Nirma University

Institute of Technology

M.Tech. in Electrical Engineering
(Power Electronics, Machines & Drives)

M.Tech. in Electrical Engineering (Power Electronics, Machines & Drives)
SEMESTER – I

3EE1110 Electric Drive System [3 0 1 4]

Course Learning Outcome:
After successful completion of the course, student will be able to
- understand theoretical concepts of dynamics of electric drives
- analyze and interpret block schematic and operation of dc motor drives and induction motor drives under various operating conditions
- evaluate the given application and load requirements and propose the most suitable drive mechanism/technique for the same
- analyze and interpret the electric braking need of a drive system for given application

Syllabus:
Basic concepts, characteristics and operating modes of drive motors, Dynamics of electric drives, Selection of motor and rating, Concept of four quadrant drive, Classification of load and its characteristics.
DC Motor drive: starting, braking, transient analysis, controlled rectifier and chopper fed DC drives.
Induction motor drives: Operation with unbalanced voltage and unbalanced rotor impedances, effect of time harmonics on the motor performance, Various methods of braking, transient analysis, speed control using change in no. of poles, stator voltage control, variable voltage variable frequency (VVVF) control, rotor resistance control, Concept of constant power and constant torque drives for slip power recovery system, Static Scherbius and Kramer drives.

Self Study:
The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

Laboratory Work:
Practical / Term work shall be based on the above syllabus.

References:

1. G.K. Dubey, Fundamentals of Electrical Drives, Narosa Publications.
2. S.K.Pillai, Analysis of Thyristor Power Conditioned Motors, University Press.
3. Vedam Subramanyam, Electric Drives – Concepts And Publications, Tata Mc Graw –Hill.
4. R. Krishnan, Electric Motor Drives, Prentice Hall Ltd.
5. W. Leonhard, Control of Electric Drives, Springer-Verlag.

M.Tech. in Electrical Engineering (Power Electronics, Machines & Drives)
SEMESTER – I

3EE1108 Digital Signal Processing [3 0 1 4]

Course Learning Outcome:
After successful completion of the course, student will be able to

- understand and Analyzed various signal manipulation techniques
- acquire the knowledge of various digital signal processor architecture and form their selection criteria
- able to develop algorithm using assembly or high level programming language on digital signal processors to arrive problem solution

Syllabus:
Digital Signal Processing Basics: Nyquist sampling theorem, aliasing, up and down sampling and its effects, Sampling of continuous time signals, Z - transform and its properties, Z - transform of basic sequences, process of Z - transform, Cauchy integral theorem, inverse Z - transform, partial fraction expansion method, power series method, residue method.
Discrete Time Fourier Transforms (DTFT): Basics and properties of DTFT, Fourier analysis of signals using discrete Fourier transforms, Fast Fourier transform. Basic structure of digital filters, digital filters specifications, concept of digital filters (IIR and FIR approach).
Introduction to Programmable DSPs: Numeric representation & arithmetic, fixed point versus floating point, floating point emulation & block floating point, path: fixed point data paths & floating point data paths, multiplier & multiplier accumulation, multiple access memory, multi-ported memory, pipelining, special addressing modes in DSP processors
Architecture of TMS320C2XX: Introduction, bus structure, central arithmetic logic unit, auxiliary register ALU, status registers, index register, parallel logic unit, program flow, memory map, CPU interrupts.
TMS320C2XX Assembly Language Instructions: Assembly language syntax, addressing modes, load/store, addition/subtraction, multiplication, program control instruction, sample programs.
Initializing TMS320C2XX DSP: Overview of compliers and emulators, using code composer studio, creating and customizing program and data memory, creating header files, initializing timers and initializing and using internal ADC.
C Programming and Signal Generation using TMS320C2XX DSP: C Programming of DSP using code composer studio, Implementation of mathematical models on DSP, customizing and initializing dead band registers, generation of signals and waveforms, generation of PWM signals, realization of filters on DSP.

Self Study:
The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

Laboratory Work:
Practical / Term work shall be based on the above syllabus.

