UNIVERSITY OF KERALA

B. TECH. DEGREE COURSE

(2013 SCHEME)

SYLLABUS FOR

VIII SEMESTER

ELECTRICAL AND ELECTRONICS ENGINEERING

SCHEME -2013

VIII SEMESTER

ELECTRICAL AND ELECTRONICS ENGINEERING (E)

Course No	Name of subject	Credits	Weekly load, hours			C A Marks	Exam Duration Hrs	U E Max Marks	Total Marks
			L	T	D/ P				
13.801	Electrical System Design (E)	4	2	2	-	50	3	100	150
13.802	Electrical Machine Design (E)	4	2	2	-	50	3	100	150
13.803	Electrical Drawing (E)	4	-	-	4	50	3	100	150
13.804	Electric Power Utilisation & Electrical Safety (E)	4	3	1	-	50	3	100	150
13.805	ELECTIVE IV	4	2	2	-	50	3	100	150
13.806	ELECTIVE V	4	2	2	-	50	3	100	150
13.807	Project & Viva Voce (E)	5	-	-	5	200		100	300
	Total	**29**	**11**	**9**	**9**	**500**		**700**	**1200**

13.805 Elective IV

13.805.1	Power System Instrumentation (E)
13.805.2	Computer Networks (E)
13.805.3	Power Electronic Applications in Power Systems (E)
13.805.4	Robotics (E)
13.805.5	Non-linear Systems (E)
	13.806 Elective V
13.806.1	Energy Conservation and Management (E)
13.806.2	HVDC and FACTS (E)
13.806.3	Electric and Hybrid Vehicles (E)
13.806.4	Industrial automation (E)
13.806.5	Digital Image Processing (E)

13.801 ELECTRICAL SYSTEM DESIGN (E)

Teaching Scheme: 2(L) - 2(T) - 0(P) **Credits**: 4

Course Objective:

To impart the knowledge of:

- *Acts and rules used for regulating the electrical supply in our country.*
- *Design and estimation of low voltage and medium voltage electrical installations*
- *Selection of distribution transformers and their installations*
- *Earthing designs in different installations and the standard dimensions of earthing systems.*

Module – I

General awareness of IS Codes (IS 3043, IS 732, IS 2675, IS 5216-P1-2, IS 2309), Indian Electricity Rules 1956, Electricity Act 2003, Bureau of Energy Efficiency (BEE) and its labeling. National Electric Code (NEC)- scope and safety aspects applicable to low and medium (domestic) voltage installations, Electric services in buildings, Classification of voltages, standards and specifications.

Module – II

General aspects of the design of electrical installations for domestic dwellings (low and medium voltage installations)–connected load calculation, selection of main distribution board, sub distribution board, MCCB, ELCB, MCB and cables for sub circuits. Pre-commissioning tests of domestic installations. Air-conditioning loads and its specifications. Energy conservation techniques in lighting and domestic applications.

Module – III

Industrial Installations-Small and Medium Industries- selection of drives and starting methods, Selection of cables and voltage drop calculations- Design of distribution systems with light power and motor loads. Selection and installation of (11kV) transformer substations upto 630 kVA capacity, switchgears and protective devices, Standby generation-types and selection criteria, Pre-commissioning tests on cables, transformers and standby generators.

Module – IV

Design of earthing system for an HT consumer - Touch, Step and Transfer potentials at EHT Substations - Earth-mat installations of special equipment like X-Ray. Design considerations for lightning protection. Design of illumination systems – Yard lighting, street lighting and flood lighting. Kerala Cinema Regulation Act – 1958, design and layout of installation for recreational and high rise building. Design aspects of Electrical system related to fire fighting, lifts and escalators.

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. Giridharan M. K., *Electrical System Design*, I K. International, 2016.
4. Raina K. B. and S. K. Bhattacharya, *Electrical Design Estimating and Costing*, New Age International, 2010.
5. Giridharan M. K., *Electrical Systems Design Data Handbook*, I K International Publishers, New Delhi, 2011.
6. Approved data and reference manuals.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Note: Approved data and reference manuals are to be permitted to use in the exam hall.

Course Outcome:

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

- *Outline the importance of NEC in electrical system design and Summarize the guidelines for design & safety as recommended by NEC*
- *Design, develop and estimate Domestic , LV & MV industries installation*
- *Choose and design appropriate transformer substation as per requirement and constraints*
- *Design electrical installations for high rise and recreational buildings*
- *Elaborate on Pre-commissioning tests of cables, transformers and generators and justify and design appropriate earthing systems*

13.802 ELECTRICAL MACHINE DESIGN (E)

Teaching Scheme: 2(L) - 2(T) - 0(P) **Credits**: 4

Course Objectives:

- *To impart complete knowledge about each and every aspect of design of electrical machines viz. DC machines, transformers, induction motors and synchronous machines*
- *To introduce computer aided design techniques.*

Module – I

Principles of electrical machine design - General design considerations - specifications of machines - types of enclosures - types of ventilation - heating - short time rating - overload capacity - temperature rise time curve -hot spot rating.
Design of transformers - single phase and three phase transformers - distribution and power transformers -output equation - core design - window area - window space factor - overall dimensions of core. Windings – no. of turns - current density - conductor section - Cooling of transformers - design of cooling tank and tubes.

