MACHAKOS UNIVERSITY

University Examinations for 2021/2022

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

FOURTH YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONICS ENGINEERING)

EEE 403: ANALOGUE ELECTRONICS III

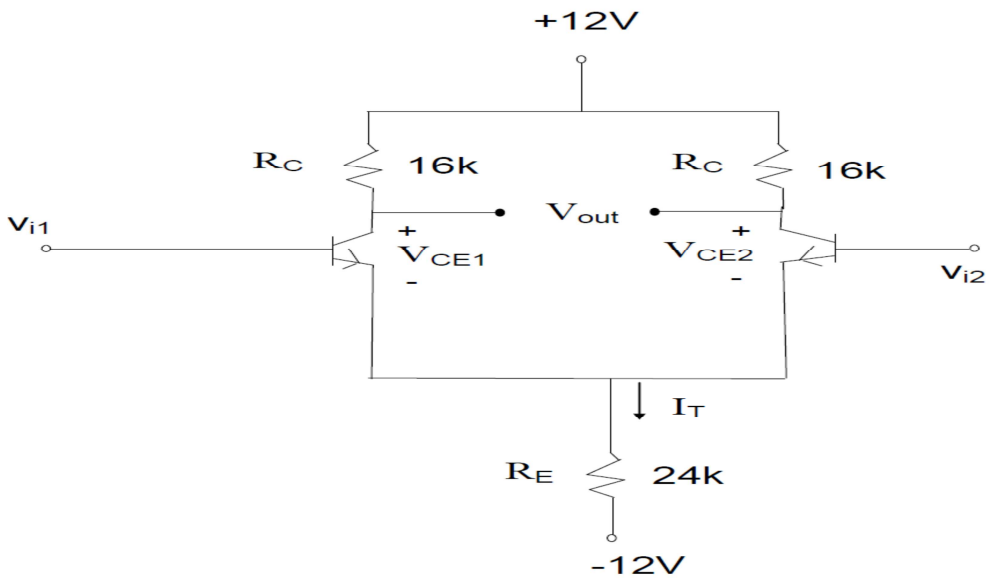
DATE: 17/3/2022 **TIME: 11.00-1.00 PM**

INSTRUCTIONS:

Answer **QUESTION ONE** and **any other TWO.**

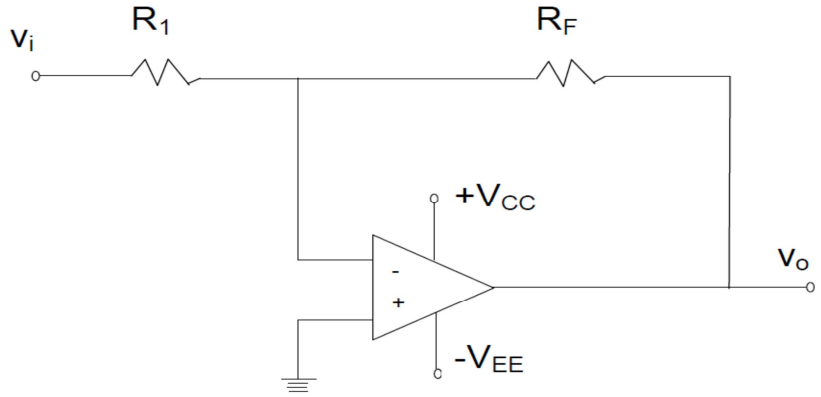
QUESTION ONE (COMPULSORY) (30 MARKS)

(a) Calculate the dc emitter current in each transistor of the differential amplifier shown below. How much is dc voltage from each collector to ground? How much is Vout. (7 marks)

