UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2010/2011

COURSE	: ELECTRICAL TECHNOLOGY
COURSE CODE	: BEE 1123/10403
PROGRAMME	: 1 BEE
EXAMINATION DATE	: APRIL/MAY 2011
DURATION	: 2 HOURS 30 MINUTES
INSTRUCTION	: ANSWER ALL QUESTIONS

THIS PAPER CONSIST OF NINE (9) PAGES

Q1 (a) (i) Briefly define peak-to-peak, V_{pp}, peak, V_p, and root mean square value, V_{rms}, of a sine wave voltage.

(3 marks)

(ii) Illustrate the sine wave value in Q1 (a) (i) in a sine wave diagram and express the equation that shows the relationship between the root mean square, V_{rms}, and peak-to-peak voltage values, V_{pp}, with the peak voltage values, V_p.

(4 marks)

(b) Consider the sine wave voltages shown in Figure Q1(b). The frequency of each signal is $f = 50$ Hz.

(i) State the time domain expression for each voltage in the form of $V_m \cos(\omega t + \varphi)$.

(4 marks)

(ii) Determine the instantaneous value of each voltage in Figure Q1(b) if the phase angle, θ equal to 45^0

(3 marks)

(iii) Sketch the phasor diagrams for all the sine wave voltage in Figure Q1(b).

(4 marks)

(iv) Determine the phase relationship between V_1 and V_2 and between V_1 and V_3

(2 marks)

(c) Solve the following complex number and leaves the result in polar form.

(i) $\dfrac{15\angle 45^0}{-3-j4} + j2$

(ii) $\dfrac{8\angle -20^0}{(2+j)(3-j4)} + \dfrac{10}{-5+j12}$

(5 marks)

Q2 (a) Explain briefly what is Lenz's law.

(1 mark)

(b) Figure Q2(b) shows the variation of X_L and X_c for a series RCL circuits with frequency, *f*. Based on the graph, explain how the circuit behaves at:

(i) High frequency

(ii) Low frequency

(4 marks)

(c) Figure Q2(c) is a series circuit with the input voltage, $v_s\ (t)$ = 240 cos(314t + 30^0) V, R = 100 Ω, L = 0.3 H and C = 40 μF. Assume the frequency is 50 Hz. Determine:

(i) the total equivalent impedance of the circuit, Z_{eq} in polar form.

(3 marks)

(ii) the steady-state current of the circuit, $i_1(t)$.

(3 marks)

(iii) the phasor voltage across each element.

(3 marks)

(iv) Construct a phasor diagram showing all the current and the voltages in the circuit.

(2 marks)

(d) Let say R, L and C in Figure Q2(c) is connected in parallel to each other. Assume the frequency is 50 Hz. Determine:

(i) the total equivalent impedance of the circuit, Z_{eq} in polar form.

(2 marks)

(ii) the steady-state current of the circuit, $i_1(t)$.

(2 marks)

(iii) the phasor current across each element

(3 marks)

(iv) Construct a phasor diagram showing all the current and the voltages in the circuit.

(2 marks)

Q3 (a) Define the following terms:

(i) Average power
(ii) Apparent power
(iii) Complex power
(iv) Reactive power
(v) Power factor

(5 marks)

(b) Consider the circuit shown in Figure Q3(b). Determine ***I*** by using:

(i) Nodal analysis

(6 marks)

(ii) Mesh analysis

(8 marks)

(c) In the circuit of Figure Q3(c), if $V_{ab} = 440\angle 10^{0}\,V$, $V_{bc} = 440\angle 250^{0}\,V$, $V_{ca} = 440\angle 130^{0}$ V, find:

(i) The line currents, I_a, I_b and I_c.

(ii) The phase voltage at the load side.

(6 marks)

Q4 (a) The model of a real transformer is constructed by considering all the losses that occurs in a transformer.

(i) Explain briefly the losses that occur in a transformer.

(4 marks)

(ii) Draw and label the equivalent circuit of a real transformer.

(2 marks)

(b) A 15 kVA 2200/110 V transformer has the following parameters:

R_p	= 1.75 Ω	X_p	= 2.6 Ω	R_c	= 10000 Ω
R_s	= 0.0045 Ω	X_s	= 0.0075 Ω	X_m	= 1550 Ω

By using equivalent circuit referred to the primary, calculate:

(i) the primary voltage of the transformer at rated load with 0.8 lagging power factor.

(ii) the efficiency and voltage regulation of the transformer.

(9 marks)

(c) A 220 V shunt DC motor has an armature resistance of 0.15 Ω and a field resistance of 70 Ω. The motor draw a 7 A of line current while running light (no load) at 1150 rpm. The line current at full load is 46 A.

(i) Determine the motor speed at full load condition.

(ii) At full load condition, if the field circuit resistance is increase to 100Ω, calculate the new speed of this DC shunt motor. Assume that the line current remain the same.

