GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3160919
Semester – VI
Subject Name: Electric Drives

Type of course: Professional Elective Course

Prerequisite: Electrical Machine and Power Electronics

Rationale: Today's industrial and domestic loads demands precise and smooth variable speed control. In the era of renewable energy and electric vehicle the efficient electric drive required for DC and AC motors. The major industrial electric load is induction motor. The development of compact power converters has made this possible. This course enables to develop the basics of electric drives and advantage over conventional speed control methods.

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	**Module 1. DC motor characteristics:** Review of emf and torque equations of DC machine, review of torque-speed characteristics of separately excited dc motor, change in torque-speed curve with armature voltage, example load torque-speed characteristics, operating point, armature voltage control for varying motor speed, flux weakening for high speed operation.	5
2	**Module 2 Chopper fed DC drive** Review of dc chopper and duty ratio control, chopper fed dc motor for speed control, steady state operation of a chopper fed drive, armature current waveform and ripple, calculation of losses in dc motor and chopper, efficiency of dc drive, smooth starting.	5
3	**Module 3: Multi-quadrant DC drive** Review of motoring and generating modes operation of a separately excited dc machine, four quadrant operation of dc machine; single-quadrant, two-quadrant and four-quadrant choppers; steady-state operation of multi-quadrant chopper fed dc drive, regenerative braking.	6
4	**Module 4 Closed-loop control of DC Drive** Control structure of DC drive, inner current loop and outer speed loop, dynamic model of dc motor dynamic equations and transfer functions, modeling of chopper as gain with switching delay, plant transfer function, for controller design, current controller	6

	specification and design, speed controller specification and design.	
5	**Module 5 Induction motor characteristics** Review of induction motor equivalent circuit and torque-speed characteristic, variation of torque speed curve with (i) applied voltage, (ii) applied frequency and (iii) applied voltage and frequency, typical torque-speed curves of fan and pump loads, operating point, constant flux operation, flux weakening operation.	**6**
6	**Module 6 Scalar control or constant V/f control of induction motor** Review of three-phase voltage source inverter, generation of three-phase PWM signals, sinusoidal modulation, space vector theory, conventional space vector modulation; constant V/f control of induction motor, steady-state performance analysis based on equivalent circuit, speed drop with loading, slip regulation.	**6**
7	**Module 7 Control of slip ring induction motor** Impact of rotor resistance of the induction motor torque-speed curve, operation of slip-ring induction motor with external rotor resistance, starting torque, power electronic based rotor side control of slip ring motor, slip power recovery.	**6**

Suggested Specification table with Marks (Theory): (For BE only)

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	**30**	**20**	**25**	**10**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above 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. G. K. Dubey, "Power Semiconductor Controlled Drives", Prentice Hall, 1989.
2. R. Krishnan, "Electric Motor Drives: Modeling, Analysis and Control", Prentice Hall, 2001.
3. G. K. Dubey, "Fundamentals of Electrical Drives", CRC Press, 2002.
4. W. Leonhard, "Control of Electric Drives", Springer Science & Business Media, 2001.
5. Bimal K. Bose, "Modern Power Electronics and AC Drives", Pearson Education
6. Vedam Subrahmanyam, "Electric Drives", TMH (I), Second Edition,
7. J.M.D. Murphy and F.G. Turnbull, "Power Electronics Control of AC Motors", Peragmo
8. Theodore Wildi, "Electrical Machines, Drives and Power Systems", sixth edition, Pearson

Course Outcomes:

At the end of this course, students will have the ability to

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the characteristics of dc motors and induction motors.	**30**
CO-2	Understand the principles of speed-control of dc motors and induction motors.	**30**
CO-3	Understand the power electronic converters used for dc motor and induction motor speed control.	**30**
CO-4	Compare conventional control and drives control for dc/ac motor.	**10**

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 v/f speed control of Induction motor.

11. To study and simulate Cycloconverter based speed control of synchronous motor.
12. To study Induction Motor drive with slip power recovery scheme

Major Equipment: Not Applicable

List of Open Source Software/learning website:

https://nptel.ac.in