M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
SCHEME OF TEACHING AND EXAMINATION FOR
M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD)
(2014-16)

I Semester   **Credit Based**

Subject Code	Name of the Subject	Teaching hours/week		Duration of Exam in Hours	Marks for		Total Marks	Credits
		Lecture	Practical / Field Work / Assignment/ Tutorials		IA	Exam		
14EPE11	Applied Mathematics	4	2	3	50	100	150	4
14 ECD 12	Modeling and Analysis of Electrical Machines	4	2	3	50	100	150	4
14 ECD 13	AC and DC Drives	4	2	3	50	100	150	4
14 ECD 14	Power Electronic Devices & Circuits	4	2	3	50	100	150	4
14 ECD15X	Elective-I	4	2	3	50	100	150	4
14 ECD 16	Drives Laboratory - I	--	3	3	25	50	75	2
14 ECD 17	Seminar	--	3	--	25	--	25	1
	Total	**20**	**16**	**18**	**300**	**550**	**850**	**23**

Elective – I

Subject Code	Name of the Subject
14ECD151	Discrete Control Systems and Multi Variable Control
14ECD152	VLSI Design
14ECD153	Computer Control of Industrial Drives

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II Semester   **Credit Based**

| Subject Code | Name of the Subject | Teaching hours/week | | Duration of Exam in Hours | Marks for | | Total Marks | Credits |
		Lecture	Practical / Field Work / Assignment/ Tutorials		IA	Exam		
14ECD21	Dynamics of Linear Systems	4	2	3	50	100	150	4
14 ECD 22	DSP Applications to Drives	4	2	3	50	100	150	4
14 ECD 23	Switched Mode Power Conversion	4	2	3	50	100	150	4
14 ECD24	Power Quality Issues and Mitigation	4	2	3	50	100	150	4
14 ECD 25X	Elective-II	4	2	3	50	100	150	4
14 ECD 26	Drives Laboratory - II		3	3	25	50	75	2
14 ECD 27	Seminar	--	3	--	25	--	25	1
	**Project Phase-I (6 week Duration)	--	--	--	--	--	--	--
Total		**20**	**16**	**18**	**300**	**550**	**850**	**23**

** Between the II Semester and III Semester, after availing a vacation of 2 weeks.

Elective – II

Subject Code	Name of the Subject
14ECD251	Nonlinear Systems
14ECD252	Modeling and Simulation of Power Electronic Systems
14ECD253	Intelligent Applications to Electric Drives

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III Semester: INTERNSHIP   **Credit Based**

Course Code	Subject	No. of Hrs./Week		Duration of Exam in Hours	Marks for		Total Marks	Credits
		Lecture	Practical/ Field Work		IA	Exam		
14ECD31	Seminar/Presentation on Internship (After 8 weeks from the date of commencement)	--	--	--	25	--	25	1
14ECD 32	Report on Internship	--	--	--	--	75	75	15
14ECD33	Evaluation and Viva-Voce	--	--	--	--	50	50	4
	Total	--	--	--	**25**	**125**	**150**	**20**

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IV Semester   **Credit Based**

Subject Code	Subject	No. of Hrs./Week Lecture	No. of Hrs./Week Field Work / Assignment / Tutorials	Duration of Exam in Hours	Marks for IA	Marks for Exam	Total Marks	Credits
14ECD41	Special Electrical Machines	4	--	3	50	100	150	4
14ECD42X	Elective-III	4	--	3	50	100	150	4
14ECD43	Evaluation of Project Phase – II	--	--	--	25	--	25	1
14ECD44	Evaluation of Project work – III	--	--	--	25	--	25	1
14ECD45	Evaluation of Project Work and Viva-voce	--	--	3	–	100+100	200	18
	Total	**8**	--	**09**	**50**	**400**	**550**	**28**

Grand Total (I to IV Sem.) : 2400 Marks; 94 Credits

Elective - III

Subject code	Name of the Subject
14ECD421	Resonant Converters
14ECD422	Embedded Systems and Applications
14ECD423	Electro Magnetic Compatibility

Note:

1) Project Phase – I:6 weeks duration shall be carried out between II and III Semesters. Candidates in consultation with the guides shall carryout literature survey / visit to Industries to finalise the topic of dissertation.

2) Project Phase – II:16 weeks duration. 3 days for project work in a week during III Semester. Evaluation shall be taken during the first two weeks of the IV Semester. Total Marks shall be 25.

3) Project Phase – III :24 weeks duration in IV Semester. Evaluation shall be taken up during the middle of IV Semester. At the end of the semester Project Work evaluation and Viva-Voce Examinations shall be conducted.

   Total Marks shall be 250 (Phase - II Evaluation: 25 Marks, Phase – III Evaluation:25 Marks, Project Evaluation marks by Internal Examiner (Guide):50, Project Evaluation marks by External Examiner :50, Viva-Voce Examination:100 Marks).

   <u>Marks of Evaluation of Project</u>:

   • The I.A. Marks of Project Phase – II & III shall be sent to the University along with Project Work report at the end of the Semester.

4) During the final viva, students have to submit all the reports.

5) The Project Valuation and Viva-Voce will be conducted by a committee consisting of the following:

   a) Head of the Department (Chairman)
   b) Guide
   c) Two Examiners appointed by the university (Out of two external examiners at least one should be present).

