HW5

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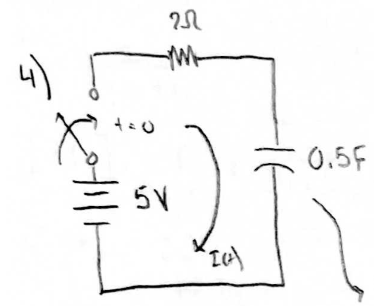
4)



impedance | current

$V_c(s) = \frac{1}{Cs} I(s)$

- Find capacitor voltage

Loop KVL

$I(s) = Cs\, V_c(s)$

$I(s) = 0.50s\, V_c(s)$

$\left(R + \frac{1}{Cs}\right) I(s) = V(s)$

$\left(2 + \frac{2}{s}\right) I(s) = V(s)$

$\left(2 + \frac{2}{s}\right)\left(0.50s\, V_c(s)\right) = V(s)$

$(s+1)\, V_c(s) = V(s)$

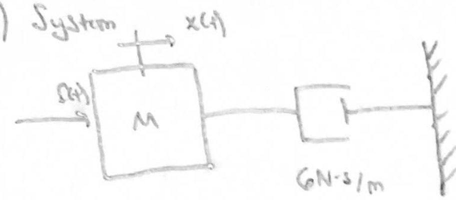
$$\frac{V_c(s)}{V(s)} = \frac{1}{s+1} \triangleq \frac{K}{\tau s + 1}$$

time constant $\tau = 1$

$T_r \approx 2.31\tau - 0.11\tau = 2.2\tau = 2.2$ seconds

$T_s \approx 4\tau = 4$ seconds

6) System



a) Relate settling time of the velocity of the mass to M

$X(s)\left(Ms^2 + 6s\right) = F(s)$

$$\frac{X(s)}{F(s)} = \frac{1}{Ms^2+6s} \qquad V(s) = sX(s)$$

$$\frac{V(s)}{F(s)} = \frac{s}{Ms^2+6s} = \frac{\cancel{s}}{\cancel{s}(Ms+6)} = \frac{1}{Ms+6}$$

General First Order System Form

$$\frac{K}{\tau s+1} \longrightarrow \frac{1/6}{\frac{M}{6}s + 1}$$

$\tau = \frac{M}{6}$, $K = 1/6$

$T_s \approx 4\tau = \frac{2M}{3}$

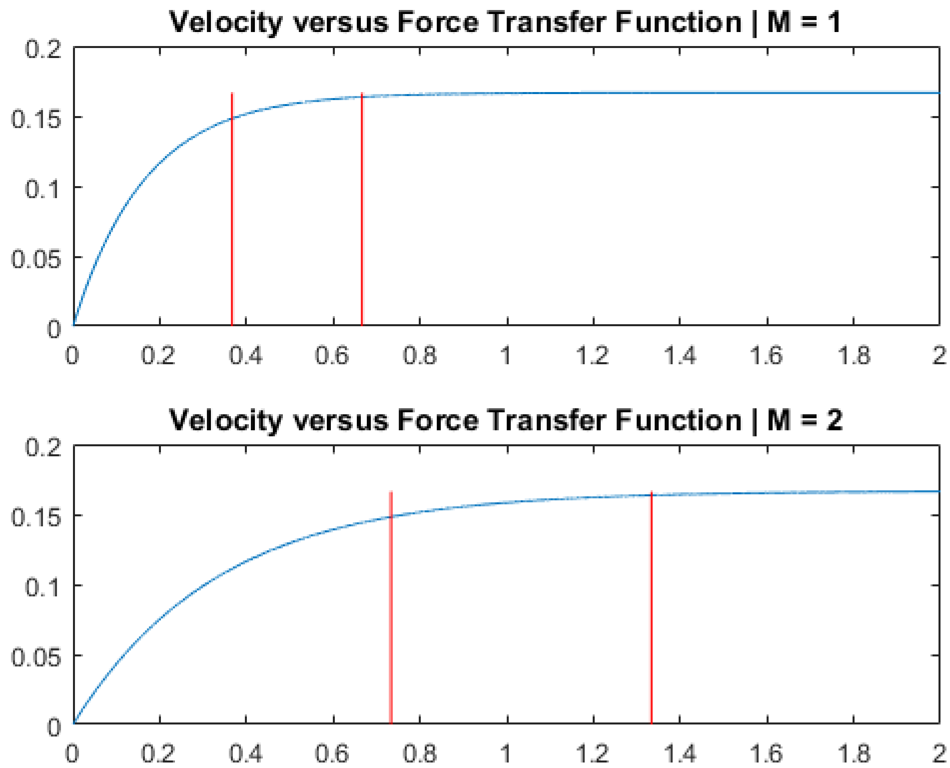
b) Relate rise time of the velocity of the mass to M

$T_r \approx 2.2\left(\frac{M}{6}\right) = \frac{11M}{30}$

7) See MATLAB script

```
%HW5
clc; close all; clear;
M = [1,2];
sysCell = cell(1,2);
sysCell{1} = tf([1/6], [M(1)/6, 1]);
[tf1N, tf1D] = tfdata(sysCell{1});
sysCell{2} = tf([1/6], [M(2)/6, 1]);
[tf2N, tf2D] = tfdata(sysCell{2});
t = linspace(0,2,10000);
unitStep = heaviside(t);
timeConstants = [tf1D{1}(1), tf2D{1}(1)];
tRise = 2.2.*timeConstants;
tFall = 4.*timeConstants;
figure()
for j =1: length(M)
    hold on;
    subplot(length(M),1,j)
    Y = lsim(sysCell{j},unitStep,t);
    plot(t, Y,[tRise(j),tRise(j)], [0,max(Y)],'r',
 [tFall(j),tFall(j)], [0,max(Y)],'r');
    title(sprintf('Velocity versus Force Transfer Function | M =
 %g',M(j)));
    fprintf('System %g\nRise Time | %g\nFall Time | %g\nTime Constant
 | %g\n',j, tRise(j), tFall(j), timeConstants(j));
    hold off
end
```

```
System 1
Rise Time | 0.366667
Fall Time | 0.666667
Time Constant | 0.166667
System 2
Rise Time | 0.733333
Fall Time | 1.33333
Time Constant | 0.333333
```



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