Module – II

Design of DC machines - output equation - specific loading - choice of speed and no of poles - calculation of main dimensions - choice of type of winding - number of slots - number of conductors per slot-current density - conductor section - slot insulation - length of air gap - design of field winding - conductor cross section – height of pole - design of interpole - flux density under interpole - calculation of turns of interpole winding – design of compensating winding – brushes of commutatators.

Module – III

Magnetic circuit calculation - calculation of field ampere turns - air gap mmf - effect of slot and ventilating duct- active iron length - mmf for teeth - real and apparent flux densities - mmf per pole.

Design of synchronous machines - output equation – choice of specific electric and magnetic loading - main dimensions - types of winding -number of turns - number of slots and slot design - field design for water wheel and turbo alternators – cooling of alternators.

Module – IV

Design of three phase induction motors – output equation - main dimensions – choice of specific electric and magnetic loading – design of stator and rotor windings -number of stator and rotor slots - rotor bar current - design of rotor bar - end ring current - design of end ring -design of slip ring rotor winding.

Introduction to computer aided design - analysis and synthesis methods -hybrid techniques – optimization – general procedure for optimization.

References

1. Sawhney A. K., *A Course in Electrical Machine Design*, Dhanpat Rai & Sons, Delhi.
2. Deshpande M. V.*, Design and Testing Of Electrical Machines*, Wheeler Publishing.
3. Agarwal R. K., *Principles of Electrical Machine Design*, Esskay Publications, Delhi.
4. Ramamoorthy M., *Computer Aided Design of Electrical Equipment*, East-West Press.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) – Five Short answer questions of 4 marks each. All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

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

- *Determine the effect of temperature on different parts of electrical machines.*
- *Explain different types of ventilation, enclosures & cooling methods.*
- *Design DC & AC machines of any rating.*
- *Design power transformers of any rating.*
- *Differentiate the various computer aided design methods.*

13.803 ELECTRICAL DRAWING (E)

Teaching Scheme: 0(L) - 0(T) - 4(P) **Credits**: 4

Course Objectives:

- *To impart the knowledge of electrical machine parts and their working.*
- *To develop the skill to design electrical machines, insulators and transmission towers and create single line diagrams for power generating stations and substations*

Course Content

1. DC Machine: (3 sheets)
   Assembly of pole and yoke of a medium size DC Machine
   Assembled views of armature and commutator
   Sectional elevation and end views of DC machines.

2. Transformer: (3 sheets)
   Sectional plan and elevation of core type and shell type single phase transformer.
   Sectional plan and elevation of three phase transformer. (Core only).
   Sectional plan and elevation of three phase transformer including winding.

3. Induction Motor : (2 sheets)
   Sectional elevation and end views of squirrel cage induction motor.
   Sectional elevation and end views of slip ring induction motor.

4. Synchronous Machines: (2 sheets)
   Dimensional sketches of hub, spider
   Half sectional elevation and end views of salient pole with spider and without spider.

5. Single line diagram of
   (a) Generating station switch yard (1 sheet)
   (b) 220 kV substation (I sheet)

6. Sketches of
   (a) Pin insulator, Disc insulator and bushings (I sheet)
   (b) 220 kV and 400 kV double circuit transmission towers. (1 sheet)

REFERENCES

1. Narang K. L., *Electrical Engineering Drawing*, Satya Prakashan, New Delhi.
2. Bhattacharya S. K., *Electrical Engineering Drawing*.
3. Sahney A. K., *Electrical Machine Design*.

Internal Continuous Assessment *(Maximum Marks-50)*

40% - Test

40% - Continuous evaluation of the Performance based on the drawing sheets.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (50 marks) - Three questions of 25 marks each. Answer any two full questions out of the three.

Part B (50 Marks) - Two questions of 50 marks each and candidates have to answer one full question out of the two.

Course Outcome:

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

- *Identify the various parts of DC machines, AC machines and transformers*
- *Visualize and develop designs for electrical machines and switchgears*
- *Develop single line diagrams for power generating stations and substations*
- *Illustrate the scheme of different types of towers, insulators and bushings*

13.804 ELECTRIC POWER UTILISATION & ELECTRICAL SAFETY (E)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objective:

- *Students will learn the principles of utilising electrical energy in different areas - heating and welding, electroplating, traction and illumination.*
- *Students get the opportunity for students to learn the safety aspects of electrical energy required by any electrical engineer.*

Module – I

Electric Heating- Advantages of electric of heating, resistance ovens, induction heating, dielectric heating. Electric welding- resistance and arc welding. Electrolytic Process - Fundamental principles, extraction, refining of metals and electroplating. Power supply for electrolytic process.

