ELECTRICAL MACHINES AND CONTROL

Full Marks – 70

Pass Marks – 28

Time – Three hours

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

Answer any *five* questions.

1. (a) State Faraday's laws of electromagnetic induction. Also explain, how an electric generator works on this law. 3

   (b) A short shunt dc compound generator supplies 200A at 100V. The resistances of armature, series field and shunt field windings are 0.04, 0.03 and 60Ω respectively. Find the emf generated. Also find the emf generated if the same machine is connected as long shunt machine. 7

   (c) Derive the emf equation of a DC generator. 4

[Turn over

2. (a) On which principle a DC motor works ? Explain. 3

(b) A 250V shunt motor on no-load runs at 1000 rpm and takes 5A. The total armature and shunt-field resistances are 0.2Ω and 250Ω respectively. Calculate the speed when loaded and taking current of 50A if armature reaction weakens the field by 3%. 7

(c) Establish a relation among speed, back emf and flux per pole of a DC motor. 4

3. (a) What do you mean by iron and copper losses of a transformer ? 4

(b) Derive the condition for maximum efficiency of a transformer. 5

(c) A 230V/2300V transformer takes a no-load current of 6.5A and absorbs 187W. If the resistance of primary is 0.06Ω, find

(i) the core loss

(ii) no-load p.f.

(iii) active component of current and

(iv) magnetizing current. 5

4. (a) Derive an expression for starting torque of a 3-ϕ induction motor. 4

   (b) A 6-pole, 3-ϕ, 50 Hz induction motor is running at full-load with a slip of 4%. The rotor is star-connected and its resistance and standstill reactance are 0.25Ω and 1.5Ω per phase respectively. The emf between slip rings is 100V. Find the rotor current per phase and p.f assuming slip rings are short circuited. 5

   (c) A 500 h.p., 3-phase, 440V, 50 Hz induction motor has a speed of 950 rpm on full-load. The machine has 6-poles. Calculate the full-load slip. How many cycles will the rotor voltage make per minute ? 5

5. (a) Derive a relation between line current and phase current in delta-connected balance system. 5

   (b) What is the significance of the operator 'J' in electrical engineering ? 4

   (c) Two vectors are given as –
   $A = 20\angle60^\circ$ and $B = 5\angle30^\circ$.
   Perform the following indicated operations and illustrate graphically

   (i) A×B and (ii) $\dfrac{A}{B}$. 5

6. Write short notes (any *two*) : $2 \times 7 = 14$

    (a) Star-delta starting of 3-ϕ induction motors.

    (b) Significance of the back-emf in DC motors.

    (c) Open-circuit and short-circuit test of single phase transformer.

    (d) Capacitor start motors.

7. (a) 'Single phase induction motors are not self-starting.' – Explain.   5

    (b) How an AC series motor works ? Also mention two main characteristics and applications of an AC series motor.

                                 $5+4=9$