PED501: Power Electronics Devices and Magnetics **Credit: 3-0-0**

UNIT1- Power Diodes, Thyristor, Triac, GTO, BJT: Structure and I-V Characteristics, Types, Breakdown Voltages and Control, On State Losses, Switching Characteristics, Reverse Recovery Transients, Snubbers, Modelling, Gate drive, Protection and Rating.

UNIT2- Power MOSFETs: Basic Structure, HexFet structure, V-I Characteristics, Turn on time and Process, On State operation, Turn off time and process, Switching Characteristics, Switching Losses, Effect of Reverse Recovery Transients on Switching Stresses and Losses - dv/dt limitations, Gating Requirements Gate Charge, Ratings, FBSOA and RBSOA Curves, Device Protection Modelling of Power MOSFETS.

UNIT3- Transistors (IGBTs): Structure and Operation, Parasitic Diode and Latch up, IGBT Switching Characteristics, Resistive Switching Specifications, Clamped Inductive Switching Specifications, IGBT Turn on and off Transients, Current Tail, Ratings of IGBTs, FBSOA and RBSOA Curves, Switching Losses, Switching Frequency Capability, Protection of IGBTs, Snubber Requirements, Modelling of IGBT,

New power semiconductor devices: MOS Gated Thyristors, MOS Controlled Thyristors or MOS GTOs, Base Resistance controlled Thyristors, Emitter Switched Thyristor, etc.

UNIT4- Thermal design of power electronic equipment: Heat transfer by conduction, convection and radiation, transient thermal impedance, Heat Sink Selection.

UNIT5- Magnetics: Magnetic Materials, Iron Cores, Amorphous Alloys, Ferrites, Magnetization Processes, Hysteresis Loop, Complex Permeability, Comparison and Applications of the Core Materials in Power Electronics, Ferrite Core Losses with Non-Sinusoidal Voltage Waveforms, Steinmetz Equation, Insulation Requirements and Standards, Self and mutual inductance, Inductor Design.

Suggested Books:

1. Ned Mohan Tore.M. Undeland and William.P Robbins, “Power Electronics converters, Applications and Design”, John Wiley and Sons.

2. B. Jayant Baliga, “Power Semiconductor Devices”, PWS Publication.

3. V. Benda, J. Gowar, and D. A. Grant, “Discrete and Integrated Power Semiconductor Devices:Theory and Applications”, John Wiley & Sons.

4. Barry W Williams,"POWER ELECTRONICS: Devices, Drivers, Applications, and Passive Components", McGraw Hill

5. Alex Van den Bossche and Vencislav Cekov Valchev,"Inductors and Transformers for Power Electronics", CRC Press, Taylor & Francis Group.

PED503: Modeling of Electrical Apparatus **Credit: 3-0-0**

UNIT 1- Reference frames, Electrical network terminology, Mesh networks, Rotating machines in quasi holonomic reference frame, Generalised machine, Generated voltage, Impedance matrix, Inductance and torque matrix, Flux linkage and flux density matrices, Rotation matrix, Electromagnetic torque, Elimination of axes, Analysis using revolving field theory, Transformation from the stationary to rotating reference frame and vice-versa.

UNIT2- Modelling of three phase Induction machine in quasi-holonomic and holonomic frames, sequence impedances, two phase symmetrical components, model of single phase induction motor, State model of induction machine.

UNIT3- Modelling of synchronous machine in quasi-holonomic and holonomic frames, Elimination of field and damper winding, Two phase alternator, torque in salient pole machine, determination of d-q axis reactances, under transients, with and without damper windings, State model of synchronous machine.

UNIT4- Transformer under sequence reference frame, Sequence reference frame, Impedance matrix, Δ -Y or Y-Δ transformers, measurement of positive, negative and zero sequence impedance, model under faults.

UNIT5- Analysis of Static Power converters, Modelling of AC-DC thyristorised converter, DC-DC PWM Converters, AC Voltage controller and single and three phase Pulsed and PWM inverters (3ph-3 wire and 3ph-4 wire).

