Homework Problems – EE301 Spring 2007

**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: \( M = 10^{\frac{M_{dB}}{20}} \)

**Problem 4 - Filters**

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
Freq. Spectra 1

Waveform B
Freq. Spectra 2

Waveform C
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 Diagram](image)

**Problem 8**

![Transistor Circuit Diagram](image)  

Notice Scaling

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**

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%, \( T_p = 0.7 \) seconds, \( Tr = 0.3 \) seconds, \( Ts = 1.7 \) seconds

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

Problem 4
Filters: \( A=3, \; B=5, \; C=6, \; D=2, \; E=1, \; F=4 \)

Problem 5
1. \begin{align*}
    \text{Mag} \; & \; \omega \\
    0 \; & \; 2\pi \\
\end{align*}

Problem 6
\( A = 2, \; B=3, \; C=1 \)

Problem 7

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

Problem 9
\[ V_o = \frac{R_2(R_1 + R_4)}{R_1(R_2 + R_3)} \times \frac{R_4}{R_i} \times V_i \]