EE 010 701: Electrical Power Transmission

Teaching scheme **Credits:** 4
2 hours lecture and 2 hours tutorial per week

Objectives

- *To impart knowledge about electrical transmission systems*

Module I (10 hours)
Transmission Line Parameters: Inductance of single phase two wire line – inductance of composite conductor lines – inductance of three phase lines – double circuit three phase lines – bundled conductors – resistance – skin effect and proximity effect – magnetic field induction – capacitance of two wire line – capacitance of a three phase line with equilateral spacing and unsymmetrical spacing – transposition of lines – effect of earth on capacitance – method of GMD – electrostatic induction

Module II (11 hours)
Analysis of Transmission Lines: Short transmission line – generalised circuit constants – medium transmission lines by nominal pi and T methods – long transmission line rigorous solution – equivalent circuit of long lines – Ferranti effect – tuned power lines – power flow through a transmission line – Effects of transformer on the performance of a transmission line – reactive power in a line – power transfer capability of transmission lines – compensation of transmission lines – power flow in a long transmission line

Module III (12 hours)
Insulators for overhead transmission lines: Ratings – types of insulators – potential distribution over a string of suspension insulators – string efficiency – methods to improve string efficiency – methods of equalising potential – insulation failure – testing of insulators.
Mechanical design of Transmission Lines: Sag and Tension – Spans of unequal length – equivalent span – effect of ice and wind loading – stringing chart – vibration and vibration dampers.
Underground cables: types of cables – capacitance of single core cables – grading of cables – power factor and heating of cables – capacitance of three core belted cable – DC cables – location of faults in underground cables (Murray and Varley tests)

Module IV (12 hours)
Substations: Types of substations – Bus bar arrangements – substation bus schemes – substation equipments
Grounding Systems: resistance of grounding systems – neutral grounding – resonant grounding – solid grounding or effective grounding – resistance grounding – reactance grounding – earthing transformer
Corona: Critical disruptive voltage – conditions affecting corona – corona loss – factors affecting corona loss – radio interference – interference between power and communication lines.

Module V (15 hours)
HVDC Transmission: Advantages and disadvantages of HVDC transmission – Types of HVDC links – Interconnection of HVDC into AC systems
FACTS Technology: Objectives of Flexible AC Transmission – FACTS devices – simple model of STATCOM, static VAR compensator(SVC), thyristor controlled reactor(TCR), thyristor switched reactor(TSR), thyristor switched capacitor(TSC), interline power flow controller(IPFC), thyristor controlled series capacitor(TCSC), thyristor controlled series reactor(TCSR) and unified power flow controller(UPFC)

Text Books

1. Power System Engineering: D P Kothari and I J Nagrath, Tata McGraw Hill
2. Electric Power Generation, Transmission and Distribution: S N Singh, PHI

Reference Books

1. Power System Analysis: William D Stevenson Jr, John J Grainger, Tata McGraw Hill
2. Electrical machines, Drives and Power Systems: Thoedore Wildi, Pearson Ed.
3. Electrical power Distribution and Transmission: Luces M. Faulkenberry, Walter Coffer, Pearson Education
4. Power System Analysis: Hadi Saadat, Tata McGraw Hill

EE 010 702: Synchronous Machines

Teaching scheme **Credits:** 4
2 hours lecture and 1 hour tutorial per week

Objectives

To impart knowledge on

- *Construction and performance of salient and non – salient type synchronous generators.*
- *Principle of operation and performance of synchronous motors*.

Module 1 (12 hours)

Synchronous Machines: Types – selection of alternators – constructional features of cylindrical and salient pole machines.
Armature windings: different types – phase grouping – single and double layer, integral and fractional slot winding – emf equation – distribution factor – coil span factor – tooth harmonic ripples – skewed slots – harmonics, elimination of harmonics – revolving magnetic field.

Module 2 (14 hours)

Armature Reaction – Synchronous reactance – circuit model of synchronous machine.
Regulation – predetermination – emf, mmf and potier methods, saturated synchronous reactance – Phasor diagrams – short circuit ratio – two-reaction theory – Phasor diagram – slip test – measurement of Xd, Xq, losses and efficiency of synchronous machines.

Module 3 (14 hours)

Parallel operation of alternators – load sharing – synchronizing power and torque – governor characteristics – method of synchronizing – synchroscope.
Synchronous Motor: Principles of operation – torque and power relationships – Phasor diagram – hunting in synchronous machines – damper winding – starting of synchronous motors.

