FACULTY OF ENGINEERING

Scheme of Instruction & Examination

(CBCS Curriculum for the Academic Year 2019-2020)

and

Syllabi

B.E. VII and VIII Semester

of

Four Year Degree Programme

In

Electrical and Electronics Engineering

(With effect from the academic year 2019– 2020)

(As approved in the faculty meeting held on 25-06-2019)

Issued by

Dean, Faculty of Engineering

Osmania University, Hyderabad – 500 007

2019

SCHEME OF INSTRUCTION & EXAMINATION
B.E. VII - Semester
(ELECTRICAL AND ELECTRONICS ENGINEERING)

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	**PC 701 EE**	Power System Operation and Control	3	1	-	4	30	70	3	3
2	**PC 702 EE**	Electric Drives and Static Control	3	1	-	4	30	70	3	3
3	**PC 703 EE**	Electrical Machine Design	3	1	-	4	30	70	3	3
4		Open Elective – II	3	-	-	3	30	70	3	3
5		Open Elective – III	3	-	-	3	30	70	3	3
Practical/ Laboratory Courses										
6	**PC 751 EE**	Electrical Simulation Lab	-	-	2	2	25	50	3	1
7	**PC 752 EE**	Microprocessor and Microcontrollers Lab	-	-	2	2	25	50	3	1
8	**PW 761 EE**	Project Work – I	-	-	4	4	50	-	-	2
9	**PW 762 EE**	Summer Internship	`	-	-	-	50	-	-	2
			15	**03**	**08**	**26**	**300**	**450**		**21**

Open Elective – II			**Open Elective – III**		
S. No.	Course Code	Course Title	S. No.	Course Code	Course Title
1	**OE 771 CE**	Green Building Technologies	1	**OE 781 CE**	Road Safety Engineering
2	**OE 772 CS**	Data Science Using R Programming	2	**OE 782 IT**	Software Engineering
3	**OE 773 EC**	Fundamentals of IoT	3	**OE 783 EC**	Principles of Electronic Communications
4	**OE 774 EE****	Non-Conventional Energy Sources	4	**OE 784 EE****	Illumination and Electric Traction systems
5	**OE 775 ME**	Entrepreneurship	5	**OE 785 ME**	Mechatronics

PC: Professional Course PE: Professional Elective
L: Lectures T: Tutorials P: Practical D: Drawing
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

Note: 1) Each contact hour is a Clock Hour
2) The practical class can be of two and half hour (clock hours) duration as per the requirement of a particular laboratory.

Note-2: * The students have to undergo a Summer Internship of four weeks' duration after VI semester and credits will be awarded in VII semester after evaluation.
** Subject is not offered to the students of EEE and EIE Department.

Course Code	Course Title						Core / Elective
PC 701 EE	**Power System Operation and Control**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Power Systems-I **Power Systems-II**	**3**	**1**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand the concepts and Importance of Load flow studies, Economic Operation of thermal power units, frequency control of inter connected Power System Networks.
- To make the students understand about reactive Power Control and Stability of Power System Networks.

Course Outcomes

After completing this course, the student will be able to

1. Solve load flow by appropriate modelling of the given power system and formulation of Ybus.
2. Evaluate generation mix for economic operation with and without transmission losses.
3. Explain load frequency control and estimate the frequency deviation through modelling.
4. Analyse and describe different types of power system stability and establish SSSL.
5. Identify various methods of voltage control and study the reactive power compensation.
6. Design the railway steel bridges and bridge bearings.

UNIT-I

Load Flow Studies: Formulation of Y bus for a system, modelling of tap changing and phase shifting transformer, Formulation of load flow problem, Solution of load flow by Gauss-Seidel, Newton-Raphson, Decoupled and Fast Decoupled methods, comparison of different load flow methods.

UNIT-II

Economic Operation of Power System: Input-Output curves, Heat rates and incremental cost curves, Equal Incremental cost criterion neglecting transmission losses with and without generator limits, Bmn coefficients, Economic operation including transmission losses.

UNIT-III

Load Frequency Control: Governor Characteristics, Regulation of two generators, coherency, concept of control area, Incremental power balance of a control area, Single area control, Flat frequency control, Flat tie-line frequency control, Tie-line bias control, Advantages of pool operation, Development of model for two-area control.

UNIT-IV

Power System Stability: Definitions of Steady state stability and Transient stability, Steady state stability of a synchronous machine connected to infinite bus, calculation of steady state stability limit, synchronous machine models with and without saliency, Equal area criterion, Application of equal area criterion, Swing equation, Step by step solution of Swing equation, factors effecting transient stability, Auto Reclosures, mathematical formulation of voltage stability problem.

UNIT-V

Reactive Power Control: Reactive power generation by synchronous generators, Automatic voltage regulators, FACTS Controllers-TCSC, STATCOM, UPFC.

Suggested Readings:

1. Modern Power System Analysis by D. P. Kothari and I.J. Nagrath Tata McGraw Hill

2. Power System Analysis by John. J. Grangier, William D. Stevenson Jr. Tata McGraw Hill
3. Electric Power Systems by C.L. Wadhwa New Age International (p) Ltd
4. Power System Analysis by Haadi Sadat Tata McGraw Hill.
5. Electrical energy Systems Theory by Elgerd Tata McGraw Hill

Course Code	Course Title						Core / Elective
PC 702 EE	**Electric Drives and Static Control**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Power Electronics	**3**	**1**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To study the static control methods of DC motor, induction motor and synchronous motor.
- To study the concepts of stability, characteristics and braking methods of DC & AC motion.
- To determine the rating of motors based on heating effects and load conditions.

Course Outcomes

By the end of this course, the students will be able to

1. Describe the structure and operation of Electric Drive and relate to study its stability
2. Analyse characteristics and the energy loss during starting and braking of DC & AC drives
3. Use the single phase rectifier, chopper and dual converter circuits to understand the closed loop control of drives.
4. Describe the speed control methods for 3 Phase Induction Motors for stator, rotor side and the slip recovery schemes.
5. Explain the control of synchronous motor brushless DC motor, Switched reluctance motors.
6. prepare estimates for various engineering structures
7. prepare schedule for civil engineering works

UNIT-I

Electric Drives: Concept and classification, four quadrant operation, Dynamics of Electric Drives, Types of Loads, Torque characteristics of Load, characteristics of Motor-Load combination, Dynamics of Motor-Load combination, Steady-state and Transient stability of Electric Drive. Characteristics of Electric Drives: Modified Speed-Torque Characteristics of D.C Shunt motors, D.C Series motor and Induction motors.

UNIT-II

Starting of Electric Motors: Methods of Starting Electric Motors, Acceleration time, Energy relation during starting, D.C Shunt and series motor and Induction motors, Methods to reduce the energy loss during starting
Electric Braking: Types of Braking- Regenerative braking, dynamic braking and Plugging, Braking of D.C Shunt motor, DC Series motor and 3-phase Induction motor, Energy relation and Dynamics of Braking. Effect of load inertia and load equalization.

UNIT-III

D.C Motor Control: Single-phase controlled rectifier and chopper circuit arrangement for continuous armature current operation. Dual converter control, circulating current and non-circulating current modes of operation, Principles of closed loop control for D.C drives.

UNIT-IV

Induction Motor Control: Speed control of 3-phase induction motor with A.C voltage regulators, Voltage source inverters and Cyclo-converters, Static rotor resistance control, slip power recovery schemes: Static Krammer drive and Scherbius drive.

UNIT-V

Synchronous Motor Control: Self-controlled and Separately controlled synchronous motors, Brushless D.C motors, Switched reluctance motors

Suggested Readings:

1. S.K. Pillai, A First Course in Electrical Drives, New Age International (P) Limited, Publishers, 2000.
2. G.K. Dubey Fundamentals of Electric Drives, Narosa publication House, Delhi, 2001
3. M.D. Singh and K.B. Khanchandani, Power Electronics, Tata McGraw Hill Publishing Company Ltd., 2000.
4. Bimal. K. Bose, Modern Power Electronics and AC Drives, Pearson Education Asia, 2002.

Course Code	Course Title						Core / Elective
PC 703 EE	**Electrical Machine Design**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Power Electronics	**3**	**1**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To Study the Qualitative & Quantitative analysis of magnetic circuit design, Electrical Circuit Design and Thermal Circuit Design of Electrical Machine.
- To understand the Design and analysis of different types of windings used for DC/AC machines.
- To understand the Design principles of different rotating machines can be studied.

Course Outcomes

After completing this course, the student will be able to

1. Make a choice of material to evolve a particular design problem at hand and make reference to the standards used by the industry
2. Understand the behavior of magnetic materials, thermal performance and rating of machines.
3. Design DC machine along with the materials, ventilation and cooling aspect used in it
4. Design AC machine along with the materials, ventilation and cooling aspect used in it.
5. To make the trials using a computer program and hundreds of design are worked in repetitive manner to evolve a cost optimized design by using computer aided design

UNIT-I

Electrical engineering materials insulating materials: Properties of ideal insulating materials, classification and types of insulating materials, conducting materials, general properties of Cu, Al and steel, High resistance alloys, carbon and other conducting materials, super Conductors-Magnetic materials: classification of magnetic materials, soft and hard magnetic materials, Sheet steel, cold rolled steels, solid core and laminated core materials.

UNIT-II

Magnetic circuit: Basic principles, magnetic circuit calculations, Flux density in air gap and Tooth-Carters coefficient, Ampere turns for gap and teeth, real and apparent flux density, Magnetic leakage, armature leakage, leakage flux from salient poles, Field distribution curves, field turns, ampere reaction ampere turns

Thermal circuit: Types of enclosures ventilation and cooling system, Losses, temperature rise time curve, rating of electrical machines, calculation for quantity of cooling medium

Rating of motors: heating effects, load conditions and classes of duty, Determination of power rating.

UNIT-III

DC Machine design: Output equation, main dimensions, Choice of specific magnetic and electric loading, selection of no of poles, Choice of armature core length, armature diameter, Length of air gap, armature design and design of field system.

UNIT-IV

AC machine design: Transformer design, main dimensions, Output equation, core design, cooling system design, 3 Phase Induction motors: output equation, main dimensions, design of stator and rotor, Design of squirrel cage rotor, design of end rings.

Synchronous machine: Output equation, main dimensions, SCR, length of air gap, Selection of armature slots, design of field system and turbo alternators.

UNIT-V

Computer aided design: Introduction, advantages of digital computers, computer aided design- different approaches, Analysis, synthesis and hybrid method, Optimization-General procedure for optimization, variable constraints, Computer aided design of 3 phase IM, lists of symbols used, general design procedure.

Suggested Readings:

1. A.K. Sawhney, A course in Electrical Machines Design, Dhanpat Rai and Sons, 1996
2. R.K. Agarwal, Principles of Electrical Machines Design, S.K. Kataria & sons, 4th Edition, 2000, New Delhi.

Course Code	Course Title						Core / Elective
OE 771 CE	**Green Building Technologies**						**Open Elective-II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To impart knowledge of the principles behind the green building technologies.
- To know the importance of sustainable use of natural resources and energy.
- To understand the principles of effective energy and resources management in buildings.
- To bring awareness of the basic criteria in the green building rating systems.
- To understand the methodologies to reduce, recycle and reuse towards sustainability.

