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(*University of Choice*)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER MAIN EXAMINATIONS

FOR THE DEGREE
OF
BACHELOR OF SCIENCE IN ELECTRICAL AND COMMUNICATIONS ENGINEERING

COURSE CODE: ECE 326

COURSE TITLE: ANALOGUE ELECTRONICS II

DATE: MONDAY, APRIL, 25TH, 2022 **TIME: 12:00 – 2:00 PM**

INSTRUCTIONS TO CANDIDATES

Question ONE (1) is compulsory
Answer Any Other TWO (2) questions

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 6 Printed Pages. Please Turn Over.

Question One (30mks)

(a) i) Define the following terms: (4mks)

i) Virtual ground

ii) Output offset voltage

iii) Common-Mode Rejection Ratio

iv) Slew rate

ii) Derive the equation for closed loop gain for the non-inverting amplifier. (3mks)

(b) For the circuit shown in Figure 1 below, find the output voltage if the input voltage is $0.4\,sin(1000t)$ V and sketch the output waveform (4mks)

The values of capacitance and resistance are: $C = 10\mu F, R = 3k\Omega$

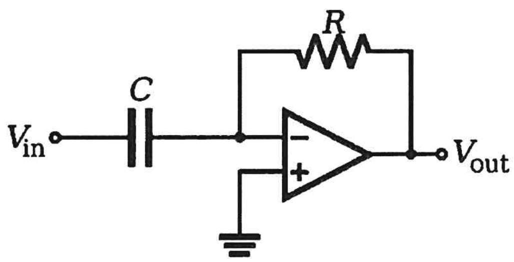

Figure 1

(c) The Figure 2 shows a difference amplifier. (6mks)

i) Derive the equation for the output voltage (V_o).

ii) Given that $\frac{R_f}{R_1} = \frac{R_g}{R_2}$ where $R_2 = 2k\Omega; R_g = 4k\Omega;$, and inputs $V_1 = 0.5V \; and \; V_2 = 0.75V$, compute V_o.

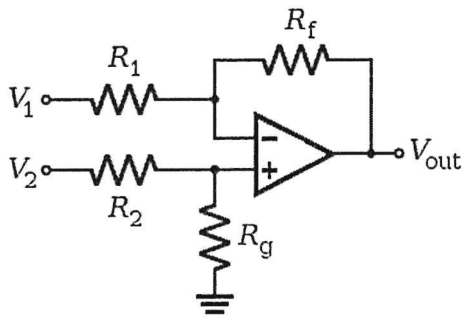

Figure 2

(d) With the aid of a circuit diagram and graphical illustration of input- output waveforms, describe the operation of a monostable Op-Amp multivibrator circuit. (8mks)

(e) Considering the circuit in Figure 3, show that the output voltage is proportional to the natural logarithm of the input voltage V_{in} for a fixed value of resistance R_1. (5mks)

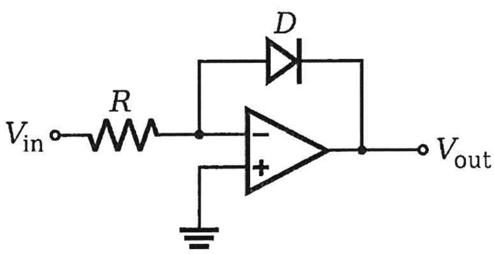

Figure 3

Question Two (20mks)

(a) Show that the output of an integrator in Figure 4 is given by; (6mks)

$$V_o = -\frac{1}{RC}\int_0^t V_i\,dt$$

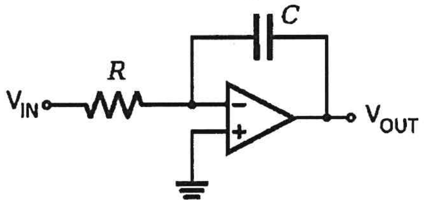

Figure 4

(b) With the aid of a circuit diagram, explain how half-wave precision rectifiers can be used to clip extremely low-level input signals (6mks)

