ELECTRONICS-I (ELEC 311/1 BB)

Mid-Term Test (Summer 2013)

(No CRIB sheet allowed. Only ENCS approved calculator allowed)

Electrical and Computer Engineering Department
Instructor: Dr. R. Raut

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Time: **70** minutes

(Answer **ALL** questions)

Please return the question paper with your answer book

Q.1: For the circuit in **Fig.1**, both diodes are identical. Find the value of R for which V = 90 mV. Assume n =2. *Hint*: Use exponential model for the diodes.

$i_1 + i_2 = 10\,mA$
$V = 90\,mV = i_2 R$
$v_{D2} = v_{D1} + 90\,mV$
$i_1 = I_S \exp\left(\frac{v_{D2}}{nV_T}\right)$
$i_2 = I_S \exp\left(\frac{v_{D2} - .09}{nV_T}\right)$

$\frac{i_1}{i_2} = \exp\left(\frac{v_{D2} - v_{D2} + .09}{2 \times .025}\right) = \exp(1.8) \approx 6.05$

But $i_1 + i_2 = 10\,mA$

Solving, $i_2 = 1.42\,mA$

$R = \frac{90\,mV}{1.42\,mA} \cong 63.45\,\Omega$

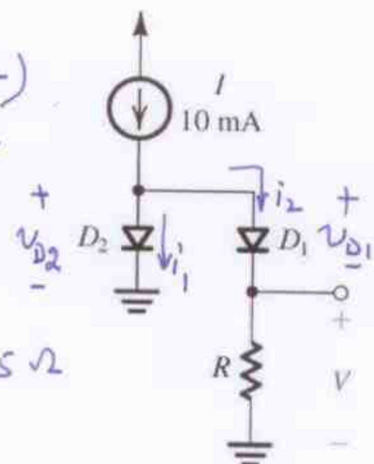


Figure 1

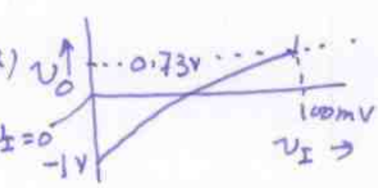
Q.2: An electronic amplifier is characterized by the output-input relation $v_O = 2[0.5 - e^{-20v_I}]$.

(a) Show a graphical sketch of the transfer characteristic over $0 < v_I < 100\text{ mV}$.

(b) What will be the **small signal** gain of the amplifier at an operating input voltage of $V_I = 50$ mV?

(c) What is the associated output operating point for $V_I = 50$ mV?

(a)



(b) $\left.\frac{\partial v_O}{\partial v_I}\right|_{v_I = 50mV} = -2(-20)e^{-20 \times .05} = 14.71\ V/V$

(c) $v_O = 2(.5 - e^{-20 \times .05}) = 0.26\ V$

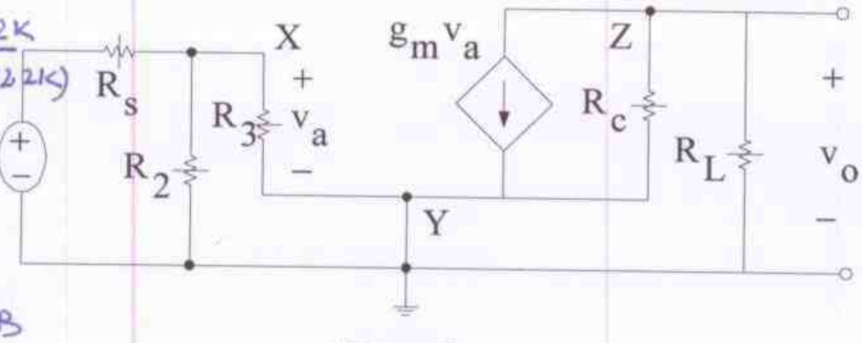
Q.3: Figure 3 shows the equivalent circuit of a BJT amplifier. Obtain the voltage amplification $\frac{v_o}{v_i}$. Express the magnitude in dB. The various component values are given as: R_s = 100 ohms, R_2 = 44k ohms, R_3 = 2.2k ohms, R_c = 3.3k ohms, R_L = 4.7k ohms, g_m = 0.05 Ω^{-1} mhos.

Use 100Ω = 0.1KΩ

$v_a = v_s \frac{44K \| 2.2K}{(0.1 + 44K \| 2.2K)}$

$v_a = 0.952 v_s$

dB gain $= 20\log_{10}|-92.1|$ = 39.28 dB



$v_o = -0.05 \times (3.3K \| 4.7K) \times v_a$

Then find $\frac{v_o}{v_s} \simeq -92.1$ V/V

Figure 3:

Q.4: Figure 4 shows a circuit for an *ac* voltmeter. The meter shows full scale deflection for a DC current of 1.5 mA. Design the resistance *R* so that an *ac* voltage v_i of 15 volts magnitude produces full deflection in the meter. The diode is ideal, and the system works like a half-wave rectifier. The meter has a resistance of 15 Ω.

$E_m = 15$ V

$v_i = 15 \sin \omega t$

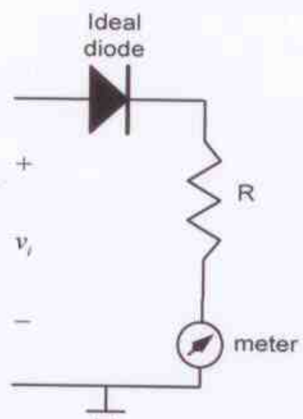


Figure 4

$i_R = \frac{V_{DC}}{R + r_m}$; $r_m = 15\Omega$

$V_{DC} = \frac{E_m}{\pi}$ for a HWR system

So $\frac{E_m}{\pi} \cdot \frac{1}{R+15} = 1.5$ mA

$R + 15 = \frac{15}{\pi \times 1.5}$ KΩ

R = ~~3.127 KΩ~~ 3.168 KΩ