

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

**COURSE CURRICULUM
COURSE TITLE: SPECIAL ELECTRICAL MACHINES
(COURSE CODE: 3350906)**

Diploma Programme in which this course is offered	Semester in which offered
Electrical Engineering	5th Semester

1. RATIONALE

Due to research and development the specialized electrical machines have been developed for specialized applications. They play an important role in industries such as production, processing, fabrications and renewable energy applications, etc. Some special electrical machines have higher efficiency, small size and useful for specific applications. This course refers to such machines which have not been considered in the earlier semesters. The most significant development in recent years in the allied area of motor control also plays an important role. Essential efforts are made in this course to familiarize the students with advanced technology in such machines which is a necessary to maintain them.

2. LIST OF COMPETENCY

The course content should be taught and implemented with the aim to develop required skills so that students are able to acquire following competency:

- **Maintain different types of special electric machines.**

3. COURSE OUTCOMES

The theory should be taught and practical should be undertaken in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domains to demonstrate the following course outcomes:

- Use different types of transformers efficiently for various applications.
- Maintain different types induction machines for different applications
- Maintain different types synchronous machines for different applications
- Maintain different types of fractional horsepower motors
- Maintain various types of Small specialised electric machines.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
3	0	2	5	70	30	20	30	150

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment.

5. COURSE DETAILS

Unit	Major Learning Outcomes (outcomes in cognitive domain)	Topics and Sub-topics
Unit – I Special Transformer Types	1a. Explain with sketches the various connection diagrams a power and distribution transformer 1b. Describe the features of a welding transformer 1c. Differentiate between a audio transformer, isolation transformers and microphone transformers	1.1 Different types of connections of power and distribution transformers 1.2 Welding transformers 1.3 Isolation transformer 1.4 Pulse transformer 1.5 Audio transformers and microphone transformers
	1d. Distinguish between current and potential transformers 1e. Distinguish between constant current and constant voltage transformers 1f. Describe the test & maintenance procedure of all the above mentioned special transformers	1.6 Instrument transformers : current transformers and potential transformers 1.7 Constant Voltage Transformer (CVT) and Constant Current Transformer (CCT) 1.8 Maintenance procedure
Unit– II Special Induction Machines	2a. Explain the working principle of dual winding squirrel cage induction generator with sketches 2b. Describe the phenomenon of cogging and crawling in induction machines. 3a. Explain working principle of soft starters with sketches 2c. Justify the need for reactive power compensation for squirrel cage induction generators.	2.1 Dual winding Squirrel cage induction generator 2.2 Soft starters 2.3 Reactive power compensation
	2d. Explain the working principle of wound rotor induction generator with sketches 2e. Explain the working principle of doubly fed induction generator with sketches 2f. Explain the working principle of brushless doubly fed induction generator 2g. Describe the maintenance procedure of all the above mentioned special induction machines	2.4 Wound rotor induction generator (WRIG) 2.5 Doubly fed induction generator (DFIG) 2.6 Brushless doubly fed induction generator (BDFIG) 2.7 Maintenance procedure
Unit– III Special Synchronous Machines	3a. Explain the working of wound rotor synchronous generator used in renewable energy applications with sketches. 3b. Explain the working of wound rotor synchronous generator used in direct-drive wind turbines with sketches.	3.1 Wound rotor synchronous generators for renewable energy applications 3.2 Wound rotor synchronous generators in large and small direct-drive wind turbines.

