BRANCH-INDUSTRIAL POWER CONTROL & DRIVES

Specialization: **Industrial** ***Power Control & Drives***

Second Semester							
Theory					**Practical**		
Course Name	**Hours/ Week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
Specialization Core-1 Load Flow & Optimal Power Control	4-0	4	100	50	-	-	-
Specialization Core-2 Advanced Electric Drives	4-0	4	100	50	-	-	-
Elective -I(Specialization related) 1.HVDC Transmission & FACTS 2. Digital Relaying 3.Solid State Control of Electric Drive 4.Power System Reliability	4-0	4	100	50	-	-	-
Elective-II (Departmental related) 1.Advance Control System 2. Design & Synthesis of Control System 3.Power Quality Improvement Techniques 4.Power System Control & Instrumentation	4-0	4	100	50	-	-	-
Elective -III(from any department) 1. Electric Drives In Hybrid Vehicle 2.Green Energy Resources & Technology 3. Transducer & Instrumentation 4.Advanced Digital Signal Processing	4-0	4	100	50	-	-	-
Lab-2 (Specialization lab to be decided by the department)					4	4	150
Seminar/Project					4	4	150
Total							
Total Marks: 1050							
Total Credits: 28							

LOAD FLOW AND OPTIMAL POWER CONTROL

Module-I : (10 Hours)

The energy system in steady state. System modeling and load flow analysis, A demonstration example, system model. The static load flow equation(SLFE), important characteristic of SLFE, classification of system variable, solution of system variable, solution of SLFE a basic diagram, modified specification, its solution generalization of N-bus system, practical state variable, constrains, practical control variable constrains , practical variable specification procedure, bus classification on basis of specification type, sensitivity analysis and the problem of control perturbation sensitivity matrices.

Module-II : (15 Hours)

Definition of load flow problem, Network formulation, a demonstration example, SLFE in general form, Network graph, choice of linearly independent network variable, Network variable in loop frame/bus frame of reference network variable. A load flow sample study, Computational aspect of the load flow problem. Iterative computation of the load flow equation. Effect of regulating transformer

The energy system in steady state optimum operating strategies.

The general programming problems, Optimum generation allocation. Line losses neglected, cost criterion, constrain relation, optimum dispatch strategy for a two bus system, optimum dispatch of N-bus system, Computational consideration, optimum generation allocation including the effect of transmission loss.

Derivation of optimum dispatch formula, optimum dispatch strategy for two bus system, optimum dispatch strategy for N-bus system, Computational consideration. The general optimum operational problem formulation. Necessary condition for optimum computational procedures.

Module-II : (15 Hours)

Control Problems:

Control system structure, Dynamic incremental state variable, coherency: power factor versus QV control: dynamic interaction between Pf Vs Qv loops megawatt frequency control problem. Fundamental characteristic of power control mechanism of an individual generator division of the power system into control area, pf. Control of single control area economic dispatch controller, pf control of multicontrol problems, control strategy: Fundamental characteristic of typical excitation system. Newer aspect of the megavar voltage control problem, Optimum system control, static versus dynamic stability, development of dynamic state variable, model for two area system, optimum control criterion ,optimum control strategy. Introduction of damping into the pf loop through voltage control

Reference:

1. Electrical Energy System Theory by O.I Elgard : TMH publisher
2. Power System Control and Stability by P.M Anderson and FOUD, A.A lowa state university press
3. Current literature

ADVANCEDELECTRICALDRIVES

Module-1(15hours)

Sensorless Introduction to AC Machines for Drives: Dynamic d-q model of Induction Motor and Salient Pole Synchronous machine. Study of PermanentMagnet(PM) machines and Variable reluctance Machine(VRM). [Ch- 2.2.12, 2.3.1-3, 2.4]

Control and Estimation of Induction Motor Drives: Small-Signal Equations of Induction Machines, Principle of vector control, Direct vector control, Indirect Vector Control, Stator flux oriented Vector control. [Ch- 8.2, 8.3, 8.4]

Module-2(15hours)

Sensorless Vector Control: Speed Estimation Methods, Direct vector control without speed signal, Direct Torque and Flux control. [Ch- 8.5, 8.6]

