TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering & Technology

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

SPECIAL/SUPPLEMENTARY UNIVERSITY EXAMINATION 2017/2018

THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 2302: ANALOGUE ELECTRONICS III

TIME: 2 HOURS

DATE: SEPTEMBER, 2018 SERIES

INSTRUCTIONS

This paper has five Questions.

Answer any **THREE** Questions.

Question ONE

(a) Consider an ideal operational amplifier.

(i) Name **TWO** primary assumptions used in the analysis of its circuits.

(ii) Name any **TWO** additional implicit assumptions or characteristics.

(4 marks)

(b) (i) Draw the equivalent circuit of a low frequency operational amplifier circuit as a voltage controlled voltage source.

(ii) Using a suitable circuit diagram, derive an expression for the overall gain of the ideal inverting configuration amplifier.

(iii) Design an inverting amplifier to have an input resistance of 20kΩ and a gain of 40dB.

(11½ marks)

(c) Consider the amplifier given in Fig. Q1(c). The passive components are R_1 =3kΩ and R_2 = 43kΩ. If the input signal V_s = +0.1V. Calculate:

(i) Voltage gain, A_v

(ii) Output voltage, V_o

(iii) Output current, i_o

Assume that the op amp is deal. **(4½ marks)**

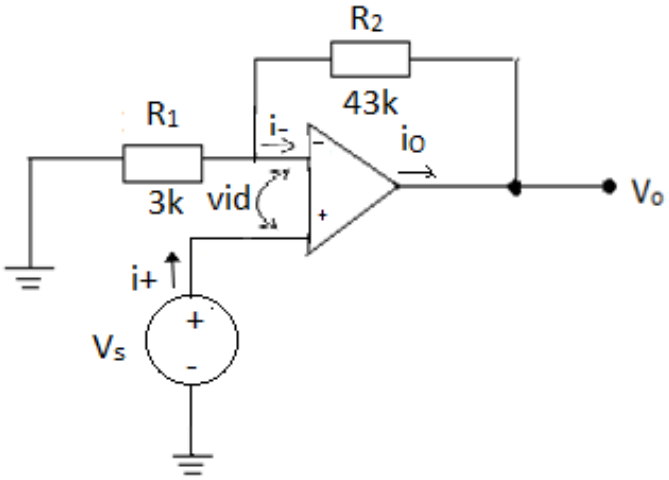

Fig. Q1(c)

Question TWO

(a) State any **TWO** advantages of an instrumentation amplifier over a differential amplifier.

(2 marks)

(b) An instrumentation amplifier is implemented using the 3-opamp configuration of Fig. Q2(b). The inputs are:

$V_2 = 2080mV$ and $V_1 = 2100mV$

The passive components are:

$R_1 = 25k\Omega$, $R_x = 50k\Omega$, $R_{1A} = R_{2A} = 25k\Omega$, $R_{2A} = R_{2B} = 50k\Omega$ and $R_G = 400\Omega$

Assuming that the opamps are ideal, determine the following:

(i) The voltage V_{01} and V_{02}

(ii) The current I_G through R_G

(iii) The current J_R through R_{2B}

(iv) The output voltage V_o

(9 marks)

