understand the basic concepts of electromagnetics.
2. Understand computational techniques for computing fields.
3. Apply the techniques to simple real-life problems.

Module	Detailed Description	Lecture/Tutorial
1.	<b>Introduction:</b> Conventional design methodology, Computer aided design aspects – Advantages. Review of basic fundamentals of Electrostatics and Electromagnetics. Development of Helmholtz equation, energy transformer vectors- Poynting and Slepian, magnetic Diffusion-transients and time-harmonic.	7L



2.	<b>Analytical Methods:</b> Analytical methods of solving field equations, method of separation of variables, Roth's method, integral methods- Green's function, method of images.	7L
3.	<b>Finite Difference Method (FDM):</b> Finite Difference schemes, treatment of irregular boundaries, accuracy and stability of FD solutions, Finite-Difference Time-Domain (FDTD) method- Uniqueness and convergence.	7L
4.	<b>Finite Element Method (FEM):</b> Overview of FEM, Variational and Galerkin Methods, shape functions, lower and higher order elements, vector elements, 2D and 3D finite elements, efficient finite element computations.	7L
5.	<b>Applications:</b> Low frequency electrical devices, static / time-harmonic / transient problems in transformers, rotating machines, actuators. CAD packages.	7L
6.	<b>Special Topics:</b> {Background of experimental methods-electrolytic tank, R-C network solution, Field plotting (graphical method)}, hybrid methods, coupled circuit - field computations, electromagnetic - thermal and electromagnetic - structural coupled computations, solution of equations, method of moments, Poisson's fields.	7L
	<b>Total Lecture/Tutorial:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

### Text/References Books:

1. P. P. Silvester and R. L. Ferrari "Finite Element for Electrical Engineers", Cambridge University press, 1996.
2. M. N. O. Sadiku, "Numerical Techniques in Electromagnetics", CRC press, 2001.

Course code	PEC-EE612(a)				
Category	Professional Elective Course (PEC)				
Course title	Digital Control Systems				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)					

### Course Outcomes: At the end of this course students will demonstrate the ability to

- 1) Obtain discrete representation of LTI systems.
- 2) Analyse stability of open loop and closed loop discrete-time systems.
- 3) Design and analyse digital controllers.
- 4) Design state feedback and output feedback controllers.

Module	Detailed Description	Lecture/ Tutorial Period
1.	<b>Discrete Representation of Continuous Systems:</b> Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modelling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent.	6L
2.	<b>Discrete System Analysis Discrete System Analysis:</b> Z-Transform and Inverse Z Transform for analysing discrete time systems. Pulse Transfer function. Pulse transfer function of closed loop systems. Mapping from s-plane to z plane. Solution of Discrete time systems. Time response of discrete time system.	6L
3.	<b>Stability of Discrete Time System:</b> Stability analysis by Jury test. Stability analysis using bilinear transformation. Design of digital control system with dead beat response. Practical issues with dead beat response design.	4L
4.	<b>State Space Approach for discrete time systems:</b> State space models of discrete systems, State space analysis. Lyapunov Stability. Controllability, reach-ability, Reconstructibility and observability analysis. Effect of pole zero cancellation on the controllability & observability.	10L
5.	<b>Design of Digital Control System:</b> Design of Discrete PID Controller, Design of discrete state feedback controller. Design of set point tracker. Design of Discrete Observer for LTI System. Design of Discrete compensator.	8L
6.	<b>Discrete output feedback control:</b> Design of discrete output feedback control. Fast output sampling (FOS) and periodic output feedback controller design for discrete time systems.	8L
	<b>Total:</b>	42L
	<b>Total Week Required:</b>	14
	<b>No. Of Week Reserved:</b>	02

**Text/Reference Books:**

- [1] . K. Ogata, "Digital Control Engineering", Prentice Hall, Englewood Cliffs, 1995.
- [2] M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
- [3] G. F. Franklin, J. D. Powell and M. L. Workman, "Digital Control of Dynamic Systems", Addison Wesley, 1998.
- [4] B.C. Kuo, "Digital Control System", Holt, Rinehart and Winston, 1980.

Course code	PEC-EE 612(b)				
Category	Professional Elective Course (PEC)				
Course title	Advanced Control Engineering				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)					

**Course Outcomes:** After the successful completion of the course the students will be able to:

- demonstrate non-linear system behavior by phase plane and describing function methods.
- perform the stability analysis nonlinear systems by Lyapunov method concepts in approaching optimal control problems.
- derive discrete-time mathematical models in both time domain (difference equations, state equations) and z-domain (transfer function using z-transform).
- predict and analyze transient and steady-state responses and stability and sensitivity of both open-loop and closed-loop linear, time-invariant, discrete-time control systems.
- acquire knowledge of state space and state feedback in modern control systems, pole placement, design of state observers and output feedback controllers.

Unit	Detailed Description	Lecture/ Tutorial Period
1	<b>Introduction</b> Concept of Linear vector space Linear Independence, Bases & Representation, domain and range. Concept of Linearity, relaxedness, time invariance, causality.: Modern Vs conventional control theory.	1L
2.	<b>State Space Approach of Control System Analysis</b> Concept of state, state variable state vector, state space, state space equations, Writing state space equations of mechanical, Electrical systems, Fluid systems, Analogous systems. State Space Representation using physical and phase variables, comparison form of system representation. Block diagram representation of state model. Signal flow graph representation. State space representation using canonical variables. Diagonal matrix. Jordan canonical form, Derivation of transfer functions from state-model. Eigen values and Eigen vector problems. Similarity transformations and diagonalization, Vandermonde matrix. State transition matrix, Properties of state transition matrix, Properties of linear transformation, Solution of state equation, Evaluation of state transition matrix using Caley-Hamilton theorem. concepts of controllability & observability, Pole placement by state feedback.	16L
3.	<b>Digital Control Systems</b> Introduction, sampled data control systems, signal reconstruction, difference equations. The z-transform, Z-Transfer Function. Block diagram analysis of sampled data systems, z and s domain relationship. Modeling of sample-hold circuit, steady state accuracy, stability in z-plane and Jury stability criterion, bilinear transformation.	9L
4.	<b>Non-linear systems</b> Non-linear systems. Characteristics of nonlinear systems Jump resonance, Chaos and bifurcation, Limit cycle, Various incidental and intentional nonlinearities, Describing functions of common Non-linearity, Stability Analysis by Describing Function method, Prediction of limit cycles using describing function technique, Phase plane analysis of linear and nonlinear second order systems, Methods of obtaining phase plane trajectories by graphical method, isoclines method, Qualitative analysis of simple control systems by phase plane methods, Stability concepts for nonlinear systems. BIBO Vs state stability. Definitions of Lyapunov functions. Lyapunov analysis of LTI systems, Asymptotic stability, Global asymptotic stability. The first and second methods of Lyapunov to analyze nonlinear systems, Popov's Circle Criterion. Introduction to variable structure control (VSC), Basics of Sliding Mode Control (SMC).	16L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

## Text/Reference Book:

1. M. Gopal: Digital Control and State Variable Methods, MGH. 2012
2. B. C. Kuo: Digital Control System, Oxford. 1980
3. Ogata K : Modern Control Engg. – PHI/ Pearson Education
4. Stefani, Design of feedback Control System, OUP
5. D. Roy, Choudhary: Modern Control Engineering, Prentice Hall of India.
6. Gibson J E : Nonlinear Control System - McGraw Hill Book Co.
7. Goodwin, Control System Design, Pearson Education

Course code	PEC-EE612(c)				
Category	Professional Elective Course (PEC)				
Course title	Digital Signal Processing				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)					

**Course Outcomes: At the end of this course students will demonstrate the ability to**

- 1) Represent signals mathematically in continuous and discrete-time, and in the frequency domain.
- 2) Analyse discrete-time systems using z-transform.
- 3) Understand the Discrete-Fourier Transform (DFT) and the FFT algorithms.
- 4) Design digital filters for various applications.
- 5) Apply digital signal processing for the analysis of real-life signals.

