Department of Electrical Engineering, IIT Kanpur

Mid-Semester Exam (Part-II), Date: 20/09/2022 Duration: 55 minutes

ESc 201: Introduction to Electronics

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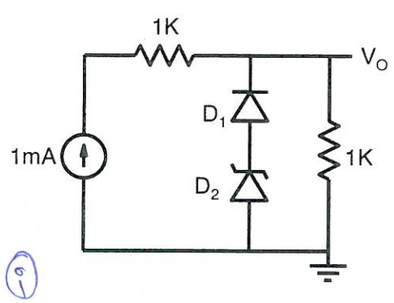
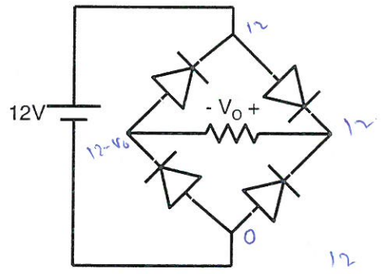
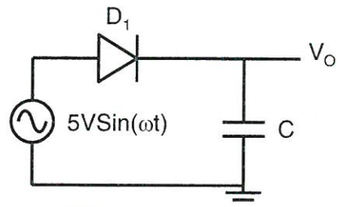
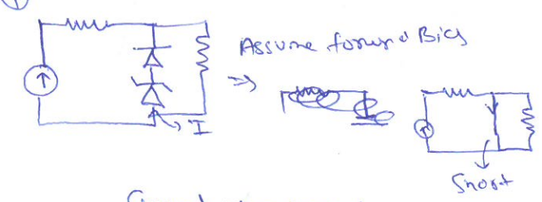
1 (a). Determine the output voltage (steady state output in case of sinusoidal input) for the circuits shown below assuming that cut-in voltage of diode and Zener diode is 0V and that Zener voltage is 3V. Give proper reasoning for your answer. [4]







(i) ⇒ Assume forward Bias



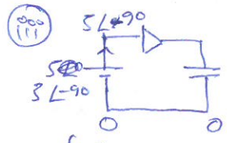
Current $I = -1mA$ hence forward not possible.

(ii) Assume $0 < V_0 < 12$

(so) we find that diode will never be forward Biased in a way we get Complete Circuit

$V_0 = 0$

(iii)



for $5V\sin\omega t > 0$

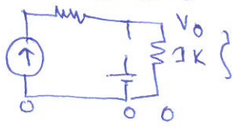
$\therefore I_Z = \frac{5\angle -90}{\angle -90}\omega C$

$I_Z = 5\omega C$

$V_0 = \left(\frac{1}{j\omega C}\right) 5\omega C$

$V_0 = 5\angle -90$

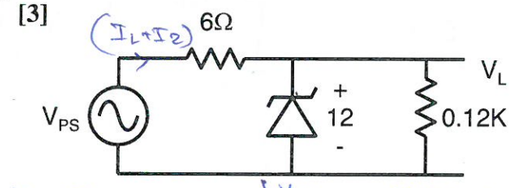
in Reverse Bias



$V_0 = (1\times10^3)(1\times10^{-3}A)$

$= 1V$

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]



$V_{pmax} = (I_L + I_{Z_{max}})\,6 + I_L\,0.12K$

$V_{pmin} = (I_L + I_{Zmin})\,6 + I_L\,0.12K$

$V_L = 12$

Calc $I_L = \frac{12}{0.12K} = \frac{1}{10}$

$V_{pmax} = 12.6 + 6\times0.5 = 15.6$

$V_{pmin} = 12.6 + 6\times0.1 = 13.2$

$\left(V_{pmax}\right) = \frac{6}{10} + 6I_{Zmin} + 12$

$\frac{V_{pmax} - 12 - \frac{6}{10}}{6} = I_{Zmax}$ (i)

$\frac{V_{pmin} - 12 - \frac{6}{10}}{6} = -I_{Zmin}$ (ii)

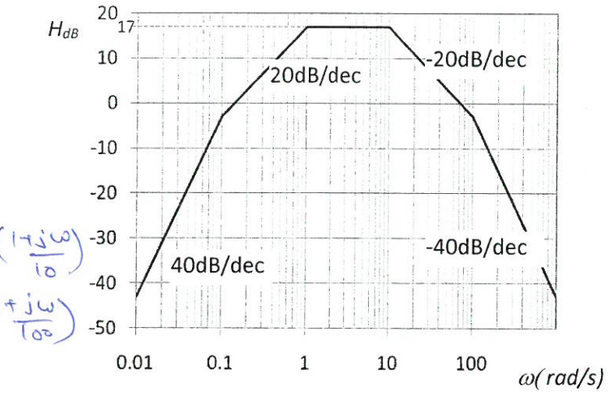
$\Rightarrow 5 = \frac{V_{max} - 12 - 0.6}{V_{pmin} - 12 - 0.6}$