Control and Estimation of Synchronous Motor Drives: Sinusoidal SPM machine Drives, Synchronous Reluctance Machine Drives, Sinusoidal IPM machine Drives, Trapezoidal SPM machine Drives, Wound-Field Synchronous Machine Drives, Switched Reluctance Motor (SRM) Drives. [Ch- 9.2, 9.3, 9.4, 9.5, 9.6, 9.8]

Module-3(10hours)

Fuzzy Logic Principles and Application: Introduction,fuzzySets, FuzzySystem, FuzzyControl, General Design Methodology, Application(Induction Motor Speed Control, Flux Programming Efficiency Improvement of IM Drive). [Ch- 11.1, 11.2, 11.3, 11.4, 11.5, 11.6]

Neural Network Principles and Application: Introduction, The Structure of a Neuron, ArtificialNeural Network, Application (PWM Controller,Vector-controlled Drive Feedback Signal estimation) [Ch- 12.1, 12.2, 12.3, 12.7.1-3]

Textbook:

1. Bose, Bimal K, 'Modern Power Electronics and AC Drive', PHI Publication, 2008

References:

1. Muhammad Rashid, 'Power Electronics Handbook', Academic Press, 2006.
2. R. Krishnan, "Electric Motor Drives Modeling, Analysis and Control", 2007.

HVDC TRANSMISSION & FACTS

Module-I(10hours)

Introduction: Comparison of AC-DC Transmission, Description and application of HVDC transmission, DC System components and their functions

Analysis of HVDC Converters: Pulse number, Converter configuration, Analysis of Graetz circuit, Bridge characteristics, 12 pulse converter.

Module-II :(11hours)

HVDC Control: Principles of DC Link control-Converter control characteristics- System control, Firing angle control- Current and extinction angle control, DC link power control, Reactive power control and VAR sources, MTDC system- types- control and protection- DC circuit breakers

Module-III:(15hours)

FACTS Concept and General System:

Transmission interconnections, Flow of power in AC system, Power flow and dynamic stability considerations of a transmission interconnection, Relative importance of controllable parameters, Basic types of FACTS controllers, Benefits from FACTS Technology, In-perspective: HVDC or FACTS

Module-IV:(15hours)

Compensators: Objective of series and shunt compensation, SVC and STATCOM, GCSC, TSSC, TCSC, and SSSC, UPFC, IPFC, Generalized and Multifunctional FACTS Controllers

Text/References:

1. Padiyar K.R., "HVDC Power Transmission System", Wiely Eastern PVT Limited
2. Kimbark, "Direct Current transmission", Vol.1, John Wielly, New York, 1971
3. Understanding FACTS: Cocepts and Technology of Flexible AC Transmission Systems. By N. G. Hingorani and L. Gyugi, Standard Publisher Distributors, IEEE Press, Delhi
4. Flexible AC Transmission Systems. By J. Arillage 13

DIGITAL RELAYING

Module1-(10 hours)

Evolution in Protection systems, characteristic of protective relay, introduction to computer relaying, Functional block diagram of digital relay, software tools for digital simulation of relaying signal, Performance issue of Current and Voltage Transformer and its improvement

Module2-(10 hours)

Discrete Fourier Transform[DFT], DFT window, Digital filtering and its benefits, simple low pass filter, simple high pass filter, finite impulse response[FIR] filter, infinite impulse response[IIR] filter.

Module3-(10 hours)

Signal conditioning, Sampling and Analogue to Digital Conversion, relaying algorithm, sample and derivative technique, Fourier full cycle and half cycle algorithm and its frequency response, differential equation algorithm, selective integration technique, digital algorithm for power system frequency measurement

Module4- (10 hours)

Digital protection scheme for Transformer, Generator, Transmission lines, Adaptive relaying, Basic concept of Artificial Neural Network[ANN] and Fuzzy logic. ANN approach and fuzzy logic method for fault detection and fault location. Testing of protecting relay

Books and Journals:-

1. Warrington A.R and Von. C . ,***Protective Relaying Theory and Practice*** Vol. II, Chapman and Hall
2. ***Computer Relaying for power system***, Arun G Phadke and James Throp, John Wiley, Inc
3. IEEE tutorial courses on Microprocessor Relay and protection Systems, Power research Group, University of Saskatchewan, 1979 and 1987
4. IEEE tutorial courses on Advancement in Microprocessor based protection and communication
5. Technical Papers from IEEE Transaction, CIGRE,IEE journals

SOLID STATE CONTROL OF ELECTRICAL DRIVES

Module -I: (8 hours)

Speed control of dc motors: Industrial motor drive requirements - typical load torque speed curves – energy savings - variable speed drives - load dynamics and modeling - load type and duty ratio - motor choice - speed control principles - constant torque - constant power . multi quadrant operations.