Module – II

Electric Traction - Introduction, requirements of an ideal traction, systems of traction, speed time curve. Selection of traction motors, method of speed control, energy saving by series parallel control, ac traction equipment. AC series motor, characteristics, regenerative braking, linear induction motor and their use. AC traction, diesel electric equipment, trains lighting system, specific energy, factors affecting specific energy consumption.

Module – III

Laws of illumination, lighting calculation, factory lighting, flood lighting, street lighting, different types of lamps-incandescent, fluorescent, vapour, CFL and LED lamps and their working, comparison, Glare and its remedy. Design of lighting scheme, conservation approach to be considered. Refrigeration and Air-conditioning - Refrigeration systems - COP - Domestic refrigerator - principle - Air conditioning systems- Human comfort - air conditioning of theatres.

Module – IV

Electrical Safety - Safety aspects of resistance - capacitance and inductance aspects - Electrical Shock and human body - modelling and conditions - Ground Grid Design - IEEE standard 80 - Safety aspects of ground grid operation and maintenance - grounding of distribution systems.

References:

1. Rajput R. K., *Utilisation of Electrical Power*, Laxmi Publication Pvt Ltd
2. Taylor E. O., *Utilisation of Electric Energy*, Orient Longman

3. Wadhwa C. L., *Generation, Distribution and Utilisation of Electrical Energy*, New Age International Pvt Ltd
4. John Cadick, Mary Capelli - Schellpfeffer and Dennis Nietzel, *Electrical Safety Handbook,* McGraw Hill Companies
5. Peter E .Sutherland, *Principles of Electrical Safety*, Wiley, IEEE Press.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, term-project, software exercises etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

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

- *Identify appropriate heating method*
- *Identify appropriate welding method*
- *Design, formulate and analyse various illumination schemes*
- *Identify appropriate traction motor for various type of locomotives*
- *Design appropriate ground grid for industrial, commercial and domestic installations.*

13.805.1 POWER SYSTEM INSTRUMENTATION (E) (Elective IV)

Teaching Scheme: 2(L) - 2(T) - 0(P) **Credits**: 4

Course Objective:

To equip engineers for operating power systems more effectively and reliably utilizing the resources in an optimal manner.

Module – I

Measurement of Electrical Quantities: Measurement of parameters in power plants; Energy meters and multipart tariff meters.
Voltage and Current Transformers: Voltage transformers for measurement and protection, errors, transient performance; capacitive voltage transformers and their transient behavior; Current transformers for measurement and protection, composite errors, transient response.

Module – II

Hydro Electric Power-Plant Instrumentation: Measurement of flow, level, pressure, temperature, hydraulic head and mechanical vibrations; Temperature scanners; Alarm annunciators.

Module – III

Thermal and Nuclear Plant Instrumentation: Measurement of gas flow; Gas and feed-water analysis; Flame monitoring; Steam turbine instrumentation.

Nuclear Power-Plant Instrumentation: Reactor safety, neutron flux measurement; Reactor power level and coolant measurements.

Module – IV

Protective Relays: Organization of protective relay; Single input, two-input and multi-input relays; Electromagnetic, electronic and digital relays.

References:-

1. Modern *Power Station Practice, Volume F: Control and Instrumentation*, British Electricity International, Pergmon Press, 1990.
2. Elliott T. C., *Standard Hand Book of Power Plant Engineering*, McGraw-Hill International Book Company, 1989.
3. Van A. R. and Warrington C., *Protective Relays- Their Theory and Practice*, Vol. 1, Chapman and Hall Ltd., 1968.

4. Rao T. S. M., *Power System Protection – Static Relays with Microprocessor Applications*, 2nd Ed., Tata McGraw-Hill Publishing Company Limited, 2008.
5. Murthy D. V. S., *Transducers and Instrumentation*, PHI Learning Pvt Ltd, 2010.
6. Rajput R. K., *Textbook of Power Plant Engineering*, Laxmi Publishers, 2008.
7. Alan S. Morris, *Measurement and Instrumentation Principles*, 3/e, Butterworth Heinemann.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

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

- *Select appropriate elements for the instrumentation of power plants.*
- *Identify, analyze and formulate the issue of measuring electrical and physical parameters in power supply stations.*
- *Select appropriate protective relay for use in control panels*

13.805.2 COMPUTER NETWORKS (E) (Elective IV)

Teaching Scheme: 2(L) - 2(T) - 0(P) **Credits**: 4

Course Objective:

- *To introduce computer networks*
- *To build a firm foundation for understanding Computer Networks and their protocols.*

Module – I

Uses of computer networks - Network hardware - Classification of networks - **LAN - MAN - WAN** (overview only). Network software - Protocol hierarchical issues for the layers - interfaces and services - connection oriented and connectionless services - service primitives - relationship of services of protocol. Reference models - **OSI** reference model - **TCP/IP** reference model.

Module – II

The Physical layer: Transmission media - twisted pair - base band coaxial cables - broadband cables - fiber optics-unguided media.

