Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2016/2017

COURSE NAME	:	ELECTRICAL TECHNOLOGY
COURSE CODE	:	BEE 10403
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	DECEMBER 2016 / JANUARY 2017
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWERS ALL **FIVE (5)** 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) A closed magnetic circuit of cast steel contains a 2 cm long path of cross-sectional area 0.5 cm^2 and a 6 cm path of cross-sectional area of 1 cm^2. A coil of 100 turns is wound around the 6 cm length of the circuit and a current of 0.8 flows. If the relative permeability of the cast steel is 750, determine the flux density in the 2 cm path of the cast steel.

(10 marks)

(b) Explain the principle of electromagnet.

(2 marks)

(c) Differentiate a permanent magnet and an electromagnet.

(3 marks)

(d) If only a permanent magnet and a wire are given, propose a way to supply **sufficient** electricity to a 12V halogen lamp with a concise justification that related to Faraday's law.

(5 marks)

Q3 (a) A 500 kVA 30kV/240V transformer has the following parameters:

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

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

By using the equivalent circuit referred to the primary as that illustrated in **Figure Q3(a)**, compute the primary voltage of the transformer at the rated load with 0.8 lagging power factor in **TWO (2)** decimal places.

(14 marks)

(b) A 5kVA, 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) Sketch the connection diagram of the auto transformer that is used to step up a voltage of 200V to 300V with all important labels of V_L, I_L, V_{SE}, V_C, I_H, and V_H.

(3 marks)

(ii) Estimate the maximum kVA that can be handled by the autotransformer without over loading any of the high voltage (HV) and low voltage (LV) coils.

(3 marks)

Q4 (a) DC machines can be categorized as DC motors and DC generators.

(i) Differentiate between DC motors and DC generators.

(3 marks)

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

(3 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) Classify the DC machine with a concise justification.

(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)

(iv) Relate the speed of the DC motor to its load a concise justification.

(2 marks)

Q5 (a) Explain briefly about

(i) The working principle of synchronous motor.

(5 marks)

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

(3 marks)

(b) The excitation voltage of a synchronous machine is 588.5 V (line to neutral) when the armature current is $5\angle -50^\circ$ A as illustrated in **Figure Q5(b).** The synchronous reactance is 22 Ω and the torque angle is 6.9 °. Show the answers of the following questions in polar forms with **TWO (2)** decimal places.

(i) Classify the synchronous machine with a concise justification.

(2 marks)

(ii) Compute the voltage across the synchronous reactance.

(2 marks)

(iii) Compute the terminal voltage of the machine.

(3 marks)

(iv) Compute the power factor of the machine.

(2 marks)

(v) Sketch the completed phasor diagram of the machine.

(3 marks)

-END OF QUESTIONS -

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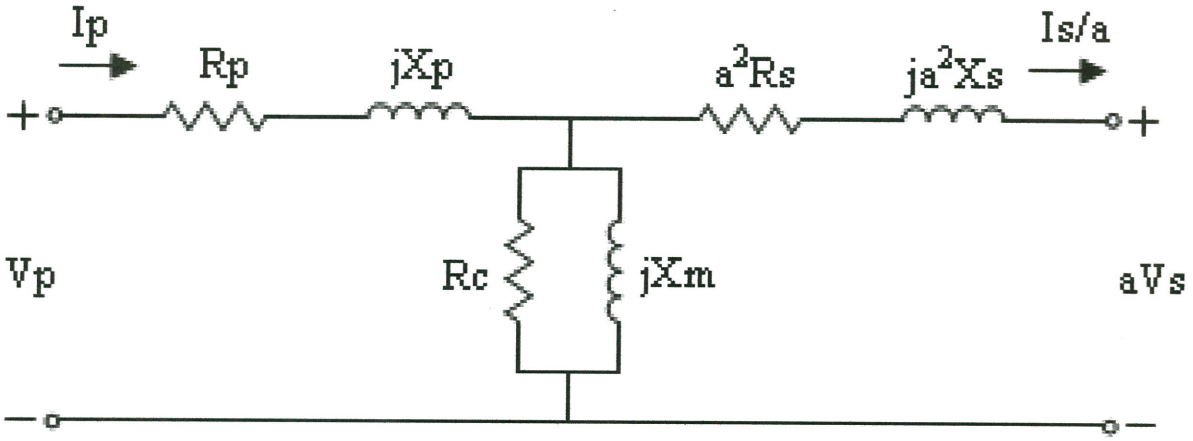