Solid state controlled DC motor - converter fed - chopper fed . operating modes . configurations - speed control . torque control . speed reversal - braking - regeneration - closed loop regulation - Inching . jogging . effect of saturation.

Module -II: (8 hours)

Design of controller and converter for dc drives: Closed loop operation - speed regulation . speed loop - current loop . tracing of waveforms . speed reversal . torque reversal . with/ without braking and regeneration . design of converters and choppers - firing scheme - simulation. Modeling of dc motors, converters, choppers - controller design, speed controller, current controller . performance analysis with and without current controller - simulation.

Module -III: (8 hours)

Speed control of induction motor . Stator side: Comparison of different ac power controllers . principles of speed control – variable voltage - variable frequency operation . constant flux operation - constant power operation . speed control of VSI and CSI fed drives - design examples. Closed loop control schemes - dynamic and regenerative braking - speed reversal. Tracing of critical waveforms - effect of non- sinusoidal supply.

Module -IV: (8 hours)

Speed control of induction motor . Rotor side: Torque slip characteristics . speed control through slip - rotor resistance controlchopper controlled resistance . equivalent resistance . TRC strategy .characteristic relation between slip and chopper duty ratio - combined stator voltage control and rotor resistance control . design solutions . closed loop control scheme.

Slip power recovery - torque slip characteristics - power factor considerations – sub and super synchronous operation - design solutions - closed loop control scheme.

Module -V: (8 hours)

Speed control of synchronous motor drives: Need for leading PF operation - open loop VSI fed drive . group drive applications. Self control . margin angle control - torque angle control - power factor control - simple design examples Closed loop speed control scheme with various power controllers - starting methods. brush less excitation systems.

TEXT BOOKS

1. Power semiconductor controlled devices, Dubey, G.K, Prentice Hall International Newjersey, 1989.
2. Electric Motor Drives . Modeling, Analysis and Control, R.Krishnan, Prentice- Hall of India Pvt. Ltd., New Delhi, 2003.

POWER SYSTEM RELIABILITY

Module-I (10Hours)

Generating Capacity Basic Probability Methods: The generation system model, Loss of load indices, Equivalent forced outage rate, Capacity expansion analysis, Scheduled outages, Evaluation methods on period basis, Load forecast uncertainty, Forced outage rate uncertainty, Loss of energy indices.

Generating Capacity Frequency & Duration Method*:* The generation model, System risk indices.

Module-II (12 Hours)

Interconnected Systems: Probability error method in two interconnected systems, Equivalent assisting unit approach to two interconnected systems, Factors affecting the emergency assistance available through the interconnections, Variable reserve versus maximum peak load reserve, Reliability evaluation in three interconnected system, multi connected system, Frequency & duration approach.

Operating Reserve: General concepts, PJM method, Extension to PJM method, Modified PJM method, Postponable outages, Security function approach, Response risk, Interconnected systems.

Module-III (10 Hours)

Composite Generation & Transmission Systems: Radial configurations, Conditional probability approach, Network configurations, State selection, System & load point indices, Application to practical systems, Data requirements for composite system reliability.

Plant & Station Availability: Generating plant availability, Derated states & auxiliary systems, Allocation & effect of spares, Protection systems, HVDC systems.

Module-IV (11 Hours)

Distribution Systems Basic Techniques & Radial Networks: Evaluation techniques, additional interruption indices, Application to radial systems, effect of lateral distributor protection, Effect of disconnects, Effect of protection failures, effect of transferring loads, Probability distributions of reliability indices.

Distribution Systems-Parallel & Meshed Networks: Basic evaluation techniques, Inclusion of busbar failures, Inclusion of scheduled maintenance, Temporary & transient failures, Inclusion of weather effects, Common modes failures, Common mode failures & weather effects, Inclusion of breaker failures.