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD) SEMESTER - I APPLIED MATHEMATICS			
Subject Code	14EPE11	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Number of Practical Hours/week	--	Number of Tutorial Hours/week	02
Total No. of Lecture Hours	52	Exam Marks	100

Numerical Methods: Solution of algebraic and transcendental equations- iterative methods based on second degree equation – Muller method,(no derivation) Chebyshev method, general iteration method (first order),acceleration of convergence, system of non-linear equations, and complex roots – Newton-Raphson method, polynomial equations – Birge –Vieta method and Bairstow's method.

Numerical Solution of Partial Differential Equations: Classification of second order equations, parabolic equations-solution of one dimensional heat equation, explicit method, Crank-Nicolson method and Du Fort-Frankel method, hyperbolic equations- solution of one dimensional wave equation.

System of Linear Algebraic Equations and Eigen Value Problems: Iterative methods - Gauss-Seidal method, SOR method, Eigen value problems – Gerschgorian circle, Eigen values and Eigen vectors of real symmetric matrices -Jacobi method, Givens method.

Interpolation: Hermite interpolation, spline interpolation, numerical solution of differential equations – Numerov method.

Optimization: Linear programming- formulation of the problem, graphical method, general linear programming problem, simplex method, artificial variable technique -M-method.

Graph Theory: Basic terminologies, types of graphs, sub graphs, graphs isomorphism, connected graphs-walks, paths, circuits, connected and disconnected graphs, operations on graphs, Eulerian paths and circuits, Hamiltonian paths and circuits, applications of graphs.

Linear Algebra: Vector spaces, linear dependent, independence, basis and dimension, elementary properties, examples.

Linear Transformations: Definition, properties, range and null space, rank and nullity, algebra of linear transformations- invertible, singular and non-singular transformations, representation of transformations by matrices.

REFERENCE BOOKS

1. M K Jain, S R K Iyengar and R K Jain, "Numerical Methods for Scientific and Engineering Computations", New Age International, 2004.
2. M K Jain, "Numerical Solution of Differential Equations", 2nd Edition, New Age International, 2008.
3. Dr. B.S. Grewal, "Numerical Methods in Engineering and Science", Khanna Publishers, 1999.
4. Dr. B.S. Grewal, "Higher Engineering Mathematics", 41st Edition, Khanna Publishers, 2011.
5. NarsinghDeo, "Graph Theory with Applications to Engineering and Computer Science", PHI, 2012.
6. Kenneth Hoffman and Ray Kunze, "Linear Algebra", 2nd Edition, PHI, 2011.

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD) SEMESTER - I MODELING AND ANALYSIS OF ELECTRICAL MACHINES			
Subject Code	14ECD12	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Number of Practical Hours/week	02	Number of Tutorial Hours/week	--
Total No. of Lecture Hours	52	Exam Marks	100

Basic Concepts of Modeling: Basic two pole machine representation of commutator machines, 3-phase synchronous machine with and without damper bar and 3-phase induction machine, Kron's primitive machine-voltage, current and torque equations.

DC Machine Modeling: Mathematical model of separately excited DC motor-steady state and transient state analysis, sudden application of inertia load, transfer function of separately excited DC motor, mathematical model of dc series motor, shunt motor, linearization techniques for small perturbations.

Reference Frame Theory: Real time model of a two phase induction machine, transformation to obtain constant matrices, three phase to two phase transformation, power equivalence.

Dynamic Modeling of Three Phase Induction Machine: Generalized model in arbitrary frame, electromagnetic torque, deviation of commonly used induction motor models-stator reference frames model, rotor reference frames model, synchronously rotating reference frames model, equations in flux linkages, per unit model, dynamic simulation.

Small Signal Equations of the Induction Machine: Derivation of small signal equations of induction machine, space phasor model, DQ flux linkages model derivation, control principle of the induction motor.

Transformer Modeling: Introduction, single phase transformer model, three phase transformer connections, per phase analysis, normal systems, per unit normalization, per unit three phase quantities, change of base, per unit analysis of normal system, regulating transformers for voltage and phase angle control, auto transformers, transmission line and transformers.

Modeling of Synchronous Machines: Introduction, voltage equations and torque equation in machine variables, stator voltage equations in arbitrary and rotor reference frame variables, Park's equations, torque equations in substitute variables, rotor angle and angle between rotors, per unit system, analysis of steady state operation.

Dynamic Analysis of Synchronous Machines: Dynamic performance during sudden change in input torque and during a 3-phase fault at the machine terminals, approximate transient torque versus rotor angle characteristics, comparison of actual and approximate transient torque-angle characteristics during a sudden change in input torque; first swing transient stability limit, comparison of actual and approximate transient torque-angle characteristics during a 3-phase fault at the machine terminals, critical clearing time, equal area criterion, computer simulation.

REFERENCE BOOKS

1. P.S.Bimbra, "Generalized Theory of Electrical Machines", 5[th]Edition, Khanna Publications, 1995.
2. R. Krishnan, "Electric Motor Drives - Modeling, Analysis & Control", PHI Learning Private Ltd, 2009.
3. P.C.Krause, Oleg Wasynczuk, Scott D.Sudhoff, "Analysis of Electrical Machinery and Drive Systems", 2[nd]Edition, Wiley(India),2010.
4. Arthur R Bergen and Vijay Vittal, "Power System Analysis", 2nd Edition, Pearson, 2009.
5. PrabhaKundur, "Power System Stability and Control", TMH, 2010.
6. Chee-MunOng, "Dynamic Simulation of Electric Machinery using Matlab / Simulink",Prentice Hall, 1998.

