Fifth Semester								
	Theory					Practical		
Code	**Course Name**	**Hours/week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/week L/T**	**Credit Practical**	**Marks**
PC	Power Electronics	3-0	3	100	50	2	1	50
PC	Microprocessor & Microcontroller	3-0	3	100	50	2	1	50
PC	Digital signal Processing	3-0	3	100	50	2	1	50
PE	Renewable Energy systems/Optoelectronics Device & Instrumentation	3-1	4	100	50			
OE	Optimization in Engg.	3-1	4	100	50			
PC	Advance Lab-I(Advanced Electrical Computational Lab-I)					8	4	200
Total		17	17	500	250	14	7	350
Total Marks: 1100								
Total Credits: 24								
Honors	Electrical Machine Design/ Industrial Process Control and Dynamics /Distributed Generation System Design	4	4	100	50			
Minor	Electrical Machines-I/ Microprocessor and Microcontrollers/ Renewable Energy Systems							

Semester : 5th

1.	PEE5D001	Honours(O4)	Electrical Machine Design	4-0-0	4
2.	PEE5D002	Honours(O4)	Industrial Process Control & Dynamics	4-0-0	4
3.	PEE5D003	Honours(O4)	Distributed Generation System Design	4-0-0	4
4.	PEE5G001	Minor(O5)	Electrical Machines - I	4-0-0	4
5.	PEE5G002	Minor(O5)	Microprocessor & Microcontroller	4-0-0	4
6.	PEE5G003	Minor(O5)	Renewable Energy Systems	4-0-0	4
7.	PEE5H001	OE(CP)	Optimization in Engineering	4-0-0	4
8.	PEE5I101	PC(CP)	Power Electronics	3-0-1	4
9.	PEE5I102	PC(CP)	Microprocessor & Microcontroller	3-0-1	4
10.	PEE5I103	PC(CP)	Digital signal Processing	3-0-1	4
11.	PEE5I201	PC(CP)	Advance Lab - I (Advanced Electrical Computational Lab-I)	0-0-4	4
12.	PEE5J001	PE(O3)	Renewable Energy Systems	4-0-0	4
13.	PEE5J002	PE(O3)	Optoelectronics Device & Instrumentation	4-0-0	4
					28

PEE5I101 POWER ELECTRONICS

Module-1 **[12 Hours]**

University portion (80%): (10 Hours)

Power semiconductor devices: (6 Hours)

Switching and V-I characteristic of devices: power diode, Thyristor family: SCR, TRIAC, GTO, Transistor Family: BJT, IGBT, and MOSFET, Series and parallel grouping of SCR. [Chapter: 1.3, 1.4, 4.2.2, 4.2.3, 4.3.2, 4.6, 4.10, 7.2, 7.4, 7.5]

Triggering Methods: (2 Hours)

SCR: (Cosine Firing Scheme), BJT gate drive, IGBT gate drive, TRIAC firing circuit, Isolation of gate and base drive [Chapter: 17.5, 17.2, 17.3, 17.4]

Protection of Devices: (2 Hours)

SCR: Over voltage, Over Current, dv/dt, di/dt, Gate Protection. Transistor: protection of power BJT, IGBT and power MOSFET, dv/dt & di/dt limitation. [Chapter: 18.4, 18.5, 18.7, 18.8, 4.8, 7.9, 7.10)

Module 2 **[12 Hours]**

University portion (80%): (10 Hours)

AC to DC converter: (6 Hours)

Un-controlled Diode rectifier: Single phase half wave and full wave rectifiers with R-L and R -L-E load, 3 phase bridge rectifier with R-L and R-L-E load. Phase Controlled Converter: Principle of phase controlled converter operation, single phase full converter with R-L and R-L-E load,3 phase full converter with R-L and R-L-E load ,single phase semi converter with R-L and R-L-E load, 3 phase semi-converter with R-L and R-L-E load and effect of source inductance. [Chapter: 3.2, 3.3, 3.4, 3.5, 3.8, 3.12, 10.2, 10.3, 10.6, 10.9, 10.10]

AC –AC converter: (4 Hours)

AC voltage controller: Single phase bi-directional controllers with R and R-L load, single phase cycloconverters. [Chapter: 11.4, 11.5, 11.9.1, 11.10]

Module 3 **[8 Hours]**

University portion (80%): (6 Hours)

DC to DC converter:

Classification: First quadrant, second quardrant, first and second quardrant, third and fourth quardrant, fourth quardrant converter. Switching mode regulators: Buck regulators, Boost regulators, Buck-Boost regulators, Cuk regulators, Isolated Types: Fly Back Converters, Forward converters, Push Pull Converters, Bridge Converter [Chapter: 5.7, 5.8.1, 5.8.2, 5.8.3, 5.8.4]

Module 4 **[8 Hours]**

University portion (80%): (6 Hours)

DC to AC converter: (4 Hours)

Inverters: Single phase Bridge Inverters, 3-Phase Inverters-1800 mode conduction, 1200 mode conduction. Voltage control of 3-Phase Inverters by Sinusoidal PWM, Current Source Inverter [Chapter: 6.4, 6.5, 6.8.1, 6.8.4, 6.10, 8.8, 8.9]

Applications: (2 Hours)

UPS, SMPS, Battery Chargers, SVC. [Chapter: 14.2.1, 14.2.2, 14.2.3, 14.2.4, 14.2.6, 13.6.4]

Text Books:

1. *Power Electronics: Circuits, Devices and Applications by M H Rashid, 3rd Edition, Pearson*
2. *Power Electronics: By P. C. Sen, Tata McGraw Hill Education, 12th Edition*
3. *Power Electronics, V R Moorthi, Oxford University Press*

Reference Books:

1. *Power Electronics Converters, Applications & Design: by N. Mohan, 2nd Edition, John Wiley & Sons*
2. *Elements Of Power Electronics: Philip T. Krein, Oxford University Press*
3. *Power Converter Circuits: by W Shepherd and L Zhang, CRC, Taylor and Francis,Special Indian Edition*

POWER ELECTRONICS LABORATORY

List of Experiment : (any ten)

1. *Study of the V-I characteristics of SCR, TRIAC, IGBT and MOSFET.*
2. *Study of the cosine controlled triggering circuit*
3. *To measure the latching and holding current of a SCR*
4. *Study of the single phase half wave controlled rectifier and semi converter circuit with R and R-L Load*
5. *Study of single phase full wave controlled rectifier circuits (mid point and Bridge type) with R and R-L Load*
6. *Study of three phase full wave controlled rectifier circuits (Full and Semi converter) with R and R-L Load*
7. *Study of the Buck converter and boost converter.*
8. *Study of the single phase pwm voltage source inverter.*
9. *Study the performance of three phase VSI with PWM control.*
10. *Study of the forward converter and flyback converter.*

PEE5I102 MICROPROCESSORS AND MICROCONTROLLER

Module-I **[10 Hours]**

University Portion (80%):(08 Hours)

Introduction of Microcomputer System: Fundamental block diagram, signal, interfacing, I/O ports and data transfer concepts, timing diagram, interrupt structure of Intel 8085 processor. Introduction of Intel 8086 processor. Basic difference between 8085 and 8086 processor. Timer and Counter. (Book 1: 2.2, 2.3, 2.4, 5.7, 5.8, 5.9, 5.10, 5.11, 5.12, 5.13, 13.1)

Module-II **[10 Hours]**

University Portion (80%): (08 hours)

Instructions and programming of 8085 and 8086: Instruction format and addressing modes, assembly language format, data transfer, data manipulation, Arithmetic instructions, Logical instructions, control and string instruction, programming: loop structure with counting and indexing, look up table, sub routine instruction stack. Stack operation, branching programming.(Book 2: Ch. 5 and 6)

Module-III **[10 Hours]**

University Portion (80%):(08 Hours)

I/O Interfacing devices

Study of Architecture and programming of ICs : 8-bit input output port 8255 PPI, 8259 PIC, 8257 DMA, 8251 USART, 8279 Keyboard display controller and 8253 timer/counter-interfacing with 8085- A/D and D/A converter interfacing(Book 1: Ch. 7)

Module-IV **[10 Hours]**

University Portion (80%): (08 Hours)

Micro controller 8051 programming and applications. Architecture of 8051. Data Transfer, manipulation, control and I/O instruction, simple programming, keyboard and display interface.(Book 1: Ch. 9 and 10)

Text book:

1. *Ramesh S.Gaonkar, "Microprocessor - Architecture, Programming and Applications with the 8085", Penram International publishing private limited, fifth edition.*
2. *Douglas V. Hall, "Microprocessors and Interfacing: Programming and Hardware",*
3. *Microprocessor & Microcontroller, N.Senthil Kumar, M.Saravanan,S. Jeevananthan, Oxford University Press*

Reference Book:

1. *Muhammad Ali Mazdi & Janice Gilli Mazdi, The 8051 Microcontroller and Embedded System, Pearson Education , 5th Indian reprint, 2003.*
2. *Microprocessors and microcontrollers Architecture, programming and system Design 8085, 8086, 8051, 8096: by Krishna Kant : PHI*
3. *The 8051 Microcontroller, Kenneth Ayala, Third Edition*

MICROPROCESSOR & MICROCONTROLLER LABORATORY

List of Experiment : 8085

1. *Addition, subtraction, multiplication and division of two 8 bit numbers*
2. *Smallest/largest number among n numbers in a given data array, Binary to Gray code, Hexadecimal to decimal conversion*

Interfacing

1. *Generate square wave on all lines of 8255 with different frequencies*
2. *Study of stepper motor and its operations*

Optional (any two)

1. *Study of traffic light controller*
2. *Study of elevator simulator*
3. *Generation of square, triangular and saw tooth wave using D to A Converter*
4. *Study of 8253 and its operation(Mode0, Mode2, Mode3)*
5. *Study of Mode0,Mode1 and BSR Mode operation of 8255*
6. *Study of 8279 (keyboard and display interface)*
7. *Study of 8259 Programmable Interrupt Controller*
8. *8051 Microcontroller: Initialize data to registers and memory using immediate, register, direct and indirect Addressing mode*

Optional (any one)

1. *Addition and subtraction of 16 bit numbers*
2. *Multiplication and division of two 16 bit numbers*
3. *Transfer a block of data to another memory location using indexing*
4. *Operation of 8255 using 8051 microcontroller 8086*
5. *1.Addition , subtraction ,multiplication and division of 16 bit numbers, 2's complement of a 16 bit number*

Optional (any one)

1. *Finding a particular data element in a given data array*
2. *Marking a specific bit of a number using look-up table*
3. *Largest/smallest number of a given data array*
4. *To separate the odd and even numbers from a given data array*
5. *Sorting an array of numbers in ascending/descending order*

PEE5I103 DIGITAL SIGNAL PROCESSING

MODULE – I

1. **The Z-Transform and Its Application to the Analysis of LTI Systems:**

   The Z-Transform: The Direct Z-Transform, The Inverse Z-Transform; Properties of the Z-Transform; Inversion of the Z-Transforms: The Inversion of the Z-Transform by Power Series Expansion, The Inversion of the Z-Transform by Partial-Fraction Expansion; Analysis of Linear Time-Invariant Systems in the z-Domain: Response of Systems with rational System Functions.