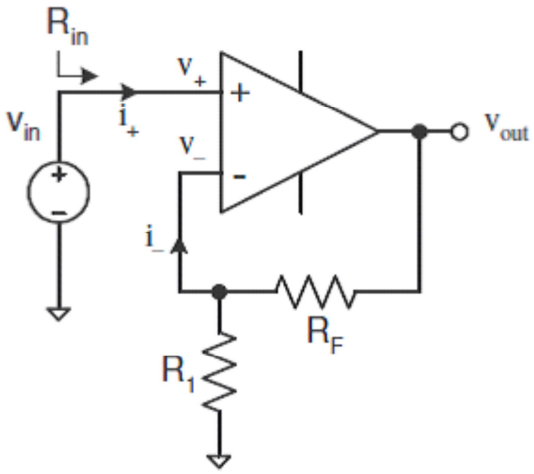


(b) Design the amplifier below to have a gain of 120 if the input resistance is 5kΩ.

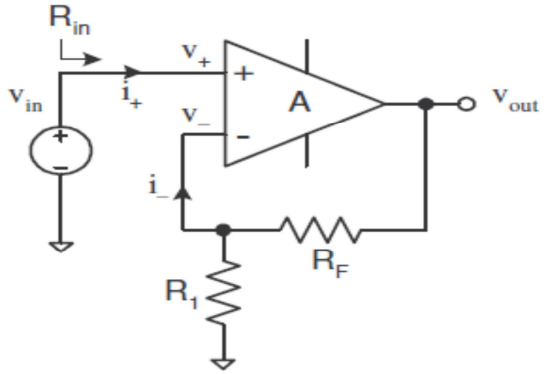
(5 marks)



(c) Obtain an expression for the output voltage of the amplifier shown below. (5 marks)

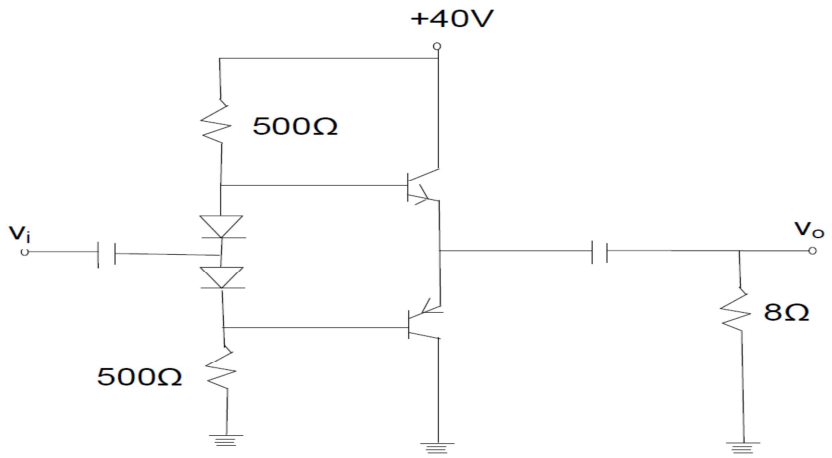


(d) Derive an expression for the finite (real) of the non-inverting amplifier below by taking in to consideration static limitations of real operational amplifiers. Given the values below, determine the actual gain of the amplifier and comment on the error. (6 marks)



