53 (IE 401) ELMC

2019

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)* Why do we represent leakage flux in a transformer by inductive reactance? Draw the circuit diagram. 5

   (b) Derive the condition for maximum efficiency in a transformer. Also, write the expression for load current corresponding to maximum efficiency. 5

(c) The primary and secondary windings of a 40*KVA*, 6600/250*V* single-phase transformer have resistances of 10Ω and 0.02Ω respectively. The leakage reactance of the transformer referred to the primary side is 35Ω. Calculate the percentage voltage regulation of the transformer when supplying full-load current at a p.f. of 0.8 lagging. Draw the circuit diagram as well as phasor diagram. 10

2. (a) How does laminations reduce the core loss? 5

(b) Draw and explain the no-load phasor diagram of *I*-phase transformer. Draw the circuit diagram also. 5

(c) A voltage $V = 200 Sin 314t$ is applied to the transformer winding in a no-load test. The resulting current is found to be $i = 3 sin (314t - 60°)$. Determine the core loss and r.m.s value of the exciting current. Draw the circuit diagram as well as phasor diagram. 10

3. (a) How does commutator work? 5

(b) Describe with relevant diagrams the different methods of excitation of D.C. machines. 5

(c) A 240*V* DC series motor takes 40*A* when giving its rated output at 1500 *rpm*. Its resistance is 0.3 *ohms*. Calculate the value of resistance which must be added to obtain rated torque at 1000 *rpm*. Draw the circuit diagram. 10

4. (a) What is meant by armature reaction? 5

(b) Sketch a 4-pole DC machine. Indicate the flux path for the four poles. 5

(c) A 4-pole shunt generator with lap-connected armature having field and armature resistances of 50Ω and 0.1Ω respectively supplies sixty 100*V*, 40*W* lamps. Calculate the total armature current, the current per armature path, and the generated electromotive force. Allow a contact drop of IV per brush. Draw the circuit diagram. 10

5. (a) What are the advantages of parallel operation of alternators? 5

(b) Write the conditions for paralleling alternator with infinite bus-bars. 5

(c) A $3-\phi$, star-connected alternator is delivering $20MW$ and $8MVAR$ to an infinite bus at $11KV$. The alternator has synchronous impedance of $(0+j3)\Omega$. Determine the load angle and the excitation e.m.f of the alternator. 10

6. (a) Write some important application of capacitor start induction motor and universal. 5

(b) What is the function of centrifugal starting switch in a single phase induction motor? 5

(c) At starting the windings of a $230V$, 50 *Hz*, split-phase induction motor have the following parameters —

Main winding : $R=4\Omega,\ X_L=7.5\Omega$

Starting winding : $R=7.5\Omega,\ X_L=4\Omega$

Find :

(i) Current I_m in the main winding

(ii) Current I_s in the starting winding

(iii) Phase angle between I_s and I_m

(iv) Line current

(v) Power factor of the motor. 10

7. (a) A $3-\phi$, 50 *Hz* induction motor has a full-load speed of 1440 *rpm*. For this motor, calculate the following —

(i) number of poles

(ii) full-load slip and rotor frequency

(iii) speed of stator field with respect to stator structure and rotor structure. 5

(b) With the help of rotor equivalent circuit of an Induction motor, show that the power transferred magnetically from stator to rotor is given by

$I_2^2 \frac{r_2}{5}$ per phase

where I_2 = per phase rotor current

r_2 = per phase rotor resistance

s = slip 5

(c) A 6-pole, 50 *Hz*, 3ϕ induction motor runs at 960 *rpm* when the torque on the shaft is 200 *Nm*. If the stator losses are $1500W$ and frictional and windage losses are $500W$, find :

(i) rotor *Cu*-loss

(ii) efficiency of the motor. 10