FNU FIJI NATIONAL UNIVERSITY

College of Engineering, Science and Technology (CEST)

SCHOOL OF ELECTRICAL & ELECTRONIC ENGINEERING

BACHELOR IN ENGINEERING (HONS) (ELECTRICAL & ELECTRONICS)

EEB601 – CIRCUIT THEORY

FINAL EXAMINATION

Monday 28th May, 2018 0900 - 1210 hours Venue: B314

INSTRUCTIONS TO CANDIDATES

1. Candidates are reminded that they should have no books, notes, paper or other material in their possession unless their use is specifically permitted by "Instructions to Candidates" set out below.
2. Reading time is of 10 minutes duration.
3. Examination time is of 3 hours duration.
4. This paper consists of 5 questions, with parts, printed on 8 pages.
5. Attempt all 5 questions. Each question may carry a different mark.
6. A set of Laplace Transforms Table is attached.
7. A Formula Sheet is also attached..
8. Write your candidate number at the top of each attached sheet.
9. Start each question on a new page.
10. Non-Programmable Calculators may be used.
11. Mobile phones are not allowed inside the examination venue.

FORMULA SHEET

1. $\int u\,dv = uv - \int v\,du$

2. Integrating Factor $R = e^{\int P(t)dt}$; $Rf(t) = \int RQ(t)dt$

3. $s = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

4. $CLTF = \dfrac{G(s)}{1 + G(s)H(s)}$

5. $f(t) = a_0 + \sum_{n=1}^{\infty}\left(a_n \cos\frac{n\pi}{L}t + b_n \sin\frac{n\pi}{L}t\right)$; $a_0 = \frac{1}{T}\int_0^T f(t)dt = \frac{1}{2L}\int_0^{2L} f(t)dt$;

$a_n = \frac{2}{T}\int_0^T f(t)\cos n\omega t\,dt = \frac{1}{L}\int_0^{2L} f(t)\cos\frac{n\pi}{L}t\,dt$;

$b_n = \frac{2}{T}\int_0^T f(t)\sin n\omega t\,dt = \frac{1}{L}\int_0^{2L} f(t)\sin\frac{n\pi}{L}t\,dt$

6. $q = CV$; $i(t) = \frac{dq}{dt}$; $i(t) = C\frac{dv}{dt}$ $i(t) = \frac{v(t)}{R}$ $w_C = \frac{1}{2}CV^2$

7. $v(t) = L\frac{di}{dt}$; $v(t) = \frac{1}{C}\int i(t)\,dt$; $v(t) = Ri(t)$; $w_L = \frac{1}{2}LI^2$

8.

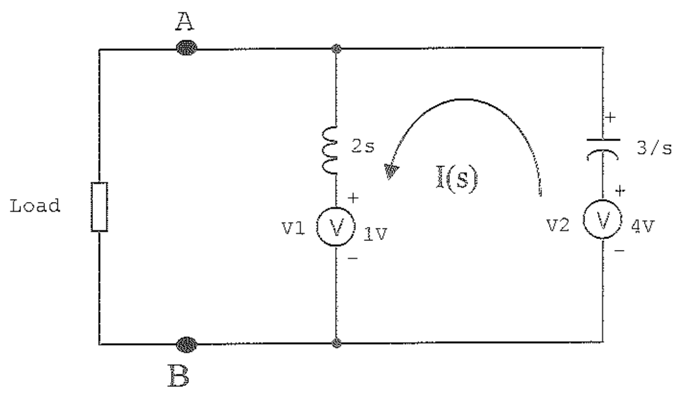
No	Damping Type	Solution
1.	Overdamped case	$i(t) = I + A_1e^{s_1t} + A_2e^{s_2t}$
2.	Underdamped case	$i(t) = I + e^{-\alpha t}\left(A_1 \cos\omega_d t + A_2 \sin\omega_d t\right)$
3.	Critically Damped case	$i(t) = I + A_1te^{-\alpha t} + A_2e^{-\alpha t}$

QUESTION 1: CIRCUIT ANALYSIS THEOREMS & APPLICATIONS

Q 1 - 1: Thevenin Theorem

Consider the frequency domain network in Figure 1.