The Data link layer: Design issues - services provided to the network layer - framing - error control - flow control - elementary data link protocols - unrestricted simplex protocol - simplex stop and wait protocol - simplex protocol for noisy channel

The medium access sub-layer: The channel allocation problem - static channel allocation - dynamic channel allocation - multiple access protocols - **ALOHA - CSMA** protocols - collision free protocols - limited contention protocols - **CDMA.** Introduction to **IEEE 802** standards – 802.3.

Module – III

The network layer :Design Issues - services provided to the transport layer - internal organisation of the network layer - comparison of virtual circuit and datagram subnets. Routing algorithms - optimality principle - shortest path routing - Dijekstra's algorithm - flooding - flow based routing - distance vector routing - link state routing - Hoffmans algorithm - hierarchical routing

Congestion control algorithms - principles - prevention policies traffic shaping - leaky bucket and token bucket - flow specification - choke packets - load shedding - jitter control.

Module – IV

The transport layer: The transport service - services provided to the upper layer - quality of service -transport layer primitives. Elements of transport protocols – **TCP and UDP**.

Addressing-Establishing a connection, releasing a connection. Flow control and buffering-Crash recovery

The Application layer: Basic ideas of network security - public key cryptography, DNS, SNMP, e-mail, www, IPv6.

References:-

1. Andrew S. Tanenbaum, *Computer Networks*, 5th edition, PHI.
2. Peterson and Davie, *Computer Networks*, Harcourt India Pvt. Ltd.
3. Bertsekas D. and Gallager, *Data Networks*, second edition Prentice Hall, 1992.
4. William Stalling, *Data and Computer Communication*.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

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

- *Explain about OSI and TCP/ IP, and to have clear understanding about different Layers in particular*
- *Understand the requirements for a given organizational structure and select the most appropriate networking architecture and technologies;*
- *Describe and compare different data link, network, and transport layer protocols*
- *Describe analyze MAC sub layer protocols*
- *Explain about network security and cryptography.*

13.805.3 POWER ELECTRONIC APPLICATIONS IN POWER SYSTEMS (E) (Elective IV)

Teaching Scheme: 2(L) - 2(T) - 0(P) **Credits**: 4

Course Objective:

- *To enable the students to apply Power Electronics basics in Power system.*
- *To impart the knowledge of operation and analysis of different power electronic circuits for renewable generation*
- *To introduce the fundamentals of active power filtering*

Module – I

Analysis of Power Electronic Converters – Review: Single phase bridge type VSI (Output rms voltage, Fourier harmonics analysis, THD), Three Phase Voltage Source Inverter -120^0 and 180^0 conduction mode (Output rms voltage, Fourier harmonics analysis, THD), Selective harmonic elimination, Single phase (bipolar and unipolar) and Three Phase Sine PWM, Space vector Modulation, Multi-Level Inverters- Diode Clamped Type, Flying Capacitor Type and H-bridge type, Current Controlled Inverter (hysteresis control).

Module – II

Application of Power Electronics for the interface of Solar Energy: Inverters for PV Grid connected system- Line-commutated inverter, Self-commutated inverter, PV inverter with high-frequency transformer, Power Control through PV Inverters.

Module – III

Application of Power Electronics for the interface of Wind Energy: Grid-connected wind energy system through dc/ac converter- Using Synchronous generator, Using Squirrel-Cage Induction Generator (Cycloconverter -Static Scherbius System, Slip Power Recovery-Static Kramer System).

Module – IV

Active Filters: Shunt Active filter- Shunt active power filter topologies implemented with PWM-VSI, Control Scheme of active filter. Series Active Filter- Circuit structure, Principle of operation.

References:-

1. Muhammad H. Rashid, *Power Electronics Handbook Devices*, *Circuits and Applications*.
2. Hingorani N. G. and L. Gyugyi, *Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems*, IEEE Press.

3. Barry W. Williams, *Principles and Elements of Power Electronics. Devices, Drivers, Applications and Passive Components*, McGraw Hill, 1992.
4. K. R. Padiyar, *FACTS Controllers in Power Transmission and Distribution*, New Age International.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

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

- *Analyse and design power electronic systems for grid integration of solar power generation systems*
- *Analyse and design power electronic systems for grid integration of wind power generation systems*
- *Design active power filters.*

13.805.4 ROBOTICS (E) (Elective IV)

Teaching Scheme: 2(L) - 2(T) - 0(P) **Credits**: 4

Course Objective:

- *To familiarize students with robot classifications and configurations.*
- *To acquaint the students with Forward Kinematics and Inverse Kinematics, Trajectory planning, dynamic modeling, control and applications of robots.*
- *To impart the knowledge about mobile robot locomotion and kinematics, environment perception, localization, mapping and navigation of mobile robots.*

Module – I

Introduction - Definitions, Robot Elements - links, joints, end effector, actuators, sensors, hydraulic, pneumatic, electric drive systems, Robot specifications, Work envelope of different robots, Classification of Robots.

