Ref. No.: Ex/PG/ELE/PC/T/111B/2025

M.E. ELECTRICAL ENGINEERING EXAMINATION-2025

(FIRST YEAR, FIRST SEMESTER)

SPECIAL PURPOSE ELECTRICAL MACHINES

Time: 3 hours Full Marks:100

(50 marks for each part)

Use separate Answer-script for each part

PART-I

Answer any Three questions. Two marks are for neatness. All symbols have their usual significance.

1. a) Show with a stator-conductors of the induction motor, how 2-poles are produced from 3-phase currents in a 3-phase Induction Motor.
   b) Explain 3-phase linear induction motor structure and operation. What is the application and limitation of this motor? **8+8=16**

2. a) Draw & describe the construction of stator and rotor of a single-phase reluctance motor.

   b) Explain all the marked portion in speed-torque characteristics of single-phase reluctance motor as shown in **fig.1**

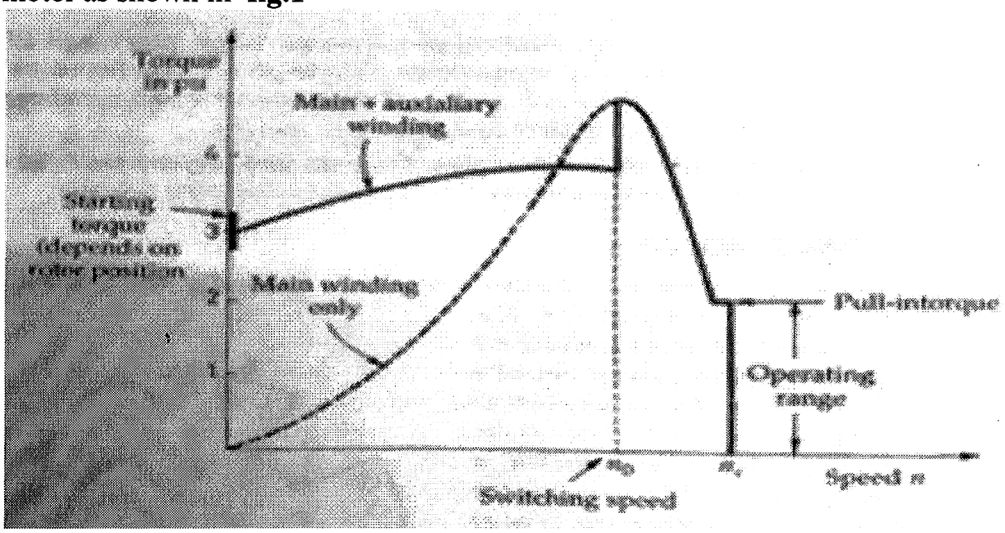

fig.1 **8+8=16**

3. Draw & describe the construction of stator and rotor and working method of a Hysteresis Motor deriving its speed-torque characteristic. State why it is a Silent Synchronous Machine. 16

4. Draw & describe the construction of stator and rotor and principle of operation of a Permanent Magnet DC Motor deriving its speed-torque characteristic. Also explain **Armature Reaction** and how it does affects this Motor. 16

[Turn over

5.

a)

Consider the operation of an electromagnetic relay shown in fig.2, where one winding is mounted on a stationary member of iron and a movable member of iron as if attached to a wall of the relay by a spring on one side. Draw the relay and derive the expression for **mechanical force** if the plunger shown in fig.2 is allowed to move an infinitesimal distance in the direction of magnetic force acting upon it.

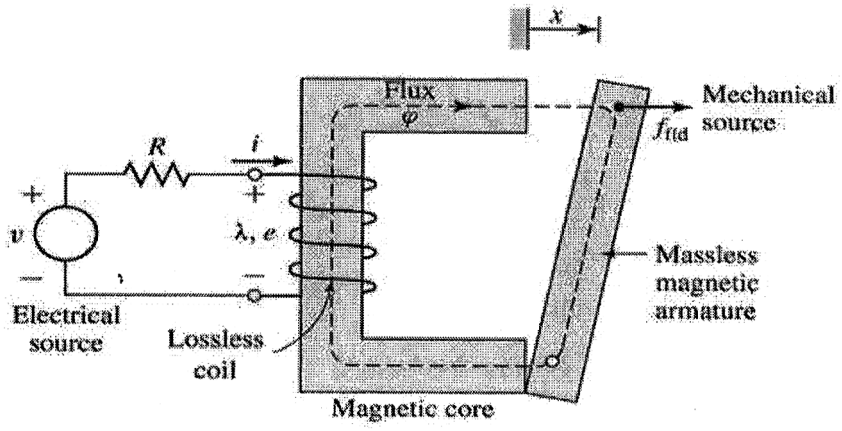

Fig.2

b) In an electromagnetic relay shown in fig. 2, the exciting winding has 3000 turns. The cross-sectional area of the magnetic core is 30 cm × 30 cm. The reluctance of the iron-magnetic path may be assumed to be negligible. Also neglect fringing effects.

i) Draw the relay and find the coil inductance for an air-gap of x = 3cm at both ends of the plunger. What is the field energy when the coil carries a current of 100A? What are the forces on the plunger under these conditions?

ii) Find the mechanical energy output when the plunger moves in the direction of magnetic force acting upon it, from

x = 3cm to x = 1cm at both ends of the plunger assuming that the coil current is maintained constant at 100A.

8+8=16

PART-II.

Answer *all* questions from this part.

6.	a) Deduce the expression for maximum torque developed in a three phase squirrel cage induction machine taking the stator parameters in to account and compare the same for motor and generator operation. (CO2)	10
	OR	
	b) Draw the circle diagram of a three phase induction generator and explain the performance parameters from the same. (CO1)	10
7.	a) Deduce the expression for reactive power in a three phase induction generator with the help of its steady state equivalent circuit. Find the slip at which maximum reactive power occurs. (CO3)	10
	OR	
	b) Draw the phasor diagram of a three phase doubly fed induction generator under sub-synchronous operation and explain the nature of its power factor. (CO3)	10
8.	(a) Show the variable speed grid connected squirrel cage induction generator converter control scheme block diagram and explain the function of each block. (CO4)	10
	OR	
	(b) Explain the voltage build-up procedure in a self-excited induction generator. Also show one capacitor calculation method for proper voltage build-up. (CO4)	10
9	(a) A 415V, 50 Hz, 4-pole, 3 phase star connected squirrel cage induction machine is operating as generator connected with grid at rated voltage and frequency. The machine running at 1560 rpm with the help of wind turbine. Find the active and reactive power delivered to grid if the machine has: per phase Rs=Rr=1.1 ohm, Xls=Xlr=3.6 ohm, Xm= 180 ohm, core losses negligible. (CO4)	10
	OR	
	(a) Show how a slip ring induction machine can operate as generator under sub-synchronous speed operation. Deduce the necessary derivations if required.	10

10	Write short notes on any One (CO2): i) Super synchronous operation of grid connected doubly fed induction generator (DFIG). iii) Voltage and current sensing techniques for induction generator controllers.	10