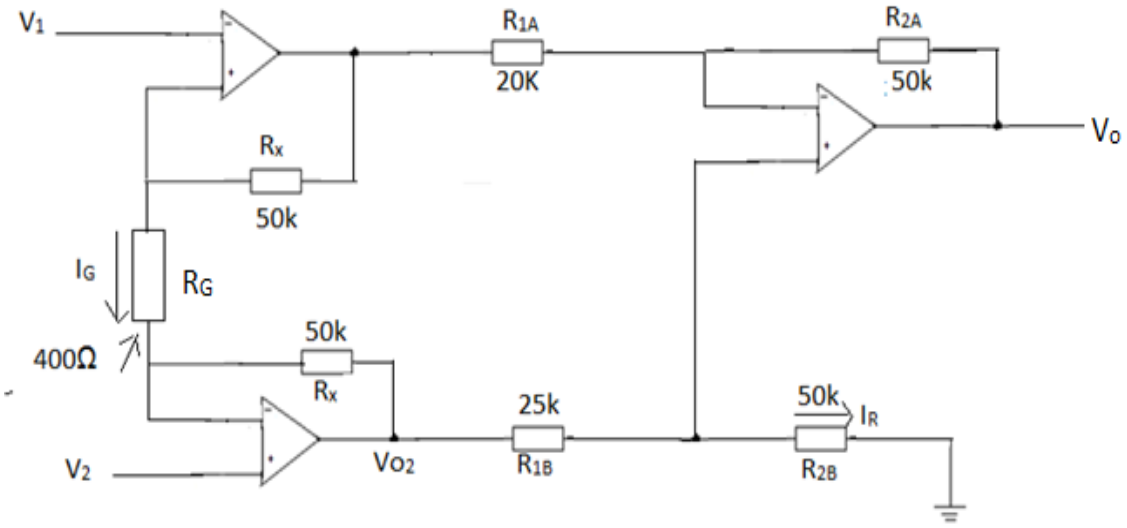

Fig. Q2(b)

(9 marks)

(c) In the circuit given in Fig. Q2(c), the opamp has the following parameters:

V_{10} = 4mV, I_B = 180nA and I_{10} = 40nA

Where V_{10} is the input offset voltage, I_B is the bias current, and I_{10} is the input offset current.

Determine the largest error or "worst case" output voltage V_o due to the input offset effects. The input V_1 = 20mV.

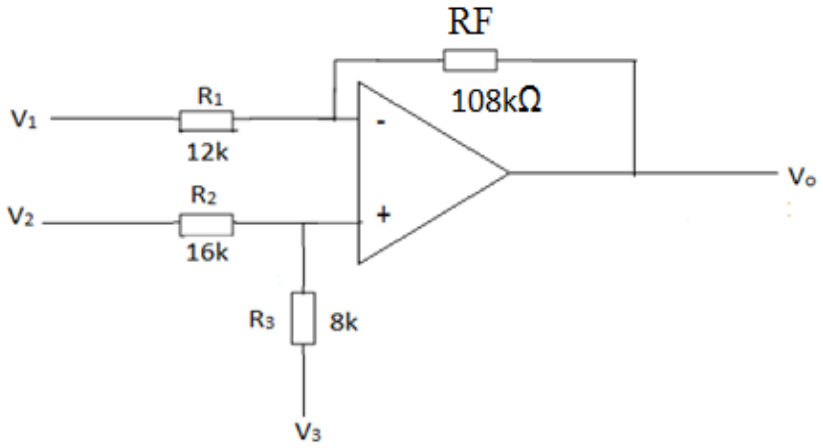

Fig.Q2(c)

Question THREE

(a) (i) Describe an oscillator.

(ii) Discuss briefly the classification of diverse oscillators.

(iii) Using a suitable block diagram, derive the condition for oscillation.

(6 marks)

(b) With the aid of a diagram, briefly describe the principles of operation of mono-stable multivibrator.

(8 marks)

(c) Consider the Wien bridge oscillator circuit given in Fig. Q3(c).

(i) Determine the frequency of oscillation.

(ii) Calculate the value of R_1necessary to maintain oscillation.

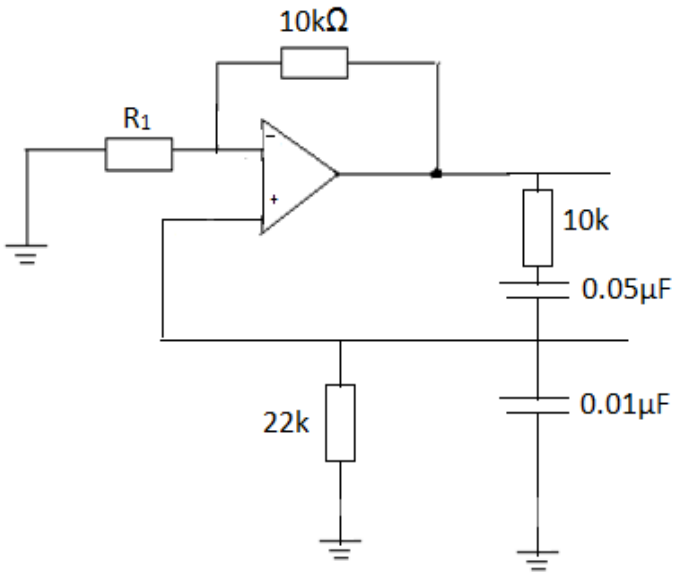

Fig. Q3(c)

(6 marks)

Question FOUR

(a) (i) With aid of a suitable diagram explain the principles of operation of a precision rectifier.