Text Books

1. Billinton Roy& Allan Ronald “Reliability of Power system”, Pitman Pub. 1984
2. Richard Elect. Brown, “Electric Power Distribution Reliabilty”, CRC Press

ADVANCED CONTROL SYSTEMS

Module-I : (10 Hours)

***Digital Control* :**State Space Representations of Discrete Time Systems, Solution of Discrete Time State Equations, Discretization of Continuous Time State Equations. Controllability and observability of Linear Time Invariant Discrete Data Systems, Pole Placement, Deadbeat response, Digital Simulation.

Module -II : (12 Hours)

Optimal Control :Performance Indices, Quadratic Optimal Regulator / Control Problems, Formulation of Algebraic Riccati Equation (ARE) for continuous and discret time systems. Solution of Quadratic Optimal Control Problem using Lograng Multiplies for continuous and discrete-time systems.Evaluation of the minimum performance Index, Optimal Observer, The Linear Quadratic Gaussia (LQG) Problem, Introduction to H_∞ Control.

Module - III : (11 Hours)

***Non linearSystems* :**The Aizerman and Kalman Conjectures : Popov's stability criterion, the generalized circle criteria, simplified circle criteria. Simple variable structure systems, sliding mode control, feedback linearization, Model reference adaptive control, (MRAC), Self Tuning Regulator (STR).

Module - IV : (10 Hours)

***Fuzzy Logic Control* :**Fuzzy sets and crispsets, Fuzzy Relations and composition of Fuzzy Relations, Introduction to Fuzzy Logic Controllers.

Books :

1. Discrete Time Control Systems, by K.Ogata, 2nd edition (2001), Pearson Education publication.
2. Digital Control Systems, by B.C. Kuo, 2nd edition (1992), Oxford University Press.
3. Digital Control and State Variable Methods, by M.Gopal, 3rd edition (2009), Tata Mc. Graw Hill Education Pvt. Ltd.
4. Systems and Control by Stanislaw H.Zak, Oxford University Press (2003).
5. Design of Feedback Control Systems by Raymond T. Stefani, B.Shalia, Clement J. Savant, Jr. Gen H. Hostetter, 4th edition (2002), Oxford University Press.
6. Introduction to Control Engineering (Modeling, Analysis and Design) by Ajit K. Mandal, New Age International (P), Ltd., Publishers (2006).
7. Non Linear Systems, by Hassan K. Khallil, 3rd edition (2002), Prentice Hall, Inc. (Pearson Education), Publications.
8. Control Theory (Multivariable and non linear Methods) by Torkel Glad &LennartLjung, Taylor & Francis (2009).

DESIGN AND SYNTHESIS OF CONTROL SYSTEM

Module-1 (15 hours)

State Variable Analysis: Introduction, Concept of State, State Variable and State Model Mathematical Modeling of dynamics system in state space State Space representation of Mechanical and Electrical Systems State Equations and Transfer functions Diagonalization, Characteristic equation, Eigen values and Eigen vectors of state matrix, Solution of state equation, Determination of State Transition matrix Concepts of Controllability and Observability

Module-2 (15 hours)

Design of Continuous System: Introductions, Design specifications, Controller Configurations Design with PD, PI and PID controllers Design with Phase lead, Phase lag and Lead-lag Compensator Design of Robust control system State Feedback Control, Pole-placement design through state feedback State Feedback with Integral control

Module-3 (10 hours)

Design of Discrete-Data control System: Introduction, Digital implementation of analog controller, Digital controller Design of discrete data control system in frequency domain

References:

1. Automatic Control System: by B. C. Kuo, PHI Pvt. Ltd.
2. Modern Control Engineering: by K. Ogata, Pearson Education.
3. Digital Control System: by M. Gopal, Wiley Eastern Ltd.

POWER QUALITY IMPROVEMENT TECHNIQUES

Module-I : (15 Hours)

Concept of Power Quality: Frequency variations, voltage variations- sag and swell,waveform distortion –dc offset,harmonics, inter-harmonics, notching and noise. Fundamentals of Harmonics: Representation of harmonics,waveform, harmonic power, measures of harmonic distortion;Current and voltage limits of harmonic distortions: IEEE, IEC, EN,NORSOK.
Causes of Harmonics: 2-pulse, 6-pulse and 12-pulse converter configurations, input current waveforms and their harmonic spectrum; Input supply harmonics of AC regulator, integral cycle control, cycloconverter, transformer, rotating machines, ARC furnace, TV and battery charger.

