National Exams

16-Elec-A6 Power Systems and Machines

Notes:

1. **FIVE (5)** questions constitute a complete exam paper. All questions are of equal value.

2. Neatness is important. Start each question on a new page, and clearly indicate the question number. Only work written on the right hand pages of the answer booklets will be marked. Use the pages on the left side for rough work only - ***work presented on the left hand side pages will NOT be marked***.

3. You may use one of the approved Casio or Sharp calculators.
4. This is a closed book exam but one aid sheet (8 ½" by 11") is allowed written on both sides. **No worked out solutions are allowed on this sheet.**
5. All ac voltages and currents are rms values unless noted otherwise. For three-phase circuits, all voltages are line-to-line voltages unless noted otherwise, and power is total real power unless noted otherwise.
6. You are strongly encouraged to use a pencil and eraser for this exam.

If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper a clear statement of any assumptions made.

Question 1

The mean radius of a toroid is 25cm (r_{av}) and its cross-sectional area is 3 cm^2 (Figure 1). The toroid is wound with a coil of N turns (600) and a direct current of 1.5A (*I*) is passed through the coil. Assume the relative permeability of the toroid is 1500. Calculate:

(a) the reluctance of the cct;

(b) the magnetomotive force, and magnetic field intensity; and,

(c) the flux and flux density inside the toroid.

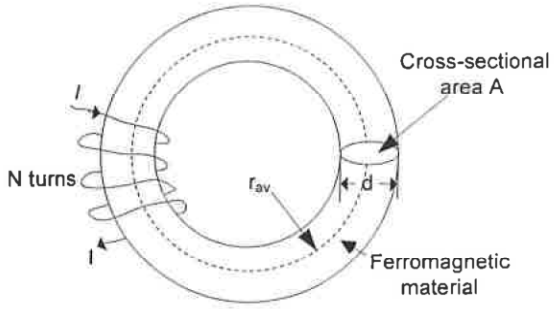

Figure 1: Partially wound toroid

Question 2

A 2300/240V, 48 kVA, 60Hz, R_1 =0.6Ω, R_2 =0.025Ω transformer requires a voltage of 238V for rated current to flow in the secondary when it is short circuited. Determine:

(a) X_{eq};

(b) P required for rated current/voltage; and,

(c) The efficiency if the load is rated load at 0.8 p.f. lagging
Assume that losses are too small to account for.

Question 3

The following test results were obtained for a 75 kVA, 2200/220 V, 60 Hz single-phase transformer:

Open-circuit Test	Short-circuit test
VOC = 220 V	VSC =42 V
IOC = 9.6 A	ISC = 57 A
POC = 710 W	PSC = 1030 W

(a) determine the approximate equivalent circuit for this transformer, with all voltages referred to the high voltage side.

(b) sketch the approximate equivalent circuit for this transformer, with all voltages referred to the high voltage side.

Question 4

The energy consumption in a factory is 100kVA at 0.45 p.f. lagging, 60Hz. A synchronous motor with 0.2 p.f. leading is added to the load. The power intake of the synchronous motor is 10kW. Determine:

(a) total real power consumption;
(b) overall p.f.; and,
(c) if the supply frequency is reduced by 5% and the load by 10% if the synchronous motor has a power angle of 35 for rated voltage, frequency and torque.

Question 5

(a) When a 3 phase motor is connected to a delta power supply, will it work if one of power supply legs opens? Explain why or why not?

(b) Explain generator droop and how it is calculated.

(c) Why is a synchronous motor not self-starting?

(d) Give five important specifications to be considered in selecting induction motors.

(e) Large utility customers with low power factor often pay a penalty for it. Why is that?

(f) A distribution transformer is rated at 18 kVA, 20 kV/480 V, and 60 Hz. Can this transformer safely supply 15 kVA to a 415 V load at 50 Hz? Why or why not?

(g) Why is the efficiency of an induction motor so poor at high slip?

(h) Harmonics can be damaging to power systems in general. Give three causes of harmonics and their potential effects on the power system.

(i) Why the iron core of a transformer is laminated and name three causes of damage to the core?