(c) For the Astable multivibrator circuit shown in Figure 5, calculate the frequency of oscillation. Sketch the input-output waveforms at supply rail of $\pm 5V$. (4mks)

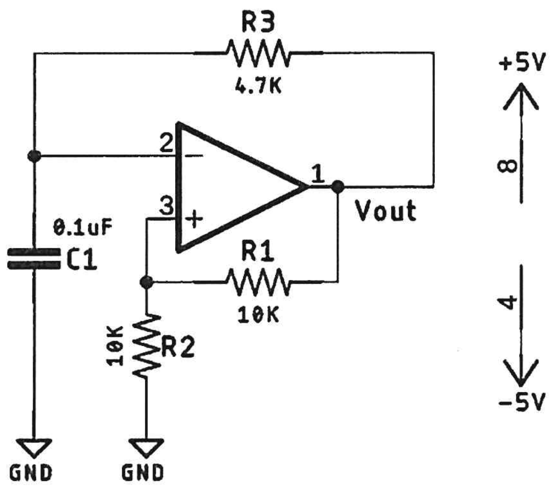

Figure 5

(d) For the circuit of Figure 6, Op-amp slew rate is $SR = 0.5V/\mu s$; $R_f = 240k\Omega$; $R_{in} = 10k\Omega$; $V_{in} = 0.02V, \omega = 300 \times 10^3 rad/s$, determine the maximum operating frequency and from the result, comment whether distortion occurs. (4mks)

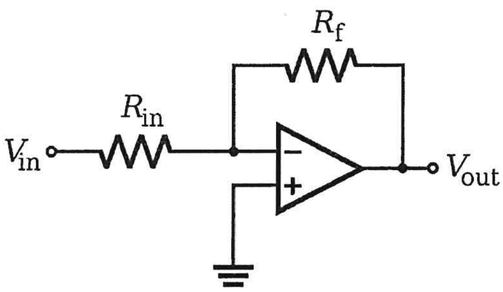

Figure 6

Question Three (20mks)

(a) The circuit diagram in Figure 7 is subjected to a square wave input of $\pm 5V$ at 1kHz frequency that changes in $0.2ms$. Ths supply voltage is $V_{cc} = \pm 12V$. Determine the output voltage if $C = 0.01\mu F, R = 15k\Omega$ and sketch the output waveform. (6mks)

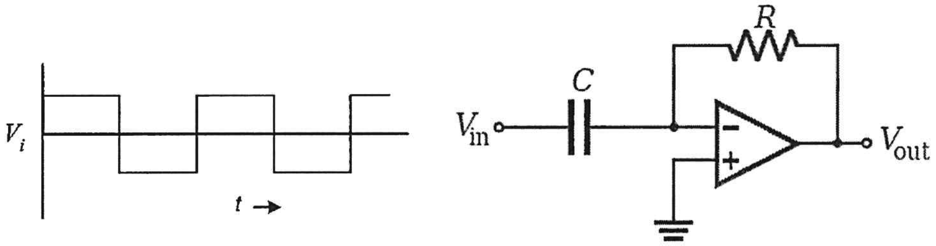

Figure 7

(b) The Op-Amp circuit in Figure 8 has the following information on the data sheet: $Z_{in} = 2\ M\Omega$, $Z_{out} = 75\ \Omega$, and $A_{ol} = 200{,}000$. If the feed back resistors are $R_1 = 10k\Omega, R_2 = 230k\Omega$, determine; (7mks)

i) The input and output impedances due to negative feedback

ii) The closed-loop voltage gain

iii) If the Op-Amp is used in the voltage-follower configuration determine the input and output impedances.

