

GUJARAT TECHNOLOGICAL UNIVERSITY

POWER ELECTRONICS (24) INDUSTRIAL DRIVES & CONTROL-I SUBJECT CODE: 2162404 B.E. 6th SEMESTER

Type of course: BE

Prerequisite: DC machine and Transformer and Power Electronics Circuit – I

Rationale:

Today's industrial and domestic loads demands 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 man power. Thus this course is must for students who want to work in industries.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks					Total Marks	
L	T	P		Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)			PA (I)
				PA	ALA	ESE	OEP			
4	0	2	6	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1.	Introduction: <ul style="list-style-type: none"> • History Of Dc Drive -Electronic Control -Solid State Control • State Of Art Of Dc Drive • Block Diagram Of Drive - Part Of Electrical Drive 	03	05-10
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.	04	10-15
3.	Dc Motors Fundamentals and Mechanical Systems: <ul style="list-style-type: none"> • DC motor- Types, induced emf, speed-torque relations; Speed 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 • Transfer function of field controlled dc motor – Transfer function of armature controlled dc motor. 	06	15-25
4.	Converter Control: <ul style="list-style-type: none"> • Principle of phase control – Fundamental relations 	06	15-25

	<ul style="list-style-type: none"> • 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 • Four Quadrant operation of DC Drive-Drive employing dual converter- Advantage and Disadvantage of Dual Converter with & without Circulating Current 		
5.	Chopper Control : <ul style="list-style-type: none"> • Chopper controlled DC motor – performance analysis, multi-quadrant control • Chopper based implementation of braking schemes • Multi-phase chopper-Reversible Drive- Selection of Drive for speed reversal • Traction Drive using semiconductor converter controlled DC motors 	06	15-25
6.	Closed Loop Control: <ul style="list-style-type: none"> • Modelling of drive elements – Equivalent circuit, transfer function of self, separately excited DC motors, Linear Transfer function model of power converters, Sensing and feeds back elements • Closed loop speed control – inner current controlled loops, Current limit and speed loops, P, PI and PID controllers – response comparison, Closed loop armature control using field weakening • Four quadrant closed loop speed control with armature reversal- Simulation of converter and chopper fed DC Drive using MATLAB 	04	10-15
7.	Digital Control of DC Drive: <ul style="list-style-type: none"> • 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 	03	5-10
8.	Special Machine Drive & Servo Drive: <ul style="list-style-type: none"> • Introduction – permanent magnet motor drive – Control and Implementation • Servo motor drive requirement – control and implementation – stepper motor drive 	04	5-10

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
10	30	20	20	10	10

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. Power Semiconductor controlled Drives,-Gopal K Dubey
2. Electric Motor Drives–Modeling, Analysis and Control,-R.Krishnan
3. Fundamentals of Electrical Drives,-GopalK.Dubey
4. Thyristorised DC Drives,-P.CSen
5. Power Semiconductor Drives,-S.Sivnagaraju

6. Control of Electrical Drives, 3rd edition, Springer 2001- Werner Leonhard
7. Power Semiconductor controlled Drives, John Wiley Pub. - S.B.Dewan, G.R.Slemon & A.Stranghan
8. Power Electronics & Motor Control: Cambridge Univ. Press - Shepherd Hullay & Liag,

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.

After learning the course the students should be able to:

1. Select a drive for a particular application based on power rating.
2. Select a drive based on mechanical characteristics for a particular drive application.
3. Operate and maintain solid state drives for speed control of DC machines.
4. Operate and maintain solid state drives for speed control of various special electrical machines

Laboratory Work:

Directions for Laboratory work:

- The list of experiments is given as a sample.
- Minimum 10 experiments should be carried out.
- At least one experiment should be selected from each group.
- Similar laboratory work fulfilling the objectives can also be considered.
- Each experiment should be simulated before verifying practically.
- As far as possible, **printed manual should be preferred** so that students can concentrate in laboratory experiments and related study.

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 solar and battery powered drives.
10. 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. Implement speed control schemes for Brushless D.C. motors
4. Select an appropriate power semiconductor device and design a power converter for the required application for DC Drive
5. Determine the power circuit configuration needed to fulfill the required power conversion with applicable constraints in view of DC Drive.
6. Design controllers for closed-loop operation of a separately excited DC motor drive

Major Equipment:

1. 4 ½ digit Digital Multimeter
2. Digital Tachometer
3. Four channel Digital Oscilloscope
4. Various Trainer boards for DC 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://www.electrical4u.com/electrical-drives/>
2. <http://nptel.ac.in/courses/108104011/>
3. <http://electrical4u.com/types-of-dc-motor-separately-excited-shunt-series-compound-dc-motor/>
4. <https://www.wisc-online.com/learn/career-clusters/stem/iau13208/fundamentals-of-a-dc-motor>
5. <http://www.ni.com/white-paper/3656/en/>
6. <http://www.minarik.com/drupal/content/products/Electrical%3E%3EControl%3E%3EDrives%3E%3EDC%20Drives/0>
7. <http://electrical-engineering-portal.com/download-center/books-and-guides/siemens-basics-of-energy/basics-of-dc-drives>
8. <https://www.joliettech.com/products/dc-variable-speed-drives/dc-drive-fundamentals/>
9. <http://www.eetimes.com/>
10. <http://www.ohioelectricmotors.com/a-guide-to-electric-drives-and-dc-motor-control-688>
11. <http://www.slideshare.net/psksiva13/63814075-electricaldrivesandcontrollecturenotes>
12. <http://metalab.uniten.edu.my>

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.