2. **The Discrete Fourier Transform: Its Properties and Applications:**
   Frequency Domain Sampling: Frequency-Domain Sampling and Reconstruction of Discrete-Time Signals, The Discrete Fourier Transform, The DFT as a Linear Transformation, Relationship of the DFT to other Transforms; Properties of the DFT: Periodicity, Linearity, and Symmetry Properties, Multiplication of Two DFTs and Circular Convolution, Additional DFT Properties; Linear Filtering Methods Based on the DFT: Use of the DFT in Linear Filtering, The Discrete Cosine Transform: Forward DCT, Inverse DCT, DCT as an Orthogonal Transform.

MODULE – II

3. **Implementation of Discrete-Time Systems:**
   Structure for the Realization of Discrete-Time Systems, Structure for FIR Systems: Direct-Form Structure, Cascade-Form Structures, Frequency-Sampling Structures; Structure for IIR Systems: Direct-Form Structures, Signal Flow Graphs and Transposed Structures, Cascade-Form Structures, Parallel-Form Structures.

4. **Design of Digital Filters:**
   General Considerations: Causality and Its Implications, Characteristics of Practical Frequency-Selective Filters; Design of FIR Filters: Symmetric and Antisymmetric FIR Filters, Design of Linear-Phase FIR Filters by using Windows, Design of Linear-Phase FIR Filters by the Frequency-Sampling Method; Design of IIR Filters from Analog Filters: IIR Filter Design by Impulse Invariance, IIR Filter Design by the Bilinear Transformation.

MODULE- III

5. **Efficient Computation of the DFT: Fast Fourier Transform Algorithm**
   Efficient Computation of the DFT: FFT Algorithms: Direct Computation of the DFT,Radix-2 FFT Algorithms: Decimation-In-Time (DIT), Decimation-In-Time (DIF); Applications of FFT Algorithms: Efficient Computation of the DFT of two Real Sequences, Efficient Computation of the DFT a 2N-Point Real Sequence.

MODULE – IV

6. **Adaptive Filters:**
   Application of Adaptive Filters: System Identification or System Modeling, Adaptive Channel Equalization, Adaptive Line Enhancer, Adaptive Noise Cancelling; Adaptive

Direct-Form FIR Filters-The LMS Algorithm: Minimum Mean Square Error Criterion, The LMS Algorithm.

Additional Module (Terminal Examination-Internal)

1. **The Z-Transform and Its Application to the Analysis of LTI Systems:**Transient and Steady-State Responses, Causality and Stability, Pole-Zero Cancellations.
2. **The Discrete Fourier Transform: Its Properties and Applications:**Filtering of Long Data Sequences; Frequency Analysis of Signals using the DFT.
3. **Efficient Computation of the DFT:** Use of the FFT Algorithm in Linear Filtering and Correlation.

Text Books

1. Digital Signal Processing Principles, Algorithms and Applications, J. G. Proakis and D. G. Manolakis, 4th Edition, Pearson.
2. Digital Signal Processing, Tarun Kumar Rawat, Oxford University Press.

Reference Books

1. Digital Signal Processing: a Computer-Based Approach, Sanjit K. Mitra, TMH
2. Digital Signal Processing, S. Salivahan, A. Vallavraj and C. Gnanapriya, TMH.
3. Digital Signal Processing, Manson H. Hayes, Schaum's Outlines, TMH.
4. Digital Signal Processing: A Modern Introduction, Ashok K Ambardar, Cengage Learning.
5. Modern Digital Signal Processing, Roberto Cristi, Cengage Learning.
6. Digital Signal Processing: Fundamentals and Applications, Li Tan, Jean Jiang, Academic Press, Elsevier.
7. Digital Signal Processing: A MATLAB-Based Approach, Vinay K. Ingle and John G. Proakis, Cengage Learning.
8. Fundamentals of Digital Signal Processing using MATLAB, Robert J. Schilling and Sandra L. Harris, Cengage Learning.

DIGITAL SIGNAL PROCESSING LAB

(At least 10 experiments should be done)

1. Familiarization with the architecture of a standard DSP kit (Preferably TMS 320C6XXX DSP kit of Texas Instruments)
2. Generation of various types of waveforms (sine, cosine, square, triangular etc.) using MATLAB and DSP kit.
3. Linear convolution of sequences (without using the inbuilt conv. function in MATLAB) and verification of linear convolution using DSP kit.
4. Circular convolution of two sequences and comparison of the result with the result obtained from linear convolution using MATLAB and DSP kit.
5. (i) Computation of autocorrelation of a sequence, cross correlation of two sequences using MATLAB.

   (ii) Computation of the power spectral density of a sequence using MATLAB also implementing the same in a DSP kit.
6. Finding the convolution of a periodic sequence using DFT and IDFT in MATLAB.
7. (i) Implementation of FFT algorithm by decimation in time and decimation in frequency using MATLAB.

   (ii) Finding the FFT of a given 1-D signal using DSP kit and plotting the same.
8. Design and implementation of FIR (lowpass and highpass) Filters using windowing techniques (rectangular window, triangular window and Kaiser window) in MATLAB and DSP kit.
9. Design and implementation of IIR (lowpass and highpass) Filters (Butterworth and Chebyshev) in MATLAB and DSP kit.
10. (i) Convolution of long duration sequences using overlap add, overlap save using MATLAB.

    (ii) Implementation of noise cancellation using adaptive filters on a DSP kit.

PEE5J001 RENEWABLE ENERGY SYSTEMS

Module I **[15 Hours]**

University Portion (80%): (13 Hours)

Introduction: Conventional energy Sources and its Impacts, Non conventional energy– seasonal variations and availability, Renewable energy – sources and features, Distributed energy systems and dispersed generation (DG) (Textbook-1, Chapter-1.10, 1.13, 1.14)

Solar Energy: Solar processes and spectral composition of solar radiation. Solar Thermal system-Solar collectors, Types and performance characteristics, Applications-Solar water heating systems (active & passive) , Solar space heating & cooling systems , Solar desalination systems, Solar cooker. Solar photovoltaic system-Operating principle, Photovoltaic cell concepts, Cell, module, array, Losses in Solar Cell, Effects of Shadowing-Partial and Complete Shadowing, Series and parallel connections, Cell mismatching, Maximum power point tracking, Applications-Battery charging, Pumping, Lighting, Peltier cooling. Modeling of PV cell. (Textbook-1, Chapter- 4.1, 4.2, 4.5, 4.10, 4.11, 5, 6)

Module II **[10 Hours]**

University Portion (80%): (8 Hours)

Wind Energy: Wind energy, Wind energy conversion; Wind power density, efficiency limit for wind energy conversion, types of converters, aerodynamics of wind rotors, 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, Characteristics of wind power plant, Concept of DFIG. (Textbook-2, Chapter-1.2, 1.4, 1.5, 1.6, 1.7, 1.8, 1.10, 1.11, 1.12, 3, 5)

Module III[9 Hours]

University Portion (80%):(9 Hours)

Biomass Power: Principles of biomass conversion, Combustion and fermentation, Anaerobic digestion, Types of biogas digester, Wood gassifier, Pyrolysis, Applications. Bio gas, Wood stoves, Bio diesel, Combustion engine, Application.
(Textbook-1, Chapter-8)

Module IV **[6 Hours]**

University Portion (80%): (4 Hours)

Hybrid Systems: Need for Hybrid Systems, Range and type of Hybrid systems, Case studies of Diesel-PV, Wind-PV, Microhydel-PV, Biomass-Diesel systems, electric and hybrid electric vehicles.
(Textbook-2, Chapter-7)

Text Books:

1. *Renewable Energy- Power for a Sustainable Future, Godfrey Boyle, Oxford University Press*
2. *B.H.Khan, Non-Conventional Energy Resources, Tata McGrawHill, 2009*
3. *S. N. Bhadra, D. Kastha, S. Banerjee, Wind Electrical Systems, Oxford Univ. Press, New Delhi, 2005.*

Reference Books:

1. *S. A. Abbasi, N. Abbasi, Renewable Energy Sources and Their Environmental Impact, Prentice Hall of India, New Delhi, 2006*

PEE5J002 OPTOELECTRONICS DEVICE & INSTRUMENTATION

Institution Level(80%)

Module –1 (14 Hrs)

Wave Optics: Wave Polarization, Transmission of light through slab, Numerical aperture, Wave propagation in cylindrical waveguides, Modes in step and graded index fibers, single mode and multimode fibres

Module –2 (10 Hrs)

Optical Components: Sources: LED, Lasers-fundamentals, conditions for oscillations, construction and principle of operation of semiconductor lasers, pulsed and continuous type lasers (Chapter 4 of TB-1, 11.2-11.4 of TB-1, Chapter 4, 4.2-4.9 of TB-2)
Fiber optic components: (at college level) couplers, splicer, polarizer, power coupled to a fibre (Chapter 9 9.2-9.12 of TB-2) Detectors: photodiodes- PIN and APD. (Chapter 12, 12.1-12.4 of TB-1)

Module –3 (12 Hrs)

Optoelectronic Instrumentation:
Modulation techniques: intensity, polarization, interference, electro-optic, electromagnetic; Sensing techniques for displacement, pressure, acceleration, flow, current and voltage measurement, Fiber optic gyroscope, Distributed fiber optic sensors- OTDR and OFDR principles. (Chapter 11, 11.2-11.3.5, 11.3.9, 11.4-11.6 and 11.9 of TB-2)

Text Books:

1. *.A. Ghatak and K. Tyagrajan: Introduction to Fiber Optics: Cambridge University Press, New Delhi, 2004. (Chapter 2, Sections 7.2-7.3, Chapter 3, Sections 4.3,8.2, 17.2, 17.8, Section 11.3, 11.6, Chapter 12, Chapter 18)*
2. *A. Tripathy, Opto-Electronics and Systems: Studium Press, New Delhi, 2016*

Reference Books:

1. *R.P.Khare: Fibre Optics & Optoelectronics, Oxford University Press, New Delhi, 2010.*
2. *John M. Senior, Optical Fibre Communications, Principles and Practice, 3rd Edn, Pearson, 2010*
3. *J.P. Bentley- Principles of Measurement Systems (3/e), Pearson Education, New Delhi, 2007.*
4. *J. Wilson and J.F.B. Hawkes: Optoelectronics: An Introduction (2/e), PHI, New Delhi, 2001. (Chapter 1, Sections 3.1-3.2; 8.1-8.2, Sections 8.3-8.4, 8.5, Sections 4.6, 5.1-5.6, 5.10.2, 7.2, Sections 3.4, 3.7, 3.8, Chapter 10)*

PEE5H001 OPTIMIZATION IN ENGINEERING

MODULE-I

1. Idea of Engineering optimization problems, Classification of optimization algorithms, modeling of problems and principle of modeling.
2. **Linear programming:** Formulation of LPP, Graphical solution, Simplex method, Big-M method, Revised simplex method, Duality theory and its application, Dual simplex method , Sensitivity analysis in linear programming

MODULE-II

3. **Transportation problems:** Finding an initial basic feasible solution by Northwest Corner rule, Least Cost rule, Vogel's approximation method, Degeneracy, Optimality test, MODI method, Stepping stone method
4. **Assignment problems:** Hungarian method for solution of Assignment problemsInteger Programming:Branch and Bound algorithm for solution of integer Programming Problems

MODULE-III

5. **Non-linear programming:** Introduction to non-linear programming. **Unconstraint optimization:** Fibonacci and Golden Section Search method.
6. **Constrained optimization with equality constraint:** Lagrange multiplier, Projected gradient method
7. **Constrained optimization with inequality constraint:** Kuhn-Tucker condition, Quadratic programming.