Module 4 (12 hours)

Synchronous machines connected to infinite bus – power angle characteristics of cylindrical rotor and salient pole machines – reluctance power – steady state stability limit – V-curves – inverted V-curves – O-curves – synchronous condenser
Symmetrical short circuit of unloaded alternators – steady state, transient and sub-transient reactance – current variation during short circuit.

Module 5 (8 hours)

Excitation systems: different types – comparison – exciter ceiling voltage – excitation limits – exciter response – methods of increasing the response of an exciter.

Brushless Alternators: Principle of operation - constructional features – excitation methods – voltage regulation.

Internal Continuous Assessment *(Maximum Marks-50)*

60% - Tests (minimum 2)
20% - Assignments (minimum 2) such as home work, problem solving, group discussions, quiz, literature survey, seminar, term-project, software exercises, etc.
20% - Regularity in the class

Note: One of the assignments shall be simulation of continuous systems using any technical computing software

Text Book

1. Electrical Machines: P.S Bhimbra, Khanna Publishers, New Delhi

References

1. The performance and Design of AC Machines: M.G. Say, Cbs Publishers
2. Theory of Alternating Current Machinery: Alexander Langsdorf, Tata Mgraw Hill
3. A course in Electrical Engg. Vol.2: C.L Dawes, McGraw- Hill Book Company inc.
4. Power System Stability – Vol. 3: Edward.W Kimbark, Ieee Computer Society Press
5. Electric Machines: D. P.Kothari & I.J.Nagrath, Tata McGraw Hill
6. Chapman S J, Electrical Machine Fundamentals, Mc Graw Hill
7. Theory and performance of Electrical Machines: J.B Gupta, S. K. Kataria & Sons

EE 010 703: Drives and Control

Teaching scheme **Credits:** 3
2 hours lecture and 2 hour tutorial per week

Objectives

- *To understand the characteristics of important types of electrical machines used in industry and the loads they drive, the speed control using solid state drives for energy efficient operation and the power electronics converters and control schemes required for realizing the drive systems.*

Module I (15 hours)
Concept of Electric Drives –parts of electrical drives – dynamics of electric drive – torque equation –Four quadrant operation of electric drives– loads with rotational and translational motion – Steady state stability- components of load torques – nature and classification of load torques – load equalization.
DC motor drive systems: Methods of speed control – single phase half wave controlled drive, half and fully controlled bridge rectifier drives-continuous and discontinuous conduction – speed torque characteristics-motoring and inverter modes of operation- commutation failure-source side power factor

Module II (10 hours)
3 Phase fully controlled and half controlled bridge rectifier drives-motoring and inverter modes of operation. Dual converter fed DC motor drives. Chopper fed drives –single, two and four quadrant operation- motoring and regenerative breaking.

Module III (10 hours)
Speed Control of three phase Induction motors**:** Stator voltage control – principle –controller configurations –speed reversal- operation and applications-VSI based induction motor drives – V/f control- Constant torque and constant power operation.

Module IV (12 hours)
Slip speed control: Slip power recovery scheme – principle – Static Kramer's drive – Static Scherbius' drive. CSI fed induction motor drives– operation under fixed frequency – operation under variable frequency – Dynamic and Regenerative Braking of CSI and VSI fed Drives. Basic principle of Vector control.

Module V (13 hours)
Speed control of synchronous motors : Adjustable frequency operation of synchronous motors – principles of synchronous motor control – Voltage Source Inverter Drive with open loop control – self controlled synchronous motor drive using load commutated thyristor inverter.
Electric Traction: Important features of traction drives-Conventional DC and AC traction drives – DC & AC traction using PWM VSI SCIM drives

Text Books

1. G.K Dubey, *Power Semiconductor controlled Drives*, Prentice hall, 1989
2. Mohammad A and E.L Sharkawi, *Fundamentals of Electric Drives*, Thomson Learning-2005

Reference Books

1. G.K. Dubey, *Fundamentals of Electrical Drives*, Narosa Publishing House, New Delhi, 2005.
2. R.Krishnan, *Electric Motor Drives – Modeling, Analysis and Control*, Prentice-Hall of India 2003.
3. W. Leonhard, *Control of Electrical drives*, Springer-Verlag, 2005
4. P.C. Sen, *Thyristor DC Drives*, Wiley-Interscience Publication 1984
5. Joseph Vithayathil, *Power Electronics-Principles and applications*, TMH, 2010
6. B. K. Bose, *Modern Power Electronics and A.C. Drives*, PHI, 2002.