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD)			
SEMESTER - I			
AC AND DC DRIVES			
Subject Code	14ECD13	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Number of Practical Hours/week	02	Number of Tutorial Hours/week	--
Total No. of Lecture Hours	52	Exam Marks	100

Adjustable Speed DC Motor Drives: Introduction, DC motor basics, speed control of a separately excited DC motor, chopper controlled DC motor drives,DC motor drives using phase controlled thyristor converters, phase controlled dual converters; control of series motors.

Adjustable Speed AC Motor Drives: Introduction,voltage source inverters, current source and current,regulated types of inverters,phase controlled cyclo-converter, adjustable speed drives using the cage-type induction motor, adjustable speed drives using the wound rotor induction motor and synchronous motor.

Vector Control of AC Motor Drives: Introduction,space vectors, voltage equations for an induction motor using space vectors, equations for the electromagnetic torque in an induction machine using space vector,vector control strategy for an induction motor, acquisition of the rotor flux linkage vector.

REFERENCE BOOKS

1.Joseph Vithyathil, "Power Electronics- Principles and Applications", TMH,
2010.
2.Bimal K. Bose, "Modern Power Electronics and A.C. Drives", PHI,2012. 3.Bimal K. Bose, "Power Electronics and Variable Frequency Drives:
Technology andApplications",Wiley India, 2010.

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD) SEMESTER - I POWER ELECTRONIC DEVICES & CIRCUITS			
Subject Code	14ECD14	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Number of Practical Hours/week	02	Number of Tutorial Hours/week	--
Total No. of Lecture Hours	52	Exam Marks	100

Power Semiconductor Devices : Introduction, types of static, ideal and real switches, power diodes, power bipolar junction transistors and power Darlington's, thyristor, asymmetrical thyristor, reverse conducting thyristor, light fired thyristor, triac, status of development of power switching devices.

Choppers: Introduction, voltage step down chopper, voltage step up chopper, two quadrant chopper, multiphase choppers, thyristor chopper, switching control circuits for chopper converters.

Inverters: Introduction, function and features of inverters, inverter applications, types of inverters, half bridge inverters, adjustment of AC frequency and AC voltage output wave forms considerations, full bridge configuration, control of AC output voltage, pulse width modulation, shaping of output voltage wave form-sinusoidal pulse width modulation, three phase inverter, input ripple current, use of an input filter, inverter operation with reverse power flow.

REFERENCE BOOKS

1.Joseph Vithyathil, "Power Electronics – Principles and Application",
TMH,2011.
2. M. H. Rashid, "Power Electronics",3rdEdition, Pearson,2011.

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD) SEMESTER - I DISCRETE CONTROL SYSTEMS AND MULTI VARIABLE CONTROL (ELECTIVE - 1)			
Subject Code	14ECD151	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Number of Practical Hours/week	--	Number of Tutorial Hours/week	02
Total No. of Lecture Hours	52	Exam Marks	100

Design of Discrete Time Systems: Using transform methods; stability analysis of closed loop systems in the Z - domain- the jury stability test.
Introduction, obtaining discrete time equivalent of continuous time filters, design principles based on a discrete time equivalent of analog controller, transient find steady state response analysis, design based on the root locus method, design based on the frequency response method, analytical design method.

Modeling: Multi variable system models, state equations, canonical forms, polynomial matrices, transmission zeroes, multi variable system analysis, solution of state equations, controllability, stability.

Observer theory, realization of transfer matrices, minimal realization, multi variable system design, pole placement, decoupling model matching, inverse Nyquist array, characteristic locus methods.

REFERENCE BOOKS

1. Ogata, "Discrete Time Control Systems",PHI,2ndEdition,2011.
2. B.C Kuo, "Automatic Control System",Wiley India Pvt Ltd,7thEdition,2010.
3. Nagrath and Gopal "Control System Engineering" 5th Edition, New Age Publishers,2009.
4. M. Gopal, "Digital Control & State Variable Methods", TMH, 2011.
5. G.F. Franklin, J. David Powell, Michael LWarkman, "Digital Control of Dynamic Systems", 3rdEdition, Addison – Wesley,1998.
6. Wonhans .W.M,"Multi Variable Control", Springer Verlag, 2ndEdition, 1997.

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD)			
SEMESTER - I			
VLSI DESIGN(ELECTIVE - 1)			
Subject Code	14ECD152	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Number of Practical Hours/week	--	Number of Tutorial Hours/week	02
Total No. of Lecture Hours	52	Exam Marks	100

Introduction: VLSI technology trends, Moore's law, Difference between MOS and BJT's, MOS transistor characteristics, types of MOS transistors, NMOS & CMOS inverters, and transmission gated structure, operation of inverter circuits.

NMOS & CMOS circuits for combinational and sequential logics, stick notation, Shannon's expansion theorem, realization of Boolean functions. PLA generators, pseudo NMOS circuits, clocked logic, simple flip flop realization, shift registers, dynamic shift registers, super buffers, RAMs and ROM's.

VLSI fabrication techniques, lithographic process, twin-tub and SOS process, design rules, specification of layers, delay and timing calculation and power estimation.

System Design: VLSI design level system, design examples,CAD tools for VLSI design, design steps CIF representation, design styles, placement, routing, and simulation,circuit extraction, design rule, checking algorithms,testability and fault tolerances, silicon compilers (in brief).

