NATIONAL ENGINEERING COLLEGE

(An Autonomous Institution Affiliated to Anna University of Technology Tirunelveli)

K.R.NAGAR, KOVILPATTI – 628 503

REGULATIONS - 2011

DEPARTMENT OF

ELECTRICAL AND ELECTRONICS ENGINEERING

CURRICULUM AND SYLLABI OF

M.E. – HIGH VOLTAGE ENGINEERING

I - SEMESTER

NATIONAL ENGINEERING COLLEGE

(An Autonomous Institution Affiliated to Anna University of Technology Tirunelveli)

M.E.- HIGH VOLTAGE ENGINEERING - SEMESTER I

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MMA102	Applied Mathematics for Electrical Engineers	3	1	0	4
2.	MHV101	Electromagnetic Field Computation and Modelling	3	1	0	4
3.	MHV102	High Voltage Generation and Measurement	3	0	0	3
4.	MHV103	Electrical Transients in Power System	3	0	0	3
5.	MHV104	Insulation Technology	3	0	0	3
6.	E1	Elective I	3	0	0	3
		TOTAL	**18**	**2**	**0**	**20**

SEMESTER II

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
1.	MHV201	High Voltage Testing Techniques	3	0	0	3
2.	MHV202	Insulation Design of High Voltage Power Apparatus	3	0	0	3
3.	MHV203	High Voltage Switchgear	3	0	0	3
4.	MHV204	EHV power transmission	3	0	0	3
5	MHV231	High Voltage Laboratory	0	0	3	2

Approved by

Chairman of BOS
Dept. of EEE
Dr.P.Subburaj

Dean (Academic)
Dr.B.sankaragomathi

Chairman of Academic Council & Principal
Dr.P.Subburaj

ELECTIVES FOR M.E. HIGH VOLTAGE ENGINEERING

SL. No	COURSE CODE	COURSE TITLE	L	T	P	C
THEORY						
1.	MHV001	Analysis of Electrical machines	3	0	0	3
2.	MHV002	Flexible AC Transmission Systems	3	0	0	3
3.	MHV003	Power Quality	3	0	0	3
4.	MHV004	Microcontroller and DSP based System Design	3	0	0	3
5.	MHV005	Special Electrical machines	3	0	0	3
6.	MHV006	Advanced Topics in High Voltage Engineering	3	0	0	3
7.	MHV007	Pollution performance of power apparatus and Systems	3	0	0	3
8.	MHV008	Electromagnetic Interference and Electromagnetic Compatibility	3	0	0	3
9.	MHV009	High Voltage Direct Current Transmission	3	0	0	3
10.	MHV010	Wind Energy Conversion System	3	0	0	3
11.	MHV011	Soft Computing Techniques	3	0	0	3
12.	MCI001	Advanced Digital System design	3	0	0	3
13.	MCI002	Advanced Digital Signal Processing	3	0	0	3
14.	MCI008	Optimal Control and Filtering	3	0	0	3
15.	MCI010	System Identification and Adaptive Control	3	0	0	3
16.	MCI016	Applications of MEMS Technology	3	0	0	3
17.	MCI102	System Theory	3	0	0	3
18.	MCI201	Computer Aided Design of Instrumentation System	3	0	0	3
19.	MHV012	Computer Aided Design of Power Electronics Circuits	3	0	0	3
20.	MHV013	Power Electronics for Renewable Energy Systems	3	0	0	3
21.	MHV014	Modern Rectifiers and Resonant Converters	3	0	0	3
22.	MHV015	Restructured Power Systems	3	0	0	3
23.	MHV016	Power System Planning and Reliability	3	0	0	3
24.	MHV017	Design of Embedded Systems	3	0	0	3
25.	MHV018	Evolutionary Computing	3	0	0	3
26.	MHV019	Power System Operation and Control	3	0	0	3
27	MHV020	Power System Analysis	3	0	0	3
28.	MHV021	Analysis of Power Converters	3	0	0	3
29.	MHV022	Control of Electric Drives	3	0	0	3

MMA102 APPLIED MATHEMATICS FOR ELECTRICAL ENGINEERS L T P C
3 1 0 4

1. **ADVANCED MATRIX THEORY: 9**

Eigen-values using QR transformations – Generalized eigen vectors – Canonical forms – Singular value decomposition and applications – Pseudo inverse – Least square approximations.

2. **LINEAR PROGRAMMING 9**

Formulation – Graphical Solution – Simplex Method – Two Phase Method –Transportation and Assignment Problems.

3 .**ONE DIMENSIONAL RANDOM VARIABLES 9**

Random variables - Probability function – moments – moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a Random Variable.

4. **QUEUEING MODELS 9**

Poisson Process – Markovian queues – Single and Multi Serve r Models –Little's formula – Machine Interference Model – Steady State analysis – Self Service queue.

5. **COMPUTATIONAL METHODS IN ENGINEERING 9**

Boundary value problems for ODE – Finite difference methods – Numerical solution of PDE – Solution of Laplace and Poisson equations – Liebmann's iteration process– Solution of heat conduction equation by Schmidt explicit formula and Crank-Nicolson implicit scheme – Solution of wave equation.

L=45: T=15, Total =60

BOOKS FOR REFERENCE:

1. Bronson, R., Matrix Operation, Schaum's outline series, McGraw Hill, New York,(1989).
2. Taha, H. A., Operations Research: An Introduction, Seventh Edition, Pearson Education Edition, Asia, New Delhi (2002).
3. R. E. Walpole, R. H. Myers, S. L. Myers, and K. Ye, Probability and Statistics for Engineers & Scientists, Asia, 8th Edition, (2007).
4. Donald Gross and Carl M. Harris, Fundamentals of Queuing theory, 2nd edition, John Wiley and Sons, New York (1985).
5. Grewal, B.S., Numerical methods in Engineering and Science, 7th edition, Khanna Publishers, 2009

MHV101 ELECTROMAGNETIC FIELD COMPUTATION AND MODELLING **L T P C**
3 1 0 4

1. INTRODUCTION **9**

Review of basic field theory – electric and magnetic fields – Maxwell's equations –Laplace, Poisson and Helmoltz equations – principle of energy conversion – force/torque calculation – Electro thermal formulation.

2. SOLUTION OF FIELD EQUATIONS I **9**

Limitations of the conventional design procedure, need for the field analysis based design, problem definition , solution by analytical methods-direct integration method – variable separable method – method of images, solution by numerical methods- Finite Difference Method.

3. SOLUTION OF FIELD EQUATIONS II **9**

Finite element method (FEM) – Differential/ integral functions – Variational method –Energy minimization – Discretisation – Shape functions –Stiffness matrix –1D and 2D planar and axial symmetry problem.

4. FIELD COMPUTATION FOR BASIC CONFIGURATIONS **9**

Computation of electric and magnetic field intensities– Capacitance and Inductance –Force, Torque, Energy for basic configurations.

5. DESIGN APPLICATIONS **9**

Insulators- Bushings – Cylindrical magnetic actuators – Transformers – Rotating machines.

L=45: T=15, Total =60

REFERENCES

1. K.J.Binns, P.J.Lawrenson, C.W Trowbridge, "The analytical and numerical solution of Electric and magnetic fields", John Wiley & Sons, 1993.
2. Nathan Ida, Joao P.A.Bastos , "Electromagnetics and calculation of fields", Springer-Verlage, 1992.
3. Nicola Biyanchi , "Electrical Machine analysis using Finite Elements", Taylor and Francis Group, CRC Publishers, 2005.
4. S.J Salon, "Finite Element Analysis of Electrical Machines." Kluwer Academic Publishers, London, 1995, distributed by TBH Publishers & Distributors, Chennai,India
5. User manuals of MAGNET, MAXWELL & ANSYS software.
6. Silvester and Ferrari, "Finite Elements for Electrical Engineers" Cambridge University press, 1983.

MHV102 HIGH VOLTAGE GENERATION AND MEASUREMENT **L T P C**
3 0 0 3

1. GENERATION OF DIRECT VOLTAGES **9**

Generation and transmission of electric energy – voltage stress – testing voltages-AC to DC conversion – single phase rectifier circuits – cascaded circuits – voltage multiplier circuits – Cockroft-Walton circuits – voltage regulation – ripple factor – Design of HVDC generator – Vande-Graff generator.

2. GENERATION OF ALTERNATING VOLTAGES **9**

Testing transformer – single unit testing transformer, cascaded transformer – equivalent circuit of cascaded transformer – series resonance circuit – resonant transformer – voltage regulation.

3. GENERATION OF IMPULSE VOLTAGES **9**

Marx generator – Impulse voltage generator circuit – analysis of various impulse voltage generator circuits – multistage impulse generator circuits – Switching impulse generator circuits – impulse current generator circuits – generation of non-standard impulse voltages and nanosecond pulses.

4. MEASURMENT OF HIGH VOLTAGES **9**

Peak voltage measurements by sphere gaps – Electrostatic voltmeter – generating voltmeters and field sensors – Chubb-Fortescue method – voltage dividers and impulse voltage measurements-

5. GENERATION AND MEASUREMENT OF IMPULSE CURRENTS **9**

Generation of impulse currents, measurement of impulse currents – Resistive shunts ,measurement using magnetic coupling - Fast digital transient recorders for impulse measurements.

