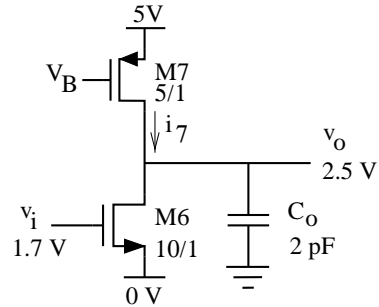


Your Name: _____

Only official course summary allowed. Do all questions directly on this paper. For extra space or for rough work, use back if necessary. Time 1 hour. - Total Marks 20%.

Question 1. (6 marks) For the gain stage shown:



$$K_{pn} = 100\mu A/V^2$$

$$K_{pp} = 50\mu A/V^2$$

$$\lambda_n = 0.02$$

$$\lambda_p = 0.03$$

$$V_{Tn} = 0.7V$$

$$V_{Tp} = -0.8V$$

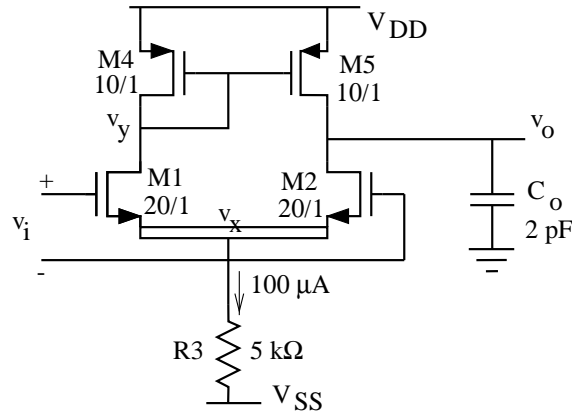
a) Find the value for i_7 .

b) Find V_B to result in a nominal output voltage of 2.5 V.

c) Find the minimum output voltage for which M6 is still in its proper region of operation.

d) The input is stepped to 2.7V. Find the resultant slew rate.

Question 2. (6 marks) For the amplifier as shown and parameters as listed:



$$K_{pn} = 100 \mu A/V^2$$

$$K_{pp} = 50 \mu A/V^2$$

$$\lambda_n = 0.02$$

$$\lambda_p = 0.03$$

$$V_{Tn} = 0.7V$$

$$V_{Tp} = -0.8V$$

a) Find g_{m1}

b) What is g_{m4} ?

c) What is the amplifier output resistance seen at v_o ?

d) What is the gain A_d for a difference-mode input?

e) What is the gain A_c for a common-mode input?

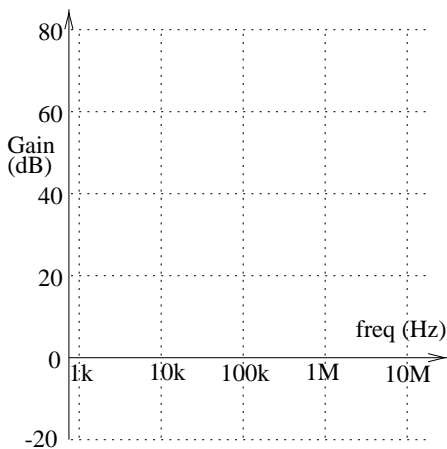
f) What is the common-mode rejection ratio?

Question 3. (3 marks) An opamp has its frequency response dominated by a single low-frequency pole at 10 kHz and DC gain of 10^3 (60 dB).

- a) If this amplifier is used to realize a closed loop gain of 10, at what frequency will the gain error be about 5%?

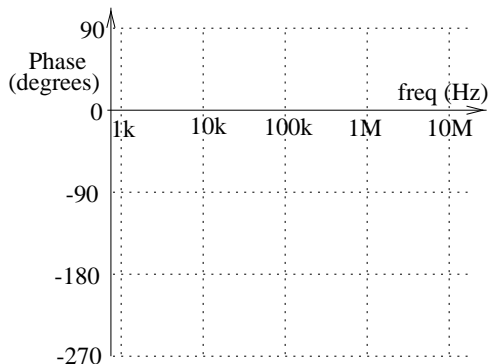
- b) With both inputs tied to 0V, the output voltage of this opamp is measured to be 0.3V. What is the input referred offset?

Question 4. (5 Marks) A two stage opamp has $f_{p1} = 10$ kHz and $f_{p2} = 100$ kHz $A_1 = 40$ dB and $A_2 = 20$ dB.



- a) On the left, sketch the overall frequency response (magnitude and phase) showing the breakpoints.

- b) Estimate the unity-gain frequency.



- c) Estimate the phase margin.

- d) To what should the frequency f_{p2} be changed to provide about 45° of phase margin?