REFERENCE BOOKS

1. Mead, Conway, "Introduction to VLSI Systems", BSP, 2009.
2. Mukherjee Amar, "Introduction to NMOS and CMOS VLSI System Design", PHI, 1986.
3. Pucknell, Eshtangina, "Basic VLSI Design Systems & Circuits", PHI, 2009.
4. Niel H E Weste, Kamran Eshranghian, "Principles of VLSI Design", Pearson Edu Asia, 2004.

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD) SEMESTER - I			
COMPUTER CONTROL OF INDUSTRIAL DRIVES(ELECTIVE - 1)			
Subject Code	14ECD153	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Number of Practical Hours/week	--	Number of Tutorial Hours/week	02
Total No. of Lecture Hours	52	Exam Marks	100

Review of Microcontrollers in Industrial Drives System: Typical Microcontrollers- 8 bit/16 bit/32 bit (only block diagram), digital data acquisition system, voltage sensors, current sensors, frequency sensors and speed sensors.

Evolution of Power Electronics in Drives: Power semiconductor devices used for drives control, GTO, BJT, Power MOSFET, IGBT, MCT and IGCT structures, ratings, comparison and their applications,block diagram for power integrated circuit for DC motor drives.

AC Machine Drives: General classification and National Electrical manufacturer Association (NEMA) classification, special control of induction motors with variable voltage, constant frequency, constant voltage variable frequency, (V/f) constant operation, drive operating regions,variable stator current operation,effect of harmonics.

Synchronous Machine Drives: Wound field machine, comparison of induction and wound field synchronous machines, torque angle characteristics of salient pole synchronous machine, synchronous reluctance permanent magnet synchronous machines (SPM), variable reluctance machine (VRM).

Phase Controlled Converters: Converter controls, linear firing angle control, wave cosine crossing control, phase-locked oscillator principle, electromagnetic interference (EMI) and line power quality problems, cyclo-converters, voltage fed converters, PWM Rectifiers, current fed converters.

Principle of Slip Power Recovery Schemes: Static Kramer's drive system, block schematic diagram and phasor diagram and limitations, static Scherbius scheme system using DC link converters with cyclo-converter modes of operation, modified Scherbius drives for variable source constant frequency (VSCF) generation.

Principle of Vector Control of AC Drives: Phasor diagram, digital implementation block diagram, flux vector-estimation, indirect vector control block diagram with open loop flux control, synchronous motor control with compensation.

Expert System Application to Drives: (only block diagram approach) Expert System shell, design methodology, ES based P-I tuning of vector controlled drive system, Fuzzy logic control for speed controller in vector control drives structure of fuzzy control in feedback system.

REFERENCE BOOKS

1. BimalK.Bose, "Power Electronics and Motor Drives", Elsevier,2010.
2. BimalK.Bose,"Modern Power Electronics & Drives", PHI, 2011.
3. Badri Ram "Fundamentals of Microprocessors and Applications", DhanpatRai, 2001.
4. W. Leonard "Control of Electric Drives", Springer Verlag,2001.
5.HaithamAbu-Rub,Atif Iqbal,Jaroslaw Guzinski "High Performance Control of AC Drives",Wiley,2012.

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD) SEMESTER - I DRIVES LABORATORY-I			
Subject Code	14ECD16	IA Marks	25
No. of Lecture Hours/Week	--	Exam Hours	03
Number of Practical Hours/week	03	Number of Tutorial Hours/week	--
Total No. of Lecture Hours	--	Exam Marks	50

1. Analysis of static and dynamic characteristic of SCR, TRIAC

2. Analysis of static and dynamic characteristic of MOSFET and IGBT

3. Performance of single phase fully controlled and semi-controlled converter for RL load for continuous current mode

4. Performance of single phase fully controlled and semi-controlled converter for RL load for discontinuous current mode

5. Study of effect of source inductance on the performance of single phase fully controlled converter

6. Performance analysis of three phase fully controlled and semi-controlled converter for RL load for continuous current mode

7. Performance analysis of three phase fully controlled and semi-controlled converter for RL load for discontinuous current mode

8. Performance analysis of single phase bridge inverter for RL load and voltage control by single pulse width modulation

9. Performance analysis of two quadrant chopper

10 ZVS operation of a Synchronous buck converter

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD) SEMESTER - I SEMINAR			
Subject Code	14ECD17	IA Marks	25
No. of Lecture Hours/Week	--	Exam Hours	--
Number of contact Hours/week	03	Number of Tutorial Hours/week	--
Total No. of contact Hours	--	Exam Marks	--

The aim of the seminar is to inculcate self-learning, face audience, enhance communication skill, involve in group discussion and present his ideas.

Each student, under the guidance of a Faculty, is required to

i)   Choose a topic of his/her interest relevant to the Course of Specialization

ii)   Carryout literature survey, organize the subject topics in a systematic order

iii)   Prepare the report with own sentences

iv)   Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such facilities

v)   Present the seminar topic at least for 20 minutes orally and/or through power point slides

vi)   Answer the queries and involve in debate/discussion lasting for about 10 minutes

vii)   Submit two copies of the typed report with a list of references

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

The internal assessment marks shall be awarded by a committee consisting of at least two staff members based on the relevance of the topic, presentation skill, participation in the question and answer session and quality of report.

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD)			
SEMESTER - II			
DYNAMICS OF LINEAR SYSTEMS			
Subject Code	14ECD21	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Number of Practical Hours/week	02	Number of Tutorial Hours/week	--
Total No. of Lecture Hours	52	Exam Marks	100

State Variable Description of Linear Systems: State space representation of electrical, mechanical and electromechanical systems,computation of state transition matrix by i) series expansion method ii) Laplace transform approach and iii) Cayley Hamilton theorem; state space equations in canonical forms; solution of linear time invariant and time variant state equations, transfer functions.