MODULE-IV

8. **Queuing models:** General characteristics, Markovian queuing model, M/M/1 model, Limited queue capacity, multiple server, Finite sources, Queue discipline.

Additional Module (Terminal Examination-Internal)

9. Introduction to Genetic Algorithm.

Text Books

1. Operations Research- Principle and Practice, A. Ravindran, D. T. Philips, J. Solberg, Second edition, Wiley India Pvt Ltd.
2. Operation Research, Prabhakar Pai ,Oxford University Press
3. Optimization for Engineering Design, Kalyanmoy Deb, PHI Learning Pvt Ltd.
4. OperationsResearch, H.A.Taha, A.M.Natarajan, P.Balasubramanie, A.Tamilarasi, Pearson Education, Eighth Edition.
5. Engineering Optimization, S S Rao, New Age International(P) Ltd, 2003.

Reference Books

1. Linear and Non-linear Optimization, **S**tephen G. Nash, A. Sofer, McGraw Hill,2nd Edition.
2. Engineering Optimization, A.Ravindran, K.M.Ragsdell, G.V.Reklaitis, Wiley India Pvt. Ltd, Second edition.
3. Operations Research, F.S.Hiller, G.J.Lieberman, Tata McGraw Hill, Eighth Edition, 2005.
4. Operations Research, P.K.Gupta, D.S.Hira, S.Chand and Company Ltd, 2014.

PEE5I201 ADVANCE ELECTRICAL COMPUTATION LAB-I

List of Experiment:

1. Power measurement of AC system using MATLAB:
2. Time response of a first/ second order system using Laplace Transform.
3. Numerical analysis:Non-linear equations and optimization ,Differential equations
4. Series & parallel resonance circuit simulation.
5. Simulation of Half wave diode bridge rectifier circuit.
6. Simulation of Full wave diode bridge rectifier circuit.
7. DC analysis for R-L, R-C and R-L-C circuits using MATLAB .
8. AC analysis for R-L, R-C and R-L-C circuits using MATLAB .

PEE5D002 INDUSTRIAL PROCESS CONTROL AND DYNAMICS (3-0-0)

Module-1 **(10 Hours)**

University portion (80%): (8 Hours)

1. Introduction to Process Control:

Introduction, control systems, process control block diagram, control system evaluation, analog and digital processing

[Chapter : 1.1, 1.2, 1.3, 1.4, 1.5]

2. Analog Signal Conditioning:

Introduction, principles of analog signal conditioning, passive circuits, operation, amplifiers, op-amp circuits in instrumentation

[Chapter : 2.1, 2.2, 2.3, 2.4, 2.5]

College/Institute portion (20%): (2 Hours)

Units, Standards and Definitions, Sensors time response, Significance and Statistics **[Chapter: 1.6, 1.7, 1.8]** Or related advanced topics as decided by the concerned faculty teaching the subject.

Module 2 **(10 Hours)**

University portion (80%): (8 Hours)

1. Digital Signal Conditioning:

Introduction, Review of digital fundamentals, converters, Data Acquisition system

[**Chapter: 3.1, 3.2, 3.3, 3.4]**

2. Thermal Sensors:

Introduction, Definition of temperature, Metal resistance versus Temperature devices, Thermistors, Thermocouples

[**Chapter: 4.1, 4.2, 4.3, 4.4, 4.5]**

3. Mechanical Sensors:

Introduction, Displacement, Location or Position sensors, Strain sensors, Motion sensors

[**Chapter: 5.1, 5.2, 5.3, 5.4]**

College/Institute portion (20%): (2 Hours)

Other thermal sensors, Pressure sensors, Flow sensors**[Chapter: 4.6, 5.5, 5.6]** Or related advanced topics as decided by the concerned faculty teaching the subject.

Module 3 **(10 Hours)**

University portion (80%): (8 Hours)

1. Optical Sensors:

Introduction, Photo detectors, Pyrometry, Optical Sources application

[Chapter: 6.1, 6.3, 6.4, 6.5]

2. Final Control:

Introduction, Final control operation, signal conversions, Industrial Electronics, Actuators, Control Elements

[Chapter: 7.1, 7.2, 7.3, 7.4, 7.5, 7.6]

3. Discrete State Process Control:

Introduction, Definition of Discrete State Process control, Characteristics of the system, Relay controllers and ladder diagram, PLCs

[Chapter: 8.1, 8.2, 8.3, 8.4, 8.5]

College/Institute portion (20%): (2 Hours)

Control Loop Characteristics **[Chapter: 12.1 – 12.6] o**r related advanced topics as decided by the concerned faculty teaching the subject.

Module 4 **(10 Hours)**

University portion (80%): (8 Hours)

1. Controller Principles:

Introduction, Process characteristics, Control system parameters, Discontinuous controller modes, continuous controller modes, composite control modes

[Chapter: 9.1, 9.2, 9.3, 9.4, 9.5, 9.6]

2. Analog Controllers:

Electronics Controller, Pneumatic controller

[Chapter: 10.3, 10.4]

3. Digital Controllers:

Digital electronics methods, Computers in process control, Characteristics of digital data

[Chapter: 11.2, 11.3, 11.4]

College/Institute portion (20%): (2 Hours)

Controller Software, Computer Controller Examples **[Chapter: 11.5, 11.6]** or related advanced topics as decided by the concerned faculty teaching the subject.

Text Books:

4. ***Process Control Instrumentation Technology*** by Curtis D. Johnson, PHI Publication

PEE5D001 ELECTRICAL MACHINE DESIGN (3-1-0)

Module-I **(12 hours)**

University Portion (80%)

Design of Transformers: Classification of transformer, transformer core, yoke, transformer winding, cooling of transformers, method of cooling of transformers, transformer tank, cooling ducts, transformer insulation, conservator and breather, output of transformer, output equation, ratio of iron loss to copper loss, relation between core area and weight of iron and copper, optimum design, variation of output and lossless in transformers with linear dimensions, design of core, selection of core area and type of core, choice of flux density, design of windings, Design of insulation, surge phenomenon, surge protection widow space factor, window dimension, width of window for optimum output, design of yoke, overall dimensions, simplified steps for transformer design, operating characteristics, resistance of winding, leakage reactance of winding, regulation.

Ch- 5.2, 5.7, 5.10, 5.17, 5.18, 5.19, 5.20, 5.21, 5.24, 5.29, 5.30-5.45, 5.46, 5.47, 5.48

College/Institute Portion (20%)

Calculation of mechanical forces, bracing of windings, change of parameters with change of frequency, temperature rise of transformers, design of tanks with tubes, thermal rating.

Ch- 5.50, 5.51, 5.53,5.54, 5.55, 5.58

Module-II **(12 hours)**

University Portion (80%)

D C Machines; Output equations, choice of average gap density, choice of ampere conductor per meter, selection of number of poles, core length, Armature diameter, pole proportions, number of ventilating ducts, estimation of air gap length, **Armature reaction;** flux distribution at load, effect of armature reaction, brush shift and its effect, reduction of effects of armature reaction **Armature design;** choice of armature winding, numbers of armature conductors, numbers of armature slots, cross section of armature conductors, insulation of armature winding, slot dimension, armature voltage drop, depth of armature core, **Design of field system;** pole design, design of field winding, design of yoke, magnetic circuit, magnetization curve, design of field winding, commutation phenomenon, forms of current in coil undergoing commutation, **Design of commutator and brushes;** number of segments, commutator diameter, length of commutator, dimension of brushes, losses at commutator surface, loss and efficiency.

Ch-9.10, 9.11-9.20, 9.22-9.30, 9.31-9.39

College/Institute Portion (20%)

Design of interpoles; time of commutation, width of commutation zone, width of interpole shoe, calculation of reactance voltage, length of interpole, flux density under interpole shoe, design of interpole winding.

Ch-9.40-9.54

Module-III **(8 hours)**

University Portion (80%)

Three Phase Induction Motors; output equation, choice of average flux density in air gap, choice of armature conductors, efficiency and power factor, main dimensions, stator winding, Shape of stator slots, number of stator slots, area of stator slots, length of mean turn, stator teeth, stator core, **Rotor design;** length of air gap, number of rotor slots, effects of harmonics, reduction of harmonic torques, design of rotor bars and slots, design of end rings, full load slip, design of wound rotor, rotor teeth, rotor core, operating characteristics; no load current, short circuit current, leakage reactance.

Ch-10.9, 10.10, 10.11-10.22, 10.22.2, 10.23-10.25, 10, 27, 10.31

College/Institute Portion (20%)

Circle diagram, dispersion coefficient and its effects, effects of change of air gap length, effect of change of number of poles, effect of change of frequency, relation between D and L for best power factor, method of improving starting torque, loss and efficiency.

Ch -10.32,10.34, 10.35-10.38

Module-IV **(12 hours)**

University Portion (80%)

Design of synchronous Machines; output equation, design of salient pole machines-main dimensions, short circuit ratio, length of air gap, shape of pole face, armature design, armature winding, coils and their insulation, slot dimension, length of mean turn, stator pole, elimination of harmonics, armature parameters, estimation of air gap length, design of rotor, magnetic circuits, Open circuit characteristics, determination of full load field mmf, design of field winding, design of turbo-Alternator- main dimension, length of air gap, stator design, rotor design.

Ch-11.8 - 11.25 and 11. 30 – 11.33

College/Institute Portion (20%)

Determination of direct and quadrature axis synchronous reactances, short circuit characteristics, losses, temperature rise,

Ch- 11.26 -11.29.