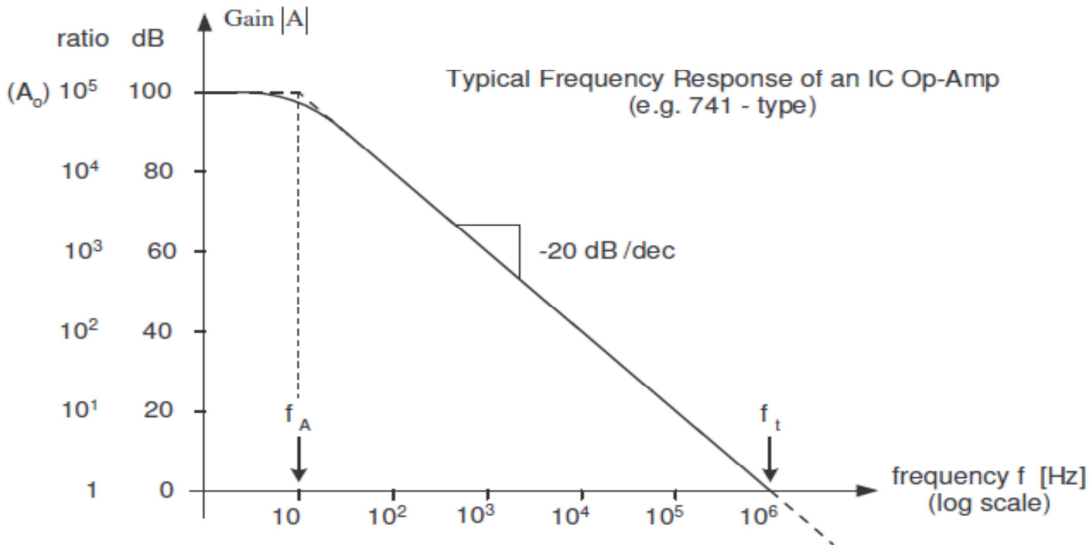
$$R_F = 90\text{k}\Omega,\ R_1 = 10\text{k}\Omega,\ A = 10^5$$

(e) Calculate maximum ac output power and the minimum power rating of the transistors in the push-pull amplifier shown in fig below. (7 marks)



QUESTION TWO (20 MARKS)

(a) Assume that the inverting amplifier uses an op-amp whose gain A(f) varies with frequency as shown below.



If the inverting amplifier with $R_F = 90k\Omega$, $R_1 = 10k\Omega$ uses a real op-amp with the response above, determine the resulting frequency response of this inverting amplifier and sketch it.

(10 marks)

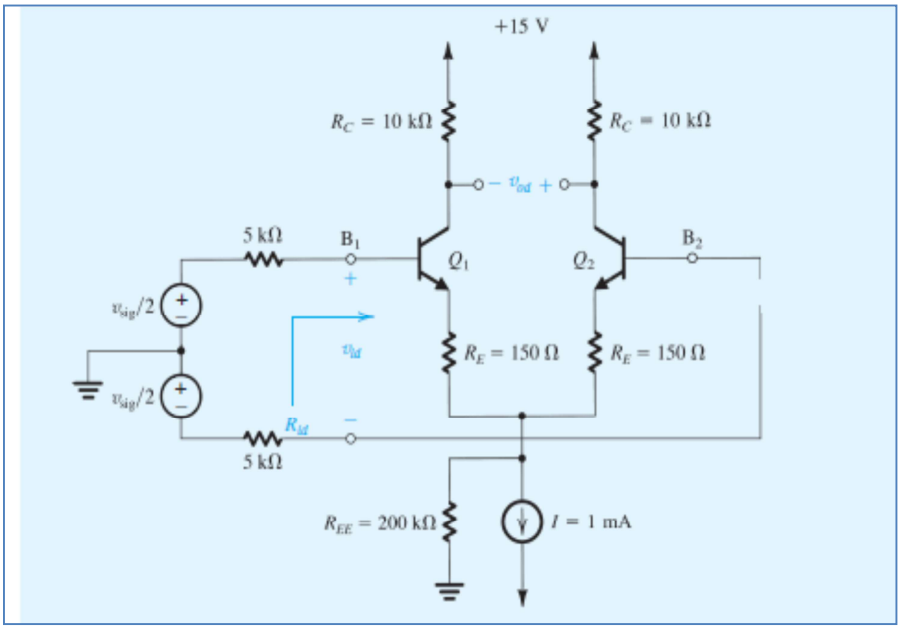
(b) The differential amplifier below uses transistors with β=100. Evaluate the following:

(i) The input differential resistance R_{id}.
(ii) The overall differential voltage gain v_{od}/v_{sig} (neglect the effect of *ro*).
(iii) The worst-case common-mode gain if the two collector resistances are accurate to within ±1%.

(iv) The CMRR, in dB.

