ESC201A MidSem Part2

SAMYAK SINGHANIA

TOTAL POINTS

16.5 / 21

QUESTION 1

Q1 7 pts

1.1 1(a) **4 / 4**

+ 4 pts Completely Correct

✓ **+ 1 pts** *Vo correctly found for first circuit*

✓ **+ 1 pts** *Vo correctly found for second circuit*

✓ **+ 2 pts** *Vo correctly found for third circuit*

+ 0 pts Completely Incorrect

+ 0 pts Not Attempted

+ 0 pts Copied

1.2 1(b) **3 / 3**

✓ **+ 3 pts** *Completely Correct*

+ 1 pts KCL Correct

+ 0 pts Completely Incorrect

+ 0 pts Not Attempted

+ 0 pts Copied

+ 1 pts VPS max correct

+ 1 pts VPS min correct

QUESTION 2

Q2 8 pts

2.1 2(a) **3.5 / 4**

+ 4 pts Completely Correct

+ 0 pts Completely Incorrect

+ 0 pts Not Attempted

+ 0 pts Copied

✓ **+ 2 pts** *Poles identified and transfer function form written correctly*

+ 2 pts Calculation for unknown frequency correct. Final transfer function correct

+ 1.5 *Point adjustment*

2.2 2(b) **0.5 / 4**

+ 4 pts Completely Correct

+ 0 pts Completely Incorrect

+ 0 pts Not Attempted

+ 0 pts Copied

+ 1 pts Circuit correct

+ 1 pts Circuit operation verified for Vin < 2 V

+ 1 pts Circuit operation verified for 2V < Vin < 3 V

+ 1 pts Circuit operation verified for Vin > 3 V

+ 0.5 *Point adjustment*

QUESTION 3

Q3 6 pts

3.1 3(a) **2.5 / 3**

+ 3 pts Completely Correct

+ 0 pts Completely Incorrect

+ 0 pts Not Attempted

+ 0 pts Copied

+ 2 pts Voltage gain calculated correctly

+ **1 pts** Current gain calculated correctly

+ **2.5** *Point adjustment*

Ai is in minus.

3.2 3(b) **3 / 3**

✓ **+ 3 pts** *Completely Correct*

+ **0 pts** Completely Incorrect
+ **0 pts** Not Attempted
+ **0 pts** Copied
+ **1 pts** vi graph correct
+ **1 pts** vo graph correct
+ **1 pts** io graph correct

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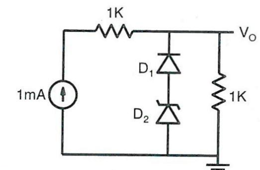
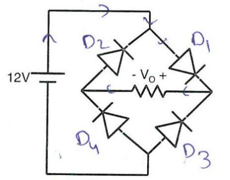
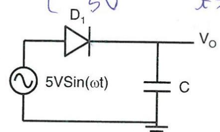
1 (a). Determine the output voltage (steady state output in case of sinusoidal input) for the circuits shown below assuming that cut-in voltage of diode and Zener diode is 0V and that Zener voltage is 3V. Give proper reasoning for your answer. [4]

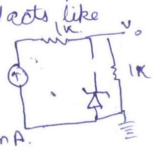




$V_o = \begin{cases} 5V\sin(\omega t) & t \le \frac{\pi}{2\omega} \\ 5V & t > \frac{\pi}{2\omega} \end{cases}$



If D_1 is on, then current through D_1 would be negative
∴ D_1 is off and acts like open circuit.



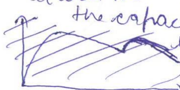
Current through 1K Ω resistor is 1mA.

∴ $V_o = 1mA \times 1k\Omega = 1V$

Here, If D_1 is on, then D_2, D_3, D_4 will be off. So no current flows in the circuit

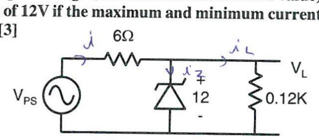
$V_o = 0V$

Here, $V_i = 5V\sin\omega t$ for half cycle, the current will flow in circuit and for the other half it will not. So once the capacitor becomes charged it will remain charged.



∴ For $t \le \frac{\pi}{2\omega}$, $V_o = 5V\sin(\omega t)$, else $V_o = 5V$

1 (b). For the circuit shown below, determine the range of input voltage (minimum and maximum value) for which the circuit would provide a constant output voltage of 12V if the maximum and minimum current ratings of the Zener diode are 0.5A and 0.1A respectively. [3]



$i = i_Z + i_L$. $V_Z = 12V$

∴ $i = \frac{V_{PS} - V_Z}{6} = i_Z + i_L$

$i_L = \frac{12}{0.12 \times 1000}$

$i_L = \frac{12}{120} = 0.1A$

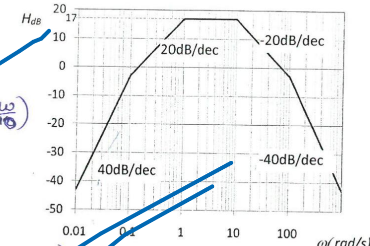
∴ $0.1 < \frac{V_{PS} - 12}{6} - i_L < 0.5$

$0.1 < \frac{V_{PS}}{6} - 2 - 0.1 < 0.5$

$2.2 < \frac{V_{PS}}{6} < 2.6$

$13.2V < V_{PS} < 15.6V$

2(a). Obtain the transfer function H(jω) corresponding to the Bode magnitude plot shown in the following figure. [4]



$H(j\omega) = \frac{A(j\omega)^2}{(1+j\frac{\omega}{100})(1+\cancel{0}j\frac{\omega}{0.1})(1+j\omega)(1+j\frac{\omega}{10})}$

At $\omega = 1$.