(10 marks)

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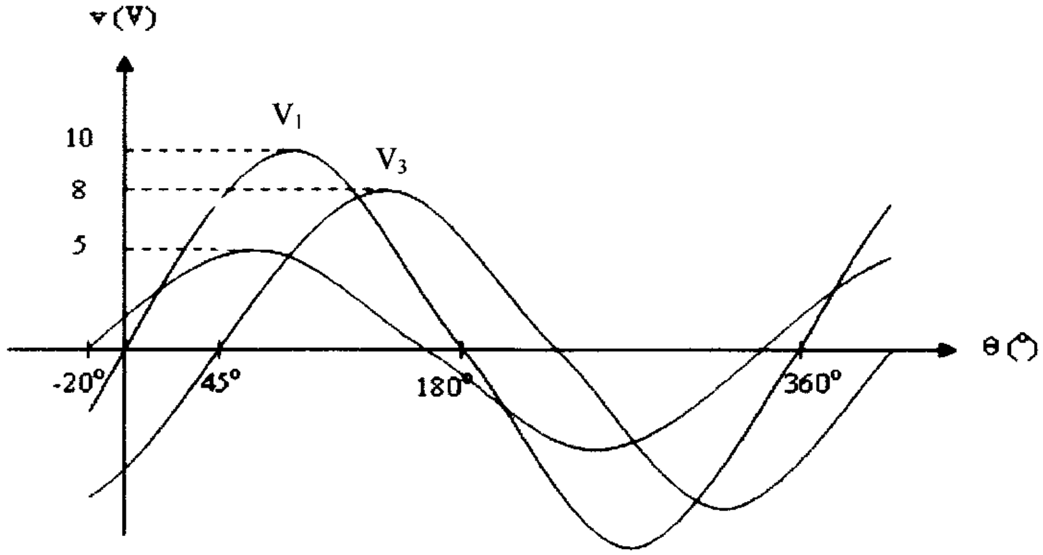

Figure Q1(b)

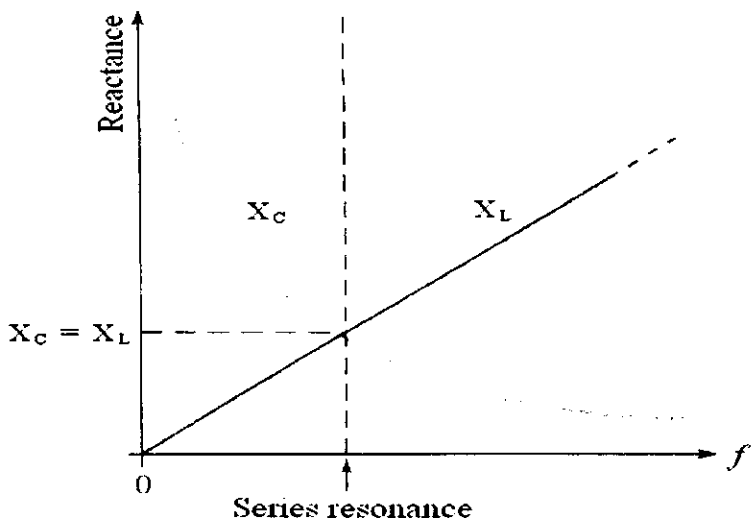

Figure Q2(b)

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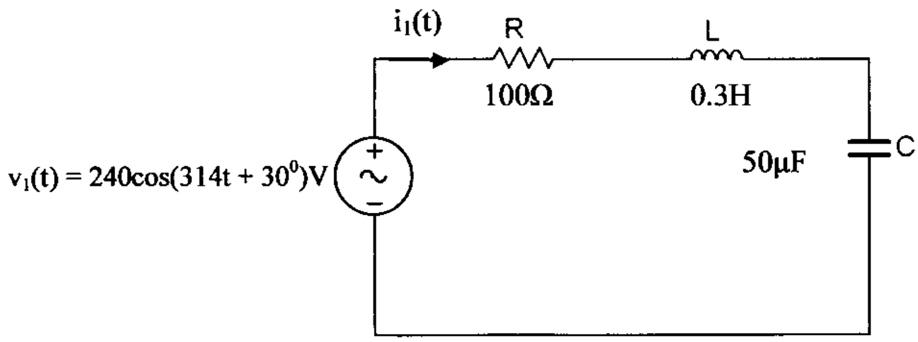

Figure Q2(c)

