GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code:3172402

Semester – VII

Subject Name: Industrial Drives and Control

Type of course: Professional Core Course

Prerequisite:
1. 311005 – Basic Electrical Engineering
2. 3132407- Electrical Machine and Application
3. 3152407- Power Processing Circuit- I
4. 3162413 -Power Processing Circuit - II

Rationale: Today's industrial and domestic loads demand precise and smooth variable speed control. The development of compact thyristor power converters has made this possible by smooth speed control of both AC and DC motors which are employed for several applications such as DC/AC drives, Vehicles, and renewable energy. This course enables to develop the basics of electric drives and maintain different typesof DC in industries. The competency in this area is highly required in diploma pass outs working in most of the industries since these industries employ large number of motors and drives and their smooth operation and maintenance requires lot of competent manpower. Thus, this course is must for students who want to work in industries.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs.
1.	**Introduction:** • History of DC Drive -Electronic Control -Solid State Control • State of Art of DC Drive • Block Diagram of Drive - Components of Electrical Drive and theirfunctions	3
2.	**Dynamics of Electrical Drives** Types of Load-Quadrantal diagram of speed –torque characteristics – Types and Characteristics of load torque – Dynamics of motor- load combination – steady state & transient stability of an electrical drive – Determination of moment of inertia- Load equalization	06
3	**DC drives** Speed-torque characteristics: DC separately excited, shunt and series motors; Modified speed-torque characteristics with resistive control; Analysis for speed-torque equations in terms of firing angle and duty cycle; Modified speed-torque characteristics with phase-controlled converters and DC-DC converters for continuous conduction and discontinuous conduction; Closed loop speed control schemes; Dynamic model of DC machine; Speed and position control scheme using the dynamic model	10

4.	**Scalar control of AC machines** Review of V/f control; VSI based Induction Motor control; Harmonics and Harmonic torques with VSI; Selection of carrier frequency and harmonic spectrum; Advantages of V/f control over other scalar controltechniques; Various operating modes for doubly fed induction machine: Sub-synchronous and super-synchronous motoring and generating; Static Scherbius drive: Design aspects like speed range, power factor, ratings of components; Closed-loop speed control schemes: slip control, current limit control; CSI fed IM; Speed-torque characteristics with current source: Comparison with VSI based control	10
5.	**Dynamic modeling and Vector control** Dynamic model of induction motor: ABC reference frame, Arbitrary reference frame, stationary reference frame, rotating reference frame; Principle of Vector control, Field oriented control: Stator Flux Controland Rotor Flux Control; Direct torque control; Comparison of FOC and DTC, Introduction to Synchronous motor and BLDC machine drive	10
6.	**Applications of Electric Drives** Introduction to Solar and battery powered Drives; Introduction totraction Drives; Servo motor drive requirement – control and implementation	06

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
10	**40**	**20**	**20**	**10**	**-**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create andabove Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Bimal K. Bose, "Modern Power Electronics and AC Drives", Pearson Education
2. Vedam Subrahmanyam, "Electric Drives", TMH (I), Second Edition,
3. G.K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi,
4. G. K. Dubey, "Power Semiconductor Controlled Drives", Prentice Hall International Edition. 1989.
5. J.M.D. Murphy and F.G. Turnbull, "Power Electronics Control of AC Motors", Peragmo
6. R.Krishnan, "Electric Motor Drives–Modeling, Analysis and Control" PHI
7. Werner Leonhard, "Control of Electrical Drives", 3rd ed., Springer, 2001
8. Theodore Wildi, "Electrical Machines, Drives and Power Systems", sixth edition, Pearson

Course Outcome:

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor, and affective domain to demonstrate following course outcomes.

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After learning the course, the students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Select drive for a particular application based on power rating and environmental consideration	20
CO-2	Identify a drive based on mechanical characteristics for a particular drive application	20
CO-3	Critique the various operating regions and speed control of the DC and AC motor drives.	30
CO-4	Analyze the Closed Loop Control of DC and AC motor drive and its application	15
CO-5	Design the basic control strategies for DC and AC motor, stepper motor and servo motor	15

List of Experiments:

1. To study the fundamental and block diagram of Electric drive.
2. To study different methods of speed control of D.C. Motor.
3. To study and simulate 1- Φ Semi Control of D.C. separately excited Motor.
4. To study and simulate 1- Φ Fully Controlled converter of separately excited Motor.
5. To study the control techniques used in D.C. chopper.
6. To study control of D.C. motor for (a) Current limit control (b) Closed loop torque control(c)Closed loop speed control.
7. To study chopper control of D.C. Motor for motoring and generating control.
8. To study D.C. Motor drive using PLL.
9. To study and simulate AC voltage controller-based speed control of AC motor.
10. To study and simulate Inverter based speed control of Induction/Synchronous motor.
11. To study and simulate Cycloconverter based speed control of synchronous motor.
12. To study and simulate AC voltage controller-based speed control of AC motor.
13. To study solar and battery powered drives.
14. To study traction drives.

Design based Problems (DP)/Open Ended Problem:

1. Specify the appropriate power circuit configuration amongst the phase-controlled rectifiers.
2. Choppers for the speed control of DC motor drives for four-quadrant operation with current limit.
3. AC voltage controllers and Inverter for speed control of AC motor drive.
4. Simulate/Implement speed control scheme for DC/AC motor drives.
5. Select an appropriate power semiconductor device and design a power converter for the required application for DC/AC Drive
6. Determine the power circuit configuration needed to fulfill the required power conversion with applicable constraints in view of DC /AC Drive.

Major Equipment:

1. 4 ½ digit Digital Multimeter
2. Digital Tachometer
3. Four channel Digital Oscilloscope

4. Various Trainer boards for DC and AC Drives.
5. Any one simulation software (Open source software preferred) : Scilab/Matlab and Simulink toolbox, CASPOC

List of Open-Source Software/learning website:

1. http://nptel.ac.in/courses/108104011/
2. https://www.wisc-online.com/learn/career-clusters/stem/iau13208/fundamentals-of-a-dc-motor
3. http://www.ohioelectricmotors.com/a-guide-to-electric-drives-and-dc-motor-control-688
4. https://sites.google.com/a/vgecg.ac.in/powerelectronics/academic/semester_vi/idc-i
5. https://sites.google.com/a/vgecg.ac.in/powerelectronics/academic/semester_vii/idc-ii