ELECTRICAL MACHINES AND CONTROL

Full Marks – 70

Time – Three hours

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

Instructions :

1. Questions on PART – A are compulsory.

2. Answer any *five* questions from PART – B.

PART – A

Marks – 25

1. Fill in the blanks :   1×10=10

   (a) The primary and secondary of a transformer are —— coupled.

   (b) A transformer will have zero efficiency at ——.

   (c) The back e.m.f in a d.c motor —— the applied voltage.

   (d) When a 3-phase induction motor is at no load, the slip is practically ——.

(e) If a 3-phase induction motor is running at a slip s, then approximate efficiency of the motor is ——.

(f) When a d.c generator carries no armature current M.N.A —— with G.N.A.

(g) The mechanical power developed in a d.c motor is maximum when back e.m.f (E_b) is equal to —— the applied voltage.

(h) In delta connected three phase system, the line current is —— times of phase current.

(i) The losses that occur during electromechanical energy conversion are converted into ——.

(j) If W_c is the constant loss and R_a is the armature resistance of a DC generator, then load current I_L corresponding to maximum efficiency is ——.

2. Choose the correct option : 1×10=10

(a) What will happen if the back emf of a DC motor vanishes suddenly ?
   (i) The motor will stop
   (ii) The motor will continue to run
   (iii) The armature may burn
   (iv) The motor will run noisy

(b) Direction of rotation of motor is determined by
   (i) Faraday's law
   (ii) Coulomb's law
   (iii) Lenz's law
   (iv) Fleming's left hand rule

(c) In which mode power is transferred in autotransformer ?
   (i) Induction
   (ii) Induction and conduction
   (iii) Conduction
   (iv) Can not be said

(d) The field of an induction motor rotates relative to the stator at
   (i) Rotor speed
   (ii) Slip speed
   (iii) Synchronous speed
   (iv) Very low speed

(e) With respect to the direction of rotation, the interpoles on a DC generator have the same polarity as the main poles

(i) behind them

(ii) ahead of them

(iii) either (i) or (ii)

(iv) neither (i) or (ii)

(f) The single-phase series motor can operate on

(i) AC only

(ii) DC only

(iii) Both DC and AC

(iv) None of the above

(g) The purpose of starting winding in a single-phase induction motor is to

(i) reduce losses

(ii) produce rotating flux in conjunction with main winding

(iii) limit temperature of the machine

(iv) None of the above

(h) A transformer has full-load copper loss of 400W. The copper loss at half full-load will be

(i) 100W   (ii) 200W

(iii) 400W   (iv) None of these

(i) The condition of induction motor on load resemble those of a transformer whose secondary is

(i) open-circuited

(ii) short-circuited

(iii) supplying a variable resistive load

(iv) None of these

(j) A 50 Hz, 4-pole, single-phase induction motor will have a synchronous speed of

(i) 1500 rpm   (ii) 1200 rpm

(iii) 750 rpm   (iv) None of these

3. Write true or false : $1 \times 5 = 5$

(a) Transformer can work on both AC and DC.

(b) Transformer is rated in kW.

(c) In a DC machine, rectification provided with commutator is full wave rectification.

(d) An autotransformer is a two winding transformer.

(e) DC generators work on the fundamental principle of Faraday's law of electromagnetic induction.

PART – B

Marks – 45

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

(b) The no load current of a transformer is 5A at 0.3 p.f. lagging when supplied at 230V, 50 Hz. The number of turns on the primary winding is 200. Calculate

(i) the maximum value of flux in the core

(ii) the core loss

(iii) the magnetizing current

(c) The primary and secondary windings of a 500 kVA, 6600 / 400V transformer have resistance of 0.42Ω and 0.0011Ω respectively and the iron loss is 2.9 kW. Calculate efficiency at   3+3+3=9

(i) full load

(ii) half full-load

Assume p.f of the load to be 0.8 lag.

2. (a) Define DC motor and DC generator. Describe the working principle of DC motor.

(b) What is armature reaction in DC generator ? Explain with the help of diagram.

(c) A shunt generator supplies 75A at 200V through feeders of resistance 0.08Ω. The armature and shunt field winding have resistance of 0.04Ω and 80Ω respectively. Find the terminal voltage and generator e.m.f.   3+3+3=9

3. (a) Derive the voltage equation of DC motor. Also derive the condition for maximum power.

(b) Describe the characteristics of DC series motors.

(c) A 230 V DC shunt motor takes 5A at no load and runs at 1000 rpm. Calculate the speed when loaded and taking a current of 30A. The armature and field resistances are 0.2Ω and 230Ω.

$3+3+3=9$

4. (a) Describe the principle of operation of three phase induction motor.

(b) What is slip ? Derive the expression for rotor current frequency.

(c) A 3-phase, 50 Hz induction motor has 8 poles. If full load slip is 2.5%.

Determine :

(i) synchronous speed

(ii) rotor speed

(iii) rotor frequency.

$3+3+3=9$

5. (a) Write some advantages of three phase system over single phase system.

(b) Derive the relation between phase voltage and line voltage in star connected three phase system. Draw the circuit diagram as well as the phasor diagram.

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(c) Three similar coils A, B, C are available. Each coil has 9Ω resistance and 12Ω reactance. They are connected in delta to a 3 phase, 440V, 50 Hz supply. Calculate for this load :

(i) the line current

(ii) the power factor

(iii) the kilovolt amperes

$3+3+3=9$

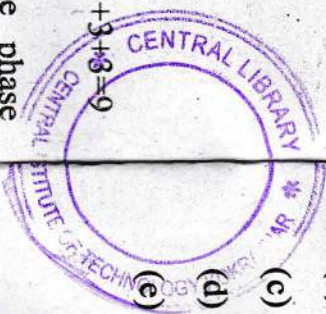6. Write short notes on any *three* : $3+3+3=9$

(a) Autotransformer

(b) Capacitor start and run motor

(c) AC series motor

(d) Direct-on-line starter

(e) Types of DC generator.

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