TOTAL : 45 PERIODS

REFERENCES

1. Kuffel, E., Zaengl, W.S. and Kuffel J., “High Voltage Engineering Fundamentals”, Elsevier India Pvt. Ltd, 2005
2. Dieter Kind, Kurt Feser, “High Voltage Test Techniques”, SBA Electrical Engineering Series, New Delhi, 1999.
3. Naidu M S and Kamaraju V, “High Voltage Engineering”, Tata McGraw-hill Publishing Company Ltd., New Delhi, 2004.
4. Gallagher, T.J., and Permain, A., “High Voltage Measurement, Testing and Design”, John Wiley Sons, New York, 1983.
5. R.Mazen Abdel-Salam, Hussein Anis, Ahdab El-Morshedy, Roshdy Radwan, “High Voltage Engineering Theory and Practice” Second Edition, Revised and Expanded, Marcel Dekker, Inc., New York, 2000.
6. N.H.Malik, A.A.Al_Arainy, M.I.Qureshi, “ Electrical Insulation in Power Systems”, marcel Dekker,Inc., New York 1988.
7. Adolf J. Schwab, “High Voltage Measurement Techniques”, M.I.T Press,1972.

MHV103 ELECTRICAL TRANSIENTS IN POWER SYSTEMS **L T P C**
3 0 0 3

1. TRAVELLING WAVES ON TRANSMISSION LINE **9**

Lumped and Distributed Parameters – Wave Equation – Reflection, Refraction, Behaviour of Travelling waves at the line terminations – Lattice Diagrams – Attenuation and Distortion – Multi-conductor system and Velocity wave.

2. COMPUTATION OF POWER SYSTEM TRANSIENTS **9**

Principle of digital computation – Matrix method of solution, Modal analysis, Z transforms, Computation using EMTP – Simulation of switches and non-linear elements.

3. LIGHTNING, SWITCHING AND TEMPORARY OVERVOLTAGES **9**

Lightning: Physical phenomena of lightning – Interaction between lightning and power system – Factors contributing to line design – Switching: Short line or kilometric fault –Energizing transients - closing and re-closing of lines - line dropping, load rejection - Voltage induced by fault – Very Fast Transient Overvoltage (VFTO)

4. BEHAVIOUR OF WINDING UNDER TRANSIENT CONDITION **9**

Initial and Final voltage distribution - Winding oscillation - traveling wave solution -Behaviour of the transformer core under surge condition – Rotating machine – Surge in generator and motor

5. INSULATION CO-ORDINATION **9**

Principle of insulation co-ordination in Air Insulated substation (AIS) and Gas Insulated Substation (GIS), insulation level, statistical approach, co-ordination between insulation and protection level –overvoltage protective devices – lightning arresters, substation earthing.

TOTAL: 45 PERIODS

REFERENCES

1. Pritindra Chowdhari, "Electromagnetic transients in Power System", John Wiley and Sons Inc., 1996.
2. Allan Greenwood, "Electrical Transients in Power System", Wiley & Sons Inc. New York, 1991.
3. Klaus Ragaller, "Surges in High Voltage Networks", Plenum Press, New York, 1980.
4. Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering",(Second edition) Newage International (P) Ltd., New Delhi, 1990.
5. Naidu M S and Kamaraju V, "High Voltage Engineering", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.
6. IEEE Guide for safety in AC substation grounding IEEE Standard 80-2000.
7. Working Group 33/13-09 (1988), 'Very fast transient phenomena associated with Gas Insulated System', CIGRE, 33-13, pp. 1-20.

MHV104 INSULATION TECHNOLOGY **L T P C**
3 0 0 3

1. GENERAL PROPERTIES OF INSULATING MATERIALS 9

Requirements of insulating materials – electrical properties – molecular properties of dielectrics – dependence of permittivity on temperature, pressure, humidity and voltage, permittivity of mixtures, practical importance of permittivity – behavior of dielectric under alternating fields – complex dielectric constants – bipolar relaxation and dielectric loss, dielectric strength.

2. BREAKDOWN MECHANISMS IN GASEOUS DIELECTRICS 9

Behaviour of gaseous dielectrics in electric fields – gaseous discharges – different ionization processes – effect of electrodes on gaseous discharge – Townsend’s theory, Streamer theory – electronegative gases and their influence on gaseous discharge –Townsend’s criterion for spark breakdown, gaseous discharges in non-uniform fields - breakdown in vacuum insulation.

3. BREAKDOWN MECHANISMS IN SOLID DIELECTRICS 9

Intrinsic breakdown of solid dielectrics – electromechanical breakdown-Streamer breakdown, thermal breakdown and partial discharges in solid dielectrics - electrochemical breakdown – tracking and treeing – classification of solid dielectrics, composite insulation and its mechanism of failure.

4. BREAKDOWN MECHANISMS IN LIQUID DIELECTRICS 9

Liquids as insulators, conduction and breakdown in pure and commercial liquids, Cryogenic insulation.

5. APPLICATION OF INSULATING MATERIALS 9

Application of insulating materials in transformers. rotating machines, circuit breakers, cables, power capacitors and bushings.

TOTAL: 45 PERIODS

REFERENCES

1. Adrinaus, J.Dekker, “Electrical Engineering Materials”, Prentice Hall of India Pvt.Ltd., New Delhi, 1979.
2. Alston, L.L, “High Voltage Technology”, Oxford University Press, London, 1968 (B.S Publications, First Indian Edition 2006)
3. Kuffel, E., Zaengl, W.S. and Kuffel J., “High Voltage Engineering Fundamentals”,Elsvier India Pvt. Ltd, 2005
4. Dieter Kind and Hermann Karner, “High Voltage Insulation Technology”, 1985.(Translated from German by Y. Narayana Rao, Friedr. Vieweg & Sohn,Braunschweig,).
5. M.S Naidu, V.Kamaraj, “High Voltage Engineering”, Tata Mc Graw-Hill Publishing Company Ltd., New Delhi, 2004.
6. V.Y.Ushakov, “Insulation of High Voltage Equipment”, Springer ISBN.3-540-20729-5, 2004.

MHV001 ANALYSIS OF ELECTRICAL MACHINES **L T P C**
3 0 0 3

1. PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION **9**

General expression of stored magnetic energy, co-energy and force/ torque –example using single and doubly excited system –Calculation of air gap mmf and perphase machine inductance using physical machine data.

2. REFERENCE FRAME THEORY **9**

Static and rotating reference frames – transformation of variables – reference frames– transformation between reference frames – transformation of a balanced set –balanced steady state phasor and voltage equations – variables observed from several frames of reference.

3. DC MACHINES **9**

Voltage and toque equations – dynamic characteristics of permanent magnet and shunt DC motors – state equations - solution of dynamic characteristic by Laplace transformation.

4. INDUCTION MACHINES **9**

Voltage and toque equations – transformation for rotor circuits – voltage and torque equations in reference frame variables – analysis of steady state operation – free acceleration characteristics – dynamic performance for load and torque variations – dynamic performance for three phase fault – computer simulation in arbitrary reference frame.

5. SYNCHRONOUS MACHINES **9**

Voltage and Torque Equation – voltage Equation in arbitrary reference frame and rotor reference frame – Park equations - rotor angle and angle between rotor – steady state analysis – dynamic performances for torque variations- dynamic performance for three phase fault – transient stability limit – critical clearing time – computer simulation.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Paul C.Krause, OlegWasyzczuk, Scott S, Sudhoff, "Analysis of Electric Machinery and Drive Systems", IEEE Press, Second Edition.
2. R.Krishnan, "Electric Motor Drives, Modeling, Analysis and Control" , Prentice Hall of India, 2002

REFERENCES

1. Samuel Seely, " Electromechanical Energy Conversion", Tata McGraw Hill Publishing Company,
2. A.E, Fitzgerald, Charles Kingsley, Jr, and Stephan D, Umanx, " Electric Machinery", Tata McGraw Hill, 5th Edition, 1992

MHV002 FLEXIBLE AC TRANSMISSION SYSTEMS **L T P C**
3 0 0 3

1. INTRODUCTION 9

Reactive power control in electrical power transmission lines –Uncompensated transmission line - series compensation – Basic concepts of static Var Compensator (SVC) – Thyristor Switched Series capacitor (TCSC) – Unified power flow controller (UPFC).

2. STATIC VAR COMPENSATOR (SVC) AND APPLICATIONS 9

Voltage control by SVC – Advantages of slope in dynamic characteristics – Influence of SVC on system voltage – Design of SVC voltage regulator –Modelling of svc for power flow and transient stability – Applications: Enhancement of transient stability –Steady state power transfer – Enhancement of power system damping – Prevention of voltage instability.

3. THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) AND APPLICATIONS 9

Operation of the TCSC – Different modes of operation – Modelling of TCSC – Variable reactance model – Modelling for Power Flow and stability studies.Applications: Improvement of the system stability limit – Enhancement of system damping-SSR Mitigation.

4. VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS 9

Static Synchronous Compensator (STATCOM) – Principle of operation – V-I Characteristics. Applications: Steady state power transfer-Enhancement of transient stability - Prevention of voltage instability. SSSC-operation of SSSC and the control of power flow –Modelling of SSSC in load flow and transient stability studies.Applications: SSR Mitigation-UPFC and IPFC

5. CO-ORDINATION OF FACTS CONTROLLERS 9

Controller interactions – SVC – SVC interaction – Co-ordination of multiple controllers using linear control techniques – Control coordination using genetic algorithms.