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Discrete-time signals and systems:</b> Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate.	6L
<b>2.</b>	<b>Z-transform:</b> Z-Transform, Region of Convergence, Analysis of Linear Shift Invariant systems using transform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z-transforms.	6L
<b>3.</b>	<b>Discrete Fourier Transform:</b> Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.	10L
<b>4.</b>	<b>Design of Digital filters:</b> Design of FIR Digital filters: Window-method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Band-stop and High-pass filters. Effect of finite register length in FIR filter design. Parametric and nonparametric spectral estimation. Introduction to multi-rate signal processing.	12L
<b>5.</b>	<b>Applications of Digital Signal Processing:</b> Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.	8L
<b>Total:</b>		<b>42L</b>
<b>Total Week Required:</b>		<b>14</b>
<b>No. of Week Reserved:</b>		<b>02</b>

**Text/Reference Books:**

- [1] S. K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill, 2011.
- [2] A.V. Oppenheim and R. W. Schaffer, "Discrete Time Signal Processing", Prentice Hall, 1989.
- [3] J. G. Proakis and D.G. Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Prentice Hall, 1997.
- [4] L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing", Prentice Hall, 1992.
- [5] J. R. Johnson, "Introduction to Digital Signal Processing", Prentice Hall, 1992.
- [6] D. J. DeFatta, J. G. Lucas and. S. Hodgkiss, "Digital Signal Processing", John Wiley & Sons, 1988.

Course code	PEC-EE 612(d)				
Category	Program Elective Course (PEC)				
Course title	Computer Architecture				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)					

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

- Understand the concepts of microprocessors, their principles and practices.
- Write efficient programs in assembly language of the 8086 family of microprocessors.
- Organize a modern computer system and be able to relate it to real examples.
- Develop the programs in assembly language for 80286, 80386 and MIPS processors in real and protected modes.
- Implement embedded applications using ATOM processor.

<b>Unit</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
1	<b>Introduction to computer organization</b> Architecture and function of general computer system, CISC Vs RISC, Data types, Integer Arithmetic - Multiplication, Division, Fixed and Floating-point representation and arithmetic, Control unit operation, Hardware implementation of CPU with Micro instruction, microprogramming, System buses, Multi-bus organization.	6L
2.	<b>Memory organization</b> System memory, Cache memory - types and organization, Virtual memory and its implementation, Memory management unit, Magnetic Hard disks, Optical Disks.	6L
3.	<b>Input – output Organization</b> Accessing I/O devices, Direct Memory Access and DMA controller, Interrupts and Interrupt Controllers, Arbitration, Multilevel Bus Architecture, Interface circuits - Parallel and serial port. Features of PCI and PCI Express bus.	8L

4.	<b>16 and 32 microprocessors</b> 80x86 Architecture, IA – 32 and IA – 64, Programming model, Concurrent operation of EU and BIU, Real mode addressing, Segmentation, addressing modes of 80x86, Instruction set of 80x86, I/O addressing in 80x86.	8L
5.	<b>Pipelining</b> Introduction to pipelining, Instruction level pipelining (ILP), compiler techniques for ILP, Data hazards, Dynamic scheduling, Dependability, Branch cost, Branch Prediction, Influence on instruction set.	8L
6.	<b>Different Architectures</b> VLIW Architecture, DSP Architecture, SoC architecture, MIPS Processor and programming	8L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

Text/Reference Book:

1. V. Carl, G. Zvonko and S. G. Zaky, “Computer organization”, McGraw Hill, 1978.
2. B. Brey and C. R. Sarma, “The Intel microprocessors”, Pearson Education, 2000.
3. J. L. Hennessy and D. A. Patterson, “Computer Architecture A Quantitative Approach”, Morgan Kauffman, 2011.
4. W. Stallings, “Computer organization”, PHI, 1987.
5. P. Barry and P. Crowley, “Modern Embedded Computing”, Morgan Kaufmann, 2012.
6. N. Mathivanan, “Microprocessors, PC Hardware and Interfacing”, Prentice Hall, 2004.
7. Y. C. Lieu and G. A. Gibson, “Microcomputer Systems: The 8086/8088 Family”, Prentice Hall India, 1986.
8. J. Uffenbeck, “The 8086/8088 Design, Programming, Interfacing”, Prentice Hall, 1987.
9. B. Govindarajalu, “IBM PC and Clones”, Tata McGraw Hill, 1991.
10. P. Able, “8086 Assembly Language Programming”, Prentice Hall India.

Course code	PEC-EE 612(e)				
Category	Professional Elective Course (PEC)				
Course title	Lighting Calculation and Design				
Scheme and Credits	L	T	P	Credits	Semester – VI
	3	0	0	3	
Pre-requisites (if any)					

**Course Outcomes:** At the end of this course students will demonstrate the ability to

- To provide an introduction to the fundamentals of illumination engineering and architectural lighting design.
- To impart lighting fundamentals, measurement, and technology and their application in the analysis and design of architectural lighting systems

Module	Detailed Description	Lecture / Tutorial Period
1.	<b>Illuminance calculation</b> - Illuminance as vector quantity; direct illuminance from point source, linear source and area sources; Flux transfer method; indirect/inter reflected illuminance. Non-planer illuminance – spherical, cylindrical, semi-cylindrical illuminance. Understanding of luminaire photometric test report and computation of lumen output from luminaire from its luminous intensity distribution - zone factor, zonal lumen.	6L
2.	<b>Calculation of lamp's colorimetric parameters from its spectral power distribution (SPD) data</b> - CIE chromaticity of light source and illuminated object; CIE standard illuminant; dominant wavelength and purity; correlated colour temperature (CCT) and colour rendering index. Grassmann's law of colour mixing and its applications.	4L
3.	<b>Indoor lighting</b> – zonal cavity method for general lighting design. Bureau of Indian Standard (BIS)/National Lighting Code (NLC) for different indoor applications; selection criteria of lamps and luminaire, design considerations and design procedure. Quality and quantity assessment of lighting systems – BIS recommendation of lux level. Evaluating the quantity of illuminance - procedures of field measurements; quality of illuminance.	6L
4.	<b>Discomfort and Disability Glare</b> -Discomfort glare evaluation of indoor general lighting – Unified Glare Rating (UGR) and Visual Comfort Probability (VCP).	3L
5.	<b>Daylighting</b> – characteristics and features of daylight; sky models – Indian clear sky, CIE standard general skies; daylighting concepts- side lighting, top lighting; Daylight Factor method; physical scale modeling of daylighting system, daylight linked artificial lighting.	3L
6.	<b>Emergency lighting</b> – escape lighting, standby lighting; maintained and non-maintained lighting systems.	2L
7.	<b>Road lighting</b> – design considerations; road classifications according to BIS, pole arrangements, installation terminologies, lamp & luminaire selection, design parameters. Design procedure – point-by-point method, Isolux diagram method; BIS recommendations. Glare assessment-Threshold Increment, Glare Control Mark.	6L
8.	<b>Flood lighting</b> - design considerations; types of floodlights- symmetric, asymmetric and double asymmetric intensity distribution, beam angle estimation; beam lumen. Design procedure - pole selection and layout – thumb rule; lamp & luminaire selection and luminaire aiming. NLC recommendation. Glare assessment – Glare Rating.	4L
9.	<b>Sports lighting</b> - special lighting requirements for football, cricket, badminton ground. NLC recommendations, lamp & luminaire selection, design considerations.	4L

