UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 1 Examination in Engineering: August 2018

Module Number: EE1302 **Module Name: Introduction to Electrical Engineering**

[Three Hours]

[Answer **all questions**, each question carries **ten** marks]

Q1 a) i) Explain what a "super mesh" is with regard to mesh analysis in DC circuits.

ii) Use mesh analysis to determine i_1, i_2 and i_3 in Figure Q1 (a).

[4 Marks]

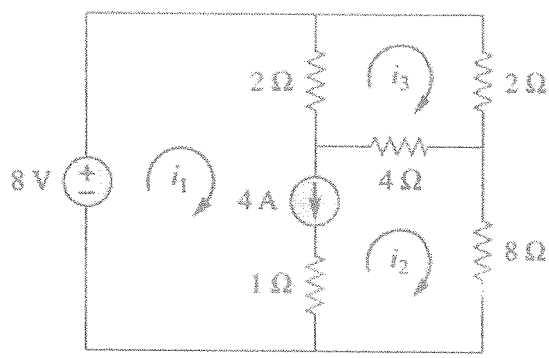

Figure Q1 (a)

b) i) State Norton's Theorem with regard to DC circuit analysis.

ii) Find the Norton Equivalent circuit at terminals $a - b$ of the circuit shown in Figure Q1 (b).

iii) Hence, find the load current if a 6 Ω load resistor is connected across terminals $a - b$.

[6 Marks]

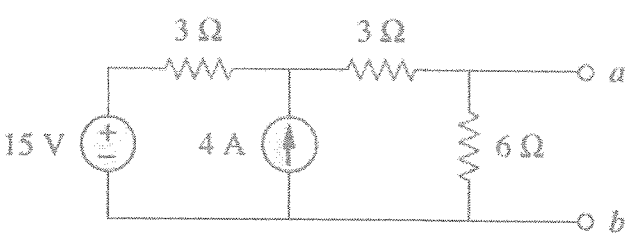

Figure Q1 (b)

Q2 a) i) Explain the typical voltage – current characteristics of a capacitor and an inductor during a transient.

ii) Under steady state conditions, find the energy stored in the capacitor and in the inductor of the circuit shown in Figure Q2 (a).

[3 Marks]

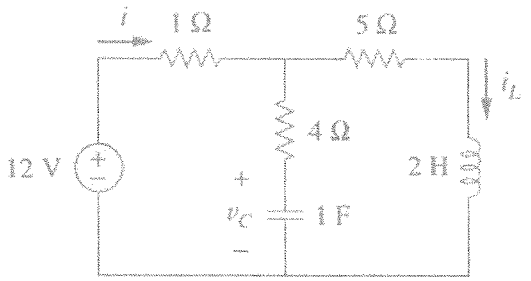

Figure Q2 (a)

b) A series connected resistor R and an inductor L is connected to a DC supply V_S at $t = 0$, as shown in Figure Q2(b). Derive an expression for the inductor current $i_L(t)$ for $t \geq 0$ in terms of the circuit parameters.

[2 Marks]

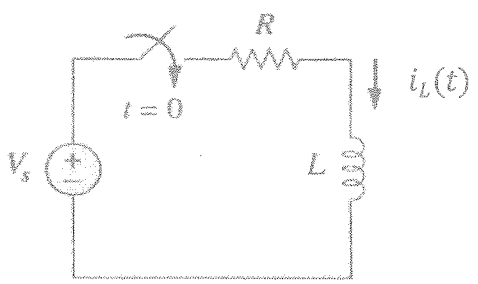

Figure Q2(b)

c) A coil of inductance 50 mH and resistance 5 Ω is connected to a 110 V, DC supply. Determine,

i) The final value of the inductor current

ii) The value of the inductor current after 4 mS

iii) The time for the current to reach to 15 A.

[5 Marks]

Q3 a) A single phase AC voltage is described by the following expression.

$$v(t) = 120\cos(314.16t + 10^0)\ \text{V}$$

Calculate its

i) rms value

ii) frequency

iii) period

iv) half cycle average value

v) form factor and

vi) voltage when time is 4 mS.

[5 Marks]

b) A coil of inductance 159.2mH and resistance 40 Ω is connected in parallel with a 30 μF capacitor across a 240 V, 50 Hz supply. Calculate

i) the current in the coil and its phase angle

ii) the current in the capacitor and its phase angle

iii) the supply current and its phase angle

iv) the active, reactive and the apparent power supplied by the source.

