Universiti Tun Hussein Onn Malaysia

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER II
## SESSION 2016/2017



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| COURSE NAME | : | ELECTRICAL TECHNOLOGY |
| COURSE CODE | : | BEE 10403 |
| PROGRAMME CODE | : | BEJ |
| EXAMINATION DATE | : | JUNE 2017 |
| DURATION | : | 3 HOURS |
| INSTRUCTION | : | ANSWER ALL QUESTIONS |

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

**Q1** A balanced three-phase system (abc sequence) is connected in wye-wye connection with phase voltage at 100V. The line impedance and load impedance are 5 – j2 Ω and 10+j8 Ω, respectively.

(a) Calculate the line current for each line.
(4 marks)

(b) Calculate the total complex power, average power and reactive power at the source.
(4 marks)

(c) Calculate the total complex power, average power and reactive power at the load.
(4 marks)

(d) Calculate the total complex power, average power and reactive power at the line.
(4 marks)

(e) Prove that the system is balanced based on your findings.
(4 marks)

**Q2** (a) Describe the differences between permanent magnet and electromagnet.
(5 marks)

(b) Using an appropriate diagram from a specific rule, explain how to determine the direction of current flowing in a conductor and the magnetic field.
(5 marks)

(c) A closed magnetic circuit of cast steel contains a 7 cm long path of cross-sectional area 1.5 $cm^2$ and a 2 cm path of cross-sectional area of 0.5 $cm^2$. A coil of 300 turns is wound around the 7 cm length of the circuit and a current of 0.5 A flows. If the relative permeability of the cast steel is 750, determine the flux density in the 7 cm path of the cast steel.
(10 marks)

**Q3** (a) Sketch the approximate transformer model that is (please label your sketch appropriately):

(i) Referred to the primary.
(1 mark)



(ii) Referred to the secondary.
(1 mark)

(iii) With no excitation branch, referred to the primary.
(1 mark)

(iv) With no excitation branch, referred to the secondary.
(1 mark)

(b) A 500 kVA 30kV/240V transformer has the following parameters:

$R_p = 0.5\ \Omega$ $X_p = 0.4\ \Omega$ $R_c = 20\ k\Omega$

$R_s = 2\ m\Omega$ $X_s = 4\ m\Omega$ $X_m = 5\ k\Omega$

By using the equivalent circuit referred to the primary as that illustrated in **Figure Q3(b)**, compute the primary voltage of the transformer at the rated load with 0.85 lagging power factor.

(16 marks)

**Q4** (a) (i) Name various power losses in a DC machine.

(2 marks)

(ii) Suggest **two (2)** methods to increase the turning force (or torque) of a DC motor.

(3 marks)

(iii) A four pole, 40 kW, DC machine operating at 1500 rpm has a generated emf of 124 V. If the speed is reduced to 80% of its original value, and the pole flux is doubled, develop: Induced emf and frequency of the rectangular wave in the armature winding.

(5 marks)

(b) A 24 V shunt DC machine in **Figure Q4(b)** has an armature resistance of 0.5 Ω and a field resistance of 100 Ω. At no load, the motor takes a line current of 0.5 A while running at 2500 rpm. If the line current at full load is 4 A,

(i) Find the field current and the induced voltage when there is no load.

(5 marks)

(ii) Find the full load speed and the speed regulation of the DC motor.

(5 marks)

**Q5** (a) Briefly explain about

(i) The working principle of synchronous motor.

(5 marks)

(ii) The differences between synchronous machine and induction machine.

(3 marks)

(b) A synchronous motor that connected to 3980 V, 3-phase line develops an excitation voltage $E_o$ of 1790 V (line to neutral) when the DC exciting current is 25 A as illustrated in **Figure Q5(b)**. The synchronous reactance is 22 Ω and the torque angle is 30°. Show the answers of the following questions in polar forms with **TWO (2)** decimal places.

(i) Compute the voltage across the synchronous reactance.

(3 marks)

(ii) Compute the ac line current.

(2 marks)

(iii) Compute the power factor of the motor.

(2 marks)

(iv) Compute the input power.

(2 marks)

(v) Sketch the phasor diagram.