TOTAL: 45 PERIODS

REFERENCES

1. R.Mohan Mathur, Rajiv K.Varma, “Thyristor – Based Facts Controllers for Electrical Transmission Systems”, IEEE press and John Wiley & Sons, Inc.
2. Narain G. Hingorani, “Understanding FACTS -Concepts and Technology of Flexible AC Transmission Systems”, Standard Publishers Distributors, Delhi- 110 006
3. K.R.Padiyar,” FACTS Controllers in Power Transmission and Distribution”, New Age International(P) Limited, Publishers, New Delhi, 2008
4. A.T.John, “Flexible A.C. Transmission Systems”, Institution of Electrical and Electronic Engineers (IEEE),1999.
5. V.K.Sood,HVDC and FACTS controllers – Applications of Static Converters in Power System, APRIL 2004, Kluwer Academic Publishers.

MHV003 POWER QUALITY **L T P C**
3 0 0 3

1. INTRODUCTION **9**

Introduction – Characterisation of Electric 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, Disturbance in supply voltage – Power quality standards.

2. NON-LINEAR LOADS **9**

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.

3. MEASUREMENT AND ANALYSIS METHODS **9**

Voltage, Current, Power and Energy measurements, power factor measurements and definitions, event recorders, Measurement Error – Analysis: Analysis in the periodic steady state, Time domain methods, Frequency domain methods: Laplace's, Fourier and Hartley transform – The Walsh Transform – Wavelet Transform.

4. ANALYSIS AND CONVENTIONAL MITIGATION METHODS **9**

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 Edison sag score, Voltage sag energy, Voltage Sag Lost Energy Index (VSLEI)- Analysis of voltage flicker, Reduced duration and customer impact of outages, Classical load balancing problem: Open loop balancing, Closed loop balancing, current balancing, Harmonic reduction, Voltage sag reduction.

5. POWER QUALITY IMPROVEMENT **9**

Utility-Customer interface –Harmonic filters: passive, Active and hybrid filters –Custompower devices: Network reconfiguring Devices, Load compensation using DSTATCOM,Voltage regulation using DSTATCOM, protecting sensitive loads using DVR, UPQC –control strategies: P-Q theory, Synchronous detection method – Custom power park –Status of application of custom power devices.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Arindam Ghosh "Power Quality Enhancement Using Custom Power Devices",Kluwer Academic Publishers, 2002
2. G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications, 1994(2ndedition)
3. Power Quality - R.C. Duggan
4. Power system harmonics –A.J. Arrillga
5. Power electronic converter harmonics –Derek A. Paice

MHV004 MICROCONTROLLER AND DSP BASED SYSTEM DESIGN **L T P C**
3 0 0 3

1. **PIC 16C7X MICROCONTROLLER** **9**
Architecture memory organization – Addressing modes – Instruction set – Programming techniques – simple programs

2. **PERIPHERALS OF PIC 16C7X** **9**
Timers – interrupts – I/O ports – I2C bus for peripheral chip access – A/D converter –UART

3. MOTOR CONTROL SIGNAL PROCESSORS **9**
Introduction- System configuration registers - Memory Addressing modes – Instruction set – Programming techniques – simple programs

4. PERIPHERALS OF SIGNAL PROCESSORS **9**
General purpose Input/Output (GPIO) Functionality- Interrupts - A/D converter-Event Managers (EVA, EVB)- PWM signal generation

5. APPLICATIONS OF PIC AND SIGNAL PROCESSORS **9**
Voltage regulation of DC-DC converters- Stepper motor and DC motor control- Clarke's and parks transformation-Space vector PWM- Control of Induction Motors and PMSM.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. John B.Peatman , 'Design with PIC Microcontrollers,' Pearson Education, Asia 2004
2. Hamid A.Toliyat, Steven Campbell, 'DSP based electromechanical motion control',CRC Press

MHV005 SPECIAL ELECTRICAL MACHINES **L T P C**
3 0 0 3

1. STEPPING MOTOR **9**

Constructional features – Principle of operation – Modes of excitation – Torque production in variable reluctance stepping motor - Dynamic characteristics – Drive systems and circuit for open loop control – Closed loop control of stepping motor.

2.SWITCHED RELUCTANCE MOTORS **9**

Constructional features – principle of operation – Torque equation – Power controllers –Characteristics and control microprocessor based controller.

3. SYNCHRONOUS RELUCTANCE MOTORS **9**

Constructional features: axial and radial air gap Motors – Operating principle –Reluctance torque – phasor diagram motor characteristics.

4.PERMANENT MAGNET SYNCHRONOUS MOTROS **9**

Principle of operation –EMF –Power input and torque expressions –Phasor diagram –power controller-Torque speed characteristics-Self control –Vector control –current control schemes.

5. PERMANENT MAGNET BRUSHLESS DC MOTORS **9**

Commutation in DC motors, Difference between mechanical and electronic commutators- Hall sensors, Optical sensors - Multiphase Brushless motor –Square wave permanent magnet brushless motor drives – Torque and emf equation-Torque speed characteristics-Controllers –Microprocessors based controller

TOTAL: 45 PERIODS

REFERENCES

1. Miller, T.J.E. "Brushless permanent magnet and reluctance motor drives",ClarendonPress, Oxford,1989.
2. Kenjo, T, "Stepping motors and their microprocessor control ",Clarendon Press,Oxford 1989.
3. R.Krishnan, "Switched Reluctance Motors Drives: Modelling, Simulation, Analysis Design and Applications", CRC Press, New York, 2001.

MHV006 ADVANCED TOPICS IN HIGH VOLTAGE ENGINEERING **L T P C**
3 0 0 3

1. MEASUREMENT AND DIAGNOSTIC TECHNOLOGIES **9**

Introduction – Digital Impulse Recorders – Digital Techniques in HV tests – Testing automation – Electric field measurement – Electro-optic Sensors- Magneto-optic Sensors – Measurement of very fast transients in GIS – Space charge measurement techniques – electro-optical imaging techniques.

2. APPLICATION OF HIGH VOLTAGE ENGINEERING IN INDUSTRY **9**

Introduction – electrostatic applications- electrostatic precipitation, separation , painting coating, spraying ,imaging ,printing ,Transport of materials – Sandpaper Manufacture –Smoke particle detector – Electrostatic spinning ,pumping , propulsion – Ozone generation – Biomedical applications.

3. SAFETY AND ELECTROSTATIC HAZARDS **9**

Introduction – Nature of static electricity – Triboelectric series – Basic laws of Electrostatic electricity– materials and static electricity – Electrostatic discharges (ESD) – Static electricity problems – Hazards of Electrostatic electricity in industry – Hazards from electrical equipment and installations – Static eliminators and charge neutralizers –Lightning protection.

4. PULSED ELECTRIC FIELDS **9**

Introduction-definitions, descriptions and applications-mechanisms of microbial inactivations-electrical breakdown-electroporation-inactivation models -Critical factorsanalysis of process, product and microbial factors-pulse generators and treatment chamber design-Research needs.

5. APPLICATION OF PEF TECHNOLOGY IN FOOD PRESERVATION **9**

Processing of juices, milk, egg, meat and fish products- Processing of water and waste.Industrial feasibility, cost and efficiency analysis.

TOTAL: 45 PERIODS

REFERENCES

1. N.H.Malik, A.A.Ai-Arainy, M.I.Qureshi, "Electrical Insulation in power systems",Marcel Dekker, inc., 1998.
2. Mazen Abdel-Salam, Hussien Anis, Ahdab EI-Morshedy, "High VoltageEngineering", Second Edition, Theory and Practice, Marcel Dekker, Inc. 2000,
3. John D.Kraus, Daniel A.Fleisch, "Electromagnetics with Applications" McGraw Hill International Editions, 1992.
4. Shoait Khan, " Industrial Power System", CRC Press, Taylor & Francis group,2008.
5. G.V. Barbosa –Canovas , "Pulsed electric fields in food processing:Fundamentalaspects and applications" CRC Publisher Edition March 1 2001.
6. H L M Lelieveld and Notermans.S,et.al., "Food preservation by pulsed electric fields: From research to application", Woodhead Publishing Ltd. October 2007.

MHV007 POLLUTION PERFORMANCE OF POWER APPARATUS AND SYSTEMS L T P C
3 0 0 3

1. INTRODUCTION 9

Fundamental process of pollution flashover – development and effect of contamination layer – creepage distance – pollution conductivity – mechanism of pollution flashover –analytical determination of flashover voltage.

2. POLLUTION TESTING 9

Artificial pollution testing – salt-fog method – solid layer method – monitoring of parameters – measurement of layer conductivity – field testing methods.

3. POLLUTION PERFORMANCE OF INSULATORS 9

Ceramic and non-ceramic insulators – design of shed profiles – rib factor effect in AC and DC insulators – modeling.

4. POLLUTION PERFORMANCE OF SURGE DIVERTERS 9

External insulation – effect of pollution on the protective characteristics of gap and gapless arresters – modeling of surge diverters under polluted conditions.

5. POLLUTION PERFORMANCE OF INDOOR EQUIPMENT 9

Condensation and contamination of indoor switch gear – performance of organic insulator under polluted conditions accelerated testing techniques.