Suggested Books:

1. K. Mukhopadhyay, “Matrix Analysis Of Electrical Machines”, New Age International
2. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff, " Analysis Of Electric Machinery And Drive Systems", IEEE Press, John Wiley & Sons.
3. William H. Kersting,"Distribution System Modeling and Analysis", CRC Press

PED505: DC Power Converters **Credit: 3-0-0**

UNIT1- Classification of power supplies, Basic functions of voltage regulators, Power relationships in DC–DC converters, DC transfer functions, Static and dynamic characteristics of DC Voltage regulators, Linear voltage regulators, Series voltage regulator, Shunt voltage regulator, Topologies of PWM DC–DC converters, Relationships among current, voltage, energy, and power, Electromagnetic compatibility.

UNIT2- Buck, Boost PWM DC–DC Converter**:** DC Analysis of PWM Buck, Boost & Buck-Boost Converter for CCM and DCM, DC Voltage Transfer Function for CCM and DCM, Boundary between CCM and DCM, Ripple Voltage for CCM, Switching Losses with Linear MOSFET Output Capacitance, Switching Losses with Nonlinear MOSFET Output Capacitance, Efficiency for CCM and DCM, DC Voltage Transfer Function of Lossy Converters for CCM, Power Factor Correction, Bidirectional Buck-boost Converter, Synthesis of Boost-buck (C´uk) Converter, Cascaded Noninverting Buck-boost Converters, Sepic Converters.

UNIT3- Flyback and Forward PWM DC–DC Converter**:** Transformers, DC Analysis of PWM Flyback and Forward Converter for CCM and DCM, DC Voltage Transfer Function for CCM and DCM, Boundary between CCM and DCM, Ripple Voltage in Converter for CCM and DCM, Power Losses and Efficiency of Converter for CCM and DCM, DC Voltage Transfer Function of Lossy Converter for CCM, Multiple-output Converters, Bidirectional Converter.

UNIT4- Half, Full-bridge & Push-Pull PWM DC–DC Converter**:** DC Analysis of PWM Half, Full-bridge & Push Pull Converter for CCM and DCM, Device Stresses, DC Voltage Transfer Function of Lossless Converters for CCM and DCM, Boundary between CCM and DCM, Ripple Voltage in Converters for CCM and DCM, Power Losses and Efficiency of Converters for CCM, DC Voltage Transfer Function of Lossy Converters for CCM, Design of Converters for CCM, Phase-controlled Full-bridge Converter.

UNIT5- Soft-switching DC–DC Converters: Zero-voltage-switching of DC–DC Converters, Buck ZVS Quasi-resonant DC–DC Converter, Boost ZVS Quasi-resonant DC–DC Converter, Zero-current-switching DC–DC Converters, Boost ZCS Quasi-resonant DC–DC ConverterMulti resonant Converters.

Suggested Book:

1. Marian K. Kazimierczuk , ‘Pulse-width Modulated DC–DC Power Converters’, John Wiley & Sons, 2008
2. Abraham Pressman, Keith Billings and Taylor Morey, ‘ Switching Power Supply Design’, Mc Graw Hill, 2009
3. Keng C. Wu, ‘Switch-Mode Power Converters: Design and Analysis’, Elsevier Science Publishing, 2005

4. K. Kit Sum, ‘Switch Mode Power Conversion’, Marcel Dekker, 1984

PED 511: Advance Power Electronics Lab **Credit: 0-0-3**

1. Study of V-I Characteristics for SCR, IGBT, TRAIC, DIAC, MOSFET
2. Study and analysis of Single phase ac voltage controller using SCR & TRIAC
3. Analysis of single-phase and three-phase controlled bridge converter with R, RL loads at different firing angle.
4. To compare the forced commutation circuits (class A, class B, class C, class D& class E) commutation (chopper) circuit module
5. To Study single phase and three-phase cyclo converter with R & RL load
6. To study single phase and three-phase bridge inverter
7. To study Morgen chopper circuit
8. To study Single phase Mc-murray Bed Ford full bridge inverter .
9. Closed loop speed control of Dc shunt motor using PI Controller
10. Speed control of (v/f control) of three phase ac induction motor
11. Closed loop speed control of ac induction motor control using DSP/FPGA Controller
12. Study of advance PWM Technique

PED502: Industrial Instrumentation and Automation **Credit: 3-0-0**

UNIT1- Logic families: TTL, CMOS etc. and their applications in design of various combinational and sequential circuits.