Course Outcomes

After completing this course, the student will be able to

1. Define a green building, along with its features, benefits and rating systems.
2. Describe the criteria used for site selection and water efficiency methods.
3. Explain the energy efficiency terms and methods used in green building practices.
4. Select materials for sustainable built environment & adopt waste management methods.
5. Describe the methods used to maintain indoor environmental quality.

UNIT-I

Introduction to Green Buildings: Definition of green buildings and sustainable development, typical features of green buildings, benefits of green buildings towards sustainable development. Green building rating systems – GRIHA, IGBC and LEED, overview of the criteria as per these rating systems.

UNIT- II

Site selection and planning: Criteria for site selection, preservation of landscape, soil erosion control, minimizing urban heat island effect, maximize comfort by proper orientation of building facades, day lighting, ventilation, etc.

Water conservation and efficiency: Rainwater harvesting methods for roof & non-roof, reducing landscape water demand by proper irrigation systems, water efficient plumbing systems, water metering, waste water treatment, recycle and reuse systems.

UNIT-III

Energy Efficiency: Environmental impact of building constructions, Concepts of embodied energy, operational energy and life cycle energy. Methods to reduce operational energy: Energy efficient building envelopes, efficient lighting technologies, energy efficient appliances for heating and air-conditioning systems in buildings, zero ozone depleting potential (ODP) materials, wind and solar energy harvesting, energy metering and monitoring, concept of net zero buildings.

UNIT-IV

Building materials: Methods to reduce embodied energy in building materials: (a) Use of local building materials (b) Use of natural and renewable materials like bamboo, timber, rammed earth, stabilized mud blocks, (c) use of materials with recycled content such as blended cements, pozzolana cements, fly ash bricks, vitrified tiles, materials from agro and industrial waste. (d) reuse of waste and salvaged materials

Waste Management: Handling of construction waste materials, separation of household waste, on-site and off-site organic waste management

UNIT-V

Indoor Environmental Quality for Occupant Comfort and Wellbeing: Daylighting, air ventilation, exhaust systems, low VOC paints, materials & adhesives, building acoustics. Codes related to green buildings: NBC, ECBC, ASHRAE, UPC etc.

Suggested Readings:

1. IGBC Green Homes Rating System, Version 2.0., Abridged reference guide, 2013, Indian Green Building Council Publishers.
2. GRIHA version 2015, GRIHA rating system, Green Rating for Integrated Habitat Assessment.
3. *Alternative building materials and technologies* by K.S. Jagadish, B.V. Venkatarama Reddy and K.S. Nanjunda Rao.
4. *Non-Conventional Energy Resources* by G. D. Rai, Khanna Publishers.
5. *Sustainable Building Design Manual*, Vol.1 and 2, TERI, New Delhi 2004.
6. Mike Montoya, *Green Building Fundamentals*, Pearson, USA, 2010.
7. Charles J. Kibert*, Sustainable Construction - Green Building Design and Delivery*, John Wiley & Sons, New York, 2008.
8. Regina Leffers*, Sustainable Construction and Design*, Pearson / Prentice Hall, USA, 2009.

Course Code	Course Title						Core / Elective
OE 772 CS	**Data Science Using R Programming**						**Open Elective-II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To learn basics of R Programming environment: R language, R- studio and R packages
- To learn various statistical concepts like linear and logistic regression, cluster analysis, time series forecasting
- To learn Decision tree induction, association rule mining and text mining

Course Outcomes

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

1. Use various data structures and packages in R for data visualization and summarization
2. Use linear, non-linear regression models, and classification techniques for data analysis
3. Use clustering methods including K-means and CURE algorithm

UNIT – I

Data Science: Introduction to data science, Linear Algebra for data science, Linear equations, Distance, Hyper planes, Half spaces, Eigen values, Eigenvectors.

UNIT II

Statistical Modelling, Random variables, Probability mass/density functions, sample statistics, hypothesis testing.

UNIT III

Predictive Modelling: Linear Regression, Simple Linear Regression model building, Multiple Linear Regression, Logistic regression

UNIT IV

Introduction to R Programming, getting started with R: Installation of R software and using the interface, Variables and data types, R Objects, Vectors and lists, Operations: Arithmetic, Logical and Matrix operations, Data frames, functions, Control structures, Debugging and Simulation in R.

UNIT V

Classification: performance measures, Logistic regression implementation in R, K-Nearest neighbours (KNN), K-Nearest neighbours implementation in R, Clustering: K-Means Algorithm, K-Means implementation in R.

Suggested Readings:

1. R Programming for Data science, by Roger D Peng, Lean Publishing.
2. Introduction to Data Science by Rafael A Irizarry, Lean Publishing

Course Code	Course Title						Core / Elective
OE 773 EC	**Fundamentals of IoT**						**Open Elective-II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Discuss fundamentals of IoT and its applications and requisite infrastructure
- Describe Internet principles and communication technologies relevant to IoT
- Discuss hardware and software aspects of designing an IoT system
- Describe concepts of cloud computing and Data Analytics
- Discuss business models and manufacturing strategies of IoT products

Course Outcomes

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

1. Understand the various applications of IoT and other enabling technologies.
2. Comprehend various protocols and communication technologies used in IoT
3. Design simple IoT systems with requisite hardware and C programming software
4. Understand the relevance of cloud computing and data analytics to IoT
5. Comprehend the business model of IoT from developing a prototype to launching a product.

UNIT - I

Introduction to Internet of Things: Definition and Characteristics of IoT, Physical Design of IoT: Things in IoT, IoT protocols, Logical Design of IoT: IoT functional Blocks, Communication Models, APIs, IoT enabling Technologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics (Ref 1)

IoT Applications: Smart Home, Smart Cities, Smart Environment, Smart Energy, Smart Retail and Logistics, Smart Agriculture and Industry, Smart Industry and smart Health (Ref1)

UNIT – II

Internet Principles and communication technology: Internet Communications: An Overview – IP, TCP, IP protocol Suite, UDP. IP addresses – DNS, Static and Dynamic IP addresses, MAC Addresses, TCP and UDP Ports, Application Layer Protocols – HTTP, HTTPS, Cost Vs Ease of Production, Prototypes and Production, Open Source Vs Closed Source. Prototyping Embedded Devices – Sensors, Actuators, Microcontrollers, SoC, Choosing a platform, Prototyping Hardware platforms – Arduino, Raspberry Pi. Prototyping the physical design – Laser Cutting, 3D printing, CNC Milling (Ref 2)

UNIT – III

API Development and Embedded programming: Getting started with API, writing a new API, Real time Reactions, Other Protocols, Techniques for writing embedded code: Memory management, Performance and Battery Life, Libraries, Debugging. (Ref 2)

Developing Internet of Things: IoT design Methodology, Case study on IoT System for weather monitoring (Ref 1)

UNIT – IV

IoT Systems - Logical Design using Python: Introduction to Python, Data Types and Structures, Control Flow, Functions, Modules, Packages, File Handling, Date/Time Operations., Classes, Python packages for IoT (Ref 1 and Ref 3) IoT Physical Devices and Endpoints: Raspberry Pi, Interfaces of Pi, Programming pi with Python - Controlling LED and LDR using Pi with python programming.

UNIT – V

Cloud computing and Data analytics and IoT Product Manufacturing: Introduction to Cloud storage models and Communication APIs, Amazon web services for IoT, Skynet IoT Messaging Platform. Introduction to Data Analytics for IoT (Ref 1). Case studies illustrating IoT Design – Smart Lighting, Weather Monitoring, Smart Irrigation. (Ref 1) Business model for IoT product manufacturing, IoT Start-ups, Mass manufacturing, Ethical issues in IoT. (Ref 2)

Suggested Readings:

1. Internet of Things (A Hands-On-Approach), Vijay Madisetti, Arshdeep Bahga, VPT Publisher, 1st Edition, 2014.
2. Designing the Internet of Things, Adrian McEwen (Author), Hakim Cassimally. Wiley India Publishers.
3. Fundamentals of Python, Kenneth A Lambert and B.L. Juneja, Cengage Learning
4. *Internet of Things* - Converging Technologies for smart environments and Integrated ecosystems, River Publishers.
5. *Internet of things* -A hands on Approach, Arshdeep Bahga, Universities press.

Course Code	Course Title						Core / Elective
OE 774 EE	**Non-Conventional Energy Sources**						**Open Elective-II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

To impart the knowledge of basics of different non-conventional types of power generation & power plants in detail so that it helps them in understanding the need and role of Non-Conventional Energy sources particularly when the conventional sources are scarce in nature

Course Outcomes

On completion of course the student will be able to:

1. Understand the different nonconventional sources and the power generation techniques to generate electrical power.
2. Understand the Solar energy power development and different applications.
3. Understand different wind energy power generation techniques and applications.
4. Design a prescribed engineering sub-system
5. Recognize the need and ability to engage in lifelong learning for further developments in this field.

UNIT-I

Review of Conventional and Non-Conventional energy sources - Need for non-conventional energy sources Types of Non- conventional energy sources - Fuel Cells - Principle of operation with special reference to H2 °2 Cell - Classification and Block diagram of fuel cell systems - Ion exchange membrane cell - Molten carbonate cells - Solid oxide electrolyte cells - Regenerative system- Regenerative Fuel Cell - Advantages and disadvantages of Fuel Cells-Polarization - Conversion efficiency and Applications of Fuel Cells.

UNIT-II

Solar energy - Solar radiation and its measurements - Solar Energy collectors -Solar Energy storage systems - Solar Pond - Application of Solar Pond - Applications of solar energy.

UNIT-III

Wind energy- Principles of wind energy conversion systems - Nature of wind - Power in the Wind-Basic components of WECS -Classification of WECS -Site selection considerations -Advantages and disadvantages of WECS -Wind energy collectors -Wind electric generating and control systems - Applications of Wind energy -Environmental aspects.

UNIT- IV

Energy from the Oceans - Ocean Thermal Electric Conversion (OTEC) methods - Principles of tidal power generation -Advantages and limitations of tidal power generation -Ocean waves - Wave energy conversion devices -Advantages and disadvantages of wave energy - Geo-Thermal Energy - Types of Geo-Thermal Energy Systems - Applications of Geo-Thermal Energy.

UNIT-V

Energy from Biomass - Biomass conversion technologies / processes - Photosynthesis - Photosynthetic efficiency - Biogas generation - Selection of site for Biogas plant - Classification of Biogas plants - Details of commonly used Biogas plants in India - Advantages and disadvantages of Biogas generation -Thermal gasification of biomass -Biomass gasifiers.

Suggested Readings:

1. Rai G.D, *Non-Conventional Sources of Energy,* Khandala Publishers, New Delhi, 1999.
2. M.M. El-Wakil, Power *Plant Technology.* McGraw Hill, 1984.