$5V_{pmin} - 5(12.6) = V_{max} - (12.6)$

$5V_{min} - V_{max} = 4\times12.6$

So $13.2 \le V \le 15.6$

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



⇒ By the different segments given :-

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

$= \frac{A}{0.01}$ At $\omega = 1$

↓ By Putting $\omega = 1$

$17 = 20\log A + 20\log(1) - 20\log(10) \Rightarrow -20\log(1) - 20\log(1) - 20\log(1)$

$17 = 20\log A - 20$

$\frac{37}{20} = \log A$

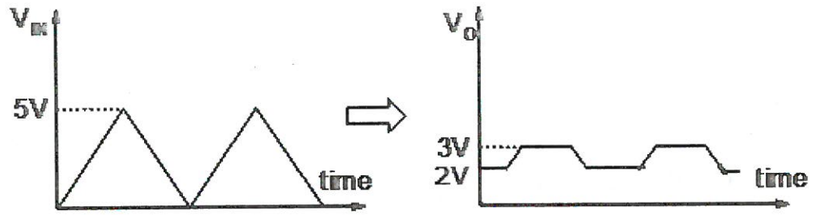
$A = 10^{37/20} = 70.794$

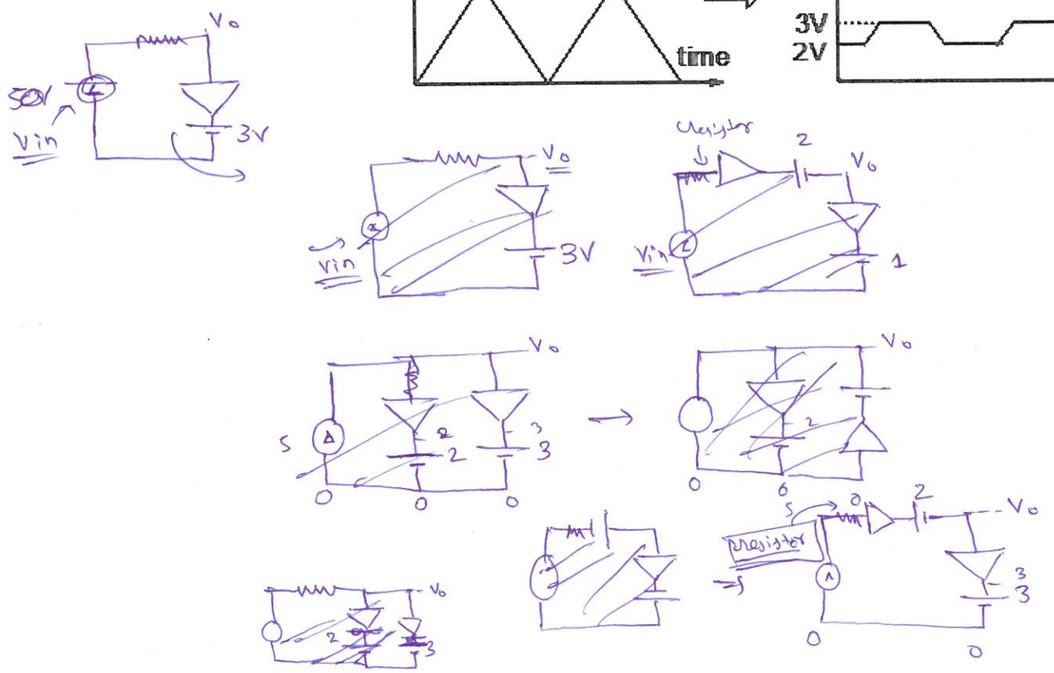
$H_{dB} = 20\log\left(\frac{A(\omega)^2}{\sqrt{1+(\frac{\omega}{0.1})^2}\sqrt{1+(\frac{\omega}{1})^2}\sqrt{1+(\frac{\omega}{10})^2}\sqrt{1+(\frac{\omega}{100})^2}}\right)$

$\frac{17}{10^{20}} = \left(\frac{A}{10}\right)$

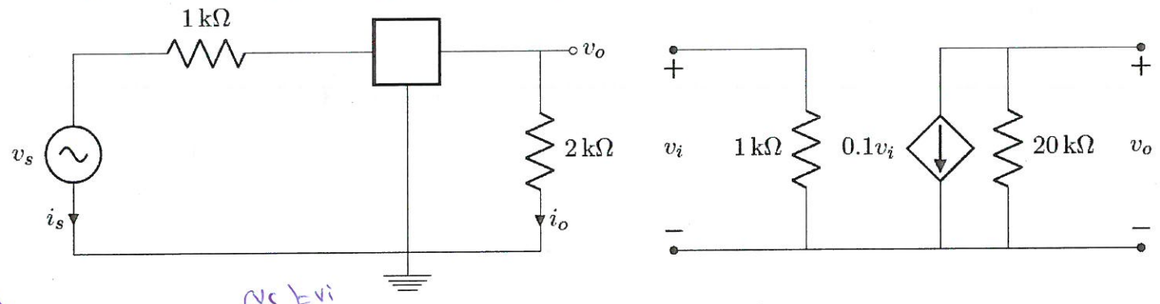
$H(j\omega) = \frac{(70.794)(j\omega)^2}{(1+\frac{j\omega}{0.1})(1+\frac{j\omega}{1})(1+\frac{j\omega}{10})(1+\frac{j\omega}{100})}$