UNIT2- Analog multipliers OTA**:** Internal Architecture and application of OTA in Resistance, Inductance, Oscillator and filter Design, Analysis of noise.

UNIT3- Sensors types: displacement, position, proximity and velocity sensors, signal processing, data display. Actuation systems: Mechanical types, electrical types, pneumatic and hydraulic systems, applications, selection of actuators, Smart sensors, semiconductor IC sensors, requirements of sensor diodes, applications of sensor diodes & characteristics, silicon temperature sensor – AD 7414, Magnetic field sensors – AD 22151, photo diodes- optical sensors, industrial auto sensors – AD 22050 & characteristics.

UNIT4- Signal conditioning circuits: Oscillators & signal generators, modulations and counters.

UNIT5- Control Systems, Types of controllers – programmable logic controllers, applications, ladder diagrams, microprocessor applications, programming interfacing, computer applications

Suggested Books:

1. Jones, B.E., “Instrument Technology”, Vol.3 Butter worth and CO., Publishers,.
2. Andrew Parr, “Industrial Control – Handbook”, Newnes Industrial Press – New Delhi.
3. Ernest O. Doebelin, “Measurement Systems”, McGraw-Hill Publishing Co., .
4. James Dally, W., “Instrumentation for Engineering Measurements”, John Wiley & Sons, Inc., .
5. Patranabis, D., “Sensors and Transducers”, Wheeler Publishing, .
6. Jonathan W Valvano, “Embedded Microcomputer system”,Asia Pvt. Ltd., Brolks /cole, Thomson, .
7. Sze Simon, “Semiconductor sensors”, Alibris Publications, Wiley Interscience.

PED504: Electric Drive Systems **Credit: 3-0-0**

UNIT1- Definition, Application range, Energy savings, Global energy savings through Power Electronic Converter drives, Load torque v/s speed curves , Motion v/s time profile match, Load dynamics and stability, Multiquadrant operation, Electric motors for drives, Power electronic converters (P.E.Cs) for drives

UNIT2- DC motor drives: Basic topologies, Performance equations, d - q model, Steady state motor characteristics, D.C. brush motor losses, Transient operation for constant flux, variable flux, Speed/excitation, transfer function, Controlled rectifier d.c. brush motor drives, Three phase converter - motor side and source side aspects, Dual converter-four quadrant operation, Chopper - controlled d.c. brush motor drives.

UNIT3- Induction motors drives**:** Torque and speed loop, Digital position control, State-space motion control, Torque perturbation observers, Sliding-mode and fuzzy motion control, Space phasor model, Electrical transients with flux linkages as variables and for constant rotor flux, A.C. braking, D.C. braking, Speed control methods, Torque-speed curves.

UNIT4- PWM inverter fed induction motor drives: Vector control-flux orientation, Current decoupling, Direct versus indirect vector current decoupling, A.C. versus D.C. current controllers, Voltage decoupling, Flux observers for direct vector control with motion sensors: Open loop and closed loop flux observers, Flux and speed observers in sensor less drives, A classification of speed observers, Speed estimators, Direct torque and flux control (DTFC), Sensor less DTFC.

