Course code	Course Name	L-T-P -C	Year of Introduction
EE431	Power System Lab	0-0-3-1	2016

Prerequisites : 1. EE301 Power generation, Transmission and Protection
2. EE306 Power System Analysis

Course Objectives

- Impart practical knowledge about various power system components
- Acquire knowledge about the operation of power systems and the philosophy behind the relay settings, fault calculations etc.
- Simulate the power system operations which will be helpful in the design of power systems
- Introduce the various testing procedures used in power systems

List of Exercises/Experiments: Both software and hardware experiments are included. At least 12 experiments including minimum 4 hardware experiments are mandatory.

Part A Power System Simulation

I. Y-Bus Formulation: Aim: To formulate a Y - Bus using an appropriate algorithm for at least a four Bus system.

II. Load flow analysis –Gauss Siedel Method

Aim: To conduct the load flow analysis of power system networks (not more than 6 bus) on any dedicated software platform using Gauss Seidel method and to verify by manual calculation at least for one iteration.

III. (a) Load flow analysis –Newton Raphson Method

Aim: To conduct the load flow analysis of power system networks (not more than 6 bus) on any dedicated software platform using Newton Raphson method.

(b) Load flow analysis –Fast Decoupled Method

Aim: To conduct the load flow analysis of power system networks (not more than 6 bus) on any dedicated software platform using Fast Decoupled method.

IV. Short Circuit Analysis – Symmetrical Faults

Aim: To conduct the fault analysis of power system networks(not more than 9 bus) on any dedicated software platform to solve a symmetrical fault and to verify by manual calculation.

V. Short Circuit Analysis – Unsymmetrical Faults

Aim: To conduct the fault analysis of power system networks(not more than 9 bus) on any dedicated software platform to solve three symmetrical faults (both at bus and in line).

VI. Stability analysis

Aim: To find the critical clearing angle by applying equal area criterion for any power system network and verify the same using any dedicated software.

VII. Automatic generation control – Single Area

Aim: To determine the change in speed, frequency and steady state error corresponding to a load disturbance in a single area power system,with and without supplementary control using any software

VIII. Automatic generation control – Two Area

Aim: To determine the change in speed, frequency and steady state error corresponding to a load disturbance in a single area power system,with and without supplementary control using any software

IX. Reactive power control

Aim: To find suitable devices for applying reactive power control of power system networks for Voltage control and Power flow control using any dedicated software.

X. Solar power calculations

Aim: To calculate the rating of solar panel required for a given area on rooftop for a given load.

Part B <u>Power System Component Testing</u> (Hardware experiments)

XI. High voltage testing -Power frequency
Aim: To test the given power system component (Circuit Breaker/ Insulator/ Lightning Arrester/ Air blast switch etc.) using AC Voltage.

XII. High voltage testing -Impulse
Aim: To test the given power system component (Circuit Breaker/ Insulator/ Lightning Arrester/ Air blast switchetc.) using Impulse Voltage.

XIII. High voltage testing -DC
Aim: To test the given power system component (Circuit Breaker/ Insulator/ Lightning Arrester/ Air blast switchetc.) using DC Voltage.

XIV. Relay Testing - Over current relay (Electromechanical/Static/Numerical)/ Earth fault

Aim: To test the pick up, drop out and plot the time current characteristics of the relay.

XV. Relay Testing - Over voltage relay (Electromechanical/Static/Numerical)/ Distance

Aim: To test the pick up, drop out and plot the time current characteristics of the relay.

XVI. Insulation Testing – LT & HT Cable

Aim : To determine the insulation resistance of the given LT & HT Cable by using appropriate testing equipments

XVII. Earth Resistance

Aim: To determine the resistance to earth of the given earthing system and design an earthing system from soil resistivity of the given area.

XVII. Testing of CT and PT

Aim: To check the specifications of the given Current transformers and Potential Transformers

XVIII. Testing of transformer oil

Aim: To measure the dielectric strength of the given sample of Transformer oil.

XX. Testing of dielectric strength of solid insulating materials

Aim: To measure the dielectric strength of solid insulting materials (mica, impregnated paper etc…) using appropriate methods.

XXI. Testing of dielectric strength of air

Aim: To measure the dielectric strength of air under different conditions

XXII. Power factor improvement

Aim: To calculate rating of capacitors for power factor correction for a load and verify it experimentally.

XXIII. String Efficiency of insulators

Aim: To determine the string efficiency of the given string of insulators.

Expected outcome.

