National University of Singapore

Department of Electrical & Computer Engineering

EE2023 Mathematics Assignment

Due Date : 27 January 2022, 23:59 hrs **Total Marks :**

Name :

Student # :

Instructions

1. Answer all 8 questions in this assignment.
2. This assignment contributes 10% to your final EE2023 grade. The maximum mark for this assignment is 40.
3. Anyone caught copying or allowing copying shall be given a zero for this assignment.
4. No graphing calculators should be used in this assignment.
5. Completed assignment should be uploaded into the respective group sub-folders under the "Maths assignment submission" folder. Your file should be named using the following convention : student-number.pdf.
6. Please take note of the digits a, b, c and d in your student number A0xx**abcd**X. These digits will be used in the questions in this assignment.

   Please write your **abcd** number from your student number in the boxes below :

   a b c d

   These **abcd** numbers must be used to solve the problems in the next page.

1. Find the polar coordinates of $z = -c + jd$. (2 marks)

2. Find the Cartesian coordinates of $z = (a + 10)e^{-j0.1(b+1)\pi}$. (2 marks)

3. Find the polar coordinates of $z = \dfrac{a + jb}{c + jd}$. What is the magnitude and phase of z?

(4 marks)

4. Suppose $z = 10(a+1) + j5(c+1)$. Find all four solutions of $z^{1/4}$. Sketch these solutions on the complex plane. (4 marks)

5. Consider the function $y(t) = \text{rect}\left(\frac{t}{d+5}\right)$. (8 marks)

(a) Sketch $y(t)$.

(c) Sketch $y(t-(a+1))$.

(b) Sketch $(d+1)y(t)$.

(d) Sketch $y(2t-(a+1))$.

6. Given a complex function $z(t) = \dfrac{1}{j0.1(c+1)t + 0.5}$. Derive the expression for $|z(t)|$ and $\angle z(t)$ and sketch them accordingly for $t \geq 0$. What does the value of $\angle z(t)$ tend to as $t \to \infty$? (8 marks)

7. Sketch the signal $s(t) = 10\,\text{rect}\left(\frac{t-b}{20}\right) - (a+5)\text{tri}\left(\frac{t-b}{5}\right)$. (4 marks)

8. Consider the RLC circuit in Figure 1. (8 marks)

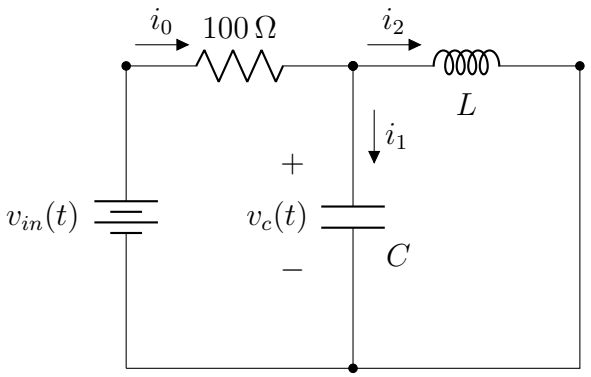

Fig. 1: RLC Circuit

Answer the following questions using the values of $v_{in}(t)$, C and L as follows :

$$v_{in}(t) = 10(d+1)\text{ V}, \quad C = (c+5)\ \mu\text{F}, \quad L = (b+2)\text{ H}$$

(a) Calculate the equivalent impedance of the circuit as seen from the battery source.

(b) Derive the differential equation that relates $v_c(t)$ to $v_{in}(t)$.

(c) Derive the differential equation that relates current $i_1(t)$ to $v_{in}(t)$.

(d) Find the steady state voltage across the capacitor as t tends to infinity.

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