Figure Q3(a)

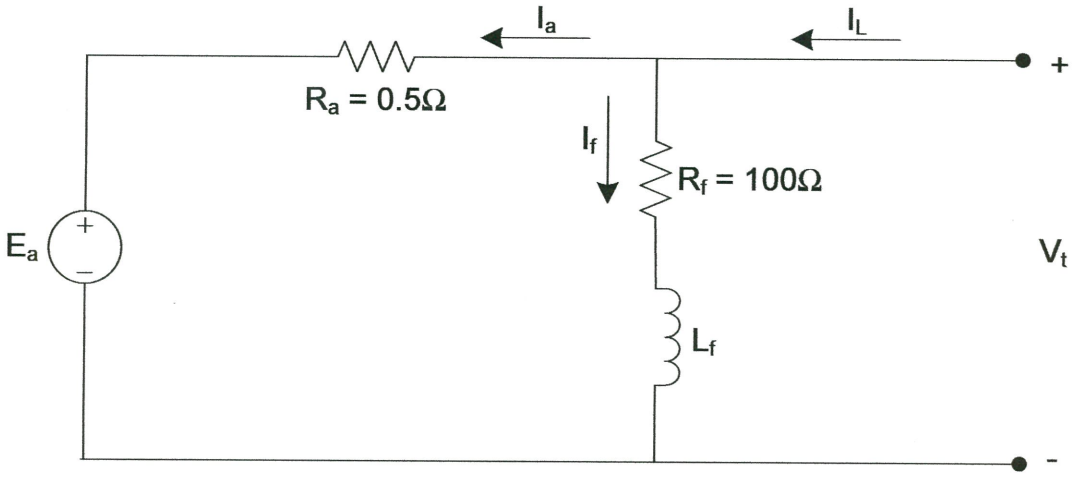

Figure Q4(b)

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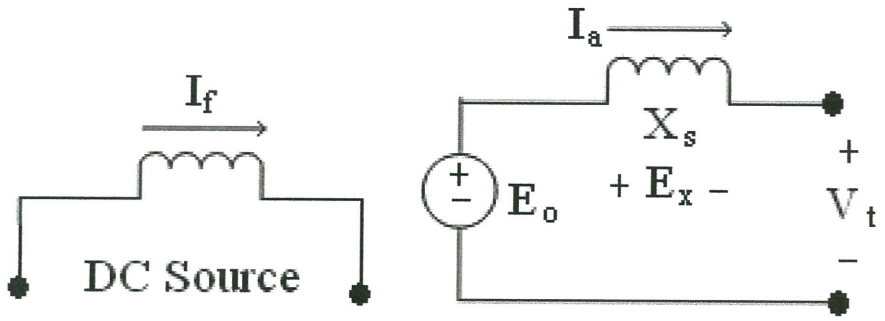

Figure Q5(b)

List of Formulae and Constant

No.	Formula / Constant	Unit
1	$\beta = \mu H$	Tesla, T
2	mmf (or F_m) = $NI = Hl$	Ampere-turns, At
3	S (or R) = $l/\mu A$ = mmf/ϕ	Ampere-turns/weber, At/Wb
4	$\phi_{max} = B_{max} a_{area}$	Weber, Wb
5	$E = 4.44 f N \phi_m$	Volt, V
6	$a = \frac{v_p}{v_e} = \frac{e_p}{e_s} = \frac{N_p}{N_s}$	
7	Permeability of vacuum, $\mu_0 = 4\pi \times 10^{-7}$	Wb/At.m (or H/m)