ELECTRIC DRIVES & POWER UTILIZATION
(ELEC 4101)

Time Allotted : 3 hrs   **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and
<u>any 5 (five)</u> from Group B to E, taking <u>at least one</u> from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

   (i) Speed control by variation of field flux results in
   (a) constant power drive and variable torque drive
   (b) constant torque drive
   (c) variable power drive
   (d) none of these.

   (ii) A four quadrant operation requires
   (a) two full converters in series
   (b) two full converters connected in parallel
   (c) two full converter connected in back to back
   (d) two semi converters connected in back to back.

   (iii) In which braking back emf exceeds supply voltage?
   (a) Regenerative   (b) Dynamic
   (c) Plugging   (d) None of these.

   (iv) The slip of an induction motor during DC rheostatic braking is
   (a) 2-s   (b) 1-s   (c) s   (d) 1+s.

   (v) High braking torque is produced in
   (a) plugging   (b) dynamic braking
   (c) regenerative braking   (d) none of these.

   (vi) Method of speed control used in 25 kV, 50 Hz single phase traction is
   (a) tap changing control of transformer   (b) reduced current method
   (c) series parallel operation of motors   (d) any of the above.

   (vii) Which motor is used in tramways?
   (a) AC single phase capacitor start motor   (b) AC three phase motor
   (c) DC series motor   (d) DC shunt motor.

   (viii) The coefficient of adhesion is highest when
   (a) the rails are dry   (b) the rails are oiled
   (c) the rails are wet with dew   (d) the rails are dusty.

   (ix) The unit of solid angle is
   (a) solid angle   (b) radian   (c) steradian   (d) candela.

   (x) Which of the following lamp gives nearly monochromatic light?
   (a) Sodium vapor lamp   (b) GLS lamp
   (c) Tube light   (d) Mercury vapor lamp.

Group – B

2. (a) Explain the block diagram of electric drive in detail.

   (b) Mention four criteria for the choice of electric drive.

                                       8 + 4 = 12

3. (a) Derive the equation which represents the thermal model of a motor.

   (b) A motor is equipped with a flywheel is to supply a load torque of 1000 N-m for 10 sec followed by a light load of 200 N-m long enough for the flywheel to regain its steady state speed. It is desired to limit the motor to 700 N-m. What should be the moment of inertia of flywheel? Motor has inertia of 10 kg-m². It's no load speed is 500 rpm and the slip at a torque of 500 N-m is 5%. Assume speed-torque characteristics of motor to be a straight line in the region of interest.

                                       5 + 7 = 12

Group – C

4. (a) Explain the process of plugging along with speed torque characteristics.

   (b) A 220V, 970 rpm, 100 A DC separately excited motor has an armature resistance of 0.05Ω. It is braked by plugging from an initial speed of 1000 rpm. Calculate
   (i) Resistance to be placed in armature circuit to limit braking current to twice the full load value.
   (ii) Braking torque.
   (iii) Torque when the speed has fallen to zero.

                                       6 + 6 = 12

5. (a) Explain VSI fed Induction Motor drive.

(b) Explain static Kramer drive in detail in slip power recovery scheme for speed control of 3-Ø Induction Motor.

7 + 5 = 12

Group – D

6. (a) Explain the terms (i) coefficient of adhesion (ii) Tractive effort (iii) Gradient.

(b) A train with a locomotive having 4 motors has a total mass of 250 tonnes. Starting from rest the train attains a speed of 40 kmph in 20 seconds on a 1% up gradient. The gear ratio is 3, the gear efficiency 95%, the wheel diameter 95 cm, train resistance (average) is 40 N per tonne and rotational inertia is 10%. Find the torque developed by each of the motors and minimum weight of the locomotive, given the adhesive coefficient is 0.25.

(3 × 2) + 6 = 12

7. (a) Compare DC and AC systems of railway electrification from the view of main line and suburban line railway services and also explain composite system.

(b) Explain how power is utilised using series parallel starting in traction motors.

4 + 4 + 4 = 12

Group – E

8. (a) What is an integrating sphere? Explain its use in illumination engineering.

(b) A lamp of 500 c.p is placed 2 meters below, a plane mirror which reflects 80% of the light falling on it. Determine illumination at point 5 metres away from the foot of the lamp which is hung 5 metres above ground.

7 + 5 = 12

9. (a) Explain dielectric heating and mention limitation on the use of extremely high frequency for dielectric heating.

(b) A slab of material 2cm thick and 15 square cm in area, having relative permittivity 4 and p.f of 0.04 is to be heated using dielectric heating. The power required is 200 watts and a frequency of 30MHz. Determine the voltage required and the current that will flow through the material. If the voltage were to be limited to 600 V, what should be the frequency for the same power requirement.

6 + 6 = 12