Module-II : (14 Hours)
Effect of Harmonics: Parallel and series resonance, effect of harmonics on static power plant – transmission lines, transformers,capacitor banks, rotating machines, harmonic interference withripple control systems, power system protection, consumer equipments and communication systems, power measurement.
Elimination/ Suppression of Harmonics: High power factorconverter, multi-pulse converters using transformer connections(delta, polygon).

Module-III : (15 Hours)
Passive Filters: Types of passive filters, single tuned and high passfilters, filter design criteria, double tuned filters, damped filters andtheir design.Active Power Filters: Compensation principle, classification ofactive filters by objective, system configuration, power circuit and control strategy.
PWM Inverter: Voltage sourced active filter, current sourced active filter, constant frequency control, constant tolerance bandcontrol, variable tolerance band control.

Module-IV : (15 Hours)
Shunt Active Filter: Single-phase active filter, principle of operation, expression for compensating current, concept of constant capacitor voltage control; Three-phase active filter: Operation, analysis and modelling; Instantaneous reactive power theory..Three-phase Series Active Filter: Principle of operation, analysis and modelling. Other Techniques: Unified power quality conditioner, voltagesource and current source configurations, principle of operation for sag, swell and flicker control.

Text/Reference Books:

1. Derek A. P., "Power Electronic Converter Harmonics", IEEE Press. 1989
2. Arrillaga J., Smith B. C., Watson N. R. and Wood A. R., "PowerSystem Harmonic Analysis", 2nd2008Ed., Wiley India.
3. Arthur R. B., "Power System Analysis", 2nd Ed., Pearson Education. 2008
4. Arrillaga J., Braedlley D. A. and Bodger P. S., "Power System Harmonics", John Wiley and Sons.1985
5. Dugan R. C., McGranaghan M. F. and Beaty H. W., Electrical Power System Quality", McGraw-Hill International Book Company.1996
6. Sankaran C., "Power Quality", CRC Press. 2001

POWER SYSTEM CONTROL AND INSTRUMENTATION

Module-I

Control of voltage, frequency and tie-line power flows, Q-V and P-f control loops. Mechanism of real and reactive power control.

Module-II

Net interchange tie line bias control.Optimal, sub-optimal and decentralised controllers.AGC in isolated and interconnected power systems, AGC with economic dispatch.Discrete mode AGC.

Module-III

Time error and inadvetent interchange correction techniques. On line computer control.Distributed digital control.Data acquisition systems.Emergency control, Preventive control, system wide optimization.

Module-IV

SCADA.supervisory control, supervisory master stations, remote terminal units, communication links, SCADA systems applications in power networks. System measurements using SCADA and computer Control.

Reference Books:

1. Wood A. J. and Wollenberg B.F., " Power Generation, Operation and Control, John Wiley & Sons
2. Kundur P. and Balu N. J., "Power System Stability and Control", EPRI Series, McGraw-Hill International Book Company.
3. "Modern Power Station Practice, Volume F: Control and Instrumentation", British Electricity International, Peragmon Press.
4. Cegrell T., "Power System Control Technology", Prentice Hall International Edition.
5. Grainger J. J. and Stevenson W. D., "Power System Analysis", Tata McGraw-Hill Publishing Company Limited.
6. Anderson P. M. and Fouad A. A., "Power system control and stability", IEEE Press.
7. Ronald L. Krutz"Securing SCADA system"johnwilly publication.
8. Fabiosaccomanno"Electric Power System Analysis and Control"IEEE Press
9. AtifS. Debs,"Modern power systems control and operation",Kluwer academic publishers

ELECTRIC DRIVES IN HYBRID VEHICLE

Module-I : (11 Hours)

Introduction: History of hybrid vehicles, architectures of HEVs,series and parallel HEVs, complex HEVs. Hybridization of Automobile: Fundamentals of vehicle,components of conventional vehicle and propulsion load; Drivecycles and drive terrain; Concept of electric vehicle and hybrid electric vehicle; Plug-in hybrid vehicle, constituents of PHEV, comparison of HEV and PHEV; Fuel Cell Vehicles and itsconstituents.

Module-II : (10 Hours)

Plug in Hybrid Electric Vehicle: PHEVs and EREVs, blended PHEVs, PHEVArchitectures, equivalent electric range of blendedPHEVs; Fuel economy of PHEVs, power management of PHEVs,end-of-life battery for electric power grid support, vehicle to grid technology, PHEV battery charging.

