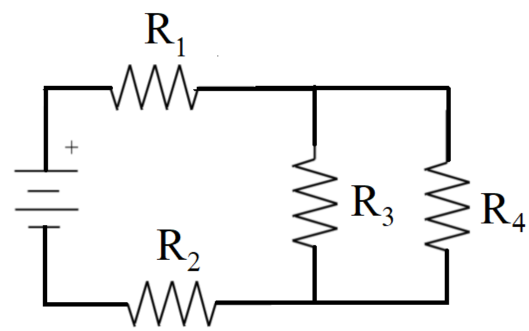
MECH 4071C
Mechatronics & Instrumentation Lab

University of Cincinnati
College of Engineering & Applied Science
Dept. of Mechanical & Materials Engineering

Review Assignment - Fall 2022

Problem #1: Determine the voltage across and current through ***R₄*** in the circuit shown in the figure below for the given parameters.



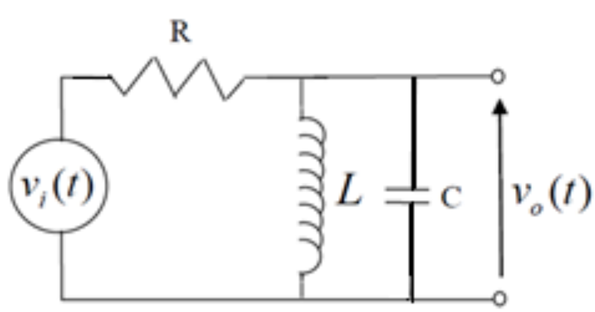
$V_{source} = 9V$

$R_1 = 22\Omega$
$R_2 = 33\Omega$
$R_3 = 100\Omega$
$R_4 = 47\Omega$

Problem #2: The frequency response function (FRF) for the circuit shown below is:

$$H(j\omega) = \frac{V_o(j\omega)}{V_i(j\omega)} = \frac{j\omega L}{R - \omega^2 LC + j\omega L}$$

Using Matlab, plot the magnitude (in dB) & phase (in degrees) of the FRF for the given parameters. Note: this should be on one figure using subplots; also use "semilogx" to plot frequency on a log scale



$R = 50\Omega$
$L = 800\ mH$
$C = \ \mu F$

$0 \leq f \leq 100{,}000\ Hz$
$1\ Hz\ intervals$

Review Assignment - Fall 2022

Problem #3: A vibrating system has the following parameters:

$m = 0.5$ kg
$k = 975$ N/cm
$c = 2.5$ N*s/cm

Determine:

- the damped natural frequency *(in Hz)*
- the undamped natural frequency *(in Hz)*
- the damping ratio

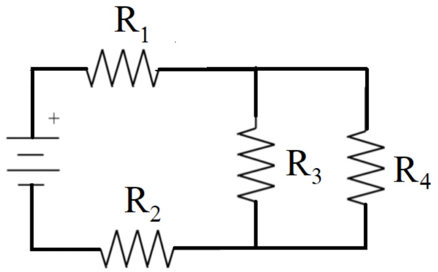
[Ans: $\omega = 57.9Hz, \Omega = 70.3Hz, \zeta = 0.566$]

Problem #4: An unknown mass of *m* kg attached to the end of an unknown spring *k* has a natural frequency of 314 Hz. When a 1-kg mass is added to *m*, the natural frequency is lowered to 275 Hz.
Determine:

- the unknown mass *m* (in kg)
- the spring constant *k* (in MN/m)

[Ans: m = 3.29 kg, k = 12.8 MN/m]

Problem #1: Determine the voltage across and current through R_4 in the circuit shown in the figure below for the given parameters.



$V_{source} = 9V$

$R_1 = 22\Omega$
$R_2 = 33\Omega$
$R_3 = 100\Omega$
$R_4 = 47\Omega$

For $R_3 . R_4$:

$$R_{eq} = \frac{R_3 \cdot R_4}{R_3 + R_4} = \frac{100 \times 47}{100 + 47} = 31.97\Omega$$

$$V_4 = V_{source} \cdot \frac{R_{eq}}{R_1 + R_2 + R_{eq}} = 9 \times \frac{31.97}{22 + 33 + 31.97} = 3.31V$$

$$I_4 = \frac{V_4}{R_4} = \frac{3.31}{47} = 0.0704A = 70.4mA$$

Problem #3: A vibrating system has the following parameters:

