Homework Problems – EE301 Spring 2008

Problem 1

Find:
- The time constant, $\tau$
- The rise time
- The settling time

Problem 2

Find:
- The percent overshoot
- The time to peak
- The rise time
- The settling time
**Problem 3**

The input to a lowpass filter is: \( \sin(t) + \sin(10t) + \sin(30t) \).

Determine the output: Hint magnitude in non-decibel can be calculated from: \( M_{dB} = M \)

**Problem 4 - Filters**

\[ V_i \xrightarrow{\text{Filter}} V_o \]

For the system shown above, \( v_i(t) = \sin(1000t) + \sin(10t) + \sin(100,000t) \). Chose the filter that would result in each output. Assume ideal behavior.

A. \( v_o = \sin (1000t) + \sin(100,000t) \) would be the result of the filter described by number __________
B. \( v_o = \sin (1000t) \) would be the result of the filter described by number __________
C. \( v_o = \sin(100,000t) + \sin (10t) \) would be the result of the filter described by number __________
D. \( v_o = \sin (10t) \) would be the result of the filter described by number __________
E. \( v_o = \sin (1000t) + \sin (10t) \) would be the result of the filter described by number __________
F. \( v_o = \sin(100,000t) \) would be the result of the filter described by number __________
Filters

1. A low pass filter with a cut-off frequency of 5000 rad/sec.
2. A low pass filter with a cut-off frequency of 500 rad/sec.
3. A high pass filter with a cut-off frequency of 500 rad/sec.
4. A high pass filter with a cut-off frequency of 50,000 rad/sec
5. A bandpass filter with a center frequency of 1000 rad/sec.
6. A bandstop (notch) filter with a center frequency of 1000 rad/sec.

Problem 5

Plot the frequency spectra for the following:

1. \( v(t) = 4 \) volts
2. \( v(t) = 1 + 4\cos(2\pi t + \pi) \)
3. \( v(t) = 4\cos(100t) + 5\sin(1000t) \)

Problem 6

Chose the correct frequency spectrum for each waveform.

Waveform A  Waveform B  Waveform C
Freq. Spectra 1  Freq. Spectra 2  Freq. Spectra 3
**Problem 7**

If \( v_s(t) = \sin(t) \), find \( v_o(t) \) and plot both waveforms. Assume the diode is ideal.

![Diode Circuit](image)

**Problem 8**

![Transistor Circuit](image)

1. If \( R_C = 100 \, \Omega \) and the \( I_B = 0.0005 \) Amps, find the voltage drop across \( R_C \). What region is the transistor operating in?
2. If \( R_C = 100 \, \Omega \) and the \( I_B = 0.0015 \) Amps, find the voltage drop across \( R_C \). What region is the transistor operating in?
3. If \( I_B = 0.0015 \) Amp when \( V_S = 5 \) volts, find \( R_B \).

**Problem 8**

![Op-Amp Circuit](image)

Find \( V_O \) in terms of the resistors and sources assuming an ideal op-amp. Hint: Use KCL
Answers:

**Problem 1**
\[ \tau = 0.01 \text{ seconds}, \ Tr= 0.022 \text{ seconds}, \ Ts=0.04 \text{ seconds} \]

**Problem 2**
Percent overshoot = 25\%, \ Tp=0.7 \text{ seconds}, \ Tr=0.3 \text{ seconds}, \ Ts=1.7 \text{ seconds}ds

**Problem 3**
Low pass filter output = \(0.995\sin(t)+0.7053\sin(10t)+0.3162\sin(30t)\)

**Problem 4**
Filters: A=3, B=5, C=6, D=2, E=1, F=4

**Problem 5**
1. 

![Diagram 1](image1)

![Diagram 2](image2)

![Diagram 3](image3)

**Problem 6**
A = 2, B=3, C=1

**Problem 7**

![Input Waveform](image4)

![Output Waveform](image5)

**Problem 8**
1. 5 volts, Active \( V_{RC}=I_C*R_C \)
2. 10 volts, Saturation \( V_{RC}=I_C*R_C \)
3. 2866.67 \Omega \quad I_B = \frac{V_S-V_{BE}}{R_B}, \ V_{BE} = 0.7 \text{ V in saturation} \)

**Problem 9**
\[
V_o = \frac{R_3(R_1+R_4)}{R_1(R_2 + R_3)}V_2 - \frac{R_4}{R_1}V_1
\]