Controllability and Observability: State variable equations of composite systems, effect of pole zero cancellation subsystems of composite systems, controllability and observability, transformation to the phase variable canonical form.

Design of Control System by State Space Methods: Control system design via pole placement techniques, design of state observer (full order and minimum order observer); effects of addition of observer on a closed loop system.

Linear, Discrete, Dynamic Systems Analysis: Introduction, linear difference equations, the discrete transfer function, discrete models of sampled data systems, signal analysis and dynamic response.

Sampled Data Systems: Introduction, analysis of sample and hold circuit, spectrum of sampled signal and aliasing.
State Space Analysis of Discrete Time Systems: State space representation of discrete-time systems solving discrete timestate space equations, the pulse-transfer function matrix, discretization of continuous time state space equations, controllability, observability of DT systems.

REFERENCE BOOKS

1. K. Ogata, "Modern Control Engineering", 5th Edition, PHI, 2011.
2. Nagrath and Gopal "Control System Engineering" 5th Edition, New Age Publishers, 2009.
3. G.F. Franklin, J. David Powell, Michael L Warkman, "Digital Control of Dynamic Systems", 3rd Edition, Addison Wesley, 1998.
4. K. Ogata, "Discrete –Time Control Systems", PHI, 2nd Edition, 2011.
5. M. Gopal, "Digital Control & State Variable Methods", TMH, 2011.

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD)			
SEMESTER - II			
DSP APPLICATIONS TO DRIVES			
Subject Code	14ECD22	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Number of Practical Hours/week	02	Number of Tutorial Hours/week	--
Total No. of Lecture Hours	52	Exam Marks	100

Introduction: To the TMS320LF2407 DSP Controller, C2xx DSP CPU architecture and instruction set.

General Purpose Input/output (GPIO) functionality interrupts on the TMS320LF2407, Analog-to-Digital Converter (ADC), event managers (EVA, EVB).

DSP-Based Applications: Of DC-DC buck-boost converters, DSP based control of stepper motors,DSP based control permanent magnet brushless DC machines, Park and Clarke's transformations.

Space Vector Pulse Width Modulation, DSP-based control of permanent magnet synchronous machines.

DSP-based vector control of induction motors.

REFERENCE BOOKS

1. Hamid Toliyat and Steven Campbell, "DSP-Based Electromechanical Motion Control", CRC Press, 2011.
2. P.C.Krause, Oleg Wasynczuk, Scott D.Sudhoff, "Analysis of Electrical Machinery and Drive Systems", 2nd Edition, Wiley India,2010
3. Chee-Mun Ong, "Dynamic Simulation of Electric Machinery using Matlab / Simulink", Prentice Hall,1998.

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD) SEMESTER - II SWITCHED MODE POWER CONVERSION			
Subject Code	14ECD23	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Number of Practical Hours/week	02	Number of Tutorial Hours/week	--
Total No. of Lecture Hours	52	Exam Marks	100

DC – DC Converters (Basic Converters): Linear voltage regulators (LVRs), a basic switching converter(SMPC), comparison between LVR & SMPC, principle of operation and analysis of buck converter analysis, inductor current ripple and output voltage ripple, capacitor resistance effect, synchronous rectification, design considerations, buck converter for discontinuous current operation, principle of operation and analysis of boost converter, inductor current ripple and output voltage ripple, inductor resistance effect, design considerations, boost converter for discontinuous current operation, principle of operation and analysis of buck-boost converter analysis, inductors current ripple and output voltage ripple, design considerations, buck-boost converter for discontinuous current operation, principle of operation and analysis of CUK converter , inductor current ripple and output voltage ripple, capacitor resistance effect, design considerations, single ended primary inductance converter(SEPIC).

Derived Converters: Introduction, transformer models, principle of operation and analysis of fly back converter-continuous and discontinuous current mode of operation, design considerations, principle of operation and analysis of forward converter, design considerations, double ended(Two switch) forward converter, principle of operation and analysis of push-pull converter, design considerations, principle of operation and analysis of full bridge and half-bridge DC-DC converters, design considerations, current fed converters, multiple outputs.

Control of DC-DC Converter: Modeling of DC-DC converters, power supply control, control loop stability, small signal analysis, switch transfer function, filter transfer function, PWM transfer function, Type-2 error amplifier with compensation, design, PSpice simulation of feedback control, Type-3 error amplifier with compensation, design.

Resonant Converters: Introduction, resonant switch ZCS converter, principle of operation and analysis, resonant switch ZVS converter, principle of operation and analysis, series resonant inverter,series resonant DC-DC converter, parallel resonant DC-DC converter, series- parallel resonant DC-DC converter, resonant converters comparison, resonant DC link converter.
Design of inductor and transformers for SMPC.

REFERENCE BOOKS

1. Daniel W Hart, "Power Electronics", Tata McGraw Hill, 2011.
2. Rashid M.H., "Power Electronics – Circuits Devices and Applications", 3rd Edition, Pearson, 2011.
3. D M Mitchel, "DC-DC Switching Regulator Analysis" McGraw-Hill Ltd, 1988.
4. Umanand L and Bhatt S R, "Design of Magnetic Components for Switched Mode Power Converters", New Age International, New Delhi, 2001
5. Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics Converters, Applications, and Design", 3rd Edition, Wiley India Pvt Ltd, 2010.