Course Code	Course Title						Core / Elective
OE 775 ME	**Entrepreneurship**						**Open Elective-II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To motivate students to take up entrepreneurship in future
- To learn nuances of starting an enterprise & project management
- To understand the design principles of solar energy systems, their utilization and performance evaluation
- To understand the behavioural aspects of entrepreneurs and time management

Course Outcomes

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

1. Understand Indian Industrial Environment, Entrepreneurship and Economic growth, Small and Large Scale Industries, Types and forms of enterprises.
2. Identify the characteristics of entrepreneurs, Emergence of first generation entrepreneurs, Conception and evaluation of ideas and their sources.
3. Practice the principles of project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis.
4. Apply the concepts of Project Management during construction phase, project organization, project planning and control using CPM, PERT techniques
5. Understand the Behavioural aspects of entrepreneurs, Time Management, Various approaches of time management, their strengths and weakness. The urgency addiction and time management matrix.

UNIT-I

Indian Industrial Environment-competence, Opportunities and Challenges. Entrepreneurship and Economic growth. Small Scale Industry in India, Objectives, Linkage among small, medium and heavy industries. Types of enterprises.

UNIT-II

Identification and characteristics of entrepreneurs. Emergence of First generation entrepreneurs, environmental influence and women entrepreneurs. Conception and evaluation of ideas and their sources. Choice of Technology - Collaborative interaction for Technology development.

UNIT-III

Project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis, project financing in India.

UNIT-IV

Project Management during construction phase, project organization, project planning and control using CPM, PERT techniques. Human aspects of project management. Assessment of tax burden.

UNIT-V

Behavioural aspects of entrepreneurs: Personality - determinants, attributes and models. Leadership concepts and models. Values and attitudes. Motivation aspects. Change behaviour. Time Management: Various approaches of time management, their strengths and weaknesses. The urgency addiction and time management matrix.

Suggested Readings:

1. Vasant Desai, *"Dynamics of Entrepreneurial Development and Management",* Himalaya Publishing House, 1997
2. Prasanna Chandra, *"Project-Planning, Analysis, Selection, Implementation and Review",* Tata McGraw-Hill Publishing Company Ltd. 1995.
3. Stephen R. Covey and A. Roger Merrill, *"First Things First",* Simon and Schuster Publication, 1994.
4. G.S. Sudha, *"Organizational Behaviour",* 1996.
5. Robert D. Hisrich, Michael P. Peters, *"Entrepreneurship",* Tata Me Graw Hill Publishing Company Ltd., 5lh Ed., 2005.

Course Code	Course Title						Core / Elective
OE 781 CE	**Road Safety Engineering**						**Open Elective-III**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**0**	**0**	**0**	**30**	**70**	**3**

Course Objectives

- Introduction to various factors considered for road safety and management
- Explain the road safety appurtenances and design elements
- Discuss the various traffic management techniques

Course Outcomes

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

1. Prepare accident investigation reports and database
2. Apply design principles for roadway geometrics improvement with various types of traffic safety appurtenances/tools
3. Manage traffic including incident management

UNIT – I

Road Accidents: Causes, scientific investigations and data collection, Analysis of individual accidents to arrive at real causes, statistical methods of analysis of accident data, Basic concepts of Road accident statistics, Safety performance function: The empirical Bayes method Identification of Hazards road location. Application of computer analysis of accident data.

UNIT – II

Safety in Road Design: Operating the road network for safety, highway operation and counter measures, road safety audit, principles-procedures and practice, code of good practice and checklists, vehicle design factors & Driver characteristics influencing road safety.

UNIT – III

Road Signs and Traffic Signals: Classification, Location of Signs, measures of sign effectiveness, Types of visual perception, sign regulations, sign visibility, sign variables, Text versus symbols. Road Marking: Role of Road markings, Classification, visibility. Traffic Signals: Need, Signal face. Illumination and location of Signals, Factors affecting signal design, pedestrians' safety, fixed and vehicle actuated signals. Design of signa1s, Area Traffic control. Delineators, Traffic Impact Attenuators, Road side rest areas, Safety Barriers, Traffic Aid Posts.

UNIT – IV

Traffic Management Techniques: Integrated safety improvement and Traffic Calming Schemes, Speed and load limit, Traffic lights, Safety cameras, Tests on driver and vehicles, pedestrian safety issues, Parking, Parking enforcement and its influence on Accidents. Travel Demand Management; Methods of Traffic management measures: Restriction of Turning Movements, One-way streets, Tidal Flow Operation Methods, Exclusive Bus Lanes and Closing Side-streets; Latest tools and techniques used for Road safety and traffic management. Road safety issues and various measures for road safety; Legislation, Enforcement, Education and Propaganda, Air quality, Noise and Energy Impacts; Cost of Road Accidents.

UNIT – V

Incident Management: Introduction, Characteristics of Traffic Incidents, Types of Incidents, Impacts, Incident management process, Incident traffic management; Applications of ITS: Motorist information, Equipment used; Planning effective Incident management program, Best practice in Incident management

programs. National importance of survival of Transportation systems during and after all natural disasters especially cyclones, earthquakes, floods etc. and manmade disasters like sabotage, terrorism etc.

Suggested Readings:

1. Guidelines on Design and Installation of Road Traffic Signals, IRC:93.
2. Specification for Road Traffic Signals, IS: 7537-1974.
3. Principles and Practice of Highway Engineering by L.R. Kadiyali and N.B. Lal.
4. Hand Book of T.E. Myer Kutz, Editor McGraw Hill, 2004.

Course Code	Course Title						Core / Elective
OE 782 CS	**Software Engineering**						**Open Elective-III**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To introduce the basic concepts of software development- processes from defining a product to shipping and maintaining that product
- To impart knowledge on various phases, methodologies and practices of software development
- To understand importance of software modelling using UML
- To understand the importance of testing in software development and study various testing strategies and software quality metrics.

Course Outcomes

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

1. Acquire knowledge about different software development processes and their usability in different problem domains.
2. Understand the process of requirements collection, analysing, and modelling requirements for effective understanding and communication with stakeholders.
3. Design and develop the architecture of real world problems towards developing a blueprint for implementation.
4. Use the UML language to design various models during software development life cycle.
5. Understand the concepts of software quality, testing and maintenance.

UNIT-I

The software Problem: Cost, Schedule and Quality, Scale and change, Software Processes: - Process and project, Component Software Processes, Software Development Process Models, Project management Process.

UNIT-II

Software Requirements Analysis and Specification: Value of a good SRS, Requirements Process, Requirements Specification, Functional Specification with Use Cases, Other approaches for analysis. Software Architecture: Role of Software Architecture Views, Component and connector view, Architectural styles for C & C view, Documenting Architecture Design, Evaluating Architectures.

UNIT-III

Planning a Software Project: Effort Estimation, Project Schedule and staffing, Quality Planning, Risk Management Planning, Project Monitoring Plan, Detailed Scheduling. Design: Design concepts, Function oriented Design, Object Oriented Design, Detailed Design, Verification, Metrics.

UNIT-IV

Coding and Unit Testing: Programming Principles and Guidelines, incrementally developing code, managing evolving code, unit testing, code inspection, Metrics. Testing: Testing Concepts, Testing Process, Black Box testing, White box testing, Metrics.

UNIT-V

Maintenance and Re-engineering: Software Maintenance, supportability, Reengineering, Business process Reengineering, Software reengineering, Reverse engineering; Restructuring, Forward engineering, Economics of Reengineering. Software Process Improvement: Introduction, SPI process, CMMI, PCMM, Other SPI Frameworks, SPI return on investment, SPI Trends.

Suggested Readings:

1. Pankaj Jalote, "Software Engineering- A Precise Approach", Wiley India, 2010.
2. Roger. S. Pressman, "Software Engineering - A Practitioner's Approach", 7th Edition, McGraw Hill Higher Education, 2010.
3. Deepak Jain, "Software Engineering", Oxford University Press, 2008.
4. Rajib Mall, "Fundamentals of Software Engineering", 4th Edition, PHI Learning, 2014.
5. Ian Sommerville, "Software Engineering", 10th Edition, Addison Wesley, 2015.

Course Code	Course Title						Core / Elective
OE 783 EC	**Principles of Electronic Communications**						**Open Elective-III**
Prerequisite	Contact Hours per Week				CIE	SEE	**Credits**
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Provide an introduction to fundamental concepts in the understanding of communications systems.
- Provide an introduction to network model and some of the network layers including physical layer, data link layer, network layer and transport layer.
- Provide an introduction to the evolution of wireless systems and current wireless technologies.

Course Outcomes

1. Understand the working of analog and digital communication systems
2. Understand the OSI network model and the working of data transmission
3. Understand the evolution of communication technologies from traditional telephony systems to modern wireless communication systems.

UNIT – I

Introduction to communication systems: Electromagnetic Frequency Spectrum, Signal and its representation, Elements of Electronic Communications System, Types of Communication Channels.

Signal Transmission Concepts: Baseband transmission and Broadband transmission,

Communication Parameters: Transmitted power, Channel bandwidth and Noise, Need for modulation

Signal Radiation and Propagation: Principle of electromagnetic radiation, Types of Antennas, Antenna Parameters and Mechanisms of Propagation.

UNIT – II

Analog and Digital Communications: Amplitude modulation and demodulation, FM modulation and demodulation, Digital converters, Digital modulation schemes – ASK, FSK, PSK, QPSK, Digital demodulation.

UNIT – III

Data Communication and Networking: Network Models, OSI Model, Data Link Layer – Media Access control, Ethernet, Network Layer – Internet Protocol (IPv4/IPv6), Transport Layer – TCP, UDP.

UNIT – IV

Telecommunication Systems: Telephones, Telephone system, Paging systems, Internet Telephony.

Optical Communications: Optical Principles, Optical Communication Systems, Fiber –Optic Cables, Optical Transmitters & Receivers, Wavelength Division Multiplexing.

UNIT – V

Wireless Communications: Evolution of Wireless Systems: AMPS, GSM, CDMA, WCDMA, OFDM. Current Wireless Technologies: Wireless LAN, Bluetooth, PAN and ZigBee, Infrared wireless, RFID communication, UWB, Wireless mesh networks, Vehicular adhoc networks.

Suggested Readings:

1. *Principles of Electronic Communication Systems*, Louis E. Frenzel, 3e, McGraw Hill, 2008.
2. *Data Communications and Networking,* Behrouz A. Forouzan, 5e TMH, 2012.
3. Kennady, Davis, *Electronic Communications systems*, 4e, McGraw Hill, 1999.

Course Code	Course Title						Core / Elective
OE 784 EE	**Illumination and Electric Traction Systems**						**Open Elective-III**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To introduce the students and understand Utilization of electrical energy for various applications like industrial heating, welding etc.,
- To understand the concept of illumination, and know the applications of various lamps to factory lighting, street lighting etc.
- To understand the concept of electrification of traction system

Course Outcomes:

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

1. Design the resistive and inductive heating and calculate the requirements of heating power for an industrial need
2. Analyse the type of motor control required and select the type and rating of motor.
3. Understand and Design illumination for different application
4. Understand the traction and use of DC machines
5. Analyse the traction mechanics to arrive at a rating of drive.

UNIT-I

Industrial Heating: Advantages and methods of electric heating. Description, operation and performance of resistance ovens — Design of elements. Core type, Coreless type furnaces, High frequency eddy current heating, Dielectric heating. Arc furnace. Electric welding, Resistance welding, welding transformer and its rating, various types of Electric arc welding and electric resistance welding.

