Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	ELECTRICAL TECHNOLOGY
COURSE CODE	:	BEE 10403
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	DECEMBER 2019/JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER ALL QUESTIONS

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

Q1 (a) 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 $5 - j2\ \Omega$ and $10 + j8\ \Omega$, respectively.

(i) Calculate the line current for each line.

(3 marks)

(ii) Calculate the total complex power, average power and reactive power at the source.

(3 marks)

(iii) Calculate the total complex power, average power and reactive power at the load.

(3 marks)

(iv) Calculate the total complex power, average power and reactive power at the line.

(3 marks)

(v) Prove that the system is balanced based on your findings.

(2 marks)

(b) For a $\Delta - \Delta$ balanced system, a line to line voltage of V_{ab} = 173 V and a load of Z_a=30+j10 Ω. If the source voltage are in positive sequence, determine the phase and line currents.

(6 marks)

Q2 (a) Describe the two conditions of 'the right hand rule' using a simple diagram.

(3 marks)

(b) A coil of 300 turns is wound uniformly on a ring of non-magnetic material. The ring has a mean circumference of 40 cm and a uniform cross sectional area of 4 cm^2. If the current in the coil is 5 A and the relative permeability of non-magnetic material is 1, calculate

(i) The magnetic field strength, H

(3 marks)

(ii) The flux density, β

(2 marks)

(iii) The total magnetic flux in the ring, Φ

(2 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, analyze the flux density in the 7 cm path of the cast steel.

(10 marks)

Q3 (a) A 5 kVA, 200 V / 100 V, 50 Hz, single phase ideal two winding transformer is used to step up a voltage of 200 V to 300 V by connecting it as an auto transformer.

(i) Show the connection diagram of the auto transformer that is used to step up a voltage of 200 V to 300 V with all important labels of V_L, I_L, V_{SE}, V_C, I_H, and V_H.

(4 marks)

(ii) Recommend the maximum value of kVA that can be handled by the autotransformer (without over loading any of coil).

(4 marks)

(iii) Determine the value of kVA that is transferred magnetically and the kVA that is transferred by electrical conduction.

(2 marks)

(b) A 500 kVA 30 kV/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 V_{Rc} (i.e. the voltage across the resistor, R_c) of the transformer at the rated load with 0.85 lagging power factor.

(10 marks)

Q4 (a) (i) Explain two main power losses in a Direct Current (DC) machine.

(3 marks)

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

(3 marks)

(iii) Differentiate between DC motors and DC generators.

(2 marks)

(b) A 12 V shunt DC machine in **Figure Q4(b)** has an armature resistance of 0.5 Ω and a field resistance of 100 Ω. The line current at full load is 2 A. At no load, the DC machine takes a line current of 0.5 A while running at 2500 rpm.

(i) Classify the DC machine with a concise explanation.

(2 marks)

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

(5 marks)

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

(5 marks)

Q5 (a) Briefly explain the followings:

(i) The working principle of a three-phase synchronous motor.

(5 marks)

(ii) The differences between a synchronous motor and an induction motor.

(3 marks)

(b) A synchronous motor that is connected to 4000V, 3-phase line develops an excitation voltage E_o of 1500 V (line to neutral) when the DC exciting current is 25A 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, E_x.

(4 marks)

(ii) Compute the AC line current, I.

(2 marks)

(iii) Compute the power factor of the motor, *p.f.*

(3 marks)

(iv) Draw the phasor diagram.

(3 marks)

- END OF QUESTIONS -

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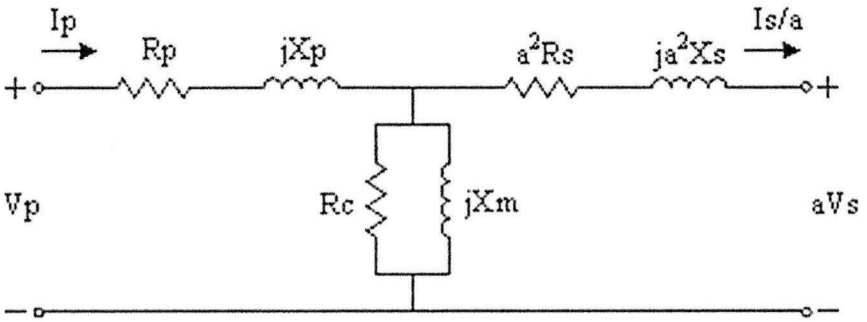

Figure Q3(b)

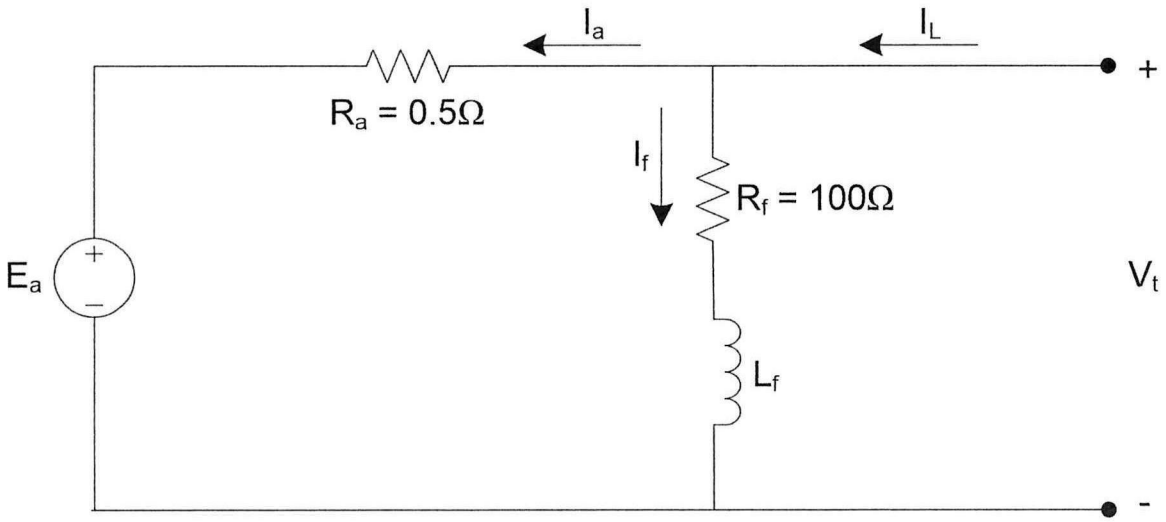

Figure Q4(b)

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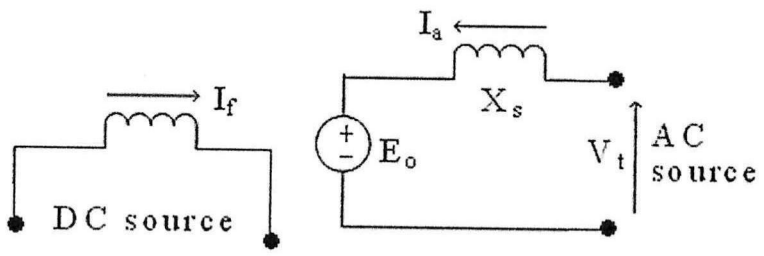

Figure Q5(b)

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/ϕ (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)