$20\log_{10}(|H(j\omega)|) = 17$.

$\log_{10}\left(\left|\frac{A}{(1)(10)(1)(1)}\right|\right) = \frac{17}{20}$

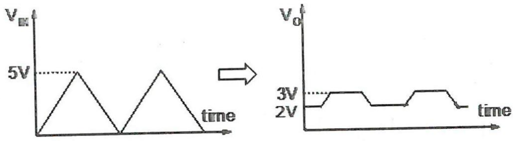
$\log_{10}\left(\frac{A}{10}\right) = 0.85$

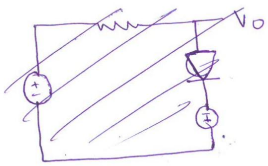
∴ $A = \cancel{0.707}\ 70.79$

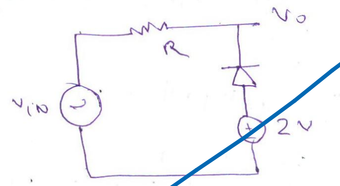
70.79

∴ $H(j\omega) = \frac{70.79(j\omega)^2}{(1+j\frac{\omega}{0.1})(1+j\frac{\omega}{1})(1+j\frac{\omega}{10})(1+j\frac{\omega}{100})}$

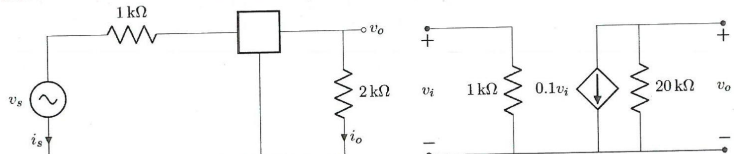
2(b). Design a diode circuit to convert the triangular waveform into the waveform shown below. Give the circuit diagram along with typical component values. Assume ideal diodes with cut-in voltage of zero volts. [4]

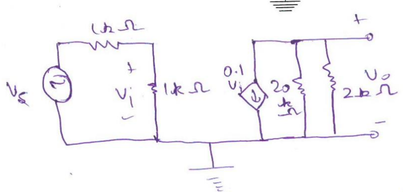






3(a). Determine the voltage gain vo/vs and current gain io/is of the amplifier shown below on the left for the transistor model shown below on the right. [3]





Net R_L $= 20k\Omega || 2k\Omega$

$= \frac{20 \times 2}{20+2} k\Omega$

$= \frac{20 \times 2}{22\,11} = \frac{20}{11} k\Omega$

$\therefore V_o = -0.1 V_i \times \frac{20}{11} kV$

$V_i = \frac{1}{2} V_s$ $\quad \therefore V_o = -0.1 \times \frac{20}{11} \times \frac{1}{2} V_s$ kV

$\Rightarrow \frac{V_o}{V_s} = -0.1 \times \frac{20}{11} \times \frac{1}{2} \times 1000 = -90.90$

$i_o = -0.1 V_i \times \frac{20}{22} = -0.1 \times \frac{20}{22} \times \frac{V_s}{2} = \frac{-V_s}{22}$ A.

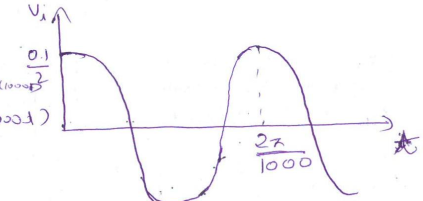
$i_s = \frac{V_s}{(1+1)k\Omega} = \frac{V_s}{2}$ mA $\Rightarrow \frac{i_o}{i_s} = \frac{-V_s \times 2 \times 1000}{22 \times V_s} = -90.90$

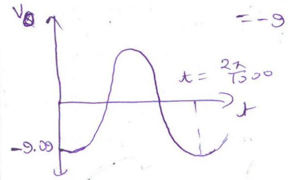
3(b). If vs = 0.1cos(1000t) in part 3(a), plot vi, vo, and io as a function of time. [3]

$v_i = \frac{V_s}{2} = \frac{0.1}{2} \cos(1000t)$

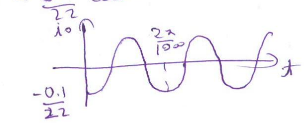
$V_o = -90.90\, V_s = -90.90 \times 0.1 \cos(1000t)$

$= -9.09 \cos(1000t)$





$i_o = -\frac{V_s}{22} = -\frac{0.1}{22}\cos(1000t)$



Rough Work