(ii) State any **THREE** limitations of a precision rectifier.

(8 marks)

(b) A differential amplifier with a nominal gain of 10 is illustrated in Fig. Q4(b) tolerances in the resistors result in the actual values shown. Determine:

(i) The output voltage Vo

(ii) The common mode gain

(iii) The Common Mode Rejection Ratio (CMRR)

(iv) The differential input impedance.

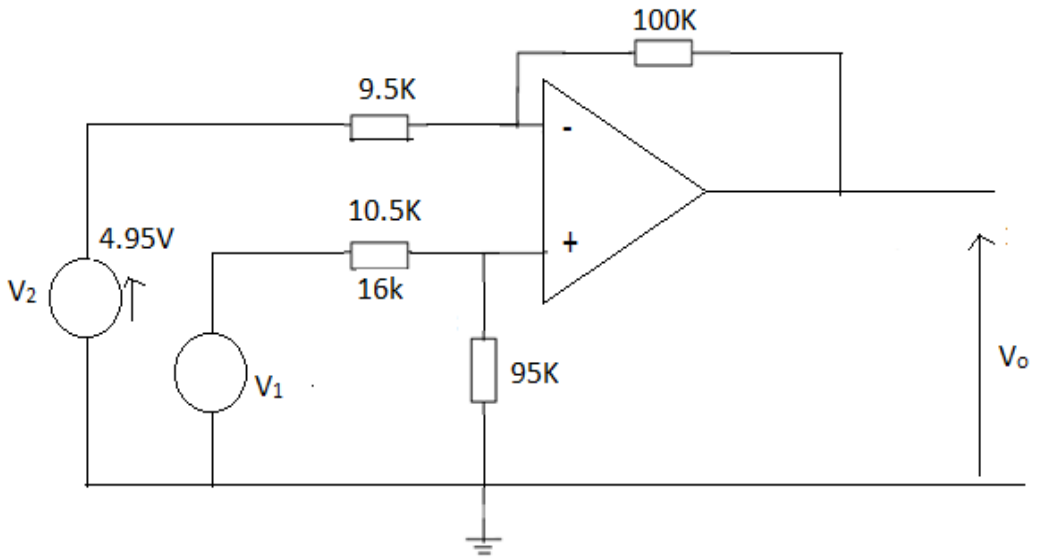

Fig. Q4(b)

(9 marks)

(c) State the **THREE** sources of unwanted offset voltages in an operational amplifier.

(3 marks)

Question FIVE

(a) The operational amplifier given in Fig. Q5(a) is ideal. If the input voltages are:

$V_1 = 60mV$, $V_2 = 48mV$ *and* $V_3 = (24\cos wt)mV$ and the resistances in the circuit are,

$R_1 = 12k\Omega$, $R_2 = 16k\Omega$, $R_3 = 8k\Omega, R_f = 108k\Omega$

Determine the output voltage V_o. **(8 marks)**

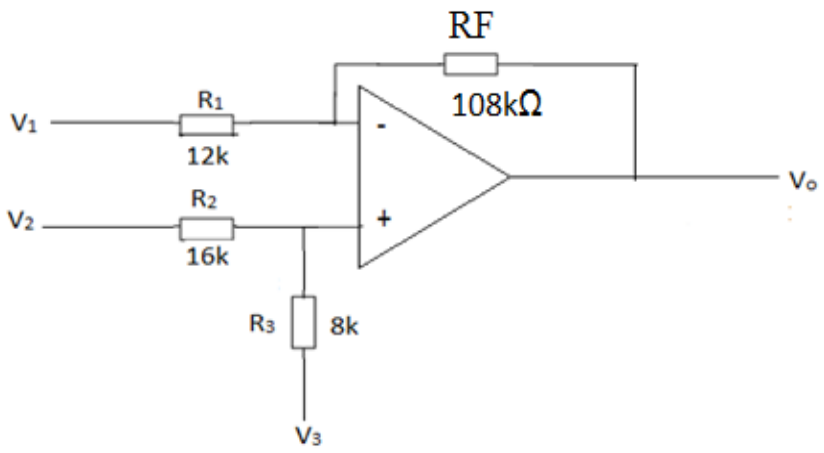

Fig. Q5(a)

(b) Design an amplifier to carry out the following operation:

f =3x +4y-5z **(7 marks)**

(c) Using appropriate diagrams derive an expression for the common-mode rejection ratio for an op-amp. **(5 marks)**