UNIT-II

Schematic Utilization and Connection Diagrams for Motor Control: Two supply sources for 3 phase Induction motors. Direct reversing, remote control operation, and jogging operating of Induction motor. Contactor control circuit. Push button control stations. Over load relays, limit switches, float switches. Interlocking methods for reversing control.

UNIT-III

Illumination: Introduction, nature and production of light, Sensitivity of the eye, Units of light. The inverse square law and cosine law, Solid angle, lighting calculations — Determination of M.S.C.P, Rousseau's construction, Discharge lamps, Sodium vapour lamps, Mercury vapour lamps — Fluorescent lamp, Starting and power factor corrections, Stroboscopic effects — Neon signs, Application to factory lighting, Street lighting and Flood lighting.

UNIT-IV

Electric Traction: System of Electric Traction — Transmission of drive — Systems of track electrification — Traction mechanics — Speed time curves — Tractive effort — Power of Traction motor — Specific energy consumption — Mechanics of train movement— Coefficient of adhesion.

Traction Motors: Desirable characteristics, DC series motors, AC series motors 3-phase induction motors, DC motor series & parallel control, Energy saving.

UNIT-V

Train Lighting: Systems of train lighting — Special requirements of train lighting — Methods of obtaining unidirectional polarity — Methods of obtaining constant output — Single battery system — Double battery parallel block system — Principal equipment of double battery system — Coach wiring — Dynamo.

Batteries: Lead acid batteries, SMF batteries, Construction and maintenance, Charging and rating of batteries.

Suggested Readings:

1. Partab H, Art and Science of Utilization of Electric Power, Dhanpat Rai & Sons, 1997.
2. K.B. Raina & S.K. Bhattacharya, Electrical Design, Estimating and Costing, Wiley Eastern Ltd., 1991.
3. Partab H, Modern Electric Traction, Dhanpat Rai & Sons, 2000.
4. B.L. Theraja, A Text Book of Electrical Technology, S. Chand & Company Ltd, Vol —I.

Course Code	Course Title						Core / Elective
OE 785 ME	**Mechatronics**						**Open Elective-III**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives:

Student has to understand the

- How to identify, formulate, and solve engineering problems
- The design a system, component, or process to meet desired needs within realistic constraints
- The how to use the techniques, skills, and modern engineering tools necessary for engineering practice
- The use of drive mechanisms and fluid power systems
- The use of industrial electronic devices
- The demonstrate the design of modern CNC machines, and Mechatronics elements

Course Outcomes:

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

1. Model and analyse electrical and mechanical systems and their interconnection
2. Integrate mechanical, electronics, control and computer engineering in the design of Mechatronics systems
3. Do the complete design, building, interfacing and actuation of a Mechatronics system for a set of specifications
4. Be proficient in the use of fluid power systems in various Mechatronics applications
5. Demonstrate the use of industrial electronic devices
6. Demonstrate the design of modern CNC machines, and Mechatronics elements

UNIT-I

Introduction to mechanization & automation: Need of interface of electrical & electronic devices with mechanical elements, the concept of Mechatronics, Flow chart of Mechatronics system, elements of Mechatronics system, drive mechanisms, actuators, feedback devices and control system, application in industries and systems development

UNIT-II

Drive mechanisms: Feeding and indexing, orientation, escapement and sorting devices, conveyor systems Introduction to electrical actuators: A.C. servomotors, D.C. servomotors, stepper motors

UNIT-III

Introduction to fluid power systems: Industrial Pneumatics and hydraulics, merits of fluid power, pneumatic & hydraulic elements symbols, study of hydraulic control valves, pumps & accessories, hydraulic circuits & mechanical servo control circuits, Electro-hydraulic and Hydro pneumatic circuits

UNIT-IV

Introduction to industrial electronic devices: Diodes, Transistors, Silicon Controlled Rectifiers (SCR), Integrated Circuits (IC), Digital Circuits, Measurement systems & Data acquisition systems: sensors, digital to analog and analog-to-digital conversion, signal processing using operational amplifiers, introduction to microprocessor & micro controller, Temperature measurement interface and LVDT interface, Systems response

UNIT-V

Design of modern CNC machines and Mechatronics elements: machine structures, guide ways, spindles, tool monitoring systems, adaptive control systems, Flexible manufacturing systems, Multipurpose control machines, PLC programming

Suggested Readings:

1. William Bolton, Mechatronics: Electronic control systems in mechanical and electrical engineering, 6th edition, Pearson Education
2. HMT Ltd, Mechatronics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1998
3. Michaels Histand & David G, Alciatore, Introduction to Mechatronics and Measurement Systems, Tata McGraw-Hill International Edition
4. Devdas Shetty, Richard A. Kolk, Mechatronics System Design, Cengage Learning
5. S.R. Majumdar, Oil Hydraulic Systems – Principles & Maintenance, McGraw-Hill Publishing Company Limited, New Delhi
6. Godfrey Onwubolu, Mechatronics: Principles and Applications, Butterworth-Heinemann

Course Code	Course Title						Core / Elective
PC 751 EE	**Electrical Simulation Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

- The student learns analysis of electrical system through computer simulation, using software packages.
- To simulate a given electrical circuits in any environment, to analyse its dynamic characteristics and to figure out its stability considerations.

Course Outcomes

After completing this course, the student will be able to

1. Simulate the concepts of Electrical Circuits, Control Systems and Power Systems and interpret data.
2. Demonstrate the knowledge of programming environment, compiling, debugging, linking and executing variety of programs in MATLAB.
3. Demonstrate ability to develop Simulink models for various electrical systems.
4. Validate simulated results from programs/Simulink models with theoretical calculations.

Simulation experiments should be conducted in the following areas using MATLAB / Simulink (with DSP Tool Box, Control System Tool Box & Power System Tool Box) PSpice /PSCAD / SABER / EDSA/ Power Trans

1. Verification of Network theorems
    a. Thevinin's theorem
    b. Superposition theorem
    c. Maximum power transfer theorem.
2. Transient responses of Series RLC, RL and RC circuits with Sine and Step inputs.
3. Series and Parallel resonance.
4. Bode plot, Root-Locus plot and Nyquist plot.
5. Transfer function analysis (i) Time response for Step input (ii) Frequency response for Sinusoidal input.
6. Design of Lag, Lead and Lag - Lead compensators.
7. Load flow studies.
8. Fault analysis.
9. Transient stability studies.
10. Economic Power Scheduling
11. Design of filters (Low pass filter).
12. Chopper fed dc motor drives.
13. VSI /CSI Fed induction motors drives. Doubly fed Induction motor.
14. Phase Control of DC motor Drives.
15. Control of BLDC motor.

Note: At least ten experiments should be conducted.

Course Code	Course Title						Core / Elective
PC 752 EE	**Microprocessor and Microcontrollers Lab (Common to EEE & EIE)**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Microprocessor & Microcontrollers	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

- To introduce the architecture of 8, 16 and 32-bit microprocessor and microcontroller.
- To impart microcontroller programming skills in students.
- To familiarize the students with data transfer and interrupt services.

Course Outcomes

After completing this course, the student will be able to

1. Apply the design concepts for development of a process and interpret data.
2. Demonstrate knowledge of programming environment, compiling, debugging, linking and executing variety of programs.
3. Demonstrate documentation and presentation of the algorithms / flowcharts / programs in a record form.
4. Validate the process using known input-output parameters.

List of Experiments:

For 8086:

Section 1: Using MASM/TASM

1. Programs for signed/unsigned multiplication and division.
2. Programs for finding average of N 16-bit numbers.
3. Programs for finding the largest number in an array.
4. Programs for code conversion like BCD numbers to 7-Segment.
5. Programs for compute factorial of a positive integer number

Section 2: ***Using 8086 Kit (Interfacing)***

1. 8279 – Keyboard Display: Write a small program to display a string of characters.
2. 8255-PPI: Write ALP to generate triangular wave using DAC.
3. 8253- Timer/Counter: Application of different modes.
4. 8251-USART: Write a program in ALP to establish Communication between two processors.
5. Traffic Signal Controller.

For 8051:

Section 3: ***Using 8051 Kit (Simple Programs)***

1. Data Transfer – Block move, Exchange, sorting, Finding largest element in an array.
2. Arithmetic Instructions: Multibyte operations.
3. Boolean & Logical Instructions (Bit manipulations).
4. Programs to generate delay, programs using serial port and on-Chip timer/Counter.
5. Use of JUMP and CALL instructions.

Section 4: Program Development using 'C' cross compiler for 8051

1. Square Wave Generation using timers.
2. Interfacing of keyboard and 7-segment Display Module.
3. ADC interfacing for temperature monitoring.
4. DAC interfacing for Generation of Sinusoidal wave.
5. Stepper motor control (clockwise, anticlockwise and in precise angles)

Course Code	Course Title						Core / Elective
PW 761 EE	**Project Work - I**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**4**	**50**	**-**	**2**

Course Objectives

- To enhance practical and professional skills.
- To familiarize tools and techniques of systematic literature survey and documentation
- To expose the students to industry practices and team work.
- To encourage students to work with innovative and entrepreneurial ideas

Course Outcomes

1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to the real-world problems.
2. Evaluate different solutions based on economic and technical feasibility
3. Effectively plan a project and confidently perform all aspects of project management
4. Demonstrate effective written and oral communication skills

The department can initiate the project allotment procedure at the end of VI semester and finalize it in the first two weeks of VII semester.

The department will appoint a project coordinator who will coordinate the following:

- Collection of project topics/ descriptions from faculty members (Problems can also be invited from the industries)
- Grouping of students (max 3 in a group)
- Allotment of project guides

The aim of project work is to develop solutions to realistic problems applying the knowledge and skills obtained in different courses, new technologies and current industry practices. This requires students to understand current problems in their domain and methodologies to solve these problems. To get awareness on current problems and solution techniques, the first 4 weeks of VII semester will be spent on special lectures by faculty members, research scholars, post graduate students of the department and invited lectures by engineers from industries and R&D institutions. After completion of these seminars each group has to formalize the project proposal based on their own ideas or as suggested by the project guide.

Seminar schedule will be prepared by the coordinator for all the students from the 5th week to the last week of the semester which should be strictly adhered to.

Each group will be required to:

1. Submit a one-page synopsis before the seminar for display on notice board.
2. Give a 30 minutes' presentation followed by 10 minutes' discussion.
3. Submit a technical write-up on the talk.

At least two teachers will be associated with the Project Seminar to evaluate students for the award of sessional marks which will be on the basis of performance in all the 3 items stated above.

The seminar presentation should include the following components of the project:

- Problem definition and specification
- Literature survey
- Broad knowledge of available techniques to solve a particular problem.
- Planning of the work, preparation of bar (activity) charts
- Presentation- oral and written.

Course Code	Course Title						Core / Elective
SI 762 EE	**Summer Internship**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**-**	**50**	**-**	**2**

Course Objectives

- Produce an accurate record of work performed during the Internship/Co-op
- Apply engineering knowledge to a problem in industry
- Produce a technical report
- Discuss work in a team environment, if relevant to the project
- Conduct herself/himself responsibly, safely, and ethically in a professional environment

Course Outcomes

After completing this course, the student will be able to

1. Get Practical experience of software design and development, and coding practices within Industrial/R&D Environments.
2. Gain working practices within Industrial/R&D Environments.
3. Prepare reports and other relevant documentation.