UNIT5- Synchronous motors drives**:** Construction aspects, Pulsating torque, phase coordinate model, Space phasor (d-q) model, Steady state operation, PM and reluctance synchronous motor drives: Classifications and control, brushless D.C. motor drives: Ideal brushless d.c. motor waveforms, Rectangular current control system, Hysteresis current controller, Extending the torque-speed domain, Vector control, Indirect vector current control, Indirect voltage and current vector control, Sensorless control of PM-SMs, Reluctance synchronous motor (RSM) drives: RSM vector control principles, Indirect vector current control of RSM, Direct torque and flux control (DTFC) of RSM, Sensor less control of RSM.

Suggested Books:

1. Boldea I., Nasar S.A., Electric Drives, CRC Press.

2. Bimal K. Bose, Power Electronics and Motor Drives, Elsevier, 2006.

3. P. C. Sen, Principles of Electrical Machines and Power Electronics, 2nd ed., Wiley, New York, 1997.

PED506: Digital Controllers Architecture and Interfacing **Credit: 3-0-0**

UNIT1- Introduction to embedded system: An embedded system, processor, hardware unit, soft ware embedded into a system, Example of an embedded system, OS services, 1/O, N/W, O/S. Real time and embedded OS, Co-design operating system, efficient I/O testing and debugging, Hardware Architecture for embedded systems, Embedded Applications.

UNIT2- Processor and memory organization: Structural unit in a processor, processor selection for an embedded systems. Memory devices, memory selection for an embedded system, allocation of memory to program statements and blocks and memory map of a system. Direct memory accesses, Pipelining and Cache Memories, Paging and Segmentation, Fragmentation.

UNIT3- Real time system**:** Types, Real Time Computing, Design Issue, Sample Systems, Hardware Requirements- Processor in a system, System Memories, System I/O, Other Hardware Devices (A/D, D/A, USART, Watchdog Timers, Interrupt Controllers). Device Drivers, Interrupt Servicing Mechanism & Interrupt Latency.

UNIT4- Real time operating system: Fundamental Requirements of RTOS, Real Time Kernel Types, Schedulers, Various Scheduling modules with examples, Latency (Interrupt Latency, Scheduling Latency and Context Switching Latency), Tasks, State Transition Diagram, Task Control Block. Inter-task communication and synchronization of tasks.

UNIT5- Micro chip PIC microcontroller: Introduction to 18cxx controller, CPU Architecture, Description of timing and control units, interfacing memory & I/O devices, Addressing modes, Instruction set, Assembly level programming, Timers, I/O port expansion, Interrupts, ITC Bus operation, Serial EEPROM, ADC, UART, DAC using PWM, Serial Programming/Parallel slave port, I2C Bus for Peripheral Chip Access, Applications.

Suggested Books:

1. Rajkamal, “Embedded System Architecture: Programming & Design”, TMH Edition.

2. H.-W. Huang, “ PIC Microcontroller:An Introduction to Software & Hardware Interfacing”

3. John B. Peatman “Design with PIC Microcontrollers”, Prentice Hall.

4. Jane W.S. Liu, “Real Time Systems”, Pearson Education.

5. Philip. A. Laplante, “Real-Time Systems Design and Analysis- An Engineer’s Handbook”- Second Edition, PHI Publications.

6. K.V.K. Prasad,“Embedded Real Time Systems: Concepts Design and Programming”, Dreamtech Press

PED508: AC Power Converter **Credit: 3-0-0**

UNIT1-PWM Techniques: Single pulse, Multiple pulse, SPWM, Modified SPWM methods, Phase displacement control, Space vector modulation technique, Hysteresis controller, other advance PWM technique

UNIT2- AC Converters **:** Single and three phase AC voltage controllers, Thyristor controlled reactors(TCR), Static VAr compensator(SVC), Thyristor controlled series capacitor(TCSC), Phase-Controlled Cycloconverters, Matrix Converters.

UNIT3- Voltage Source Converter**:** Principle of operation, performance parameters, single phase half and full bridge inverters and Three-Phase naturally commutated controlled bridge inverter, Three-Phase step-wave inverter circuits, Voltage control of single phase inverters, Voltage control of three phase inverter, Harmonic reduction, Current source inverter, Comparison between VSI & CSI.