Figure 1: Frequency Domain Network



(a) Condense the network to the right of terminals A and B, to its Thevenin equivalent circuit, thus obtaining V_{Th} and Z_{Th}. **[6 marks]**

(b) Determine the short-circuit current when A is connected to B. **[2 marks]**

Q 1 - 2: Source Transformation

Refer to the network in Figure 3. The load resistor R_2 is across terminals A and B with the output voltage taken across the terminals. Use Source Transformation to determine the output voltage, V_0, and output current, I_0. **[6 marks]**

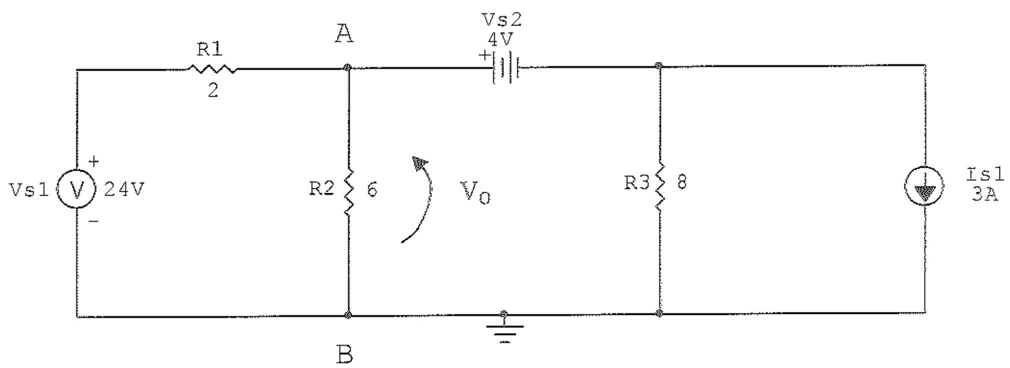


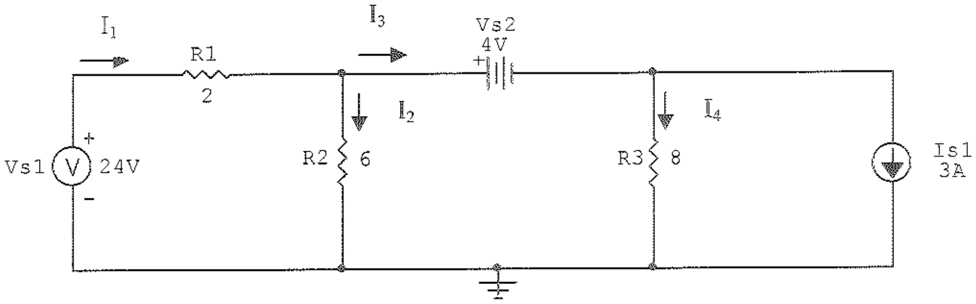
Figure 3: Network

Q1 - 3: Norton Theorem **[6 marks]**

Use Norton's Theorem to reduce the network in Figure 3 to its Norton equivalent circuit. Determine the output current and output voltage through the load resistance of 6 Ω.

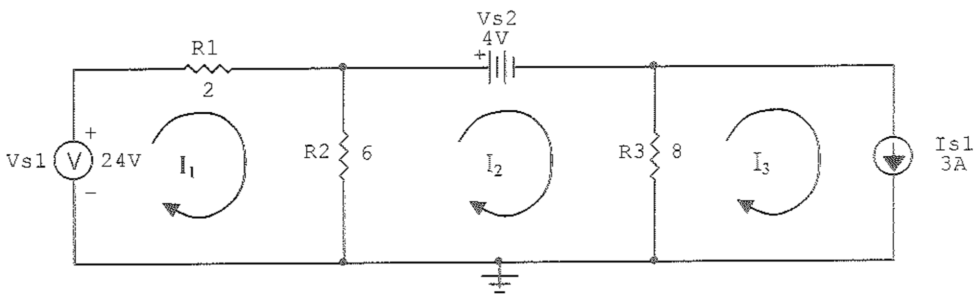
Q1 - 4: Superposition Theorem **[7 marks]**

Utilize the Superposition Theorem to determine the four unknown currents in the circuit given. Then determine the voltage drop across the 6Ω load.