Text book

1. A course in Electrical Machine Design by A.K. Sawhney and Dr. A. Chakrabarti – Publisher: Dhanpat Rai & Company Pvt. Ltd., Year of Edition- 2015

References

2. Clayton A E & Hancock N N : The Performance and Design of Direct Current Machines ; CBS Publishers and Distributors Electrical Engineering
3. Say M G : The Performance and Design of Alternating Current Machines; CBS Publishers and Distributors
4. Sen S K : Principles of Electrical Machine Design with Computer Programs ; Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi,
5. A.Shanmugasundaram, G.Gangadharan, R.Palani 'Electrical Machine Design Data Book', New Age Intenational Pvt. Ltd.

Sixth Semester								
	Theory					Practical		
Code	**Course Name**	**Hours/ Week L/T**	**Credit Theory**	**University Marks**	**Internal Evaluation**	**Hours/ Week L/T**	**Credit Practical**	**Marks**
PC	Electrical Drives	3-0	3	100	50	2	1	50
PC	Power System & Operation & Control	3-0	3	100	50	2	1	50
PE	VLSI Design/Generalized Theory of Electrical Machines/HVDC Transmission	3-1	4	100	50			
PE	Control System Engineering II/Advanced Digital Signal Processing	3-1	4	100	50			
MC & GS	Environmental Science & Engineering	3-0	3	100	50			
OE	Industrial Lecture #					3	1	50
HS	Business Communication & Skill for Interview ##	2-0	1		50	4	2	100
MC	Yoga					2	1	50
Total		19	18	500	300	13	6	300
Total Marks: 1100								
Total Credits: 24								
Honors	Special Electromechanical Devices / Flexible AC Transmission Systems /Utilization of Electrical Energy	4	4	100	50			
Minor	Electrical Machines-II/ Control System Engineering-II							

Semester : 6th

Sl. No.	Subject Code	Category	Subject Name	L-T-P	Credit
1.	PEE6D001	Honours(O3)	Special Electro-Mechanical in Devices	4-0-0	4
2.	PEE6D002	Honours(O3)	Flexible AC Transmission Systems	4-0-0	4
3.	PEE6D003	Honours(O3)	Utilization of Electrical Energy	4-0-0	4
4.	PEE6E101	HS(CP)	Business Communication & Skill for Interview	1-0-2	3
5.	PEE6G001	Minor(O4)	Electrical Machines - II	4-0-0	4
6.	PEE6G002	Minor(O4)	Control System - II	4-0-0	4
7.	PEE6H301	OE(CP)	Industrial Lecture #	0-0-1	1
8.	PEE6I101	PC(CP)	Electrical Drives	3-0-1	4
9.	PEE6I102	PC(CP)	Power System & Operation & Control	3-0-1	4
10.	PEE6J001	PE(O1)	VLSI Design	4-0-0	4
11.	PEE6J002	PE(O1)	Generalized Theory of Electrical Machines	4-0-0	4
12.	PEE6J003	PE(O1)	HVDC Transmission	4-0-0	4
13.	PEE6J004	PE(O2)	Control System Engineering - II	4-0-0	4
14.	PEE6J005	PE(O2)	Advanced Digital Signal Processing	4-0-0	4

PEE6I101 ELECTRIC DRIVES (3-0-1)

MODULE-I **(10 HOURS)**

University portion (80%): (8 Hours)

Requirements, AC and DC drives, Advantages of Electrical Drives, Fundamentals of Torque Equations, Speed Torque Conventions and Multi-quadrant Operation, Equivalent Values of Drive Parameters, Components of Load Torques, Calculation of Time and Energy Loss in Transient Operations, Steady State Stability, Load Equalization, Control of Electrical Drives, Thermal Model of Motor for Heating and Cooling, Classes of Motor Duty, Determination of Motor Rating. **[Book 1 Ch- 1.1,1.2,2,3,4]**

College/Institute portion (20%): (2 Hours)

Electrical Motors, Power Modulators, Choice of electrical Drives, modern trends in drives technology, Nature and Classification of Load Torques. **[Book 1 Ch- 1.3,1.4,1.5,2.5]** Or related advanced topics as decided by the concerned faculty teaching the subject.

MODULE-II **(10 HOURS)**

University portion (80%): (8 Hours)

Steady State Performance of DC/AC Drives:DC Motors and their Performances, Starting, Braking, Transient Analysis, Speed Control, Methods of Armature Voltage Control, Controlled Rectifier Fed DC Drives,Induction Motor Drives: Speed Control, Pole Changing, Pole Amplitude Modulation, Stator Voltage Control, Variable Frequency Control from Voltage Source, Voltage Source Inverter Control, Variable Frequency Control from Current Source, Current Source Inverter Control, Current Regulated Voltage Source Inverter Control, Rotor Resistance Control, Slip Power Recovery.**[Book 1 Ch- 5.1,5.2,5.3,5.4,5.5,5.6,5.9,6.8, 6.9,6.10,6.11,6.12,6.13,6.16,6.17,6.18,6.20,6.21]**

College/Institute portion (20%): (2 Hours)

Transformer and Uncontrolled Rectifier Control, Chopper Controlled DC Drives.**[Book 1 Ch- 5.8,5.18]** Or related advanced topics as decided by the concerned faculty teaching the subject.

MODULE-III **(10 HOURS)**

University portion (80%): (8 Hours)

Synchronous Motor Drives: Synchronous Motor Variable Speed Drives, Variable Frequency Control of Multiple Synchronous Motors. Electric Traction: System of electric traction Mechanics of Train Movement: Speed- time, distance- time and simplified speed-time curves, Attractive effort for acceleration and propulsion, effective weight, train resistance, adhesive weight, specific energy output and consumption. **[Book 1 Ch- 7.3, 7.4,10.2,10.6]**

College/Institute portion (20%): (2 Hours)

Traction Motors: Review of characteristics of different types of DC and AC motors used in traction and their suitability.**[Book 1 Ch- 10.10.9,10.10,10.12,10.15,10.16]** Or related advanced topics as decided by the concerned faculty teaching the subject.

MODULE-IV **(10 HOURS)**

University portion (80%): (8 Hours)

Drives for specific application like Textile Mills, Steel Rolling Mills, Cranes and Hoist Drives, Cement Mills, Sugar Mills, Machine Tools, Paper Mills, Coal Mines, Centrifugal Pumps. Application Areas and Functions of Microprocessors in Drive Technology.**[Book 2 Ch-7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8, 7.9, 8.3]**

College/Institute portion (20%): (2 Hours)

Control of DC Drives using Microprocessors, some aspects of control system design of microprocessor based variable speed drive **[Book 2 Ch-8.4,8.5]** Or related advanced topics as decided by the concerned faculty teaching the subject.

BOOKS

[1]. G.K.Dubey,Norasa Pub. House ND "Electric Drive"
[2]. V.Subrahmanyam,TMH "Electric Drives"
[3]. M.H.Rashid (P.H.I.Edition)"Power Electronics"

Electrical Drives Lab

(Any Eight Experiments)

1. Speed Control of Single Phase Induction Motor by using Single Phase AC to AC Converter.
2. Speed Control of Separately Excited DC Shunt Motor using Single Phase Fully Controlled AC to DC Converter.
3. Speed Control of Separately Excited DC Shunt Motor using Four-Quadrant Chopper.
4. Speed Control of Separately Excited DC Shunt Motor using Single Phase Dual Converter.
5. Speed Control of Three Phase Squirrel Cage Induction Motor using Three Phase AC to AC Controller.
6. Speed Control of Three Phase Squirrel Cage Induction Motor using Three Phase PWM Inverter.
7. Speed Control of Three Phase Slip Ring Induction Motor using Rheostatic Control Method.
8. Speed Control of DC Shunt Motor using Three Phase AC to DC Converter.
9. Determination of the Transfer Function of DC Shunt Motor.
10. Determination of the Moment of Inertia of DC Shunt Motor Drive System by Retardation Test.

PEE6I102 POWER SYSTEM OPERATION & CONTROL (3-0-1)

Module – I **[14 Hours]**

University Portion (80%): (12 Hours)

Fundamentals of Power System (Book No.1, Ch. 1)

Introduction, Single Subscript Notation, Double Subscript Notation, Power in Single Phase AC Circuit, Complex Power, The Power Triangle, Direction of Power Flow, Voltage and Current in Balanced Three Phase Circuits, Power in Balanced Three Phase Circuits, Per-Unit Quantities, Changing the Base in Per- Unit Quantities, Node Equations, The Single Line or One Line Diagram, Impedance and Reactance Diagrams. (Book-1:Ch. 1.1, Ch. 1.2, Ch. 1.3, Ch. 1.4, Ch. 1.5, Ch. 1.6, Ch. 1.7, Ch. 1.8, Ch. 1.9, Ch. 1.10, Ch. 1.11, Ch. 1.12, Ch. 1.13, Ch. 1.14).

The Admittance Models & Network Calculations (Book – 1: Ch. 7 (7.1 To 7.5))

Branch and Node Admittances, Mutually Coupled Branches in Ybus, an Equivalent Admittance Network, Modification of Ybus, the Network Incidence Matrix and Ybus. (Book-1:Ch. 7.1, Ch. 7.2, Ch. 7.3, Ch. 7.4, Ch. 7.5.)

Power Flow Solutions (Book – 1, Ch. 9)

The Power-Flow Problem, the Gauss-Seidal Method, the Newton-Raphson Method, the Newton-Raphson Method, Power-Flow Studies in System Design and Operation, Regulating Transformers, the Decoupled Method. (Book-1:Ch. 9.1, Ch. 9.2, Ch. 9.3, Ch. 9.4, Ch. 9.5, Ch. 9.6, Ch. 9.7.)

Module – II **[14 Hours]**

University Portion (80%): (12 Hours)

Economic Operation of Power System (Book – 1, Ch.13)

Distribution of Load between Units within a Plant, Distribution of Load between Plants, The Transmission-Loss Equation, An interpretation of Transformation C, Classical Economic Dispatch with Losses, Automatic Generation Control, Unit Commitment, Solving the Unit Commitment Problems.

(Book-1: Ch. 13.1, Ch. 13.2, Ch. 13.3, Ch. 13.4, Ch. 13.5, Ch. 13.6, Ch. 13.7, Ch. 13.8.)

Load Frequency Control, Control Area Concept (Book – 2, Ch.9)

Automatic Load-Frequency Control of Single Area Systems: Speed-Governing System, Hydraulic Valve Actuator, Turbine-Generator Response, Static Performance of Speed Governor, Closing the ALFC Loop, Concept of Control Area, Static Response of Primary ALFC Loop, Dynamic Response of ALFC Loop, Physical Interpretation of Results, The Secondary ("Reset") ALFC Loop, Economic Dispatch Control. (Book – 2: Ch. 9.3.1, Ch. 9.3.2, Ch. 9.3.3,Ch. 9.3.1, Ch. 9.3.4, Ch. 9.3.5, Ch. 9.3.6, Ch. 9.3.7, Ch. 9.3.8, Ch. 9.3.9, Ch. 9.3.10, Ch. 9.3.11.)

