İTÜ-EEF ANALOG ELECTRONIC CIRCUITS 2013

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FINAL EXAM Jan. 5, 2014

1)- The unloaded voltage gain of a given inverting amplifier is 100, and the input resistance r_i=15kΩ. The amplifier is driven with a voltage source with an internal impedance of R_g. Load is R_L=10kΩ.

a)- The unloaded midband gain of the circuit is v_o/v_g=-60. When the load impedance R_L is connected to the output, the circuit gain drops to v_o/v_g=-48. Find R_g and the amplifier output resistance R_o.

b)- The amplifier is connected to the source and load over coupling capacitors C_1 and C_2, respectively. Find the C_1/C_2 ratio so that $f_{k2}=2f_{k1}$ for the associated low frequency poles.

c)- Find C_1 and C_2 for a low frequency cutoff (-3dB) of 100Hz for the circuit.

$$\frac{f_{k1}}{f_{k2}}$$

Note: When poles are close $f_k=(f_{k1}f_{k2}f_{k3}\ldots)^{\frac{1}{n}}$ and $f_L=\dfrac{f_k}{\sqrt{2^{\frac{1}{n}}-1}}$

d)- Find the tilt at the output when a pulse with Tp=35μs is applied to the input (the pulse generator has the same R_g). Note: $\delta_T=\delta_1+\delta_2+\ \ldots$

e)- If the amplifier input capacitance C_i=40pF, output capacitance C_o=2pF, and the feedback capacitance is C_r=0.5pF, find the high frequency poles and the high cutoff frequency for the circuit (assume generator has the same R_g). *Note: Miller theorem: input: $(1-K)C_r$, output $(1-1/K)\,C_r$*

f)- A pulse with a rise time of 0.1μs is applied to the input and the output rise time is measured using a scope with a rise time of 0.1μs. Find the measured output rise time (the pulse generator has the same R_g).

$$t_r=\frac{0.35}{f_H},\quad t_r\approx\sqrt{t_1^{\,2}+t_2^{\,2}+\ \ldots}$$

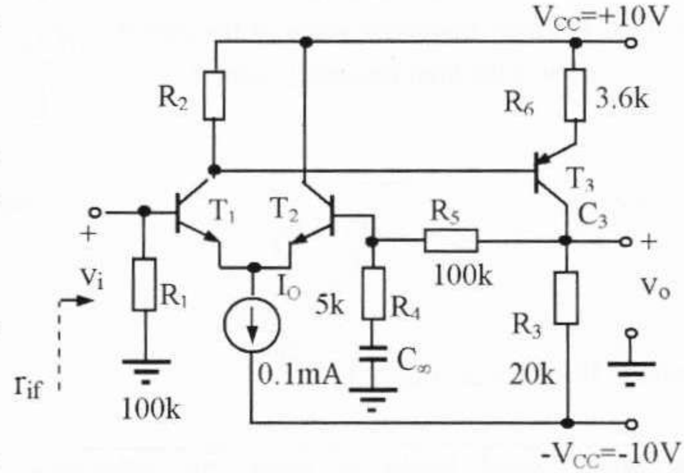
2)- In the given circuit, $|V_{BE}|\approx 0.7$V, V_T=25mV, $\beta_1=\beta_2=200$, $\beta_3=500$.

a)- Find the value for R_2 so that V_{C3Q}=0V.

b)- Find the open loop midband gain of the circuit with β loading. What is the feedback topology?

c)- Find v_o/v_i with feedback.

d)- Find v_o/v_g with feedback when the source resistance is R_g=40kΩ.