[5 Marks]

Q4 a) i) What are the conditions to be satisfied in order to have a balanced three phase supply?

ii) Determine the phase sequence of a balanced three phase circuit in which $V_{bn} = 440\angle 130^0$ V and $V_{cn} = 440\angle 10^0$ V.

iii) Find V_{an} for the circuit described in ii).

[4 Marks]

b) Figure Q4 (b) shows a three phase power system with two loads. The Y connected generator is producing a phase voltage of 120 V. Load 1 is Δ connected with a phase impedance of $24 - j30$ Ω and Load 2 is Y connected with a phase impedance of $12 + j5$ Ω. Calculate

i) the line current drawn by Load 1

ii) the line current drawn by Load 2

iii) the line current supplied by the generator

iv) the real, reactive and the apparent power supplied by the generator

v) the operating power factor of the generator.

[6 Marks]

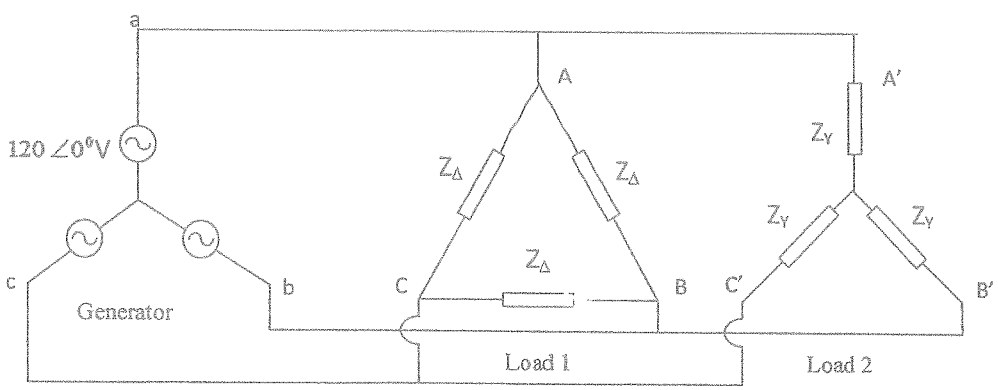

Figure Q4 (b)

Q5 a) i) What are the requirements that need to be fulfilled in a structure of a rotating electric machine? Explain your answer using suitable laws you have learnt.

ii) What are the basic types of ac rotating electric machines? How do you differentiate them?

iii) Why do the armature windings of a dc motor produce an electromotive force?

[2.5 Marks]

b) The field circuit of a separately excited dc motor is connected to a constant dc source. The armature applied voltage is 200 V. It rotates at 1000 rpm generating an armature emf of 180 V. The armature current is 50 A. Assume that except for copper losses, there are no other types of losses in the machine and the friction torque is negligible.

i) Determine the resistance of the armature circuit.

ii) Determine the electromagnetic torque in Nm.

iii) If the load connected to the machine is removed, what will be the rotation speed of the machine in rpm?

[3.5 Marks]

c) Primary referred approximate equivalent circuit of a 15 KVA, 2300/230 V single phase transformer with the usual notations is shown in Figure Q5 (c). The transformer is supplying the rated load at the rated voltage and 0.8 lagging power factor. Calculate its

i) secondary current

ii) primary input voltage

iii) voltage regulation

iv) efficiency.

[4 Marks]

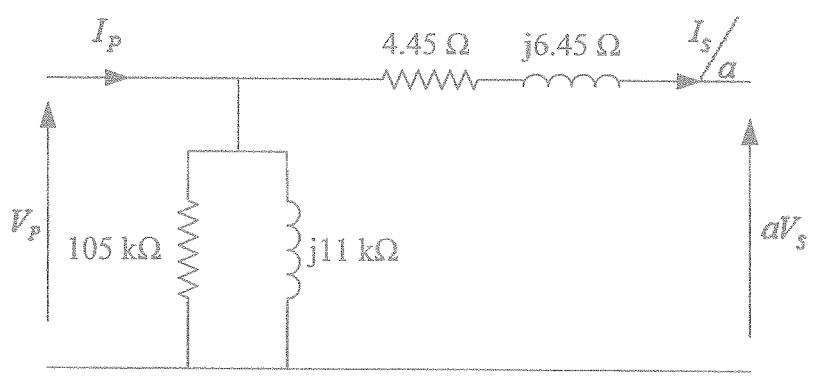

Figure Q5 (c)