UNIT4- Multilevel inverters: Transformer and inverter based configuration, Diode clamped multi level inverters, Neutral point clamped multilevel inverters, Flying capacitor multilevel inverters, Circuits for 12, 24, 36, 48 pulses, Applications.

UNIT5- Current Source Converters: Basic concept, ASCI configuration, Single phase and three-phase CSI configurations, Comparison of CSI and VSI

Suggested Books:

1. Ned Mohan, Tore. M. Undeland and William. P Robbins, “Power Electronics: Converters, Applications and Design”, John Wiley and Sons.

2. Thomas H. Barton, “Rectifiers, Cycloconverters and AC controllers”, Clarendon Press, Oxford.

3. Marian P. Kazmierkowski, R Krishnan and Frede Blaabjerg,” Control in Power Electronics”, Academic Press.

4. William Shepherd and Li ZhangPower, "Power Converter Circuits", Marcel Dekker Inc.

5. Fang Lin Luo, Hong Ye and Muhammad Rashid, "Digital Power Electronics and Applications", Academic Press.

6. Robert W. Erickson, "Fundamentals of Power Electronics", Kluwer Academic Publishers

7. Barry W Williams,"POWER ELECTRONICS: Devices, Drivers, Applications, and Passive Components", McGraw Hill

8. Marian K. Kazimierczuk, "Pulse-width Modulated DC–DC Power Converters", John Wiley & Sons

PED544: Advance Electric Drive Lab **Credit: 0-0-3**

1. Study & performances analysis of vector control of Induction Motor drive
2. Study & performances analysis of direct torque control (DTC) of induction motor drive
3. Study & performances analysis of permanent magnet synchronous motor (PMSM) drive
4. Study & performances analysis of switched reluctance motor drive
5. Study & performance evaluation of different FPGA based controller for DC motor
6. Study & performance evaluation of DSP based control of AC drives
7. Study of power electronics interface for solar PV based AC system
8. Study and training on PLC based Automation for motor control.

PED601: Special Electromechanical Devices **Credit: 3-0-0**

UNIT-1:

Introduction to special electrical machines, Magnetic devices, and Permanent magnet materials

UNIT-2:

Constructional and functional aspects of Permanent magnet machines, Permanent magnet brushless DC machines, Stepper motors, Hysteresis motors, Switched reluctance motors, Hybrid motors

Configurations, modeling, analysis, and circuits of Power electronics converters and interface used in special electromechanical devices

UNIT-3:

Construction, Classification, Operation , analysis , Applications of linear machines and other magnetic devices

UNIT-4:

Applications, in robotics industry automation, Electric vehicles, Aerospace and defense systems, etc, Super conducting machines and Other advanced machines,

Unit-5:

Computer aided simulation and design of special electrical machines, Case studies.

Suggested Books:

1. Rakosh Das Begamudre "Electro Mechanical Energy Conversation with Dynamics of Machines", New Age International, 2003.
2. Hughes, A. (1994). *Electric Motors and Drives*. Newnes.
3. Leonhard,W. (1990). *Control of Electrical Drives*. Springer-Verlag, Berlin Heidelberg NewYork, Tokyo, 2 edition.
4. Ned Mohan, Tore. M. Undeland and William. P Robbins, "Power Electronics: Converters, Applications and Design", John Wiley and Sons.
5. Boldea I., Nasar S.A., Electric Drives, CRC Press.
6. Bimal K. Bose, Power Electronics and Motor Drives, Elsevier, 2006.
7. P. C. Sen, Principles of Electrical Machines and Power Electronics, 2nd ed., Wiley, New York, 1997.

8. T.J.E. Miller, “Brushless Permanent Magnet and Reluctance Motor Drives”, Oxford Science Publication, 1989

9.

PED603: Power Quality **Credit: 3-0-0**

UNIT1- Overview**:** Characterization of Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – Power quality problems: Poor load power factor, Non linear and unbalanced loads, DC offset in loads, Notching in load voltage, power quality standards.