EE 010 704: Modern Control Theory

Teaching Schedule: 2hours Lecture and 1hour Tutorial Credits -3

Objective: *To provide sound knowledge of advanced control systems*

Module 1 (9 Hrs**)**

Design of modern control systems- Concept of Controllability and Observability, Kalman's and Gilbert's tests for controllability and observability. Pole placement design using state variable feed back. Observers- design of full order observer.

Module 2. (9Hrs)

Non-linear systems – Characteristics – Phase plane analysis – linearization and stability of equilibrium points – Iscoline method – limit cycles of phase plane – stability of limit cycles.

Module 3.(9Hrs)

Describing function method– Harmonic linearization, describing function of nonlinear systems(On-Off, saturation and dead-zone only)-Analysis of nonlinear systems using describing function. Limit cycles' amplitude and frequency – Stability of non-linear systems – Lyapunov's method for non-linear system – Popov's criterion.

Module 4. (9Hrs)

Discrete time systems – Sampling theorem – sample and hold circuits and data reconstruction – Z-transforms – inverse Z transforms – pulse transfer function – state variables – description of discrete time systems – time domain analysis – stability using Jury's tests and Schurcohn method.

Module 5. (9Hrs)

Computer control of industrial processes(Basic Concepts only) – Control hierarchies for plant level automation – Microprocessor/microcontroller/DSP-based control.

Programmable logic controllers –Principle of operation- Architecture. Introduction to PLC programming –symbols used in ladder diagrams-AND,OR,NOR,XOR,Latch operations, Illustrative example of a motor control using PLC.

PC-based control – Direct Digital control (Basic concept only). Distributed Digital control (Basic Concept only) .

Text Books:

1. K.P. Mohandas, *Modern Control Engineering*, Sanguine Technical Publishers.

2 S.Hassan Saeed, *Automatic Control Systems*. Katson Books

3 M.N. Bandyopadhay, *Control Engineering-Theory and Practice,* PHI.

Reference:

1 Alberto Isidori – Non-linear control systems
2. S. Wiggins – Introduction to applied non-linear dynamical systems and chaos
3. Gene. F. Franklin and David Powel – Digital control of dynamic systems,Pearson.
4. Benjamin .C. Kuo – Digital control systems
5. Digital Control Engineering-Analysis and Design, M.Sami Sadali, Elsevier
6. M. Gopal – Digital control and state variable methods,TMH
7. Stefani,Shahian,Savant and Hostetter, Design of feedback Control Systems, Oxford University Press.
8. Krishna Kant , Computer Based Industrial Control ,PHI(Module 5)
9. S.K. Singh, Process Control, Concepts, Dynamics and Applications, PHI.(Module 5)
10. W.Bolton – Instrumentation and control systems, Elsevier(Module 5)

EE 010 05 : Communication Engineering

Teaching Scheme **Credits: 3**

2 hours lecture and 1 hour tutorial per week.

Objectives

- To develop student's basic concepts in communication engineering.
- To expose the students to modern communication systems.

Module 1 (6 Hours)

Review of AM and FM.

AM receiver- Superheterodyne AM receiver- RF amplifier, mixer, detector and AGC circuits.

FM Transmitter-Reactance modulator (BJT, FET)-Block schematic of Armstrong FM Modulator.

FM receiver-Block Schematic of Superheterodyne FM receiver-FM detector-Ratio detector.

Module 2 (9 Hours)

Television: Composite video signal – synchronizing pulse – blanking pulse-equalizing pulse, Video BW, Positive and negative modulation, Vestigial side band transmission, Television standards.

Colour Television: Compatibility, characteristics of colour transmission and reception, luminance, hue & saturation, colour difference signal, I & Q signals, frequency interleaving, colour sub carrier-block schematic of NTSC,SECAM and PAL transmitters and receivers-comparison.

Module 3 (6 Hours)

Radar: Basic radar system, radar range equation – performance factors, Pulsed radar, Continuous wave radar – advantages-limitations-applications, CW radar, MTI radar system. Radio navigational aids – ILS – GCA-war & peace application.