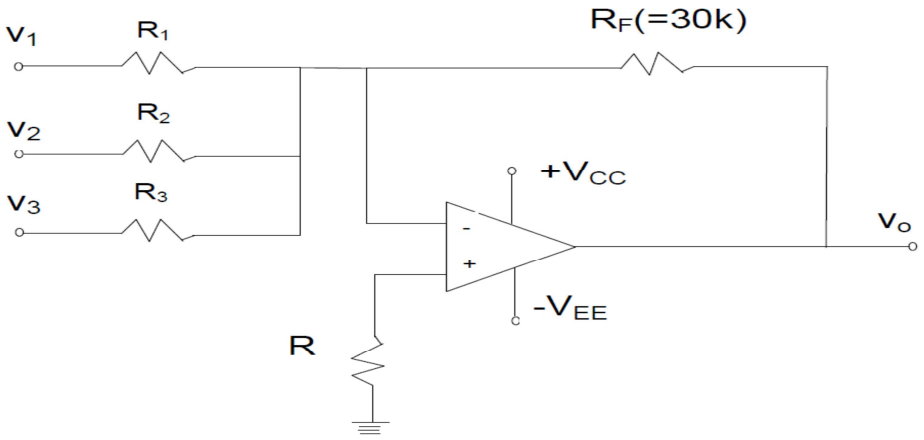
(v) The input common-mode resistance (assuming that the Early voltage V_A=100 V).

ake V_T to be 25mV. (10 marks)

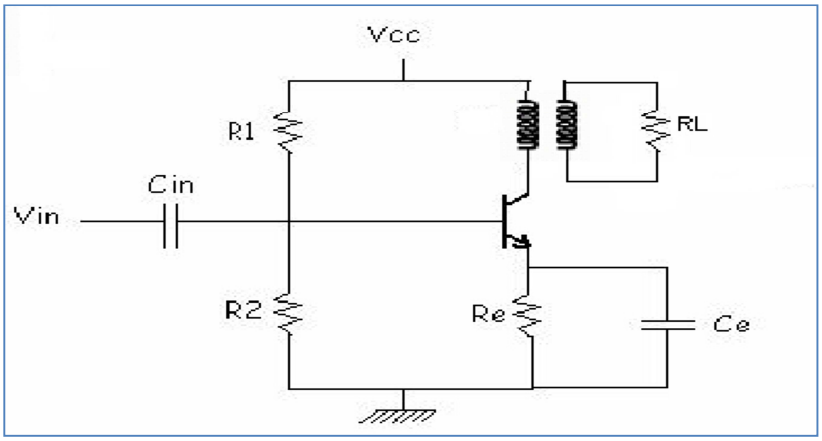


QUESTION THREE (20 MARKS)

(a) For the summing amplifier shown in fig below., estimate the values of resistors R_1,R_2 and R_3 so that the output V_0 is, V_0 = - (3V1 + V2 + 0.2V3) What is the approximate value of the compensating resistor R? (7 marks)