Unit	Major Learning Outcomes (outcomes in cognitive domain)	Topics and Sub-topics
	3c. Explain the working of permanent magnet synchronous generators used in direct drive large wind turbines with sketches 3d. Explain the working of permanent magnet synchronous generators used in direct drive small wind turbines with sketches 3e. Describe the test & maintenance procedure of all the above mentioned special synchronous machines	3.3 Permanent magnet synchronous generators in large and small direct-drive wind turbines 3.4 Maintenance procedure
Unit-IV Fractional Horse Power Motors	4a. Describe the concept of FHP motor and their applications 4b. Explain the working of hysteresis motor with sketches and application 4c. Explain the working of permanent magnet motors and their applications 4d. Differentiate the working principles of Reluctance motor and Switched reluctance motor with sketches and application. 4e. Describe the test & maintenance procedure of all the above mentioned fractional horse power motors	4.1 Fractional horse power (FHP) motor 4.2 Hysteresis motor 4.3 Permanent magnet motor 4.4 Reluctance motor 4.5 Switched reluctance motor 4.6 Maintenance procedure
Unit-V Other Special Motors	5a. Explain the working principle of different types of stepper motors 5b. Explain working principle of Brushless DC Motor and their applications 5c. Explain working principle of a Servomotor with sketches and application 5d. Explain working principle of synchros with sketches and application 5e. Explain working principle of resolvers with sketches and application. 5f. Describe the test & maintenance procedure of all the above mentioned special motors	5.1 Stepper motor and its types. 5.2 Brushless DC motors 5.3 Servomotors 5.4 Synchros 5.5 Resolvers 5.6 Maintenance procedure

6. SUGGESTED SPECIFICATION TABLE WITH HOURS and MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Special Transformer Types	08	00	06	04	10
II	Special Induction Machines	06	00	08	02	10
III	Special Synchronous Machines	06	00	08	08	16
IV	FHP motors	08	04	04	08	16
V	Other Special Motors	14	04	06	08	18
Total		42	08	38	24	70

Legends: R = Remembrance; U = Understanding; A = Application 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.

7. SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills (*outcomes in psychomotor and affective domain*) so that students are able to acquire the competencies/course outcomes. Following is the list of practical exercises for guidance.

Note: outcomes in psychomotor domain are listed here as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of Course Outcomes related to affective domain. Thus over all development of Programme Outcomes (as given in a common list at the beginning of curriculum document for this programme) would be assured.

Faculty members should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes

S. No.	Unit No.	Practical Exercises (Major Outcomes in Psychomotor Domain)	Approx Hours Required
1	II	Identify the various parts of a squirrel cage induction generator (SCIG)	02
2	II	Dismantle a small SCIG.	02
3	II	Test & Assemble a small SCIG.	02
4	II	Operate the squirrel cage induction motor as a SCIG to test the performance.	02
5	II	Identify the various parts of a wound rotor induction generator (WRIG).	02
6	II	Dismantle a small WRIG.	02
7	II	Test & Assemble a small WRIG.	02
8	II	Operate the wound rotor induction motor as a WRIG to test the performance.	02

S. No.	Unit No.	Practical Exercises (Major Outcomes in Psychomotor Domain)	Approx Hours Required
9	II	Identify the various parts of a doubly-fed induction generator (DFIG).	02
10	II	Dismantle a small DFIG.	02
11	II	Test & Assemble a small DFIG.	02
12	II	Operate the DFIG to test the performance.	02
13	III	Identify the various parts of a wound rotor synchronous generator (WRSG)	02
14	III	Dismantle a WRSG.	02
15	III	Test & Assemble a WRSG.	02
16	III	Operate the WRSG to test the performance.	02
17	III	Identify the various parts of a permanent magnet synchronous generator (PMSG)	02
18	III	Dismantle a PMSG.	02
19	III	Test & Assemble a PMSG.	02
20	III	Operate the PMSG to test the performance.	02
21	IV	Dismantle/assemble/test a Hysteresis motor	02
22	IV	Dismantle/assemble/test a Permanent magnet motor	02
23	IV	Dismantle/assemble/test a Reluctance motor	02
24	IV	Dismantle/assemble/test a Switched reluctance motor	02
25	V	Dismantle/assemble/test a Stepper motor and its types.	02
26	V	Dismantle/assemble/test a Brushless DC motors	02
27	V	Dismantle/assemble/test a Synchros	02
28	V	Dismantle/assemble/test a Resolvers	02
29	V	Dismantle/assemble/test a Servomotors	02
TOTAL (perform any practical worth 28 hours from above depending upon the availability of resources so that most units are covered)			58