Module 4 (14 Hours)

Satellite Communication: Satellite frequency band- orbits & inclination-Geostationary orbits-effects of solar eclipse-orbital height-Apogee and Perigee calculation-Satellite subsystem-Altitude & orbit control-Tracking ,Telemetry & command-Power System-Transponder-functions-up link/down link converters. HPA-Antenna subsystem-Satellite link Analysis-Path losses-Link budget calculation-C/N & G/T-up link down link modeling-Multiple access techniques-TDMA-FDMA-CDMA-DA FDMA-DA TDMA-SPADE-Earth Station Block Schematic.

Module 5 (10 Hours)

Digital Communication: Digital Coding of Analog Waves: PCM, Differential PCM, Delta Modulation, PAM, Adaptive Digital Coding.

Modulation Techniques- Basic principles of Binary and M-Ary modulation. Basic Principles of Binary Amplitude Shift Keying-Binary Phase Shift Keying-Binary Frequency Shift Keying-M-Ary Amplitude Shift Keying- M-Ary Frequency Shift Keying- M-Ary Phase Shift Keying.

Text Books

1. Electronic Communication Systems: Wayne Tomasi, Pearson Education, LPE
2. Radio Engineering: M.L.Gupta, Dhanpat Rai Publishing Co (P) Ltd;

References

1 Electronic Communication Systems: George Kennedy, TMH
2. Monochrome and Colour Television: R.R Gulati, Wiley Eastern
3. Satellite Communications: K.N. Raja Rao, PHI
4. Satellite Communication: Manoj Mitra, Khanna Publishers
5. Radio Engineering :Mithal,Khanna Publishers
6. Digital Communications: V.K.Khanna S Chand Publishers.
7. Digital and Analog Communication System: K Sam Shanmugam

EE 010 706 L01: HVDC Transmission

Teaching scheme **Credits:** 4
2 hours lecture and 2 hours tutorial per week

Objectives

- *To impart the basic concepts of HVDC Transmission systems and components*

Pre-requisites: *Fundamentals of Power Electronics*

Module I (13 hours)
Introduction: Comparison of AC, DC transmission – Description of DC transmission systems – Planning for HVDC transmission – Thyristor device characteristics and protection – Pulse number of converters – choice of converter configuration – Review of Graetz circuit – Valve rating – Transformer rating – Simplified analysis of Graetz circuit(without overlap and with overlap) – Converter bridge characteristics.

Module II (10 hours)
HVDC System Control: principles of DC link control – converter control characteristics – system control hierarchy – firing angle control – Current and extinction angle control – Higher level controllers – starting and stopping of DC link – power control

Module III (10 hours)
Converter faults and protection: types of faults – commutation failure – arc through, misfire and current extinction – protection against over currents – over voltages – surge arresters – protection against over voltages – smoothing reactors – DC line – transient over voltages in DC line – Protection of DC line – DC breakers

Module IV (12 hours)
Reactive power control: Steady state reactive power requirements – sources of reactive power – static VAR systems – Thyristor Controlled Reactor – Thyristor switched capacitor – Reactive power control during transients

Harmonics and filters: Generation of harmonics in HVDC systems – criteria of design for AC filters – types of AC filters – DC filters – Carrier frequency and radio interference noise

Module V (15 hours)
Multi-terminal DC systems: applications of MTDC systems – types – comparison – Control and protection

Modeling: Converter model – modelling of DC and AC networks

Text Books
1. HVDC Power Transmission Systems-Technology and System Interactions: K.R Padiyar, New Age Int'l.

Reference Books
1. Direct Current Transmission Vol 1: E.W Kimbark, Wiley
2. HVDC and FACTS controllers – Vijay K Sood – Kluwer Academic Publishers

EE 010 706 L02: Industrial Instrumentation

Teaching Scheme **Credits: 4**

Lecture 2 Hours Tutorial 2 Hours / Week

Objectives

- To describe the construction and operation of measurement and calibration instruments for pressure, level and temperature.
- To select a suitable measurement instrument for a given process measurement.
- To describe the installation procedure for a selected measurement instrument in a particular industrial situation, and correctly interpret measurements obtained.
- To provide latest knowledge of Industrial Instrumentation systems.