TOTAL: 45 PERIODS

REFERENCES

1. Kind and Karner, "High Voltage Insulation", Translated from German by Y.Narayana Rao, Frider. Vieweg, & Sohn, Braunschweig, Weishaden, 1985.
2. Kuffel, E., Zaengl, W.S. and Kuffel J., "High Voltage Engineering Fundamentals",Elsvier India Pvt. Ltd, 2005.
3. Klaus Ragaller, "Surges in High Voltage Networks", Plenum Press, New York,1980.
4. Looms, J.S.T., "Insulators for High Voltages", Peter Peregrinus Ltd., London,1988.
5. Dieter Kind and Kurt Feser, "High Voltage Test Techniques", Second Edition,SBA Electrical Engineering Series, New Delhi, 1999.
6. Ravi S. Gorur "Outdoor Insulators", Inc. Phoenix, Arizona 85044, USA, 1999

MHV008 ELECTROMAGNETIC INTERFERENCE AND ELECTROMAGNETIC COMPATIBILITY **L T P C**

3 0 0 3

1. INTRODUCTION **9**

Sources of EMI, Conducted and radiated interference- Characteristics - Designing for electromagnetic compatibility (EMC)- EMC regulation- typical noise path- use of network theory- methods of eliminating interferences.

2. METHOD OF HARDENING **9**

Cabling –capacitive coupling- inductive coupling- shielding to prevent magnetic radiation- shield transfer impedance, Grounding – safety grounds – signal grounds single point and multipoint ground systems-hybrid grounds- functional ground layout – grounding of cable shields- ground loops-guard shields.

3. BALANCING, FILTERING AND SHIELDING **9**

Power supply decoupling- decoupling filters-amplifier filtering –high frequency filtering shielding – near and far fields- shielding effectiveness- absorption and reflection loss,Shielding with magnetic material-conductive gaskets, windows and coatings- groundingof shields.

4. **DIGITAL CIRCUIT NOISE AND LAYOUT** **9**

Frequency versus time domain- analog versus digital circuits- digital logic noise- internal noise sources-digital circuit ground noise –power distribution-noise voltage objectives measuring noise voltages-unused inputs-logic families.

5.ELECTROSTATIC DISCHARGE,STANDARDS AND LABORATORY TECHNIQUES **9**

Static Generation- human body model- static discharges-ED protection in equipment design- ESD versus EMC, Industrial and Government standards – FCC requirements – CISPR recommendations-Laboratory techniques- Measurement methods for field strength-EMI.

TOTAL: 45 PERIODS

REFERENCES

1. Henry W.Ott, “ Noise reduction techniques in electronic systems”, John Wiley &Sons, 1989.
2. Bernhard Keiser, “Principles of Electro-magnetic Compatibility”, Artech House, Inc.(685 canton street, Norwood, MA 020062 USA) 1987.
3. Bridges, J.E Milleta J. and Ricketts.L.W., “EMP Radiation and Protective techniques”, John Wiley and sons, USA 1976.
4. IEEE National Symposium on “Electromagnetic Compatibility”, IEEE, 445, hoes Lane, Piscataiway, NJ 08855.

MHV009 HIGH VOLTAGE DIRECT CURRENT TRANSMISSION **L T P C**
3 0 0 3

1. DC POWER TRANSMISSION TECHNOLOGY **6**

Introduction - Comparison of AC and DC transmission – Application of DC transmission – Description of DC transmission system - Planning for HVDC transmission – Modern trends in DC transmission – DC breakers – Cables, VSC based HVDC.

2. ANALYSIS OF HVDC CONVERTERS AND HVDC SYSTEM CONTROL **12**

Pulse number, choice of converter configuration – Simplified analysis of Graetz circuit - Converter bridge characteristics – characteristics of a twelve pulse converter detailed analysis of converters. General principles of DC link control – Converter control characteristics – System control hierarchy - Firing angle control – Current and extinction angle control – Generation of harmonics and filtering - power control – Higher level controllers.

3. MULTITERMINAL DC SYSTEMS **9**

Introduction – Potential applications of MTDC systems - Types of MTDC systems - Control and protection of MTDC systems - Study of MTDC systems.

4. POWER FLOW ANALYSIS IN AC/DC SYSTEMS **9**

Per unit system for DC Quantities - Modelling of DC links - Solution of DC load flow -Solution of AC-DC power flow - Case studies.

5. SIMULATION OF HVDC SYSTEMS **9**

Introduction – System simulation: Philosophy and tools – HVDC system simulation –Modeling of HVDC systems for digital dynamic simulation – Dynamic intraction between DC and AC systems.

TOTAL: 45 PERIODS

REFERENCES

1. K.R.Padiyar, , "HVDC Power Transmission Systems", New Age International (P)Ltd., New Delhi, 2002.
2. J.Arrillaga, , "High Voltage Direct Current Transmission", Peter Pregrinus, London,1983.
3. P. Kundur, "Power System Stability and Control", McGraw-Hill, 1993.
4. Erich Uhlmann, " Power Transmission by Direct Current", BS Publications, 2004.
5. V.K.Sood,HVDC and FACTS controllers – Applications of Static Converters in Power System, APRIL 2004 , Kluwer Academic Publishers.

MHV010 WIND ENERGY CONVERSION SYSTEMS **L T P C**
3 0 0 3

1. INTRODUCTION **9**

Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory-Power coefficient-Sabinin's theory-Aerodynamics of Wind turbine

2. WIND TURBINES **9**

HAWT-VAWT-Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations-Tip speed ratio-No. of Blades-Blade profile-Power Regulation-yaw control-Pitch angle control-stall control-Schemes for maximum power extraction.

3. FIXED SPEED SYSTEMS **9**

Generating Systems- Constant speed constant frequency systems -Choice of Generators-Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model wind turbine rotor - Drive Train model- Generator model for Steady state and Transient stability analysis.

4. VARIABLE SPEED SYSTEMS **9**

Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed generators modeling - Variable speed variable frequency schemes.

5. GRID CONNECTED SYSTEMS **9**

Stand alone and Grid Connected WECS system-Grid connection Issues-Machine side & Grid side controllers-WECS in various countries

TOTAL: 45 PERIODS

REFERENCES

1. L.L.Freris "Wind Energy conversion Systems", Prentice Hall, 1990
2. Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006.
3. E.W.Golding "The generation of Electricity by wind power", Redwood burn Ltd.,Trowbridge,1976.
4. S.Heir "Grid Integration of WECS", Wiley 1998.

MHV011 SOFT COMPUTING TECHNIQUES **L T P C**
3 0 0 3

1. INTRODUCTION **9**

Approaches to intelligent control. Architecture for intelligent control. Symbolic reasoning system, rule-based systems, the AI approach. Knowledge representation. Expert systems.

2.ARTIFICIAL NEURAL NETWORKS **9**

Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, simple perceptron, Adaline and Madaline, Feed-forward Multilayer Perceptron. Learning and Training the neural network. Data Processing: Scaling, Fourier transformation, principal-component analysis and wavelet transformations. Hopfield network, Self-organizing network and Recurrent network. Neural Network based controller

3. FUZZY LOGIC SYSTEM **9**

Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control. Fuzzification, inferencing and defuzzification. Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Self-organizing fuzzy logic control. Fuzzy logic control
for nonlinear time-delay system.

4. GENETIC ALGORITHM **9**

Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other search techniques like tabu search and anD-colony search techniques for solving optimization problems.

5. APPLICATIONS **9**

GA application to power system optimisation problem, Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab - Neural Network toolbox.Stability analysis of Neural-Network interconnection systems. Implementation of fuzzy logic controller using Matlab fuzzy-logic toolbox. Stability analysis of fuzzy control systems.

TOTAL: 45 PERIODS

REFERENCES

1. Jacek.M.Zurada, "Introduction to Artificial Neural Systems", Jaico Publishing House, 1999.
2. KOSKO,B. "Neural Networks And Fuzzy Systems", Prentice-Hall of India Pvt Ltd., 1994.
3. KLIR G.J. & FOLGER T.A. "Fuzzy sets, uncertainty and Information", Prentice-Hall of India Pvt. Ltd., 1993.
4. Zimmerman H.J. "Fuzzy set theory-and its Applications"-Kluwer Academic Publishers, 1994.
5. Driankov, Hellendroon, "Introduction to Fuzzy Control", Narosa Publishers.

MCI001 ADVANCED DIGITAL SYSTEM DESIGN **L T P C**
3 0 0 3

1. SEQUENTIAL CIRCUIT DESIGN **9**
Analysis of Clocked Synchronous Sequential Networks (CSSN) Modelling of CSSN –State Stable Assignment and Reduction – Design of CSSN – Design of Iterative Circuits– ASM Chart – ASM Realization, Design of Arithmetic circuits for Fast adder- Array Multiplier.

2. ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN **9**
Analysis of Asynchronous Sequential Circuit (ASC) – Flow Table Reduction – Races in ASC – State Assignment Problem and the Transition Table – Design of ASC – Static and Dynamic Hazards – Essential Hazards – Data Synchronizers – Designing Vending Machine Controller – Mixed Operating Mode Asynchronous Circuits.

3. FAULT DIAGNOSIS AND TESTABILITY ALGORITHMS **9**
Fault Table Method – Path Sensitization Method – Boolean Difference Method – Kohavi Algorithm – Tolerance Techniques – The Compact Algorithm – Practical PLA's – Fault in PLA – Test Generation – Masking Cycle – DFT Schemes – Built-in Self Test.

4. SYNCHRONOUS DESIGN USING PROGRAMMABLE DEVICES **9**
Programming Techniques -Re-Programmable Devices Architecture- Function blocks, I/O blocks, Interconnects, Realize combinational, Arithmetic, Sequential Circuit with Programmable Array Logic; Architecture and application of Field Programmable Logic Sequence.