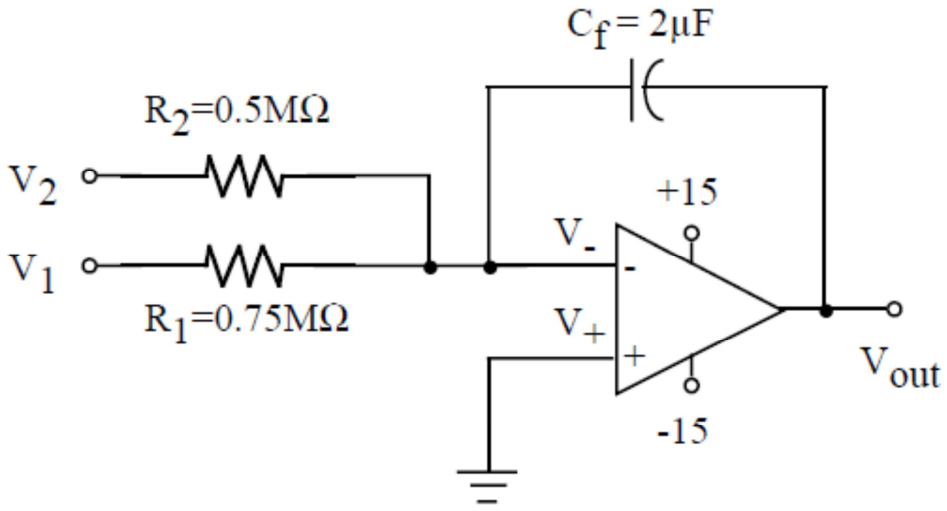


(b) Design the amplifier below using the data: P_L = 5 W, V_{cc} = 12 V. Calculate full load efficiency, max power dissipation: (13 marks)



QUESTION FOUR (20 MARKS)

(a) For the circuit shown below, $V_1 = 10sin\ (200t)$ and $V_2 = 15sin\ (200t)$. What is V_{out}? The op amp is ideal with infinite gain. (7 marks)



(b) For the class B amplifier show that the maximum efficiency is 78.54%. (7 marks)

(c) For a class B amplifier providing a 20-V peak signal to a 16-Ω load (speaker) and a power supply of V_{CC} = 30 V, determine the input power, output power, and circuit efficiency. (6 marks)

QUESTION FIVE (20 MARKS)

(a) In a transformer, give the relationship between

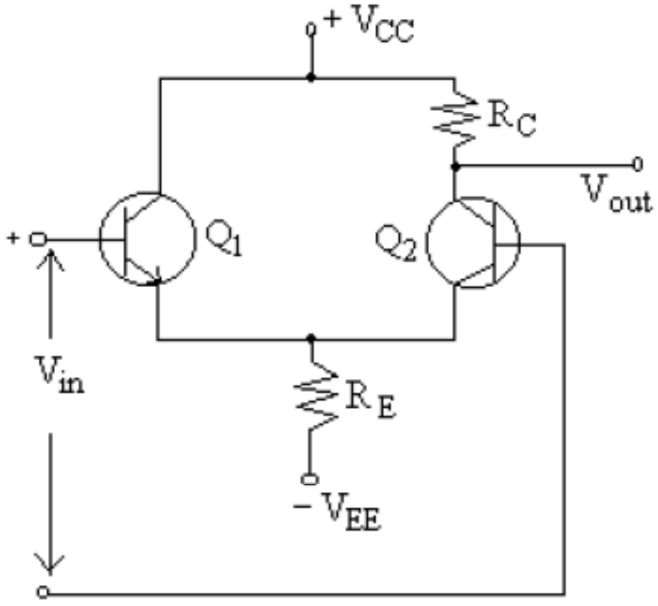
(i) turns ratio and its primary and secondary impedances

(ii) turns ratio and primary/secondary voltage.

In a transformer-coupled amplifier, the transformer used has a turns ratio N1:N2 = 10:1. If the source impedance is 8 KΩ, what should be the value of load impedance for maximum powertransfer to the load? Also find the load voltage if the source voltage is 10 volts.

(5 marks)

(b) For the circuit shown in Fig. below, determine voltage gain, input impedance, output impedance, common-mode gain and CMRR if V_{CC}=15v, V_{EE}=15v , $R_C = R_E$ =1MΩ and transistors Q_1 and Q_2 are identical with β_{dc} = 100 . Determine output voltage when V_{in}= 0Vand when V_{in}=-1mV. (4 marks)



(c) The collector voltage of a Class B push pull amplifier with V_{CC}=40 Volts swings down to a minimum of 4 volts. The total power dissipation in both the transistors is 36 watts. Compute the total dc power input and conversion efficiency of the amplifier? (5 marks)

(d) A differential amplifier has inputs V_{s1}=10mV, V_{s2} = 9mV. It has a differential mode gain of 60 dB and CMRR is 80 dB. Find the output voltage. (6 marks)