Q1

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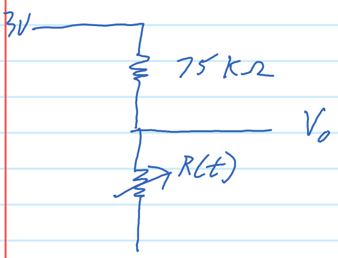
$R(t) = 161 \cdot e^{-0.013t}$ $(k\Omega)$



1.1 200 Hz

1.2 $R(80) = 56.91\ k\Omega \rightarrow \left(\frac{56.91}{56.91+75}\right)(3) = 1.29\ V$

1.3 $R(40) = 95.72\ k\Omega \rightarrow \left(\frac{95.72}{95.72+75}\right)(3) = 1.68\ V$

1.4 $\frac{8000\ B}{2} = 4000$, $\frac{4000}{200} = 20\ s$

1.5 $8000 \cdot 8 = 64000$, $\frac{64000}{12} = 5333$, $\frac{5333}{200} = 26.7\ s$

1.6 $\frac{2.5}{2^{12}}\ V = 0.00061\ V$

1.7 $115200/8 = 14{,}400\ Hz$

1.8 $R(60) = 73.8\ k\Omega \rightarrow \left(\frac{73.8}{73.8+75}\right)(3) = 1.488\ V$

$$\frac{V_{in} - V_{R-}}{\frac{2.5}{2^{12}}} = \frac{1.488 - 0}{0.00061} = 2437$$

1.9 10 MHz = 10,000,000 Hz
240 cycles / sample
Data acquisition = 0.0002 s
$F_s = 40\ Hz \rightarrow T_s = 0.025\ s$

$$\frac{240}{10{,}000{,}000} = 0.000024\ s/\text{sample}$$

$$\begin{array}{r} 0.000024 \\ +\ 0.000200 \\ \hline 0.000224 \end{array}\ s = 0.224\ ms/\text{sample}$$

$$\frac{0.000224}{0.025} = 0.00896$$

15 500 instructions

Q2

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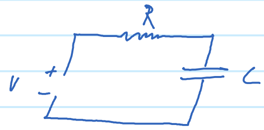
2.1 $R = 4.7\ k\Omega$

$C = 1\ \mu F$



$$H(s) = \frac{\frac{1}{Cs}}{\frac{1}{Cs} + R} = \frac{1}{1 + RCs} \quad , \quad s = j\omega = j2\pi f$$

$$s = j(2\pi)(500) = j1000\pi = 3142$$

$$H(500\,Hz) = \frac{1}{1 + \underset{(R)}{(4.7\times10^{3})}\underset{(C)}{(1\times10^{-6})}\underset{(s)}{(3142j)}} = \frac{1}{1 + 14.77j}$$

$$\left| H(500\,Hz) \right| = \frac{1}{\sqrt{1^2 + (14.77j)^2}} = 0.676$$

Q3

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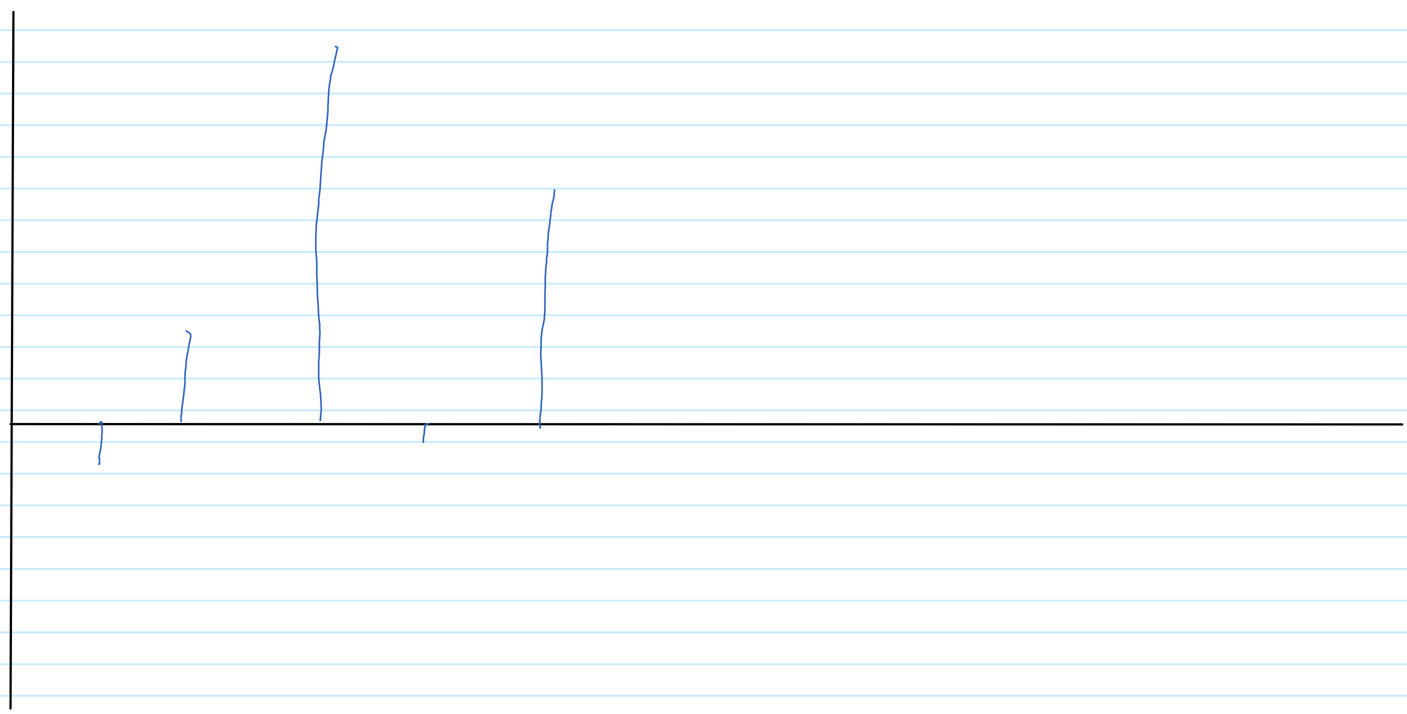
$$y[n] = \sum_{i=0}^{N-1} x[i] \cdot h[n-i]$$