Module – III **[6 Hours]**

University Portion (80%) : (4 Hours)

Two Area Systems (Book – 2, Ch.9)

ALFC of Multi-Control-Area Systems (Pool Operation): The Two Area Systems, Modeling the Tie-Line, Block Diagram Representation of Two Area System, Mechanical Analog of Two Area System, Dynamic Response of Two Area System, Static System Response, Tie-Line Bias Control of Multi-area Systems. (Book – 2: Ch. 9.4.1, Ch. 9.4.2, Ch. 9.4.3 Ch. 9.4.1, Ch. 9.4.4, Ch. 9.4.5, Ch. 9.4.6, Ch. 9.4.7, Ch. 9.4.8, Ch. 9.4.9, Ch. 9.4.10.)

Module- IV **[6 Hours]**

University Portion (80%) : (4 Hours)

Power System Stability (Book-1, Ch.16)

The Stability Problem, Rotor Dynamics and the Swing Equation, Further Considerations of the Swing Equations, The Power-Angle Equation, Synchronizing Power Coefficients, Equal-Area Criterion for Stability, Further Applications of the Equal-Area Criterion, Multi-machine Stability Studies: Classical Representation, Step-By-Step Solution of the Swing Curve, Computer Programs for Transient Stability Studies, Factors Affecting Transient Stability. (Book-1:Ch. 16.1, Ch. 16.2, Ch. 16.3, Ch. 16.4, Ch. 16.5, Ch. 16.6, Ch. 16.7, Ch. 16.8, Ch. 16.9, Ch. 16.10, Ch. 16.11.)

Text Books:

1. *Power System Analysis- By John. J. Grainger & W. D. Stevenson, Jr., TMH, 2003 Edition, Fifteenth Reprint.*
2. *An Introduction to Electric Energy System Theory- By O. I. Elgerd, TMH, Second Edition.*
3. *Power System Analysis, T K Nagsarkar and M S Sukhija, Oxford University Press*

Reference:

1) *Power System Analysis- By Hadi Saadat, TMH, 2002 Edition, Eighth Reprint.*
2) *Power System Analysis Operation and Control- By A. Chakrabarti and S. Haldar, Third Edition, PHI Publications, 6th Reprint, 2010.*

POWER SYSTEM LAB

Any 10 experiments out of which atleast 7 experiments from Group-A and 3 experiments from Group-B.

Group A: *HARDWARE BASED*

1. *To determine negative and zero sequence synchronous reactance of an alternator.*
2. *To determine sub-transient direct axis and sub-transient quadrature axis synchronous reactance of a 3-ph salient pole alternator.*
3. *To determine fault current for L-G, L-L, L-L-G and L-L-L faults at the terminals of an alternator at very low excitation.*
4. *To study the IDMT over-current relay and with different plug setting and time setting multipliers and plot its time – current characteristics.*
5. *To determine the operating characteristics of biased different relay with different % of biasing.*
6. *To study the MHO and reactance type distance relays.*
7. *To determine A, B, C, D parameters of an artificial transmission line.*
8. *To compute series inductance and shunt capacitance per phase per km of a three phase line with flat horizontal spacing for single stranded and bundle conductor configuration.*
9. *To determine location of fault in a cable using cable fault locator.*
10. *To study the Ferranti Effect and voltage distribution in HV long transmission line using transmission line model.*
11. *Insulation test for Transformer oil.*
    a) *Study of various types of Lightning arrestors.*
    b) *Study of layout of outdoor pole mounted & plinth mounted sub-stations.*

Group B : *SIMULATION BASED (USING MATLAB OR ANY OTHER SOFTWARE)*

1. *To obtain steady-state, transient and sub-transient short-circuit currents in an alternator.*
2. *To formulate the Y-Bus matrix and perform load flow analysis.*
3. *To compute voltage, current, power factor, regulation and efficiency at the receiving end of a three phase Transmission line when the voltage and power at the sending end are given. Use Π model.*
4. *To perform symmetrical fault analysis in a power system.*
5. *To perform unsymmetrical fault analysis in a power system.*
6. *Write a program in 'C' language to solve economic dispatch problem of a power system with only thermal units. Take production cost function as quadratic and neglect transmission loss.*

Text books:

1. *Hadi Sadat- Power System Analysis – TMH*
2. *T. K. Nagsarkar and M. S. Sukhija - Power System Analysis – Oxford University Press*

PEE6J001 VSLI DESIGN (4-0-0)

Module – I 08 Hours

Introduction: Historical Perspective, VLSI Design Methodologies, VLSI Design Flow, Design Hierarchy, Concept of Regularity, Modularity and Locality, VLSI Design Styles, Computer-Aided Design Technology.

Fabrication of MOSFETs: Introduction, Fabrication Processes Flow – Basic Concepts, The CMOS n-Well Process, Layout Design Rules, Stick Diagrams, Full-Customs Mask Layout Design.

MOS Transistor: The Metal Oxide Semiconductor (MOS) Structure, The MOS System under External Bias, Structure and Operation of MOS Transistor (MOSFET), MOSFET Current-Voltage Characteristics, MOSFET Scaling and Small-Geometry Effects, MOSFET Capacitance.

(Chapter 1 to 3 of Text Book 1 and for Stick Diagram Text Book 2)

Module – II 14 Hours

MOS Inverters – Static Characteristics: Introduction, Resistive-Load Inverters, Inverters with n-Type MOSFET Load, CMOS Inverter.

MOS Inverters – Switching Characteristics and Interconnect Effects: Introduction, Delay-Time Definitions, Calculation of Delay-Times, Inverter Design with Delay Constraints, Estimation of Interconnect Parasitics, Calculation of Interconnect Delay, Switching Power Dissipation of CMOS Inverters.

Combinational MOS Logic Circuits: Introduction, MOS Logic Circuits with Depletion nMOS Loads, CMOS Logic Circuits, Complex Logic Circuits, CMOS Transmission Gates (Pass Gates).

(Chapter 5 to 7 of Text Book 1)

Module – III 18 Hours

Sequential MOS Logic Circuits: Introduction, Behaviour of Bistable Elements, SR Latch Circuits, Clocked Latch and Flip-Flop Circuits, CMOS D-Latch and Edge-Triggered Flip-Flop.

Dynamic Logic Circuits: Introduction, Basic Principles of Pass Transistor Circuits, Voltage Bootstrapping, Synchronous Dynamic Circuit Techniques, Dynamic CMOS Circuit Techniques, High Performance Dynamic CMOS Circuits.

Semiconductor Memories: Introduction, Dynamic Random Access Memory (DRAM), Static Random Access Memory (SRAM), Non-volatile Memory, Flash Memory.

Design for Testability: Introduction, Fault Types and Models, Ad Hoc Testable Design Techniques, Scan-Based Techniques, Built-In Self-Test (BIST) Techniques, Current Monitoring I_{DDQ} Test.

Text Books:

1. Sung-Mo Kang and Yusuf Leblebici, *CMOS Digital Integrated Circuits: Analysis and Design*, 3rd Edn., Tata McGraw-Hill Publishing Company Limited, 2003.
2. K. Eshraghian and N.H.E. Weste, *Principles of CMOS VLSI Design – a Systems Perspective*, 2nd Edn., Addison Wesley, 1993.

Reference Books:

1. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, *Digital Integrated Circuits – A Design Perspective*, 2nd Edn., Pearson Education, 2003.
2. Debaprasad Das, *VLSI Design*, Oxford University Press, 2015
3. Wayne Wolf, *Modern VLSI Design System – on – Chip Design*, 3rd Edn., Pearson Education, 2003.
4. John P. Uyemura, *CMOS Logic Circuit Design*, Springer (Kluwer Academic Publishers), 2001.
5. Ken Martin, *Digital Integrated Circuit Design*, Oxford University Press, 2000.

PEE6J002 GENERALIZED THEORY OF ELECTRICAL MACHINES (3-1-0)

Module – 1: **[10 hours]**

University portion (80%):

Theory of electromechanical energy conversion: Magnetically Coupled Circuits, Electromechanical Energy Conversion, Elementary ac Machines. (Ch-1.1,1.2,1.3,1.4)

Distributed windings in ac machinery: Describing Distributed Windings, Winding Functions, Air-Gap Magneto motive Force, Rotating MMF, Flux Linkage and Inductance, Resistance, Voltage and Flux Linkage Equations for Distributed Winding Machines.(Ch-2.1,2.2,2.3,2.4,2.5,2.6,2.7,2.8)

Reference-frame theory: Equations of Transformation, Change of Variables, Stationary Circuit Variables Transformed to the Arbitrary Reference Frame, Commonly Used Reference Frames, Transformation of a Balanced Set, Balanced Steady-State Phasor Relationships, Balanced Steady-State Voltage Equations.
(Ch-3.1,3.2,3.3,3.4,3.5,3.6,3.7,3.8)

Institute portion (20%):

Variables Observed from Several Frames of Reference, Transformation between Reference Frames, Specialty Transformations, Space-Phasor Notation(Ch-3.9,3.10,3.11,3.12) Or Related topics as decided by the concerned faculty teaching the subject

Module – 2: **[10 hours]**

University portion: (80%)

Permanent-magnet AC machines: Voltage and Torque Equations in Machine Variables, Voltage and Torque Equations in Rotor, Reference-Frame Variables, Analysis of Steady-State Operation, Brushless dc Motor, Phase Shifting of Applied Voltages of a Permanent-Magnet ac Machine, Control of Stator Currents.
(Ch-4.1,4.2,4.3,4.4,4.5,4.6,4.7)

Synchronous Machines: Voltage Equations in Machine Variables, Torque Equation in Machine Variables, Stator Voltage Equations in Arbitrary Reference-Frame Variables, Voltage Equations in Rotor Reference-Frame Variables, Torque Equations in Substitute Variables, Rotor Angle and Angle Between Rotors(Ch-5.1,5.2,5.3,5.4,5.5,5.6,5.7)

Institute portion (20%):

Per Unit System, Analysis of Steady-State Operation, Stator Currents Positive Out of Machine, Synchronous Generator Operation, Computer Simulation.(Ch-5.8,5.9,5.10,5.11) Or Related topics as decided by the concerned faculty teaching the subject

Module – 3: **[10 hours]**

University portion: (80%)

Symmetrical Induction Machines: Voltage Equations in Machine Variables, Torque Equation in Machine Variables, Equations of Transformation for Rotor Circuits, Voltage Equations in Arbitrary Reference-Frame Variables, Torque Equation in Arbitrary Reference-Frame Variables, Commonly Used Reference Frames, Per Unit System, Analysis of Steady-State Operation, Free Acceleration Characteristics, Free Acceleration Characteristics Viewed from Various Reference Frames.(Ch-6.1,6.2,6.3,6.4,6.5,6.6,6.7,6.8,6.9,6.10,6.11)

