Strathmore UNIVERSITY

SCHOOL OF COMPUTING AND ENGINEERING SCIENCES
BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING
END OF SEMESTER EXAMINATION
BEE3205 ANALOGUE ELECTRONICS II

DATE: 11th December 2023 **Time: 08:00-11:00 Hours**

Instructions
1. This examination consists of **FIVE** questions.
2. Answer **Question ONE (COMPULSORY)** and any other **TWO** questions.

QUESTION 1 (30 marks)

a) State the **criterion** for the classification of power amplifiers

(1 marks)

b) State the Barkhausein criterion of oscillation in oscillators

(2 marks)

c) Figure 1 shows a circuit diagram of a monostable multivibrator using 555 timer IC. The supply voltage is $+12$ volts. Resistor values are $R_1 = 71.0\ k\Omega \quad R_2 = 15.0\ k\Omega$.

i. Determine the value of the capacitor C_1 that should be used to obtain a pulse width of 2.0 s at the output of a monostable multivibrator.
ii. Explain the reason for the use of resistor R_2 in the circuit and capacitor C_2

(5 marks)

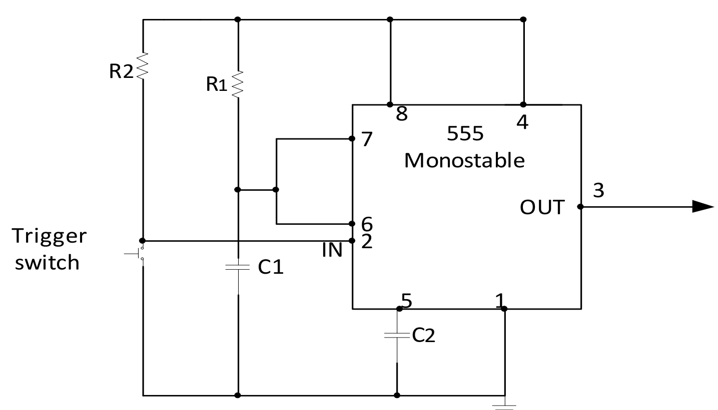

Figure 1

d) Explain the:

i. origin of the **two** distortions in class B amplifiers;
ii. solutions to the problems in c(i).

(4 marks)

e) The block diagram in Fig.2 shows the main circuit components of an operational amplifier.

i. Name the blocks A and B.
ii. State the reasons for the circuit components used in the input and output.

(4 marks)

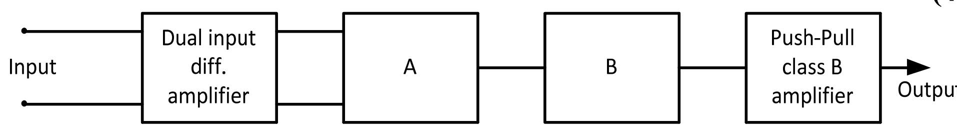

Figure 2

g) An ideal op-amp voltage inverting amplifier is shown in Fig. 3 with ideal input impedance R_i and voltage gain A_v.

i. Derive the expression of Z_i
ii. show that if Z is:

I. a capacitor, then the Miller capacitance is given by $C_m = C(1 + A_v)$
II. a resistor R then the input impedance $Z_i \approx R_i$

(6 marks)

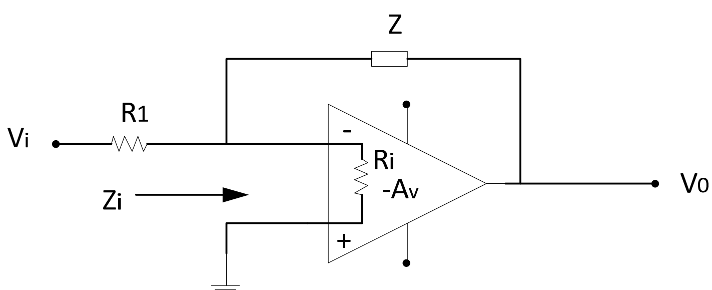

Figure 3

f) Explain the significance of **gain-bandwidth** product in operational amplifiers

(2 marks)

g) State the **three** classifications of the multivibrators

(3 marks)

h) Draw the diagram of **a voltage follower** amplifier and state its area of application.