MODULE 1 [12Hours]

Displacement, Torque and speed measurement
Transducers-Classification- Measurement of displacement- Resistance potentiometer-Resistance Strain gauge-LVDT- Capacitive transducer-Piezoelectric transducer Measurement of force- Hydraulic force meter- Pneumatic force meter-Electric force transducer-Pressductor load cells- Measurement of torque- Inline rotating Torque sensor-Inline stationary Torque sensor- Proximity Torque sensor- Measurement of speed-Revolution counter-Resonance Tachometer-Eddy current tachometer- Tachometer Generators-D.C. Tachometer- Contactless Tachometer

MODULE 2 [12Hours]

Density, Viscosity and pH Measurement
Density Measurement- Types-Solid-Liquid-Gas- Magnetic methods-Vibrational methods-Weigh methods-Hydrometers-Radiation Densitometer- Refractometric Densitometer-Viscosity Measurement- Types-Capillary-Efflux cup-Rotational-Industrial-Applications of Viscometers- pH Measurement- Working Principle-Construction of electrodes-Glass electrode pH Measurement.

MODULE 3 [12Hours]

Level Measurement
Direct Methods-Hook type Level Indicator-Sight Glass- Float type- Displacer type Level Indicator- Indirect Methods-Hydrostatic pressure type- Pressure gauge Method- Air Bellows- Air purge system- Liquid purge system- Electrical Methods- Capacitance Level Indicator- Radiation Level Detectors- Laser level sensors-- Microwave Level switches-Optical Level Detectors- Ultrasonic Level Detectors- Eddy current Level Measurement sensors- Servicing of Level Measuring Instruments- Selection of Level sensors

MODULE 4 [12Hours]

Pressure Measurement

Different types of Pressure- Methods of Pressure Measurement-Manometers-Elastic Pressure Transducers- Measurement of vacuum- Force balance Pressure gauges- Electrical Pressure Transducers- Pressure switches- Calibration of Pressure Measuring Instruments- Maintenance and repair of Pressure Measuring Instruments-Troubleshooting

MODULE 5 [12Hours]

Temperature measurement

Thermocouple-RTD-Thermistor-LDR-Optical transducers Temperature scales-Methods of Temperature measurement- Expansion Thermometer **–** Filled system Thermometer- Electrical Temperature Instruments-Pyrometers-Fiber optic Temperature measurement systems- Ultrasonic Thermometer – Calibration of Thermometers- Temperature measurement considerations-

TEXT BOOKS

1. S K Singh , Industrial instrumentation and control, Tata McGraw Hill Publishing Ltd., New Delhi.
2. Arun K.Ghosh , Introduction to Measurements and Instrumentation , PHI Learning Private Limited , New Delhi.

REFERENCE BOOKS

1. D.Patranabis, Principles of Industrial Instrumentation, Tata McGraw Hill Publishing Ltd., New Delhi.
2. A.K.Sawhney, A course in Electrical and Electronic Measurement and Instrumentation – Dhanpat Raj and Sons, New Delhi
3. P.Holman, Experimental Methods for Engineers International Student Edition, McGraw Hill Book Company
4. B.C.Nakra and K.K.Chaudary, Instrumentation Measurement and Analysis, Tata McGraw Hill Publishing Company Ltd., New Delhi

EE 010 706 L03: Power Quality

Teaching scheme

Credits: 4

Lecture 2 hours and Tutorial 2 hours per week

Objectives

- *To impart the basic concepts of Power quality the various measures to improve power quality*

Module-1 (12 Hours)

Definition of **power quality**- power quality progression-power quality terminology –power issues- susceptibility criteria-cause and effects – treatment criteria-PQ weak links-interdependence – Stress-strain criteria –PQ Vs equipment immunity- classification of PQ issues-PQ measures and standards .

Module-2 (12 Hours)

Power frequency disturbances.

Introduction –Common power frequency disturbances- voltage sags-voltage swells

Cures for low frequency disturbances:- Isolation transformers- voltage regulators-static uninterruptible power source systems-Rotary uninterruptible power source units-voltage tolerance criteria. Conclusions

Module-3 (12 Hours)

Electrical Transients:-

Impulsive transients-oscillatory transients-transient system model.

Sources of transient over voltages:- Capacitor switching-magnification of capacitor-switching transients-Lightening –Ferro resonance- other switching transients-principles of over voltage protection- Devices for over voltage protection:- surge arresters and transient voltage surge suppressers- low pass filters- low impedance power conditioners- utility surge arresters. Switching transient problems with loads:- transients from load switching-transformer energizing :– Computer tool for transients analysis

Module-4 (12 Hours)

Harmonics:- Definition –harmonic distortion –voltage vs. current distortion- harmonics vs. transients .