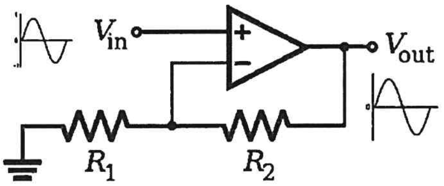

Figure 8

(c) The circuit in Figure 9 shows an inverting amplifier with a supply voltage of $750mV$ at the inverting input terminal and $Vcc = \pm 10V$ (7mks)

i) Find the output voltage if the variable resistor $R_x = 8\text{k}\Omega$

ii) Determine the maximum value of R_x for the Op-Amp to avoid saturation.

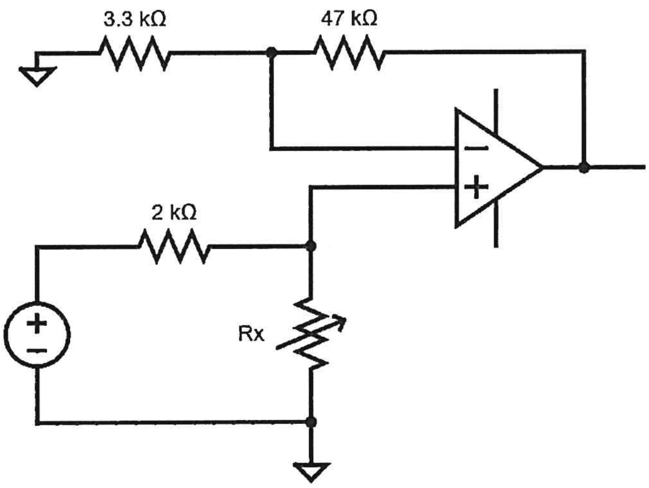

Figure 9

Question 4 (20mks)

Calculate;

i) The rate of change of the output voltage during the capacitor's charging time.

ii) The total change in voltage.

iii) Draw the output waveform.

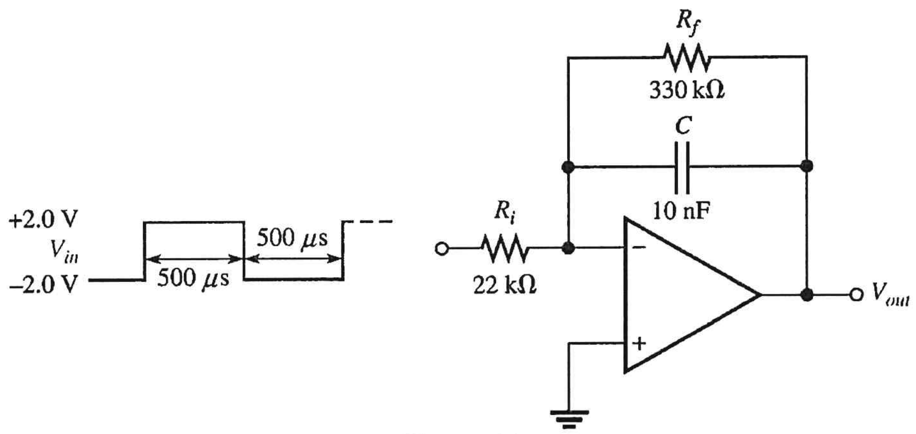

Figure 10

(b) Design an Op-Amp circuit with inputs V_1 and V_2 such that; (7mks)

$$V_o = 7.5V_1 - 2V_2$$

(c) For the instrumentation amplifier circuit shown in the Figure 11 assuming that no current flows into the Op-Amps, and neglecting the input offset voltage, the same voltage V_{in} is seen at both inputs V_+ and V_-. Determine the load current I_L. (7mks)

