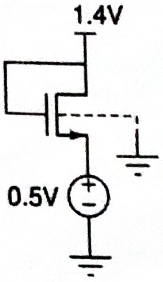
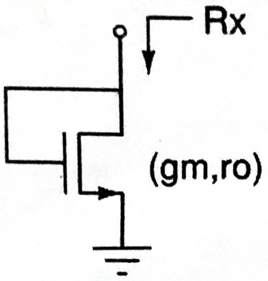
Sravan K Suresh
22B3936

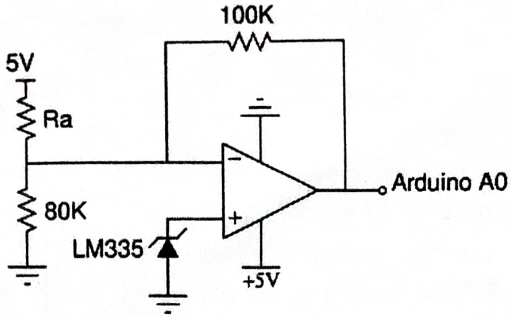
EE204 End Semester Examination 2023

Time 3 hours

Marks: 100







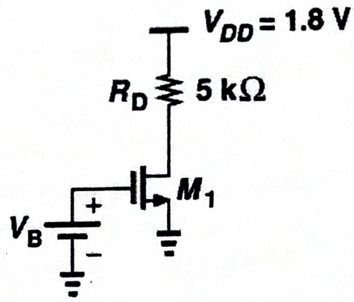


Fig 1 | Fig 2 | Fig 3 | Fig 4

1) In the circuit shown in the Fig.1. Determine the drain current if $\lambda = 0$. Assume $\mu n Cox$ =100$\mu A/V^2$, W/L=50, V_{TH0}=0.6V,$\gamma = 0.4\sqrt{V}$,$\phi F = 0.4\ V$. **[6]**
2) Determine the small signal resistance Rx at the output node for the configuration shown in Fig.2. Asume $\lambda \neq 0$ **[6]**
3) The following circuit (Fig.3) was designed to scale a temperature sensor (LM335) signal. The temperature measurement range is 0°celsius to 100° celsius. Determine the value of Ra and the gain of differential amplifier, such that the differential amplifier produces the output voltage (for the Arduino ADC) between 0V to 5V for the measured temperature range. Assume op-amp to ideal **[6]**
4) Advanced MOS devices do not follow the square-law behavior expressed by the following equation. $I_D=(\frac{1}{2})u_nC_{ox}(W/L)(V_{GS}-V_{TH})^{\alpha}(1+\lambda V_{DS})$. Determine the small signal transconductance (g_m) and output resistance (r_o) of such a device. **[10]**
5) In the circuit given Fig 4, W/L = 20/0.18, u_nC_{ox}=200 uA/V^2, V_{TH}=0.4 V, and λ = 0.1 V−1. What value of V_B places the transistor at the edge of saturation? **[10]**
6) Input voltage (V_i) is applied to the integrator amplifier (circuit shown in Fig. 5a). Input voltage V_i follows the waveform shown in Fig. 5b. Assume that the capacitor C_f is initially uncharged. The op-amp under operation is ideal. Taking R_1 = 100kΩ, C_f = 0.1μF, t_1 = 1s, obtain the following:
   a. Output voltage $V_o(t)$ equation.
   b. Values of $V_o(t)$ at t=1s and t=2s.
   c. Plot of $V_o(t)$ vs t. **[2+4+2]**
7) For the differentiator circuit shown in Fig. 6, determine the output voltage when V_i=30t V. Draw the waveform of the output voltage. Take the op-amp to be ideal, and the capacitor to be initially uncharged. R = 10kΩ, C = 2μF. **[6]**
8) Design an op-amp circuit which gives the following output: $V_o = 2V_1 - 3V_2 + 4V_3 - 5V_4$. Assume the op-amp to be ideal. You can use more than one op-amp. **[6]**
9) A sinusoidal signal with peak value of 6mV and 2kHz frequency is applied to the input of an ideal op-amp integrator with R1 = 100kΩ and Cf = 1μF. Find the output voltage. **[6]**

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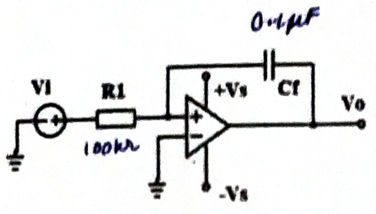