References:

1. Alan V. Oppenheim, Ronald W. Schafer and John R. Buck, “Discrete Time Signal Processing,” Pearson Education.
2. John G. Proakis and Dimitris G. Manolakis, “Digital Signal Processing: Principles, Algorithms and Applications,” Pearson Education.
3. Sanjit K. Mitra, “Digital Signal Processing: A Computer Based Approach,” Tata McGraw-Hill.
4. “TMS320C28X DSP CPU and Instruction Set Reference Guide,” Texas Instruments.
5. Hamid A. Toliyat and Steven G. Campbell, “DSP-Based Electromechanical Motion Control,” CRC Press.
6. B. Venkataramani and M. Bhaskar, “Digital Signal Processors: Architecture, Programming and Applications,” Tata McGraw-Hill.
7. Phil Lapslay, “DSP Processor Fundamental”, IEEE Press.

M.Tech. in Electrical Engineering (Power Electronics, Machines & Drives) SEMESTER – I

3EE1109 Power Electronic Devices and Circuits [3 0 0 3]

Course Learning Outcome:
After successful completion of the course, student will be able to

- select power semi conductor switches for different applications
- design triggering circuits for different switches
- understand different Power Electronic converter circuits
- design Power Supply and Converters using Integrated Circuits

Syllabus:
Construction and operation of power semiconductor switching devices, such as; SCR, GTO, Power BJT, Power MOSFET, IGBT and MCT. Comparison of these devices for power rating, operating frequency, losses, and applications. Commutation circuits of SCR: natural and forced commutation. Various trigger techniques using isolation transformer and opto-couplers and protection circuits for these devices. Phase controlled rectifier configuration: semi-converter, full-converter and dual converter. Unity power factor rectifier with reduced total harmonic distortion in input current. Basic inverter circuits: half-bridge and full bridge. Three-phase inverter: operation with 120° and 180° conduction. Choppers: fundamentals of operation and steady state time domain analysis of step-down, step-up and step-up-down configurations. Introduction to multi-phase chopper. Resonant converter, SMPS using ICs.

Self Study:
The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

References:

1. B.K.Bose, Power Electronics and A.C. Drives, Prentice Hall.
2. M.H.Rashid, Power Electronics, Prentice Hall of India.
3. N.Mohan, T.M. Undeland and W.P. Robbins, Power Electronics: Converter Application and Design, John Wiley and Sons.

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SEMESTER – I

3EE1107 Advanced Electrical Machines [3 0 0 3]

Course Learning Outcome:
After successful completion of the course, student will be able to
- understand constructional aspects, operational aspects , characteristic and control of different advanced electrical machines
- analyze advanced electrical machines with an insight in to its applicability
- understand characteristics and applications of Permanent Magnet material

Syllabus:
Permanent magnet materials and magnetic circuits, permanent magnet brushless dc motors, permanent magnet brushless ac motor, axial field permanent magnet motors, stepper motors, switched reluctance motors, New topologies of switched reluctance motors, bearingless switch reluctance motor, bearingless induction motor, doubly salient permanent magnet motor.

Self Study:
The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

References:

1. T.J.E. Miller , Brushless PM and Reluctance Motor Drives, Clarendon Press Oxford..
2. Jacek Gierasewing, P. M. Motor Technology,Marcel Dekker.
3. R. Krishnan, Electric Motor Drives, PHI.
4. Kelly , Denis, Performance and Control of Electrical Machines, McGraw-Hill.
5. P.C. Sen, Principles of Electrical Machines and Power Electronics, John Wiley and Sons.
6. Latest IEEE Transactions on Industry Applications.

M.Tech. in Electrical Engineering (Power Electronics, Machines & Drives)
SEMESTER – I

3EE1104 NUMERICAL METHOD AND OPTIMIZATION TECHNIQUES (3 0 0 3

Course Lerning Outcome:
After successful completion of the course, student will be able to

- apply numerical methods in various electrical engineering related projects, seminars a
- apply the knowledge of iterative methods to solve algebraic and transcendental equat linear equations and ODE.
- have knowledge of finite differences, interpolation, numerical differentiation and nun
- apply the knowledge of LPP and optimization technique in network analysis, PERT a critical path problems, slack time, project documentation and monitoring costs

Syllabus:

Errors: Truncation error, round off error, absolute error, relative and percentage error.
Iterative methods: Bisection, false position, secant, Newton-Raphson method, successive a method, Newton – Raphson method for two variables, discussion of convergence, solving p Budan's theorem, Bairstow's method, Graeff's root squaring method.
Interpolation: Difference tables and calculus of difference, cubic spines, inverse interpolati and non linear regression using least square approximation, Chebyshev polynomials.
Numerical differentiation and integration: Differentiation formulae based on polynomia Simpson's and Gaussian quadrature formulae.
Solution of simultaneous linear equations and ordinary differential equations: Gauss (pivoting, ill conditioned equations, Gauss Seidel and Gauss Jacobi iterative methods, Taylor methods, error analysis, Runge Kutta method, predictor corrector method.
Linear programming: Introduction, formulation of LPP, graphical solution of LPP, solutic simplex method, mixed constraints, dual of linear programming problem, application of line
Network analysis: Pert and CPM: background & development, networking, difference in C determination of critical path, slack and its uses, shortest path problems, introduction to sho method of finding the shortest path, processing/balancing & time scheduling.