Robot Coordinate Systems- Fundamental and composite rotations, homogeneous coordinates and transformations, Kinematic parameters, Direct Kinematics-The D-H representation, The Arm equation-Kinematic analysis of a typical robot with DoF less than or equal to 3. The inverse kinematics problem – general properties of solutions, Inverse kinematics of a typical 3 DoF Robot.

Module – II

Tool configuration vector, Workspace analysis, trajectory planning- steps in trajectory planning, joint space techniques, Cartesian space techniques, The pick and place operation –Continuous path motion, Tool configuration Jacobian matrix and manipulator Jacobian.

Manipulator Dynamics - Dynamic model of a robot using Lagrange's Equation, 1 DoF manipulator dynamic modelling, State space model. Steps for building servomotor controlled robot arm (Basics only).

Module – III

Robot control: The control problem, Linear model and linear control schemes, Single axis PID control, nonlinear control schemes- PD gravity control, Computed torque control. Robot vision -Image representation, Perspective and inverse perspective Transformations. Robot programming and programming languages.

Autonomous mobile robots- wheeled mobile robots- types, mobile robot kinematics- kinematic model of differential drive and car like mobile robots. Car like mobile robot- Moving to a point, following a line, following a path, moving to a pose.

Module – IV

Perception- sensors for mobile robots, Sensor classification, Wheel/motor sensors, Heading sensors, Accelerometers, IMU, Ground-based beacons, Active ranging, Motion/speed sensors, Vision-based sensors, Basics of mobile robot localization and navigation

Making of a line following robot (LFR)-Basic Ideas and Principles, DC Motor control, Servo Control. Hardware requirements. Motor Drivers - L293D, TB6612FNG; PWM Speed Control, Differential Drive; Implementation of PID Control.

References:-

1. Robert. J. Schilling, *Fundamentals of robotics – Analysis and control*, Prentice Hall of India 1996.
2. Mittal R. K. and I. J. Nagrath, *Robotics and Control*, Tata McGraw Hill, New Delhi, 2003.
3. John. J. Craig, *Introduction to Robotics (Mechanics and Control)*, Pearson Education Asia, 2002.
4. Ashitava Ghosal, *Robotics - Fundamental Concepts and Analysis*, Oxford University press.
5. John Iovine - *PIC Robotics: A Beginner's Guide to Robotics Projects Using the PIC Micro*, McGraw Hill.
6. Siegwart R., I. Nourbakhsh and D. Scaramuzza, *Introduction to Autonomous Robots, Intelligent Robotics and Autonomous Agents Series*, The MIT Press, Massachusetts Institute of Technology, Cambridge, Massachusetts.
7. Peter Corke, *Robotics, Vision and Control – Fundamental Algorithms in MATLAB*, Springer Tracts in Advanced Robotics, volume 73.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

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

- *Identify the configurations of a robot*
- *Solve forward and inverse kinematic problems*
- *Derive the dynamic model and arrive at state space representation of a robot with minimal DoF*
- *Illustrate path planning, image representations and different robot control methods.*
- *Identify and explain various types of sensors used in robotics.*

13.805.5 NON-LINEAR SYSTEMS (E) (Elective IV)

Teaching Scheme: 2(L) - 2T) - 0(P) **Credits**: 4

Course Objective:

To introduce the methods used for the stability analysis of non-linear systems and to impart knowledge about the different linearization techniques.

Module – I

Introduction and classical techniques- Characteristics of nonlinear systems - classification of equilibrium points-periodic orbits - limit cycles-analysis of systems with piecewise constant inputs using phase plane analysis. Existence and uniqueness of solutions, Lipschitz condition.

Module – II

Stability of Nonlinear Systems - Lyapunov stability - local stability - local linearization and stability in the small- Direct method of Lyapunov - generation of Lyapunov function for linear and nonlinear systems – variable gradient method - Centre manifold theorem - region of attraction - Invariance theorems.

Module – III

Feedback Control and Feedback Stabilisation- Analysis of feedback systems- Circle Criterion – Popov Criterion-Feedback linearization- Design via linearization- stabilization - regulation via integral control- gain scheduling.

Module – IV

Exact Feedback Linearization - Input state linearization - input output linearization - state feedback control - stabilization -tracking - integral control.

References:-

1. Hassan K. Khalil, *Nonlinear Systems*, McMillan Publishing Company, NJ, 2004.
2. John E. Gibson, *Nonlinear Automatic Control*, McGraw-Hill, New York.
3. Jean-Jacques E. Slotine and Weiping Li, *Applied Nonlinear Control*, Prentice-Hall, NJ, 1991.
4. Vidyasagar M., *Nonlinear Systems Analysis*, Prentice-Hall, India, 1991,
5. Shankar Sastry, *Nonlinear System Analysis, Stability and Control*, Springer, 1999.
6. Alberto Isidori, *Nonlinear Control Systems: An Introduction*, Springer-Verlag, 1985

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

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

- *Understand different features of non-linear systems*
- *Analyse a non linear system for stability*
- *Apply feedback stabilization and feedback linearization techniques to non-linear systems.*

13.806.1 ENERGY CONSERVATION AND MANAGEMENT (E) (Elective V)

Teaching Scheme: 2(L) - 2(T) - 0(P) **Credits**: 4

Course Objective:

Objective of the course is to discuss various aspects of energy auditing, energy conservation and energy management.

