



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering

Level: PG

Branch: Power Electronics

Course / Subject Code: ME01000231

Course / Subject Name: Industrial Drives and Control

w. e. f. Academic Year:	2024-25
Semester:	1 <sup>st</sup> Semester
Category of the Course:	PCC

Prerequisite:	DC Motors and Induction Motor at UG level
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 types of 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.

## Course Outcome:

After Completion of the Course, the student will able to:

No	Course Outcomes
01	Select drive for a particular application based on power rating and environmental
02	Identify a drive based on mechanical characteristics for a particular drive application
03	Critique the various operating regions and speed control of the DC and AC motor drives.
04	Analyze the Closed Loop Control of DC and AC motor drive and its application
05	Design the basic control strategies for DC and AC motor, stepper motor and servo motor

## Teaching and Examination Scheme:

Teaching Scheme in Hours)			Total Credits	Assessment Pattern and Marks				Total Marks
L	T	PR	C	Theory		Tutorial / Practical		
				ESE	PA / CA	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150



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## Course Content:

Unit No.	Content	No. of Hours	% of Weightag
1.	<b>Introduction:</b> History of DC Drive -Electronic Control -Solid State Control State of Art of DC Drive Block Diagram of Drive - Components of Electrical Drive and their functions	06	15
2.	<b>Dynamics of Electrical Drives</b> 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	07	15
3.	<b>DC drives</b> 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	07	15
4.	<b>Scalar control of AC machines</b> 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 control techniques; 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	25
5.	<b>Dynamic modeling and Vector control</b> 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 Control and Rotor Flux Control; Direct torque control; Comparison of FOC and DTC, Introduction to Synchronous motor and BLDC machine drive	09	20



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6.	<b>Applications of Electric Drives</b> Introduction to Solar and battery powered Drives; Introduction to traction Drives; Servo motor drive requirement – control and implementation	4	10
<b>Total</b>		<b>45</b>	<b>100</b>

## Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
40	20	20	20	0	0

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

### (a) **Books:**

1. G.K, Dubey, "Power semiconductor-controlled Drives", Prentice Hall international, New Jersey, 1989.
2. R.Krishnam, "Electric motor drives modeling, analysis and control", PHI-India-2009.
3. G. K. Dubey, "Fundamentals of electric Drives, Narosa Publishing House", 2<sup>nd</sup> edition, 2011.
4. W. Leonhard, "Control of Electrical drives", Springer, 3<sup>rd</sup> edition, 2001.
5. P.C. Krause –, "Analysis of Electric Machine", Wiley-IEEE press 3<sup>rd</sup> edition.
6. K. Bose, "Modern Power Electronics and AC Drives", Prentice Hall publication, 1<sup>st</sup> edition, 2001.

### (b) **Open source software and website:**

1. <https://www.nptel.ac.in>
2. <https://www.mathworks.com/>
3. <https://powersimtech.com>
4. <https://www.scilab.org/>
5. <http://nptel.ac.in/courses/108104011/>
6. <https://www.wisc-online.com/learn/career-clusters/stem/iau13208/fundamentals-of-a-dc-motor>
7. <http://www.ohioelectricmotors.com/a-guide-to-electric-drives-and-dc-motor-control-688>
8. [https://sites.google.com/a/vgecg.ac.in/powerelectronics/academic/semester\\_vi/idc-i](https://sites.google.com/a/vgecg.ac.in/powerelectronics/academic/semester_vi/idc-i)
9. [https://sites.google.com/a/vgecg.ac.in/powerelectronics/academic/semester\\_vii/idc-ii](https://sites.google.com/a/vgecg.ac.in/powerelectronics/academic/semester_vii/idc-ii)

### Suggested Course Practical List:

1. To study the fundamental and block diagram of Electric drive.
2. To study the different methods of speed control of D.C. Motor.
3. To study and simulate 1-  $\Phi$  Semi Control of D.C. separately excited Motor.



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4. To study and simulate 1-  $\Phi$  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.

In addition to experiments, a small project work related to the subject should be assigned.

### **List of Laboratory/Learning Resources Required:**

DC motor with loading, Induction motor with loading, Stepper motor DC Drive trainer, Phase controller drive trainer, Stepper motor drive trainer, Power Oscilloscope with necessary probes, Voltmeter, Ammeter, DMM PC with necessary simulation software.

### **Suggested Activities for Students: If any**

In addition, students can be assigned some case study related to theory topics and the work can be presented.

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