Self Study:
The self study contents will be declared at the commencement of semester. Around 10% of th asked from self study contents.

References:

1. S.S. Sastry, Introduction to Numerical Analysis, Prentice Hall of India
2. Kanti swarup, Manmohan and Gupta – Operations Research, S.Chand & Sons, New Delhi
3. S.D. Sharma, Operations Research, Kedarnath Ramnath & Co. Meerut
4. H. A. Taha, Operations Research, Prentice Hall, New Delhi

M.Tech. in Electrical Engineering (Power Electronics, Machines & Drives)
SEMESTER – I

3EE1126 Modern Control Theory (Elective – I) [3 0 0 3]

Course Learning Outcome:
After successful completion of the course, student will be able to
- understand and apply modern control theory in the field of engineering
- able to analyze linear as well as non-linear control system
- able to test stability and modification to be applied to improve the performance of control system

Syllabus:
State variable analysis: Introduction, concepts of state, state variables and state model, state-space representation for linear continuous-time systems and discrete-time systems.
Time, domain solution of state equations: Solution of homogeneous state equations, state transition matrix, evaluation of matrix exponential (e^{At}), solution of non- homogeneous state equations.
State-space representation: State-space representation of high-order differential equations, state space representation of transfer function in controllable, observable and diagonal form, relationship between state equations and transfer function. Signal flow graph of state equations, decomponsition of transfer function, diagonalization, eigen values and eigen vectors, modal matrix.
Controllability and observability: Concepts, alternative tests on controllability and observability, relationship between controllability, observability and transfer function, pole placement by state feedback, design of state feedback controller.
Nonlinear systems: Introduction, common physical nonlinearities-saturation,dead-zone,relay,relay with dead zone, hysteresis, backlash, etc, jump resonance, limit cycle.
Phase-plane analysis-phase plane and phase trajectory, singular points, construction of phase trajectory, evaluation of time, stability analysis.
Liapunov stability analysis: Introduction, Liapunov stability, criterion, direct method of Liapunov, Popov's method, construction of Liapunov function for linear system.

Self Study:
The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

References:

1. Nagrath & Gopal, Control System Engineering, New Age International.
2. Ken dutton, Steve Thompson & Bill, The Art of Control Engineering, Prentice Hall.
3. M. Gopal, Digital Control & State Variable Method, PHI.

M.Tech. in Electrical Engineering (Power Electronics, Machines & Drives)
SEMESTER – II

3EE1201 Modelling and Analysis of Electrical Machines [3 0 0 3]

Course Learning Outcome:
After successful completion of the course, student will be able to
- apply theoretical concepts in modeling of conventional electrical machines
- analyze electrical machines' performance/behaviour for different operating conditions
- use tools/techniques for solution of typical issue related to electrical drive system

Syllabus:
Unified machine theory, generalized torque equation, performance and speed control of d.c. machine, induction machine and synchronous machine using generalized theory, Transformation methods (stationary, rotor and synchronous frames) and corresponding equivalent circuits. Park's transformations, drives and control techniques, concept of space vector.

Self Study:
The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

References:

1. Paul C. Krause, Oleg Wasynczuk and Scott D. Sudhoff, Analysis of Electric Machinery and Drive Systems, John Wiley & Sons, NewYork.
2. C.V.Jones, The Unified Theort of Electric Machines, Butterworth, London.
3. P. Vas, Vector Control of AC Machines" Clarendon Press, Oxford.
4. J. Murphy and F.G.Turnbull, Power Electronics Control of AC Motors, Paramon Press.

