403148: Power Electronic Controlled Drives

Teaching Scheme		Credits	Examination Scheme [175 Marks]		
Theory	: 4 Hrs./Week	04	In Sem	:	30 Marks
Practical	: 2 Hrs./Week	01	End Sem	:	70 Marks
			PR	:	50 Marks
			Term work	:	25 Marks

Prerequisite:
1. Construction, working and characteristic of different electrical motors and soft starting methods.
2. Power Electronic Applications such as converter, inverter, chopper etc.
3. Basic concept of control system

Course Objective: The course aims to
- To understand motor load dynamics.
- To analyze the operation of the converter fed and chopper fed dc drives.
- To elaborate braking methods of D.C. and Induction motor drive.
- To explain vector control of induction motor.
- To differentiate synchronous and BLDC motor drive.
- To identify classes and duty of motor.
- To describe the modes of operation of drive in various applications.

Course Outcome: Upon successful completion of this course, the students will be able to

1. Explain motor load dynamics and multi quadrant operation of drives
2. Analyze operation of converter fed and chopper fed DC drives.
3. Describe braking methods of D.C. and induction motor drive.
4. Explain vector control for induction motor drives
5. Describe synchronous motor drive.
6. Identify classes and duty cycles of motor and applications of drives in industries.

Unit 01 : Electrical Drives (08 Hrs)

A. Definition, Advantages of electrical drives, Components of Electric drive system, Types of Electrical Drives (DC and AC).
B. Motor-Load Dynamics, Speed Torque conventions and multi quadrant operation, Equivalent values of drive parameters. Load Torque Components, Nature and classification of Load. Constant Power operation of a Drive. Steady state stability, Numerical based on motor load dynamics.

Unit 02 : DC Motor Drives (08 Hrs)

A. Braking methods: Rheostatic, Plugging, and Regenerative. Closed loop control of drives: current limit control, torque control and speed control.
B. Single phase and three phase fully controlled converter drives and performance of converter fed separately excited DC Motor for speed control operations.
Chopper controlled drives for separately excited and series DC Motor operations.
Numerical based on above. Closed loop speed control of DC motor below and above base speed.

Unit 03 : Induction motor Drives I (08 Hrs)

Braking methods: DC Dynamic Braking, AC Rheostatic braking, Plugging, Regenerative Braking, V/f control and comparison with stator voltage control, voltage source inverter (VSI) control, Steady State Analysis. Current source inverter (CSI) control-open and closed loop, Regenerative braking and multiquadrant operation of Induction motor drives, relative merits and demerits of VSI and CSI for induction motor drives, Numerical on VSI and CSI fed I.M. drives

Unit 04 : Induction Motor Drives II (08 Hrs)

A. Principle of vector control, Block diagram of Vector control of induction motor. Servo mechanism in drives and block diagram for position control (Descriptive treatment only).
B. Thermal model of motor for heating and cooling, classes of motor duty, types of enclosures for motor.

Unit 05 : Synchronous motor Drives (08 Hrs)

Types of motor, cylindrical rotor wound field motor, equivalent circuit, speed torque characteristics and effect of power factor, salient pole wound field motor, phasor diagram, simple numerical based on above, closed loop speed control of self controlled synchronous motor drives fed from VSI and CSI.
BLDC drives, block diagram and speed torque characteristics.

Unit 06 : Industrial application (08 Hrs)

A. Specific requirement and choice of drives for following applications.
1. Machine tools
2. Textile mills
3. Steel rolling mills
3. Sugar mills
4. Traction drives
5. Crane and hoist drives
6. Solar and battery powered drives

Guidelines for Instructor's Manual

- Title and circuit diagram of power electronic controlled drives/ electrical machine circuit.
- Working operation and output characteristics / output waveforms of power electronic switching device /converter circuit used to control the electric motor.
- Procedure to carry out the experiment

Guidelines for Student's Lab Journal

- Title, aim, circuit diagram, procedure and theory of power electronic switching device or converter circuit and expected machine performance with speed torque characteristics.
- Equipments along with the specifications needed to carry out the experiment.
- Circuit diagram, observation table, calculations must be written on left side of the journal and aim, theory related to experiment and procedure must be written on right side.
- Analyse and interpret the experimental results and write the conclusions appropriately.

Guidelines for Laboratory conduction

- Each group in the lab should have not more than three students.
- All the students in the group must do the connections and perform the practical under the guidance of the staff member.
- Staff member has to check the result of all the groups.

List of Experiments: Minimum eight experiments are to be performed out of the list mentioned as below:

GROUP A: Any FIVE Experiment (Hardware)

1. Study of Electrical braking of D.C. Shunt motor (Rheostatic, Plugging).
2. Study speed control characteristics of single phase fully converter fed separately excited D.C. motor
3. Study speed control characteristics of 3-ph fully converter fed separately excited D.C. motor
4. Study of Chopper fed D.C. series/separately motor speed control characteristics.
5. Study of electrical braking of 3 phases Induction Motor (DC Dynamic Braking, Plugging).
6. Study of VSI fed 3 phase Induction motor (using V/f control PWM inverter) speed control characteristics.
7. Study of Solid state stator voltage control of 3 phase Induction motor (Using AC voltage Regulator).
8. Study of constant torque and constant power characteristic of induction motor.

GROUP B: Any THREE Experiment (Software)

1. Simulation of starting characteristics of D.C. motor.
2. Simulation of starting characteristics of 3 phase Induction motor.
3. Study of Closed loop speed control of separately excited D.C. motor/ Induction Motor.
4. Simulation of an electric drive system for steady state and transient analysis.
5. Simulation of closed loop control of synchronous motor
6. Simulation of chopper controlled DC series motor.

Industrial Visit:

Minimum one industrial visit must be organized for drives application in industry such as railways, sugar mill, machine shop, textile mill, paper mill etc.

Text Books:

[T1] G. K. Dubey, "Fundamentals of Electric Drives", 2nd Edition, Narosa Publishing House

[T2] N. K. De, P. K. Sen, "Electric Drives", Prentice Hall of India Eastern Economy Edition

[T3] S. K. Pillai, "Analysis of Thyristor Power Conditioned Motors", University Press

[T4] R. Krishnan, "Electric Motor Drives – Modeling Analysis and Control", PHI India

[T5] G.K. Dubey, "Power Semiconductor controlled drives", PHI publication

Reference Books:

[R1] B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education

[R2] Malcolm Barnes, "Practical Variable Speed Drives and Power Electronics", Elsevier Newnes Publications

[R3] V. Subrahmanyam, "Electric Drives: Concepts and Application", Tata Mc-Graw Hill (An imprint of Elsevier)

[R4] M.D. Singh and Khanchandani "Power Electronics", Tata Mc-Graw Hill

[R5] Austin Huges, "Electrical motor and drives: Fundamental, types and applications", Heinemann Newnes, London

[R6] Tyagi MATLAB for engineers oxford (Indian Edition)

Unit	Text Books	Reference Books
1	T1	R3
2	T1,T5	R2,R4
3	T1,T4	R1,R5
4	T1,T2,T5	R1,R2
5	T1,T3,T5	R1,R6
6	T1,T2	R3,R5