Summer Internship is introduced as part of the curricula of encouraging students to work on problems of interest to industries. A batch of three students will be attached to a person from the Government or Private Organisations/Computer Industry/Software Companies/R&D Organization for a period of 4-6 weeks. This will be during the summer vacation following the completion of the III-year Course. One faculty coordinator will also be attached to the group of 3 students to monitor the progress and to interact with the industry co-ordinate (person from industry).

The course schedule will depend on the specific internship/training experience. The typical time per topic will vary depending on the internship

- Overview of company/project
- Safety training
- Discussions with project teams
- Background research, review of documents, white papers, and scientific papers
- Planning, designing, and reviewing the planned work
- Executing the plans
- Documenting progress, experiments, and other technical documentation
- Further team discussions to discuss results
- Final report writing and presentation

After the completion of the project, each student will be required to:

1. Submit a brief technical report on the project executed and
2. Present the work through a seminar talk (to be organized by the Department)

Award of sessionals are to be based on the performance of the students at the workplace and awarded by industry guide and internal guide (25 Marks) followed by presentation before the committee constituted by the department (25 Marks). One faculty member will co-ordinate the overall activity of Industry Attachment Program.

Note: Students have to undergo summer internship of 4-6 weeks at the end of semester VI and credits will be awarded after evaluation in VII semester.

SCHEME OF INSTRUCTION& EXAMINATION
B.E. VIII - SEMESTER
(ELECTRICAL AND ELECTRONICS ENGINEERING)

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	**PC 801 EE**	Utilization of Electrical Energy	3	-	-	3	30	70	3	3
2		Professional Elective – III	3	-	-	3	30	70	3	3
3		Professional Elective – IV	3	-	-	3	30	70	3	3
4		Professional Elective – V	3	-	-	3	30	70	3	3
Practical/ Laboratory Courses										
5	**PC 851 EE**	Power Systems Lab	-	-	2	2	25	50	3	1
6	**PW 961 EE**	Project Work – II	-	-	16	16	50	100	-	8
			12	**-**	**18**	**30**	**195**	**430**		**21**

Professional Elective – III		
S. No.	Course Code	Course Title
1	**PE 821 EE**	Power System Reliability
2	**PE 822 EE**	Electric Vehicle and Hybrid Electric Vehicle
3	**PE 823 EE**	Machine Modelling Analysis
4	**PE 824 EE**	High Voltage DC Transmission

Professional Elective – IV		
S. No.	Course Code	Course Title
1	**PE 831 EE**	Advanced Control Systems
2	**PE 832 EE**	Electrical Estimation Costing & Safety
3	**PE 833 EE**	Advanced Power Electronics
4	**PE 834 EE**	Power Quality

Professional Elective – V		
1	**PE 841 EE**	Smart Grid Technologies
2	**PE 842 EE**	Energy Management Systems and SCADA
3	**PE 843 EE**	Special Electrical Machines
4	**PE 844 EE**	Power Electronics Applications to Renewable Energy
5	**PE 845 EE**	Electrical Substation Design and Equipment

PC: Professional Course PE: Professional Elective
L: Lectures T: Tutorials P: Practical D: Drawing
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

Note: 1) Each contact hour is a Clock Hour
2) The duration of the practical class is two clock hours, however it can be extended wherever necessary, to enable the student to complete the experiment

Course Code	Course Title						Core / Elective
PC 801 EE	**Utilization of Electrical Energy**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To introduce the students and understand Utilization of electrical energy for various applications like industrial heating, welding etc.,
- To understand the concept of illumination, and know the applications of various lamps to factory lighting, street lighting etc.
- To understand the concept of electrification of traction system.

Course Outcomes

After completing this course, the student will be able to

1. Design the resistive and inductive heating and calculate the requirements of heating power for an industrial need
2. Analyse the type of motor control required and select the type and rating of motor.
3. Design illumination for different application.
4. Understand the traction and mechanics and drive systems DC and AC
5. Analyse the use of batteries and its usage and maintenance.

UNIT-I

Industrial Heating: Advantages and methods of electric heating. Description, operation and performance of resistance ovens. Design of elements. Core type furnace, Coreless type furnace, High frequency eddy current heating, Dielectric heating, Arc furnace. Electric Welding: Resistance welding, Welding transformer and its rating. Various types of Electric arc welding and Electric resistance welding.

UNIT-II

Schematic Utilization and Connection Diagram for Motor Control:

Two supply sources for 3-phase Induction motors. Direct reversing, remote control operation, Jogging operation of induction motor. Contactor control circuit. Pushbutton control stations. Over load relays, limit switches, Float switches. Interlocking methods for reversing control. Starting of Synchronous motor and motor protection.

UNIT-III

Illumination: Introduction, nature and production of light, Sensitivity of the eye, Units of light. The inverse square law and cosine law, Solid angle, lighting calculations, determination of M.S.C.P, Rousseau's construction, Discharge lamps, Sodium vapour lamps, Mercury vapour lamps, Fluorescent lamps, Starting and power factor corrections, Stroboscopic effects, Neon signs, Application to factory lighting, Street lighting and Flood lighting.

UNIT-IV

Electric Traction: System of Electric Traction, transmission of Drive, system of track electrification, Traction mechanics, Speed time curves, tractive effort, Power of Traction motor, Specific energy consumption, Mechanics of train movement, Coefficient of adhesion.

UNIT-V

Traction Motors: Desirable characteristics, DC series motors, AC series motors, 3-phase induction motors, DC motor series & parallel control, Shunt bridge transition, Energy saving. Batteries: Lead acid batteries, SMF batteries, Construction and maintenance, Charging and rating of batteries.

Suggested Readings:

1. Partab G, "*Art and Science of Utilization of Electric Power*", publisher Dhanpatrai& Sons, 1990.
2. Raina K.B & Bhattacharya S.K., "*Electrical Design, Estimating and Costing*", publisher, Wiley Eastern Ltd., 1991.
3. Dubey G.K., "*Fundamentals of Electric Drives*", publisher, Narosa Public House, Delhi, 2001.
4. Openshaw Taylor, "*Utilization of Electrical Energy*".
5. Wadhwa C.L., "*Generation, Distribution & Utilization of Electrical Energy*", publisher, Wiley, 1989

Course Code	Course Title						Core / Elective
PE 821 EE	**Power System Reliability**						**Elective**
Prerequisites	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Power System-I Power System-II	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Understand various reliability evaluation techniques.
- Analyse generating system reliability using time and frequency methods.
- Analyse reliability for transmission and distribution systems.

Course Outcomes

After completing this course, the student will be able to

1. Understand the theory of probability.
2. Explain the terms Bath tub curve, system security, contingency and reliability of power system network.
3. Understand the importance of load point and system reliability indices of power system network.
4. Able to develop capacity outage probability tables of composite power system networks.
5. Understand the basic reliability indices

UNIT-I

Elements of Probability Theory - Probability Distributions: Random variables, density and distribution functions, Mathematical expectation- Mean and Variance, Binominal distribution, Poisson distribution, Normal distribution, Exponential distribution, Weibull distribution.

UNIT-II

Definition of Reliability: Component reliability, Hazard rate, derivation of the reliability function in terms of the hazard rate. Causes of failures, types of failures. Bath tub curve, MTTR, MTBF. Reliability logic diagrams for series, parallel, series-parallel, non-series-parallel configurations. Minimal cut-set and decomposition methods

UNIT-III

Discrete Markov Chains: General modelling concepts, stochastic transitional probability matrix, time dependent probability evaluation and limiting state probability evaluation. Absorbing states. Continuous Markov Processes: Modelling concepts, State space diagrams, Stochastic Transitional Probability Matrix, Evaluating limiting state Probabilities. Reliability evaluation of repairable systems.

UNIT-IV

Generating System Reliability Analysis: Generation system model – capacity outage probability tables – Recursive relation for capacitive model building – sequential addition method – unit removal – Evaluation of loss of load and energy indices. Frequency and Duration methods – Evaluation of equivalent transitional rates of identical and non-identical units – Evaluation of cumulative probability and cumulative frequency of non-identical generating units – 2-level daily load representation – merging generation and load models

UNIT-V

Distribution System Reliability Analysis: Radial networks –Evaluation of Basic reliability indices, performance indices - load point and system reliability indices – customer oriented, loss and energy oriented indices. Parallel networks- inclusion of bus bar failures, scheduled maintenance – temporary and transient failures – weather effects – common mode failures –Evaluation of various indices.

Suggested Readings:

1. Roya Billington and Ronal N Allan, "Reliability Evaluation of Engineering Systems", Plenum Press.
2. Roy Billinton and Tonal N. Allahn, Reliability Evaluation of Power Systems, Plenum Press, New York and London (Second Edition), 1996
3. J. Endrenyi, Reliability Modelling in Electric Power Systems, John Wiley and Sons 1978 (First Edition).

Course Code	Course Title						Core / Elective
PE 822 EE	**Electric Vehicle and Hybrid Electric Vehicle**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand the basics of electric and hybrid electric vehicles and their working
- To understand the basics of batteries and their role for electric/hybrid vehicle applications
- To obtain the knowledge of various types of electric/hybrid vehicles
- To understand the real time challenges in the implementation of this technology

Course Outcomes

After completing this course, the student will be able to

1. Choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources
2. Design and develop basic schemes of electric vehicles and hybrid electric vehicles.
3. Analyse battery charging and discharging characteristics and estimate electric vehicle battery capacity.
4. Understand the concepts and design of hybrid electric vehicle.
5. Understand charging methods of electric, hybrid electric vehicles and sizing of ultra-capacitors

UNIT-I

Introduction to Electric Vehicles: Sustainable Transportation - EV System - EV Advantages - Vehicle Mechanics - Performance of EVs - Electric Vehicle drivetrain - EV Transmission Configurations and Components-Tractive Effort in Normal Driving - Energy Consumption - EV Market - Types of Electric Vehicle in Use Today - Electric Vehicles for the Future.

UNIT-II

Electric Vehicle Modelling - Consideration of Rolling Resistance - Transmission Efficiency - Consideration of Vehicle Mass - Tractive Effort - Modelling Vehicle Acceleration - Modelling Electric Vehicle Range - Aerodynamic Considerations - Ideal Gearbox Steady State Model - EV Motor Sizing - General Issues in Design.

UNIT-III

Introduction to electric vehicle batteries - electric vehicle battery efficiency - electric vehicle battery capacity - electric vehicle battery charging - electric vehicle battery fast charging - electric vehicle battery discharging - electric vehicle battery performance – testing.

UNIT-IV

Hybrid Electric Vehicles - HEV Fundamentals -Architectures of HEVs- Interdisciplinary Nature of HEVs - State of the Art of HEVs - Advantages and Disadvantages - Challenges and Key Technology of HEVs - Concept of Hybridization of the Automobile-Plug-in Hybrid Electric Vehicles **-** Design and Control Principles of Plug-In Hybrid Electric Vehicles - Fuel Cell Hybrid Electric Drive Train Design - HEV Applications for Military Vehicles.