M.Tech. in Electrical Engineering (Power Electronics, Machines & Drives)
SEMESTER – II

3EE1206 CAD of Electrical Apparatus [3 0 1 4]

Course Learning Outcome:
After successful completion of the course, student will be able to

- apply theoretical concepts in designing of transformers, dc machines, induction motors and electromagnets
- develop computer aided program pertaining to design of transformers, dc machines, induction motors and electromagnets
- prepare and solve model in FEA simulation software

Syllabus:
Design review: review of design process of transformers, rotating machines, electromagnets etc.
CAD: Basic design methodology and engineering consideration, selection of input data and design variables, flow charts for design and design optimization of transformers, rotating machines, electromagnets etc.
Finite element method of design: Fundamentals of Finite Element(FE) design, FE techniques and their applications for designing transformers, rotating machines, electromagnets etc, 2D and 3D parametric analysis, methods of FE analysis, FEM in one dimension, 2D, 3D, Governing equations. CAD programming using "C" language and MATLAB.

Self Study:
The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

Laboratory Work:
Practical / Term work shall be based on the above syllabus

References:

1. M. G. Say, Performance and Design of Electrical Machines, John Wiley and Sons.
2. Veinott, Cad of Electrical Machines, MIT Press.
3. S. K. Sen, Principles of Electrical Machine Design With Computer Programmes,Oxford & Ibh.
4. Ramamoorthy, Computer Aided Design of Electrical Equipments.
5. Silvester and Ferrari, Finite Elements Methods for Electrical Engineers, Cambridge University Press.
6. C. S. Ratnajeewan , Finite Elements, Electromagnetics Design, Hoole Els Evier, 1995.

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SEMESTER – II

3EE1207 Control of Electric Drives [3 0 1 4]

Course Learning Outcome:
After successful completion of the course, student will be able to

- acquire knowledge and skill on control aspects of electrical motor drive systems
- integrate schematic block diagrams related to electrical drive systems for control applications
- effectively use simulating tools for analysis of electrical motor drive systems

Syllabus:
DC Motor Drive: DC motor drive using PWM rectifier, Closed loop control using sensor and sensorless operation of drive.
Induction Motor Drive: Principles of soft starting in inverter, Concept of field oriented control, direct and indirect field oriented control of induction motor, direct torque control, closed loop drive using sensor and sensorless operation.
Switched Reluctance Motor Drive: Various drive configurations, Sensor and sensorless control of SRM, reduction in torque pulsation.
Permanent Magnet Motor Drive: Vector control of the PMSM drive, Direct torque control of PMSM drive, Sensor and sensorless control of PMBLDC and PMSM drives.

Self Study:
The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

Laboratory Work:
Practical / Term work shall be based on the above syllabus.

References:

1. B. K. Bose, Power Electronics & AC Drives, Prentice-Hall, New Jersey.
2. P. Vas, Vector Control of AC Machines, Clarandon Press, Oxford.
3. G. K. Dubey, Power Semiconductor Controlled Drives, Prentice-Hall, Eaglewood Cliffs.
4. T.J.E. Miller, Brushless Pm and Reluctance Motor Drives, Clarendon Press Oxford.
5. Recent IEEE Publication & Transactions on Power Electronics, Industry Applications and Power Delivery.

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SEMESTER – II

3EE1208 Analysis of Power Electronic Controllers [3 0 1 4]

Course Learning Outcome:

After successful completion of the course, student will be able to

- explore the various power electronic converters and their applications
- make comparative analysis of various PWM techniques for various power electronic converters
- enhance the capability to use different simulation tool for the performance analysis of any power electronic controller

Syllabus:

Single phase and three phase ac voltage controllers, triggering techniques for power factor and harmonic improvements in ac voltage controllers. Design and analysis of phase control circuits, integral cycle control and solid state transfer switches for ac voltage controllers. Concept of three-phase to single-phase and single-phase to three-phase cycloconverters. Symmetrical and asymmetrical control, harmonic analysis of output voltage, and effect of source inductance. Inverters: configuration of three-phase VSI and CSI, concepts of pulse width modulation (PWM) techniques, single and multiple pulse width modulation forms, periodic and dc level modulation strategies, reduction of harmonics in output voltage, software and hardware method of PWM based firing pulse generation for inverters. 1 ϕ and 3 ϕ , UPS, on-line, off-line and their design, analysis and design of electronic ballast.

Self Study:

The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

Laboratory Work:

Practical / Term work shall be based on the above syllabus.

References :

1. G.K. Dubey, Power Semiconductor Controlled Drives, Prentice Hall.
2. N. Mohan, T.M. Undeland & W.P.Robbins, Power Electronics: Converter Application & Design, John Wiley & Sons.
3. Recent IEEE Publications and Transactions on Power Electronics, Industry Applications, and Power Delivery.