(3 marks)

QUESTION TWO

a) State **Two** features of a differential amplifier
b) For the amplifier in Fig.4
   i. Perform the dc analysis and obtain the:
      I. Tail current, I_T
      II. Emitter current, I_E
      III. Quiescent collector emitter voltage, V_{CEQ}
   ii. Given that for both transistors, $\beta = 300$ obtain the:
      I. ac output voltage;
      II. input impedance of the differential amplifier.

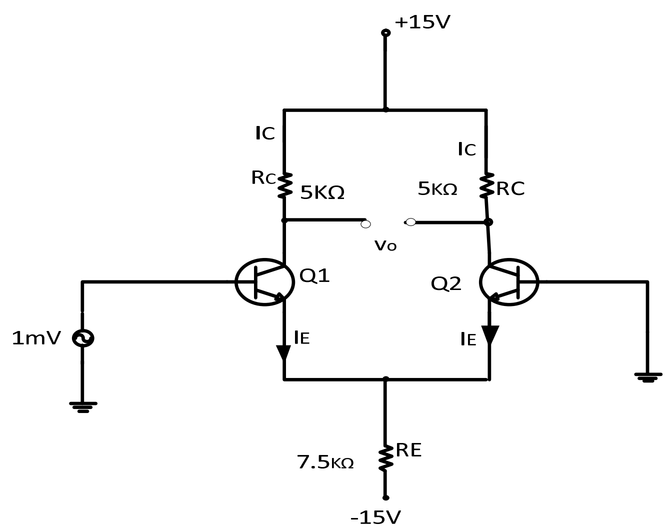

Figure 4

c) Figure 5 shows an op amp differential circuit. Derive the expression for the output voltage V_0.

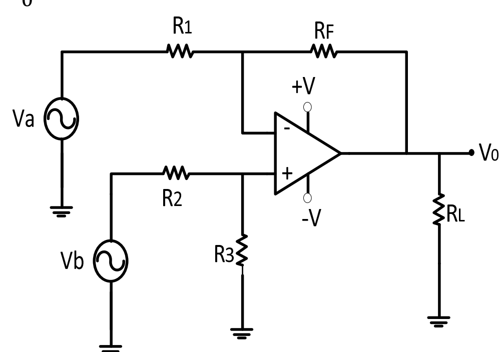

Figure 5

QUESTION THREE

a) Figure 6 shows a class C tuned circuit.

i. Identify the clamper bias circuit and explain its usage in the amplifier operation.

ii. With reasons, state the possible areas of application of the amplifier.

b) For the components values in given in Fig. 6, determine each of the following:

i. The resonance frequency;

ii. The equivalent parallel resistance of the coil R_p given that the Q_L of the inductor is 100

iii. The Q-factor of the overall circuit;

iv. The bandwidth of the circuit;

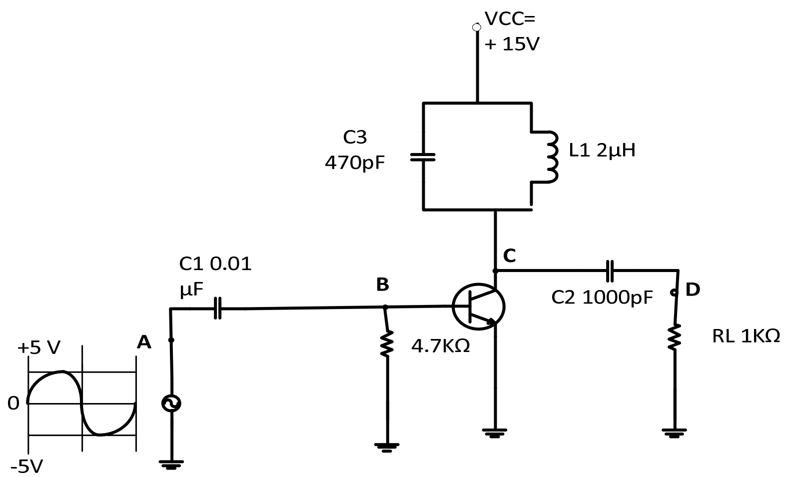

Figure 6

c) Figure 7 shows a class B push-pull configuration amplifier. Determine the:
   i. DC input power
   ii. Maximum ac output power
   iii. The circuit efficiency