Module – I

Energy Scenario - Classification of Energy resources, Commercial and non-commercial energy, primary and secondary sources, commercial energy production, final energy consumption, Energy needs of growing economy, short terms and long terms policies, energy sector reforms, distribution system reforms and up-gradation, energy security, importance of energy conservation, energy and environmental impacts, emission check standard, Kyoto Protocol, Clean Development Mechanism, salient features of Energy Conservation Act 2001 and Electricity Act 2003. Indian and Global energy scenario. Introduction to IE Rules. Study of Energy Conservation Building Code (ECBC), Concept of Green Building. GDP coupling - General principles of energy management and energy management planning. Establishing energy database.

Module – II

Energy Audit - Definition, need of energy audit, types of audit, procedures to follow, data and information analysis, energy audit instrumentation, energy consumption – production relationship, pie charts. Sankey diagram, Cusum technique, least square method and numerical based on it. Outcome of energy audit and energy saving potential, action plans for implementation of energy conservation options. Bench- marking energy performance of an industry. Energy Audit Report writing as per prescribed format. Audit case studies of sugar, steel, paper and cement industries.

Module – III

Thermodynamics and energy - Energy efficiency analysis - Coefficient of performance - Energy effectiveness. Management of heating, ventilating and air-conditioning (HVAC): principles, opportunities and case studies. Management of process energy: principles, opportunities and case studies. - Management opportunities with electric drives, lighting, heating and electrolytic systems - Electrical load analysis - Peak demand control. Energy efficient motors. Management of electrical load and lighting - Energy Efficient lightings- CFL’s, advantages and disadvantages. LED, power LED’s, advantages and disadvantages. Surface mounted devices. Solar powered lightings.

Module – IV

Financial evaluation of energy projects - Evaluation of proposals - Payback method - Average rate of return method - Internal rate of return method - Present value method - Life cycle costing approach, Life cycle cost – analysis of lamps. Least cost power planning; end-use oriented energy scenario - DEFENDUS strategy. Use of computers in energy management (description about basic ideas only). Co-generation of electricity.

References:-

1. Charles M. Gottschalk*, Industrial Energy Conservation*, John Wiley & Sons, 1996.
2. Craig B. Smith, *Energy Management Principles*, Pergamon Press.
3. *IEEE Recommended Practice for Energy Management in Industrial and Commercial Facilities*, IEEE Std 739 - 1995 (Bronze book).
4. Rajan G. G., Optimizing energy efficiencies in industry - Tata McGraw Hill, Pub. Co., 2001.
5. Paul O'Callaghan, *Energy Management*, McGraw Hill Book Co.
6. Wayne C. Turner, *Energy Management Hand Book*, The Fairmount Press, Inc., 1997.
7. Rao S. and B. B. Parulekar, *Energy Technology,* Khanna Publishers, 1999.
8. *Success Stories of Energy Conservation* by BEE (www. Bee-india.org)
9. Tripathi S. C., *Utilization of Electrical Energy*, Tata McGraw Hill.
10. Murphy W. R. and Mackay, *Energy Management*, B.S. Publication.
11. Gupta B.R., *Generation and Utilization of Electrical Energy,* S. Chand Publication.
12. Balasubramanian, *Energy Auditing Made Simple,* Bala Consultancy Services.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

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

- *Interpret the present day issues of global warming and the need for energy conservation.*
- *Explain the process of energy auditing and the functions of various governmental agencies related to energy conservation and management.*
- *Outline the principles of energy management in heating, ventilating air-conditioning (HVAC), electric drives, lighting and electrolytic systems.*
- *Prioritize the need for Energy Efficient lightings and Solar powered lightings.*
- *Identify, evaluate and implement feasible energy conservation opportunities.*
- *Outline various methods for the financial evaluation of energy projects.*
- *Illustrate the use of computers in energy management and the need for co-generation of electricity.*

13.806.2 HVDC AND FACTS (E) (Elective V)

Teaching Scheme: 2(L) - 2(T) - 0(P) **Credits**: 4

Course Objective:

- *To apply Power Electronics in Power transmission systems.*
- *To impart knowledge about operation and analysis of different FACTS devices and HVDC transmission.*

Module – I

Analysis of uncompensated AC Power transmission system: active and reactive power related to sending and receiving end, Power angle characteristics-Transient stability, Limitations of Power flow.

Concept of FACTS: Definition of FACTS, types of FACTS compensators.

Module – II

Principle of Shunt Compensation: active and reactive power related to sending & receiving end, active and reactive power related to compensator. FACTS based shunt compensators: TCR, TSC and SVC (Analysis-waveforms, Effective reactance, Compensator Current and Reactive power, VI characteristics), STATCOM – (Analysis - phasor diagram, Compensator Current and Reactive power, VI characteristics).

