CCIT4076: Engineering and Information Science
Assignment 1

Due 5:30pm on Friday, October 28, 2022

Instructions: Please read this document before handing in any submission. The full mark of this assignment is **50 points**. The estimated duration of completing questions 3–7 is 90 minutes.

Q1. Consider the following engineering domains:

- Computer science and engineering
- Electronic and information engineering
- Data science and engineering

which are the focus area of AEng. According to your own interest, pick any one of these and collect reliable information on the state of the art this field. Write an essay (800–1200 words) to discuss i) what are the key aspects in the theme, ii) what are possible innovative technology in the theme and, most importantly, iii) why do you want to be involved in the specialization.

Q2. Conduct a background research on the development history of wireless earphone. Write an essay (800–1200 words) to describe how does the engineering design process fit-in to this example.

Q3. Given the following circuits:

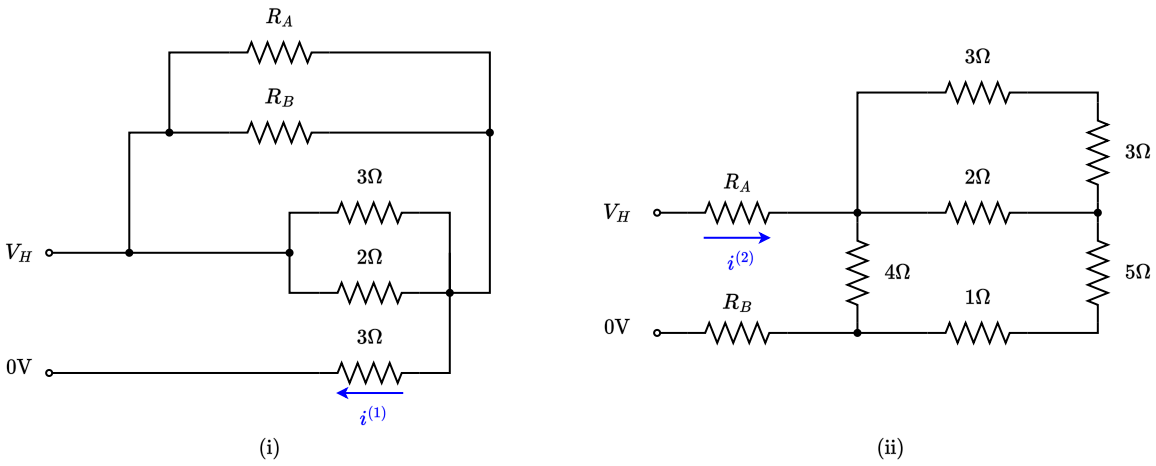

Figure: Question 3.

Assume $0 \leq R_A < \infty$ and $0 \leq R_B < \infty$.

(a) Assume $R_A = 3\Omega$ and $R_B = 7\Omega$. Calculate the equivalent resistance of circuit (i).

(b) Assume $R_A = 3\Omega$ and $R_B = 7\Omega$. Calculate the equivalent resistance of circuit (ii).

(c) Show that, if $R_A = 1\Omega$, then there is no R_B such that $i^{(1)} = i^{(2)}$.

(d) Use OrCAD Lite to build and simulate the above circuits to verify your results in (a) and (b).

Q4. Consider the following linear circuit:

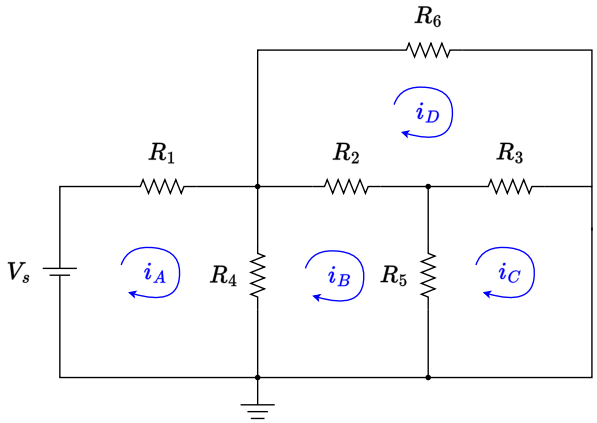

Figure: Question 4.

wherein i_A, i_B, i_C and i_D are looping current variables. Values of the source voltage V_s and internal resistance R_i's are to be announced in class.

(a) Formulate four linear equations such that i_A, i_B, i_C and i_D are solvable.

(b) Translate the equations acquired in (a) into a matrix-vector equality.

(c) Ask OCTAVE to solve the matrix equality above.

(d) Use ORCAD LITE to build and simulate the above circuit to verify your results.

Q5. Check the problem statement on this page.