10.	<b>Lighting energy management and economics</b> – lighting power budget; lighting power limit; evaluation of existing system; retrofitting of lighting systems. Components of cost and savings; simple payback analysis.	2L
11.	<b>Lighting controls</b> – different control equipment- on/off switch, simple automatic switches, photocell, occupancy sensor, timer, lighting contactors, dimmer.	2L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

Text/Reference Books:

- [1] Lamps and Lighting – Edited by J.R.Coaton and A.M.Marsden, 4th Edition, Arnold
- [2] Lighting for energy efficient luminous environments - Ronald N. Helms & M Clay Belcher.
- [3] Lighting - D.C..Pritchard
- [4] Illuminating Engineering: From Edison's Lamp to the LED - J B Murdoch
- [5] Applied Illumination Engineering, Second Edition, Jack L Lindsey, Prentice Hall
- [6] Lighting Engineering: Applied Calculations - R. H. Simons, Robert Bean.

#### **Project and Internship**

Course code	PROJ-EE 691				
Category	Project and Internship				
Course title	Term Paper Leading to Project Work				
Scheme and Credits	L	T	P	Credits	Semester – VI
	0	0	4	2	
Pre-requisites (if any)					

The object of **Term Paper Leading to Project Work** is to enable the student to take up investigative study in the broad field of Electrical Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on five/six students in a group, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work.

The assignment to normally include:

1. Survey and study of published literature on the assigned topic;
2. Preparing a Written Report (term paper) on the Study proposed for the project work to be conducted from 7<sup>th</sup> semester onwards.
3. Presentation of the term paper before a departmental committee.



### Humanities and Social Sciences including Management Courses

Course Code	HSM-HU 681 (For Laboratory)					
Category	Humanities and Social Sciences including Management Courses					
Course Title	Group Discussion & Personal Interview					
Scheme and credits	L	T	P	Credits	Semester—VI	
	0	0	2	1		
Pre-requisites (if any)	Basic knowledge of oral & technical communication					

Module	Detailed Description	Lecture/Tutorial Period
1.	<b>Advanced Techniques in Technical Communication:</b> using e-mail for business communication; standard e-mail practices; language in e-mail, using internet for collecting information; referencing while using internet materials for project reports; writing for media.	5L
2.	<b>Presentation:</b> Techniques of effective presentations by using various audiovisual aids	5L
3.	<b>Interview:</b> methods and Etiquettes; practice of mock interview; interview through telephone/ video-conferencing	8L
4	<b>Group Discussion:</b> Model group discussion through the choice of appropriate programmers.	7L
5.	Interaction with experts.	3L
	<b>Total</b>	<b>28L</b>
	<b>Total week required</b>	<b>14</b>
	<b>No. of week reserved</b>	<b>02</b>

#### Text Books:

1. How to Prepare for Group Discussion & Interview, Hari Mohan Prasad, Rajnish Mohan Tata McGraw Hill Education, New Delhi: 2012.
2. Mastering Interviews and Group Discussions, Dinesh Mathur CBS Publication, 2017.
3. Technical Interviews, Anil Kumar Maini, Excel with Ease. Pearson, 2011.

**Reference Books:**

1. Group Discussions and Interviews, Anand Ganguly RPH, 2014.
2. The Interview Book: Your Definite Guide to the Perfect Interview Technique, James Innes. Prentice Hall Business, 2009.

**Course outcomes:**

On completion of the course students will be to:

- Learn structure and format for effective communications, using e-mail for business communication; standard e-mail practices; language in e-mail, using internet for collecting information; referencing while using internet materials for project reports; writing for media.
- Deliver effective power-point presentation.
- Take part in Interview through telephone/video-conferencing.
- Become proficient to face interviews and model group discussions through the choice of appropriate programmers.

**Semester VII (Fourth year) Curriculum**  
**Branch/Course: Electrical Engineering**

Sl. No	Type of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1	Professional Elective Course <sup>#</sup>	PEC-EE 711	Professional Elective-IV	3	0	0	3	100
2	Professional Elective Course <sup>#</sup>	PEC-EE 712	Professional Elective-V	3	0	0	3	100
3	Open Elective Course <sup>##</sup>	OEC-X* 721	Open Elective-III	3	0	0	3	100
4	Open Elective Course <sup>##</sup>	OEC-X* 722	Open Elective-IV	3	0	0	3	100
5	Humanities and Social Sciences including Management courses	HSM-HU 703	Economics and Accountancy	2	0	0	2	100
6	Project and Internship	PROJ-INT 791	Internship	0	0	4	2	100
7	Project and Internship	PROJ-EE 792	Project Stage-I	0	0	4	2	100
<b>Total:</b>							<b>18</b>	<b>700</b>

\* X refers to offering codes such as M/EE/HU/ME/EC/EI/CSE

**<sup>#</sup>Professional Elective Course (PEC-EE 711)**

Sl. No	Paper code	Semester	Name of the paper
1	PEC-EE 711(a)	7th	High Voltage Engineering
2	PEC-EE 711(b)	7th	Electrical Energy Conservation and Auditing
3	PEC-EE 711(c)	7th	Wind and Solar Energy Systems
4	PEC-EE 711(d)	7th	Electrical and Hybrid Vehicles

**<sup>#</sup>Professional Elective Course (PEC-EE 712)**

Sl. No	Paper code	Semester	Name of the paper
1	PEC-EE 712(a)	7th	Power System Protection
2	PEC-EE 712(b)	7th	HVDC Transmission Systems
3	PEC-EE 712(c)	7th	Power Quality and FACTS
4	PEC-EE 712(d)	7th	Power System Dynamics and Control

**<sup>##</sup>Open Elective Course (OEC-X 721)**

Sl. No	Paper code	Semester	Name of the paper
1.	OEC-HU 721(a)	7th	Introduction to Comparative literature
2.	OEC-HU 721(b)	7th	Economic Policies in India
3.	OEC-M 721(c)	7th	Mathematical Formulation & Approximations
4.	OEC-HU 721(d)	7th	Soft Skills & Interpersonal Communication
5.	OEC-EI 721(e)	7th	MEMS
6.	OEC-EC 721(f)	7th	Nano Electronics

**<sup>##</sup>Open Elective Course (OEC-X 722)**

Sl. No	Paper code	Semester	Name of the paper
1.	OEC-EE 722(a)	7th	Renewable Energy
2.	OEC-ME 722(b)	7th	Modern Manufacturing Practice
3.	OEC-ME 722(c)	7th	Thermal Engineering & Fluid Machinery

**<sup>##</sup> Refer to the OEC booklet for detailed syllabus**

### Professional Elective Courses

Course code	PEC-EE 711(a)				
Category	Professional Elective Course (PEC)				
Course title	High Voltage Engineering				
Scheme and Credits	L	T	P	Credits	Semester –VII
	3	0	0	3	
Pre-requisites (if any)					

#### Course Outcomes:

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

- Understand the basic physics related to various breakdown processes in solid, liquid and gaseous insulating materials.
- Knowledge of generation and measurement of D. C., A.C., & Impulse voltages.
- Knowledge of tests on H. V. equipment and on insulating materials, as per the standards.
- Knowledge of how over-voltages arise in a power system, and protection against these over-voltages.