Module – III

Principle of Series Compensation: active and reactive power related to sending & receiving end, active and reactive power related to compensator. FACTS based series compensators: GCSC, TSSC and TCSC (Analysis-waveforms, Effective reactance, Compensator voltage and Reactive power).

Combined Series –shunt Compensator: Unified Power Flow Controller (UPFC).

Module – IV

DC Power Transmission - Concept, Comparison of AC & DC transmission, application of DC transmission, types of DC links. Converter station equipment, analysis of HVDC converter, Graetz circuit. Power flow control in DC link, HVDC breaker-Only basic concept of DC circuit interruption, Monopolar Operation.

References:-

1. Hingorani N. G. and L. Gyugyi, *Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems*, IEEE Press

2. Barry W. Williams, *Principles and Elements of Power Electronics. Devices, Drivers, Applications, and Passive Components*, Published by Barry W Williams.
3. K. R. Padiyar, *FACTS Controllers in Power Transmission and Distribution*, New Age International
4. T.J.E Miller, *Reactive Power Control in Electric Systems*, John Wiley & Sons.
5. Ned Mohan et.al, *Power Electronics*, John Wiley and Sons.
6. Ashok S. and K. S. Suresh Kumar *FACTS Controllers and applications* course book for STTP, 2003.
7. Rashid M. H., *Power Electronics Circuits, Design and Applications*, Pearson Education
8. Wadhwa C. L., *Electric Power Systems*, Wiley Eastern Ltd
9. Padiyar K. R., *High Voltage DC Transmission*, Wiley, 1993.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

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

- *Apply the Engineering knowledge for analyzing the voltage control issue in an ac transmission line.*
- *Develop solutions to above problems using FACTS devices adaptable for the situation*
- *Analyze and estimate an HVDC project.*

13.806.3 ELECTRIC AND HYBRID VEHICLES (E) (Elective V)

Teaching Scheme: 2(L) - 2(T) - 0(P) **Credits**: 4

Course Objective:

- *To teach the concepts, principles and design of hybrid and electric vehicles.*
- *To give a broad idea about storage devices used.*

Module – I

Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Module – II

Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies. Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives.

Module – III

Introduction to Energy Storage- Requirements in Hybrid and Electric Vehicles. Different Storage options: Batteries, Fuel Cell, Super Capacitor.

Batteries : Basics – Types, Parameters – Capacity, Discharge rate, State of charge, state of Discharge, Depth of Discharge, Technical characteristics, Battery pack Design, Properties of Batteries.

Module – IV

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems.

References:-

1. Iqbal Hussein, *Electric and Hybrid Vehicles: Design Fundamentals*, CRC Press, 2003.
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay and Ali Emadi, *Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design*, CRC Press, 2004.

3. James Larminie, John Lowry, *Electric Vehicle Technology Explained*, Wiley, 2003.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

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

- *To understand the concepts and principles of hybrid and electric vehicles.*
- *To analyse various aspects of hybrid and electric drive train such as their configuration, types of electric machines*
- *To design of hybrid and electric vehicles*
- *To compare the performance of different vehicle configuration.*

13.806.4 INDUSTRIAL AUTOMATION (E) (Elective V)

Teaching Scheme: 2(L) - 2(T) - 0(P) **Credits**: 4

Course Objective:

- *To provide thorough knowledge in the various automation methodologies used in industries.*

Module – I

Overview of Automation System - Architecture of Industrial Automation Systems, Different devices used in Automation, Comparison between Automated and Manual Operated Systems.

Industrial Control Systems, Process Industries Versus Discrete-Manufacturing Industries, Continuous Versus Discrete Control, Computer Process and its Forms.

Module – II

Introduction to Sequence Control, PLCs- Working, applications, Block Diagram of PLC, Processing cycle of PLC, Different types of PLC's available in the market, Specifications of PLC Onboard/Inline/Remote IO's, Comparison of PLC & PC, Relay Ladder Logic- PLC Programming, Building simple logic in PLC, Overview of different types of Data types in PLC programming, Standard format for addressing the variables

Study of SCADA software, SCADA systems, SCADA architecture - Monolithic, distributed and networked.

Module – III

Distributed control systems (DCS): Introduction, DCS - Functions advantages and limitations. DCS as an automation tool to support enterprise resource planning. DCS architecture of different make and specifications.

DCS communication, third party interface display etc. DCS supervisory computer task. Interfacing PLC with SCADA. DCS integration with PLC and computer. DCS communication protocols-FDDI, Ethernet-TCP/IP.

Module – IV

Standard Time formats, Working with Digital Signals/ IO's, Function & Function Blocks, Introduction to Timer/Counters/Triggers, Exercises based on Timers, Counters, Usage of Mathematical Operators, Comparators, Exercises based on the above operators.