UNIT2-Analysis of Nonlinear Systems: Single phase static and rotating AC/DC converters, Three phase static AC/DC converters, Battery chargers, Arc furnaces, Fluorescent lighting, Pulse modulated devices, Adjustable speed drives.

UNIT3- Measurement techniques and error analysis**:** Voltage, Current, Power and Energy measurements, power factor measurement and definitions, event recorders, Measurement Error-Analysis: Analysis in the periodic steady state, Time domain method, Frequency domain methods: Laplace, Fourier and Hartley transform – The Walsh transform – Wavelet Transform.

UNIT4- Analysis of Mitigation Methods**:** Analysis of Power outages, Analysis of unbalance: Symmetrical components of phasor quantities, instantaneous symmetrical components, Instantaneous real and reactive powers, Analysis of distortion : On–line extraction of fundamental sequence components from measured samples – Harmonic indices- Analysis of voltage sag: Detorit Edition sag score, Voltage sag energy, Voltage Sag Lost Energy Index (VSLEI)- Analysis of Voltage flicker, Reduced duration and customer impact of outgas, Classical load balancing problem: Open loop balancing, Closed loop balancing, current balancing, Harmonic reduction, Voltage sag reduction.

UNIT5- Power Quality Improvement**:** Utility- Customer interface-Harmonic filter, Custom power devices: Network reconfiguring Devices, Load compensation using DSTATCOM, Protecting sensitive loads using DVR, UPQC-Control strategies-Q theory, modified P-Q theory, Synchronous detection method.

Suggested Books:

1. Arindam Ghosh “Power Quality Enhancement Using Custom Power Devices”, Kluwer Acadamic Publishers.
2. J. Arrillaga, N.R. Watson, S. Chen, Power System Quality Assessment, John Wiley & sons, New York.
3. M H.J. Bollen, Understanding Power quality problems, IEEE Press, New York
4. George J. Wakileh, “Power System Harmonics”, Springer

PED605: Computer Aided Design of Electrical Apparatus **Credit: 3-0-0**

UNIT1- Magnetic Circuits and Materials

Basic design methodology and engineering considerations, Factors, Limitations,

Calculation of mmf for teeth and gap, flux densities, leakage flux, iron losses, Specific permeance, Properties of electric magnetic and insulating materials, Choice of materials

UNIT2- Heating and Cooling Aspects

Temperature gradient, Choice of frames, Modes of heat dissipation, Type of ventilation, Cooling methods, amount of coolant, Ratings

UNIT3- Constraints in Design

Specific loading, output equation, output coefficient, effect of linear dimension

UNIT4- Design of Various Machines

Design of induction, synchronous (based on steady and dynamic model) and FHP motors, Length of airgap, Selection of rotor slots, Design of bars and end rings for squirrel cage machine, Design of wound rotor for induction motor, Design of field system for synchronous motor.

Design of PMSM from cost and performance point of view

UNIT5- Application of Computers in Electrical Machines Design

Computerisation of design procedures, Optimization techniques and their application to design problems (deterministic and heuristic approach), design algorithms, Database and knowledge based expert systems, Development of design software

Familiarization with latest design softwares

Suggested Books:-

1. S.K.Sen, "Principles of Electrical Machine Design with Computer Programmes", Oxford and IBM publishing co., pvt. Ltd., New Delhi, 1987.
2. M. Ramamoorty, “Computer aided design of electrical equipment”, Eastern press pvt. Ltd, New delhi
3. H.M.Rai, "Principles of Electrical Machine Design", Sathya prakashan, Delhi., 1988.
4. A.E.Clayton, "Performance and design of Direct Current Machines", The English Language Book Society and sir Isaac pitman and sons Ltd., London, 1962.
5. M.G.Say, "The performance and design of Alternating current Machines", Sir Isaac pitman and sons Ltd., London, 1958.