M.Tech. in Electrical Engineering (Power Electronics, Machines & Drives)
SEMESTER – II

3EE1209 Minor Project [0 0 2 2]

Course Learning Outcome:
After successful completion of the course, student will be able to

- analyze performance of a specific electrical or electronic circuit with a detailed insight into its various functional components
- design and fabricate a small circuit for specific applications
- evaluate and troubleshoot any electrical or electronic circuit with varied applications

A student is required to carry out project work. The project shall be on design and fabrication work of power electronics application.
At the end of the semester, student will be required to submit a report of work done and will defend his/her work carried out before examiners

M.Tech. in Electrical Engineering (Power Electronics, Machines & Drives)
SEMESTER – II

3EE1256 Multi-Level Inverters for High-Power Induction Motor Drives (Elective–II) [3 0 0 3]

Course Learning Outcome:
After successful completion of the course, student will be able to
- able to analyze different multi-level inverter topologies and select them based on application need
- acquire the knowledge of various PWM techniques and their comparative analysis for multi-level inverters
- understand issues related to multi-level inverters and various mitigation techniques used for problems

Syllabus:
Basic concept of general n-level inverter, comparison of multi-level inverter with their two-level number part (two-level inverter), advantages and disadvantages, scope and applications of multi-level inverters for high power induction motor drives, types of multi-level inverters: Neutral Point Clamped (NPC),capacitor clamped (flying capacitor), cascaded multi-cell (cascaded H-bridge), hybrid H-bridge, cascaded inverters, dual-inverter fed open-end winding induction motor structure, asymmetric dc-link structure, voltage and current controlled PWM techniques used for multi-level inverters, comparative analysis of various PWM control techniques used for multi-level inverters, problems of common-mode voltage generation and dc-link capacitor voltage unbalance in multi-level inverters and various mitigation techniques for these problems in multi-level inverters. Direct conversion drives using SGCT and IGCT.

Self Study:
The self study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self study contents.

References:

1. Ned Mohan, Tore M. Undeland and William P. Robbins, Power Electronics: Converters, Applications and Design, John Wiley & Sons.
2. B. K. Bose, Power Electronics & AC Drives, Prentice-Hall.
3. M. H. Rashid, Power Electronics, Prentice Hall of India.
4. Recent Papers of IEEE Trans. on Power Electronics, IEEE Trans. on Industrial Electronics, IEEE Trans. on Industry Applications, IEEE Trans. on Power Systems, IEEE Trans. on Power Delivery etc.

M.Tech. in Electrical Engineering (Power Electronics, Machines & Drives)
SEMESTER – III

3EE1302 **Major Project: Part – I** **[0 0 0 15]**

Course Learning Outcome:

After successful completion of the course, student will be able to

- understand the issues related with the recent trends in the field of engineering and its applications
- formulate the problem definition, analyze and do functional simulation of the same
- design, Implement, test and verify the engineering solution related to problem definition
- compile, Comprehend and Present the work carried out
- manage Project

The Major Project Part-I is aimed at training the students to analyze independently any problem in the field of power electronics and electric drives. The project may be analytical or computational or experimental or combination of them based on the latest developments in area mentioned.

At the end of the semester, the students will be required to submit detailed report. It should consist of objectives of study, scope of work, critical literature review and preliminary work done pertaining to the project undertaken.

M.Tech. in Electrical Engineering (Power Electronics, Machines & Drives)
SEMESTER – IV

3EE1402 **Major Project: Part – II** **[0 0 0 15]**

Course Learning Outcome:

After successful completion of the course, student will be able to

- understand the issues related with the recent trends in the field of engineering and its applications
- formulate the problem definition, analyze and do functional simulation of the same
- design, Implement, test and verify the engineering solution related to problem definition
- compile, Comprehend and Present the work carried out
- manage Project

Major Project Part-II is a continuation of the work done by the student during Semester III. The student is required to submit the project report (thesis) as a partial fulfillment of the M. Tech. degree. The project report should include the work of Major Project Part-I, which is completed before. In addition, the project report should consist of the detailed study of the project undertaken, concluding remarks, future scope of work, if any. The project report is expected to show clarity of thought and expression, critical appreciation of the existing literature and analytical computation and experimental aptitude of the student, as applicable.