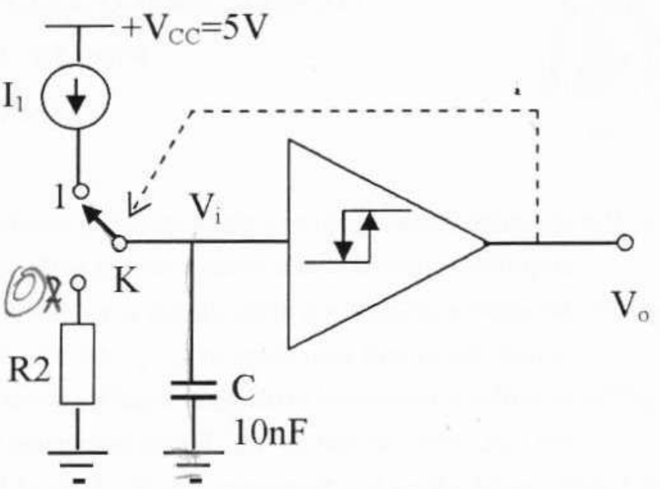
Note: Diff. Amp. Single ended gain is

$$K_d=-\frac{R_{Leff}}{2r_e}$$

CONTINUED ON THE BACK- TURN OVER ☞

$C\frac{dV_C}{dt} = I_C$

3)- In the relaxation oscillator given in the figure, the noninverting Schmitt circuit has: V_{IH}=3.5V, V_{IL}=1.5V, V_{OH}=5V, V_{OL}=0V. Commutator switch K is connected to "1" when Vo is low, and to "0" when Vo is high.



a)- Briefly describe the operation of the circuit.

b)- For a square wave output (on/off ratio t_d/t_b=1) with a frequency of 10kHz, find R_2 and the current I_1. What does the on-off ratio depend on?

c)- Design a suitable PNP currrent mirror current source for I_1. ($|V_{BE}| \approx 0.7$V)

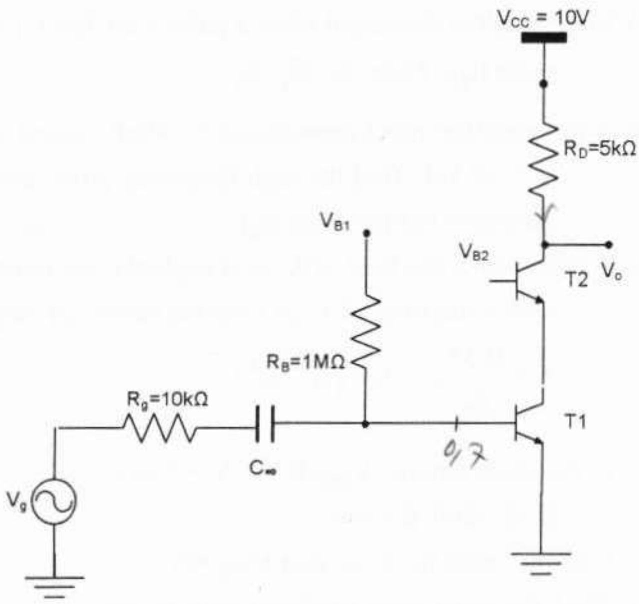
4)- In the given circuit, T1 and T2 transistors are identical and both are biased in the forward conduction region. V_{BE}=0.7V, β_F=100, V_T=25mV, $h_{oe1} \approx 0$, $h_{oe2} \approx 0$, $C_{be1}=C_{be2}$=20pF, $C_{cb1}=C_{cb2}$=0.5pF

a)- Find I_{C1} for V_{B1}=5.7V

b)- Find the value range for V_{B2} for proper operation of the circuit.

c)- Draw the small signal equivalent circuit and find the midband gain v_o/v_g.

d)- Find the high frequency poles of the circuit. What is the high frequency cutoff?



$h_{oe}=1/r_{ce}$

Hint: Do you recognize this circuit configuration!

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Points: 30 + 30 + 20 + 20 = 100

Time 120".

Notes: Closed books & notes. No cellphones. You may make reasonable engineering approximations. All your approximations, roundings, and assumptions should be clearly visible. Be careful with your units.

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