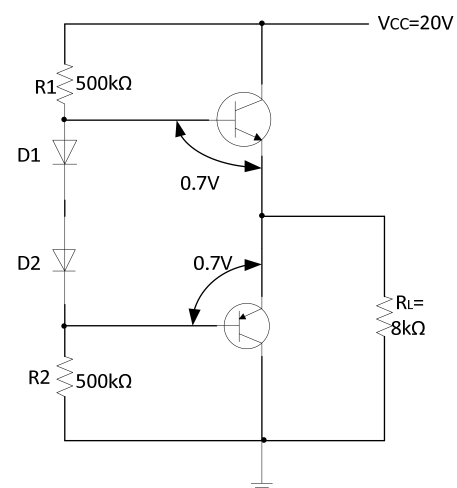

Figure 7

QUESTION FOUR

a) Explain each of the following operational amplifier characteristics
   i. Frequency response
   ii. Slew rate

(2 marks)

b) A 741 op-amp has bias currents $I_{B+} = 0.4\mu A$ and $I_{B-} = 0.3\mu S$. Determine the
   i. average bias current I_B;
   ii. Offset current I_{OS}.

(4 marks)

c) Figure 8 shows an operational amplifier circuit. Show that :
   i. $V = 2.3\frac{kT}{q}log_{10}\frac{I}{I_0}$
   where I_0 is the theoretical reverse saturation current.

   ii. $v_0 = -2.3\frac{kT}{q}log_{10}\frac{I}{I_0}\left(\frac{R_1+R_2}{R_1}\right)$

(7 marks)

d) State TWO applications of logarithmic amplifier

(2 marks)

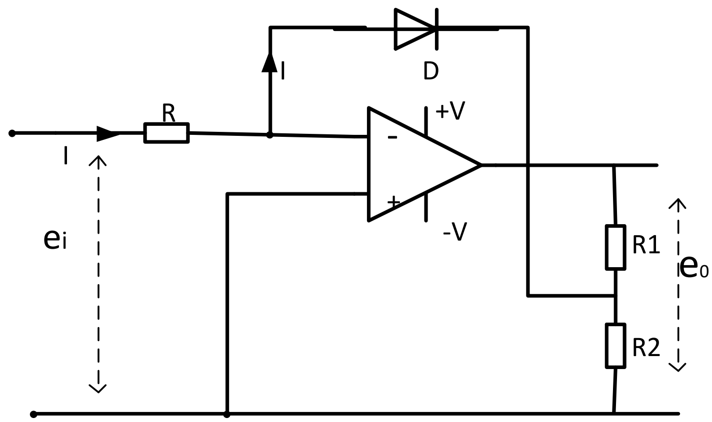

Figure 8

QUESTION 5

a) State **one advantage** and **one disadvantage** of Wien-bridge oscillators

(2 marks)

b) (i)Figure 9 shows a Wien Bridge oscillator. Derive the expressions for the:

I. Resonant frequency
II. Feedback gain

(6 marks)

(ii)Design the Wien-bridge in Fig. 8 to oscillate at $f_0 = 800Hz$. Assume $R = R_1 = 10k\Omega$

(4 marks)

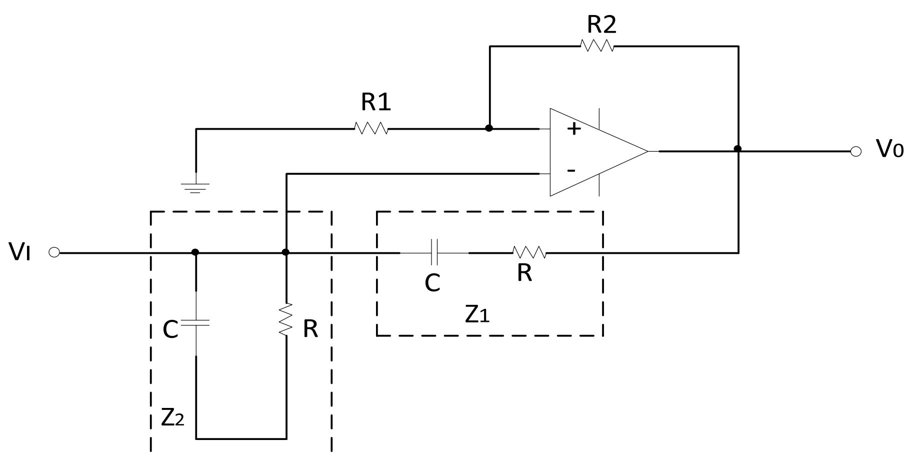

Figure 9

c) Calculate the resonance frequency of a Hartley oscillator with the elements of the tank circuit as $L_1 = 1.5mH$, $L_2 = 10mH$ and $C = 470pF$

(3 marks)