Fig 5a

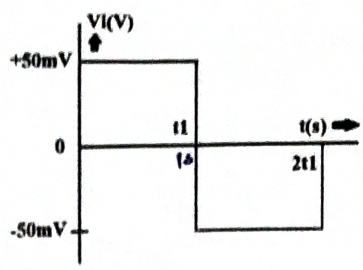

Fig 5b

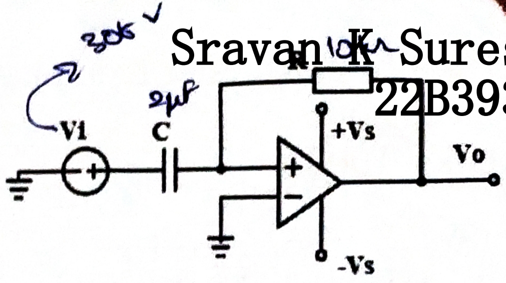

Fig 6

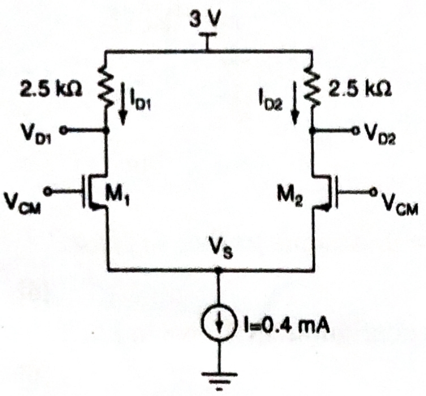

Fig 7

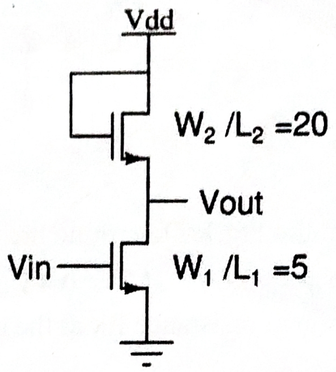

Fig 8

10) For the MOS differential pair(Fig 7) with common-mode voltage V_{CM} applied as shown in figure. the (W/L) of $M_{1,2}$=(100 μm/10 μm) and neglect channel-length modulation. u_nC_{OX}=200 uA/V^2, V_{TH}=0.4 V, Assume that the current source I requires a minimum voltage of 0.3 V to operate properly.

a) For V_{CM} = 2.5 V, find I_{D1}, I_{D2}, V_{D1} and V_{D2} and V_{GS} for each transistor. [4]

b) For V_{CM} = 2.5 V, find V_S. [2]

c) What is the highest permitted value of V_{CM} so that transistors remain in saturation? [2]

d) What is the lowest value allowed for V_{CM} so that transistors conduct? [2]

11) Find the small signal voltage gain (Vout/Vin) of the circuit shown in Fig.8 All the transistor have same output resistance ro of 6 M Ω. The transconductance parameter $\mu_n C_{ox} = 60\mu A/V^2$ and the mosfet is biased at the drain current of 150uA. [6]

12) A Thermocouple based temperature measurement system is shown in the adjoining figure. Relevant thermocouple emf data in (mV) based table is given below. The cold junction is kept at 0^{0}C. The temperature is 30^{0}C in the other parts of the system. The emf V is measured to be 26.74 mV. Calculate the temperature of the hot liquid?? [10]

Temperature	EMF of material (A-B)	EMF of material (C-B)
10^{0}C	0.591	0.391
20^{0}C	1.192	0.789
30^{0}C	1.801	1.196
370^{0}C	26.549	19.027
380^{0}C	27.345	19.638

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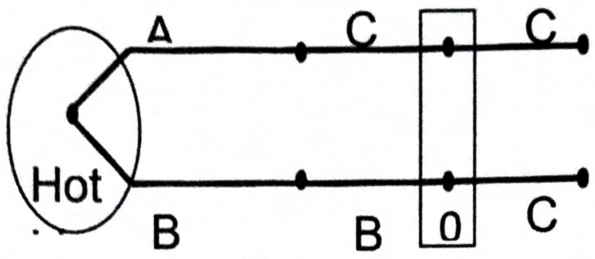
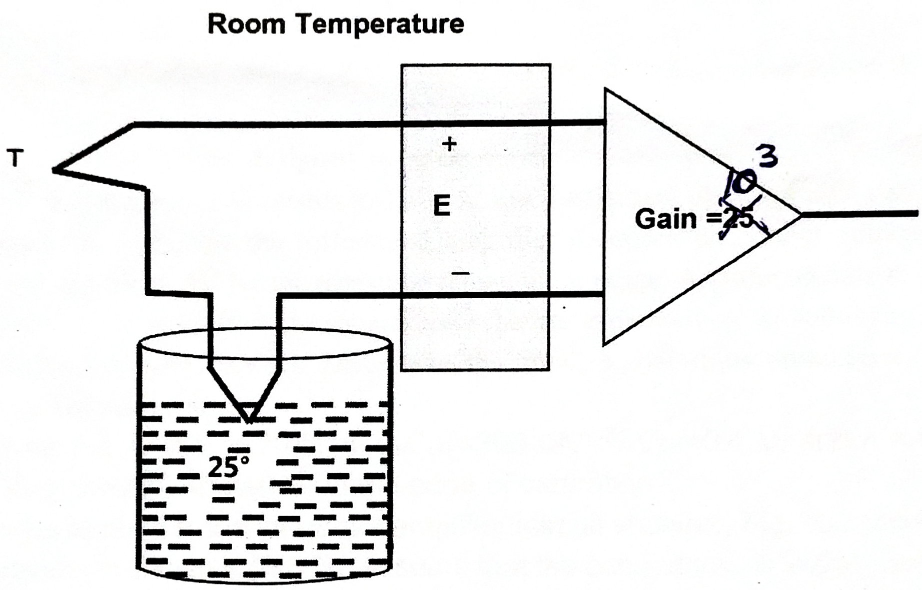


13) Two constantan thermocouples are connected such that the two constantan wires are joined together. The two copper wires are connected to the input of a low noise chopper stabilized differential amplifier having a gain of 1000. One of the thermocouple junctions is immersed in a flask containing ice and water in equal proportions. The other thermocouple is at temperature T. As shown in figure theta (θ) is measured using a k type thermocouple it has sensitivity of $41\mu V/°C$ If the output of the amplifier is 2.050 V, then calculate the value of the temperature T? **[6]**



14) As shown in figure theta (θ) is measured using a k type thermocouple it has sensitivity of $40\mu V/°C$. The gain G of the ideal instrumentation amplifier is 25. The output Vo is 96 mV, then find the value of theta (θ) in degrees? **[4]**