5. NEW GENERATION PROGRAMMABLE LOGIC DEVICES **9**
Foldback Architecture with GAL, EPLD, EPLA , PEEL, PML; PROM – Realization State machine using PLD – FPGA – Xilinx FPGA – Xilinx 2000 - Xilinx 3000

TOTAL: 45 PERIODS

REFERENCES:

1. Donald G. Givone, "Digital principles and Design", Tata McGraw Hill 2002.
2. Stephen Brown and Zvonk Vranesic, "Fundamentals of Digital Logic with VHDL Deisgn", Tata McGraw Hill, 2002
3. Mark Zwolinski, "Digital System Design with VHDL", Pearson Education, 2004
4. Parag K Lala, "Digital System design using PLD", BS Publications, 2003
5. John M Yarbrough, "Digital Logic applications and Design", Thomson Learning, 2001
6. Nripendra N Biswas, "Logic Design Theory", Prentice Hall of India, 2001
7. Charles H. Roth Jr., "Fundamentals of Logic design", Thomson Learning, 2004.

MCI002 ADVANCED DIGITAL SIGNAL PROCESSING **L T P C**
3 0 0 3

1. INTRODUCTION **9**

Mathematical description of change of sampling rate – Interpolation and Decimation, Filter implementation for sampling rate conversion – direct form FIR structures, DTFT, FFT, Wavelet transform and filter bank implementation of wavelet expansion of signals

2. ESTIMATION AND PREDICTION TECHNIQUES **9**

Discrete Random Processes – Ensemble averages, Stationary processes, Autocorrelation and Auto covariance matrices. Parseval's Theorem, Wiener-Khintchine Relation – Power Spectral Density**.** AR, MA, ARMA model based spectral estimation. Parameter Estimation, Linear prediction – Forward and backward predictions, Least mean squared error criterion – Wiener filter for filtering and prediction, Discrete Kalman filter.

3. DIGITAL SIGNAL PROCESSOR **9**

Basic Architecture – Computational building blocks, MAC, Bus Architecture and memory, Data Addressing, Parallelism and pipelining, Parallel I/O interface, Memory Interface, Interrupt, DMA.

4. APPLICATION OF DSP **9**

Design of Decimation and Interpolation Filter, FFT Algorithm, PID Controller, Application for Serial Interfacing, DSP based Power Meter, Position control.

5. VLSI IMPLEMENTATION **9**

Basics on DSP sytem architecture design using VHDL programming, Mapping of DSP algorithm onto hardware, Realisation of MAC & Filter structure.

TOTAL: 45 PERIODS

REFERENCES:

1. Bernard Widrow, Samuel D. Stearns, "Adaptive Signal Processing", Pearson Education, third edition, 2004.
2. Dionitris G. Manolakis, Vinay K. Ingle, Stepen M. Kogon, "Statistical &Adaptive signal processing, spectral estimation, signal modeling, Adaptive filtering & Array processing", McGraw-Hill International edition 2000.
3. Monson H. Hayes, "Statistical Digital Signal Processing and Modelling", John Wiley and Sons, Inc.,
4. John G. Proaks, Dimitris G. Manolakis, "Digital Signal Processing", Pearson Education 2002.
5. S. Salivahanan, A. Vallavaraj and C. Gnanapriya "Digital Signal Processing",TMH,2000.
6. Avatar Sing, S. Srinivasan, "Digital Signal Processing- Implementation using DSP Microprocessors with Examples from TMS320C54xx", Thomson India,2004.
7. Lars Wanhammer, "DSP Integrated Circuits", Academic press, 1999,New York.
8. Ashok Ambardar,"Digital Signal Processing: A Modern Introduction",Thomson India edition, 2007.
9. Lars Wanhammer, "DSP Integrated Circuits", Academic press, 1999,New York.

MCI008 OPTIMAL CONTROL AND FILTERING **L T P C**
3 0 0 3

1. INTRODUCTION **9**

Statement of optimal control problem – Problem formulation and forms of optimal Control – Selection of performance measures. Necessary conditions for optimal control –Pontryagin's minimum principle – State inequality constraints – Minimum time problem.

2. LQ CONTROL PROBLEMS AND DYNAMIC PROGRAMMING **9**

Linear optimal regulator problem – Matrix Riccatti equation and solution method –Choice of weighting matrices – Steady state properties of optimal regulator – Linear tracking problem – LQG problem – Computational procedure for solving optimal control problems – Characteristics of dynamic programming solution – Dynamic programming application to discrete and continuous systems – Hamilton Jacobi Bellman equation.

3. NUMERICAL TECHNIQUES FOR OPTIMAL CONTROL **9**

Numerical solution of 2-point boundary value problem by steepest descent and Fletcher Powell method solution of Ricatti equation by negative exponential and interactive Methods

4. FILTERING AND ESTIMATION **9**

Filtering – Linear system and estimation – System noise smoothing and prediction – Gauss Markov discrete time model – Estimation criteria – Minimum variance estimation – Least square estimation – Recursive estimation.

5. KALMAN FILTER AND PROPERTIES **9**

Filter problem and properties – Linear estimator property of Kalman Filter – Time invariance and asymptotic stability of filters – Time filtered estimates and signal to noise ratio improvement – Extended Kalman filter.

TOTAL: 45 PERIODS

REFERENCES:

1. KiRk D.E., 'Optimal Control Theory – An introduction', Prentice hall, N.J., 1970.
2. Sage, A.P., 'Optimum System Control', Prentice Hall N.H., 1968.
3. Anderson, BD.O. and Moore J.B., 'Optimal Filtering', Prentice hall Inc., N.J.,1979.
4. S.M. Bozic, "Digital and Kalman Filtering", Edward Arnould, London, 1979.
5. Astrom, K.J., "Introduction to Stochastic Control Theory", Academic Press, Inc,N.Y., 1970.
6. David G.Hull., "Optimal control theory for Applications", Springer Publishing Company, 2004.
7. D. Subbaram Naidu, "Optimal control systems", CRC Press (Aug 2002).

MCI010 SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL **L T P C**
3 0 0 3

1. MODELS FOR INDENTIFICATION **9**

Models of LTI systems: Linear Models-State space Models-OE model- Model sets,Structures and Identifiability-Models for Time-varying and Non-linear systems: Models with Nonlinearities – Non-linear state-space models-Black box models, Fuzzy models'.

2. NON-PARAMETRIC AND PARAMETRIC IDENTIFICATON **9**

Transient response and Correlation Analysis – Frequency response analysis – Spectral Analysis – Least Square – Recursive Least Square –Forgetting factor- Maximum Likelihood – Instrumental Variable methods.

3. NON-LINEAR IDENTIFICATION AND MODEL VALIDATION **9**

Open and closed loop identification: Approaches – Direct and indirect identification –Joint input-output identification – Non-linear system identification – Wiener models – Power series expansions - State estimation techniques – Non linear identification using Neural Network and Fuzzy Logic.

4. ADAPTIVE COTROL AND ADAPTATION TECHNIQUES **9**

Introduction – Uses – Auto tuning – Self Tuning Regulators (STR) – Model Reference Adaptive Control (MRAC) – Types of STR and MRAC – Different approaches to selftuning regulators – Stochastic Adaptive control – Gain Scheduling.

5. CASE STUDIES **9**

Inverted Pendulum, Robot arm, process control application: heat exchanger, Distillation column, application to power system, Ship steering control.

TOTAL: 45 PERIODS

REFERENCES:

1. Ljung," System Identification Theory for the User", PHI, 1987.
2. Torsten Soderstrom, Petre Stoica, "System Identification", prentice Hall `International (UK) Ltd,1989.
3. Astrom and Wittenmark," Adaptive Control ", PHI
4. William S. Levine, " Control Hand Book".
5. Narendra and Annasamy," Stable Adaptive Control Systems, Prentice Hall, 1989.

MCI016 APPLICATIONS OF MEMS TECHNOLOGY **L T P C**
3 0 0 3

1. MEMS: MICRO-FABRICATION, MATERIALS AND ELECTRO-MECHANICAL CONCEPTS **9**

Overview of micro fabrication – Silicon and other material based fabrication processes – Concepts: Conductivity of semiconductors-Crystal planes and orientation-stress and strain-flexural beam bending analysis-torsional deflections-Intrinsic stress- resonant frequency and quality factor.

2. ELECTROSTATIC SENSORS AND ACTUATION **9**

Principle, material, design and fabrication of parallel plate capacitors as electrostatic sensors and actuators-Applications

3. THERMAL SENSING AND ACTUATION **9**

Principle, material, design and fabrication of thermal couples, thermal bimorph sensors, thermal resistor sensors-Applications.

4. PIEZOELECTRIC SENSING AND ACTUATION **9**

Piezoelectric effect-cantilever piezo electric actuator model-properties of piezoelectric materials-Applications.

5. CASE STUDIES **9**

Piezoresistive sensors, Magnetic actuation, Micro fluidics applications, Medical applications, Optical MEMS.

TOTAL: 45 PERIODS

REFERENCES

1. Chang Liu, "Foundations of MEMS", Pearson International Edition, 2006.
2. Marc Madou , "Fundamentals of microfabrication",CRC Press, 1997.
3. Boston , "Micromachined Transducers Sourcebook",WCB McGraw Hill, 1998.
4. M.H.Bao "Micromechanical transducers :Pressure sensors, accelerometers and gyroscopes", Elsevier, New york, 2000.

MCI102 SYSTEM THEORY **L T P C**
3 0 0 3

1. STATE VARIABLE REPRESENTATION **9**

Introduction-Concept of State-State equation for Dynamic Systems-Time invariance and linearity-Nonuniqueness of state model-State Diagrams-Physical System and State Assignment.

