Sixth Semester B.E. Degree Examination, July/August 2021
Microelectronic Circuits

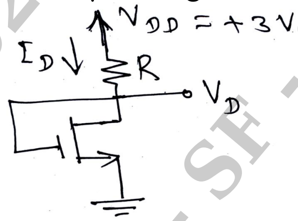
Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. Draw drain current versus drain-to source voltage characteristic for an enhancement-type NMOS, Mark all regions and explain it. **(06 Marks)**

b. Design a MOSFET circuit show in Fig.Q.1(b) to obtain a current I_D of 80μA. Find the value required for R and find the dc voltage V_D. Let the NMOS transistor have $V_t = 0.6V$, $\mu_n C_{ox} = 200\mu A/V^2$, $L = 0.8\mu m$ and $W = 4\mu m$. Neglect the channel length modulation effect.

Fig.Q.1(b)



(06 Marks)

c. Explain the development the T-equivalent circuit model for the MOSFET and also body effect. **(08 Marks)**

2 a. For the NMOS transistor with W/L = 10 fabricated in the 0.18μm process. Find: i) The values of V_{OV} and V_{GS} required to operate the device at $I_D = 100\mu A$; ii) V_{BE} for an npn transistor fabricated in the low-voltage process and operated at $I_C = 100\mu A$. Assume $\mu_n C_{ox} = 387\ \mu A/V^2$, $V_{tn} = 0.48V$, $I_S = 6 \times 10^{-18} A$ and $V_T = 0.02sv$. **(06 Marks)**

b. Explain the process of generating bias current for different amplifier stages of various amplitudes. **(06 Marks)**

c. Derive the expression of upper 3-dB frequency of an amplifier and also find the 3-dB frequency of a

$$F_H(s) = \frac{1 - \frac{s}{10^5}}{\left(1 + \frac{s}{10^4}\right)\left(1 + \frac{s}{4 \times 10^4}\right)}$$

(08 Marks)

3 a. For the common gate amplifier W/L = 7.2μm/0.36μm, $\mu n\ C_{ox} = 387\mu A/V^2$, $r_o = 18K\Omega$, $I_D = 100\mu A$, $g_m = 1.25mA/V$, $\chi = 0.2$, $R_S = 10K\Omega$, $R_L = 100K\Omega$, $C_{gs} = 20fF$, $C_{gd} = 5fF$, $C_L = 0$, find A_{v_o}, R_{in}, R_{out}, Gv, Gis, Gi and f_H. **(08 Marks)**

b. Explain the high frequency response of the CS-amplifier using open circuit time constants and also obtain 3-dB frequency. **(08 Marks)**

c. What is cascade amplifier? Explain the basic idea behind the cascade amplifier. **(04 Marks)**

4 a. Explain the working of a Wilson current mirror and derive the expression of current transfer ratio. **(08 Marks)**

b. The differential amplifier shown in Fig.Q.4(b) uses transistors with B = 100, determine:

i) Input differential resistance R_{id}

ii) Over all differential voltage gain

iii) Worst-case common-mode gain if the two collector resistances are accurate to within ±1%

iv) CMRR. **(08 Marks)**

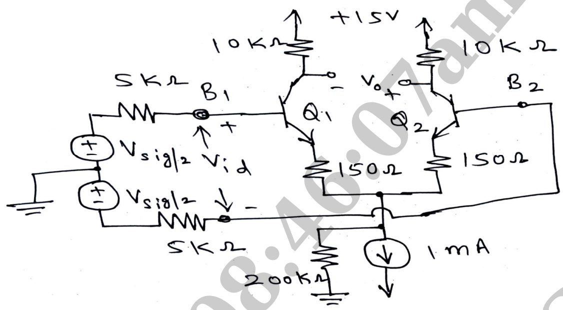


Fig.Q.4(b)

c. Mention the reasons why differential amplifiers are well suited for IC fabrications. **(04 Marks)**

5 a. Derive the expression of a CMRR of a active loaded MOS differential amplifier. **(08 Marks)**

b. Explain the main functions of multistage amplifier. **(06 Marks)**

c. Draw the circuit of a differential to single ended conversion and explain it. **(06 Marks)**

6 a. Draw the block diagram of a shunt-shunt feedback and derive the expression of input resistance and output resistance with feedback. **(08 Marks)**

b. Discuss the effect of feedback on the amplifier poles. **(06 Marks)**

c. Discuss the properties of negative feedback with mathematical analysis. **(06 Marks)**

7 a. Using the superposition principle to find the output voltage of the circuit shown in Fig.Q.7(a). **(04 Marks)**

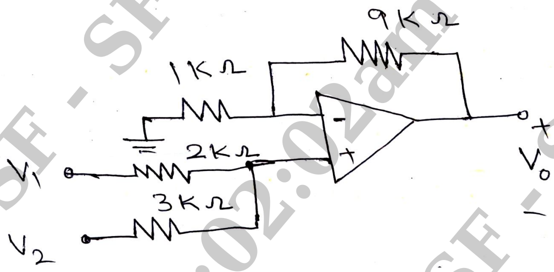


Fig.Q.7(a)

b. What are the major disadvantages of instrumentation amplifier using op-amp? **(04 Marks)**

c. For the circuit shown in Fig.Q.7(c) derive an expressions for the transfer function $V_0(s)/V_1(s)$, dc gain and the 3-dB frequency. **(06 Marks)**

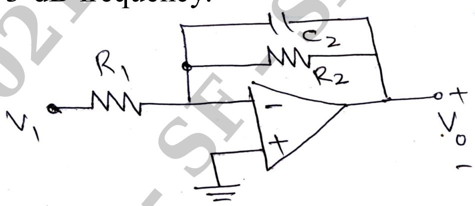


Fig.Q.7(c)

d. Draw the circuit diagram of sample and hold circuit using op-amp and explain it. **(06 Marks)**

8 a. Discuss the reasons for CMOS displacing bipolar technology in digital applications. **(04 Marks)**

b. Implement the following Boolean expression:

i) $F = \left(\overline{A} + B\right)\left(C + \overline{D}\right)$ using OAI gate logic.

ii) $F = \overline{\overline{A}\,\overline{B} + CD}$ using AOI gate logic. **(08 Marks)**

c. Explain the transistor sizing in CMOS gate circuits. **(08 Marks)**

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