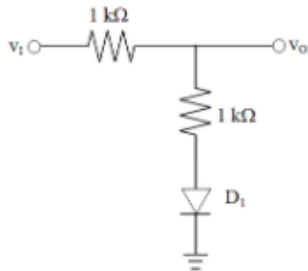


### Short Answer Problems

Consider the following circuit that contains an ideal diode.

The source,  $v_i$ , is an 10 V peak sinusoid. For what values of  $v_i$  is the diode conducting (or on).



☐ Diode is on for all values of  $v_i$

☐  $v_i < 0$

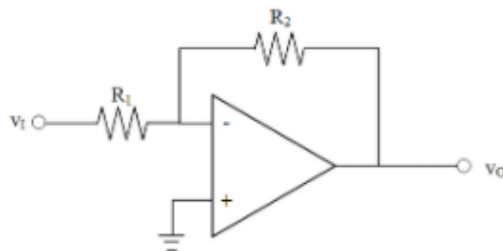
☒  $v_i > 0$

Consider an inverting configuration using an ideal operational amplifier (see circuit below) that can use resistor values up to  $1\text{ M}\Omega$ .

If the voltage gain is 40db and you want to maximize the input resistance, what would the values of

$R_1$   and  $R_2$  be  ?

**Note:** Your final answers should be in this format (no units). R.RReX (EX.  $512.95\text{k}\Omega$  is entered as 5.13e5 or  $20\text{k}\Omega$  is entered as 2.00e4)

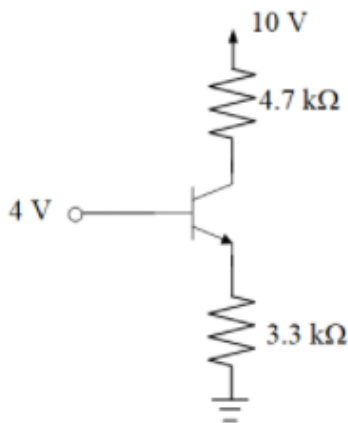


$R_1=10\text{kohm}$

$R_2=1\text{Mohm}$

Given the following npn BJT with  $V_{BE}=0.8\text{ V}$  and  $\alpha=.98$ . What are the base  , collector  , and emitter  currents?

Give your answers in orders of mA and give three decimal places/significant figures (EX:  $5.613\text{E-}6\text{ A}$  =  $0.00563\text{ mA}$  - do not include the units in your answer)



You are given a zener diode where it is known that for a zener voltage of  $5.6\text{ V}$ , the zener current is  $3.2\text{mA}$ . The incremental resistance of the diode is  $10\Omega$ . What is  $V_{zo}$ ?

*Enter your answer with no units and no more than 2 decimal places.*

$V_{zo} = 5.57\text{ volts}$

A common gate amplifier has the following characteristics:  $k'_n=0.5 \frac{\text{mA}}{\text{V}^2}$ ,  $\frac{W}{L}=10$ ,  $\lambda=0$ , and  $V_t=1.1 \text{ V}$ .

The amplifier is biased for  $V_{GSQ}=2.2 \text{ V}$  and has a drain resistor of  $5.1 \text{ k}\Omega$ , a load resistor of  $8 \text{ k}\Omega$  and a signal resistor of  $280 \Omega$ .

What is the input resistance  $R_{in}$ ?  in ohms

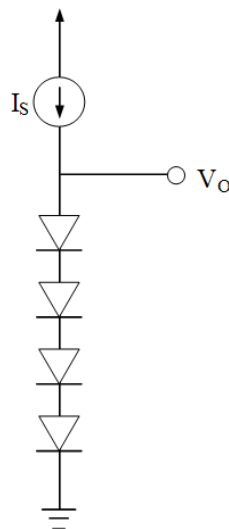
What is the output resistance  $R_O$ ?  in kohms

What is the parameter,  $g_m$ ?  in mA/V

What is the voltage gain,  $G_v$ ?  in V/V

All answers should round to two decimal places.

Consider the following circuit that contains diodes that operate in the forward bias region and are identical. It is known that when the diode voltage is  $0.8 \text{ V}$ , the diode current is  $1 \text{ mA}$ . If the current source,  $I_s$  is  $3 \text{ mA}$ , what is the voltage  $V_o$ . Assume the thermal voltage is  $25 \text{ mV}$ .



3.31 Volts

### Long Design Problems:

You have been asked to design an amplifier using the common source configuration :

$$k'_n = 800 \frac{\mu A}{V^2}, \quad V_t = 1 \text{ V}, \quad \lambda = 0.03 \text{ V}^{-1} \text{ and } \frac{W}{L} = 10$$

The Q-point is at  $I_{DQ} = 0.4 \text{ mA}$ . There is a drain resistance,  $R_D = 12 \text{ k}\Omega$  and the amplifier is driven by a signal source,  $v_{SIG}$ , in series with a signal resistance,  $R_{sig}$ ,  $500 \text{ k}\Omega$ .

- [20 pts] Find  $V_{GSQ}$ ,  $r_o$ , and  $g_m$ .
- [20 pts] Draw the small-signal model. Label and solve for the input resistance,  $R_{in}$ , the output resistance,  $R_o$ , the open-circuit voltage gain,  $A_{vo}$
- [15 pts] A variable load,  $R_L$ , requires the overall voltage gain,  $G_v$ , to be in  $-5 \text{ V/V}$ . What should the variable load be set to achieve this overall gain.

Please enter only the load resistor in the box. Show all other work on your submission.

Using an single ideal op-amp, one  $100 \text{ k}\Omega$  potentiometer, and one additional resistor ( $R_1$ ), design an amplifier that allows a range of closed loop gain from  $1 \text{ V/V}$  to  $20 \text{ V/V}$ .

Show all your work including the circuit you designed. The value of  $R_1$  should go in the box.