References:-

1. Mickell P. Groover, *Automation, Production and Computer Integrated Manufacturing,* Prentice Hall of India, 1992.
2. Frank Lamb*, Industrial Automation: Hands-On*, McGraw-Hill Education, 2013.
3. Madhuchhanda Mitra and Samarjit Sengupta, *Programmable Logic Controllers and Industrial Automation An Introduction,* Penram, 2008.
4. Gary Dunning*, Introduction to Programmable Logic Controllers,* Cengage, 2006.
5. Installation and User Manuals of Different DCS & PLC Vendors.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

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

- *To identify potential areas for automation and justify need for automation*
- *To select suitable major control components required to automate a process or an activity*
- *To translate and simulate a real time activity using modern tools and discuss the benefits of automation. To identify suitable automation hardware for the given application.*
- *To recommend appropriate modeling and simulation tool for the given manufacturing application.*

13.806.5 DIGITAL IMAGE PROCESSING (E) (Elective V)

Teaching Scheme: 2(L) - 2(T) - 0(P) **Credits**: 4

Course Objective:

- *To provide fundamental knowledge about image fundamentals and mathematical transforms necessary for image processing.*
- *To introduce the various image modifying/processing techniques.*

Module – I

Digital image fundamentals: Physics of vision, image digitization, sampling and quantization. Fundamental steps in image processing. Basic pixel based transformation, Basic geometric transformation.

Image transforms: Introduction to 2D DFT and FFT – Separable Image Transforms -Walsh Transform, Hadamard Transform, Discrete Cosine Transform, Haar transforms.

Module – II

Image enhancement: Spatial Domain methods: Basic grey level transformation – Histogram equalization – Image subtraction – Image averaging.

Spatial filtering: Smoothing, sharpening filters – Laplacian filters – Frequency domain filters : Smoothing – Sharpening filters – Homomorphic filtering. Image restoration: degradation, noise models- inverse filtering- Image denoising- median filtering.

Module – III

Image compression: Variable length coding, LZW Coding, Bit plane coding, predictive coding and wavelet coding.

Basics of Image compression standards: JPEG, MPEG. Basics of Binary and colour Image processing- Colour Models, RGB, CMY, HSI.

Module – IV

Morphological Image processing- Dilation, Erosion, opening and closing - Morphological Reconstruction- Gray Scale Morphology

Image segmentation: Region based approach, thresholding and edge detection- Gradient operators- Robets, Prewitt, Sobel and Canny.

References:-

1. Rafael C. Gonzalez and Richard E. Woods, *Digital Image Processing*, 2nd Edition, Pearson Education 2003.

2. Jayaraman S., S. Esakkirajan and T. Veerakumar, *Digital Image Processing*, TMH, 2009.
3. William K Pratt, *Digital Image Processing*, John Willey, 2001.
4. Millman Sonka, Vaclav Hlavac and Roger Boyle, *Image Processing Analysis and Machine Vision*, Cengage, 2014.
5. Jain A. K., *Fundamentals of Digital Image Processing*, PHI, New Delhi, 1995.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) – Five Short answer questions of 4 marks each. All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

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

- *Illustrate different stages of Digital Image Processing and Classify pixel based transformations*
- *Determine the different Geometric transformations.*
- *Determine the basis of different image transforms*
- *Analyze the different methods of Image enhancement and image restoration.*
- *Summarize image segmentation and image compression methods*

13.807 PROJECT AND VIVA VOCE (E)

Teaching Scheme: 0(L) - 0(T) - 5(P) **Credits**: 5

Course Objective :

- *To develop the ability to identify a problem, clearly state the problem specifying its scope and objectives.*
- *To develop the ability to choose the most appropriate method with justification and apply relevant knowledge of the curriculum content along with research effort to solve the problem.*

Course Content

Student groups with not more than five students in a group will be doing a project. Each group is expected to do the project in the domain of Electrical and Electronics Engineering using modern software/Hardware tools. The project evaluation committee consisting of the project coordinator, the guide and other three members of the relevant subject group/ specialization will perform the interim and final evaluations of the project, based on the presentations done by each group at the middle of the semester and at the semester end respectively. Each group should also submit a project report at the end of the semester.

Internal Continuous Assessment *(Maximum Marks-200)*

Marks for interim evaluation – 50

Marks for final evaluation – 50

The interim and final evaluation should be based on following criteria

15%- Project scope and suitability
15%- Review of Literature
25% - Problem statement & Methodology:
25% - Results & Quality of the project
20% - Project Presentation/ Demonstration

Marks to be awarded by the project guide – 100

The mark awarded by the guide should be based on the following criteria

25% - Subject knowledge
35%- Actual work (*Applying subject knowledge to the work and putting research effort*)
10% - Regularity in the class and active participation in discussions
10% - Team work
10%- Communication and documentation skills
10%- Project Report

University Examination

Viva Voce *(Maximum Marks-100)*

35% - Project
15% - Seminar
50% - Viva voce based on general curriculum

Course Outcome:

Upon successful completion of the project, students will be able to:

- *Conduct literature survey using Peer reviewed journals and other resources.*
- *Implement the ideas generated, through learning the fundamental and core components of the curriculum.*
- *Conduct study/experiment, analyze and interpret data and arrive at inferences / conclusions.*
- *Present, document and publish the findings.*