$m = 0.5$ kg
$k = 975$ N/cm
$c = 2.5$ N*s/cm

Determine:

- the damped natural frequency *(in Hz)*
- the undamped natural frequency *(in Hz)*
- the damping ratio

[Ans: $\omega = 57.9Hz, \Omega = 70.3Hz, \zeta = 0.566$]

$$(a)\ W_r = \sqrt{\frac{k}{m} - \left(\frac{c}{2m}\right)^2} = \sqrt{\frac{97500}{0.5} - \left(\frac{250}{2\times 0.5}\right)^2} = 364 \text{ rad/s} \text{ or } 57.93\text{ Hz}$$

$$(b)\ \Omega_r = \sqrt{\frac{k}{m}} = \sqrt{\frac{97500}{0.5}} = 441.58 \text{ rad/s} \text{ or } 70.28\text{ Hz}$$

$$(c)\ \zeta = \frac{c}{2\sqrt{mk}} = \frac{250}{2\sqrt{0.5\times 97500}} = 0.566$$

Problem #4: An unknown mass of *m* kg attached to the end of an unknown spring *k* has a natural frequency of 314 Hz. When a 1-kg mass is added to *m*, the natural frequency is lowered to 275 Hz.
Determine:

- the unknown mass *m* (in kg)
- the spring constant *k* (in MN/m)

[Ans: m = 3.29 kg, k = 12.8 MN/m]

$W_1 = 314\,Hz \quad W_2 = 275\,Hz$

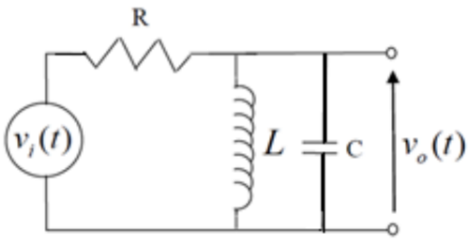
We have $\begin{cases} W_1 = \sqrt{\frac{k}{m}} = 314\,Hz \\ W_2 = \frac{\sqrt{k}}{\sqrt{m+1}} = 275\,Hz \end{cases}$

By calculation: $\begin{cases} m = 3.29\,kg \\ k = 12.81 \times 10^6\,N/m \end{cases}$

Problem #2: The frequency response function (FRF) for the circuit shown below is:

$$H(j\omega) = \frac{V_o(j\omega)}{V_i(j\omega)} = \frac{j\omega L}{R - \omega^2 LC + j\omega L}$$

Using Matlab, plot the magnitude (in dB) & phase (in degrees) of the FRF for the given parameters.
Note: this should be on one figure using subplots; also use “semilogx” to plot frequency on a log scale



$R = 50\Omega$
$L = 800\ mH$
$C = \ \mu F$

$0 \le f \le 100{,}000\ Hz$
$1\ Hz\ intervals$

Code:

```
%% HW1

% Name: Hongrui Yi

% Content: Q2 HW1


%% Innitialization

close all; clear; clc;

%% Set parameter

R = 60;          % Set the value for the resictance

L = 800*10^(-3); % Set the value for the inductor

C = 33*10^(-6);  % Set the value for the capacitor

f = 0:1:100000;  % Set the value for the frequency
```

```
H = zeros(size(f)); % Create a matricx for the
frequency response function (FRF)
%% Calculation
for i = 1:length(f)
H(i) = (1i*2*pi*f(i)*L)/(R-
(2*pi)^2*(f(i).^2)*L*C+1i*2*pi*f(i)*L); %
Calculate the FRF
end
%% Result
figure % Make the graph
subplot(2,1,1) % Create the first subplot of 2
rows, 1 colum
semilogx(f,2*abs(H)) % Make the frequency in a
log scale
xlabel(['$ f\;\mathrm{[Hz]}
$'],'interpreter','latex') % Create a label
for x
ylabel(['$ magnitude\;\mathrm{[dB]}]
$'],'interpreter','latex') % Create a label
for y
grid on % Open the grid
subplot(2,1,2) % Create the second subplot of
```

```
2 rows, 1 colum
semilogx(f,rad2deg(angle(H))) % Make the
frequency in a log scale
xlabel(['$ f\;\mathrm{[Hz]}
$'],'interpreter','latex') % Create a label
for x
ylabel(['$ phase\;\mathrm{[dB]}
$'],'interpreter','latex') % Create a label
for y
grid on % Open the grid
```

Graph: