Code: A-10 **Subject: ELECTRICAL ENGINEERING**
Time: 3 Hours **June 2006** **Max. Marks: 100**

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or best alternative in the following: (2x10)

a. The polarity test is not necessary for the single-phase transformer shown in Fig. 1 so as to correctly determine _____ of the transformer.

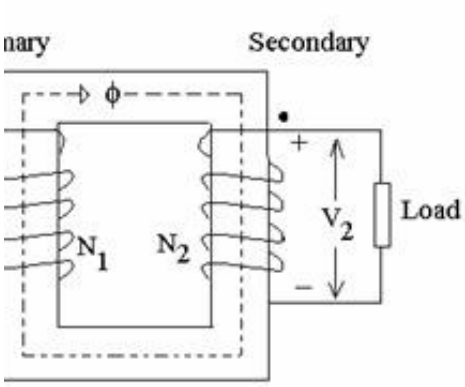

Fig. 1

(A) shunt branch parameters.
(B) transformation ratio.
(C) series parameters.
(D) any of the above characteristics.

b. The short-circuit ratio of a typical synchronous machine is obtained from the OCC and SCC curves of Fig.2 as

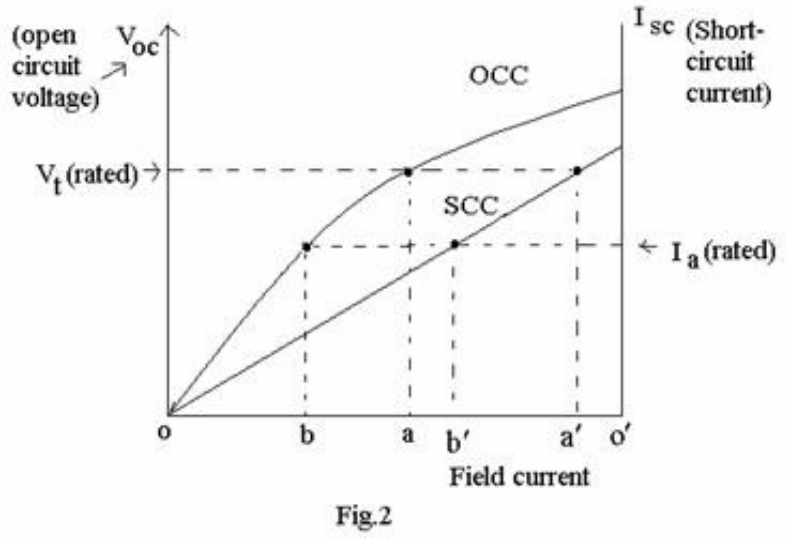

Fig.2

(A) $\frac{oa}{ob}$

(B) $\frac{oa'}{ob'}$

(C) $\frac{oa}{ob'}$

(D) $\frac{oc'}{ob}$

c. The speed-torque characteristics of a DC series motor are approximately similar to those of the _____motor.

(A) universal **(B)** synchronous
(C) DC shunt **(D)** two-phase

d. The rotor frequency for a 3 phase 1000 RPM 6 pole induction motor with a slip of 0.04 is_____Hz

(A) 8 **(B)** 4
(C) 6 **(D)** 2

e. The torque-speed characteristics of an a.c. operated universal motor has a _____characteristic and it_____ be started under no-load condition.

(A) inverse, can **(B)** nearly inverse, can
(C) inverse, cannot **(D)** nearly inverse, cannot

f. In the heating process of the _____type a simple method of temperature control is possible by means of a special alloy which loses its magnetic properties at a particular high temperature and regains them when cooled to a temperature below this value.

(A) Indirect induction over **(B)** core type induction furnace
(C) coreless induction furnace **(D)** high frequency eddy current

g. In order to reduce the harmful effects of harmonics on the a.c. side of a high voltage D.C. transmission system _____are provided.

