[This question paper contains 4 printed pages.]

Your Roll No...............

Sr. No. of Question Paper : 5528 **J**

Unique Paper Code : 2512012401

Name of the Paper : Electrical Technology (DSC)

Name of the Course : **B.Sc. (H) Electronics**

Semester : IV (NEP UGCF)

Duration : 3 Hours Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **five** questions out of **seven**.
3. **First** Question is Compulsory.
4. **All** questions carry equal marks.
5. Non-programable scientific calculator is allowed.

1. (a) A 10 kVA, 240/120-V, 50-Hz transformer has a high voltage winding resistance of 0.1 Ω and a leakage reactance of 0.2 Ω. The low voltage winding resistance is 0.03 Ω and the leakage reactance is 0.01 Ω. Find the equivalent winding resistance, reactance and impedance referred to the high voltage side. (3)

   (b) Draw diagram of a DC long shunt compound wound generator and write its voltage equation (KVL equation). (3)

   (c) Why the speed of a DC shunt motor remains approximately constant with varying load, as compared to a DC series motor? (3)

   (d) A star-connected 3-phase induction motor is running when it is connected to 230V/50Hz line. State the frequency of rotor current when (a) it is rotating at near synchronous speed and (b) when rotor gets locked due to excessive physical load. (3)

   (e) Why a capacitor is used in a domestic ceiling fan? (3)

(f) Mention the types of losses that are (i) similar and (ii) unique to both DC and AC motors. (3)

2. (a) Prove that the emf induced in the transformer secondary is $4.44fN_2BmA$. where f is the frequency, N_2 is the number of turns in the secondary and Bm is the max. flux density and A is the cross sectional area of the core. The maximum flux density in the core of a 250/3000- volts, 50-Hz single-phase transformer is 1.2 Wb/m^2 If the e.m.f. per turn is 8V, determine primary and secondary turns. (6)

(b) A single-phase transformer with a ratio of 440/110-V takes a no-load current of 5A at 0.2 power factor lagging. If the secondary supplies a current of 120 A at a p.f. of 0.8 lagging, estimate the current taken by the primary. (6)

(c) Define voltage regulation in a transformer. Which of the losses in a transformer affect its voltage regulation and why? Which transformer is considered better, that with higher voltage regulation or lower voltage regulation. (6)

3. (a) What are constant losses and variable losses in a DC generator. How can each one of these be minimized. (6)

(b) A shunt generator delivers 195A at a terminal potential difference of 250V. The armature resistance and shunt field resistance are 0.02Ω and 50Ω respectively. Iron and friction losses equal 950W. Find (i) E.M.F. generated (ii) Copper loss (iii) commercial, mechanical, electrical efficiency. (6)

(c) Draw and explain the Internal characteristics of a DC shunt generator. Referring to the characteristics explain the limit on load resistance for build-up, if excited on load. Give reasons in support. (6)

4. (a) Write voltage equation of a D.C. shunt motor and hence derive the condition for maximum power developed in it. What is the significance of back E.M.F. in D.C. motor. (6)

(b) Explain the various characteristics of D.C. series motor with suitable diagrams. (6)

(c) A 230 V D.C. shunt motor runs at 800 r.p.m. and takes armature current of 50 A. Find resistance to be added to the field circuit to increase speed to 1000 r.p.m. at an armature current of 80A. Assume flux proportional to field current. Armature resistance = 0.15Ω and field winding resistance= 250Ω. (6)

5. (a) Plot instantaneous torque (i.e. with respect to time) generated in the rotor of a 3-phase induction motor along with rotor emf and rotor current. Plot another torque, emf, current curve(s) corresponding to relatively reduced power factor and explain the effect of power factor on torque. Suggest how the torque of a 3-phase induction motor can be increased in real-life applications. (6)

(b) The expression for the running torque of a 3-phase induction motor is given by (6)

$$T = \frac{K \cdot s \cdot E_2^2 \cdot R_2}{R_2^2 + (sX_2)^2}$$

Where

K is a proportionality constant,

s is the slip,

E_2 is the rotor EMF per phase at standstill,

R_2 is the rotor resistance per phase,

X_2 is the rotor reactance per phase at standstill.

Derive the expression for maximum torque in the induction motor under running condition.

For N_s = 1500 rpm and taking arbitrary value for starting torque and maximum torque, plot LABELLED "Torque Vs Speed" curve for a 3-phase induction motor for :

(i) Rotor resistance = 0.3Ω and rotor reactance = 1.5Ω.

(ii) Additional external resistance of 0.3Ω connected in series with the rotor

(iii) Rotor resistance made equal to rotor reactance

(c) The rotor of 3-phase induction motor with resistance and reactance of 1Ω and 4Ω respectively, is star connected and has an induced e.m.f. of 80V between the slip-rings at standstill. Given N_s = 6000 rpm. Calculate

(i) Rotor current per phase and starting torque

(ii) Rotor current per phase and starting torque if additional 3Ω resistance is connected in series with the rotor.

(iii) State the reason for increase in starting torque in case (ii) despite decrease in current. (6)

6. (a) Why single-phase induction motor is not self-starting? Describe any 2 methods to make a single-phase induction motor rotate on its own. (6)

(b) Draw diagram of a capacitor-start single phase induction motor. Explain, giving the phase relationship between its currents and applied voltage, how the use of higher capacitance improves its power factor. What effect does higher power factor has on its torque and why? (6)

(c) Compare a Universal motor with a DC motor and a single-phase induction motor. Describe how it run on single-phase ac without the need of a capacitor in the absence of a rotating magnetic field. (6)

7. (a) Enumerate the advantages of having stationary armature and rotating field system in an alternator (synchronous generator) in contrast to a DC generator. State 2 real-life applications of such a generator. (6)

(b) Give reason for the need of (i) an auxiliary motor and (ii) DC excitation, in starting of a synchronous motor. Compare the starting torque of a synchronous motor with single-phase induction motor and 3-phase induction motor, citing reason thereof. (6)

(c) What advantages does a synchronous motor has over a 3-phase induction motor. (6)