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD) SEMESTER - II			
POWER QUALITY ISSUES AND MITIGATION			
Subject Code	14ECD24	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Number of Practical Hours/week	02	Number of Tutorial Hours/week	--
Total No. of Lecture Hours	52	Exam Marks	100

Introduction: Introduction to power quality, overview of power quality phenomena, power quality and EMC standard.

Long Interruptions and Reliability Evaluation: Introduction, observation of system performance, standards and regulations, overview of reliability evaluation, reliability evaluation techniques, cost of interruptions, comparison of observation and reliability evaluation, examples.

Short Interruptions: Introduction, terminology, origin of short interruptions, monitoring of short interruptions, influence on equipment, single phase tripping, stochastic prediction of short interruptions.

Voltage Sags - Characterization: Introduction, voltage sag magnitude, voltage sag duration, three phase unbalance, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, other characteristic of voltage sags, load influence on voltage sags, sag due starting of induction motors.

Voltage Sags – Equipment Behavior: Introduction, computers and consumer electronics, adjustable speed AC drives, adjustable speed DC drives, other sensitive load.

Voltage Sags – Stochastic Assessment: Compatibility between equipment and supply, voltage sag coordination chart, power quality monitoring, method of fault positions, method of critical distances.

Mitigation of Interruptions and Voltage Sags: Overview of mitigation methods, power system design – redundancy through switching and parallel operation, system equipment interface.

REFERENCE BOOKS

1. Math H J Bollen, "Understanding Power Quality Problems; Voltage Sags and Interruptions", Wiley India, 2011.
2. Roger C Dugan, et.al, "Electrical Power Systems Quality", 3rd Edition, TMH, 2012.
3. G T Heydt, "Electric Power Quality", Stars in Circle Publications, 1991.
4. Ewald F Fuchs, et.al, "Power Quality in Power System and Electrical Machines", Academic Press, Elsevier, 2009.

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD) SEMESTER - II			
NONLINEAR SYSTEMS(ELECTIVE - II)			
Subject Code	14ECD251	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Number of Practical Hours/week	--	Number of Tutorial Hours/week	02
Total No. of Lecture Hours	52	Exam Marks	100

Non-linear phenomena, piece-wise linear approximation, harmonic linearization, describing functions.

Phase plane method, phase plane plots, trajectories, singular points, limit cycle stability, testing, Nyquist method.

Dual input describing function, sub harmonic and jump phenomena, Lyapunov methods, generation of functions for linear and non-linear systems, analysis of stability.

Lure's criteria, Popov's method, circle criteria and its applications, BIBO stability relay.

REFERENCE BOOKS

1. Hsu, J C Mayer, A U, "Modern Control Principles & Applications", Mc-Graw Hill, 1968.
2. Atherton D P, " Non Linear Control Systems" Van Nostrand 1975.
3. Vidyasagar M., "Non Linear Systems", 2ndEdition Prentice Hall, 2002.
4. Holtzman J M, "Nonlinear System Theory, Functional Analysis Approach", Prentice Hall,1970.
5. John E Gibson, "Non-Linear Automatic Control", McGraw Hill Publication,1963.
6. Graham, D, McRuer M., "Analysis of Nonlinear Systems", John Wiley,1961.

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD) SEMESTER - II			
MODELING AND SIMULATION OF POWER ELECTRONIC SYSTEMS (ELECTIVE - II)			
Subject Code	14ECD252	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Number of Practical Hours/week	--	Number of Tutorial Hours/week	02
Total No. of Lecture Hours	52	Exam Marks	100

Computer   Simulation of Power Electronic Converters and Systems: Challenges in computer simulation, simulation process: types of analysis, methods of simulation: circuit-oriented simulators, equation solvers, comparison of circuit oriented simulators and equation solvers, solution techniques for time-domain analysis.

Linear   differential equations, trapezoidal method of integration, nonlinear differential equations, widely used circuit oriented simulators, equation solvers.

Modeling of Power Electronic System Components: DC to DC converters: steady-state equivalent circuit modeling, losses and efficiency, DC transformer model, inclusion of inductor copper loss, construction of equivalent circuit model, mathematical model of a single phase diode-bridge rectifier with a filter capacitor, simulation models for single phase and three phase PWM inverters, DC motor, induction motor.

System Level Modeling, Analysis, and Design of Electrical Machines: Phase controlled DC motor drives, chopper-controlled DC motor drive, phase controlled induction motor driveand frequency controlled induction motor drives.

REFERENCE BOOKS

1.   Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics Converters, Applications, and Design", 3rd Edition,Wiley India Pvt Ltd, 2010.
2. Robert W. Erickson, Dragan Maksimovic, "Fundamentals of Power Electronics", 3rd Edition, Kluwer Academic Publishers.
3. R.Krishnan, Electric Motor Drives: "Modeling**,** Analysis and Control", PHI, EEE, 2009.

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD) SEMESTER - II INTELLIGENT APPLICATIONS TO ELECTRIC DRIVES (ELECTIVE - II)			
Subject Code	14ECD253	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Number of Practical Hours/week	--	Number of Tutorial Hours/week	02
Total No. of Lecture Hours	52	Exam Marks	100

Fuzzy Logic Systems: General-Proven advantages of various industrial fuzzy logic applications-fuzzy logic system,fuzzy logic basics-classical set, characteristic function-classical set operations-fuzzy set, member ship function, fuzzy set operations-ns of fuzzy sets, the extinction principle, fuzzy rules, fuzzy reasoning-fuzzy logic inference system, Sugeno fuzzy logic inference system, Tsukamoto fuzzy logic inference system-fuzzy logic system design: automatic generation of fuzzy rules from data-adaptive fuzzy logic systems.

