Cork Institute of Technology

Higher Certificate in Engineering in Electrical Engineering-Award

(National Certificate in Engineering in Electrical Engineering-Award)

(NFQ-Level 6)

Autumn 2005

Electrical Engineering

(Time: 3 Hours)

Attempt **Five** Questions

Booklet of Electrical Engineering Formulae to be available to Students

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1. (a) Three similar circuits, connected in star, take a total power of 1.5 kW at a power factor of 0.2 leading from a three-phase 400 V, 50 Hz supply. Calculate the resistance and capacitance of each circuit. (12 marks)

   (b) If one of the circuits is short-circuited calculate the resulting current in each line. (8 marks)

2 (a) An increase in the secondary current in a transformer results in an increase in the primary current. Explain how this takes place and what is the relationship between these current changes. (5 marks)

   (b) A 100 kVA single-phase transformer has an iron loss of 400 W and a copper loss of 1.2 kW at full load. Calculate the efficiency at half load when the power-factor is 0.8 lagging. (10 marks)

   (c) At what value of load is the efficiency of this transformer maximum and calculate the maximum efficiency. (5 marks)

3. (a) The load taken from an a.c. supply consists of: (a) a heating load of 6kW at unity power-factor; (b) a motor load of 8kVA at 0.6 power-factor lagging; (c) a load of 10kW at 0.7 power-factor lagging.

Calculate the total load from the supply in kW and kVA and its power-factor.

(7 marks)

What would be the kVAr rating of a capacitor to bring the power-factor to 0.95 lagging and how would the capacitor be connected? (3 marks)

(b) A resistance of 200 Ω is connected in series with two impedances of 480 - j360 Ω and 400 + j200 Ω, which are in parallel. Calculate the current in each impedance and the power factor of the main current when the combined circuit is supplied at 500 V. Find also the voltage across each circuit component. (10 marks)

4. (a) With the aid of diagrams show how a rotating magnetic field may be produced in a three-phase induction motor. You need only show a 60^{o} rotation. How could the direction of such a rotating field be reversed? (6 marks)

(b) A four pole induction motor is connected to a normal voltage 50 Hz supply. The E.M.F. between the slip rings at standstill is 120 V and the rotor resistance and standstill reactance per phase are 0.5 Ω and 4.5 Ω respectively. If the full load speed of the motor is 1450 rev/min. Calculate the rotor current and power factor at full load if the slip rings are short-circuited. (10 marks)

(c) At what speed does maximum torque occur and what is the rotor current when the torque is maximum? (4 marks)

5 (a) In the three-phase four-wire distribution system it is normal to distribute the loads across the phases. Why is this? (5 marks)

(b) A school has the following single-phase loads in its workshop area:

R 10 kW at unity power factor,

Y 6 kW at 0.7 lagging power factor,

B 4 kW at 0.8 lagging power factor.

If the supply is 400V three phase four-wire calculate the current in each line and the neutral current. Assume the phase sequence to be RYB.(15 marks)

6. (a) How can the speed of a shunt type motor be varied? (6 marks)

(b) A shunt type D.C. motor is supplied at 460 V and under no load conditions takes a current of 3.2 A and runs at 1200 rev/min. The armature resistance is 0.4 Ω and the resistance of the shunt field is 200 Ω. A resistance is connected in series with the shunt field for speed control. When the motor is at full load the armature current is 43A and the motor runs at a speed of 1190 rev/min. Assuming that the flux is proportional to the field current and ignoring the effects of armature reaction, find the value of the series resistor in the field circuit. (14 marks)

7. Define the time-constant as applied to a R-C circuit. (6 marks)

A 50 μF capacitor in series with an insulation resistance of 2.2 MΩ is connected across a 100 V supply for 100 s. The supply is then removed and the charged capacitor is shorted across a 5 MΩ resistor. Find the voltage across the capacitor 100s after the short has been applied. (14 marks)