Module	Detailed Description	Lecture/ Tutorial
1.	<b>Breakdown in Gases:</b> Ionization processes and de-ionization processes, Types of Discharge, Gases as insulating materials, Breakdown in Uniform gap, non-uniform gaps, Townsend's theory, Streamer mechanism,	8L
2.	<b>Breakdown in liquid and solid Insulating materials:</b> Breakdown in pure and commercial liquids, Solid dielectrics and composite dielectrics, intrinsic breakdown, electromechanical breakdown and thermal breakdown, Partial discharge, applications	7L
3.	<b>Generation of High Voltages:</b> Generation of high voltages, generation of high D. C. and A.C. voltages, generation of impulse voltages, generation of impulse currents, tripping and control of impulse generators.	6L
4.	<b>Measurements of High Voltages and Currents:</b> Peak voltage, impulse voltage and high direct current measurement method, cathode ray oscillographs for impulse voltage and current measurement, measurement of dielectric constant and loss factor, partial discharge measurements.	7L
5.	<b>Lightning and Switching Over-voltages:</b> Charge formation in clouds, Stepped leader, Dart leader, Lightning Surges. Switching over voltages, Protection against over-voltages, Surge diverters, Surge modifiers.	7L
6.	<b>High Voltage Testing of Electrical Apparatus and High Voltage Laboratories:</b> Various standards for HV Testing of electrical apparatus, IS, IEC standards, testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, power transformers and some high voltage equipment, High voltage laboratory layout, indoor and outdoor laboratories, testing facility requirements, safety	7L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

**Text/References Books:**

1. M. S. Naidu and V. Kamaraju, "High Voltage Engineering", McGraw Hill Education, 2013.
2. C. L. Wadhwa, "High Voltage Engineering", New Age International Publishers, 2007.

Course code	PEC-EE 711(b)				
Category	Professional Elective Course (PEC)				
Course title	Electrical Energy Conservation and Auditing				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)					

**Course Outcomes:**

**At the end of this course, students will have the ability to**

- [1] Understand the current energy scenario and importance of energy conservation.
- [2] Understand the concepts of energy management.
- [3] Understand the methods of improving energy efficiency in different electrical systems.
- [4] Understand the concepts of different energy efficient devices.

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Energy Scenario:</b> 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 and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.	<b>6L</b>
<b>2.</b>	<b>Basics of Energy and its various forms:</b> 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.	<b>7L</b>
<b>3.</b>	<b>Energy Management &amp; Audit:</b> 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. <b>Material and Energy balance:</b> Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.	<b>6L</b>

4.	<b>Energy Efficiency in Electrical Systems:</b> 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. <b>Electric motors:</b> Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.	7L
5.	<b>Energy Efficiency in Industrial Systems:</b> <b>Compressed Air System:</b> 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, <b>Fans and blowers:</b> Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. <b>Cooling Tower:</b> Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities, assessment of cooling towers.	10L
6.	<b>Energy Efficient Technologies in Electrical Systems:</b> Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.	6L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

**Text / References:**

- 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)
- 3) S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991.
- 4) Success stories of Energy Conservation by BEE, New Delhi ([www.bee-india.org](http://www.bee-india.org))

Course code	PEC-EE 711(c)				
Category	Professional Elective Course (PEC)				
Course title	Wind and Solar Energy Systems				
Scheme and Credits	L	T	P	Credits	Semester –VII
	3	0	0	3	
Pre-requisites (if any)					

**Course Outcomes:**

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

- 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.

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial</b>
1.	<b>Physics of Wind Power:</b> 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.	6L
2.	<b>Wind generator topologies:</b> 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,	12L
3.	<b>The Solar Resource:</b> Introduction, solar radiation spectra, solar geometry, Earth Sun angles, observer Sun angles, solar day length, Estimation of solar energy availability.	4L
4.	<b>Solar photovoltaic:</b> Technologies-Amorphous, mono-crystalline, 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.	8L
5.	<b>Network Integration Issues:</b> 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 behavior during grid disturbances. Power quality issues. Power system interconnection experiences in the world. Hybrid and isolated operations of solar PV and wind systems.	8L
6.	<b>Solar thermal power generation:</b> Technologies, Parabolic trough, central receivers, parabolic dish, Fresnel, solar pond, elementary analysis.	4L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

**Text/References Books:**

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.

5. G. N. Tiwari and M. K. Ghosal, “Renewable Energy Applications”, Narosa Publications, 2004.

6. J. A. Duffie and W. A. Beckman, “Solar Engineering of Thermal Processes”, John Wiley & Sons, 1991.

Course code	PEC-EE 711(d)				
Category	Professional Elective Course (PEC)				
Course title	Electrical and Hybrid Vehicles				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)					

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

- Understand the models to describe hybrid vehicles and their performance.
- Understand the different possible ways of energy storage.
- Understand the different strategies related to energy storage systems.

<b>Unit</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
1	<p><b>Introduction:</b></p> <p><b>Conventional Vehicles:</b> Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.</p> <p><b>Introduction to Hybrid Electric Vehicles:</b> History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.</p> <p><b>Hybrid Electric Drive-trains:</b> Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.</p>	10L
2.	<p><b>Electric Trains:</b></p> <p><b>Electric Drive-trains:</b> Basic concept of electric traction, introduction to various electric drivetrain topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.</p> <p><b>Electric Propulsion unit:</b> Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.</p>	10L
3.	<p><b>Energy Storage:</b></p> <p>Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.</p>	12L



4.	<b>Energy Management Strategies</b> Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).	10L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

Text/Reference Book:

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
4. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.

<b>Course code</b>	<b>PEC-EE 712(a)</b>				
<b>Category</b>	Professional Elective Course (PEC)				
<b>Course title</b>	<b>Power System Protection</b>				
<b>Scheme and Credits</b>	<b>L</b> 3	<b>T</b> 0	<b>P</b> 0	<b>Credits</b> 3	<b>Semester – VII</b>
<b>Pre-requisites (if any)</b>					

**Course Outcomes:**

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

- Understand the different components of a protection system.
- Evaluate fault current due to different types of fault in a network.
- Understand the protection schemes for different power system components.
- Understand the basic principles of digital protection.
- Understand system protection schemes, and the use of wide-area measurements.