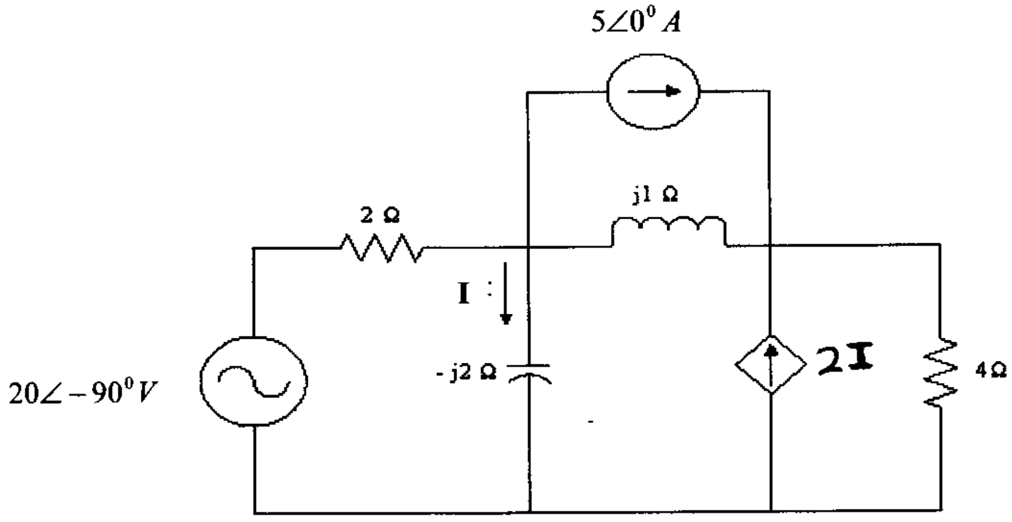

Figure Q3(b)

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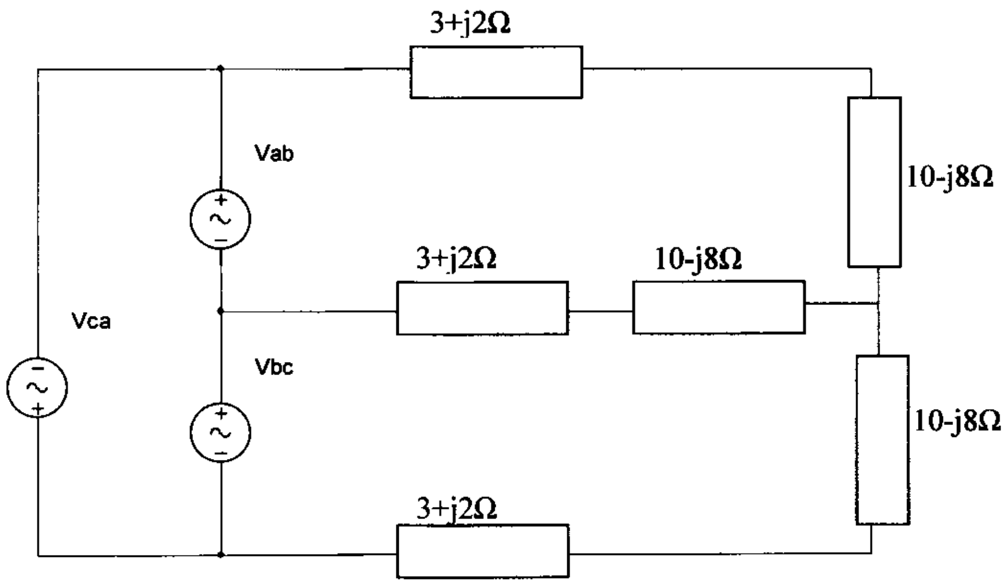

Figure Q3(c)

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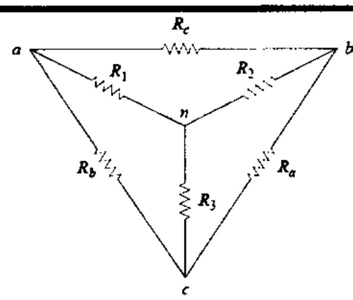
Formulae

Trigonometric identities

$$\sin(\omega t \pm 180^0) = -\sin \omega t$$
$$\cos(\omega t \pm 180^0) = -\cos \omega t$$
$$\sin(\omega t \pm 90^0) = \pm \cos \omega t$$
$$\cos(\omega t \pm 90^0) = \mp \sin \omega t$$

The delta to wye (Δ-Y) and wye to delta (Y-Δ) conversion formulas

Delta to wye conversion (Δ - Y)	Wye to delta conversion (Y - Δ)	Superposition of Y and Δ network
$R_1 = \dfrac{R_b R_c}{R_a + R_b + R_c}$	$R_a = \dfrac{R_1R_2 + R_2R_3 + R_3R_1}{R_1}$	
$R_2 = \dfrac{R_c R_a}{R_a + R_b + R_c}$	$R_b = \dfrac{R_1R_2 + R_2R_3 + R_3R_1}{R_2}$	
$R_3 = \dfrac{R_a R_b}{R_a + R_b + R_c}$	$R_c = \dfrac{R_1R_2 + R_2R_3 + R_3R_1}{R_3}$	

Transformer voltage regulation

$$VR = \frac{V_{s,nl} - V_{s,fl}}{V_{s,fl}} \times 100\%$$

Transformer Efficiency

$$\eta = \frac{P_{out}}{P_{out} + P_{loss}} \times 100\%$$

Terminal voltage equation for DC shunt motor

$$V_t = E_a + I_a R_a$$