UNIT-V

Advanced topics - Battery Charger Topologies, Charging Power Levels, and Infrastructure for Plug-In Electric and Hybrid Vehicles - The Impact of Plug-in Hybrid Electric Vehicles on Distribution Networks – Sizing Ultra capacitors for Hybrid Electric Vehicles.

Suggested Readings:

1. Modern Electric, Hybrid Electric and Fuel Cell Vehicles – Fundamentals, Theory and Design, Mehrdad Ehsani, Uimin Gao and Ali Emadi - Second Edition - CRC Press, 2010.
2. Electric Vehicle Technology Explained - James Larminie, John Lowry - John Wiley & Sons Ltd, - 2003.
3. Electric Vehicle Battery Systems – Sandeep Dhameja – Newnes - New Delhi – 2002.
4. Hybrid electric Vehicles Principles and applications with practical perspectives -Chris Mi, Dearborn - M. AbulMasrur, David WenzhongGao - A John Wiley & Sons, Ltd., - 2011.
5. Electric & Hybrid Vehicles – Design Fundamentals -Iqbal Hussain, Second Edition, CRC Press, 2011

Course Code	Course Title						Core / Elective
PE 823 EE	**Machine Modelling and Analysis**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Electrical Machines	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

To make the student familiar with the concepts of

- Know the concepts of generalized theory of electrical machines, its voltage and current relationship.
- Transformation of machine variables between different reference frames.
- Investigate the steady state and transient behavior of the electrical machines.
- Learn the issues affecting the behavior of different types machines such as sudden application of loads, short circuit etc.
- Linearize the machine equations for different machines.

Course Outcomes

After completing this course, the student will be able to

1. Represent a transfer function model for a DC machine.
2. Convert a 3-phase reference axis to a 2-phase reference axis and vice-versa.
3. Analyse the state space mode of induction machine.
4. Analyse the steady state and dynamic behavior of induction machine and synchronous machine.
5. Linearize of the induction machine and synchronous machine

UNIT-I

Basic Principles for Electric Machine Analysis: Magnetically coupled circuits, Electromechanical energy conversion, Basic Two pole DC Machine – primitive 2 axis machine – Voltage and Current relationship – Torque equation.

Theory of DC Machines: Mathematical model of separately excited DC Motor, DC Series Motor, DC shunt motor and D.C. Compound Motor in state variable form – Transfer function of the motor.

UNIT-II

Reference Frame Theory: Equations of transformation - Change of variables, Stationary circuit variables Transformed to the Arbitrary Reference Frame, commonly used reference frames, Transformation between reference frames, Transformation of a balanced set, Balanced steady state phasor Relationships, Balanced steady state equations, Variables observed from various frames.

UNIT-III

Theory of Symmetrical Induction Machines: Voltage and torque equations in machine variables, Equations of transformation for Rotor circuits, Voltage and torque equations in arbitrary reference frame variables, Analysis of steady state operation- state-space model of induction machine in 'd-q' variables, Free Acceleration Characteristics, Dynamic Performance-during sudden changes in load- during a 3 phase fault at the machine terminals.

UNIT-IV

Theory of Synchronous Machines: Voltage and Torque equations in machine variables, Stator Voltage equations in Arbitrary Reference Frame Variables, Voltage Equations in Rotor Reference Frame Variables: park's Equations, Torque Equations in Substitute Variables, Analysis of steady state operation, Dynamic performance - During sudden changes in Input Torque - During a 3 phase fault at the machine terminals.

UNIT-V

Linearized Machine Equations: Introduction, Machine equations to be Linearized-Induction machine, Synchronous machine. Linearized machine Equations-Induction machines, Synchronous machines. Small-displacement Stability-Eigen values, Eigen values of typical Induction machines and synchronous machines.

Suggested Readings:

1. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, "*Analysis of Electric Machinery and drive systems*" John Wiley and Sons, 2nd Edition, 2006
2. C.V. Jones, *"Unified Theory of Electrical Machines"* Butterworths Publishers.
3. P.S. Bhimbra, *"Generalized Theory of Electrical Machines"*, Khanna publishers, 2002.
4. J. Meisel, "*Principles of Electromechanical Energy Conversion" McGraw Hill, 1966.*

Course Code	Course Title						Core / Elective
PE 824 EE	**High Voltage DC Transmission**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Power Electronics	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To study the fundamentals of HVDC Transmission system and Converters
- To understand the control aspects of HVDC System
- The power conversion between Ac to DC and DC to AC.
- To deal with firing angle and Protection of HVDC System

Course Outcomes

After completing this course, the student will be able to

1. Understand the concept of HVDC along with applications, different kinds, planning and modern trends. Comparison with HVAC including corona losses.
2. Understand properties of converter circuits and analyse Bridge Converter circuits with and without overlap for HVDC application including inverter operation.
3. Demonstrate knowledge in the control aspects of HVDC systems
4. Understand different types of faults and protection aspects of HVDC Systems
5. Acquire Conceptual knowledge in applications of MTDC systems and their control

UNIT-I

General consideration of DC and AC Transmission systems: Comparison of AC and DC Transmission systems, Application of DC transmission, Economic Consideration, kinds of DC links, planning for HVDC Transmission, Modern Trends in DC Transmission, Corona loss in AC and DC system.

UNIT-II

Converter Circuits: Properties of Converter circuits, Different kinds of Arrangements, Analysis of bridge converters with grid control, with and without Overlap angle, Equivalent circuit of rectifier.
Inversion: Operation as an inverter, Equivalent circuit of inverter.

UNIT-III

Control: Basic means of control, Limitations of manual control, Desired features of control, combined characteristics of rectifier and inverter, Power reversal, Constant minimum ignition angle control, Constant Current control, Constant Extinction angle control.

UNIT-IV

Protection: Short-circuit current: Arc-back, Commutation failure, Bypass valves, DC reactors, DC circuit breakers, Protection against over voltages, Harmonic filters.

UNIT-V

Multi-terminal DC systems: Application of MTDC system, Types of MTDC System, Comparison of series and parallel MTDC systems, Control of MTDC System.

Suggested Readings:

1. Kimbark E.W., Direct current Transmission Vol-1, John Wiley, 1971.
2. Padiyar K.R., HVDC Power Transmission Systems, Wiley Eastern 1990
3. Arrilaga. J & Peter Peregrines Ltd, HVDC Transmission, Pergamon Press,1983.

Course Code	Course Title						Core / Elective
PE 831 EE	**Advanced Control Systems**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To learn the methods for analysing the behavior of nonlinear control systems and the designing of control systems.
- To familiarize with the time response analysis of different systems.
- To introduce linear and non-linear systems using Lyapunov function
- To illustrate various frequency domain techniques for the system analysis.

Course Outcomes

After completing this course, the student will be able to

1. Recall continuous, discrete time systems and transfer functions.
2. Test the controllability and observability of a given system and Design of pole placement and observer using state feedback.
3. Identify and analyse non-linear systems using describing function analysis
4. Analyse linear and non-linear systems using Lyapunov function and design Lyapunov function for stable systems
5. Formulate an optimal control problem and design optimal control signal.

UNIT-I

Review of state-space representation: Review of continuous time systems and their solution, state models for discrete time systems described as difference Equations and transfer functions, Transfer function from State model, State- Transition matrix and solution of state equations for discrete time systems.

UNIT-II

Controllability and Observability: Concepts of Controllability and Observability, Controllability tests for continuous time, discrete-time, time- invariant systems. Observability tests for continuous time, discrete-time, time-invariant systems. And Controllability and Observability modes in State. Jordan's canonical form, Controllable and Observable companion forms for single input single output Systems, pole placement by State feedback.

UNIT-III

Nonlinear Systems: Behavior of Nonlinear systems, jump resonance, Sub-harmonic oscillation, Limit cycles, common physical non-linearities, Singular points, phase plane-method, Construction of phase plane trajectories, Isoclines method, Delta method, Computation of time.

UNIT-IV

Stability: Lyapunov's stability criteria, Theorems, Direct method of Lyapunov for linear systems, Non-Linear Systems, Methods of constructing Lyapunov function Krasovki's, Method; Variable gradient method.

UNIT-V

Optimal Control: Formulation of optimal control problem, calculus of variations, Minimization of functionals. Formulation of variational calculus using Hamiltonian method.

Suggested Readings:

1. Gopal.M., Modern Control System Theory, Wiley Eastern Limited, 2004
2. Schulz D.G, Melsa J.L., State Functions of Linear Control Systems, McGrawHill.

Course Code	Course Title						Core / Elective
PE 832 EE	**Electrical Estimation Costing and Safety**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Understand Electrical Wiring with IE rules. Residential Building Electrification, Electrification of commercial Installation, Electrification of factory unit Installation
- Protection against electric shocks, Safety Measures & Prevention of Accidents

Course Outcomes

After completing this course, the student will be able to

1. Acquire the knowledge of different types of wires and wiring systems, I.E. rules and Electric supply act.
2. Explain the importance of earthling, rating of wires & cables, procedures for residential, commercial electrification.
3. Able to estimate the length of wire, cable, conduit, earth wire, and earthing and also cost of residential, commercial electrification.
4. Estimate electrification system for factory unit installation.
5. Understand and apply various safety and prevention measures against electric shocks and accidents.

UNIT-I

Electrical Wiring with IE rules: Introduction, define types of wires; Different types of wiring system; Comparison of different types of wiring; Different types and specifications of wiring materials; Accessories and wiring tools; Prepare I.E. rules for wiring, including Electricity supply act 2003& 2005.

Elements of Estimating: Definition of ―Estimation‖. Types of estimation and estimation tools; Overhead and service charges; Purchase procedure.

UNIT-II

Residential Building Electrification: General rules guidelines for wiring of Residential Installation and positioning of equipment‘s; Principles of circuit design in lighting and power circuits.; Procedures for designing the circuits and deciding the number of circuits.; Method of drawing single line diagram.; Selection of type of wiring and rating of wires &cables.; Load calculations and selection of size of conductor.; Selection of rating of main switch, distributions board, protective switchgear ELCB and MCB and wiring accessories.; Earthing of Residential Installation.; Sequence to be followed for preparing Estimate; Preparation of detailed estimates and costing of Residential Installation.

UNIT-III

Electrification of commercial Installation: Concept of commercial Installation.; Differentiate between electrification of Residential and commercial Installation.; Fundamental considerations for planning of an electrical Installation system for commercial building.; Design considerations of electrical Installation system for commercial building.; Load calculations & selection of size of service connection and nature of supply.; Deciding the size of cables, bus bar and bus bar chambers.; Mounting arrangements and positioning of switch boards, distribution boards main switch etc.; Earthing of the electrical Installation; Selection of type wire, wiring system & layout.; Sequence to be followed to prepare estimate.; Preparation of detailed estimate and costing of commercial Installation.