Find fifth sample $(4 * T_s)$

h(n)	-0.1	0.2	-0.05		
x(n)		0.1	0.35	0.24	0.39	0.41

-0.01	0.02	-0.005		
	0.035	0.07	-0.0175	
		-0.024	0.048	
			-0.039	
-0.01	0.055	0.41	-0.0085	0.025

$$y[n] = [-0.01,\ 0.055,\ 0.41,\ -0.0085,\ 0.025\ \ldots]$$



Q4

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1.1 $L = \frac{10}{17} m = 0.588 m \rightarrow mg = Kx$

$10 = K(\frac{10}{17})$

$m = 1 Kg$ $K = 17$

$c = 2$

$\mathcal{L}\left[\frac{d^2y}{dt} + 2\frac{dy}{dt} + 17y = x(t)\right]$

With initial conditions $= 0$ ∴

$s^2Y(s) - sY(s) + 2sY(s) - 2 + 17Y(s) = X(s)$

$Y(s)[s^2 + 2s + 17] - s - 2 = X(s)$

$H(s) = \frac{s+2}{s^2+2s+17} = \frac{s+2}{(s+1)^2+16}$

$\mathcal{L}^{-1}[H(s)] = \mathcal{L}^{-1}\left[\frac{s+2}{(s+1)^2+4^2}\right]$

$\boxed{h(t) = \frac{1}{4}e^{-t}(\sin(4t) + 4\cos(4t)) \cdot u(t)}$

$\mathcal{L}[u(t)] = \frac{1}{s}$ $(H(s)) \cdot s = S(s)$

$S(s) = \frac{s(s+2)}{(s+1)^2 + 4^2}$ ∴ $s(t) = \frac{-17}{4}e^{-t}\sin(4t)$

$\boxed{s(t=1.8) = -0.558}$

4.2 Steady state $= 0$

Q5

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$$\frac{1}{5}x(n) + \frac{1}{5}x(n-1) + \frac{1}{5}x(n-2) + \frac{1}{5}x(n-3) + \frac{1}{5}x(n-4) = y(n)$$

$$A[0] = 1$$

$$B[2] = \frac{1}{5}$$

Q6

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6.1 $\frac{500}{2048} = 0.2441$

Q7

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```
%% David Thornton
% CPE 381 Final
%input signal X

%load x data
load('fintest.mat');

Fs = 200; %sampling frequency
N = 1024; %NFFT
H = 1024; %Hanning window size

%apply Hanning window
Hwindow = transpose(hann(H));
X_windowed = x .* Hwindow;

%compute fft
%fft_out = fft(x,N);
fft_out = fft(X_windowed,N);

%define frequency domain and get one-sided spectrum
f = Fs*(0:(N/2))/N; %max freq is half of sampling freq, N bins
spectra2 = abs(fft_out/N);
spectra1 = spectra2(1:N/2+1);
spectra1(2:end-1) = 2*spectra1(2:end-1);

plot(f,spectra1)
```