GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Engineering
Level: PG
Branch: Power Electronics
Course / Subject Code: ME01000241

Course / Subject Name: Special Machine and Application

w. e. f. Academic Year:	2024-25
Semester:	1st Semester
Category of the Course:	PEC

Prerequisite:	DC Motors and Induction Motor at UG level
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 machines 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 of institutions 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.

Course Outcome:

After Completion of the Course, the student will able to:

No	Course Outcomes
01	Explain the construction and working of the Special Electrical Machine.
02	Illustrate the characteristics of Special Electrical Machine.
03	Identify the suitable application of Special Electrical Machine.
04	Analyse the different Speed control methods for Special Electrical Machine.
05	Create block diagram Electric Drive for speed control of the Special Electrical Machine.

Teaching and Examination Scheme:

Teaching Scheme in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightag
1.	**Stepper and Reluctance Motor:** 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	07	15
2.	**Behavioral Phenomena of Induction Motor:** Torque / speed Curve, Current / Speed Curve, Torque / Speed Characteristic Under Load, Induction Motor operation as a Generator, Complete Torque / speed curve for a 3-phase machine, Measurement of slip, Power Stages, Torque equation, Synchronous Watt, Variations in Rotor Current, Analogy with a Mechanical Clutch, Analogy with a DC Motor, Sector Induction Motor, Linear Induction Motor, Properties of Linear IM, Magnetic Levitation.	07	15
3.	**Electrical Machine with Specific Applications:** Types Construction working Principle and Applications of Stepper Motors, Variable Reluctance Stepper Motors, Multi-stack VR Stepper Motor, Permanent-Magnet Stepping Motor, Hybrid Stepper Motor, Permanent-Magnet DC Motor, Low-inertia DC Motors, Permanent-Magnet Synchronous Motors, Switched Reluctance Motor, Servo Motors, Synchro and Resolver.	10	25

4.	**Permanent Magnet Motors:** 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	11	25
5.	**Linear Electric Machines:** 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	10	20
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (%)					
R Level	U Level	A Level	N Level	E Level	C Level
40	20	20	20	0	0

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) 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 Howard

Sedding,
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 Howard Sedding,
10. Condition Monitoring of Power Transformers using DGA and Fuzzy Logic, By: Bálint Németh, Szilvia Laboncz, István Kiss, 2009 IEEE Electrical Insulation Conference, Montreal, QC, Canada, 31 May - 3 June 2009.

(b) Open source software and 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/

Suggested Course Practical List:

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.

In addition to experiments, a small project work related to the subject should be assigned.

List of Laboratory/Learning Resources Required:

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 Microcontroller, controller circuit, 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, speed sensor, 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,

Suggested Activities for Students: If any

In addition, students can be assigned some case study related to theory topics and the work can be presented.

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