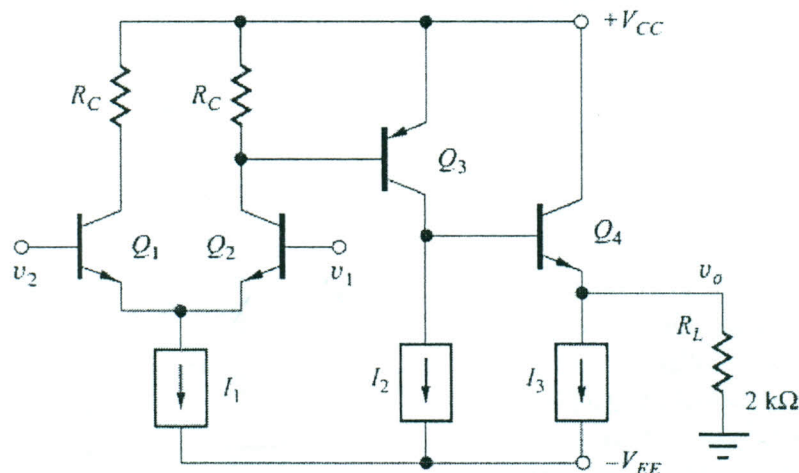


TWO PAGES EXAM

Answer the following questions (Assume any missing data)
 Organize your answers, if I can't read it, I can't grade it

Q1) The following circuit shows an Op Amp circuit with the following parameters:
 $V_{CC} = 15\text{ V}$, $V_{EE} = -15\text{ V}$, $V_{A3} = 75\text{ V}$, $\beta_{01} = \beta_{02} = \beta_{03} = \beta_{04} = 150$,
 $I_1 = 100\text{ }\mu\text{A}$, $I_2 = 500\text{ }\mu\text{A}$, $I_3 = 5\text{ mA}$, Current source I_1 output resistance, $R_1 = 750\text{ k}\Omega$,
 Current source I_2 output resistance, $R_2 = 150\text{ k}\Omega$, Current source I_3 output
 resistance, $R_3 = 15\text{ k}\Omega$, and $R_L = 2\text{ k}\Omega$, I_C (of Q_2) = $49.7\text{ }\mu\text{A}$, I_{C3} (of Q_3) = $533\text{ }\mu\text{A}$, I_{C4} (of
 Q_4) = 4.97 mA , $V_{CE3} = 14.3\text{ volts}$. Find: (25 points)

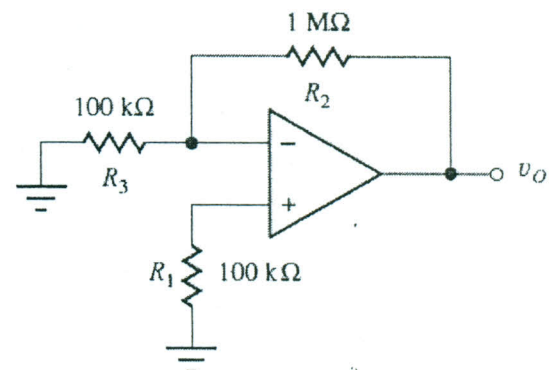
- The value of R_C
- The differential mode voltage gain, input resistance, and output resistance
- The CMRR
- If the input is a sinusoid having 1 mv amplitude, what is the efficiency of the opAmp circuit? What is the best possible efficiency for the circuit?



Q2) An op amp has $R_{id} = 500\text{ k}\Omega$, $R_o = 35\text{ }\Omega$, and $A_o = 5 \times 10^4$. You must decide if a single-stage amplifier can be built that meets all of the specifications below.
 (a) Which configuration (inverting or noninverting) must be used and why?
 (b) Assume that the gain specification must be met and show which of the other specifications can or cannot be met. (15 points)

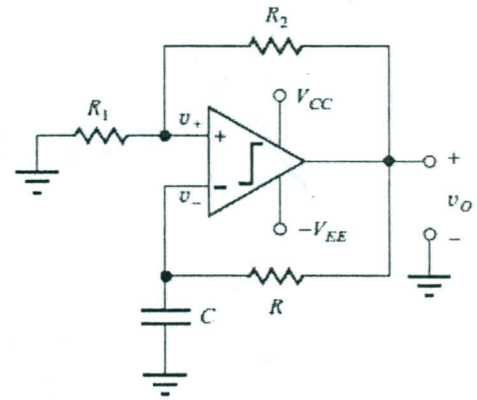
$$|A_v| = 200 \quad R_{in} \geq 2 \times 10^8 \text{ }\Omega \quad R_{out} \leq 0.2 \text{ }\Omega$$

