Syllabus

CODE	COURSE NAME	CATEGORY	L	T	P	CREDITS
EET282	ELECTRICAL MACHINES	Minor	3	1	0	4

Preamble : This course gives exposure to the students about the concepts of electrical machines including constructional details, principle of operation and performance analysis.

Prerequisite : **Basics of Electrical Engineering**

Course Outcomes : After the completion of the course the student will be able to:

CO 1	Identify the appropriate Electrical machines required for different applications, considering the parameters like input supply voltage, output torque and speed.
CO 2	Evaluate the performance of a single phase transformer based on appropriate test results.
CO 3	Analyse the performance of single phase and permanent magnet motors which can be used for household applications.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2										2
CO 2	2	3										2
CO 3	3	2										2

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	10	10	10
Understand (K2)	20	20	40
Apply (K3)	20	20	50
Analyse (K4)	-	-	-
Evaluate (K5)	-	-	-
Create (K6)	-	-	-

End Semester Examination Pattern : There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Discuss the types of dc generators based on the method of excitation.(K2)
2. Discuss the applications of dc motors based on their characteristics.(K3)
3. Derive the expression for induced emf of alternator.(K1)
4. Problems on calculating induced emf of alternator. (K2, K3)
5. Why synchronous motor is not self starting? Discuss any two starting methods of synchronous motor? (K1)
6. What are V and Inverted V curves? (K1)
7. Explain the working principle of a three phase induction motor.(K1)
8. Why starting current of induction motor is high? Explain any two starting methods? (K2)

Course Outcome 2 (CO2):

1. Draw the phasor diagram of a single phase transformer. (K1)
2. Problems based on efficiency calculations, all day efficiency.(K2, K3)

Course Outcome 3 (CO3):

1. With the help of a neat diagram explain any two starting methods of single phase induction motor. (K1)
2. Discuss the advantages of permanent magnet rotor compared to the conventional construction. (K2)
3. Explain the principle of operation of a stepper motor.(K1)

Model Question paper

QP CODE:

PAGES:2

Reg. No:_____
Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY THIRD SEMESTER B.TECH DEGREE EXAMINATION, MONTH & YEAR

Course Code: EET 282
Course Name: Electrical Machines

Max. Marks: 100 **Duration: 3 Hours**

PART A
Answer all Questions. Each question carries 3 Marks

1. Derive an expression for emf generated in a dc machine.
2. Explain the principle of operation of a dc motor.
3. Draw the phasor diagram of a single phase transformer working under no load condition.
4. The emf per turn of a single phase 2200/220 V, 50 Hz transformer is approximately 12 V. Calculate (a) the primary and secondary turns (b) the net cross sectional area of the core if the maximum flux density is 1.5Wb/m^2.
5. How is voltage regulation of an alternator affected by the load connected to its terminals?
6. Why is synchronous motor not self starting?
7. Explain torque-slip characteristics of a three phase induction motor.
8. A three phase induction motor has 2 poles and is connected to 400 V, 50 Hz supply. Calculate the actual rotor speed and rotor frequency when slip is 4%.
9. Explain the working of a single phase induction motor.
10. List any three applications of PMBLDC motors.

(10 x 3 = 30)

PART B
Answer any one full question from each module. Each question carries 14 Marks

Module 1

11. (a) Briefly explain armature reaction of a dc machine. **(5)**
    (b) Classify dc generators based on their method of excitation with the help of neat diagrams. **(9)**
12. (a) Explain the power stages of a dc motor. **(4)**
    (b) A 75 kW, 250 V dc compound generator has the following data. R_a = 0.04Ω, R_{se}=0.004Ω, R_f = 100Ω, Brush contact drop = 1V/brush. Compare the generated emf when fully loaded for (i) short shunt compound (ii) long shunt compound. **(10)**

Module 2

13. (a) Draw the equivalent circuit of a single phase transformer and explain how the parameters are obtained from the test results. **(10)**

    (b) In a 25 kVA, 2000/200 V transformer, the iron and copper losses are 300 W and 400 W respectively. Calculate the efficiency at unity pf at (i) full load (ii) half load. **(4)**

14. (a) What is all day efficiency? Explain its significance. **(4)**

    (b) A transformer has its maximum efficiency of 0.98 at 20 kVA at unity pf. During the day it is loaded as follows: 12 hours - 2 kW at pf 0.6, 6 hours – 10 kW at pf 0.8, 6 hours – 20 kW at pf 0.9. Find the all day efficiency of the transformer. **(10)**

Module 3

15. (a) Explain the constructional details of a synchronous machine. **(9)**

    (b) A 200 kVA, 3.3 kV, 50 Hz, three phase synchronous generator is star connected. The effective armature resistance is 5Ω/phase and synchronous reactance is 29.2Ω/phase. At full load calculate the voltage regulation for 0.8 lagging and 0.8 leading power factors. **(5)**

16. (a) (i) Explain V curves of a synchronous motor. **(3)**

    (ii) What is a synchronous condenser? **(2)**

    (b) What is voltage regulation? Explain the method of finding regulation by emf method. **(9)**

Module 4

17. (a) Explain the working principle of a three phase induction motor. **(5)**

    (b)Explain the methods of starting of a three phase induction motor. **(9)**

18. (a) The no load and blocked rotor test results conducted on a 30 hp, 835 rpm, 440V, 3 phase, 60 Hz, squirrel cage induction motor are as follows.