Power system quantities under non sinusoidal conditions:- Active, reactive and apparent power- power factor- displacement and true harmonic phase sequences- triplen harmonics .Effects of harmonics on power system devices- THD,TIF ,DIN .

Module-5 (12 Hours)

Power Quality monitoring (basic ideas only needed)-Power quality measurements equipment:- Wiring & grounding testers-multimeters- Oscilloscope-disturbance analyzer-spectrum analyzer and harmonic analyzer-combination disturbance & harmonic analyzer-flicker meter-smart power quality monitors- transducer requirements.

TEXT BOOKS:

1. Surya Santoso, H Wayne Beaty, Roger C Dugan, Mark F McGranaghan, Electrical Power System Quality, McGraw Hill, 2002
2. C. Sankaran , Power Quality, CRC Press

REFERENCES

1 Fuchs,Power Quality in Power systems and Electrical Machines; Elsevier Publications, 2009

2.G T Heydt, Electric Power Quality, West Lafayette, Stars in a circle Publications,1991

3 Jose Arillaga and Newille R Watson, Power System Harmonics, John Wiely,2003

4. J Arrilaga Power System Quality Assessment, John Wiley,2000

5. Math H Bollen, Understanding Power Quality Problems, IEEE Press Standard Publishers, Delhi,2001

EE 010 706 L04 PLC Based systems

Teaching scheme **Credits: 4**

Lecture 2 hours and Tutorial 2 hours per week

Objectives

- *To impart the basic concepts of handling analog and discrete signal, by PLC for industrial automation using Ladder programming.*

Module I (12 Hours)

Configuration of PLC-Basic block diagram-Types of PLC- Open frame and Shoe box PLCs-Discrete and analog I/O voltage levels-scan time, and scan rate and Scan cycle. Central processing Unit, memory of PLC. Power supply to PLC – Interfacing I/O modules (module layout)
Electromechanical relay-NO and NC contacts-time delay relays- Delay On timer relay-Delay off timer relay. Realization of logic gates with relay contacts. AC motor control (ON/OFF) using contactors.

Module II (14 Hours)

PLC programming-Programming formats. Ladder diagram basics - rail, rung, sub rung, timer, contacts. Relation of digital gate logic to contact/coil logic. Process Scan-scan rate. Internal relays - Oscillators in PLC- simple examples. Process Scan-scan rate. Discrete I/O to PLC – Opto isolated inputs and outputs- Isolated inputs and non -isolated inputs. Output wiring- Relay outputs - solid state output with sinking and sourcing
Mnemonic based programming of PLC- simple examples.

Module III (12 Hours)

Registers – General characteristics- input, output and holding registers. PLC arithmetic functions- addition, subtraction, multiplication, division, square root, trigonometric and logarithmic functions. PLC timer functions- process timing applications. PLC counter functions. Shift register applications and sequencers in PLC.
Skip and Jump functions in PLC, Data move and FIFO functions. Bit operations- changing a register bit status.

Module IV (10 Hours)

Sensors – output classification-Connecting discrete sensors to PLC. Sensors of physical quantities- proximity sensors – Temperature sensors – Liquid level sensors – Force sensors – Pressure sensors – Flow sensors – Acceleration sensors – Rotating speed sensors - linear displacement sensors.

Module V (12 Hours)

Analog PLC operation – analog modules - voltage and current levels. PID control in PLC – Importance of Proportional , Derivative and Integral components - Tuning methods – Adjust and observe method , Ziegler-Nichols method , Auto tuning.
Networking of PLC – Distributed Control System(DCS) with PLCs. Speed control of DC and AC motors using PLC.

Text Books

1. Programmable Logic Controllers : John R. Hackworth, Pearson Education.
2. Programmable Logic Controllers – Principles and Applications : John W. Webb and Ronald A. Reis , PHI learning (Fifth edition)

Reference Books

1. Programmable Logic Controllers : Petruzella , Mc Graw Hill Publication (Third edition)
2. Programmable Logic Controllers – Principles and Applications : NIIT , PHI learning

3 .Programmable Logic Controllers- Bolton, Elsevier Publications,Fifth edition

EE 010 706 L05: MEMS Technology

Teaching scheme **Credits: 4**

Lecture 2 hours and Tutorial 2 hours per week

Objectives:

- Makes students conversant with unfamiliar concepts and practices that are needed to solve MEMS problems.
- Presents exciting new opportunities for students to become involved in specific application domain such as bio engineering, nanotechnology, optical engineering, power & energy, wireless communication, etc…

Module I (12 Hours)
Micro Electro Mechanical Systems (MEMS) : History of MEMS development – characteristics of MEMS.
Microfabrication – introduction – micro electro fabrication process – silicon based MEMS process – new materials and fabrication process.