Institute portion (20%):

Dynamic Performance During Sudden Changes in Load Torque , Dynamic Performance During a Three-Phase Fault at the Machine Terminals, Computer Simulation in the Arbitrary Reference Frame(Ch-6.12,6.13,6.14) Or Related topics as decided by the concerned faculty teaching the subject

Module – 4: **[10 hours]**

University portion: (80%)

Machine Equations in operational impedances and time constants: Park's Equations in Operational Form, Operational Impedances and G(p) for a Synchronous Machine with Four Rotor Windings, Standard Synchronous Machine Reactances, Standard Synchronous Machine Time Constants, Derived Synchronous Machine Time Constants, Parameters from Short-Circuit Characteristics, Parameters from Frequency-Response Characteristics(Ch-7.1,7.2,7.3,7.4,7.5,7.6,7.7,7.8)

Alternative forms of machine equations: Machine Equations to Be Linearized, Linearization of Machine Equations, Small-Displacement Stability: Eigen values, Eigen values of Typical Induction Machines, Eigen values of Typical Synchronous Machines, Neglecting Electric Transients of Stator Voltage Equations, Induction Machine Performance Predicted with Stator Electric Transients Neglected(Ch-8.1,8.2,8.3,8.4,8.5,8.6,8.7,8.8)

Institute portion (20%):

Synchronous Machine Performance Predicted with Stator Electric Transients Neglected, Detailed Voltage Behind Reactance Model, Reduced Order Voltage Behind Reactance Model (Ch-8.9,8.10,8.11) Or Related topics as decided by the concerned faculty teaching the subject

Text Book:

1. Analysis of Electric Machinery and Drive Systems, 3rd Edition, by Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, Steven Pekarek (Chapter 1- Chapter 8)

Reference:

1. Generalized Machine Theory by P.S Bimbhra

PEE6J003 HIGH VOLTAGE DC TRANSMISSION (4-0-0)

(Revised)

MODULE-I[12 hrs]

INTRODUCTION TO HVDC TRANSMISSION: Basic concepts of power transmission, Comparison of AC and DC Transmission, Application of DC transmission, description of dc transmission system, Planning of HVDC transmission. Morden trends in HVDC technology. Operating problems in HVDC transmission. HVDC transmission based on voltage converters.

MODULE-II[12 Hrs]

TYPES OF CONVERTERS: Line commutated converters and voltage source converters.Analysis of HVDC converters.

CONTROL OF HVDC CONVERTER AND SYSTEMS: Principle of DC link control, Converter control characteristics, firing angle control, current and extension angle control, starting and stopping of DC link, Synchronisation techniques for power converters.

MODULE-III[10 hrs]

CONVERTER FAULT & PROTECTION: Converter faults – protection against over current and over voltage in converter station – surge arresters – smoothing reactors – DC breakers –Audible noise-space charge field-corona effects on DC lines- Radio interference\

REACTIVE POWER AND HARMONICS CONTROL: Reactive power requirements in steady state – Sources of reactive power – SVC and STATCOM – Generation of harmonics – Design of AC and DC filters – Active filters

MODULE-IV[8 hrs]

POWER FLOW ANALYSIS IN AC/DC SYSTEMS: Modelling of DC Links-DC Network-DC Converter-Controller Equations-Solution of DC loadflow – P.U. System for d.c. quantities-solution of AC-DC Power flow-Simultaneous method Sequential method.

Text Book:

1. HVDC Power Transmissions Systems: Technology & Systems Interaction, K.R.Padiyar, New Age Publication, 2005

Reference Book(s):

1. "**HVDC Transmission**" By S. Kamakshaiah& V. Kamaraju, TMH Education Private Ltd., 2011, New Delhi.
2. "HVDC and FACTS controllers" by Vijay K. Sood, KLUWER academic publishers.

PEE6J004 CONTROL SYSTEM ENGINEERING-II (4-0-0)

Module-I **[15 Hours]**

Discrete - Time Control Systems :

Introduction: Discrete Time Control Systems and Continuous Time Control Systems, Sampling Process.

Digital Control Systems: Sample and Hold, Analog to digital conversion, Digital to analog conversion.The Z-transform: Discrete-Time Signals, The Z-transform, Z-transform of Elementary functions, Important properties and Theorms of the Z-transform. The inverse Ztransform, Z Transform method for solving Difference Equations.

Z-Plane Analysis of Discrete Time Control Systems: Impulse sampling & Data Hold, Reconstruction of Original signals from sampled signals: Sampling theorm, folding, aliasing. Pulse Transfer function: Starred Laplace Transform of the signal involving Both ordinary and starred Laplace Transforms; General procedures for obtaining pulse Transfer functions, Pulse Transfer function of open loop and closed loop systems. Mapping between the s-plane and the z-plane, Stability analysis of closed loop systems in the z-plane: Stability analysis by use of the Bilinear Transformation and Routh stability critgion, Jury stability Test. Book No. 1: 1.1; 1.2; 1.4; 2.1; 2.2; 2.3; 2.4; 2.5; 2.6; 3.2; 3.4; 3.5; 4.2; 4.3.

Module -II **[15 Hours]**

State Variable Analysis & Design:

Introduction: Concepts of State, State Variables and State Model (of continuous time systems): State Model of Linear Systems, State Model for Single-Input-Single-Output Linear Systems, Linearization of the State Equation. State Models for Linear Continuous – Time Systems: State-Space Representation Using Physical Variables, State – space Representation Using Phase Variables, Phase variable formulations for transfer function with poles and zeros, State – space Representation using Canonical Variables, Derivation of Transfer Function for State Model. Diagonalization: Eigenvalues and Eigenvectors, Generalized Eigenvectors.

Solution of State Equations: Properties of the State Transition Matrix, Computation of State Transition Matrix, Computation by Techniques Based on the Cayley-Hamilton Theorem, Sylvester's Expansion theorm. Concepts of Controllability and Observability: Controllability, Observability, Effect of Pole-zero Cancellation in Transfer Function. Pole Placement by State Feedback, Observer Systems. State Variables and Linear Discrete – Time Systems: State Models from Linear Difference Equations/z-transfer Functions, Solution of State Equations (Discrete Case), An Efficient Method of Discretization and Solution, Linear Transformation of State Vector (Discrete-Time Case), Derivation of z-Transfer Function from Discrete-Time State Model. Book No. 2: 12.1 to 12.9.

Module -III **[12 Hours]**

Nonlinear Systems :

Introduction : Behaviour of Non linear Systems, Investigation of nonlinear systems. Common Physical Non Linearities: Saturation, Friction, Backlash, Relay, MultivariableNonlinearity. The Phase Plane Method: Basic Concepts, Singular Points: Nodal Point, Saddle Point, Focus Point, Centre or Vortex Point, Stability of Non Linear Systems: Limit Cycles, Construction of Phase Trajectories: Construction by Analytical Method, Construction by Graphical Methods. The Describing Function Method: Basic Concepts: Derivation of Describing Functions: Dead-zone and Saturation, Relay with Dead-zone and Hysteresis, Backlash. Stability Analysis by Describing Function Method: Relay with Dead Zone, Relay with Hysteresis, Stability Analysis by Gain-phase Plots. Jump Resonance. Liapunov's Stability Analysis: Introduction, Liapunov's Stability Critrion: Basic Stability Theores, Liapunov Functions, Instability. Direct Method of Liapunov & the Linear System: Methods of constructing Liapunov functions for Non linear Systems. Book No. 2: 13.1 to 13.4; 15.1 to 15.10.

Text Book:

1. *Discrete-Time Control System, by K.Ogata, 2nd edition (2009), PHI.*
2. *Control Systems Engineering, by I.J. Nagrath and M.Gopal., 5th Edition (2007 / 2009), New Age International (P) Ltd. Publishers.*

Reference Book:

1. *Design of Feedback Control Systems by Stefani, Shahian, Savant, Hostetter, Fourth Edition (2009), Oxford University Press.*
2. *Modern Control Systems by K.Ogata, 5th Edition (2010), PHI.*
3. *Modern Control Systems by Richard C. Dorf. And Robert, H.Bishop, 11th Edition (2008), Pearson Education Inc. Publication.*
4. *Control Systems (Principles & Design) by M.Gopal, 3rd Edition (2008), Tata Mc.Graw Hill Publishing Company Ltd.*
5. *Control Systems Engineering by Norman S.Nise, 4th Edition (2008), Wiley India (P) Ltd.*

PEE6J005 ADVANCE DIGITAL SIGNAL PROCESSING

Module:-1

Multirate Digital Signal Processing: Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling rate Conversion by a rational factor I/D, Implementation of Sampling rate Conversion, Multistage implementation of Sampling rate Conversion, Sampling rate Conversion of Band pass Signals, Sampling rate Conversion by an Arbitrary Factor, Digital Filter Banks, Two-channel Quadrature Mirror Filter Bank.

Module:-2

Linear Prediction and Optimum Linear Filters: Random Signals, Correlation Functions, and Power Spectra , Innovation Representation of a Stationary Random Process, Forward and Backward Linear Prediction, Solution of the normal equations: The Levinson-Durbin Algorithm. Properties of the Linear Prediction Error filters. Wiener filters for filtering and Prediction.

Adaptive Filters: Applications of Adaptive filters, Adaptive Direct-Form FIR filters- The LMS Algorithm.

Module:-3

Power Spectrum Estimation: Estimation of Spectra from Finite Duration Observations of Signals, Nonparametric Methods for Power Spectrum estimation, Relationship between the Autocorrelation and the model parameters. Bayes Theorem, Maximum Likelyhood detection.

Module:-4

The Yule-Walker Method for the AR Model Parameters, The Burg Method for the AR model Parameters, Unconstrained Least-Squares Method for the AR model parameters, MA Model for Power Spectrum Estimation, ARMA model for Power Spectrum Estimation.

Additional Module (Terminal Examination-Internal)

Filter Bank Methods, Eigenanalysis Algorithms for Spectrum Estimation

Text Book:

1. *Digital Signal Processing, John G.Proakis, Dimitris G. Manolakis, Pearson Education, New Delhi, 4th Edition, 2013.*

Reference Book:

1. *Adaptive Filter Theory, Simon Haykin, Pearson Education, 5th Edition 2017.*
2. *Adaptive Signal Processing, Bernard Widrow, Samuel D Stearns, Pearson Education,*

PMG6M001 ENVIRONMENTAL SCIENCE AND ENGINEERING

Module I

Multidisciplinary nature of environmental studies

Definition, scope and importance, Need for public awareness.

Natural Resources:

Renewable and non-renewable resources:

Natural resources and associated problems.

a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people.

b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

e) Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies.

f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

- Role of an individual in conservation of natural resources.
- Equitable use of resoureces for sustainable lifestyles.

Module II

Ecosystems

Concept of an ecosystem.

