2012

ELECTRICAL MACHINES-I

Time Allotted : 3 Hours   *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words

as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following :

$10 \times 1 = 10$

i) In a DC series motor torque is approximately

proportional to

a) I_a^2 b) Ia

c) V^2 d) V.

ii) Which type of motor is used for lifting purpose in

crane ?

a) Shunt motor b) Series motor

c) Induction motor d) None of these.

iii) A commutator in *dc* machines can

a) convert *dc* to *ac*

b) provide full wave rectification

c) convert *ac* to *dc*

d) both (b) & (c).

iv) If the field of a *dc* shunt motor gets opened while the

motor is running, then

a) speed of the motor will reduced

b) motor will attain dangerously high speed

c) armature current will drop

d) armature will oscillate about original speed as the

mean speed.

v) A *DC* shunt generator when driven without any

excitation shows an open ciruit voltage of 10V. When

the field winding is excited, the voltage dropped to zero.

The reason is

a) there is no residual magnetism

b) field resistance is greater than the critical

resistance

c) field winding is wrongly connected

d) none of these.

vi) Open circuit test in a transformer is performed with

a) rated transformer voltage

b) rated transformer current

c) direct current

d) high frequency current.

vii) A 1 : 1 transformer is used as

a) pulse transformer

b) isolating transformer

c) potential transformer

d) current transformer.

viii) Tertiary winding is used in case of

a) delta-delta b) star-zigzag

c) star-star d) none of these.

ix) In Scott connections, the teaser transformer operates

on 0.866 of its

a) rated current b) rated voltage

c) rated power d) rated impedance.

x) If two transformers not having the same precentage

impedances are connected in parallel for load sharing,

then

a) one of the transformers will be fully loaded

b) one of the transformers is likely to get burnt

c) load sharing will not be proportional to their kVA

rating

d) p.f. of both the transformer will be lagging.

xi) A three phase 440 V, 50 Hz induction motor has slip of

3%. The frequency of rotor emf will be

a) 150 Hz b) 15 Hz

c) 3 Hz d) 1·5 Hz.

xii) In a induction motor 5% change in supply voltage, will

cause rotor torque variation of above

a) 2·55% b) 5%

c) 10% d) 50%.

xiii) For a slip ring induction motor, if the rotor resistance is

increased, then

a) starting torque and efficiency increase

b) starting torque and efficiency decrease

c) starting torque decreases but efficiency increases

d) starting torque increases but efficiency decreases.

xiv) The absence of odd harmonics in magnetizing current

of a 3-phase transformer, will make the

a) voltage wave sinusoidal

b) voltage wave non-sinusoidal

c) load current non-sinusoidal

d) none of these.

xv) Blcoked rotor test on a 3-phase induction motor helps

to find out

a) short circuit power factor

b) fixed losses

c) motor resistance referred to stator

d) none of these.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3x5 = 15

2. With neat diagram, explain the functions of compensating

windings in large DC machines. Show the physical location

of this winding in a DC machine.

3. Explain three point starter with neat diagram. What is the

advantage of four point starter over three point starter ?

4. Name and draw the schematic diagrams of the methods of

speed control of a D.C. motor.

5. What is armature reaction ? Describe the effects of armature

reaction on the operation of a DC machine. How is the

armature reaction minimized ?

6. In 3-phase shell type transformers, a considerable economy

is achieved in the core material if the middle phase winding

is wound in the reversed direction as compared with the

outer two phase windings. Explain

7. Explain why it is not possible to operate a star/delta

transformer in parallel with a star/star or delta/delta

transformer.

8. Compare a single three-phase transfer with 3 single phase transformers forming a three phase transformer.

9. Why the rotor bar is skewed in case of squirrel case induction motor ?

10. Derive the expression for dveloped torque in a 3-phase induction motor and state the condition for maximum torque.

11. Explain the phenomena of cogging and crawling of a 3-phase induction motor.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3x15 = 45

12. a) Why are DC series motors used in trains ? 3

b) Draw and explain the method of speed control of a DC motor by flux control method. Discuss the ranges of speed control by the flux control method. 6

c) A 250 A shunt motor has an armature resistance of 0.6 ohm and a field resistance of 250 ohm. When driving at 650 rpm, a constant torque load, the armature takes 20A. If it is required to raise the speed from 650 rpm, to 850 rpm, what resistance must be inserted in the shunt field circuit assuming linear magnetization characteristics ? 6