Q3) Calculate the worst-case output voltage for the following circuit if $V_{OS} = 1\text{ mV}$, $I_{B1} = 100\text{ nA}$, and $I_{B2} = 95\text{ nA}$. What is the ideal output voltage? What is the total error in this circuit? Is there a better choice for the value of R_1 ? If so, what is the value? (15 points)



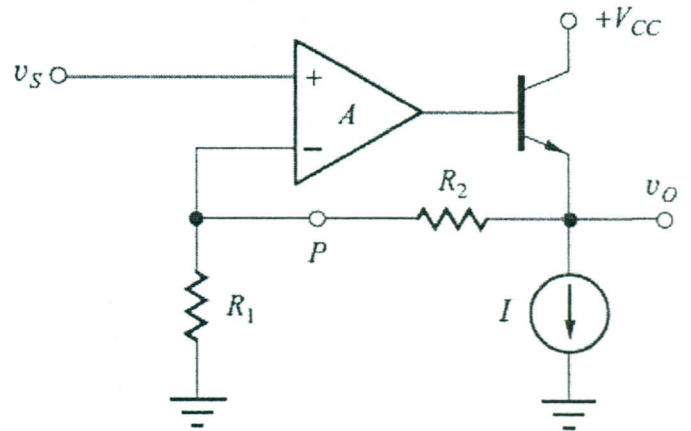
Q4) (a) Design an astable multivibrator to oscillate at a frequency of 1 kHz. With symmetric supplies of ± 5 V. Assume that the total current from the op amp output must never exceed 1 mA. (Assume that $R_1=R_2$) (b) If the resistors have $5\pm$ percent tolerances and the capacitors have $10\pm$ percent tolerances, what are the worst-case values of oscillation frequency? (c) If the power supplies are actually $+4.75$ and -5.25 V, what is the oscillation frequency for the nominal resistor and capacitor design values?

(20 points)



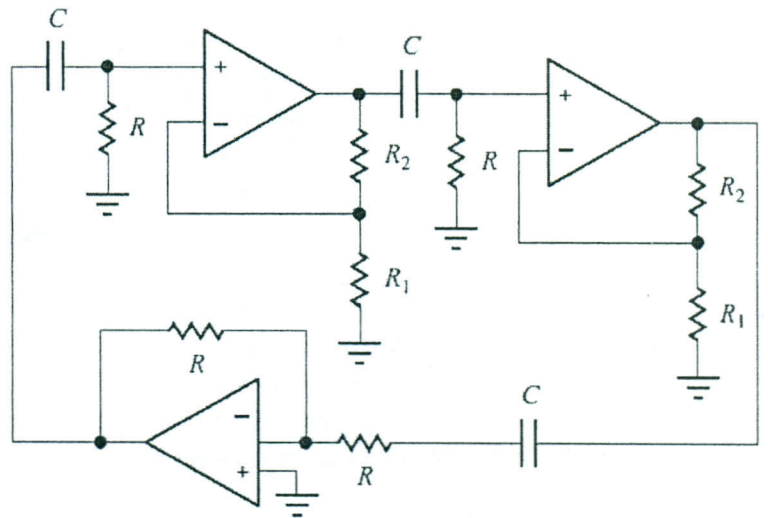
Q5) Find the closed-loop gain, input resistance, and output resistance for the shown circuit using feedback theory indicating the type of feedback. Assume $R_1 = 2$ k Ω , $R_2 = 10$ k Ω , $\beta_0 = 150$, $V_A = 75$ V, $I = 100$ μ A, $V_{CC} = 7.5$ V, $A = 40$ dB, $R_{id} = 50$ k Ω , and $R_o = 500$ Ω . $I_C = 0.1$ mA, and $V_{CE} \ll V_A$

(25 points)



Q6) Derive an expression for the frequency of oscillation of the three-stage phase-shift oscillator in the shown Figure. What is the ratio R_2/R_1 required for oscillation?

(20 points)



Good Luck Sherif Kishk