UNIT-IV

Electrification of factory unit Installation: Concept of Industrial load.; Concept of Motor wiring circuit and single line diagram. Important guidelines about power wiring and Motor wiring.; Design consideration

of Electrical Installation in small Industry/Factory/workshop.; Motor current calculations.; Selection and rating of wire, cable size & conduct.; Deciding fuse rating, starter, distribution boards main switch etc.; Deciding the cable route, determination of length of wire, cable, conduit, earth wire, and earthing.; Sequence to be followed to prepare estimate.; Preparations of detailed estimate and costing of small factory unit/ workshop.

UNIT-V

Protection against electric shocks: Electric shock- General, Protection against direct contact, Protection against indirect contact, Protection of goods in case of insulation fault, Implementation of the TT system, Implementation of the TN system, Implementation of the IT system. Protection provided for enclosed equipment: codes IP and IK, IP code definition, Elements of the IP Code and their meanings, IK Code definition, IP and IK code specifications for distribution switchboards

Safety Measures & Prevention of Accidents: Concept of electrical safety, electrical accidents, its causes & preventions.; Safety signs and symbols used in industry.; Electrical shocks and factors affecting the severity of it, method of rescuing electrocuted person & different methods of artificial respiration.; Electrical safety as per I.E. Rules 1956.; Do's & don‘ts regarding safety while working on electrical installations.; Concept of Permit system, its preparation & regulation for attending to electrical work.; Precautions to be taken to avoid fire due to electrical reasons, operation of fire extinguishers, types of fire extinguishers.

Suggested Readings:

1. S.L. Uppal of Electrical Wiring, Estimating and Costing, New Age International (p) Limited, New Delhi.
2. Electrical Design Estimating and Costing, K.B. Raina & S.K. Battacharya, new age international (p) limited. Publishers
3. Electrical estimating & costing 2nd addition by Surjitsingh
4. Electrical Installation Estimating & Costing, Gupta, J.B., S. K. Kataria & Sons, New Delhi

Course Code	Course Title						Core / Elective
PE 833 EE	**Advanced Power Electronics**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

To make the student familiar with the concepts of

- Understanding of requirements of high power devices.
- Understanding the operation of various power converters.
- Design concepts of controllers for power electronic converters.

Course Outcomes

After completing this course, the student will be able to

1. Explain about High power devices
2. Obtain emulated resistance by using PWM rectifiers.
3. Perform state space modelling of DC-DC converters.
4. Explain the operation of Multi-level inverters.
5. Understand design of various controllers for power electronic systems

UNIT-I

Introduction to switches: Advanced Silicon devices - Silicon HV thyristors, MCT, BRT &EST. SiC devices - diodes, thyristors, JFETs & IGBTs. Gallium nitrate devices - Diodes, MOSFETs.

UNIT-II

Pulse Width Modulated Rectifiers: Properties of ideal rectifier, realization of near ideal rectifier, control of the current waveform, single phase and three-phase converter systems incorporating ideal rectifiers and design examples. Non-linear phenomena in switched mode power converters: Bifurcation and Chaos.

UNIT-III

Control of DC-DC converters: State space modelling of Buck, Boost, Buck-Boost, Cuk Fly back, Forward, Push-Pull, Half & Full-bridge converters. Closed loop voltage regulations using state feedback controllers. Soft-switching DC - DC Converters: zero-voltage-switching converters, zero-current switching converters, Multi-resonant converters and Load resonant converters.

UNIT-IV

Advance converter topologies: Multi level converters - Cascaded H-Bridge, Diode clamped, NPC, Flying capacitor. Modular Multi-level converters(MMC), Multi-Input DC-DC Converters, Multi pulse PWM current source converters, Interleaved converters, Z-Source converters.

UNIT-V

Control Design Techniques for Power Electronic Systems: Modelling of systems, Digital Controller Design, Optimal and Robust Controller Design.

Suggested Readings:

1. Andrzej M Trzynadlowski, 'Introduction to Modern Power Electronics, John Wiley and sons. Inc, New York, 1998
2. L. Umanand, 'Power Electronics Essentials &Applications', Wiley publishing Company, 1st Edition, 2014
3. B. Jayant Balinga, 'Advanced High Voltage Power Device Concepts', Springer New York 2011.
4. BIN Wu, 'High Power Converters and AC Drives', IEEE press Wiley Interscience, 2006.

Course Code	Course Title						Core / Elective
PE 834 EE	**Power Quality**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- The student able to learn and understand the importance of power quality, different power quality issues and their effects in power system network

Course Outcomes

1. Describe the different PQ disturbances and state remedies to improve PQ.
2. Determine voltage sag for different network configurations.
3. Demonstrate the effect of ASD systems on power quality and the effect of voltage sags on operation of various electrical machines.
4. Evaluate harmonic levels for distribution systems.
5. Describe power quality monitoring and measuring techniques.

UNIT-I

Introduction: Introduction of the Power Quality (PQ) problem, Terms used in PQ: Voltage Sag, Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption, overview of power quality phenomenon, Remedies to improve power quality, power quality monitoring. Power Quality Data: Data collection, Data analysis, Database structure, Creating PQ databases, Processing PQ data.

UNIT-II

Voltage Sag Characterization: Voltage sag – definition, causes of voltage sag, voltage sag magnitude, monitoring, theoretical calculation of voltage sag magnitude, voltage sag calculation in non-radial systems, Meshed systems, voltage sag duration. Three phase faults, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, load influence on voltage sags.

UNIT-III

PQ Considerations in Industrial Power Systems: Adjustable speed drive (ASD) systems and applications, mitigation of harmonics. Characterization of voltage sags experienced by three-phase ASD systems: Types of sags and phase - angle jumps. Effects of momentary voltage dips on the operation of induction and synchronous motors. Voltage sag coordination for reliable plant operation.

UNIT-IV

Effects of Harmonics on Power Quality: Harmonic analysis of industrial customers, technical barriers in ASDs. Methods of evaluation of harmonic levels in industrial distribution systems. Harmonic effects on transformers. Impact of distribution system capacitor banks on PQ. Guidelines for limiting voltage harmonics.

UNIT-V

Power Quality Monitoring: Introduction, site surveys, Transducers, IEC measurement techniques for Harmonics, Flicker, IEC Flicker meter.

Suggested Readings:

1. Math H.J. Bollen, Understanding Power Quality Problems, IEEE Press, 1999.
2. Roger C. Dugan, MarkF. McGranaghan, Surya Santoso, H. WayneBeaty, Electrical Power Systems Quality, Second Edition, Tata McGraw-Hill Edition.
3. C. Sankaran, Power Quality, CRC Press, 2002.

Course Code	Course Title						Core / Elective
PE 841 EE	**Smart Grid Technologies**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand various aspects of smart grid
- To study various smart transmission and distribution technologies
- To appreciate distribution generation and smart consumption
- To know the regulations and market models for smart grid

Course Outcomes

1. Understand technologies for smart grid
2. Appreciate the smart transmission as well distribution systems
3. Realize the distribution generation and smart consumption
4. Know the regulations and market models for smart grid

UNIT-I

Introduction to Smart Grid: Working definitions of Smart Grid and Associated Concepts – Smart Grid Functions-comparison of Power Grid and Smart Grid-New Technologies for Smart Grid – Advantages – Present development and International policies in Smart Grid, Indian Smart Grid. Key Challenges for Smart Grid. Components and Architecture of Smart Grid-Description.

UNIT-II

DC Distribution and Smart Grid: AC Vs DC Sources-Benefits of and drives of DC power delivery systems – Powering equipment and appliances with DC-Data centers and information technology loads equipment and appliances with DC-Data centers and information technology loads – Future neighbourhood-Potential future work and research.

UNIT-III

Smart Grid Communications and Measurement Technology: Communication and Measurement – Monitoring, Phasor Measurement Unit (PMU), Smart Meters, Wide area measurement System (WAMS).

UNIT-IV

Renewable Energy and Storage: Introduction to Renewable Energy Technologies-Micro grids-Storage Technologies-Electric Vehicles and plug-in hybrids-Environmental impact and Climate Change-Economic Issues. Grid integration issues of renewable energy sources.

UNIT-V

Smart Power Grid System Control: Load Frequency Control (LFC) in Micro Grid System – Voltage Control in Micro Grid System, Reactive Power Control in Smart Grid.

Suggested Readings:

1. Stuart Borlase, Smart Grids, Infrastructure, Technology and Solutions, CRC Press, 2013.
2. A.G. Phadke and J.S. Thorp, "Synchronized Phasor Measurements and their Application", Springer Edition, 2010.
3. Iqbal Hussein, "Electric and Hybrid Vehicle: Design fundamentals", CRC Press, 2003.
4. Gil Masters, Renewable and Efficient Electric Power System, Wiley-IEEE Press, 2004.
5. Fereidoon P. Sioshansi, "Smart Grid: Integrating Renewable, Distributed & Efficient Energy", Academic Press, 2012.
6. Jean Claude Sabonnadiere, Nouredine Hadjsaid, "Smart Grids". Wiley-ISTE, IEEE Press, May 2012.

Course Code	Course Title						Core / Elective
PE 842 EE	**Energy Management Systems and SCADA**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Outline energy management systems and unit commitment and its solution techniques.
- Discuss power generation scheduling with limited energy.
- Describe the architecture, functions and applications of supervisory control and data acquisition (SCADA).
- Apply SCADA in power system automation and communications.

Course Outcomes

After completing this course, the student will be able to

1. Understand energy management centers.
2. Know the principles of power generation scheduling.
3. Be acquainted with the configurations of SCADA
4. Have a knowledge of SCADA communication

UNIT-I

Energy Management Centers: Introduction, Energy management centers and their functions, architectures, recent developments, characteristics of power generating units and economic dispatch, unit commitment (spinning reserve, thermal, hydro and fuel constraints), solution techniques of unit commitment.

UNIT-II

Generation Scheduling: Generation scheduling with limited energy, energy production cost models, budgeting and planning, practical considerations, interchange evaluation for regional operations, types of interchanges, exchange costing techniques.

UNIT-III

Supervisory Control And Data Acquisition: Introduction to supervisory control and data acquisition, SCADA functional requirements and components. SCADA Application: General features, functions and applications, benefits of SCADA, architectures of SCADA, applications of SCADA.

UNIT-IV

SCADA and Power Systems: Configurations of SCADA, RTU (remote terminal units) connections, power systems SCADA and SCADA in power system automation.

UNIT-V

SCADA and Communication: SCADA communication requirements, SCADA communication protocols: past present and future, structure of a SCADA communications protocol.

Suggested Readings:

1. Handschin E, "Energy Management Systems", Springer Verlag, 1st Edition, 1990.
2. Handschin E, "Real Time Control of Electric Power Systems", Elsevier, 1st Edition, 1972.
3. John D Mc Donald, "Electric Power Substation Engineering", CRC press, 1st Edition, 2001.
4. Wood, A J and Wollenberg, B F, "Power Generation Operation and Control", John Wiley and Sons, 2nd Edition 2003.
5. Green, J N Wilson, R, "Control and Automation of Electric Power Distribution Systems", Taylor and Francis, 1st Edition, 2007.
6. Turner, W C, "Energy Management Handbook", Fairmont Pres, 5th Edition, 2004.