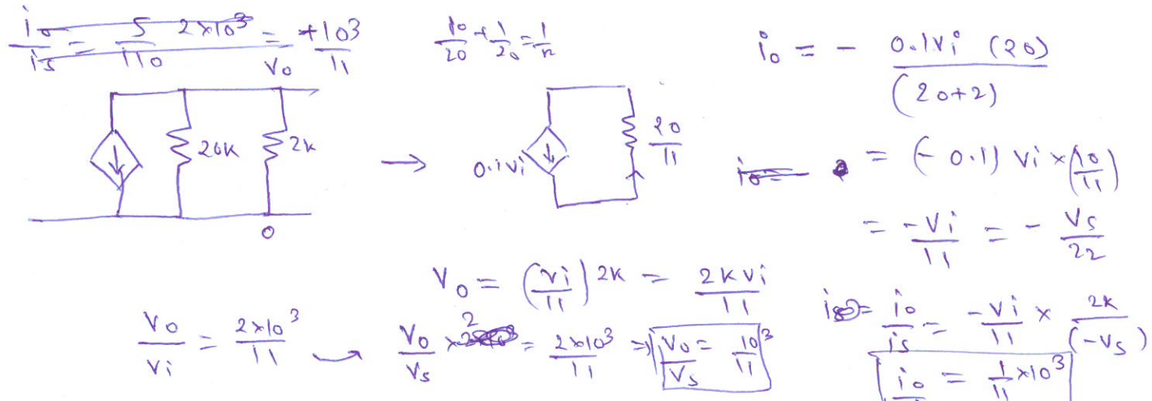
2(b). Design a diode circuit to convert the triangular waveform into the waveform shown below. Give the circuit diagram along with typical component values. Assume ideal diodes with cut-in voltage of zero volts. [4]



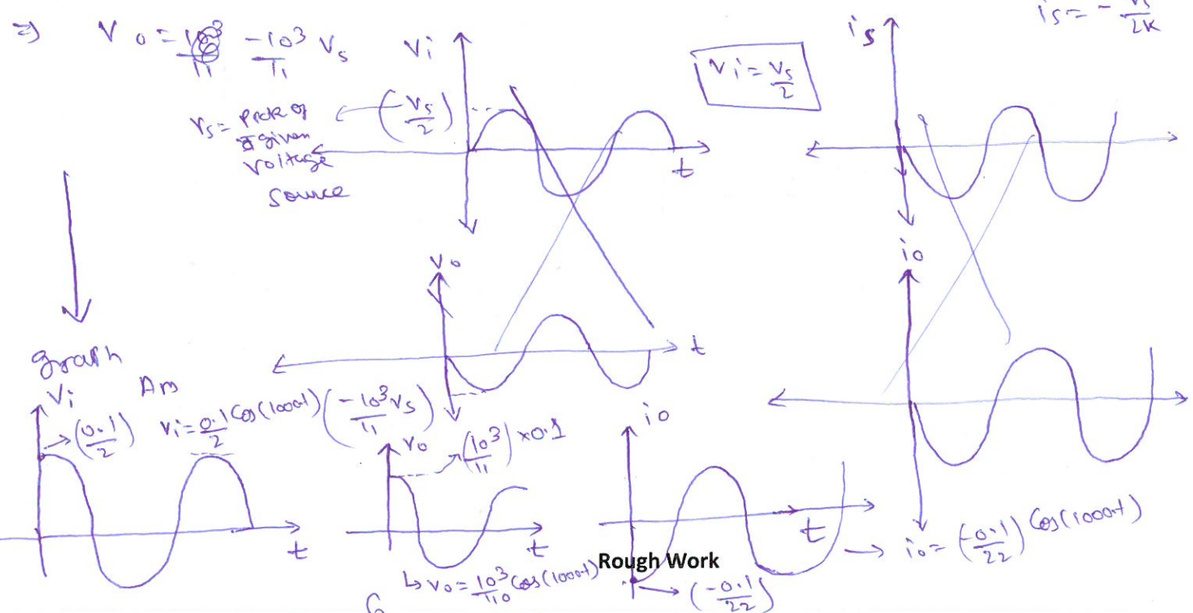


3(a). Determine the voltage gain vo/vs and current gain io/is of the amplifier shown below on the left for the transistor model shown below on the right. [3]





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



Rough Work