53 (IE 401) ELMC

2015

ELECTRICAL MACHINES

Paper : IE 401

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1. *(a)* Define a transformer. How is the energy transferred from one circuit to another ? 2+5=7

   (b) In an ideal transformer, discuss how impedance is transferred form secondary to primary or vice-versa. 5

(c) A 50-*Hz*, 1-phase transformer has a turn-ratio of 6. The resistances are $0 \cdot 90\Omega$ and $0 \cdot 03\Omega$ and the reactances 5Ω and $0 \cdot 13\Omega$ for high-voltage and low-voltage winding respectively. find the voltage to be applied to the high-voltage side to obtain full load current of 200*A* in the low-voltage winding on short-circuit. Also find the power factor on short-circuit. 8

2. (a) Describe the constructional details of commutator of dc machine. 5

(b) Develop the circuit model of a dc machine. 5

(c) A 250-*V* shunt motor on no-load runs at 1000 *rev* per min and takes 5*A*. The total armature and shunt field resistances are respectively $0 \cdot 2\Omega$ and 250Ω. Calculate the speed when loaded and taking a current of 50*A*, if armature reaction weakens the field by 3%. 10

3. (a) Develop and draw space and time phasor diagrams for a cylindrical-rotor machine in case the alternator operates at an internal power factor of *(a)* zero lagging *(b)* cos ψ lagging. 10

(b) A 3-phase star-connected alternator with synchronous impedance of $0+5$, Ω per phase is connected to an $11\text{-}kV$ system. The alternator power output is found to be $10MW$ and reactive power output as 3 MVA. Compute the magnitude of excitation voltage, load angle, line current and power factor. 10

4. (a) Show that the voltage generated in the rotor circuit of a 3-phase induction motor at any slip S is equal to S times the voltage generated at standstill. 4

(b) Explain the terms air-gap power P_g, internal mechanical power developed P_m and shaft power P_{sh}. How are these terms related with each other? Hence show that P_g : rotor ohmic loss : P_m = $1 : S : (1-S)$. 6

(c) The power input to the rotor of a $440V$. $50Hz$, 6-pole, 3-phase induction motor is $80kW$. The rotor electromotive force is observed to make 100 complete alternations per min. Calculate *(a)* the slip *(b)* the rotor speed *(c)* the mechanical power developed *(d)* the rotor copper loss per phase. *(e)* the rotor resistance per phase if the rotor current is $65A$. 10

5. *(a)* Draw the phasor diagram of a single-phase transformer supplying a leading power factor load. 5

(b) Define voltage regulation of a transformer. What causes a change in secondary terminal voltage of a transformer, as it is loaded? 2+3=5

(c) Describe with relevant diagrams, the different methods of excitation of dc machines. 10

6. *(a)* Draw the equivalent circuit diagram of a single phase induction motor. Explain the diagram. 10

(b) Derive an expression for pitch factor. What should be the value of chording angle for eliminating third harmonic? 5+5=10

7. *(a)* A 50 *kVA* transformer has a core-loss of 500*W* and full load loss of 900*W*. If the power factor of the load is 0·8 lagging, calculate *(a)* the full load efficiency *(b)* the maximum efficiency. 10

(b) Write brief notes on : ***(any one)*** 10

(i) Reluctance Motor.

(ii) Hysteresis Motor