Module-III : (10 Hours)

Power Electronics in HEVs: Rectifiers used in HEVs, voltage ripples; Buck converter used in HEVs, non-isolated bidirectional DC-DC converter, regenerative braking, voltage source inverter,current source inverter, isolated bidirectional DC-DC converter, PWM rectifier in HEVs, EV and PHEV battery chargers.

Module-IV: (11 Hours)

Electric Machines and Drives in HEVs: Induction motor drives, Field oriented control of induction machines; Permanent magnet motor drives; Switched reluctance motors; Doubly salientpermanent magnet machines.

Suggested Books:

1. Pistooa G., "Power Sources , Models, Sustanability, Infrstructure and the market", Elsevier 2008
2. Mi Chris, Masrur A., and Gao D.W., " Hybrid Electric Vehicle: Principles and Applications with Practical Perspectives"1995

GREEN ENERGY RESOURCES & TECHNOLOGY

Module-I :

Solar photovoltaics: Introduction, Solar cell characteristics, Losses in solar cells, Modeling of solar cell, Solar PV modules, Bypass diode in PV module, Design of PV module, PV module power output, I-V curve of PV module, BOS of PV module, Batteries for solar PV, Battery charge controllers, DC-DC converters, DC-AC converters, MPPT, Different algorithm for MPPT, Types of PV system, Performance analysis of solar cell, Working of solar cell power plant.

Module-II :

Wind energy: Wind energy conversion, power ~ speed and torque ~ speed characteristics of wind turbines, wind turbine control systems; conversion to electrical power: induction and synchronous generators, grid connected and self excited induction generator operation, constant voltage and constant frequency generation with power electronic control, single and double output systems, reactive power compensation;

Ocean Energy: Ocean energy resources-ocean energy routes - Principles of ocean thermal energy conversion systems- ocean thermal power plants- Principles of ocean wave energy conversion and tidal energy conversion.

Module-III :

Biomass Energy: Introduction, Biomass conversion technology, Biogas, Composition of Biogas, Properties of Biogas, Biogas production reaction, Factor affecting biogas production, Biogas plant site selection, Biogas plants, Types of Biogas plants, Biogas purification, Biogas storage, Biogas dispensing, Advantages and disadvantages of Biogas, Emission from Biogas engines, Digester Filling and Biogas plant operation, Biogas digester sizing.

Module-IV :

Hybrid Power Syatems: Introduction, Need for hybrid systems, Range of hybrid systems, Types of Hybrid systems, Diesel-PV system, Wind-PV system, Micro hydel-PV system, Biomass-PV system, Electric vehicles, Hybrid electric vehicles.

Energy Conservation, Management and Economics: Impact of renewable energy on environment, Principle and strategies of energy conservation, energy management, energy audit, energy planning, Total energy system concept, Power tariff, Cost of electricity production from renewable.

Text/Reference Books:

1. S. N. Bhadra, D. Kastha, S. Banerjee, *Wind Electrical Systems*: Oxford Univ. Press, 2005.
2. S. S. Thipse, Non Conventional and Renewable Energy Sources, Narosa Publishing House, 2014.

3. S.A. Abbasi, N. Abbasi, *Renewable Energy Sources and Their Environmental Impact:* Prentice Hall of India, 2004.
4. S.P. Sukhatme - Solar Energy: Principles of thermal Collection and Storage,TMH,New Delhi
5. Duffic and Beckman - Solar Engineering of Thermal Processes, John wiley
6. Green Management and Green Technologies: Exploring the Causal Relationship by Jazmin Seijas Nogarida,2008.
7. Green Marketing and Management: A global Perspective by John F. Whaik, 2005

TRANSDUCERS AND INSTRUMENTATION

Module-1 (10 hours)

TRANSDUCER CLASSIFICATION

Introduction, Electrical Transducer, Classification, Basic requirements of a Transducer.

PERFORMANCE CHARACHTERISTICS OF AN INSTRUMENTATION SYSTEM

Introduction, Generalized measurements, Zero-order system, First-order system, Second-order system, Dead-time element, Specification and testing of dynamic response.