PED633: Power Converters and Simulation Lab **Credit: 0-0-3**

1. Study of various PWM techniques
2. Study & analysis DC- DC Converter
3. Study and training on power supplies SMPS
4. Study & analysis of STATCOM
5. Study and training on power supply and UPS

Matlab/Simulink based study and analysis

6. Simulation and comparison of PWM techniques
7. Simulation Studies on performances analysis of vector control of Induction Motor drive
8. Simulation Studies on performances analysis of direct torque control (DTC) of induction motor drive
9. Simulation Studies on performances analysis of permanent magnet synchronous motor (PMSM) drive
10. Simulation Studies on performances analysis of switched reluctance motor drive
11. Simulation Studies for power electronics interface for solar PV based AC system
12. PLC based programming for automation for motor control

PED551: Soft Computing Techniques **Credit: 3-0-0**

UNIT1: Introduction to various computation techniques including classical techniques, Concept of Artificial intelligence, problem solving methods and searching techniques,

UNIT2-Fuzzy Systems**:** Fuzzy sets, operation on fuzzy sets, Fuzzy Relations, Membership functions, Matrix representation, Fuzzy logic controller.

UNIT3-Artificial Neural Networks**:** Fundamental concepts, Basic Models, Learning Rules, Single layer and multi-layer feed-forward and feedback networks, Supervised and unsupervised learning, Recurrent networks, modular Network, Self organizing maps, Function networks, Simulated Evolution for neural network learning, fast learning algorithms for training Neural, Networks Neural network controller.

UNIT4-Genetic Algorithm**:** Basic principle, Evolution of genetic algorithm, Genetic operators, Various selection schemes, Binary and real coded GA, Constraint handling in GA, Hybrid genetic algorithm.

UNIT5-Hybrid Systems and other Computation Technique**:** Integrated GA-Neural- Fuzzy system combinational approach, Differential Evaluation, Bacteria foraging, Simmulated Annealing, Harmony Search, PSO

Applications**:** Use of MATLAB tools, Induction motor drive (Vector control, flux estimation**,** Speed observer etc.), DC motor drive, Four quadrant drive control

Suggested Books:-

1. D.E. Goldberg, “Genetic algorithm for search optimization and machine learning”, Addison-Wesley, 1989
2. Lin C. and Lee G., “Neural fuzzy System”, Prentice Hall International Inc.
3. Kosko B., “Neural networks and fuzzy systems: A dynamical systems approach to machine intelligence”, PHI Publication.
4. Rajasekaran S. and Pai G.A.V., “Neural networks, fuzzy logic and genetic algorithm synthesis and applications”, PHI New Delhi

PED651: HVDC and Flexible AC Transmission Systems **Credit: 3-0-0**

UNIT1- Conventional power grid and power transfer mechanism, A more Flexible Power Grid: Power Electronics Control, HVDC Transmission: Thyristor-Based CSC Transmission, VSC Transmission Based on the Integrated Gate Bipolar Transistor (IGBT), Multi-terminal HVDC, The Flexibility Concept Applied to HVDC, Relative Power Carrying Capability of AC and DC Transmission Lines, The Impact of Distributed Generation.

UNIT2-

Line-Commutated HVDC Conversion: Three-Phase AC–DC Conversion: CSC Operating Principles, Effect of Delaying the Firing Instant, The Commutation Process: Analysis of the Commutation Circuit, Rectifier Operation, Inverter Operation, Power Factor and Reactive Power, Characteristic Harmonics: DC Side and AC Side Harmonics, Multi-Pulse Conversion: Transformer Phase Shifting, DC Ripple Reinjection, Uncharacteristic Harmonics and Inter harmonics: Imperfect AC Source, DC Modulation, Control System Imperfections, Firing Asymmetry, Magnification of Low-Order Harmonics, Harmonic Reduction by Filters, Frequency Cross-Modulation Across the LCC

Self-Commutating Conversion HVDC Conversion: Voltage Source Conversion: VSC Operating Principles, Converter Components, The Three-Phase VSC, Comparison of LCC and VSC: Current Source Conversion: Analysis of the CSC Waveforms, The Reinjection Concept with Self-Commutation: Application to VSC, Application to CSC, Multi-level VSC and CSC Transmission: Configurations, merits

UNIT3- Concept of reactive power control, methods of voltage control, AC Transmission Line and Reactive Power Compensation- Uncompensated Transmission Line: Loadability characteristics of O/H lines, on open – circuit, uncompensated transmission line under load, effect of line length, load power, p.f. on voltage and reactive power, mare power & stability, compensation of line and its effect.