2. SOLUTION OF STATE EQUATION **9**

Existence and uniqueness of solutions to Continuous-time state equations-Solution of Nonlinear and Linear Time Varying State equations-Evaluation of matrix exponential- System modes-Role of Eigenvalues and Eigenvectors.

3. CONTROLLABILITY AND OBSERVABILITY **9**

Controllability and Observability-Stabilizability and Detectability-Test for Continuous time Systems-Time varying and Time invariant case-Output Controllability-Reducibility- System Realizations.

4. STABILTY **9**

Introduction-Equilibrium Points-Stability in the sense of Lyapunov-BIBO Stability-Stability of LTI Systems-Equilibrium Stability of Nonlinear Continuous Time Autonomous Systems-The Direct Method of Lyapunov and the Linear Continuous-Time Autonomous Systems-Finding Lyapunov Functions for Nonlinear Continuous Time Autonomous Systems-Krasovskii and Variable-Gradiant Method.

5. MODEL CONTROL **9**

Introduction-Controllable and Observable Companion Forms-SISO and MIMO Systems- The Effect of State Feedback on Controllability and Observability-Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order and Reduced Order Observers.

TOTAL: 45 PERIODS

REFERENCES:

1. M. Gopal, “Modern Control System Theory”, New Age International, 2005.
2. K. Ogatta, “Modern Control Engineering”, PHI, 2002.
3. John S. Bay, “Fundamentals of Linear State Space Systems”, McGraw-Hill,1999.
4. D. Roy Choudhury, “Modern Control Systems”, New Age International, 2005.
5. John J. D’Azzo, C. H. Houpis and S. N. Sheldon, “Linear Control System Analysis and Design with MATLAB”, Taylor Francis, 2003.
6. Z. Bubnicki, ”Modern Control Theory”, Springer, 2005.

MCI201 COMPUTER AIDED DESIGN OF INSTRUMENTATION SYSTEMS LT P C
3 0 0 3

1. DATA ACQUISITION AND INSTRUMENT INTERFACE 9

Programming and simulation of Building block of instrument Automation system – Signal analysis, I/O port configuration with instrument bus protocols - ADC, DAC,DIO, counters & timers, PC hardware structure, timing, interrupts, DMA, software and hardware installation, current loop, RS 232/RS485, GPIB, USB protocols.

2. VIRTUAL INSTRUMENTATION PROGRAMMING TECHNIQUES 9

Block diagram and architecture of a virtual instrument, Graphical programming in data flow, comparison with conventional programming, Vis and sub-Vis, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, string and file I/O.

3. DESIGN TEST & ANALYSIS 9

Spectral estimation using Fourier Transform, power spectrum, correlation methods, Stability analysis, Fault analysis –Sampling, Data Parity and error coding checks, Synchronization testing – Watch dog timer, DMA method – Realtime Clocking, Noise- Gaussian, White analysis.

4. PC BASED INSTRUMENTATION 9

Introduction – Evolution of signal standard – HART Communication protocol – Communication modes – HART networks – control system interface – HART commands – HART field controller implementation – HART and the OSI model

5. SIMULATION OF PHYSICAL SYSTEMS 9

Simulation of linear & Non-linear models of systems, Hardware in loop simulation of physical systems using special softwares.

TOTAL: 45 PERIODS

REFERENCES:

1. K. Ogatta, “Modern control Engineering”, Fourth edition, Perason education 2002.
2. Dorf and Bishop, “Modern Control Engineering”, Addison Weseley, 1998.
3. Patrick H. Garrett,” High performance Instrumentation and Automation”, CRC Press, Taylor & Francis Group, 2005.
4. MAPLE V programming guide
5. MATLAB/SIMULINK user manual
6. MATHCAD/VIS SIM user manual.
7. LABVIEW simulation user manual

MHV012 COMPUTER AIDED DESIGN OF POWER ELECTRONIC CIRCUITS L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Importance of simulation – General purpose circuit analysis – Methods of analysis of power electronic systems – Review of power electronic devices and circuits.

UNIT II ADVANCED TECHNIQUES IN SIMULATION 9

Analysis of power electronic systems in a sequential manner – coupled and decoupled systems – Various algorithms for computing steady state solution in power electronic systems – Future trends in computer simulation.

UNIT III MODELING OF POWER ELCTRONIC DEVICES 9

Introduction – AC sweep and DC sweep analysis – Transients and the time domain analysis – Fourier series and harmonic components – BJT, FET, MOSFET and its model- Amplifiers and Oscillator – Non-linear devices.

UNIT IV SIMULATION OF CIRCUITS 9

Introduction – Schematic capture and libraries – Time domain analysis – System level integration and analysis – Monte Carlo analysis – Sensitivity/stress analysis – Fourier analysis.

UNIT V CASE STUDIES 9

Simulation of Converters, Choppers, Inverters, AC voltage controllers, and Cycloconverters feeding R, R-L, and R-L-E loads – computation of performance parameters: harmonics, power factor, angle of overlap.

L: 15 TOTAL: 45 PERIODS

REFERENCES:

1. Rashid, M., Simulation of Power Electronic Circuits using pSPICE, PHI, 2006.
2. Rajagopalan, V. “Computer Aided Analysis of Power Electronic systems”-Marcell – Dekker Inc., 1987.
3. John Keown “Microsim, Pspice and circuit analysis”-Prentice Hall Inc., 1998.

MHV013 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems.

UNIT II ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION 9

Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

UNIT III POWER CONVERTERS 9

Solar: Block diagram of solar photo voltaic system -Principle of operation: line commutated converters (inversion-mode) - Boost and buck-boost converters- selection Of inverter, battery sizing, array sizing Wind: three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers,PWM Inverters, Grid Interactive Inverters-matrix converters.

UNIT IV ANALYSIS OF WIND AND PV SYSTEMS 9

Stand alone operation of fixed and variable speed wind energy conversion systems and solar system-Grid connection Issues -Grid integrated PMSG and SCIG Based WECSGrid Integrated solar system

UNIT V HYBRID RENEWABLE ENERGY SYSTEMS 9

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PVMaximum Power Point Tracking (MPPT).

TOTAL: 45 PERIODS

REFERENCES:

1. Rashid .M. H “power electronics Hand book”, Academic press, 2001.
2. Rai. G.D, “Non conventional energy sources”, Khanna publishes, 1993.
3. Rai. G.D,” Solar energy utilization”, Khanna publishes, 1993.
4. Gray, L. Johnson, “Wind energy system”, prentice hall linc, 1995.
5. Non-conventional Energy sources B.H.Khan Tata McGraw-hill Publishing Company, New Delhi.

MHV014 MODERN RECTIFIERS AND RESONANT CONVERTERS **L T P C**
3 0 0 3

UNIT I POWER SYSTEM HARMONICS & LINE COMMUTATED RECTIFIERS 9

Average power-RMS value of a waveform-Power factor-AC line current harmonic standards IEC 1000-IEEE 519- The Single phase full wave rectifier-Continuous Conduction Mode-Discontinuous Conduction Mode-Behaviour when C is large-Minimizing THD when C is small-Three phase rectifiers- Continuous Conduction Mode-Discontinuous Conduction Mode-Harmonic trap filters.

UNIT II PULSE WIDTH MODULATED RECTIFIERS 9

Properties of Ideal rectifiers-Realization of non ideal rectifier-Control of current waveform-Average current control-Current programmed Control- Hysteresis control-Nonlinear carrier control-Single phase converter system incorporating ideal rectifiers-Modeling losses and efficiency in CCM high quality rectifiers-Boost rectifier Example -expression for controller duty cycle-expression for DC load current-solution for converter Efficiency η.

UNIT III RESONANT CONVERTERS 9

Review on Parallel and Series Resonant Switches-Soft Switching- Zero Current Switching - Zero Voltage Switching -Classification of Quasi resonant switches-Zero Current Switching of Quasi Resonant Buck converter, Zero Current Switching of Quasi Resonant Boost converter, Zero Voltage Switching of Quasi Resonant Buck converter, Zero Voltage Switching of Quasi Resonant Boost converter: Steady State analysis.

UNIT IV DYNAMIC ANLYSIS OF SWITCHING CONVERTERS 9

Review of linear system analysis-State Space Averaging-Basic State Space Average Model-State Space Averaged model for an ideal Buck Converter, ideal Boost Converter, ideal Buck Boost Converter, for an ideal Cuk Converter.

UNIT V CONTROL OF RESONANT CONVERTERS 9

Pulse Width Modulation-Voltage Mode PWM Scheme-Current Mode PWM Scheme-Design of Controllers: PI Controller, Variable Structure Controller, Optimal Controller for the source current shaping of PWM rectifiers.

TOTAL: 45 PERIODS

REFERENCES

1. Robert W. Erickson &Dragon Maksimovic" Fundamentals of Power Electronics" Second Edition, 2001 Springer science and Business media
2. William Shepherd and Li zhang" Power Converters Circuits"Marceld Ekkerin,C.
3. Simon Ang and Alejandro Oliva "Power- Switching Converters" Taylor & Francis Group

MHV015 RESTRUCTURED POWER SYSTEMS **L T P C**
3 0 0 3

UNIT I OVERVIEW OF KEY ISSUES IN ELECTRIC UTILITIES RESTRUCTURING 9

Restructuring Models: PoolCo Model, Bilateral Contracts Model, Hybrid Model - Independent System Operator (ISO): The Role of ISO - Power Exchange(PX): Market Clearing Price(MCP) - Market operations: Day-ahead and Hour-Ahead Markets, Elastic and Inelastic Markets - Market Power - Stranded costs - Transmission Pricing: Contract Path Method, The MW-Mile Method - Congestion Pricing: Congestion Pricing Methods, Transmission Rights - Management of Inter-Zonal/Intra Zonal Congestion: Solution procedure, Formulation of Inter-Zonal Congestion Sub problem, Formulation of Intra-Zonal Congestion Sub problem.