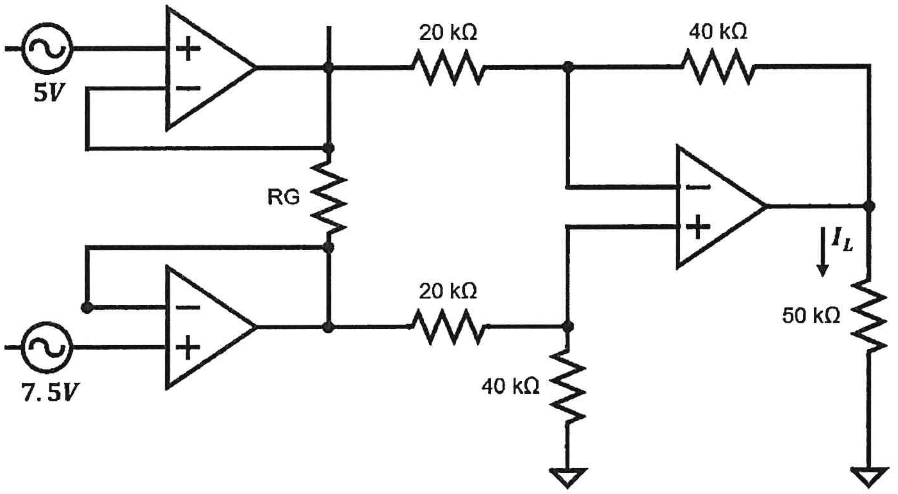

Figure 11

Question 5 (20mks)

(a) Calculate the output voltage for the circuit of Figure 12, for the following inputs; $V_1 = 50\,sin(1000t)\,mV;\ V_2 = 10\,sin(3000t)\,mV$ (3mks)

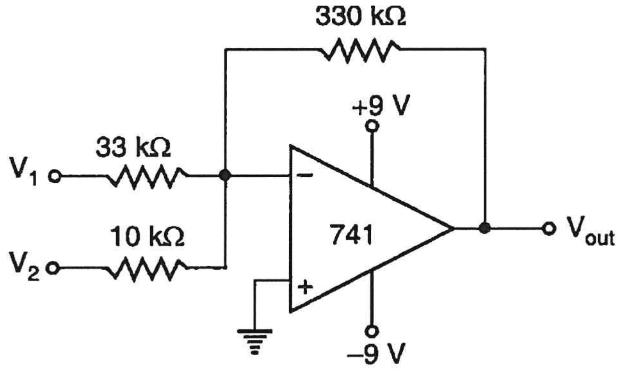

Figure 12

(b) An Op-Amp monostable circuit is constructed using the components as shown in Figure 13.If it is supplied from a $\pm$ 5V and the timing period is initiated with a 10ms pulse. (8mks)

Calculate:

a) The circuits timing period (τ)
b) Capacitor recovery time
c) Total time between trigger pulses

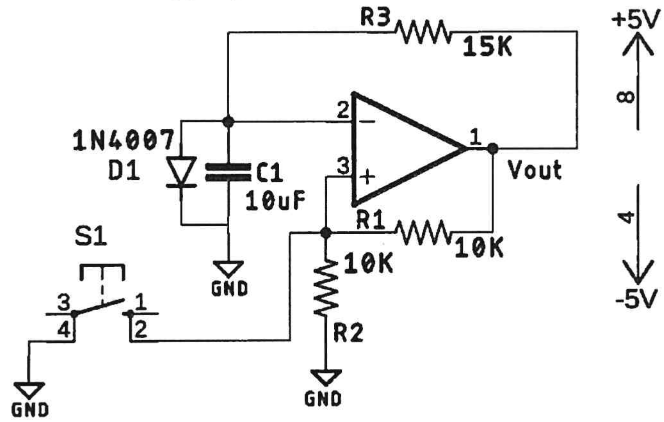

Figure 13

(c) For the circuit of Figure 13 determine the value of resistor Rx so that the output voltage is zero. (9mks)

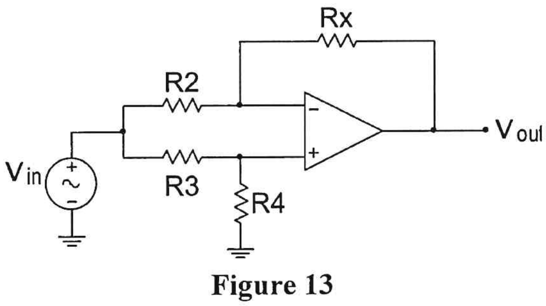

Figure 13