UNIT4- Static Compensation: Principle, properties, types – TCR, TSC etc. Sub synchronous Resonance: Introduction, methods of controlling SSR. Synchronous Condensers: Introduction, characteristics, and its operation, Unified Power Flow Controller, Interphase Power Controller, Reactive Power Management:

UNIT5- Custom Power Devices, Structure and Control of Power Converters, Solid State Limiting, Breaking and Transferring Devices, Networking type devices, Shunt and Series compensation, DSTATCOM, Voltage control and current control, 3Ph-3Wire system, 3Ph-4Wire systems, Series devices, Selection of components, Insertion and desertion techniques, DVR, Capacitor supported and power supported, Neutral compensation, Series-shunt devices, UPFC configuration and control.

Suggested Books:-

1. Sood Vijay K., HVDC and FACTS Controllers Applications of Static Converters in Power Systems, KLUWER ACADEMIC PUBLISHERS, 2004.
2. Kimbark, E.W., Direct Current Transmission, Wiley Interscience, New York, 1971.
3. Padiyar, K.R., HVDC Power Transmission Systems – Technology and System Interactions, New Delhi-Eastern, 1990.
4. T.J.E. Miller – Reactive Power Control in Electric Systems, John Wiley & Sons, 1982
5. N.G. Hingorani, Gyugi - Understanding Facts, Concepts, Technology of Flexible AC Transmission Systems IEEE Press, year of publications 1999
6. Arindam Ghosh “Power Quality Enhancement Using Custom Power Devices”, Kluwer Acadamic Publishers.

PED675: Digital Signal Processing and its Application **Credit: 3-0-0**

UNIT1- Review of difference equations and Z—transforms, Z- transfer function (Pulse transfer function), Z- Transforms analysis, sampled data systems, Stability analysis (Jury's Stability Test and Bilinear Transformation), Pulse transfer functions and different configurations for closed loop Discrete-time control systems.

UNIT 2: Review of DSP Fundamentals; FIR filter design by windowing; Adaptive filtering techniques; Fourier analysis of signal using FFT;

UNIT 3: Introduction to Real time DSP and TMS320F2407/TMS320C6XXX/ADMC401, Architecture,; Instruction set; Addressing modes; Simple Assembly programs; Real time digital FIR filter; Real time LMS adoptive filers; Real time frequency domain processing.

UNIT4- State model for continuous time and discrete time systems, Solutions of state equations (for both continuous and discrete systems), Concepts of controllability and observability (For both continuous and discrete systems), Pole Placement by state feedback (for both continuous and discrete systems), Full order and reduced order observes (for both continuous and discrete systems), Dead beat control by state feedback, Optimal control problems using state variable approach, State Regulator and output regulator,

UNIT 5: Concepts of Model reference control systems, Adaptive Control systems and design.

Suggested Books:

1. Oppenheim and Schafer, "Digital Signal Processing", Prentice Hall.

2. Proakis J, "Digital Signal Processing", Prentice Hall.

3. Rulph Chassaing and Donald Reay, "Digital Signal Processing and Applications with the TMS320C6713 and TMS320C6416 DSK", John Wiley and Sons.

4. Samuel Stearns, "Digital Signal Processing with examples in MATLAB", CRC Press.

5. Ogata K "Discrete time Control Systems", PHI.

6. M Gopal "Modem Control System Theory"; Wiley Eastern Ltd.

7. M. Gopal, "Digital Control & State Variable Methods", TMH.