Q6. [8 pts.] **Signal Representations.** A signal is defined by

$$g(t) = A_1 \sin(2\pi f_1 t) + A_2 \sin(2\pi f_2 t) + A_3 \sin(2\pi f_3 t)$$

wherein we assume $A_i > 0$ for $i = 1, 2, 3$ and that $f_3 \geq f_2 \geq f_1$.

(a) State a necessary condition on the frequencies f_1, f_2 and f_3 such that $g(t)$ is periodic.

(b) State a necessary condition on the amplitudes A_1, A_2 and A_3 such that $g(t)$ is said to be high-pass.

(c) On OCTAVE, plot $g(t)$ for $t \in [-10, 10]$ assuming

$$A_i = \frac{\text{the } i\text{-th digit of your SID} + 1}{3}; \qquad f_i = \frac{4}{\text{the } (8-i)\text{-th digit of your SID} + 1}$$

label the x-axis as `t/second` and the y-axis as `g(t)`. Make a good judgement on how dense should you sample on the time axis. The signal shape has to be visible. The title of the figure should be `Your Full Name`. Provide your source code as well.

(d) Under the same settings in (c), sketch the spectrum $G(f)$ for $f \geq 0$ manually.

Copyright © 2022 by Wai-Yiu Keung. All rights reserved.

Q7. Consider a frequency domain sketch of a signal $x(t)$:

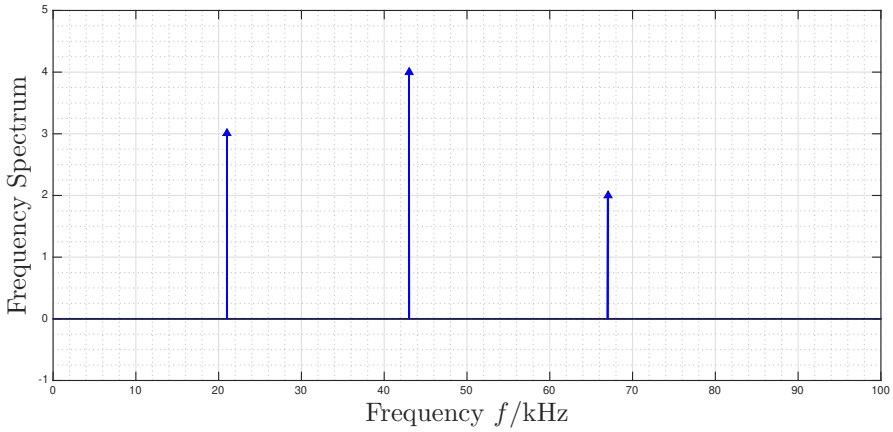

Figure: Question 6

(a) Give a mathematical description of the signal $x(t)$.

(b) If the above signal is heard by a human, sketch the spectrum that corresponds to the signal perceived by the brain. State your assumptions clearly.

(c) Consider a filter characterized by $H(f) = (1 + f/10)^{-1}$, which is plotted in the subsequent figure. What is the output signal $y(t)$ if $x(t)$ is passed through the filter $H(f)$?

$$H(f) = \frac{1}{1+0.1f}$$

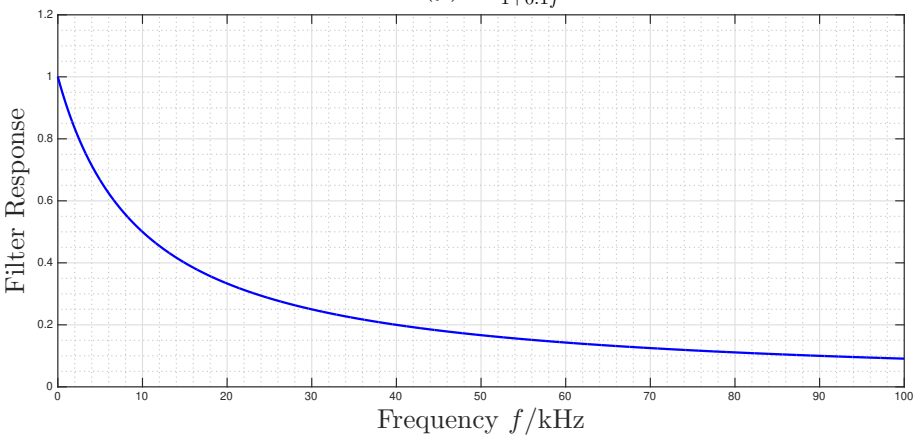

Figure: Question 7(c)–(d)

(d) Determine whether $H(f)$ is low-pass, band-pass or high-pass filter.

— THE END —

Copyright © 2022 by Wai-Yiu Keung. All rights reserved.