UNIT II ELECTRIC UTILITY MARKETS IN THE UNITED STATES: 9

California Markets: ISO, Generation, Power Exchange, Scheduling Co-ordinator, UDCs, Retailers and Customers, Day-ahead and Hour-Ahead Markets, Block forwards Market, Transmission Congestion Contracts(TCCs) - New York Market: Market operations - PJM interconnection - Ercot ISO - New England ISO - Midwest ISO: MISO's Functions, Transmission Management, Transmission System Security, Congestion Management, Ancillary Services Coordination, Maintenance Schedule Coordination - Summary of functions of U.S. ISOs.

UNIT III OASIS: OPEN ACCESS SAME-TIMEINFORMATION SYSTEM: 9

FERC order 889 - Structure of OASIS: Functionality and Architecture of OASIS - Implementation of OASIS Phases: Phase 1, Phase 1-A, Phase 2 - Posting of information: Types of information available on OASIS, Information requirement of OASIS, Users of OASIS - Transfer Capability on OASIS: Definitions, Transfer Capability Issues, ATC Calculation, TTC Calculation, TRM Calculation, CBM Calculation - Transmission Services - Methodologies to Calculate ATC - Experiences with OASIS in some Restructuring Models: PJM OASIS, ERCOT OASIS.

UNIT IV ELECTRIC ENERGY TRADING 9

Essence of Electric Energy Trading - Energy Trading Framework: The Qualifying factors - Derivative Instruments of Energy Trading: Forward Contracts, Futures Contracts, Options, Swaps, Applications of Derivatives in Electric Energy Trading - PortFolio Management: Effect of Positions on Risk Management - Energy Trading Hubs - Brokers in Electricity Trading - Green Power Trading.

UNIT V ELECTRICITY PRICING - VOLATILITY, RISK AND FORECASTING 9

Electricity Price Volatility: Factors in Volatility, Measuring Volatility - Electricity Price Indexes: Case Study for Volatility of Prices in California, Basis Risk - Challenges to Electricity Pricing: Pricing Models, Reliable Forward Curves - Construction of Forward Price Curves: Time frame for Price Curves, Types of Forward Price Curves – Short-term Price Forecasting: Factors Impacting Electricity Price, Forecasting Methods, Analyzing Forecasting Errors, Practical Data Study.

TOTAL: 45 PERIODS

REFERENCES

1. G.W.Stagg, A.H.El.Abiad "Computer Methods in Power System Analysis", McGraw Hill, 1968.
2. M.K. Jain, N.D.Rao, G.J.Berg, "Improved Area Interchange Control Method for use with any Numerical Technique", I.E.E.E. P.E.S Winter Power Meeting 1974.
3. J.P.Britton, "Improved Area Interchange Control for Newton's method Load Flows", Paper 69 TP 124-PWR presented at IEEE Winter Power Meeting, NewYork, Jan 26-31, 1969.
4. W.F.Tinney and W.S.Meyer, "Solution of Large Sparse System by Ordered Triangular Factorization" IEEE Trans. on Automatic Control, Vol : AC-18, pp:333-346, Aug 1973.
5. K.Zollenkopf, "Bi-Factorization : Basic Computational Algorithm and Programming Techniques ; pp:75-96 Book on "Large Sparse Set of Linear Systems" Editor: J.K.Rerd, Academic Press, 1971.

MHV016 POWER SYSTEM PLANNING AND RELIABILITY **L T P C**
3 0 0 3

UNIT I LOAD FORECASTING **9**

Objectives of forecasting - Load growth patterns and their importance in planning - Load forecasting Based on discounted multiple regression technique-Weather sensitive load forecasting-Determination of annual forecasting-Use of AI in load forecasting.

UNIT II GENERATION SYSTEM RELIABILITY ANALYSIS **9**

Probabilistic generation and load models- Determination of LOLP and expected value of demand not served – Determination of reliability of iso and interconnected generation systems.

UNIT III TRANSMISSION SYSTEM RELIABILITY ANALYSIS **9**

Deterministic contingency analysis-probabilistic load flow-Fuzzy load flow probabilistic transmission system reliability analysis-Determination of reliability indices like LOLP and expected value of demand not served.

UNIT IV EXPANSION PLANNING **9**

Basic concepts on expansion planning-procedure followed for integrate transmission system planning, current practice in India-Capacitor placer problem in transmission system and radial distributions system.

UNIT V DISTRIBUTION SYSTEM PLANNING OVERVIEW **9**

Introduction, sub transmission lines and distribution substations-Design primary and secondary systems-distribution system protection and coordination of protective devices.

TOTAL: 45 PERIODS

REFERENCES:

1. Proceeding of work shop on energy systems planning & manufacturing CI.
2. R.L .Sullivan, “ Power System Planning”,.
3. Roy Billinton and Allan Ronald, “Power System Reliability.”
4. Turan Gonen, Electric power distribution system Engineering ‘McGraw Hill,1986

MHV017 DESIGN OF EMBEDDED SYSTEMS **L T P C**
3 0 0 3

UNIT I EMBEDDED DESIGN LIFE CYCLE **9**

Product specification – Hardware / Software partitioning – Detailed hardware and software design – Integration – Product testing – Selection Processes – Microprocessor Vs Micro Controller – Performance tools – Bench marking – RTOS Micro Controller – Performance tools – Bench marking – RTOS availability – Tool chain availability – Other issues in selection processes.

UNIT II PARTITIONING DECISION **9**

Hardware / Software duality – coding Hardware – ASIC revolution – Managing the Risk – Co-verification – execution environment – memory organization – System startup – Hardware manipulation – memory mapped access – speed and code density.

UNIT III INTERRUPT SERVICE ROUTINES **9**

Watch dog timers – Flash Memory basic toolset – Host based debugging – Remote debugging – ROM emulators – Logic analyser – Caches – Computer optimisation – Statistical profiling

UNIT IV IN CIRCUIT EMULATORS **9**

Buller proof run control – Real time trace – Hardware break points – Overlay memory – Timing constraints – Usage issues – Triggers.

UNIT V TESTING **9**

Bug tracking – reduction of risks & costs – Performance – Unit testing – Regression testing – Choosing test cases – Functional tests – Coverage tests – Testing embedded software – Performance testing – Maintenance.

TOTAL: 45 PERIODS

REFERENCES

1. Arnold S. Berger – “Embedded System Design”, CMP books, USA 2002.
2. Sriram Iyer, “Embedded Real time System Programming”
3. ARKIN, R.C., Behaviour-based Robotics, The MIT Press, 1998.

MHV018 EVOLUTIONARY COMPUTING L T P C

3 0 0 3

UNIT I **9**

Introduction , Possible applications of evolutionary computations, a history of evolutionary computation, Genetic algorithms Evolution strategic Evolutionary programming Derivative methods-Stochastic processes Modes of stochastic convergence, schema processing, transform methods ,Fitness landscape, probably approximately correct(PAC) learning analysis, Limitation of evolutionary computation methods, Local performance measures.

UNIT II **9**

Representation – Binary strings, Real-valued vectors, Permutations, finite-state representation, Parse trees, Guidelines for a suitable encoding, Other representations Selection – Proportional selection and sampling algorithms, Tournament selection Rank based selection, Boltz Mann selection, Other selection methods, hybrids Generation gap methods, A comparison of selection mechanisms, Interactive evolution, Search Operators-Mutation , recombination , Other operators.

UNIT III **9**

Fitness Evaluation –Encoding and decoding functions, Competitive fitness, evaluation, Complexity – based fitness evaluation, Multi objective optimization, Constraint-Handling techniques, Penalty functions, Decoders, Repair algorithms, Constraint –preserving operators, Other constraint –handling methods, Constraint satisfaction problems, Population structures-Niching Methods, Specification methods, Island(migration)models: evolutionary algorithms based on punctuated equilibria, Diffusion.

UNIT IV **9**

Self-adaptation ,Meta evolutionary approaches, Neural –Evolutionary systems, New areas for evolutionary computation research in evolutionary systems, fuzzy-Evolutionary Systems, Technology and issues, A cart pole system, combination with Other Optimization Methods, Combination with local search, Uses of problem-specific heuristics, Combination with dynamic programming, Simulated annealing and tabu search, comparison with existing optimization.

UNIT V **9**

Heuristics for Parameter setting Issues- Population size, Mutation parameters, Recombination parameters, Implementation of Evolutionary Algorithms-Efficient implementation of algorithms, Computation time of evolutionary operators, Hardware realizations of evolutionary algorithms-applications, classical optimization problems, control Identification ,scheduling ,Pattern recognition, Simulation models, Multi criterion decision making, simulated evolution

Total: 45 Periods

REFERENCES

1. Thomas Back etal., Handbook on evolutionary computation, Institute of Physics, Publishing,2000.
2. Xin Yao, evolutionary Computations: Theory and Applications, World Scientific Publishing.1999, Singapore.
3. Goldberg, Genetic algorithm in search, optimization and machine learning, Addison Wesley,1998.
4. Davis, Hand book on Genetic Algorithms, NewYork, 1991, Vannostrand.
5. Kenneth A. De Jong, Evolutionary Computation: A Unified Approach, MIT Press, 2006

MHV019 POWER SYSTEM OPERATION AND CONTROL **L T P C**
3 0 0 3

UNIT I LOAD FORECASTING **9**

Introduction – Estimation of Average and trend terms – Estimation of periodic components – Estimation of Stochastic components : Time series approach – Auto- Regressive Model, Auto-Regressive Moving – Average Models – Kalman Filtering Approach – On-line techniques for non stationary load prediction.