Students will be able to

1. Analyse a power system by carrying out load flow and short circuit experimentations.
2. Analyse Power System Stability
3. Design a solar panel required for a specified area
4. Validate the performance of Power System devices by appropriate tests.

Text Books:

1. Nagrath I J and Kothari D P , “Modern Power System analysis” Tata McGraw Hill
2. Wadhwa C L “ Electrical Power Systems” New Age International
3. Badri Ram and Vishwakarma D N “ Power System Protection and Switch Gear” Tata McGraw Hill.
4. Ned Mohan, First Course in Power Systems , Wiley.

Course code	Course Name	L-T-P -Credits	Year of Introduction
EE 472	Internet of Things	3-0-0-3	2016

Prerequisite : NIL

Course Objectives

- Vision and Introduction to IoT.
- Understand IoT Market perspective.
- Data and Knowledge Management and use of Devices in IoT Technology.
- Understand State of the Art – IoT Architecture.
- Understand Real World IoT Design Constraints, Industrial Automation and Commercial Building Automation in IoT.

Syllabus

Internet in general and Internet of Things,IoTTechnology Fundamentals, Communication Technology for IoT, Data Management, Sensors and security of IoT, Standardisation and Protocol, IoT architectures, Embedded design for IoT, Case Studies and smart applications

Expected outcome.

i. Explain in a concise manner how the general Internet as well as Internet of Things work.
ii. Understand constraints and opportunities of wireless and mobile networks for Internet of Things.
iii. Use basic sensing and measurement and tools to determine the real-time performance of network of devices
iv. Develop prototype models for various applications using IoT technology

Text Books:

1. Rajkamal, "Internet of Things : Architecture and Design Principles", McGraw Hill (India) Private Limited.
2. Vijay Madisetti and Arshdeep Bahga, **"**Internet of Things (A Hands-on-Approach)"**,** 1st Edition, VPT, 2014

References:

1. The Internet of Things (The MIT Press Essential Knowledge series)Paperback – March 20, 2015 by Samuel Greengard
2. The Internet of Things : Converging Technologies for Smart Environments and Integrated Ecosystems, OviduVermesan and Peter Friess, River Publishers.
3. Internet of Things - From Research and Innovation to Market Deployment -RIVER PUBLISHERS , PETER FRIESS , OVIDIU VERMESAN (Editors)

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	Introduction : Definition , Internet of Things IoT Architectural view, IoT Technology M2M Communication, Success Factors of Internet of Things, IoT Application Areas , IoT Functional View, Design Principles for connected Devices, Communication Technologies	6	15%
II	IoT Data Management, Device Management Gateways, Design Principles for Web Connectivity, Web communication protocols for connected devices, Web connectivity for connected devices using Gateways- Internet connectivity Principles – Internet based communication, IP addressing in the IoT	8	15%

FIRST INTERNAL EXAMINATION			
III	Data acquiring and storage for IoT devices, Organization of Data, Big data, Acquiring methods, management techniques, Analytics, Storage technologies. Cloud computing for Data storage (concept only)	8	15%
IV	Sensor Technologies for IoT Devices, Industrial IoT and Automotive IoT, Actuators for various devices, Sensor data communication protocols, Wireless Sensor network Topology	8	15%
SECOND INTERNAL EXAMINATION			
V	Prototyping concepts, Basics of Embedded computing, Embedded platforms for prototyping, Iot Connected devices through Cloud Designing software for IoT, Prototyping embedded device software	8	20%
VI	Case Study& Advanced IoT Applications: Sensors and sensor Node and interfacing using any Embedded target boards (Raspberry Pi / ARM Cortex/ Arduino)- Block diagram, specifications. Internet of Things SMART Applications : Energy management and Smart grid, IoT for Home ,Cities , Environment monitoring, Agriculture, Supply chain and customer monitoring	8	20%
END SEMESTER EXAM			

QUESTION PAPER PATTERN (End Sem Exam)

Maximum Marks: 100 Exam Duration: 3Hrs.

Part A: 8 questions.

One question from each module of Module I - IV; and two each from Module V & VI.

Student has to answer all questions. (8 x5)=40

Part B: 3 questions from modules I & II with at least one question from each module. Student has to answer any 2 from the 3 questions: (2 x 10)=20

Part C: 3 questions from modules III & IV with at least one question from each module. Student has to answer any 2 from the 3 questions: (2 x 10) =20

Part D: 3 questions from modules V & VI with at least one question from each module. Student has to answer any 2 from the 3 questions: (2 x 10) =20

Course code	Course Name	L-T-P - Credits	Year of Introduction
EE405	Electrical System Design	3-1-0-4	2016

Prerequisite: Nil

Course Objectives

- To make aware of the Acts and Rules regulating the design of electrical .systems in India.
- To impart knowledge in the design of low voltage and medium voltage electrical installations.
- To give basic knowledge of design of distribution transformer substations, their installations and earthing design for transformer substations
- To familiarise lighting calculations and external lighting.