13. a) What is commutation ? Briefly explain the factors that prevent sparkless commutation in a dc machine. 5

b) Write down the function of the carbon brushes used in a DC machine. 3

c) A 4 pole dc genrator has a simplex lap winding with 144 coils each of 5 turns and runs at 300 rpm. The

resistance of each turn is 0.01 ohm. The pole pitch is

25 cm. The armature length is 50 cm and pole

arc/pole pitch ratio is 0.7. If the air-gap flux density is

0.5 Wb/m², find

i) average value of induced emf

ii) armature resistance. 7

14. a) Describe the different types of excitation of DC

machines. Explain the build up process of voltage of a

DC shunt generator. Mention the different reasons of

failure to building up process of DC shunt genrator.

$3 + 5$

b) A 10 kW, 250 V, shunt generator having an armature

resistance of 0.1Ω and field resistance of $250\ \Omega$

delivers full load at rated speed of 800 rpm and at

rated voltage of 250 V. Machine now runs as a motor

while taking 10 kW at 250 V. Find the speed of the

machine as motor. Neglect brush contract drop. 7

15. a) What is the advantage of V-V connection of

transformer ? 2

b) Three single phase transformers are connected in delta.

If one of the transformers is found faulty and removed,

what will be the reduction in kVA supplied ? 5

c) Three single phase transformers, connected in

Δ/Δ supply a balanced three-phase load of 1500 kW at

4400 V at 0·8 p.f. lagging. The transformers are

supplied from 3-phase mains at 11000 V. Find the

current in the windings of the each transformer. If one

transformer is found faulty and is removed and the

supply is maintained in V-V connection, determine the

currents in the windings and power supplied by each of

the transformers. 2 + 2 + 2 + 2

16. a) Explain with the help of connection diagram, how Scottconnection

are used to obtain two-phase supply from

three phase mains. 7

b) Two 110 V, single phase furnaces takes loads of

500 kW and 800 kW respectively at a power factor of

0.71 lagging and are supplied from 6600V, 3-phase

mains through a Scott-connected transformer

combination. Calculate the current in 3-phase line.

Neglect transformer losses. Draw the corresponding

phasor diagram. 8

17. a) What is meant by vector group of 3-phase

transformer ? Draw the connection diagram and

corresponding phasor diagram for the vector groups :

i) Dy11

ii) Dz0   6

b) What is the effect of

i) unequal per unit impedance ?

ii) unequal x/r ratio on the parallel operation of two

transformers ? 3

c) Two equal ratio, 3phase transformers A and B, are

operating in parallel to supply a demand of 600 kVA at

0.8 power factor lag at 6600V. The rating and

impedance of the transformers are

Transformer A : 400 kVA, $Z = 0.01 + j\,0.05$ p.u.

Transformer B : 200 kVA, $Z = 0.012 + j\,0.04$ p.u.

Find the currents supplied by each transformer and its

power factor. 6

18. a) Why an induction motor cannot run at synchronous

speed ? 3

b) Draw and indicate the different parts of the speedtorque

curve of an induction motor. Indicate how this

curve will vary with varying supply voltage and rotor

circuit resistance. 6

c) Determine the parameters of the equivalent circuit of a

3-phase induction motor from the following test

results :

No-load test : 400V, 9.5A, 1400W

Block-rotor test : 200 V, 50A, 7000W. 6

19. a) Develop the equivalent ciruit of a 3-phase induction

motor. Show that the mechanical power developed can

be represented by a pure resistance in the rotor circuit.

5

b) Show that a star-delta started of a three phase

induction motor is equivalent to an auto transformer

starter with 58% tapping. 6

c) What are cogging and crawling ? 4

20. a) Draw and explain in brief the different starting methods

of a three phase induction motor. 6

b) Classify the three phase induction motor on the basis of

its rotor construction. Describe the constructional

features of each type with the necessary diagram. 4

c) A 400V, 50Hz, 4-pole, three phase induction motor has

a rotor resistance of 0.04 Ω per phase. The maximum

torque occurs at a speed of 1200 rpm. Calculate the

ratio of the starting torque to the maximum torque. 5

=======