- Structure and function of an ecosystem.
- Producers, consumers and decomposers.
- Energy flow in the ecosystem.
- Ecological succession.
- Food chains, food webs and ecological pyramids.
- Introduction, types, characteristic features, structure and function of the following ecosystem :-

a) Forest ecosystem
b) Grassland ecosystem
c) Desert ecosystem
d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Environmental Pollution Definition

- Cause, effects and control measures of :-

a) Air pollution
b) Water pollution
c) Soil pollution
d) Marine pollution
e) Noise pollution
f) Thermal pollution
g) Nuclear hazards

- Solid waste Management: Causes, effects and control measures of urban and industrial wastes.
- Role of an individual in prevention of pollution.
- Pollution case studies.

- Disaster management: floods, earthquake, cyclone and landslides.

Module III

Social Issues and the Environment

- From Unsustainable to Sustainable development
- Urban problems related to energy
- Water conservation, rain water harvesting, watershed management
- Resettlement and rahabilitation of people; its problems and concerns. Case Studies
- Environmental ethics : Issues and possible solutions.
- Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies.
- Wasteland reclamation.
- Consumerism and waste products.
- Environment Protection Act.
- Air (Prevention and Control of Pollution) Act.
- Water (Prevention and control of Pollution) Act
- Wildlife Protection Act
- Forest Conservation Act
- Issues involved in enforcement of environmental legislation.
- Public awareness.

Module IV

Human Population and the Environment

- Population growth, variation among nations.
- Population explosion – Family Welfare Programme.
- Environment and human health.
- Human Rights.
- Value Education.
- HIV/AIDS.
- Women and Child Welfare.
- Role of Information Technology in Environment and human health.
- Case Studies.

References

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. R. Rajagopalan, Environmental Studies, Oxford University Press
3. Ajith Sankar, Environmental Mangement, Oxford University Press
4. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India, Email:mapin@icenet.net (R)
5. Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480p
6. Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
7. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. 2001, Environmental Encyclopedia, Jaico Publ. House, Mumabai, 1196p
8. De A.K., Environmental Chemistry, Wiley Eastern Ltd.
9. Down to Earth, Centre for Science and Environment (R)

PEN6E101 BUSINESS COMMUNICATION AND SKILL FOR INTERVIEW

Course Objectives

- To develop communication competence in prospective engineers.
- To enable them to convey thoughts and ideas with clarity and focus.
- To develop report writing skills.
- To equip them to face interview & Group Discussion.
- To inculcate critical thinking process.
- To prepare them on problem solving skills.
- To provide symbolic, verbal, and graphical interpretations of statements in a problem description.
- To understand team dynamics & effectiveness.
- To create an awareness on Engineering Ethics and Human Values.
- To install Moral and Social Values, Loyalty and also to learn to appreciate the rights of others.
- To learn leadership qualities and practice them.

MODULE I

Communication Skill: Introduction to Communication, The Process of Communication, Barriers to Communication, Listening Skills, Writing Skills, Technical Writing, Letter Writing, Job Application, Report Writing, Non-verbal Communication and Body Language, Interview Skills, Group Discussion, Presentation Skills, Technology-based Communication.

MODULE II

Critical Thinking & Problem Solving: Creativity, Lateral thinking, Critical thinking, Multiple Intelligence, Problem Solving, Six thinking hats, Mind Mapping & Analytical Thinking.

Teamwork: Groups, Teams, Group Vs Teams, Team formation process, Stages of Group, Group Dynamics, Managing Team Performance & Team Conflicts.

MODULE III

Ethics, Moral & Professional Values: Human Values, Civic Rights, Engineering Ethics, Engineering as Social Experimentation, Environmental Ethics, Global Issues, Code of Ethics like ASME, ASCE, IEEE.

MODULE IV

Leadership Skills: Leadership, Levels of Leadership, Making of a leader, Types of leadership, Transactions Vs Transformational Leadership, VUCA Leaders, DART Leadership, Leadership Grid & leadership Formulation.

Expected outcome:

The students will be able to

- Communicate effectively.
- Make effective presentations.
- Write different types of reports.
- Face interview & group discussion.
- Critically think on a particular problem.
- Solve problems.

- Work in Group & Teams
- Handle Engineering Ethics and Human Values.
- Become an effective leader.

References:

1. Barun K. Mitra; (2011), "Personality Development & Soft Skills", First Edition; Oxford Publishers.
2. Kalyana; (2015) "Soft Skill for Managers"; First Edition; Wiley Publishing Ltd.
3. Larry James (2016); "The First Book of Life Skills"; First Edition; Embassy Books.
4. Shalini Verma (2014); "Development of Life Skills and Professional Practice"; First Edition; Sultan Chand (G/L) & Company
5. John C. Maxwell (2014); "The 5 Levels of Leadership", Centre Street, A division of Hachette Book Group Inc.

PEE6D001 SPECIAL ELECTROMECHANICAL DEVICES (HONORS) (4-0-0)

Module- I **[12 HOURS]**
University Portion (80%):

STEPPER MOTOR(6 hours)
Variable Reluctance (VR) Stepper Motor, Permanent Magnet Stepper Motor, Hybrid Stepper Motor (HSM), Windings in Stepper Motor, Torque Equation, Characteristics of Stepper Motor, Open Loop Control of Stepper Motor, Closed Loop Control of Stepper Motor, Comparison of Stepper Motor, Application of Stepper Motor. Ch.1.1 to 1.9, Ch. 1.11, Ch. 1.12
SWITCHED RELUCTANCE MOTOR (SRM) (5 hours)
Construction, Principle of Working, Basics of SRM Analysis, Constraints on Pole Arc and Tooth Arc, Torque equation and Characteristics, Power Converter Circuits, Control of SRM, Rotor Position Sensor, Current Regulators Ch.2.1 to 2.9

Module- II **[10 HOURS]**
University Portion (80%): (9 Hours)

Permanent Magnet DC (PMDC) Motors: Construction, Principle of Working, Torque Equation and Equivalent Circuit, Performance Characteristics, Moving Coil (MC) Motors, Printed Circuit (PC) Motors, Shell Type PMDC Motors, Disc Motors
Ch. 3.1 (3.1.1 to 3.1.8)
Brushless Permanent Dc (BLDC) Motors: Classification of BLDC Motors, Construction, Electronic Commutation, Principle of Operation, Type of BLDC Motor, Control of BLDC Motor, Microprocessor Based Control of BLDC Motor, DSP Based Control of BLDC Motor, Sensor less Control of BLDC Motor, Comparison of Conventional DC Motor and BLDC Motor, Application of BLDC Motor
Ch. 3.2 (3.2.1 to 3.2.4, 3.2.6 to 3.2.12)

Module- III **[8 HOURS]**
University Portion (80%):
PERMANENT MAGNET SYNCHRONOUS MOTOR (PMSM) (4 hours)
Construction, Principle of Operation, EMF Equation of PMSM, Torque Equation, Phasor Diagram, Circle Diagram of PMSM, Comparison of Conventional and PM Synchronous Motor, Application of PMSM
Ch. 4.1 to 4.7, 4.9
SYNCHRONOUS RELUCTANCE MOTOR (SyRM)(3hours)
Construction of SyRM, Working of SyRM, Phasor Diagram and Torque Equation of SyRM, Control of SyRM, Advantages of SyRM, Applications of SyRM
Ch. 5.1 to 5.6

MODULE- IV **[10 HOURS]**

University Portion (80%):(9 Hours)

LINEAR ELECTRIC MACHINES

Linear Induction Motor (LIM): Construction of LIM, Thrust equation of LIM, Performance Equation Based on Current Sheet Concept, Goodness Factor, Equivalent Circuit of LIM, Characteristic of LIM, Certain Design Aspects of LIM, Control of LIM.

Linear Synchronous Motor (LSM): Type and Construction of LSM, Thrust equation of LSM, Control of LSM, Application of LSM.

DC Linear Motor (DCLM): Type and Construction of DCLM, Persistent Current Tubular Electromagnetic Launcher, Induction Tubular EML, DC Pulsed Flat Series EML, DC Tubular Series EML.

Ch. 8.1(8.1.1 to 8.1.8), Ch. 8.2(8.2.1 to 8.1.4), Ch. 8.3(8.3.1 to 8.3.6)

Text Book:

1. *Special Electric Machines – E.G.JANARDANAN – PHI Learning Pvt. Ltd,.*

Reference Book(s):

1. *Special Electric Machines –K. VENKATARATNAM- Universities Press Pvt. Ltd.*
2. *Electromechanical System and Devices- Sergey E. Lyshevski-CRC Press*
3. *Linear Motion Electromagnetic Devices- I.Boldea, S.A. Nasar-Taylor and Francis*

PEE6D002 FLEXIBLE AC TRANSMISSION SYSTEMS (HONORS) (4-0-0)

Module-I **[12 Hours]**

FACTS concept and General System Considerations: Transmission Interconnections, Flow of Power in an AC System, What limits the Loading Capability, Power Flow and Dynamic Stability Considerations of a Transmission Interconnection, Relative Importance of Controllable Parameters, Basic Types of FACTS Controllers, Basic Description and Definitions of FACTS Controllers.

Static Shunt Compensation: Objectives of Shunt Compensation, Methods of Controllable VAR Generation, Static VAR Compensators, SVC and STATCOM.

(Chapter-1: 1.1, 1.2, 1.3, 1.4, 1.5, 1.6 and 1.7)

(Chapter-5: 5.1, 5.2 and 5.3)

Module-II **[12 Hours]**

Static Series Compensators: Objective of Series Compensation (GCSC, TSSC, TCSC), Variable Impedance Type Series Compensators, Switching Converter Type Series Compensators (SSSC) Static Voltage and Phase Angle Regulators: Objectives of Voltage and Phase Angle Regulators, Approaches to Thyristor-Controlled Voltage and Phase Angle Regulators (TCVRs and TCPARs).

(Chapter-6: 6.1, 6.2 and 6.3)

(Chapter-7: 7.1 and 7.2)

MODULE-III **[10 Hours]**

Combined Compensators: Introduction, Unified Power Flow Controller (UPFC), The Interline Power Flow Controller (IPFC), Generalized and Multifunctional FACTS Controllers.

(Chapter-8: 8.1, 8.2, 8.3 and 8.4)

Text book:

1. *"Understanding FACTS: Concepts & Technology of Flexible AC Transmission Systems" By N.G.Hingorani & L.Gyugyi, IEEE Press, Standard Publishers Distributors, Delhi.*

Reference Book:

1. *Facts Controllers in Power Transmission & Distribution by K.R.Padiyan, New Age Intermational.*
2. *Modelling & Simulation in Power Networks, Enrique Acha, Clandio Esquival & H.A.Perez,CA Camcho, John Wiley & Sons.*

PEE6D003 UTILIZATION OF ELECTRICAL ENERGY (HONOR) (4-0-0)

UNIT I: ELECTRIC DRIVES

Basic concept of electric drives, choice of electric drives, fundamental torque equation, speedtorque converter and multi quadrant operation, equivalent values of drive parameters, concept of load torque, calculation of time and energy loss in transient operation, steady state stability and load equalization,types of industrial loads, continuous, intermittent and variable loads,Review of torque speed characteristicsof AC and DC motors.