UNIT II UNIT COMMITMENT **9**

Constraints in unit commitment – Spinning reserve – Thermal unit constraints – Other constraints – Solution using Priority List method, Dynamic programming method - Forward DP approach Lagrangian relaxation method – adjusting λ.

UNIT III GENERATION SCHEDULING **9**

The Economic dispatch problem – Thermal system dispatching with network losses considered – The Lambda – iteration method – Gradient method of economic dispatch – Economic dispatch with Piecewise Linear cost functions – Transmission system effects – A two generator system – coordination equations – Incremental losses and penalty factors-Hydro Thermal Scheduling using DP.

UNIT IV CONTROL OF POWER SYSTEMS **9**

Review of AGC and reactive power control -System operating states by security control functions – Monitoring, evaluation of system state by contingency analysis – Corrective controls (Preventive, emergency and restorative) - Energy control center – SCADA system – Functions – monitoring , Data acquisition and controls – EMS system.

UNIT V STATE ESTIMATION **9**

Maximum likelihood Weighted Least Squares Estimation: - Concepts - Matrix formulation - Example for Weighted Least Squares state estimation ; State estimation of an AC network: development of method – Typical results of state estimation on an AC network – State Estimation by Orthogonal Decomposition algorithm – Introduction to Advanced topics : Detection and Identification of Bad Measurements , Estimation of Quantities Not Being Measured , Network Observability and Pseudo – measurements – Application of Power Systems State Estimation .

TOTAL : 45 PERIODS

REFERENCES

1. O.I.Elgerd, “Electric Energy System Theory - an Introduction”, - Tata McGraw Hill, New Delhi – 2002.
2. P.Kundur ; “Power System Stability and Control”, EPRI Publications, California , 1994.
3. Allen J.Wood and Bruce.F.Wollenberg, “Power Generation Operation and Control’, John Wiley & Sons , New York, 1996.
4. A.K.Mahalanabis, D.P.Kothari. and S.I.Ahson., “Computer Aided Power System Analysis and Control”, Tata McGraw Hill publishing Ltd , 1984

MHV020 POWER SYSTEM ANALYSIS **L T P C**
3 0 0 3

UNIT I SOLUTION TECHNIQUE 9

Sparse Matrix techniques for large scale power systems: Optimal ordering schemes for preserving sparsity. Flexible packed storage scheme for storing matrix as compact arrays – Factorization by Bifactorization and Gauss elimination methods; Repeat solution using Left and Right factors and L and U matrices.

UNIT II POWER FLOW ANALYSIS 9

Power flow equation in real and polar forms; Review of Newton's method for solution; Adjustment of P-V buses; Review of Fast Decoupled Power Flow method; Sensitivity factors for P-V bus adjustment; Net Interchange power control in Multi-area power flow analysis: ATC, Assessment of Available Transfer Capability (ATC) using Repeated Power Flow method; Continuation Power Flow method.

UNIT III OPTIMAL POWER FLOW 9

Problem statement; Solution of Optimal Power Flow (OPF) – The gradient method, Newton's method, Linear Sensitivity Analysis; LP methods – With real power variables only – LP method with AC power flow variables and detailed cost functions; Security constrained Optimal Power Flow; Interior point algorithm; Bus Incremental costs.

UNIT IV SHORT CIRCUIT ANALYSIS 9

Fault calculations using sequence networks for different types of faults. Bus impedance matrix (Z_{BUS}) construction using Building Algorithm for lines with mutual coupling; Simple numerical problems. Computer method for fault analysis using Z_{BUS} and sequence components. Derivation of equations for bus voltages, fault current and line currents, both in sequence and phase domain using Thevenin's equivalent and Z_{BUS} matrix for different faults.

UNIT V TRANSIENT STABILITY ANALYSIS 9

Introduction, Numerical Integration Methods: Euler and Fourth Order Runge-Kutta methods, Algorithm for simulation of SMIB and multi-machine system with classical synchronous machine model ; Factors influencing transient stability, Numerical stability and implicit Integration methods.

TOTAL = 45 PERIODS

REFERENCES:

1. G W Stagg , A.H El. Abiad "Computer Methods in Power System Analysis", McGraw Hill, 1968.
2. P.Kundur, "Power System Stability and Control", McGraw Hill, 1994.
3. A.J.Wood and B.F.Wollenberg, "Power Generation Operation and Control", John Wiley and sons, New York, 1996.
4. W.F.Tinney and W.S.Meyer, "Solution of Large Sparse System by Ordered Triangular Factorization" IEEE Trans. on Automatic Control, Vol : AC-18, pp:333-346, Aug 1973.
5. K.Zollenkopf, "Bi-Factorization : Basic Computational Algorithm and Programming Techniques; pp:75-96 ; Book on "Large Sparse Set of Linear Systems" Editor: J.K.Rerd, Academic Press, 1971.

MHV021 ANALYSIS OF POWER CONVERTERS **L T P C**

3 0 0 3

1. SINGLE PHASE AC-DC CONVERTERS **9**

Uncontrolled, half controlled and fully controlled with R-L, R-L-E loads and free wheeling diode - continuous and discontinuous modes of operation – inverter operation –Dual converter – Sequence control of converters – Performance parameters: harmonics, ripple, distortion, power factor – effect of source impedance and overlap.

2. THREE PHASE AC-DC CONVERTERS **9**

Uncontrolled, half controlled and fully controlled with R-L, R-L-E loads and free wheeling diodes – Inverter operation and its limit – Dual converter – Performance parameter effect of source impedance and overlap.

3. DC – DC CONVERTERS **9**

Principles of step-down and step-up converters – Analysis of buck, boost, buck-boost and Cuk converters – Time ratio and current limit control – Full bridge converter – Resonant and Quasi-resonant converters.

4. DC – AC CONVERTERS **9**

Voltage source inverters - Principle of operation of half and full bridge inverters – 180 degree and 120 degree conduction mode inverters – Voltage control of three phase inverters using various PWM techniques – Harmonics and various harmonic elimination techniques – Analysis with R-L, R-L-E loads – Multi level inverters.

5. AC – AC CONVERTERS **9**

Principle of operation of AC Voltage Controllers, Cycloconverters – Analysis with R-L, RL-E loads – Introduction to Matrix converters.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Ned Mohan , Undeland and Robbin, “Power Electronics: Converters, Application and Design” A John Wiley and Sons, Inc., Newyork, 1995
2. Rashid M.H . “Power Electronics Circuits , Devices and Applications”, Prentice Hall of India, New Delhi, 1995

REFERENCES

1. P.C Sen .”Modern Power Electronics” Wheeler publishing Co ,First Edition ,New Delhi- 1998
2. P.S.Bimbra , “Power Electronics”, Khanna Publishers, Eleventh Edition , 2003.
3. Bin Wu, “High Power Converters and AC Drives”, IEEE Press, A John Wiley and Sons, Inc., 2006.

MHV022 CONTROL OF ELECTRIC DRIVES **L T P C**
3 0 0 3

1. CONVERTER FED DC DRIVES **9**

Microcontroller hardware circuit, flow charts waveforms, Performance characteristics of dc drives fed through single phase converters, 3-phase converters, dual converters, 1-phase fully controlled converter and 3-phase fully controlled converter fed dc drive.

2. CHOPPER FED DC DRIVES **9**

Microcontroller hardware circuits and waveforms of various modes of operation of chopper fed DC drives.

3. INVERTER FED INDUCTION MOTOR DRIVE **9**

Microcomputer controlled VSI fed induction motor drive - Detailed power circuit, generation of firing pulses and firing circuit, flow charts and waveforms for 1-phase, 3-phase Non-PWM and 3-phase PWM VSI fed induction motor drives. Sampling techniques for PWM inverter.

4. MATHEMATICAL MODELING OF FREQUENCY CONTROLLED DRIVE **9**

Development of mathematical model for various components of frequency controlled induction drive, mathematical model of the system for steady state and dynamic behaviour, Study of stability based on the dynamic model of the system.

5. CLOSED LOOP CONTROL OF MICROCOMPUTER BASED DRIVES **9**

Voltage, Current, Torque and Speed measurements using digital measurement techniques. Types of controllers, position and velocity measurement algorithm, closed loop control of microcomputer based drives.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Bose.B.K., Power Electronics and Motor Drives - Advances and Trends, IEEE Press, 2006.
2. Buxbaum, A. Schierau, and K.Staughen, “A design of control systems for DC drives”, Springer-Verlag, Berlin,1990.
3. Thyristor control of Electric drives, Vedam Subrahmanyam, Tata McGraw Hill, 1988.

REFERENCES:

1. R.Krishnan, “Electric Motor Drives, Modeling, Analysis and Control” Prentice Hall of India, 2002.
2. Bin Wu, “High Power Converters and AC Drives”, IEEE Press, A John Wiley and Sons, Inc., 2006.
3. Dubey G.K., Power semiconductor controlled drives, Prentice-HALL 1989
4. Control of Electric Drives, Leonard W, Springer Verlag, NY, 1985
5. Bose B.K., Microcomputer control of power electronics and drives, IEEE Press, 1987.
6. Bose B.K., Adjustable Speed A.C. drives, IEEE Press, 1993.