GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3172422

Semester – VII
Subject Name: Advanced Industrial Drives

Type of course: Professional Elective Course

Prerequisite:
1. 311005 – Basic Electrical Engineering
2. 3132407- Electrical Machine and Application
3. 3152407- Power Processing Circuit- I
4. 3162413 -Power Processing Circuit - II

Rationale: Conventional rotating electrical machine like direct current machine, induction machine and synchronous machines are mainly used for bulk energy conversion. There are other types of electrical machine such as stepper motor, switched reluctance motor, permanent magnet DC and AC motors,brushless DC motor, linear electric machine, permanent magnet axial flux machine. With rapid developments in semiconductor technology and digital control systems, during past few decades, the implementation of fast and accurate control schemes could be realized. At present large number ofinstitutions and industries are actively involved in research for further improvement in construction and performance of special electrical machine. This subject enables the students to develop the understanding of Brushless DC Machines & Stepper Motors. Understand the concept of Switched Reluctance Motor & Linear Induction Machines and permanent magnet DC & AC or PMSM motor.

Teaching and Examination Scheme:

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

Content:

Sr. No.	Content	Total Hrs
1.	Introduction: Electric Drives – Advantage –Parts of Drives- Choice of Drives – State of Art for Special Electrical Machine – Limitation – Application – Electric Drive System – Component used for obtaining signals interlocking and sequencing operation – Protection	5
2.	Special Electrical Machines: Brushless DC Machines Construction and working principle, Equivalent magnetic circuit, Type of converter and speed control, Comparison between the axial and radial permanent magnet motors, Applications. PMSM Introduction, Features of PMSM, industrial aspects, Construction and working of PMSM Linear Induction Machines Construction, Operation, Performance, control, and applications SRM, PMAF Machine	8

3.	Control of Special Electrical Machines: Stepper Motor: Characteristics – Open Loop and Closed Loop Control – Control Strategies - Power Converter Circuit – Microprocessor, DSP and Microcontroller based Control Switched Reluctance Motor: Characteristics – Open Loop and Closed Loop Control – Control Strategies - Power Converter Circuit – Microprocessor, DSP and Microcontroller based Control – Sensor less control Servo Motor: Characteristics – Open Loop and Closed Loop Control – Control Strategies - Power Converter Circuit – Microprocessor, DSP and Microcontroller based Control	8
4.	Control of Special Electrical Machines: PMDC and BLDC Motor: Characteristics – Open Loop and Closed Loop Control – Control Strategies - Power Converter Circuit – Microprocessor, DSP and Microcontroller based Control PMSM Motor: Characteristics – Open Loop and Closed Loop Control – Control Strategies - Power Converter Circuit – Microprocessor, DSP and Microcontroller based Control PMAF Machine: Characteristics – Open Loop and Closed Loop Control – Control Strategies -Power Converter Circuit – Microprocessor, DSP and Microcontroller based Control	8
5.	Linear Induction Machine: Construction – Types – Working –Feature – Thrust Equation – Control – Application Linear Synchronous Machine: Construction – Types – Working –Feature – Thrust Equation – Control – Application DC Linear Motor: Construction – Types – Working –Feature – Thrust Equation – Control – Application Linear Reluctance Motor: Construction – Types – Working –Feature – Thrust Equation – Control – Application	8
6.	Energy Conservation in Electrical Drives: Standard motor efficiency, concept of Energy efficient motor, Efficiency evaluation technique, Direct Measurement method, Loss in Electric Drive System, Segregation method, Comparison, motor efficiency labeling, Energy efficient motor standards, Motor life cycle, Direct Savings and pay back analysis, Efficiency evaluation factor, Improvement of Power Factor, Quality of Supply, Harmonics Reduction and mitigation technique.	8

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	**35**	**20**	**20**	**10**	**05**

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. Special Electrical Machine E. G. Janardanan
2. Fundamental of Electrical Drives G. K. Dubey
3. Brushless Permanent-Magnet Motor Design", D. C. Hanselman
4. Analysis of electric machinery and drive systems, - Paul C.Krause, Oleg Wasynnczuk, and S.D. Sudhoff
5. "Principles of Power Electronics", P. C. Sen.
6. Wind Electrical Systems by Bhakra, Kastha & Benerajee
7. "Condition Monitoring of Rotating Electrical Machines", Peter Tavner, Li Ran, Jim Penman and HowardSedding,
8. Wind Energy Systems Electronic Edition by Gary L. Johnson Manhattan, KS.
9. Condition monitoring of rotating electrical machines by Peter Tavner, Li Ran, Jim Penman and HowardSedding,
10. Condition Monitoring of Power Transformers using DGA and Fuzzy Logic, By: Bálint Németh, SzilviaLaboncz, István Kiss, 2009 IEEE Electrical Insulation Conference, Montreal, QC, Canada, 31 May - 3 June 2009.

