Ref. No. : EX/PE/T/214/2019

# Bachelor of Power Engineering 2nd Year 1st Semester Examination 2019

## Subject: Electrical Machines I

**Time: 3 hrs** **Full Marks: 100**

All questions carry equal marks. Two marks for neatness. Answer as per the directions for each group

Group-A

Answer **any two** of the following: (14*2= 28)

Q1. (a) What is the purpose of commutator? **02**

Q1. (b) Write the expression for induced emf of DC machine and state the name of the different symbols that are used in this equation. **02**

Q1. (c) A lap connected 12kW, 8-pole D.C. generator develops an emf of 200V at 1440rpm. The average flux density over a pole pitch is 0.85Tesla. The length and diameter of the armature are 0.25m and 0.3m respectively. Calculate: (i) the flux per pole; (ii) the total number of active conductors in the armature and (iii) the torque developed by the machine when the armature supplies a current of 50A. **10**

Q2. (a) What do you mean by voltage build up process in a DC Motor? **02**

Q2. (b) What is the necessity of a Starter? **02**

Q2. (c) A 220 V D.C shunt motor runs at no-load while taking an armature current of 2A. The armature resistance including brushes is 0.5ohm. At rated load and rated voltage, the armature current is 25A. Find the speed regulation if:

(i) 2 ohm is placed in series with armature and 4 ohm in parallel with it.
(ii) Only 4 ohm is inserted in series with the armature. **10**

Q3. (a) Draw the Speed Current Characteristics of a DC Series Motor. **02**

Q3. (b) Why DC Series Motor can drive a high Inertia Load. **02**

Q3. (c) A 250 V D.C series motor has armature and series-field resistance of 0.25Ω and 0.15Ω respectively.

(i) Calculate the current for developing a torque of 90 N-m at 1400 rpm.
(ii) Calculate the percentage reduction in flux when the motor runs at 1400 rpm at half the current obtained in part (i) above. **10**

Q4. (a) What is Armature Reaction **02**

Q4. (b) What is Demagnetising Ampere Turns, Compensating Winding and Interpole. **02**

Q4. (c) A compensated DC machine has 18,000 armature ampere turns per pole. The ratio of pole arc to pole pitch is 0.70. Interpolar air gap length and flux density are respectively 1cm and 0.3 Tesla. For rated armature current of 950A, calculate the compensating winding conductors per pole and the number of turns on each interpole. **10**

## Group-B

Answer **any two** of the following: (14*2= 28)

Q5. (a) Write Three Conditions of Parallel Operation of a Single Phase Transformer. **02**

Q5. (b) How the polarities are checked before parallel operation is done. **02**

Q5. (c) The short circuit tests on two single phase transformers gave the following results:
200kVA: 4% rated voltage; rated current at 0.3 p.f. lag
500kVA: 6% rated voltage; rated current at 0.4 p.f. lag
(i) When two transformers are connected in parallel, how do they share a load of 580kW at 0.9 p.f. lag?
(ii) If their voltage ratings are 11000/400V, calculate the secondary terminal voltage at the load given in part (a). **10**

Q6. (a) Write down the condition of Maximum Efficiency Single Phase of a Transformer **02**

Q6. (b) What is Voltage Regulation of a Transformer **02**

Q6. (c) The maximum efficiency of a 3300/440V single-phase transformer is 98% and occurs at ¾ full load at unity power factor. If the impedance is 6%, calculate voltage regulation at full-load 0.8 power factor lagging. **10**

Q7. (a) Write down the Equations of hysteresis and eddy current losses in terms of Flux and Frequency **02**

Q7. (b) Draw the Phasor diagram at Full load Condition **02**

Q7. (c) An 11/0.4 kV, 25Hz single phase transformer has ohmic, hysteresis and eddy current losses of 1.8%, 0.8% and 0.5% respectively. What do these losses become if the transformer is operated from 22kV, 50Hz supply system. The current is assumed to remain same in both cases. Also calculate the efficiency in each case. **10**

Q8. (a) What is a Auto Transformer **02**

Q8. (b) Draw the Equivalent Circuit of a Single Phase Transformer **02**

Q8. (c) A 5 kVA, 2200/220 V, single-phase transformer has the following parameters: **10**

h.v. side: $r_1 = 3.6\ \Omega$, $x_1 = 8.4\ \Omega$,

l.v. side : $r_2 = 0.025\ \Omega$ $x_2 = 0.075\ \Omega$

(a) The transformer is made to deliver rated current at 0.8 lagging power factor, to a load connected on the l.v. side. If the load voltage is 220 V, calculate the terminal voltage on the h.v. side.