DC Drive with Fuzzy Controllers: Drive with fuzzy speed controller- drive with fuzzy speed and armature current controller- drive with fuzzy speed, armature current and flux controller- drive with fuzzy firing angle compensation, fuzzy speed controller and armature current controller-drive scheme-linearization of converter non-linear characteristics-fuzzy firing angle compensator-fuzzy speed and current controllers-simulation results.

Induction Motor Vector Drive with Fuzzy Controllers-Vector drive with four controllers, design and tuning of fuzzy controllers-experimental results, drive with single fuzzy controller- experimental results, drive with two fuzzy controller-experimental results, drive with four fuzzy controller-fuzzy controlled DTC induction motor drives-switching vector selection-to obtain faster torque and flux responses-switching vector selection using a fuzzy rule base-fuzzy inference-simulation results-fuzzy logic based DTC drive with constant switching frequency.

Applications of Artificial Neural Networks: ANN fundamentals-biological neuron model, artificial neuron model, ANN networks-Hardware implementation of ANNs-various ANNs and training strategies for different applications-applications of the error back propagation algorithm-data preparation for the back propagation algorithm-nodes, layers-back propagation training and learning, learning curve-generalized data rule- application of simultaneous input vectors: batching-numerical acceleration techniques, avoidance of overfitting- Levenberg-Marquardt algorithm-unsupervised learning, competitive learning-main features of unsupervised learning and winner-take-all learning techniques-three computational stages of clustering- winner-take-all network initialization and weight adjustment algorithm-limitations of winner-take-all algorithm, all other algorithms-KFM and other self-organizing techniques-lateral connections in a biological neural network- lateral connections in an artificial neural network: the Kohonen feature map-KMF learning algorithm, main characteristics.

ANN and DC Drive: DC drives with ANN controllers, application of combined ANN controllers-DC motor control using indirect adaptive neuro-control with reference model- DC motor control using direct inverse adaptive neuro-control- DC drive with combined neuro-controller.

AI Based Steady-State and Transient Analysis of Induction Machines: AI based steady-state and transient analysis of induction machines-conventional steady state and transient analysis-ANN based steady state and transient analysis-ANNs for slip-ring induction machine- ANNs for squirrel-cage induction machine- fuzzy-neural-network-based steady-state and transient analysis of induction machines-vector drive with self-organizing fuzzy-neural speed controller, experimental results, minimal configuration- vector drive with a neural speed controller, experimental results, minimal configuration.

REFERENCE BOOK

Peter Vas, "Artificial Intelligence Based Electrical Machine and Drives", Oxford University Press, 1999.

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD) SEMESTER - II			
DRIVESLABORATORY - II			
Subject Code	14ECD26	IA Marks	25
No. of Lecture Hours/Week	--	Exam Hours	03
Number of Practical Hours/week	03	Number of Tutorial Hours/week	--
Total No. of Practical Hours	--	Exam Marks	50

1. Modelling and validation of a separately excited DC motor
 (i)To verify the performance under open loop for different input voltages of Step, Ramp and Step-ramp
2. Closed loop operation of a separately excited DC motor
 (i)To study the closed loop operation using P & PI gain speed controller and PI current controller
3. Operation of two pulse converter
 (a)Simulation of operation of a single phase fully controlled converter and generation of firing pulses
 (b)Validate the output voltage of the converter for various control voltages
4. Operation of six pulse converter simulation of a three phase controlled converter and generation of firing pulses
5. Implementation of two quadrant chopper DC drive
6. Study of thyristor converter based DC drive
7. Study and evaluation of the performance of a cycloconverter
8. Study of AC motor drive
 (a) V/f open loop control
 (b) Closed loop speed control with slip compensation
9. Study of space vector PWM (VSI) based Induction Motor drive
10. Testing of motor drive under various load conditions (mechanical coupling of 2 motor drives)

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD)			
SEMESTER - II			
SEMINAR			
Subject Code	14ECD27	IA Marks	25
No. of Lecture Hours/Week	--	Exam Hours	--
Number of contact Hours/week	03	Number of Tutorial Hours/week	--
Total No. of Hours	--	Exam Marks	--

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD) SEMESTER - III INTERNSHIP				
Subject Code	14ECD31	IA Marks Seminar/Presentation		25
Duration	16 weeks	Exam Marks	14ECD32	Report on Internship	75
			14ECD33	Internship Evaluation and Viva-voce	50

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD) SEMESTER - IV			
SPECIAL ELECTRICAL MACHINES			
Subject Code	14ECD41	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Number of Practical Hours/week	--	Number of Tutorial Hours/week	--
Total No. of Lecture Hours	52	Exam Marks	100

Stepper Motor: Introduction, types, hybrid stepper motor; construction, principle of operation, two phases energized at a time, conditions for operation, different configurations, VR stepper motor; single stack and multi stack, drive systems and circuit for open loop and closed loop control of stepping motor, dynamic characteristics, single phase stepper motor, expression of voltage, current and torque for stepper motor and criteria for synchronization.

Switched Reluctance Motor: Constructional features, principle of operation, design aspects and profile of the SRM, torque equation, power converters and rotor sensing mechanism, expression of torque and torque – speed characteristics.