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 will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	Select drive for a particular application based on Power Rating and Environmental consideration.	20
CO-2	Identify a drive based on mechanical characteristics and Energy Conservation requirement for a particular drive application.	20
CO-3	Interpret the various operating regions of the Advanced Electrical Motor	30
CO-4	Compare the speed control of advanced electrical motor, Field Oriented and Direct torque control of ac machine.	15
CO-5	Design the basic control strategies for advanced electrical machine drive.	15

List of Experiments:

The list is for guideline only. As far as possible, the term work given should be in digitized form.

1. To study and perform microprocessor-based Control of Stepper Motor.
2. To study and perform microprocessor-based Control of Switched Reluctance Motor.
3. To study and perform Sensor Less Control of Switched Reluctance Motor.
4. To study and perform microprocessor-based Control of PMBLDC.
5. To study and perform DSP based Control of PMBLDC.
6. To study and perform sensor less Control of PMBLDC.
7. To study and perform Vector Control of PMSM.
8. To study and perform Sensor less and Self Control of PMSM.

9. To study and perform microprocessor and DSP based Control of PMSM.
10. To study constant direct axis current control of scheme for Synchronous Reluctance Motor.
11. To study and perform AC and DC Servo Motor Control Using microprocessor.
12. To study and perform DSP based Control scheme for trapezoidal or sinusoidal PMAF Motor.

Design based Problems (DP)/Open Ended Problem:

1. Develop and analyze a dynamic model of a separately excited dc motor model, its control structure anddesign current, speed and position controllers for both constant torque and constant power operation.
2. Identify and analyze different chopper topologies for to drive a separately excited dc motor in different quadrants.
3. Develop and analyze an induction motor model suitable for a scalar controller and the different speedcontrol schemes.
4. Develop and analyze dynamic model of an induction motor using space phasor and reference frametheory approach suitable for vector control of induction motor for improved transient performance.
5. Develop and analyze rotor and stator (DTC) control schemes.
6. Analyze field oriented permanent magnet synchronous motor drives.

Major Equipment:

1. 4 ½ digit hand held Digital Multimeter
2. Hand held Digital Tachometer
3. Four channel Digital Oscilloscope
4. Various Trainer boards for AC Drives.
5. V/f control of three-phase induction motor. IGBT inverter power module, 3 phase induction motor0.5HP, V/f controller display meters
6. Micro controller based speed control of Stepper motor. Stepper motor, PIC Micrcontroller, controllercircuit, Interface circuit.
7. Speed control of BLDC motor. Power module, BLDC motor(0.5HP) Controller circuit, sensor circuit,display meter.
8. DSP based speed control of SRM motor. SRM motor-0.5 HP, PIC DSP/TMS DSP Processor, speedsensor, Power module, Display meter,
9. Any one simulation software (Open source software preferred): Scilab /Matlab and Simulink toolbox,CASPOC
10. Voltage Regulation of three-phase Synchronous Generator. Synchronous generator – 0.5HP, Power module(MOSFET/IGBT), Controller circuit,

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/document.asp?doc_id=1274114&page_number=3
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/~anisa/eeeb443.htm
13. http://www.ijareeie.com/upload/november/18_THREE%20PHASE%20INDUCTION.pdf
14. http://futuronix.in/download/Basics%20of%20AC%20drives.pdf
15. http://www.egr.msu.edu/~fzpeng/ECE320/ECE320-Notes-Part1.pdf
16. http://www.vssut.ac.in/lecture_notes/lecture1424084684.pdf
17. http://ir.nmu.org.ua/bitstream/handle/123456789/132706/6d3772cee6f3501e45cdee4aefb4b028.pdf?sequence=1
18. http://www.svecw.edu.in/Docs%5CEEEPELNotes2013.pdf
19. http://cdn.intechopen.com/pdfs-wm/35260.pdf
20. http://www.motor-design.com/cmsAdmin/uploads/induction_motor_modelling.pdf
21. http://cache.freescale.com/files/product/doc/AN1930.pdf
22. http://www.drivetechinc.com/articles/IM98VC1.pdf
23. http://ethesis.nitrkl.ac.in/5162/1/211EE2136.pdf
24. http://dspace.thapar.edu:8080/dspace/bitstream/10266/1489/1/Kulraj+Kaur+(800941016).pdf
25. www.sciencedirect.com
26. www.delnet.nic.in

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 website 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.