Syllabus

Electrical system design practices – general awareness of IS Codes, Electricity Acts & Rules, NEC etc. Domestic Installations, Industrial Installations and 11 kV substations. Design features of Recreational buildings and High-rise building. Selection of Standby generators and their Installations. Underground cable installations and their accessories. Design features of external lighting, lightning protection and special requirements for lifts and fire fighting equipments.

Expected outcome

The students will be able to

i. Know the basic Rules and Regulations of electrical systems design.
ii. Design simple electrical systems and prepare the schematic diagram with all the specifications.

Text Books

1. J. B. Gupta, A Course in Electrical Installation Estimating and Costing, S.K. Kataria & Sons; Reprint 2013 edition (2013).
2. K. B. Raina, S. K. Bhattacharya, Electrical Design Estimating Costing, NEW AGE; Reprint edition (2010).
3. M. K. Giridharan, Electrical Systems Design, , I K International Publishers, New Delhi, 2nd edition, 2016

Data Book (Approved for use in the examination):

1. M K Giridharan, Electrical Systems Design Data Hand book, I K International Publishers, New Delhi, 2011
2. N. Rajendran, Electrical System Design Data Book

References:

1. National Electric Code, Bureau of Indian Standards publications, 2011.
2. Relevant Indian Standard – specifications (IS – 732, IS – 746, IS – 3043, IS – 900), etc.
3. S. L. Uppal, Electrical Wiring Estimating & Costing, Khanna Publishers, 2008

Course Plan

Module	Contents	Hours	Sem. Exam Marks
I	General awareness of IS Codes (IS 3043, IS 732, IS 2675, IS 5216-P12, IS 2309), The Indian Electricity Act 2003, National Electric Code (NEC **2011**) - scope and safety aspects applicable to low and medium (domestic) voltage installations, Electric services in buildings, Classification of voltages, standards and specifications.	8	15%

II	General aspects of the design of electrical installations for domestic dwellings as per NEC guidelines (low and medium voltage installations)–connected load calculation, sub circuit determination, selection of main distribution board, sub distribution board, MCB, ELCB, MCCB and cables for sub circuits. Pre-commissioning tests of domestic installations.	10	15%
FIRST INTERNAL EXAMINATION			
III	Industrial installations –classifications- Design of distribution systems with light power and motor loads for small and medium industries. Selection of transformer substations, switchgears and protective devices – Design of indoor and outdoor 11 kV substations up to 630 kVA.	10	15%
IV	Short circuit calculations and Design of earthing for 11 kV substation of capacity up to 630 kVA. Pre-commissioning tests of cables and transformers.	8	15%
SECOND INTERNAL EXAMINATION			
V	Design of illumination systems – Average lumen method- lighting design calculations using Coefficient of utilisation (CU) and light loss factor (LLF) - classification and selection of luminaires. Exterior lighting design- road lighting and area lighting. Design requirements for high rise buildings and recreational buildings.	8	20%
VI	Energy conservation techniques in lighting and power. Selection of standby generator –power rating - Continuous, prime power and standby power, installation and its protection, Introduction to Automatic Main Failure (AMF) System. Introduction to Solar PV systems for domestic applications. Simple design projects.	10	20%
END SEMESTER EXAMINATION			

QUESTION PAPER PATTERN (End semester exam)

Maximum Marks: 100 Exam Duration: 3 Hourrs.

(Approved data handbook to be permitted inside examination hall)

Part A: Eight compulsory questions. One question from each module of Modules I - IV; and two each from Module V & VI. Student has to answer all questions. (8 x5) = 40

Part B: Three questions uniformly covering Modules I & II. Student has to answer any 2 from the 3 questions: (2 x 10) = 20. Each question can have maximum of 4 sub questions (a, b, c, d), if needed.

Part C: Three questions uniformly covering Modules III & IV. Student has to answer any 2 from the 3 questions: (2 x 10) = 20. Each question can have maximum of 4 sub questions (a, b, c, d), if needed.

Part D: Three questions uniformly covering Modules V & VI. Student has to answer any 2 from the 3 questions: (2 x 10) = 20. Each question can have maximum of 4 sub questions (a, b, c, d), if needed.