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M.Sc. TE (2 Year), 2nd Sem. Date: February 22, 2023 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course No.: EEE 6295
Course Title: Advanced Electronics

Summer Semester, A.Y. 2021-2022
Time: 90 Minutes
Full Marks: 75

There are **4 (four)** questions. Answer **any 3 (three)** questions. All questions carry equal marks. Marks in the margin indicate full marks. Programmable calculators are not allowed. Do not write on this question paper.

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1. a) In Figure 1(a), the op-amp has an open-loop voltage gain of 2×10^5, input resistance of $2M\Omega$, and output resistance of 50Ω. 2+4+4=10

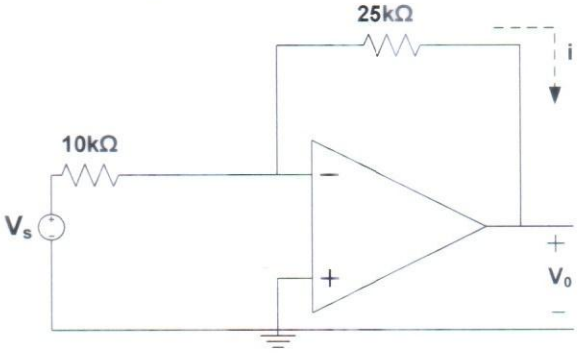

Figure:1(a)

For non-ideal model op-amp:

i. Draw the equivalent Circuit diagram.
ii. Find the closed-loop gain ($\frac{v_0}{v_s}$).
iii. Determine current (i) for $v_s = 4V$.

b) Consider the op-amp of Figure 1(a) as ideal and determine: 4+4=8

i. Closed-loop gain ($\frac{v_0}{v_s}$).
ii. Determine current (i) for $v_s = 4V$.

c) Based on the calculation of question 1(a) and 1(b), comment which type of model is preferable and why? Also point out the assumptions that are made to consider the model of an op-amp as ideal. 7

2. a) Design and verify a three channel inverting amplifier with op-amp. The gains for each channel have been listed in Table 2(a). Select a 10 kΩ resistor for the input resistance of the channel with the highest gain. 7+5=12

Table: 2(a)

Channel number	Voltage gain
1	-10
2	-6
3	-3

b) Design an operational amplifier circuit with inputs v_1 , v_2, v_3 and v_4 such that output is $v_0 = 3v_1 + 5v_2 - 10 \int v_3 - 20 \frac{dv_4}{dx}$. 13

3. a) The digital-to-analog converter (DAC) transforms digital signals into analog form. A typical example of a four-bit DAC is illustrated in Fig. 3.b. Now, in the operational amplifier of Figure 3(b), let $R_f = 5k\Omega, R_1 = 5k\Omega, R_2 = 10k\Omega, R_3 = 20k\Omega$, and $R_4 = 40k\Omega$. Obtain the analog output for binary inputs [0000], [0001], [0010], . . ., [1111]. 20

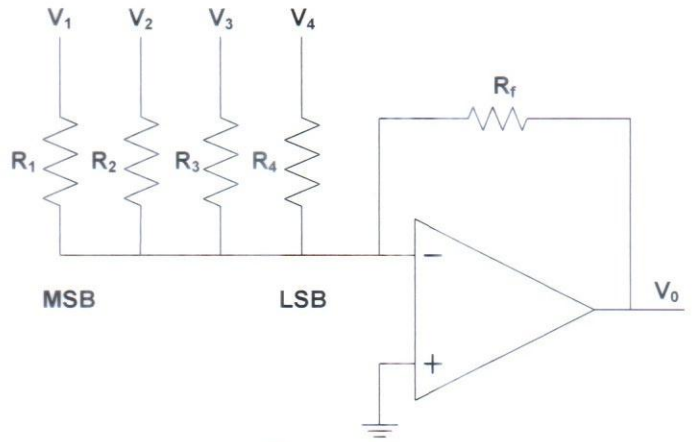

Figure: 3(b)

b) Construct a single stage op-amp circuit that allows to add a dc voltage to triangular wave. 5

4. a) An instrumentation amplifier shown in Figure 4(a) is an amplifier of low-level signals used in process control or measurement applications and commercially available in single-package units. Show that 15

$$v_0 = \frac{R_2}{R_1}\left(1 + \frac{2R_3}{R_4}\right) v_2 - v_1.$$

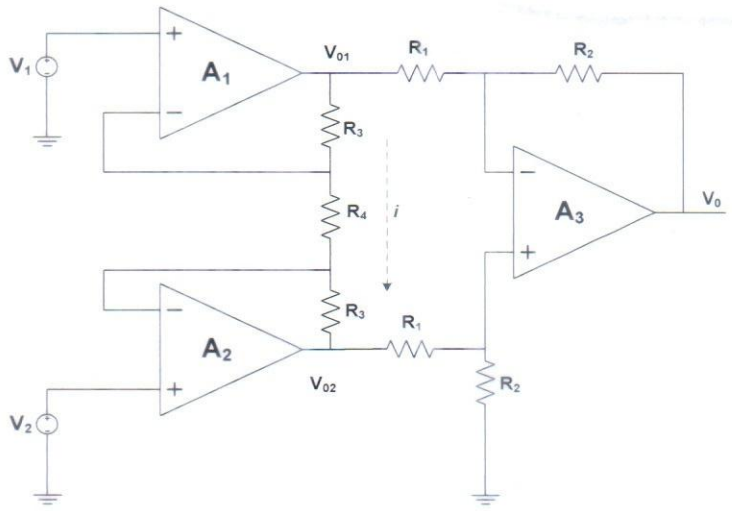

Figure: 4(a)

b) Design an operational amplifier circuit with inputs v_1 and v_2 such that $v_0 = -6v_1 + 10v_2$. Use only one op-amp in the design. 10