UNIT II: ILLUMINATION

Production of light - lighting calculations - determination of MHCP and MSCP - Polar curves of different types of sources - Rousseau's construction - photometers - interior and exterior illumination systems - lighting schemes - Design of lighting schemes - factory lighting - flood lighting - electric lamps - gaseous discharge lamps

UNIT III: HEATING AND WELDING:

Salient features of electric heating, resistance heating, induction heating, electric arc heating, methods of generating high frequency power.Arc Furnaces - Construction and fields of application - control equipment, Electric welding, resistance and arc welding, control devices and welding equipment, butt welding, spot welding. ;

UNIT IV: ELECTRIC TRACTION

System of electric traction and track electrification. Review of existing electric traction systems in India. Special features of traction motor, methods of electric braking-plugging rheostatic braking and regenerative braking.

Mechanics of train movement. Speed-time curves for different services – trapezoidal and quadrilateral speed time curves.Recent trend in electric traction

TEXT BOOKS:

1. Utilisation of Electric Energy – by E. Openshaw Taylor, Orient Longman.
2. Art & Science of Utilization of electrical Energy – by Partab, Dhanpat Rai & Sons.

REFERENCE BOOKS:

1. Utilization of Electrical Power including Electric drives and Electric traction – by

N.V.Suryanarayana, New Age International (P) Limited, Publishers, 1996.
2. Generation, Distribution and Utilization of electrical Energy – by C.L. Wadhwa, New Age International (P) Limited, Publishers, 1997.
3. S. C. Tripathy, Electric Energy Utilisation and Conservation, Tata McGraw Hill, 1991.
4. W. F. Stocker and J.W. Jones, Refrigeration & Air Conditioning, McGraw Hill, 1985.
Supplementary Reading:
5. N.V. Suryanarayana, Utilisation of Electric Power, Wiley Eastern Ltd., 1993.

PEE6G001 ELECTRICAL MACHINES-II (MINOR)(4-0-0)

Module-I
University Portion (80%):
General principles of DC machines: Armature Windings (Simplex Lap and Simplex Wave), Expression for EMF Induced and Torque developed in the Armature counter Torque and Counter or Back EMF, Methods of Excitation, Armature Reaction, Commutation.
DC Machine Characteristics: Conditions for Self Excitation, Critical Resistance and Critical Speed. Internal and External Characteristics for self and Separately Excited DC Generator. Characteristic for Speed~ Armature Current, Torque~ Armature Current and Speed~ Torque of a DC Shunt, Series and Compound Motor and Comparison.

Module-II
University Portion (80%):
DC Motor Starting and Performance: Necessity of a Starter, Starting of DC Shunt, Series and Compound Motors, Speed Control of DC Shunt and Series motor Losses, efficiency and power flow diagram.
Three Phase Synchronous Generators: Synchronous Generator Construction (both Cylindrical Rotor and Salient Pole type), the Speed of Rotation of a Synchronous Generator, Induced voltage in A.C Machines, The Internal Generated Voltage of a Synchronous Generator, The Equivalent Circuit of a Synchronous Generator (Armature Reaction Reactance, Synchronous Reactance and Impedance).
Cylindrical Rotor type Three Phase Synchronous Generators: The Phasor Diagram of a Synchronous Generator, Power and Torque in Synchronous Generators (Power Angle Equation and Power Angle Characteristic), Measuring Synchronous Generator Model Parameters (Open Circuit and Short Circuit Tests and Determination of Synchronous Impedance and Reactance, The Short Circuit Ratio), Voltage Regulation and Speed Regulation. Voltage Regulation by Synchronous Impedance Method
.

Module-III
University Portion (80%):
Salient Pole type Three Phase Synchronous Generators: Two Reaction Concept, Development of the Equivalent Circuit of a Salient Pole type Three Phase Synchronous Generator (Direct axis and Quadrature axis Reactance, Phasor Diagram for various load power factors,), Torque and Power Equations of Salient Pole Synchronous Generator (Power Angle Equation and Power Angle Characteristic with stator resistance neglected). Slip Test for determination of Direct axis and Quadrature axis Reactance.
Parallel operation of Three Phase A.C. Synchronous Generators.The Conditions Required for Paralleling, The General Procedure for Paralleling Generators, Frequency - Real Power and Voltage – Reactive Power Characteristics of a Three Phase Synchronous Generator.

Module-IV

University Portion (80%):

Three Phase Synchronous Motors: Basic Principles of Motor operation, Steady State Synchronous Motor operation, Starting Synchronous Motors, Synchronous Generators and Synchronous Motors, Operation of synchronous motors connected to bus and phasor diagrams for normal, under and over excited conditions, V and Λ curves, Synchronous Motor Ratings. Application.

Special Purpose Motors: The Universal series motor: constructional features and performance characteristics

Text books:

1. *Stephen J. Chapman-'Electric Machinery and Fundamentals'- Mc Graw Hill International Edition, (Fourth Edition), 2015.*
2. *M.G.Say-'Alternating Current Machines', English Language Book Society (ELBS)/ Longman , 5th Edition, Reprinted 1990.*
3. *Electrical Machines – Prithwiraj Purkait & Indrayudh Bandyopadhyay, Oxford University Press*

Reference books:

1. *B.S.Guru & H.R.Hiziroglu-'Electric Machinery & Transformers'-3rd Ed-Oxford Press, 2014.*
2. *P.C.Sen-'Principles of Electric Machines and Power Electronics'-2nd Edition, John Wiley and Sons, Wiley India Reprint, 2014.*
3. *A.E.Fitgerland, Charles Kingslay Jr. & Stephen D. Umans -Electric machinery – 6th Edition Mc Graw Hill – Reprint 2015.*
4. *D.P. Kothari & I.J. Nagrath - Electric Machines – 4th Edition Mc Graw Hill – Reprint 2015.*
5. *P S Bimbhra – Electrical Machinery –Khanna Publishers.*

PEE6G002 CONTROL SYSTEM ENGINEERING-II (MINOR) (4-0-0)

Module-I **[15 Hours]**

Discrete - Time Control Systems :

Introduction: Discrete Time Control Systems and Continuous Time Control Systems, Sampling Process.

Digital Control Systems: Sample and Hold, Analog to digital conversion, Digital to analog conversion.The Z-transform: Discrete-Time Signals, The Z-transform, Z-transform of Elementary functions, Important properties and Theorms of the Z-transform. The inverse Ztransform, Z Transform method for solving Difference Equations.

Z-Plane Analysis of Discrete Time Control Systems: Impulse sampling & Data Hold, Reconstruction of Original signals from sampled signals: Sampling theorm, folding, aliasing. Pulse Transfer function: Starred Laplace Transform of the signal involving Both ordinary and starred Laplace Transforms; General procedures for obtaining pulse Transfer functions, Pulse Transfer function of open loop and closed loop systems. Mapping between the s-plane and the z-plane, Stability analysis of closed loop systems in the z-plane: Stability analysis by use of the Bilinear Transformation and

Routh stability critgion, Jury stability Test. Book No. 1: 1.1; 1.2; 1.4; 2.1; 2.2; 2.3; 2.4; 2.5; 2.6; 3.2; 3.4; 3.5; 4.2; 4.3.

Module -II **[15 Hours]**

State Variable Analysis & Design:

Introduction: Concepts of State, State Variables and State Model (of continuous time systems): State Model of Linear Systems, State Model for Single-Input-Single-Output Linear Systems, Linearization of the State Equation. State Models for Linear Continuous – Time Systems: State-Space Representation Using Physical Variables, State – space Representation Using Phase Variables, Phase variable formulations for transfer function with poles and zeros, State – space Representation using Canonical Variables, Derivation of Transfer Function for State Model. Diagonalization: Eigenvalues and Eigenvectors, Generalized Eigenvectors.

Solution of State Equations: Properties of the State Transition Matrix, Computation of State Transition Matrix, Computation by Techniques Based on the Cayley-Hamilton Theorem, Sylvester's Expansion theorm. Concepts of Controllability and Observability: Controllability, Observability, Effect of Pole-zero Cancellation in Transfer Function. Pole Placement by State Feedback, Observer Systems. State Variables and Linear Discrete – Time Systems: State Models from Linear Difference Equations/z-transfer Functions, Solution of State Equations (Discrete Case), An Efficient Method of Discretization and Solution, Linear Transformation of State Vector (Discrete-Time Case), Derivation of z-Transfer Function from Discrete-Time State Model. Book No. 2: 12.1 to 12.9.

Module -III **[12 Hours]**

Nonlinear Systems :

Introduction : Behaviour of Non linear Systems, Investigation of nonlinear systems. Common Physical Non Linearities: Saturation, Friction, Backlash, Relay, MultivariableNonlinearity. The Phase Plane Method: Basic Concepts, Singular Points: Nodal Point, Saddle Point, Focus Point, Centre or Vortex Point, Stability of Non Linear Systems: Limit Cycles, Construction of Phase Trajectories: Construction by Analytical Method, Construction by Graphical Methods. The Describing Function Method: Basic Concepts: Derivation of Describing Functions: Dead-zone and Saturation, Relay with Dead-zone and Hysteresis, Backlash. Stability Analysis by Describing Function Method: Relay with Dead Zone, Relay with Hysteresis, Stability Analysis by Gain-phase Plots. Jump Resonance. Liapunov's Stability Analysis: Introduction, Liapunov's Stability Critrion: Basic Stability Theores, Liapunov Functions, Instability. Direct Method of Liapunov & the Linear System: Methods of constructing Liapunov functions for Non linear Systems. Book No. 2: 13.1 to 13.4; 15.1 to 15.10.

Text Book:

3. *Discrete-Time Control System, by K.Ogata, 2nd edition (2009), PHI.*
4. *Control Systems Engineering, by I.J. Nagrath and M.Gopal., 5th Edition (2007 / 2009), New Age International (P) Ltd. Publishers.*

Reference Book:

6. *Design of Feedback Control Systems by Stefani, Shahian, Savant, Hostetter, Fourth Edition (2009), Oxford University Press.*
7. *Modern Control Systems by K.Ogata, 5th Edition (2010), PHI.*
8. *Modern Control Systems by Richard C. Dorf. And Robert, H.Bishop, 11th Edition (2008), Pearson Education Inc. Publication.*
9. *Control Systems (Principles & Design) by M.Gopal, 3rd Edition (2008), Tata Mc.Graw Hill Publishing Company Ltd.*
10. *Control Systems Engineering by Norman S.Nise, 4th Edition (2008), Wiley India (P) Ltd.*