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Question Paper Code: 41337

B.E. / B.Tech. DEGREE EXAMINATION, MAY 2016

Third Semester

Electronics and Communication Engineering

14UEE323 – ELECTRICAL MACHINES

(Common to Instrumentation and Control Engineering and Mechanical Engineering)

(Regulation 2014)

Duration: Three hours Maximum: 100 Marks

Answer ALL Questions

PART A - (10 x 1 = 10 Marks)

1. EMF induced in a coil rotating in a uniform magnetic field will be maximum when the

   (a) Flux linking with the coil is maximum
   (b) Rate of change of flux linkage is minimum
   (c) Rate of change of flux linkage is maximum
   (d) Rate of cutting flux by the coil sides is minimum

2. A DC shunt generator, when driven at its rated speed, is found to be not generating any voltage. Which of the following would account for this?

   (i) There is no residual magnetism
   (ii) The connection of the field winding is not proper with respect to armature terminals
   (iii) The resistance of the field circuit is greater than the critical field resistance
   (iv) The load resistance is less than the critical armature resistance

   Select the correct answer using the codes given below:

   (a) (iii) and (iv) (b) (i), (iii) and (iv)
   (c) (i), (ii) and (iii) (d) (i), (ii), (iii) and (iv)

3. If the supply frequency of a transformer is increased, keeping the supply voltage constant, then

   (a) Both magnetising component and core loss component of current will decrease
   (b) Both magnetising component and core loss component of current will increase
   (c) Magnetising component of current will increase while core loss component of current will decrease
   (d) Magnetising component of current will decrease while core loss component of current will increase

4. Full-load voltage regulation of a power transformer is zero when power factor of the load is near

   (a) Unity and leading (b) Zero and leading
   (c) Zero and lagging (d) Unity and lagging

5. In a 3-phase slip ring induction motor, the rotor winding terminals are brought out through slip-rings to

   (a) Connect extra resistance across them during starting
   (b) Connect them either in star or in delta as per need
   (c) Connect to 3-phase AC supply
   (d) Close the rotor circuit externally

6. Which one of the following statements is correct in respect of an induction motor?

   (a) The maximum torque will depend on rotor resistance
   (b) Although the maximum torque does not depend on rotor resistance, yet the speed at which maximum torque is produced depends on rotor resistance
   (c) The maximum torque will not depend on standstill rotor reactance
   (d) The slip of induction motor decreases as rotor increases

7. The frequency of EMF generated by an alternator depends upon the alternator speed (N in rpm) and number of poles on the alternator field P and is given as

   (a) $PN/60$ (b) $60N/P$ (c) $PN/120$ (d) $120N/P$

8. A synchronous motor is operating with normal excitation. With the increase in load the armature current drawn from the supply main increases due to

   (a) Increase in back emf (b) Fall in motor speed
   (c) Increase in resultant voltage across the armature (d) Increase in power factor

9. In a capacitor-start, capacitor-run single-phase induction motor if C_1 is the capacitance required for best starting torque and C_2 is the capacitance required for best running characteristic then

(a) C_1 is much smaller than C_2
(b) C_1 is approximately equal to C_2
(c) C_1 is much larger than C_2
(d) Nothing can be stated definitely regarding their relative merits

10. The motor which can produce uniform torque from standstill to synchronous speeds is

(a) Universal motor (b) Stepper motor
(c) Reluctance motor (d) Hysteresis motor

PART - B (5 x 2 = 10 Marks)

11. A DC shunt motor is connected to a 3-point starter. What would happen if the field circuit becomes open-circuited with the motor running at no load?

12. A single-phase transformer has 400 primary and 1000 secondary turns. The net cross-sectional area of the core is 60 cm^2. If the primary winding be connected to a 50 *Hz* supply at 500 *V*. Calculate the peak value of the flux density in the core.