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial</b>
1.	<b>Introduction and Components of a Protection System:</b> Principles of Power System Protection, Relays, Instrument transformers, Circuit Breakers	3L
2.	<b>Faults Analysis:</b> Analysis of symmetrical and asymmetrical faults in power system	8L
3.	<b>Different types of circuit breakers:</b> General requirements of circuit breakers, their relative merits and demerits. Specific field of usage Auto- reclosing feature – three pole & single pole auto-reclosing. Formation of electric arc. Arc build-up and quenching theory, recovery voltage and RRRV, Arc re-striking phenomena. Problems of capacitive and low inductive current interruptions. Rating of circuit breakers and effect of transient current on it. Different types of arc quenching media and special devices for arc quenching. Testing of circuit breakers. D.C circuit breaking	9L

4.	<b>Different types of relays:</b> Protective Relays; Basic requirements and type of protection, reviews of relay characteristics and operating equations, protective CTs, PTs, , phase and amplitude comparator, classification of Electromagnetic relays, Plug Setting Multiplier and Time Multiplier setting, Universal Torque Equation, Non Directional Relay, Directional relay, Distant relay, Differential relay.	8L
5.	<b>Protection of Alternators:</b> Protection against Stator fault (Phase to Phase and Phase to Ground), Balanced earth fault protection, Stator inter turn protection, Unbalanced loading of Alternator, Prime Mover failure, Overvoltage protection, Overloading (or over current) Protection, Restricted Earth fault and standby earth fault protection, Rotor Fault Protection. <b>Protection of Transformer:</b> Overcurrent and unrestricted Earth fault protection, Different CT connections, Balanced (Restricted) earth fault protection, Harmonic restraint, Frame leakage protection.	8L
6.	<b>Bus bar, Feeder, Transmission line Protection:</b> Bus bar Protection: Circulating Current Protection, Frame Leakage Protection. Feeder protection: Time Graded protection, Differential Protection. Transmission Line Protection: Introduction to distance relay, Simple Impedance relay, Reactance relay, Mho relays, comparison of distance relay – Choice between Impedance, Reactance and Mho relay, High speed Impedance relay, setting of distance relays. Pilot Relaying Schemes: Wire Pilot Protection, Carrier Current Protection.	6L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

#### Text/References Books:

1. J. L. Blackburn, “Protective Relaying: Principles and Applications”, Marcel Dekker, New York, 1987.
2. Y. G. Paithankar and S. R. Bhide, “Fundamentals of power system protection”, Prentice Hall, India, 2010.
3. A. G. Phadke and J. S. Thorp, “Computer Relaying for Power Systems”, John Wiley & Sons, 1988.
4. A. G. Phadke and J. S. Thorp, “Synchronized Phasor Measurements and their Applications”, Springer, 2008.
5. D. Reimert, “Protective Relaying for Power Generation Systems”, Taylor and Francis, 2006.

Course code	PEC-EE 712(b)				
Category	Professional Elective Code (PEC)				
Course title	HVDC Transmission Systems				
Scheme and Credits	L	T	P	Credits	Semester – VII
	3	0	0	3	
Pre-requisites (if any)					

**Course Outcomes:** At the end of this course students will demonstrate the ability to:

1. Understand the advantages of dc transmission over ac transmission.
2. Understand the operation of Line Commutated Converters and Voltage Source Converters.
3. Understand the control strategies used in HVDC transmission system.
4. Understand the improvement of power system stability using an HVDC system.

Unit	Detailed Description	Lecture/ Tutorial Period
1	<b>DC Transmission Technology:</b> Comparison of AC and dc Transmission (Economics, Technical Performance and Reliability). Application of DC Transmission. Types of HVDC Systems. Components of a HVDC system. Line Commutated Converter and Voltage Source Converter based systems.	4L
2.	<b>Analysis of Line Commutated and Voltage Source Converters:</b> Line Commutated Converters (LCCs): Six pulse converter, Analysis neglecting commutation overlap, harmonics, Twelve Pulse Converters. Inverter Operation. Effect of Commutation Overlap. Expressions for average dc voltage, AC current and reactive power absorbed by the converters. Effect of Commutation Failure, Misfire and Current Extinction in LCC links. Voltage Source Converters (VSCs): Two and Three-level VSCs. PWM schemes: Selective Harmonic Elimination, Sinusoidal Pulse Width Modulation. Analysis of a six-pulse converter. Equations in the rotating frame. Real and Reactive power control using a VSC.	10L
3.	<b>Control of HVDC Converters:</b> Principles of Link Control in a LCC HVDC system. Control Hierarchy, Firing Angle Controls – Phase-Locked Loop, Current and Extinction Angle Control, Starting and Stopping of a Link. Higher level Controllers Power control, Frequency Control, Stability Controllers. Reactive Power Control. Principles of Link Control in a VSC HVDC system: Power flow and dc Voltage Control. Reactive Power Control/AC voltage regulation.	10L
4.	<b>Components of HVDC systems:</b> Smoothing Reactors, Reactive Power Sources and Filters in LCC HVDC systems DC line: Corona Effects. Insulators, Transient Over-voltages. Dc line faults in LCC systems. dc line faults in VSC systems. dc breakers. Monopolar Operation. Ground Electrodes.	8L
5.	<b>Stability Enhancement using HVDC Control:</b> Basic Concepts: Power System Angular, Voltage and Frequency Stability. Power Modulation: basic principles – synchronous and asynchronous links. Voltage Stability Problem in AC/dc systems.	5L
6.	<b>MTDC Links:</b> Multi-Terminal and Multi-Infeed Systems. Series and Parallel MTDC systems using LCCs. MTDC systems using VSCs. Modern Trends in HVDC Technology. Introduction to Modular Multi-level Converters.	5L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

Text Book:

1. K. R. Padiyar, "HVDC Power Transmission Systems", New Age International Publishers, 2011.

2. J. Arrillaga, "High Voltage Direct Current Transmission", Peter Peregrinus Ltd., 1983.
3. E. W. Kimbark, "Direct Current Transmission", Vol.1, Wiley-Interscience, 1971.

<b>Course code</b>	<b>PEC-EE 712(c)</b>				
<b>Category</b>	Professional Elective Course (PEC)				
<b>Course title</b>	<b>Power Quality and FACTS</b>				
<b>Scheme and Credits</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Semester – VII</b>
	3	0	0	3	
<b>Pre-requisites (if any)</b>					

#### Course Outcomes:

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

- Understand the characteristics of ac transmission and the effect of shunt and series reactive compensation.
- Understand the working principles of FACTS devices and their operating characteristics.
- Understand the basic concepts of power quality.
- Understand the working principles of devices to improve power quality.

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial</b>
1.	<b>Transmission Lines and Series/Shunt Reactive Power Compensation:</b> Basics of AC Transmission. Analysis of uncompensated AC transmission lines. Passive Reactive Power Compensation. Shunt and series compensation at the mid-point of an AC line. Comparison of Series and Shunt Compensation.	6L
2.	<b>Thyristor-based Flexible AC Transmission Controllers (FACTS):</b> Description and Characteristics of Thyristor-based FACTS devices: Static VAR Compensator (SVC), Thyristor Controlled Series Capacitor (TCSC), Thyristor Controlled Braking Resistor and Single Pole Single Throw (SPST) Switch. Configurations/Modes of Operation, Harmonics and control of SVC and TCSC. Fault Current Limiter.	6L
3.	<b>Voltage Source Converter based (FACTS) controllers:</b> Voltage Source Converters (VSC): Six Pulse VSC, Multi-pulse and Multi-level Converters, Pulse-Width Modulation for VSCs. Selective Harmonic Elimination, Sinusoidal PWM and Space Vector Modulation. STATCOM: Principle of Operation, Reactive Power Control: Type I and Type II controllers, Static Synchronous Series Compensator (SSSC) and Unified Power Flow Controller (UPFC): Principle of Operation and Control. Working principle of Interphase Power Flow Controller. Other Devices: GTO Controlled Series Compensator. Fault Current Limiter.	8L
4.	<b>Application of FACTS:</b> Application of FACTS devices for power-flow control and stability improvement. Simulation example of power swing damping in a single-machine infinite bus system using a TCSC. Simulation example of voltage regulation of transmission mid-point voltage using a STATCOM.	4L