Module II (12 Hours)
Electrostatic sensors and actuators – introduction – parallel plate capacitors – applications of parallel plate capacitors – interdigitated finger capacitors.
Thermal sensors and actuators – introduction - sensors and actuators based on thermal expansion – thermal couples – thermal resistors – applications.

Module III (12 Hours)
Piezoresistive sensors – origin and expression of piezoresistivity - piezoresistive sensor materials – applications of piezoresistive sensors.
Piezoelectric sensors and actuators – introduction – properties of piezoelectric materials – applications.
Magnetic actuation – introduction – essential concepts and principles – fabrication of micromagnetic components.

Module IV (12 Hours)
Micromachining and silicon anisotropic etching – introduction – anisotropic wet etching - dry etching of silicon – plasma etching – Deep reactive ion etching (DRIE) – isotropic wet etching.
Surface micromachining – basic surface micromachining process – structural and sacrificial materials – acceleration of sacrificial etch.

Module V (12 Hours)
Instruments for scanning probe microscopy – introduction – general fabrication methods for Tips – cantilevers with integrated Tips – SPM probes with sensors and actuators.
Optical MEMS – introduction – passive MEMS – optical components – actuators for active optical MEMS.

Text Book

1. Foundations of MEMS – Chang Liu (University of Illinois at urbana – chapaign)

Reference

1 .MEMS and MOEMS Technology and applications – P. Rai-Choudhury (PHI Learning Private Limited, New Delhi)

EE 010 706 L06: Special Electrical Machines

Teaching scheme **Credits: 4**

Lecture 2 hours and Tutorial 2 hours per week

Objective: *To introduce special types of electric machines and their applications.*

Module I (12 Hours)
Stepping Motors
Constructional features, principle of operation, modes of excitation, single phase stepping motors, torque production in variable Reluctance (VR) stepping motor, Dynamic characteristics, Drive systems and circuit for open loop control

Module II (12 Hours)
Switched Reluctance Motors
Constructional features, principle of operation. Torque equation, Power controllers, Characteristics and control.

Module III (12 Hours)
Synchronous Reluctance Motors
Constructional features: axial and radial air gap Motors. Operating principle, reluctance torque – Phasor diagram, motor characteristics.

Module IV (12 Hours)
Permanent Magnet Brushless DC Motors
Commutation in DC motors, Difference between mechanical and electronic commutators, Hall sensors, Optical sensors, Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Torque and emf equation, Torque-speed characteristics, Controllers

Module V (12 Hours)
Permanent Magnet Synchronous Motors
Principle of operation, EMF, power input and torque expressions, Phasor diagram, Power controllers, Torque speed characteristics

REFERENCES

1. Kenjo T, Sugawara A, *Stepping Motors and Their Microprocessor Control*, Clarendon Press, Oxford, 1994.
2. Miller T J E, *Switched Reluctance Motor and Their Control*, Clarendon Press, Oxford, 1993.
3. Miller T J E, *Brushless Permanent Magnet and Reluctance Motor Drives*, Clarendon, Press, Oxford, 1989.
4. B K Bose, *Modern Power Electronics & AC drives*, Pearson, 2002.

EE 010 707: Electrical CAD

Teaching scheme **Credits:** 2

3 hours practical per week

Objective:

To develop skills in computer aided drafting of electrical machines and lay-out of various electrical installations.

Familiarization of CAD Environment- Creating files/folders- Naming of files/folders-Basic features of CAD software like AutoCAD, ProE, CATIA etc. Drafting and modelling- Setting the work space/work bench- 2D drafting/sketching- Status bar/tool bar settings.