(A) synchronous condensers **(B)** shunt capacitors
(C) shunt filters **(D)** static compensators

h. An a.c. tachometer is just a _____with one phase excited from the carrier frequency.

(A) two-phase a.c. servomotor **(B)** two-phase induction motor
(C) a.c. operated universal motor **(D)** hybrid stepper motor.

i. The torque, in a _____is proportional to the square of the armature current

(A) DC shunt motor **(B)** stepper motor
(C) 2-phase servomotor **(D)** DC series motor

j. The synchronous speed for a 3 phase 6-pole induction motor is 1200 rpm. If the number of poles is now reduced to 4 with the frequency remaining constant, the rotor speed with a slip of 5% will be _____.

(A) 1690 rpm **(B)** 1750 rpm
(C) 1500 rpm **(D)** 1710 rpm

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

Q.2 a. The losses of a 30 kVA, 2000/200 V transformer are

Iron losses: 360 W
Full load copper losses : 480 W

Calculate the efficiency at unity power factor for (i) full load and (ii) half load. Also determine the

load for maximum efficiency; also compute the iron and copper losses for this maximum efficiency condition. **(12)**

b. What are the various losses occurring in a transformer? **(4)**

Q.3 a. Describe how the synchronous reactance of a synchronous machine is determined. **(6)**

b. A 22 KV, 3 phase star-connected turbo- alternator with a synchronous impedance of 1.4 Ω /phase is delivering 240 MW at unity p.f. to a 22 KV grid. If the excitation is increased by 25%, then the turbine power is increased till the machine delivers 280 MW. Calculate the new current and power factor.
(10)

Q.4 a. Explain how speed control is achieved for DC shunt motors. **(4)**

b. A 250 V DC shunt motor has an armature resistance of 0.55 Ω and runs with a full load armature current of 30A. The field current remaining constant, if an additional resistance of 0.75 Ω is added in series with the armature, the motor attains a speed of 633 RPM. If now the armature resistance is restored back to 0.55Ω, find the speed with (i) full load and (ii) twice full load torque. **(12)**

Q.5 a. Explain how the circuit model of an induction motor is obtained from no-load and block-rotor tests. **(4)**

b. A 4-pole, 3 phase, 400 v, 50 Hz, induction motor has the following parameters for its circuit model (rotor quantities referred to the stator side) on an equivalent-star basis:

$R_1 = 1.6\Omega.\ X_1 = 2.4\Omega.\ R_2^1 = 0.48\Omega, X_2^1 = 1.2\Omega$ and $X_m = 40\ \Omega$. Rotational losses are 720 W. Neglect stator copper losses. For a speed of 1470 RPM, calculate the input current, input power factor, net mechanical power output, torque and efficiency. **(12)**

Q.6 a. Draw the torque-speed characteristics of a single phase induction motor and explain how it can be obtained. **(6)**

b. A universal motor has a 2-pole armature with 1020 conductors. When it is operated on load with a.c. supply with an armature voltage of 150, the motor speed is 5400 RPM. The other data is:
Input power : 360 W
Armature current : 5.2 A
Armature resistance: 5.5 Ω

Compute (i) the effective armature reactance and (ii) maximum value of armature flux per pole. **(10)**

Q.7 a. List out the important advantages of HVDC transmission. **(8)**

b. A single phase generator supplies an inductive load of 4800 KW at a power factor of 0.6 lagging by means of an overhead line which is 25 km long. The line resistance and inductance are respectively 0.02 Ω and 0.58 m H per km. The voltage at the receiving end is to be kept constant at 10.5 KV. Find the sending end voltage and the voltage regulation of the line. **(8)**

Q.8 a. Describe the primary and back-up protection features that are provided for transmission lines. **(8)**

b. Describe a typical coreless type of induction furnace and its special features. **(8)**

Q.9 Write notes on **ANY TWO** of the following:

(i) Differential relays.
(ii) Inductive interference in a transmission line.
(iii) Nickel-cadmium cells. **(8+8)**