5.	<b>Power Quality Problems in Distribution Systems:</b> Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, Wave-form Distortions: harmonics, noise, notching, dc-offsets, fluctuations. Flicker and its measurement. Tolerance of Equipment: CBEMA curve.	4L
6.	<b>DSTATCOM:</b> Reactive Power Compensation, Harmonics and Unbalance mitigation in Distribution Systems using DSTATCOM and Shunt Active Filters. Synchronous Reference Frame Extraction of Reference Currents. Current Control Techniques in for DSTATCOM.	8L
7.	<b>Dynamic Voltage Restorer and Unified Power Quality Conditioner:</b> Voltage Sag/Swell mitigation: Dynamic Voltage Restorer – Working Principle and Control Strategies. Series Active Filtering. Unified Power Quality Conditioner (UPQC): Working Principle. Capabilities and Control Strategies.	6L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

#### Text/References Books:

1. N. G. Hingorani and L. Gyugyi, “Understanding FACTS: Concepts and Technology of FACTS Systems”, Wiley-IEEE Press, 1999.
2. K. R. Padiyar, “FACTS Controllers in Power Transmission and Distribution”, New Age International (P) Ltd. 2007.
3. T. J. E. Miller, “Reactive Power Control in Electric Systems”, John Wiley and Sons, New York, 1983.
4. R. C. Dugan, “Electrical Power Systems Quality”, McGraw Hill Education, 2012.
5. G. T. Heydt, “Electric Power Quality”, Stars in a Circle Publications, 1991.

<b>Course code</b>	<b>PEC-EE 712(d)</b>				
<b>Category</b>	Professional Elective Course (PEC)				
<b>Course title</b>	<b>Power System Dynamics and Control</b>				
<b>Scheme and Credits</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Credits</b>	<b>Semester – VII</b>
	3	0	0	3	
<b>Pre-requisites (if any)</b>					

#### Course Outcomes:

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

- Understand the problem of power system stability and its impact on the system.
- Analyze linear dynamical systems and use of numerical integration methods.
- Model different power system components for the study of stability.
- Understand the methods to improve stability.

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial</b>
1.	<b>Introduction to Power System Operations:</b> Introduction to power system stability. Power System Operations and Control. Stability problems in Power System. Impact on Power System Operations and control.	3L

2.	<b>Analysis of Linear Dynamical System and Numerical Methods:</b> Analysis of dynamical System, Concept of Equilibrium, Small and Large Disturbance Stability. Modal Analysis of Linear System. Analysis using Numerical Integration Techniques. Issues in Modeling: Slow and Fast Transients, Stiff System.	4L
3.	<b>Modeling of Synchronous Machines and Associated Controllers:</b> Modeling of synchronous machine: Physical Characteristics. Rotor position dependent model. D-Q Transformation. Model with Standard Parameters. Steady State Analysis of Synchronous Machine. Short Circuit Transient Analysis of a Synchronous Machine. Synchronization of Synchronous Machine to an Infinite Bus. Modeling of Excitation and Prime Mover Systems. Physical Characteristics and Models. Excitation System Control. Automatic Voltage Regulator. Prime Mover Control Systems. Speed Governors.	12L
4.	<b>Modeling of other Power System Components:</b> Modeling of Transmission Lines and Loads. Transmission Line Physical Characteristics. Transmission Line Modeling. Load Models - induction machine model. Frequency and Voltage Dependence of Loads. Other Subsystems – HVDC and FACTS controllers, Wind Energy Systems.	9L
5.	<b>Stability Analysis:</b> Angular stability analysis in Single Machine Infinite Bus System. Angular Stability in multi-machine systems – Intra-plant, Local and Inter-area modes. Frequency Stability: Centre of Inertia Motion. Load Sharing: Governor droop. Single Machine Load Bus System: Voltage Stability. Introduction to Torsional Oscillations and the SSR phenomenon. Stability Analysis Tools: Transient Stability Programs, Small Signal Analysis Programs.	10L
6.	<b>Enhancing System Stability:</b> Planning Measures. Stabilizing Controllers (Power System Stabilizers). Operational Measures-Preventive Control. Emergency Control.	4L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Text/References Books:**

1. K.R. Padiyar, “Power System Dynamics, Stability and Control”, B. S. Publications, 2002.
2. P. Kundur, “Power System Stability and Control”, McGraw Hill, 1995.
3. P. Sauer and M. A. Pai, “Power System Dynamics and Stability”, Prentice Hall, 1997.

## Humanities and Social Sciences including Management Courses

Course Code	HSM-HU703				
Category	Humanities and Social Sciences including Management Courses				
Course title	Economics and Accountancy				
Scheme and Credits	L	T	P	Credits	Semester –VII
	3	0	0	3	
Pre-requisites (if any)					

### Theory Syllabus:

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
1	<b>Definition of Economics</b> Concept of economic activities and economic agents, the concept of market as an institution, distinction between micro and macro theory, the basic concept of price.	2L
2	<b>The concept of consumption and demand</b> Marshallian and indifference curve theory -- basic concepts-- derivation of law of demand- demand function, market demand curve – elasticity of demand – different form of elasticity of demand – relation between elasticity, expenditure, ARSMR	5L
3	<b>The theory of production</b> Isoquant and isocost function – AP, MP, AC, MC curves. Their relationship – concept of short run and long run cost consume – law of variable proportion and returns to scale.	5L
4	<b>Concept of product pricing</b> Profit maximization objective – short run long run equilibrium conditions of firm and industry, the industry supply curve and its relation with externalities, price determination, Monopoly, equilibrium condition, concept of monopoly power, oligopoly: basic concept of non-collusive forms.	5L
5	<b>Behavioristic goals by firm: sales maximization</b>	2L
6	<b>National income and accounting analysis</b> Concept of GDP, GNP and NNP, Methods of measuring national income.	2L
7	Consumption and saving function, investment, determination of equilibrium national income, concept of multiplier and accelerator.	5L
8	Concept of inflationary gap, demand pull and cost push inflation : anti- inflationary policies, basic idea	2L
9	Principles of banking, Central bank, Commercial Banks and other financial institutions: basic concepts and functions	3L

10	<b>Basic accounting concepts&amp; Recording of the primary books</b> Fundamental concepts of accountancy, Golden Rules of Accounts, Principle of double entry, financial statements and their nature. Different types of the primary books, recording of transactions, preparation of the case books and journal paper. Ledger and Trial Balance, Final Account, Cash Book, Depreciation Methods, Bank reconciliation statement	6L
11	<b>Financial Accounting (Elementary Treatment)</b> Financial Ratio Analysis, Cash flow analysis, Funds flow analysis, Comparative financial statements- Analysis & Interpretation of financial statements. Concepts of Investments: Risks and return evaluation of investment decision, Average rate of return, Payback Period, Net Present Value, Internal rate of return	5L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

#### **Text Books/ Reference Books:**

- 1) Samuelson: Economics
- 2) R. Lipsy: An introduction to positive economics
- 3) A. Kautsagiannis: Modern Economics Theory
- 4) D. C. Rowan: Output, Inflation and growth.
- 5) Hasengreen: Introduction to Accounting.
- 6) Mankiw Gregory N. (2002), Principles of Economics, Thompson Asia
- 7) V. Mote, S. Paul, G. Gupta (2004), Managerial Economics, Tata McGraw Hill
- 8) Misra, S.K. and Puri (2009), Indian Economy, Himalaya
- 9) Pareek Saroj (2003), Textbook of Business Economics, Sunrise Publishers

