

B.E. ELECTRICAL ENGINEERING
FOURTH YEAR
FIRST SEMESTER EXAM 2024
SPECIAL ELECTRICAL MACHINES & DRIVES
(ELECTIVE-I)

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. Show with a structure of the Linear Induction Motor, how 2-poles are produced from 3 phase currents in a Linear Induction Motor; then explain how linear motion is produced there. What is the application and limitation of this motor? 16
2. Describe the construction and principle of operation of a single-phase reluctance motor; also explain all the marked portion in speed-torque characteristics of single-phase reluctance motor as shown in fig.1.

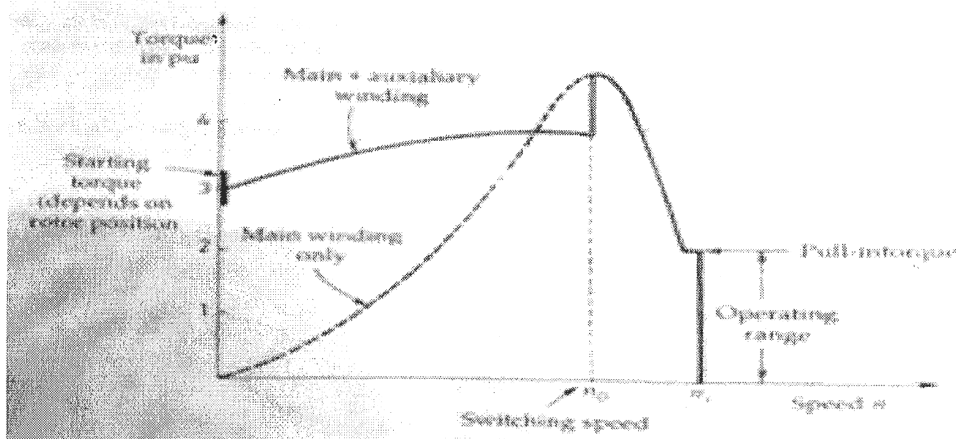


fig.1

16

3. Describe construction and working method of a Hysteresis Motor deriving its speed-torque characteristic. State why it is a Silent Machine compare to others. 16
4. Describe the construction and principle of operation of a Permanent Magnet DC Motor deriving its speed-torque characteristic. Also explain how its armature reaction affects this Motor. 16
5. Write short notes on any two: 8+8=16
 - a) Permanent magnet Stepper Motor.
 - b) Hybrid Stepper Motor.
 - c) Reluctance motor is a Synchronous machine instead of Induction machine.

PART-II.

Answer *all* questions from this part.

6. a) Draw the equivalent circuit of a three phase squirrel cage induction generator and show using its phasor diagram that it can operate at leading power factor. (CO2) 10

OR

- b) For an induction machine, deduce the expression for the ratio of the electromagnetic torque under motoring and generating modes using steady state equivalent circuit with stator parameters are included in the model. Indicate which of the machine parameters can mostly affect this ratio. (CO1) 10

7. a) Using the steady state equivalent circuit show that a doubly fed slip ring induction machine can generate electrical power both below and above synchronous speed. (CO3) 10

OR

- b) Discuss with relevant diagrams the different current and speed sensing techniques of doubly fed induction generator controllers along with their merits and demerits. (CO3) 10

8. a) A 415V, 3-phase, 50Hz, 6 pole star connected cage type induction machine has following per phase parameters referred to stator: 10

$R_s = R_r = 0.5 \text{ ohm}$, $X_{ls} = X_{lr} = 1.5 \text{ ohm}$, $X_m = 87 \text{ ohm}$ and R_c very large

It is driven by a prime mover at 1540 rpm. Determine (i) stator current and power factor and power developed (ii) The maximum power it can develop and the corresponding speed under generating mode. Neglect mechanical losses. (CO4)

OR

- b) A 4.7 kW, 415V, 3 phase, 50 Hz, star connected, 1440 rpm, cage type induction machine is operating as a capacitor excited stand-alone generator at 1200 rpm with the help of a prime mover delivering a power of 1.5 kW with pf of 0.8 lag to a load at rated voltage. Determine (i) connected capacitor per phase, capacitor current (ii) stator current and operating frequency. (CO4) 10

The per phase parameters referred to stator:

$R_s=R_r=0.40$ ohm, $X_{ls}=X_{lr}=1.5$ ohm, $X_m=65$ ohm and R_c very large

Assume linear magnetic circuit.

- 9 a) A slip ring type 1.5kW, 1440 rpm, 3-phase, 50 Hz grid connected induction machine (DFIG) is having following ratings and parameters referred to stator side: 10
- Stator : 415 V, $R_s= 1.0$ ohm, $X_{ls}= 2.3$ ohm,
 Rotor : 230V, $X_{lr}=2.3$ ohm, $R_r=1.1$ ohm, stator to rotor turns ratio 1:1
 $L_m=170$ mH, friction, windage and core losses negligible.
 It is running at 1400 rpm with the help of wind turbine and delivering rated stator power to grid at upf and rated voltage. Determine the active and reactive power with proper sign at the rotor side converter output terminal, mechanical power provided by wind turbine and stator current. Assume an interconnecting reactor of 10 mH between DFIG stator and grid. (CO4)

OR

- b) Show with block diagram the input and output signals and their interfacing techniques when DSP is employed for control of doubly fed induction generator (DFIG) connected to grid. Indicate the application areas for the same. (CO3) 10
- 10 Write short notes on any Two: (CO2) 5 + 5
- a) Voltage build-up procedure of self excited induction generator.
 - b) Doubly fed induction generator (DFIG).
 - c) Grid connected operation of squirrel cage induction generators.