(b) The transformer exciting current is 4% of full-load current. Calculate voltmeter, ammeter and wattmeter readings for the open-circuit test at rated voltage and short-circuit test at rated current. The instruments are connected on l.v. side for open-circuit test and on h.v. side for the short circuit test.

## Group-C

Answer **any two** of the following: (14*2= 28)

Q9. (a) How a Rotating Magnetic Field is created in a Three Phase Induction Motor **02**

Q9. (b) What is Air Gap Power **02**

Q9.(c) A 3-phase, 400 V, 50 Hz induction motor takes a power input of 45 kW at its full-load speed of 960 rpm. The total stator losses are 1.5 kW and the friction and windage losses are 1.5 kW. Calculate the followings - (a) slip (b) rotor ohmic losses (c) shaft power (d) shaft torque (e) efficiency. **10**

Q10. (a) Why the Starting Power Factor of a Three Phase Induction Motor is poor **02**

Q10. (b) How the Mechanical Load is represented inside an Equivalent Circuit **02**

Q10. (c) A 400V, 50Hz, 3-phase star connected squirrel cage induction motor gave the following test results:

No Load Test: 400V, 9A, 560W
Blocked Rotor Test: 110V, 36A, 4820W
The effective stator resistance is 0.75Ω per phase. Calculate the equivalent circuit parameters.**10**

Q11. (a) Draw the Torque Speed Characteristics of a Three Phase Induction Motor **02**

Q11. (b) What are the Different Starting Methods of a Three Phase Induction Motor **02**

Q11. (c) In a 3-phase induction motor, the leakage reactance is four times the resistance for both stator and rotor circuits. But stator leakage reactance is equal to rotor standstill leakage reactance referred to stator. The motor develops a torque of 200Nm at a slip of 0.05. Compute the starting and maximum torques. Neglect exciting current.

Q12. (a) What are the different Methods of Speed Control of a Three Phase Induction Motor **02**

Q12. (b) Write the relation between $S$ and $S_{mT}$ in terms of T and $T_{max}$ ; Symbols have their usual meaning. **02**

Q12. (c) A 3-phase slip ring induction motor has a synchronous speed of 1500rpm and develops 4hp at 1410 rpm. Calculate the stator input if the stator power loss is 500W. If a resistance is inserted in the rotor circuit so that the mechanical power is 5hp at 1125rpm, then calculate the stator input assuming stator losses to be 150% of previous value. **10**

## Group-D

Answer **any one** of the following: (14*1= 14)

Q13. (a) What is two-field theory of a Single Phase Induction Motor? **02**

Q13. (b) Why a single phase induction motor has no starting torque? **02**

Q13. (c) A 220 V, single –phase induction motor has the following test results

No-load test: V = 220 V, I = 6 A , P = 350 V

Blocked-rotor test: V =125 V, I =15 A, P = 580 W

The stator winding resistance is 1.5 ohm measured with direct current. Estimate the power factor, output, efficiency. **10**

Q14. (a) What are the different types of starting method for Single Phase Induction motor? **02**

Q14. (b) How a revolving field is produced by external means in Single Phase Induction motor? **02**

Q14. (c) A 50Hz split phase induction motor has the following impedance at standstill:

Main winding: $r = 0.2$ ohm, $x = 5.0$ ohm

Starting winding: $r = 3.5$ ohm, $x = 6.0$ ohm

Determine the capacitance in series with the starting winding for maximum starting torque. **10**