(3 marks)

**- END OF QUESTIONS -**

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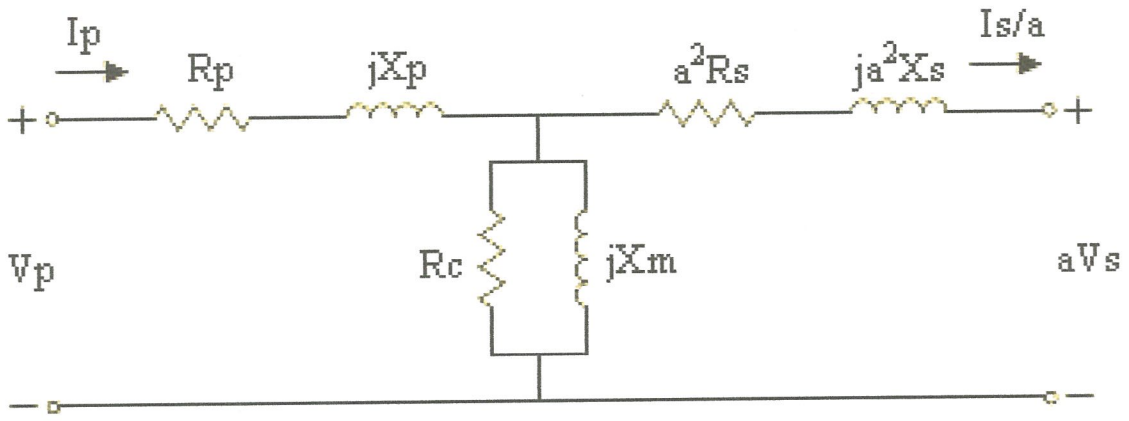


**Figure Q3(b)**

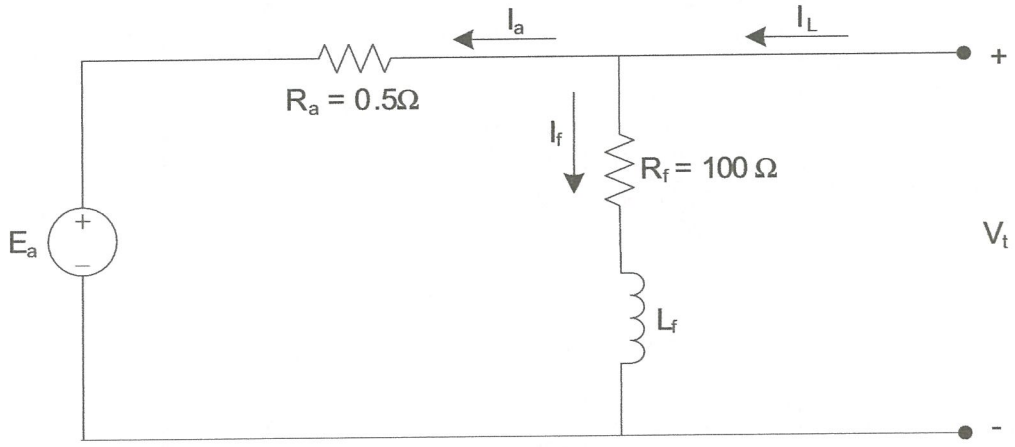


**Figure Q4(b)**

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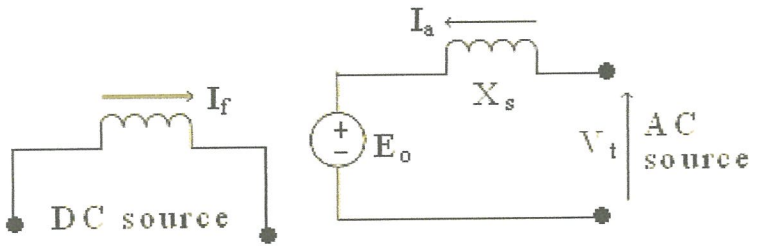


**Figure Q5(b)**

## List of Formulae and Constant

1. $\beta = \mu H$ (unit: Tesla, T)

2. mmf (or $F_m$) = $NI = Hl$ (unit: Ampere-turns, At)

3. $S$ (or $R$) =$l/\mu A$ = mmf/$\phi$ (unit: Ampere-turns/weber, At/Wb)

4. $\phi_{\max} = B_{\max} a_{area}$ (unit: Weber, Wb)

5. $E = 4.44 f N \phi_m$ (unit: Volt, V)

6. $a = \frac{v_p}{v_e} = \frac{e_p}{e_s} = \frac{N_p}{N_s}$ (unit: -)

7. Permeability of vacuum, $\mu_0 = 4\pi \times 10^{-7}$ Wb/At.m (or H/m)