Course		Number	Section
Electronics I I		ELEC 312	W
Examination	**Date**	**Time**	**# of pages**
Mid-Term Test	February 17, 2012	45 minutes	3

Instructor(s)

Dr. R. Raut

Materials allowed: [X] No [ ] Yes (Please specify)

Calculators allowed: [ ] No [X] Yes

NO formula sheet is allowed.
ONLY ENCS approved calculator is allowed.

Special Instructions:

Write your ID# on the front page of your answer book
Attempt all questions.
Show all steps clearly in neat and legible handwriting.
Students are required to return question paper together with exam booklet(s).

******** Some useful formulae************

BJTs

$$r_e = \alpha / g_m \quad g_m = I_C / V_T \quad r_\pi = h_{fe} / g_m \quad h_{fe} = i_c / i_b \quad r_o = V_A / I_C$$

$$\alpha = \frac{h_{fe}}{h_{fe} + 1} \qquad V_T = \frac{kT}{q} \approx 25mV \text{ at room temperature}$$

Diodes $I = I_s \exp(v_{BE}/V_T)$

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Q.1: Consider the basic current mirror in Figure 1. Design R, so that I_o =2 mA. Given V_{CC}=5 Volts, β=100, I_{S2} =10^{-14} Amp., I_{S1} = 0.25×10^{-14} Amp. I_S is the scale current (i.e., reverse saturation current for the respective EB junctions of the transistors).

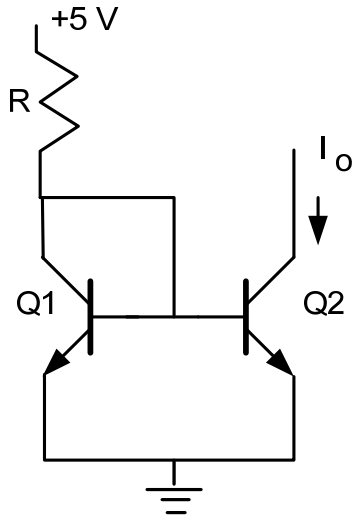


Figure 1:

Q.2: The BJT differential amplifier in Fig.2 is supplied with a differential ac signal v_D= v_1-v_2. The differential output signal is given by the expression

$$v_{o1} - v_{o2} = R_c I[\frac{\exp(-v_D / V_T)}{1+\exp(-v_D / V_T)} - \frac{\exp(v_D / V_T)}{1+\exp(v_D / V_T)}]$$

Where V_T is the thermal voltage (~ 25 mV). The bias current I is arranged to be 2 mA

Calculate the voltage gain (v_{o1}-v_{02})/v_D, when (i) v_D=30 mV and (ii) v_D= 2 mV. How do these compare with the theoretical small signal voltage gain value of $|\, g_m R_C \,|$, where g_m is the trans-conductance of each BJT device.

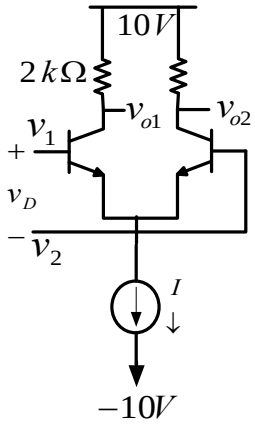
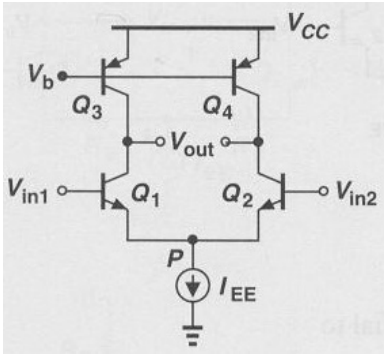


Figure 2:

Q.3: The following figure illustrates an implementation of a differential amplifier with current-source active load using complementary BJT devices. The current I_{EE} = 2 mA. The early voltages are :

V_{AN} (for NPN BJT) =25 V, V_{AP} (for PNP BJT)=50 V.



The signals V_{in1} and V_{in2} are balanced differential. Calculate the differential voltage gain $V_{out}/(V_{in1} - V_{in2})$?

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BJTs

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$$\alpha = \frac{h_{fe}}{h_{fe} + 1} \qquad V_T = \frac{kT}{q} \approx 25mV \text{ at room temperature}$$

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