Permanent Magnet Materials: Permanent magnetic materials, properties, minor hysteresis loop and recoil line, equivalent circuit, stator frames with permanent magnets.
Brushless DC Motors: Construction, operation, sensing and switching logic scheme, drive and power circuit, theoretical analysis and performance prediction, transient analysis.
Linear Induction Motor: Construction and principle of operation, calculation of the force on rotor.

REFERENCE BOOKS

1. K Venkataratham, "Special Electrical Machines", University Press (India), 2009.
2. T J E Miller, "Brushless Permanent Magnet and Reluctance Motor Drives", Clerendon Press, Oxford, 1989.
3. Kenjo T and Nagamori S, "Permanent Magnet and Brushless DC Motors", Clerendon press, Oxford, 1985.
4. KenjoT, "Stepping Motors and their Microprocessor Control" Clerendon Press, Oxford, 1984.
5. Krishan R,"Switched Reluctance Motor Drives" Modeling, Simulation Design and Applications,CRC,2001.
6. Ali Emadi, "Energy Efficient Motors", 3rdEdition, Special Indian Edition, Marcel Dekker, 2011.

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD)			
SEMESTER - IV			
RESONANT CONVERTERS (ELECTIVE - III)			
Subject Code	14ECD421	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Number of Practical Hours/week	--	Number of Tutorial Hours/week	--
Total No. of Lecture Hours	52	Exam Marks	100

Introduction: Switch-mode inductive current switching, zero-voltage and zero-current switching, classification of resonant converters, basic resonant circuit concepts – series resonant circuits, parallel resonant circuits, load converters – series-loaded resonant DC-DC converters, discontinuous mode with $\omega_s < \frac{1}{2}\omega_o$, continuous- conduction mode with $\frac{1}{2}\omega_o < \omega_s < \omega_o$, continuous- conduction mode with $\omega_s > \omega_o$, steady state operating characteristics, control of SLR DC-DC converters, parallel loaded resonant DC-DC converters, discontinuous mode of operation, continuous mode of operation below ω_o, continuous mode of operation above ω_o, Steady state operating characteristics, hybrid resonant DC-DC Converter, current source, parallel-resonant DC to AC inverters for induction heating, start-up, Class E converters.

Resonant Switch Converters: ZCS resonant-switch converters, ZVS resonant-switch converters, comparison of ZCS and ZVS topologies.

Zero voltage-switching, clamped-voltage topologies, ZVS-CV DC-DC converters, ZVS-CV DC-AC inverters, ZVS-CV DC-DC converters with voltage cancellation.

Resonant – DC-link inverters with Zero-voltage switching, high frequency-link integral-half-cycle converters-applications.

REFERENCE BOOK

Ned Mohan, Tore M. Undeland, William P. Robbins, "Power Electronics Converters, Applications, and Design", 3rd Edition. Wiley India Pvt Ltd, 2010

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD) SEMESTER - IV			
EMBEDDED SYSTEMS AND APPLICATIONS(ELECTIVE - III)			
Subject Code	14ECD422	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Number of Practical Hours/week	--	Number of Tutorial Hours/week	--
Total No. of Lecture Hours	52	Exam Marks	100

Introduction to Embedded System: An embedded system, processor, hardware unit, software embedded into a system, example of an embedded system, OS services, I/O, N/W, O/S, real time and embedded OS.

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.

Microchip PIC Microcontroller:Introduction to 16fxx controller, CPU architecture, 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, I^2C Bus for peripheral chip access.

REFERENCE BOOKS

1. Rajkamal,"Embedded System Architecture- Programming & Design",2nd
   Edition, TMH 2011.
2. J.B.Peatman, "Design with PIC Microcontrollers", Pearson,2004.
3. J.W.Valvano, "Embedded Microcomputer System, Real Time Interfacing",
Thomson, 2007.
4. Jane W.S. Liu, "Real Time Systems", Prentice Hall,2000.

M.TECH. COMPUTER APPLICATION IN INDUSTRIAL DRIVES (ECD)			
SEMESTER - IV			
ELECTRO MAGNETIC COMPATIBILITY(ELECTIVE - III)			
Subject Code	14ECD423	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Number of Practical Hours/week	--	Number of Tutorial Hours/week	--
Total No. of Lecture Hours	52	Exam Marks	100

Review of EMI Theory: Sources of EMI, noise pick up modes and reduction techniques for analog circuits.

Emissions and Reduction Techniques: Use of co-axial cables and shielding of signal lines; conducted and radiated noise emission in power electronic equipment and reduction techniques,EMI induced Failure Mechanisms for power electronic equipment; EMC in design of digital circuits.

Electro Static Discharges: ESD and switching interference reduction; susceptibility aspects of power electronic and digital equipment; shielding of electronic equipment.

EMC Standards and Test Equipment.

REFERENCE BOOKS

1. Otto H. W., "Noise Reduction Techniques in Electronic Systems", 2nd Edition,John Wiley and Sons, 1988.
2. Paul Clayton, Introduction to Electromagnetic Compatability,2nd Edition, Wiley Interscience,2006.
3. William B. Greason, "Electrostatic Damage in Electronics: Devices and Systems", John Wiley and Sons, 1986.
4. Joseph Di Giacomo, "Digital Bus Hand Book", McGraw Hill Publishing Company, 1990.
5. White, R. J. "Handbook series of Electromagnetic Interference and Compatibility", Don White consultants Inc. 1981.

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