GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: Power Electronics and Electrical Drives (45)
SUBJECT NAME: Solid State DC Drives
SUBJECT CODE: 3714508
M.E. 1st SEMESTER

Type of course: Engineering Science (ELECTRICAL)

Prerequisite: N.A.

Rationale:.N.A.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Fundamentals of DC Motor Drive** Control method of DC motor-armature and field speed control, Constant torque and constant horse power operations. 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** Modelling 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 DC Drive**	7	10%

	Phase Locked Loop and micro-computer control of DC drives – 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 Jersy,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) Pvt. 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. G. K. Dubey – Power semiconductor-controlled drives, Prentice-Hall, Eaglewood cliffs.

Course Outcome:

After learning the course, the students should be able to:

1. Understand significance of speed-torque characteristics of motor-load combination. (Undetstand)
2. Select power electronics converter/device (phase-controlled rectifier-based DC drive / Chopper feed DC drive) for DC motor for the particular application. (Apply)
3. Develop mathematical model of DC motor drive. (Apply)
4. Design open-loop and closed-loop controller (to select K_p, K_i and K_d) to meet the specific dynamic response (Evaluate)
5. Analyze the performance of different types of converter fed DC drive. (Analyze)
6. Develop digital speed controller for the DC motor drive using microcontrollers. (Create)

List of Experiments:

1. Analyze different speed control techniques of DC motor
2. Analyze phase-controlled rectifier-based control of DC motor.
3. Analyze the operation of chopper fed DC motor drive
4. Perform closed loop control of DC motor drive with linear controller.
5. Analyze the four-quadrant operation of DC motor drive.
6. Analyze the performance of dual converter for DC motor drive.
7. Develop phase locked loop suitable for DC motor drive.

Major Equipment:

1. Phase Controlled Converter fed DC drive trainer kit
2. Chopper fed DC drive trainer kit
3. Digital Storage Oscilloscope
4. Current Clamp
5. Differential Voltage Probe

List of Open Source Software/learning website:

1. http://www.industrial-electronics.com/ind-mtr-cntrl_034.html
2. https://www.youtube.com/watch?v=9h2lEIpo74A
3. https://www.electricaltechnology.org/2015/11/what-are-dc-drives-types-of-electrical-dc-drives.html
4. https://www.electrical4u.com/dc-motor-drives/