After completing the course, the students will be able to

- Know and identify economic activities and why problem of choice arises and how this concept can be applied to practical field in micro and macro level; Acquire the knowledge of different types of markets and market mechanism and how prices are fixed there with changing demand, supply and elasticity and how they are regulated
- Enable them to comprehend different types costs and to carry out cost analysis and how they affect production in the short run and long run period; Explain national income and how they are measured and what are its impacts on the national economy and standard of living of a country
- Have a clear concept of inflation and its different types and how they affect organizational budget and national budget and standard of living of a country; Understand banking system and its role in the development and growth of a country and how these facilities can be availed for the growth of the particular organization/ firm
- Understand the business language and concept of Accounting and Accounting Cycle, Accounting Equation and different accounting terms like asset, liability, capital, income, expenditure etc. to understand financial health and strength of a particular organization.
- Know the concepts of financial management and how top management test the financial health of a concern and exercises financial control using different accounting tools like comparative financial statement analysis, ratio analysis, cash flow and fund flow analysis etc.
- Realize time value of money and use of different capital investment appraisal techniques such as NPV, IRR, Profitability Index, and Payback period etc. to test the feasibility of a project.



### Project and Internship

<b>Course code</b>	<b>PROJ-INT 791</b>				
<b>Category</b>	Project and Internship				
<b>Course title</b>	<b>Internship</b>				
<b>Scheme and Credits</b>	<b>L</b> <b>0</b>	<b>T</b> <b>0</b>	<b>P</b> <b>4</b>	<b>Credits</b> <b>2</b>	<b>Semester – VII</b>
<b>Pre-requisites (if any)</b>					

Minimum of six weeks in an Industry in the area of Electrical Engineering. The summer internship should give exposure to the practical aspects of the discipline. In addition, the student may also work on a specified task or project which may be assigned to him/her. The outcome of the internship should be presented in the form of a report.

<b>Course code</b>	<b>PROJ-EE 792</b>				
<b>Category</b>	Project and Internship				
<b>Course title</b>	<b>Project Stage-I</b>				
<b>Scheme and Credits</b>	<b>L</b> <b>0</b>	<b>T</b> <b>0</b>	<b>P</b> <b>4</b>	<b>Credits</b> <b>2</b>	<b>Semester – VII</b>
<b>Pre-requisites (if any)</b>					

The object of **Project Stage-I** is to enable the student to engage in conduction of investigative study on a research area assigned by the Department on five/six students in a group, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work.

The assignment to normally include:

1. Working out a preliminary Approach to the Problem relating to the assigned topic;
2. Conducting preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility;
3. Preparing a Written Report on the Study conducted for presentation to the Department;
4. Final Seminar, as oral Presentation before a departmental committee.

**Semester VIII (Fourth year) Curriculum**  
**Branch/Course: Electrical Engineering**

Sl. No	Type of Course	Code	Course Title	Hours per week			Credits	Marks
				L	T	P		
1	Professional Elective Course <sup>#</sup>	PEC-EE 811	Professional Elective-VI	3	0	0	3	100
3	Open Elective Course <sup>##</sup>	OEC-X* 821	Open Elective-V	3	0	0	3	100
4	Open Elective Course <sup>##</sup>	OEC-X* 822	Open Elective-VI	3	0	0	3	100
7	Project and Internship	PROJ-EE 892	Project Stage-II	0	0	14	7	100
<b>Total:</b>							<b>16</b>	<b>400</b>

\* X refers to offering codes such as M/EE/HU/ME/EC/EI/CSE

**#Professional Elective Course (PEC-EE 811)**

Sl. No	Paper code	Semester	Name of the paper
1	PEC-EE 811(a)	8th	Advanced Electric Drives
2	PEC-EE 811(b)	8th	Utilization of Electrical Power

**## Open Elective Course (OEC-X 821)**

Sl. No	Paper code	Semester	Name of the paper
1.	OEC-M 821(a)	8th	Advanced Operations Research
2.	OEC-EE 821(b)	8th	Advanced Topics in Power Systems
3.	OEC-HU 821(c)	8th	Quality Control & Management
4.	OEC-HU 821(d)	8th	Cyber Law and Computer Ethics
5.	OEC-EC 821(e)	8th	Satellite Communication
6.	OEC-EE 821(f)	8th	Energy Audit & Management

**## Open Elective Course (OEC-X 822)**

Sl. No	Paper code	Semester	Name of the paper
1.	OEC-HU 822(a)	8th	Digital Marketing
2.	OEC-HU 822(b)	8th	Human Resource Development & Organizational Behavior
3.	OEC-EC 822(c)	8th	Machine Learning
4.	OEC-EI 822(d)	8th	Sensor Technology
5.	OEC-EE 822(e)	8th	Automotive Control & Robotics
6.	OEC-ME 822(f)	8th	Power Plant Engineering

**## Refer to the OEC booklet for detailed syllabus**

### Professional Elective Courses

<b>Course code</b>	<b>PEC-EE 801(a)</b>				
<b>Category</b>	Professional Elective Course (PEC)				
<b>Course title</b>	<b>Advanced Electric Drives</b>				
<b>Scheme and Credits</b>	<b>L</b> 3	<b>T</b> 0	<b>P</b> 0	<b>Credits</b> 3	<b>Semester – VIII</b>
<b>Pre-requisites (if any)</b>					

**Course Outcomes:** At the end of this course students will demonstrate the ability to:

1. Understand the operation of power electronic converters and their control strategies.
2. Understand the vector control strategies for ac motor drives
3. Understand the implementation of the control strategies using digital signal processors.

<b>Unit</b>	<b>Detailed Description</b>	<b>Lecture/ Tutorial Period</b>
1	<b>Power Converters for AC drives:</b> PWM control of inverter, selected harmonic elimination, space vector modulation, current control of VSI, three level inverter, Different topologies, SVM for 3 level inverter, Diode rectifier with boost chopper, PWM converter as line side rectifier, current fed inverters with self-commutated devices. Control of CSI, H bridge as a 4-Q drive.	10L
2.	<b>Induction motor drives:</b> Different transformations and reference frame theory, modelling of induction machines, voltage fed inverter control-v/f control, vector control, direct torque and flux control (DTC).	9L
3.	<b>Synchronous motor drives:</b> Modelling of synchronous machines, open loop v/f control, vector control, direct torque control, CSI fed synchronous motor drives.	5L
4.	<b>Permanent magnet motor drives:</b> Introduction to various PM motors, BLDC and PMSM drive configuration, comparison, block diagrams, Speed and torque control in BLDC and PMSM.	6L
5.	<b>Switched reluctance motor drives:</b> Evolution of switched reluctance motors, various topologies for SRM drives, comparison, Closed loop speed and torque control of SRM.	6L
6.	<b>DSP based motion control:</b> Use of DSPs in motion control, various DSPs available, realization of some basic blocks in DSP for implementation of DSP based motion control.	6L
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. Of Week Reserved:</b>	<b>02</b>

**Text Book:**

1. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, Asia, 2003.
2. P. C. Krause, O. Wasynczuk and S. D. Sudhoff, "Analysis of Electric Machinery and Drive Systems", John Wiley & Sons, 2013.
3. H. A. Taliyat and S. G. Campbell, "DSP based Electromechanical Motion Control", CRC press, 2003.
4. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC motor Drives", CRC Press, 2009.