    No load test: 440V, 14 A, 1470 W

    Blocked rotor test: 163V, 60A, 7200W

    Resistance measured between two terminals is 0.5Ω. Determine the equivalent circuit parameters. **(10)**

    (b) What is a self-excited induction generator? **(4)**

Module 5

19. (a) What are the applications of servomotors? **(4)**

    (b) Explain the different types of stepper motors. **(10)**

20. (a) What are universal motors? Explain their working. **(9)**

    (b) Write a short note on permanent magnet motors. **(5)**

(14 x 5 = 70)

Syllabus

Module 1

DC Machines-principle of operation of DC generator - emf equation - types of excitations - separately excited, shunt and series excited DC generators, compound generators. General idea of armature reaction, Open circuit and load characteristics-simple numerical problems. Principles of dc motors-torque and speed equations-torque speed characteristics-Characteristics and applications of dc shunt, series and compound motors. Methods of starting, losses and efficiency - simple numerical problems.

Module 2

Transformers –principle of operation –emf equation - phasor diagram - losses and efficiency –OC and SC tests. Equivalent circuits-efficiency calculations - maximum efficiency –all day efficiency –simple numerical problems.

Module 3

Synchronous machines–Parts of synchronous generator – principle of operation–types –emf equation of alternator – regulation of alternator under lagging and leading power factor – determination of regulation by emf method – numerical examples. Principle of operation of synchronous motors - methods of starting - V curves - synchronous condenser.

Module 4

Three phase induction motors-slip ring and squirrel cage types-principle of operation–rotating magnetic field–equivalent circuit, torque slip characteristics-no load and blocked rotor tests. Methods of starting –direct online, star delta, rotor resistance and auto transformer starting.

Induction generator- principle of operation – self excited induction generators.

Module 5

Single phase motors - principle of operation of single phase induction motor –split phase motor – capacitor start motor.

Stepper motor – principle of operation – types. Principle of operation and applications of universal motor and servomotor (dc and ac).

Permanent magnet motors– principle of operation of PMSM and PMBLDC motor, applications.

Text Books

1. Bimbra P.S., “Electrical Machinery”, 7/e, Khanna Publishers, 2011.
2. Nagrath J. and D.P. Kothari, “Theory of AC Machines”, Tata McGraw Hill, 2006.

Reference Books

1. Fitzgerald A.E., C. Kingsley and S. Umans, "Electric Machinery", 6/e, McGraw Hill, 2003.
2. Langsdorf M.N., "Theory of Alternating Current Machinery", Tata McGraw Hill, 2001.
3. Say M.G., "The performance and Design of AC Machines", CBS Publishers, New Delhi, 2002.

Course Contents and Lecture Schedule:

No	Topic	No. of Lectures
1	**DC Machines(10 hours)**	
1.1	Principle of operation-emf equation-types of excitations -separately excited, shunt and series excited DC generators, compound generators.	3
1.2	Generalidea of armature reaction, OCCand load characteristics-simple numerical problems.	2
1.3	Principles of dc motors-torque and speed equations-torque speed characteristics	2
1.4	Characteristics and applications of dc shunt, series and compound motors. Principles of starting, losses and efficiency–simple numerical problems.	3
2	**Transformers (8 hours)**	
2.1	Principle of operation –emf equation - phasor diagram.	2
2.2	losses and efficiency –OC and SC tests. Equivalent circuit.	3
2.3	efficiency calculations-maximum efficiency –all day efficiency –simple numerical problems.	3
3	**Synchronous machines (9 hours)**	
3.1	Parts of synchronous generator – principle of operation – types	2
3.2	emf equation of alternator –regulation of alternator under lagging and leading power factor – simple numerical problems.	2
3.3	determination of regulation by emf method – numerical examples.	2
3.4	Principle of operation of synchronous motors-methods of starting.V-curves-synchronous condenser.	3

4	**Three phase induction motors (9 Hours)**	
4.1	Slip ring and squirrel cage types-principle of operation–rotating magnetic field.	2
4.2	Torque-slip characteristics-no load and blocked rotor tests, equivalent circuit - simple numerical problems.	3
4.3	Methods of starting –direct online, star-delta, rotor resistance and autotransformer starting.	2
4.4	Induction generator- principle of operation – self excited induction generators.	1
5	**Single phase motors (9 Hours)**	
5.1	Principle of operation of single phase induction motor –split phase motor –capacitor start motor-	2
5.2	Stepper motor – principle of operation - types	2
5.3	Universal motor, –servomotor – dc and ac servomotors – principle of operation, applications.	3
5.4	Permanent magnet motors – principle of operation of PMSM and PMBLDC motor, applications.	2