CCIT4076: Engineering and Information Science **Fall 2022**

Solution to Demo Midterm Exam

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Solution 1.

(a) $R_{eq} = \big((6||2) + 8\big)||3 = 9.5||3 = 2.28\Omega$

(b) The respective KVL/KCL equations are:

$$\begin{aligned} 10 &= 8(i_A - i_B) + 6(i_A - i_C) \\ 6(i_A - i_C) &= 2(i_C - i_B) + 4 \\ 3i_B &= 8(i_A - i_B) + 2(i_C - i_B) \end{aligned}$$

The linear system can be re-written as:

$$\begin{aligned} 10 &= 14i_A - 8i_B - 6i_C \\ 4 &= 6i_A + 2i_B - 8i_C \\ 0 &= 8i_A - 13i_B + 2i_C \end{aligned}$$

which can be solvable once we cast it into matrix-vector form:

$$\begin{bmatrix} 10 \\ 4 \\ 0 \end{bmatrix} = \begin{bmatrix} 14 & -8 & -6 \\ 6 & 2 & -8 \\ 8 & -13 & 2 \end{bmatrix} \begin{bmatrix} i_A \\ i_B \\ i_C \end{bmatrix}$$

Solving the above equations reveals $(i_A, i_B, i_C) = (2.7368, 2.0000, 2.0526)$ ampere.

(c) This can be done by the following lines of codes:

```
A = [14 -8 -6; 6 2 -8; 8 -13 2];
b = [10; 4; 0];
x = inv(A)*b;
```

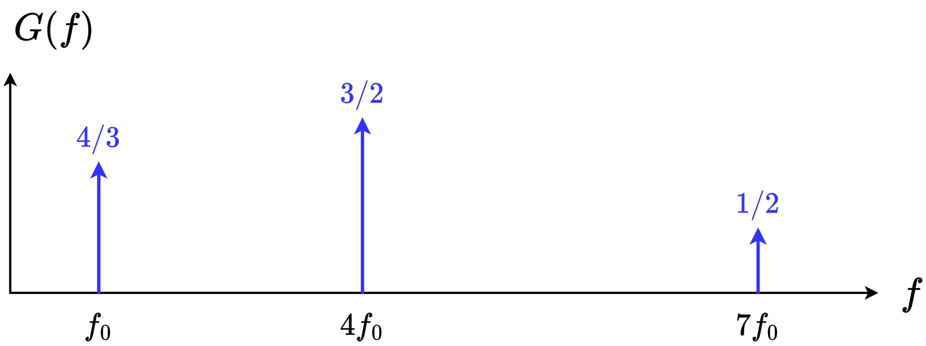
and the values will be stored in the array `x`.

(d) In (a), $p = 0$; and in (b), $p = (-i_C)(4) = -8.2105$ watts.

Solution 2.

(a) Everyone has their own $g(t)$. We will stick with the above example $g(t)$ in subsequent discussions.

(b) The sketch is straightforward:



(c) For $g(t)$ to be fully audible, we need all its spectral content to be contained within $[20, 20k]$ hertz. Equivalently, we need

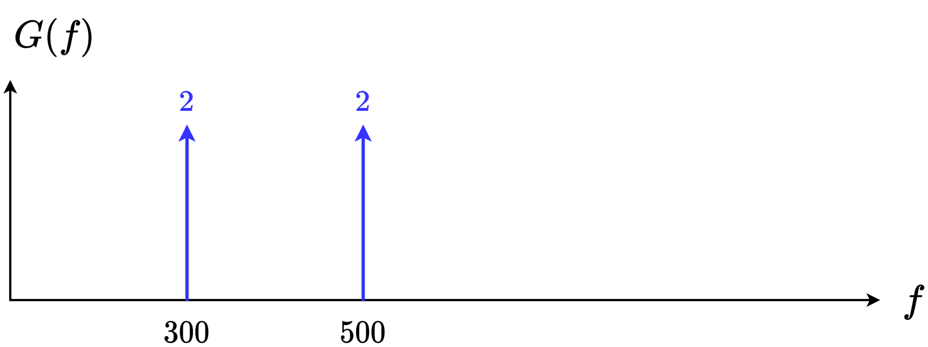
$$f_0 \geq 20 \text{ ; and } \ 7f_0 \leq 20k \qquad \Longleftrightarrow \qquad 20 \leq f_0 \leq 2.8571k.$$