<b>Course code</b>	<b>PEC-EE 811(b)</b>				
<b>Category</b>	Professional Elective Course (PEC)				
<b>Course title</b>	<b>Utilization of Electrical Power</b>				
<b>Scheme and Credits</b>	<b>L</b> 3	<b>T</b> 0	<b>P</b> 0	<b>Credits</b> 3	<b>Semester – VIII</b>
<b>Pre-requisites (if any)</b>					

**Course Outcomes:**

At the end of this course, students will have the ability to

- [1] Examine various applications in indoor and outdoor areas where use of light sources is essential.
- [2] Recognize different process of utilizing electric energy for heating and electrolytic process.
- [3] Apply proper traction systems depending upon application considering economic and technology up gradation.

<b>Module</b>	<b>Detailed Description</b>	<b>Lecture / Tutorial Period</b>
<b>1.</b>	<b>Electric Traction:</b> Requirement of an ideal traction system, Supply system for electric traction, Train movement (speed time curve, simplified speed time curve, average speed and schedule speed), Mechanism of train movement (energy consumption, tractive effort during acceleration, tractive effort on a gradient, tractive effort for resistance, power & energy output for the driving axles, factors affecting specific energy consumption, coefficient of adhesion). Electric traction motor & their control: Parallel and series operation of Series and Shunt motor with equal and unequal wheel diameter, effect of sudden change of in supply voltage, Temporary interruption of supply, Tractive effort and horse power. Use of AC series motor and Induction motor for traction. Traction motor control: DC series motor control, Multiple unit control, Braking of electric motors, Electrolysis by current through earth, current collection in traction system, Power electronic controllers in traction system.	<b>8L</b>
<b>2.</b>	<b>Illumination:</b> The nature of radiation, Polar curve, Law of illumination, Photometry (brightness measurement), Types of Lamps: Conventional and energy efficient, Basic principle of light control, Different lighting scheme & their design methods, Flood and Street lighting. Light and electromagnetic radiation; sources of light- daylight and artificial light; filament lamp; discharge lamp; solid state lamp -light emitting diode. Spectral power distribution (SPD) of light sources. Radiometric and photometric quantities, visual response curves of CIE standard observer - Photopic vision and Scotopic vision; relation between lumen and watt (optical radiation). Operating principle and electrical characteristics of (1) fluorescent lamp, function of ballast and starter; (2) solid state lamp (LED), function of driver. Luminaire - its function; Ingress Protection (IP) rating; application-based classification. Laws of illumination; perfect diffuser; Lambert's law.	<b>16L</b>

	<p>Working principles of Photometer - Luxmeter, Luminance meter, Integrating sphere, Goniophotometer. Polar intensity diagrams of indoor, streetlight and floodlight luminaires.</p> <p>General principles of indoor and outdoor lighting design; lighting design parameters; selection of lamp and luminaires. Indian standards on indoor and outdoor lighting design.</p> <p>Application of Lumen method in indoor lighting design. Concepts of energy efficient lighting design and payback calculation.</p>	
<b>3.</b>	<b>Electric Heating:</b> Types of heating: (Resistance heating, Induction heating, Arc heating, Dielectric heating, Microwave heating).	<b>6L</b>
<b>4.</b>	<b>Electric Welding:</b> General principle of electric welding and its advantages. Types of Electric Welding: (Electric Arc Welding, Electric Resistance Welding, modern forms of welding).	<b>6L</b>
<b>5.</b>	<b>Electrolytic processes:</b> Basic principles, Faraday's law of Electrolysis, Electro deposition, Extraction and refining of metals, Power supply of Electrolytic processes.	<b>6L</b>
	<b>Total:</b>	<b>42L</b>
	<b>Total Week Required:</b>	<b>14</b>
	<b>No. of Week Reserved:</b>	<b>02</b>

#### **Text / References:**

- 1) Art and Science of Utilization of Electrical Energy, H. Partab, Dhanpat Rai & Sons.
- 2) Utilization of Electric Energy, E. Openhaw Taylor, Orient Longman.
- 3) Lamps and Lighting – Edited by J.R. Coaton and A.M. Marsden, 4th Edition, Arnold
- 4) Lighting for energy efficient luminous environments - Ronald N. Helms & M Clay Belcher.
- 5) Lighting - D.C. Pritchard
- 6) Illuminating Engineering: From Edison's Lamp to the LED - J B Murdoch

## Project and Internship

Course code	PROJ-EE 892				
Category	Project and Internship				
Course title	Project Stage-II				
Scheme and Credits	L	T	P	Credits	Semester – VII
	0	0	14	7	
Pre-requisites (if any)					

The object of **Project Stage-II** is to enable the student to extend further the investigative study taken up under **Project Stage-I**, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership.

The assignment to normally include:

1. In depth study of the topic assigned in the light of the Report prepared under **Project Stage I**;
2. Review and finalization of the Approach to the Problem relating to the assigned topic;
3. Preparing an Action Plan for conducting the investigation, including team work;
4. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed;
5. Final development of product/process, testing, results, conclusions and future directions;
6. Preparing a paper for Conference presentation/Publication in Journals, if possible;
7. Preparing a Dissertation in the standard format for being evaluated by the Department.
8. Final Seminar Presentation before a Departmental Committee.

### Common Open Elective Courses (OEC) List

Sl. No	Paper code	Sem.	Name of the paper
1.	OEC-HU 521(a)	5th	Sanskrit for Technical Knowledge
2.	OEC-PH 521(b)	5th	Material Science
3.	OEC-EC 521(c)	5th	Bio Medical Electronics
4.	OEC-CS/IT 521(d)	5th	Programming using Python
5.	OEC-HU 621(a)	6th	History of Science & Engineering in India
6.	OEC-HU 621 (b)	6th	Infrastructure Finance
7.	OEC-PH 621(c)	6th	Optoelectronics
8.	OEC-EC/EI 621(d)	6th	Microprocessors & Its Applications
9.	OEC-M 621(e)	6th	Computational Methods
10.	OEC-HU 721(a)	7th	Introduction to Comparative literature
11.	OEC-HU 721(b)	7th	Economic Policies in India
12.	OEC-M 721(c)	7th	Mathematical Formulation & Approximations
13.	OEC-HU 721(d)	7th	Soft Skills & Interpersonal Communication
14.	OEC-EI 721(e)	7th	MEMS
15.	OEC-EC 721(f)	7th	Nano Electronics
16.	OEC-EE 722(a)	7th	Renewable Energy
17.	OEC-ME 722(b)	7th	Modern Manufacturing Practice
18.	OEC-ME 722(c)	7th	Thermal Engineering & Fluid Machinery
19.	OEC-M 821(a)	8th	Advanced Operations Research
20.	OEC-EE 821(b)	8th	Advanced Topics in Power Systems
21.	OEC-CE 821(c)	8th	Quality Control & Management
22.	OEC-HU 821(d)	8th	Cyber Law and Computer Ethics
23.	OEC-EC 821(e)	8th	Satellite Communication
24.	OEC-EE 821(f)	8th	Energy Audit & Management
25.	OEC-HU 822(a)	8th	Digital Marketing
26.	OEC-HU 822(b)	8th	Human Resource Development & Organizational Behavior
27.	OEC-EC 822(c)	8th	Machine Learning
28.	OEC-EI 822(d)	8th	Sensor Technology
29.	OEC-EE 822(e)	8th	Automotive Control & Robotics
30.	OEC-ME 822(f)	8th	Power Plant Engineering

**## Refer to the OEC booklet for detailed syllabus**