13. What is the necessity of short-circuited rotor conductors in a 3-phase squired cage induction motor.

14. Mention the reasons if a 3-phase synchronous motor fails to start.

15. What happens when the brush axis of a repulsion motor is aligned with its stator pole axis?

PART - C (5 x 16 = 80 Marks)

16. (a) (i) Derive the EMF equation of DC generator. (8)

(ii) An 8-pole DC shunt generator has 778 wave-connected armature conductors running at 500 *rpm*, supplies a load of 12.5 *ohm* resistance at a terminal voltage of 250 *V*. The armature resistance is 0.24 *ohm* and the field resistance is 250 *ohm*. Find out the armature current, the induced EMF and the flux per pole. (8)

Or

(b) (i) A 5 *kW*, 230 *V*, DC shunt motor has an armature resistance of 0.5 *ohm* and a field resistance of 230 *ohm*. At no-load the motor runs at a speed of 1000 rpm and draws a current of 3 *A*. At full-load and rated voltage, the current drawn is 23 *A* and the armature reaction causes a drop of 2% in flux. Determine full-load speed and full-load torque. (8)

(ii) Discuss in detail the speed-torque characteristics of DC shunt motor, DC series motor with a neat sketch. (8)

17. (a) (i) What is an Ideal transformer? Derive an expression for induced EMF in a transformer in terms of frequency, the maximum value of flux and the number of turns on the windings. (10)

(ii) A 230/460 *V* transformer has a primary resistance of 0.2 *ohm* and a reactance of 0.5 *ohm* and the corresponding values for the secondary are 0.75 *ohm* and 1.8 *ohm* respectively. Find the secondary terminal voltage when supplying (I) 10 *A* at 0.8 p.f. lagging. (6)

Or

(b) A 15 *kVA*, 2300/230 *V*, 50 *Hz* single phase transformer gave the following test data:

Open-circuit test : $V_0 = 2300\ V$; $I_0 = 0.21\ A$; $W_0 = 50\ W$

Short-circuit test : $V_s = 47\ V$; $I_s = 6.0\ A$; $W_s = 160\ W$

Calculate the following

(i) Find the equivalent circuit parameters referred to high voltage side and draw the equivalent circuit

(ii) Calculate the full-load voltage regulation at 0.8 power factor lagging when the load voltage is held at 220 V

(iii) Determine the efficiency at half the rated load at unity power factor

(iv) Find the maximum efficiency and corresponding output power. Assume unity power factor (16)

18. (a) With the help of neat sketches brief about the differences between the 3-phase slip-ring induction motor and the 3-phase squirrel cage induction motor. (16)

Or

(b) Draw the exact equivalent circuit of a 3-phase induction motor. State the difference between the exact and approximate equivalents? Discuss. From the approximate equivalent circuit, find the rotor output, output power and output torque. Also find the slip at maximum torque. (16)

19. (a) (i) Starting from the first principles, derive the EMF equation of 3-phase synchronous generators or alternators. (8)

(ii) A 3-phase, 4-pole, 50 *Hz*, star-connected alternator has 60 slots with 2 conductors per slot and having armature winding of the double layer type. Coils are short-pitched, that is, if one coil side lies in slot number 1, the other coil side lies in slot number 13. Find the useful flux per pole required to induce a line voltage of 6.6 *kV*. (8)

Or

(b) (i) With a neat experimental setup, discuss the procedure to draw the families of curves of synchronous motor at no-load and full-load showing the relation between (a) armature current and field current (b) power factor and field current. (10)

(ii) A 3-phase, 500 *V*, synchronous motor draws a current of 50 *A* from the supply while driving a certain load. The stator is star connected with armature resistance of 0.4 *ohm* per phase and a synchronous reactance of 4 *ohm* per phase. Find the power factor at which motor would operate when the field current is adjusted to give the line values of generated EMF as (a) 600 *V* and (b) 380 *V*. (6)

20. (a) State the principle that the double revolving field theory makes use of. Discuss the performance of capacitor start capacitor run single-phase induction motor with a neat sketch. Mention their relative advantages and disadvantages. Also mention a few applications of a single-phase induction motor. (16)

Or

(b) Describe the constructional features and working of 'variable-reluctance type' stepper motors. (16)

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