Simple drawing commands: line, ray, arc, circle, spline, ellipse, polygon etc., text, text editing

Edit commands – cut, copy, paste…, **View commands**- zoom, pan, redraw, regen …,

Modify commands- erase, copy, mirror, offset, move, rotate, trim, extend, arrays….,
Object selection – Window, crossing, last, previous…

Preparation of 2D drawings -Dimensioning- Layer and block control, Block Editor, Dimension styles, Scaling, Editing Preparation of 2D drawings-X-ref- commands, Printing/ Plotting of drawings

Electrical CAD- Symbol libraries, Electrical User interface, icon menus, PCB drawing, Help system, Basic work flow, Project manager- opening, activating and closing projects

Drawing Examples- DC simplex Lap and Wave windings- Schematic wiring, Wires, Ladders, Wire numbering, Signal arrows…etc, Three phase ac double layer Lap winding and single layer Mush winding

Circuits- Multiple phase circuits, Electrical Schematic drawing of an 11kV indoor Sub-station, HT/LT panels with Circuit Breakers-Electrical Schematic drawings of MSB with supplies from a Transformer and Standby DG set, relays, indication lamps, metering etc.

Editing- Editing tools, Schematic symbols, Updating of blocks, Rail assembly.

Electrical Machine (2D) dimensioned drawings- Half sectional elevation and end view of Induction motor, Synchronous machine and DC machine.

Introduction to 3D (demonstration only)

References

1. Auto CAD reference manual (Release 2008 or later)
2. A text book computer aided machine drawing: S. Trymbaka Murthy
3. CAD/ CAM principle, practice and manufacturing management: Chris McMahon, Jimmie Browne

EE 010 708: Control And Simulation Laboratory

Teaching Scheme **Credits: 2**

3 hours lab per week

Objectives

1. *To impart knowledge in various aspects of control systems through experiments*
2. *To impart knowledge in the simulation of different systems*

PART A

1. Transfer function of armature controlled D.C. motor b) Field controlled D.C. motor.
2. Transfer function and characteristics of amplidyne.
3. Load characteristics of amplidyne under different levels of compensation.
4. Closed loop voltage regulation of separately excited D.C generator using amplidyne.
5. Characteristics of synchro pair and its transfer function
6. Closed loop feedback control system for D.C. servo motor with velocity feedback.
7. Level process control/ Temperature process control using PI, PD and PID control.
8. Transfer function and characteristics of A.C. servomotor.
9. Closed loop performance of inverted pendulum.
10. Open loop control of stepper motor using microprocessor.

PART B

1. Step response and computation of time-domain specifications of typical second order systems using MATLAB.
2. Frequency response and computation of frequency -domain specifications of typical second order systems using MATLAB.
3. Design of lag compensator using MATLAB. Verification of the frequency response characteristics of the designed compensator using passive elements.
4. Design of lead compensator using MATLAB. Verification of the frequency response characteristics of the designed compensator using passive elements.
5. Design of PD,PI and PID controllers for conceptual systems using MATLAB/LabView.
6. State variable analysis of inverted pendulum using MATLAB.
7. Simulation of models(Transfer function and state –space) of conceptual systems using SIMULINK/Lab View.
8. Simulation and analysis of non-linear and discrete time systems using SIMULINK.

9. Analysis of D.C and A.C circuits using PSpice(for independent sources and dependent sources).
10. Analysis BJT/MOSFET circuits using PSice.

References:

1. Richard C. Dorf and Robert H. Bishop, Modern Control Systems,Eleventh Edition, Pearson Educatio,n2009.
2. Katsuhiko Ogatta, Modern Contro Engineering,Fourth Edition, Pearson Education,2002.
3. Muhammad H. Rashid, Introduction to PSpice Using Orcad for Circuits and Electronics, Third Edition,PHI2009.
4. R.K. Bansal,A.K. Goel,M.K Sharma,MATLAB and Its Application in Engimneering, Second edition, Pearson,2010.

EE 010 709 Seminar

Teaching scheme **credits: 2**

2 hours practical per week

The seminar power point presentation shall be fundamentals oriented and advanced topics in the appropriate branch of engineering with references of minimum seven latest international journal papers having high impact factor.

Each presentation is to be planned for duration of 25 minutes including a question answer session of five to ten minutes.

The student's internal marks for seminar will be out of 50. The marks will be awarded based on the presentation of the seminar by the students before an evaluation committee consists of a minimum of 4 faculty members. Apportioning of the marks towards various aspects of seminar (extent of literature survey, presentation skill, communication skill, etc.) may be decided by the seminar evaluation committee.

A bona fide report on seminar shall be submitted at the end of the semester. This report shall include, in addition to the presentation materials, all relevant supplementary materials along with detailed answers to all the questions asked/clarifications sought during presentation. All references must be given toward the end of the report. The seminar report should also be submitted for the viva-voce examination at the end of eighth semester.

For Seminar, the minimum for a pass shall be 50% of the total marks assigned to the seminar.