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities like:

- i. Prepare journals based on practical performed in laboratory.
- ii. Prepare/Download a dynamic animation to illustrate the following:
 - Working of double cage induction generator
 - Working wound rotor induction generator
 - Working doubly fed induction generator
 - Working synchronous generators used in direct drive wind turbines

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

Visit transformer and induction motor manufacturer/testing facilities

10. SUGGESTED LEARNING RESOURCES

A) List of Books

S. No.	Title of Book	Author	Publication
1.	Electrical Technology Vol. II	Theraja ,B. L.	S Chand and Co., New Delhi
2.	Wind Power Technology	Earnest , Joshua	PHI Learning, New Delhi, 2014
3.	Fundamentals of Electrical Engg.	Mehta, V.K.	S Chand and Co., New Delhi
4.	Electrical Machines	Ghosh, Smarajit	Pearson Learning, New Delhi
5.	Electrical Machinery	Fitzgerald,,A.E. Charles Kingsley, Jr., Stephen D. Umans	Mc. Graw Hill, New Delhi
6.	Theory and performance of Electrical Machines	Gupta, J.B.	S.K. Kataria and sons, New Delhi
7.	Electrical Machines	Hussain, Ashfaq	Dhanpat Rai and Company, New Delhi

B) List of Major Equipment/ Instrument with Broad Specifications

- i. Squirrel Cage Induction Generator: Air cooled, three phase, 3/5 kW, 400V, 50 Hz. - 2 Nos
- ii. Wound Rotor Induction Generator: Air cooled, three phase, 3/5 kW, 400V, 50 Hz. - 2 Nos
- iii. Doubly fed Induction Generator: Air cooled, three phase, 3/5 kW, 400V, 50 Hz. -- 2 Nos
- iv. Wound Rotor Synchronous Generator: Air cooled, three phase, 3/5 kW, 400V, 50 Hz. - 2 Nos
- v. Permanent Magnet Synchronous Generator: Air cooled, three phase, 3/5 kW, 400V, 50 Hz. - 2 Nos
- vi. Welding transformers - 1 No.
- vii. Isolation transformer - 1 No.
- viii. Pulse transformer - 1 No.
- ix. Audio transformers - 1 No.
- x. Microphone transformers - 1 No.
- xi. Hysteresis motor - 1 No.
- xii. Permanent magnet motor - 1 No.
- xiii. Reluctance motor - 1 No.
- xiv. Switched reluctance motor - 1 No.
- xv. Stepper motors of different types - 1 No.
- xvi. Brushless DC motors - 1 No.
- xvii. Servomotors - 1 No.
- xviii. Synchros - 1 No.
- xix. Resolvers - 1 No.

C) List of Software/Learning Websites

- i. http://www.learnabout-electronics.org/ac_theory/transformers04.php
- ii. <http://www.tpub.com/celec/5.htm>
- iii. <http://www.wisegeek.com/what-is-a-fractional-horsepower-motor.htm>
- iv. www.sskphdmm.com
- v. www.nptel.iitm.ac.in
- vi. www.electricalandelectronics.org
- vii. www.allaboutcircuits.com
- viii. www.nmbtc.com

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE**Faculty Members from Polytechnics**

- **Prof. R.D. Panchal**, Lecturer, Electrical Engineering, RC Technical Institute, Ahmedabad
- **Prof. H.C. Chawda**, Lecturer, Electrical Engineering, RC Technical Institute, Ahmedabad
- **Dr. A S Pandya**, Head, Electrical Engineering, Government Polytechnic, Rajkot
- **Prof. N. N. Pandya**, Lecturer, Electrical Engineering, Government Polytechnic, Ahmedabad

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr (Mrs.) C. S. Rajeshwari**, Professor and Head, Department of Electrical and Electronics Engineering
- **Dr. Joshua Earnest**, Professor, Department of Electrical and Electronics Engineering