Course Code	Course Title						Core / Elective
PE 843 EE	**Special Electrical Machines**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To explain theory of operation and control of switched reluctance motor.
- To explain the performance and control of stepper motors, and their applications.
- To describe the operation and characteristics of permanent magnet dc motor.
- To distinguish between brush dc motor and brush less dc motor.
- To explain the theory of travelling magnetic field and applications of linear motors.

Course Outcomes

1. Explain theory of operation and control of switched reluctance motor.
2. Explain the performance and control of stepper motors, and their applications.
3. Describe the operation and characteristics of permanent magnet dc motor.
4. Distinguish between brush dc motor and brush less dc motor.
5. Explain the theory of travelling magnetic field and applications of linear motors.

UNIT -I

Stepper Motors: Constructional features, Principle of operation, Variable Reluctance (VR) stepping motor-Single Stack, Multi-Stack, Permanent Magnet Step motor, Hybrid Step Motor, Torque Equation Open Loop Drive, Open loop and closed loop control of Step Motor, Applications.

UNIT -II

Switched Reluctance Motors: Constructional features, Principle of Operation, Torque equation, Torque-speed characteristics, Power Converter for SR Motor-Asymmetrical converter, DC Split converter, Control of SRM, Rotor Position sensors, Current Controllers, Applications.

UNIT-III

Permanent Magnet Synchronous Motor: Permanent magnets and their characteristics, Machine Configurations-SPM, SIPM, IPM and Interior PM with circumferential, Sensorless control, Applications.

UNIT -IV

Brushless DC Motor: Construction, Principle of Drive operation with inverter, Torque speed Characteristics, Closed loop control, Sensorless control, Applications.

UNIT-V

Linear Induction Motors and Linear Synchronous Motors: Linear induction motor, Construction details, LIM Equivalent Circuit, Steps in design of LIM, Linear Synchronous Motor: Principle and Types of LSM, LSM Control, Applications.

Suggested Readings:

1. R. Krishnan*, Electric Motor Drives*, Pearson Education, 2007
2. B.K. Bose, *Modern Power Electronics and AC Drives*, PHI, 2005
3. Venkataratnam, *Special electrical Machines*, University Press, 2008
4. E.G. Janardanan, *Special Electrical Machines*, PHI, 2014
5. T.J.E. Miller, *Brushless Permanent Magnet and Reluctance Motor Drive*, Clarendon Press, Oxford, 1989

Course Code	Course Title						Core / Elective
PE 844 EE	**Power Electronic Applications to Renewable Energy**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand the various Non-Conventional sources of energy
- To explain the DC to DC converters for Solar PV source of energy
- To explain the inverters and its control techniques for a grid connected system
- To understand the characteristics of a solar PV and wind power sources
- To explain the types of distributed generators and batteries in DG and micro grid system

Course Outcomes

1. To acquire knowledge on Non-Conventional energy sources
2. To analyze various technologies and for renewable energy systems
3. To develop standalone DG sets and micro grid systems from renewable energy sources

UNIT-I

Introduction to renewable sources: world energy scenario, Wind, solar, hydro, geothermal, availability and power extraction.

Introduction to solar energy: Photovoltaic effect, basics of power generation, P-V &I-V characteristics, effect of insolation, temperature, diurnal variation, shading, Modules, connections, ratings, Power extraction (MPP) tracking and MPPT schemes; standalone systems, grid interface, storage, AC-DC loads.

UNIT-II

DC-DC converters for solar PV: buck/boost/buck-boost /flyback /forward/cuk, bidirectional converters, Interleaved and multi-input converters.

UNIT-III

Grid connected Inverters: 1ph, 3ph inverters with & w/o x'mer, Heric, H6, Multilevel Neutral point clamp, Modular multilevel, CSI; Control schemes: unipolar, bipolar, PLL and synchronization, power balancing / bypass, Parallel power processing; Grid connection issues: leakage current, Islanding, harmonics, active/reactive power feeding, unbalance.

UNIT-IV

Introduction to wind energy: P-V, I-V characteristic, wind power system: turbine-generator-inverter, mechanical control, ratings; Power extraction (MPP) and MPPT schemes. Generators for wind: DC generator with DC to AC converters; Induction generator with & w/o converter.

UNIT-V

Synchronous generator with back to back controlled/ uncontrolled converter; Doubly fed induction generator with rotor side converter topologies; permanent magnet based generators. Battery: Types, charging discharging. Introduction to AC and DC microgrids.

***Suggested Readings*:**

1. Sudipta Chakraborty, Marcelo G. Simes, and William E. Kramer. Power Electronics for Renewable and Distributed Energy Systems: A Sourcebook of Topologies, Control and Integration. Springer Science & Business, 2013.
2. Nicola Femia, Giovanni Petrone, Giovanni Spagnuolo, Massimo Vitelli, Power Electronics and control for maximum Energy Harvesting in Photovoltaic Systems,CRC Press,2013.
3. Chetan Singh Solanki, Solar Photovoltaics: fundamentals, Technologies and Applications, Prentice Hall of India, 2011.
4. N. Mohan, T.M. Undeland& W.P. Robbins, Power Electronics: Converter, Applications & Design, John Wiley & Sons, 1989

5. Muhammad H. Rashid, Power Electronics: Circuits, Devices, and Applications, Pearson Education India, 2004
6. E. Guba, P. Sanchis, A. Ursa, J. Lpez, and L. Marroyo, Ground currents in single-phase transformerless photovoltaic systems, Progress in Photovoltaics: Research and Applications, vol. 15, no. 7, 2007.
7. Remus Teodorescu, Marco Liserre, Pedro Rodriguez, Grid Converters for Photovoltaic and Wind Power Systems, John Wiley and Sons, Ltd., 2011.
8. Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, Wiley-IEEE Press, 2011

Course Code	Course Title						Core / Elective
PE 845 EE	**Electrical Substation Design and Equipment**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To provide in-depth knowledge on design criteria of Air Insulated Substation (AIS) and Gas Insulated Substation (GIS)
- To study the equipment in AIS and GIS
- To study the substation insulation co-ordination and protection scheme
- To study the control room design along with protective devices for reliable operation

Course Outcomes

1. Ability to design the substation for present requirement with proper insulation
2. Ability to apply awareness towards substation equipment and their arrangements.
3. Coordination and protection against high voltages

UNIT-I

Introduction to AIS and GIS: Introduction – characteristics – comparison of Air Insulated Substation (AIS) and Gas Insulated Substation (GIS) – main features of substations, Environmental considerations, Planning and installation- GIB / GIL

UNIT-II

Major Equipment and Layout of AIS and GIS: Major equipment –Bus bars, Circuit Breakers, Isolators, CT, PT and CVT, Wave traps, Transformers and transmission lines, design features –Sag –Tension calculations and wind force calculations equipment specification, substation switching schemes- single feeder circuits; single or main bus and sectionalized single bus-double main bus-main and transfer bus- main, reserve and transfer bus- breaker-and-a- half scheme-ring bus

UNIT-III

Insulation Coordination of AIS and GIS: Introduction – stress at the equipment – insulation strength and its selection – standard BILs – Application of simplified method – Comparison with IEEE and IEC guides.

UNIT-IV

Grounding and Shielding: Definitions – soil resistivity measurement – ground fault currents – ground conductor – design of substation grounding system – shielding of substations – Shielding by wires and masts. Reflection and refraction of waves on transmission line.

UNIT-V

Control room layout, reactive compensation equipment, shunt capacitor sand static VAR systems, HTLT circuit Breaker, selection and sizing, Substation Automation, selection and sizing of lighting protection and selection of luminaries

***Suggested Readings*:**

1. Andrew R. Hileman, “Insulation coordination for power systems”, Taylor and Francis, 1999.
2. M.S. Naidu, “Gas Insulation Substations”, I.K. International Publishing House Private Limited, 2008. 3 Klaus Ragallar, “Surges in high voltage networks” Plenum Press, New York, 1980.
3. “Design guide for rural substation”, United States Department of Agriculture, RUS Bulletin, 1724E-300, June 2001

Course Code	Course Title						Core / Elective
PC 851 EE	**Power System Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

- To determine regulation & efficiency of short, medium and long transmission lines and to calculate A, B, C, D constants.
- To understand the importance of protective relays in power system such as different protection of transformer DMT Characteristics of over current relay, Buchholz relay and static relays.
- To understand the procedure to determine sequence parameters of transformer and alternator.

Course Outcomes

1. Determine ABCD constants of transmission lines and evaluate regulation, efficiency.
2. Acquire knowledge in relay setting for safe operating of power system.
3. Determine sequence parameters of transformer and alternator and draw its importance.
4. Determine the time constant of an alternator.
5. Determine the dielectric strength of oil and calculate the efficiency of string insulators.

List of Experiments:

1. Determination of regulation & efficiency of Short, Medium and Long transmission lines.
2. IDMT characteristics of Over-current relay & Study of Bucholz relay.
3. Determination of A, B, C, D constants of Short, Medium and Long lines. Drawing of Circle diagrams.
4. Differential protection of transformer.
5. Sequence impedance of 3-Phase Alternators.
6. Determination of positive, negative and zero-sequence reactance of 3- Phase transformers using sequence current excitation fault calculation.
7. Synchronous machine reactance and time constant from 3-Phase S. Ctest.
8. Characteristics of Static relays.
9. Static excitation of Synchronous Generator.
10. Determination of dielectric strength of oils and study of Megger.
11. Parallel operation of Alternators.
12. Measurement of capacitance of 3-core cables.
13. Fault location of Underground cables.
14. Simulation of string of insulators for determination of Voltage distribution and String efficiency.

Course Code	Course Title						Core / Elective
PW 961 EE	**Project Work – II**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**16**	**50**	**100**	**8**

Course Objectives

- To enhance practical and professional skills.
- To familiarize tools and techniques of systematic literature survey and documentation
- To expose the students to industry practices and team work.
- To encourage students to work with innovative and entrepreneurial ideas

Course Outcomes

1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to the real-world problems.
2. Evaluate different solutions based on economic and technical feasibility
3. Effectively plan a project and confidently perform all aspects of project management
4. Demonstrate effective written and oral communication skills

The aim of Project work –II is to implement and evaluate the proposal made as part of Project Work - I. Students can also be encouraged to do full time internship as part of project work-II based on the common guidelines for all the departments. The students placed in internships need to write the new proposal in consultation with industry coordinator and project guide within two weeks from the commencement of instruction.

The department will appoint a project coordinator who will coordinate the following:

1. Re-grouping of students - deletion of internship candidates from groups made as part of project Work-I
2. Re-Allotment of internship students to project guides
3. Project monitoring at regular intervals

All re-grouping/re-allotment has to be completed by the 1st week of VIII semester so that students get sufficient time for completion of the project.

All projects (internship and departmental) will be monitored at least twice in a semester through student presentation for the award of sessional marks. Sessional marks are awarded by a monitoring committee comprising of faculty members as well as by the supervisor. The first review of projects for25 marks can be conducted after completion of five weeks. The second review for another 25 marks can be conducted after 12 weeks of instruction.

Common norms will be established for the final documentation of the project report by the respective departments. The students are required to submit draft copies of their project report within one week after completion of instruction.

Note: Three periods of contact load will be assigned to each project guide.