MEASUREMENT OF DISPLACEMENT ,FORCE AND PRESSURE

Introduction, Resistive transducers, Metal Strain Gauges, Carbon Strain Gauge, Inductive transducers, Capacitive transducer. Force measurement with Strain Gauges, Carbon-washer-column force transducer, Magnetostrictive Force Transducers, Piezoelectric force Transducer.

Module-2 (15 hours)

MEASUREMENT OF SPEED AND VELOCITY

Introduction, Transducers for measurement of translational velocity, Transducers / Methods for Measurement of rotational velocity/speed.

MEASUREMENT OF TORQUE

Introduction, Torque sensing shafts, Strain gauge torque transducers, Magnetostrictive torque transducers, Angular-shift torque transducer

MEASUREMENT OF TEMPERATURE

Introduction, Thermal Expansion methods, Resistance thermometers , Thermocouple Thermometer.

Module-3 (15 hours)

DIGITAL TRANSDUCRES

Introduction,Digital encoders disc type,Linear displacement transducers,Digital tachometer,Frequency output type transducers .

DIGITAL SIGNAL TRANSMISSION AND TELEMETRY SYSTEMS

Introduction,Data transmission systems,Pulse code formats,Modulation techniques for Digital data transmission. Telemetry systems, Introduction, Fundamentals of telemetry system, Classification of Telemetry systems, Intensity or proximity telemetry systems, current telemetry systems, voltage telemetry Systems,Analog systems of frequency and pulse typesCommunication channels for telemetry system,Short-range radio-telemetry, comparision of various telemetry system.

INPUT-OUTPUT DEVICES AND DISPLAYS

Introduction,Analog Displays and Recoders,Digital Input-Output devices,displays

POWER PLANT ISTRUMENTS

Introduction,The power plant scheme,pressure,temperature,flow and level,vibration And Expansion.

REFERENCES:

1. Principle of Industrial Instrumentation,2nd Edition by D Patranabis, TMH Publication
2. Instrumentation Devices and Systems, 2nd Edition,C S Ragan,G R Sarma,VSV Mani,by TMH Publication
3. Measurement and Systems, Application and Design by Ernest O Doebelin & Dhanesh N Manik by TMH Publication

ADVANCED DIGITAL SIGNAL PROCESSING

Module-I: (15 hours) Discrete time signals, systems and their representations: Discrete time signals- Linear shift invariant systems- Stability and causality- Sampling of continuous time signals- Discrete time Fourier transform- Discrete Fourier seriesDiscrete Fourier transform- Z- transform- Properties of different transforms- Linear convolution using DFT- Computation of DFT .

Module II: (15 hours) Digital filter design and realization structures Design of IIR digital filters from analog filters- Impulse invariance method and Bilinear transformation method- FIR filter design using window functions- Comparison of IIR and FIR digital filters- Basic IIR and FIR filter realization structures- Signal flow graph representations.

Module III (10 hours) Analysis of finite word-length effects Quantization process and errors- Coefficient quantisation effects in IIR and FIR filters A/D conversion noise- Arithmetic round-off errors- Dynamic range scaling- Overflow oscillations and zero input limit cycles in IIR filters.

Module IV (11 hours) Statistical signal processing. Linear Signal Models . All pole, All zero and Pole-zero models .Power spectrum estimation- Spectral analysis of deterministic signals . Estimation of power spectrum of stationary random signals-Optimum linear filters-Optimum signal estimation-Mean square error estimation-Optimum FIR and IIR filters.

Text/ References

1. Sanjit K Mitra, Digital Signal Processing: A computer-based approach ,TataMc Grow-Hill edition .1998

2. Dimitris G .Manolakis, Vinay K. Ingle and Stephen M. Kogon, Statistical and Adaptive Signal Processing, Mc Grow Hill international editions .-2000

3. Alan V . Oppenheim, Ronald W. Schafer, Discrete-Time Signal Processing, Prentice-Hall of India Pvt. Ltd., New Delhi, 1997

4. John G. Proakis, and Dimitris G. Manolakis, Digital Signal Processing(third edition), Prentice-Hall of India Pvt. Ltd, New Delhi, 1997

5. Emmanuel C. Ifeachor, Barrie W. Jervis , Digital Signal Processing-A practical Approach, Addison . Wesley,1993

6. Abraham Peled & Bede Liu, Digital Signal Processing,John Wiley & Sons, 1976