

GUJARAT TECHNOLOGICAL UNIVERSITY

POWER ELECTRONICS & ELECTRICAL DRIVES (45)

SOLID STATE DC DRIVES

SUBJECT CODE: 2714502

M.E. 1st SEMESTER

Type of course: Engineering Science (ELECTRICAL)

Prerequisite: N.A.

Rationale: N.A.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks		Practical Marks				
			ESE (E)	PA (M)	PA (V)		PA (I)			
					ESE	OEP	PA	RP		
4	2#	2	6	70	30	20	10	10	10	150

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1	FUNDAMENTALS OF DC MOTOR DRIVE DC motor- Types, induced emf, speed-torque relations; Control; armature and field speed control, Ward Leonard control, Constant torque and constant horse power operations. Characteristics of mechanical system – dynamic equations, components of torque, types of load; Requirements of drives characteristics – multi-quadrant operation; Drive elements, types of motor Duty and selection of motor rating.	6	15
2	CONVERTER CONTROLLED DC DRIVE Principle of phase control – Fundamental relations; Analysis of series and separately excited DC motor with single-phase and three-phase converters – waveforms, performance parameters, Performance characteristics. Continuous and discontinuous armature current operations; Current ripple and its effect on Performance; Operation with freewheeling diode; Implementation of braking schemes; Drive employing dual converter.	10	30
3	CHOPPER CONTROLLED DC DRIVE Introduction to time ratio control and frequency modulation; Class A, B, C, D and E chopper controlled DC motors – performance analysis, multi-quadrant control - Chopper based implementation of Braking schemes; Multi-phase chopper; Related problems.	10	30
4	CLOSED LOOP CONTROL OF DC DRIVE Modeling of drive elements – Equivalent circuit, transfer function of self, separately excited DC motors; Linear Transfer function model of power converters; Sensing and feedback elements Closed loop speed control – current and speed loops, P, PI and PID controllers –response comparison. Simulation of converter and chopper fed DC drive.	7	15
5	DIGITAL CONTROL OF D.C DRIVE Phase Locked Loop and micro-computer control of DC drives –	7	10

	Program flow chart for constant Horse power and load disturbed operations; Speed detection and gate firing.		
--	---	--	--

Reference Books:

1. Gopal K Dubey, "Power Semiconductor controlled Drives", Prentice Hall Inc., New Yersey, 1989.
2. R.Krishnan, "Electric Motor Drives – Modeling, Analysis and Control", Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.
3. Gobal K.Dubey, "Fundamentals of Electrical Drives", Narosal Publishing House, NewDelhi,2001.
4. Bimal K.Bose "Modern Power Electronics and AC Drives", Pearson Education (Singapore) Pte. Ltd., New Delhi, 2003
5. Vedam Subramanyam, "Electric Drives – Concepts and Applications", Tata McGraw-Hill publishing company Ltd., New Delhi, 2002.
6. P.C Sen. "Thyristor DC Drives", John wiely and sons, New York, 1981.
7. B. K. Bose – Power Electronics& AC Drives Prentice-Hall, New Jersey.
8. P. Vas – Vector control of ac machines, Clarandon Press, Oxford.
9. G. K. Dubey – Power semiconductor controlled drives, Prentice-Hall, Eaglewood cliffs.
10. T.J.E. Miller – Brushless PM and Reluctance Motor Drives, clarendon Press Oxford.
11. Recent IEEE publication & transactions on power electronics, industry applications and power delivery.

Course Outcomes:

After learning the course the students should be able to:

1. Understand significance of speed-torque characteristics of motor as well as that of load.
2. Analyze specific torque demand of different types of load at different speed
3. Select power electronics converter/device (phase controlled rectifier based DC drive / Chopper feed DC drive) for DC motor to be best suited for the particular application.
4. Develop mathematical model of DC motor along with that of converter and controller.
5. Develop transfer function of complete DC motor drive
6. Design open-loop and closed-loop controller (to select K_p , K_i and K_d) to meet the specific dynamic response.
7. Analyze the performance of different types of converter of DC drive
8. Select the electric motor as well as control technique to meet the requirement of specific application.
9. Develop digital speed controller for the DC motor drive using microcontrollers.

List of Experiments:

- 1 To perform and analyze different speed control techniques of DC motor
- 2 To perform and analyze phase controlled rectifier based control of DC motor
- 3 To perform and analyze voltage commutated chopper fed DC motor drive
- 4 To perform and analyze current commutated chopper fed DC motor drive
- 5 To perform and analyze closed loop control of DC motor drive
- 6 To perform and analyze four quadrant operation of DC motor drive
- 7 To perform and analyze operation of dual converter DC motor drive
- 8 To perform and analyze microcontroller based DC motor drive
- 9 To simulate and analyze performance of phased controlled rectifier based DC drive
- 10 To simulate and analyze performance of chopper fed DC motor drive
- 11 To simulate dual converter DC drive Sin PWM &

Open Ended Problems:

Major Equipments:

The necessary motors, power electronics drives, measuring equipments, accessories and instruments to be provided to conduct the above practical in a group of 4 students.