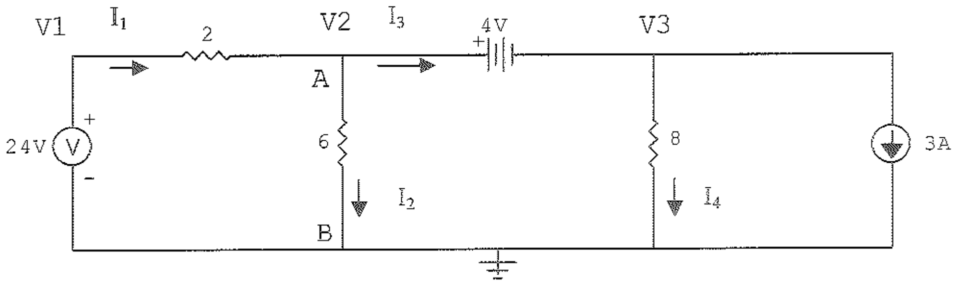


Q1 - 5: Loop Analysis **[7 marks]**

Use the loop currents given to resolve this circuit. Then determine the current through, and the voltage drop across the 6Ω load.



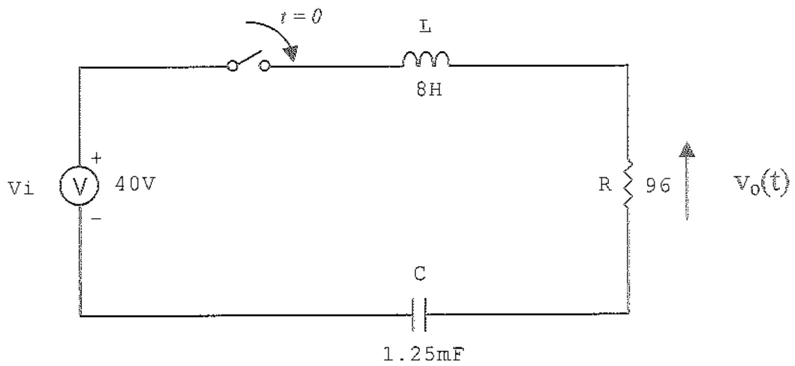
Q1 - 6: Nodal Analysis **[6 marks]**
Utilize the branch currents shown to determine the current through the 6Ω load, and hence the voltage drop across it in the figure given..



[TOTAL = 40 MARKS]

QUESTION 2: SECOND ODER *RLC* NETWORKS & TRANSIENTS

Q2 - 1: **Consider the Series *RLC* Under-damped circuit shown. The output is taken across the resistor, *R*. Assume zero initial conditions.**



(a) Derive the second order Differential Equation model of the system. [2 marks]

(b) Transform the Differential Equation from *time* to *s*-domain. [5 marks]

(c) Find $q(t)$. [3 marks]

Q2 - 2: Analyze the Series *RLC* Critically damped circuit shown in Figure 4. The initial conditions are $v(0) = 2$ V and $i(0) = 1$ A. Derive the step response $i(t)$ and $v(t)$ for the *RLC* circuit. **[Total: 10 marks]**

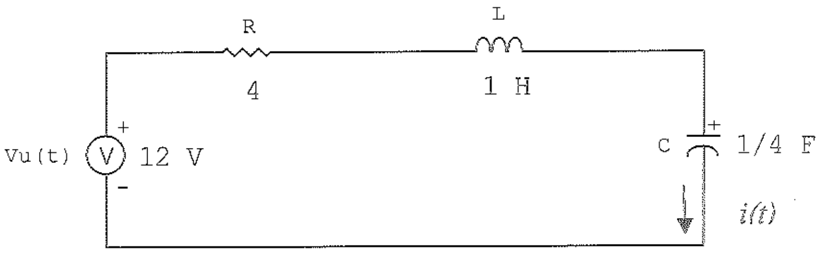


Figure 4: Series *RLC* circuit – Critically damped

QUESTION 3: AC NETWORKS **[Total: 15 marks]**

Q3 – 1: Determine the following for each branch in Figure 5:

(a) Average Power,
(b) Apparent Power,
(c) Reactive Power, and
(d) Power Factor, *Fp*,

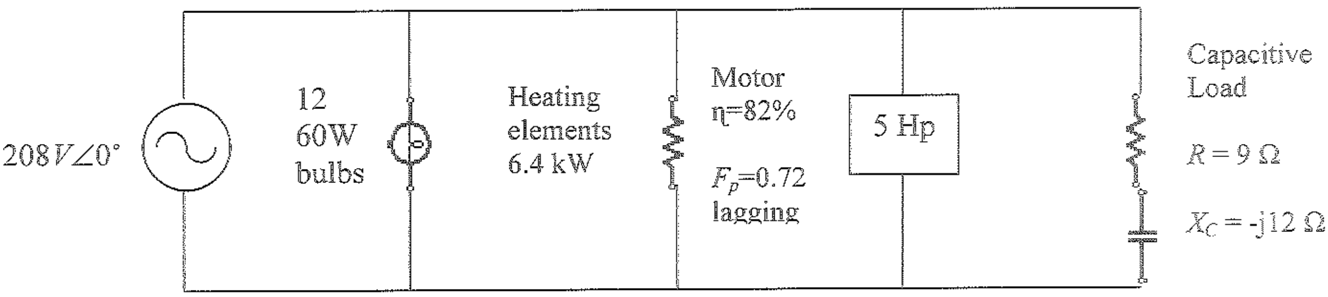


Figure 5

QUESTION 4: SINGLE PHASE & 3-PHASE SYSTEMS **[Total: 15 marks]**

Q4 - 1: Three identical loads Z having unity power factor are connected to a single-phase power source, as shown in Figure 6. The following facts are known: (i) the line voltage across the load is V_L = 11,000 V_{rms}; (ii) the resistance per conductor is R = 0.6 Ω; and (iii) the total power delivered to the load is P_T =4,000 kW.

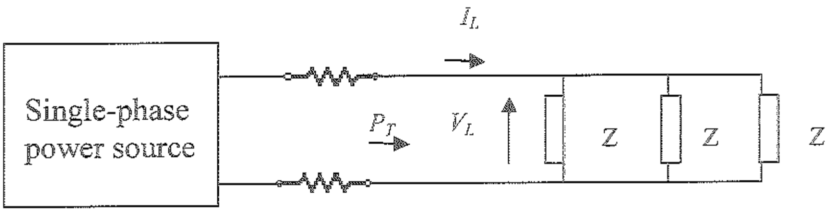


Figure 6

Determine the following:

(a) Power loss in the connecting lines [3 marks]

(b) Efficiency of power transmission. [3 marks]

Q4 - 2: A balanced Δ-connected load having an impedance 20-j15 Ω is connected to a Δ-connected positive-sequence generator having $V_{ab} = 330\angle 0° \text{ V}$ **Calculate the phase currents of the load and the line currents.** [9 marks]

QUESTION 5: TWO-PORT NETWORKS **[Total: 10 marks]**

Q5 – 1: Compute the z-parameters for the circuit of Figure 7.

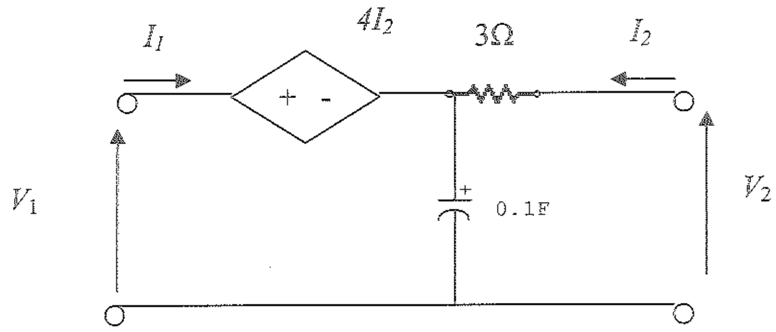


Figure 7

[END OF EXAMINATION]

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