(d) This can be done by the following lines of codes:

```
f0 = 100; T = 1/f0;
t = linspace(0, 2*T, 1e6);
g = (4/3)*sin(2*pi*f0*t) + (3/2)*sin(2*pi*4*f0*t) + ...
     (1/2)*sin(2*pi*7*f0*t);
plot(t, g);
```

Solution 3.

(a) We can write $g(t) = 2\sin(2\pi 300t) + 2\sin(2\pi 500t)$ and the frequency domain representation is:



(b) From the filter's response, it is obvious that

$$H(f) = \begin{cases} f/W & f < W \\ 1, & f \geq W \end{cases}$$

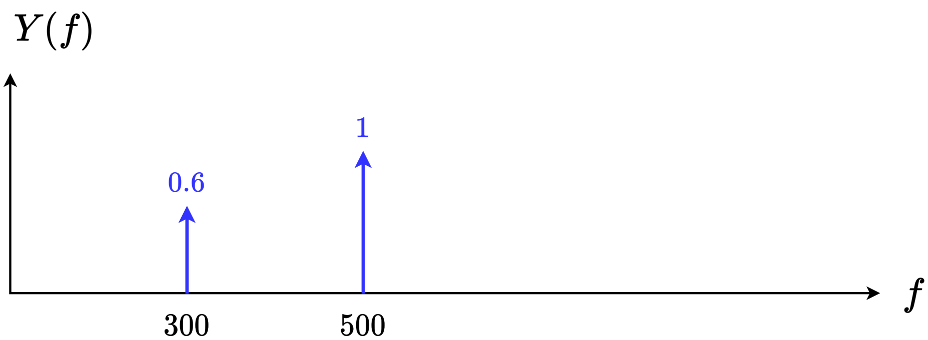
and thus when $W = 1000$ we are able to find

$$H(300) = 300/1000 = 0.3; \qquad H(500) = 500/1000 = 0.5.$$

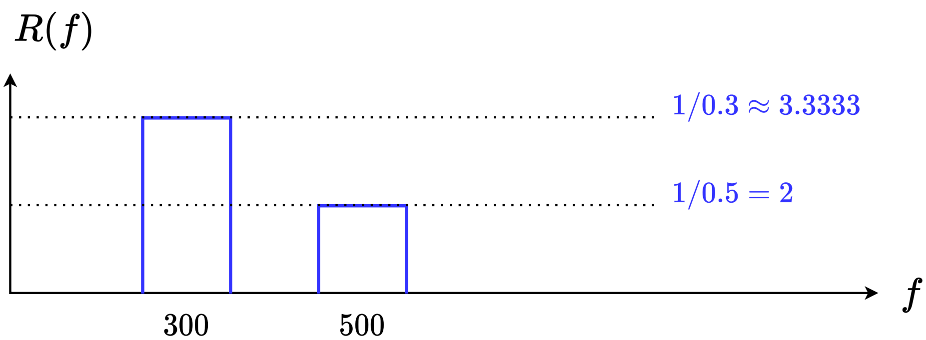
(c) We can write

$$y(t) = H(300) \cdot 2\sin(2\pi 300t) + H(500) \cdot 2\sin(2\pi 500t) = 0.6\sin(2\pi 300t) + \sin(2\pi 500t)$$

and the frequency domain representation is:



(d) The effect can be compensated by the following filter/equalizer:



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