# MACHAKOS UNIVERSITY

**University Examinations for 2021/2022 Academic Year**

**SCHOOL OF ENGINEERING AND TECHNOLOGY**

**DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING**

**THIRD YEAR SECOND SEMESTER EXAMINATIONS FOR**

**BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONIC ENGINEERING)**

**EEE 309: ANALOGUE ELECTRONICS II**

**DATE:** **TIME:**

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**INSTRUCTIONS**

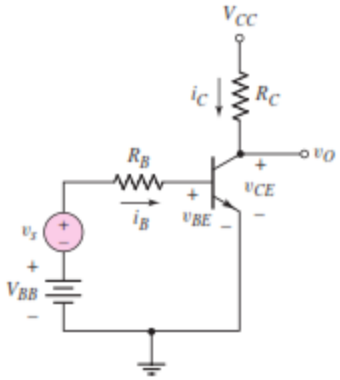
Answer question **ONE** and **ANY OTHER TWO** questions

**QUESTION ONE (COMPULSORY) (30 MARKS)**

a) Describe how one can measure the following parameters of an op-amp:
   i. Differential gain;
   ii. Common mode gain.
(6 marks)

b) With inputs $v_{i1}$ = -50 mV, and $v_{i2}$ = +50 mV, a differential amplifier has output $v_o$ = 1.0043 V. With inputs $v_{i1} = v_{i2}$ = 5 V the output is $v_o$ = 0.4153 V. Determine the CMRR, expressed in dB. (4 marks)

c) The transistor amplifier in FigQ1 (c) has the following parameters: $V_{CC}$ = 10 V, $R_C$ = 3 kΩ $R_B$ = 100 kΩ, $V_{BB}$ = 3 V, β = 100 and $r_o = \infty$. Determine the voltage gain $A_v = v_o/v_s$ by performing dc and ac analysis.




**FigQ1 (c)**

(12 marks)

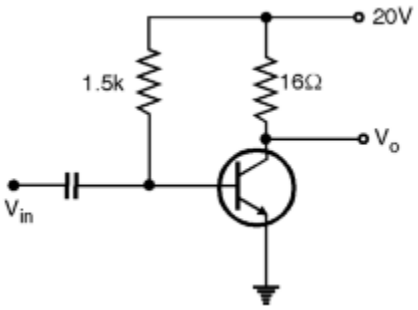
d) A series fed class-A amplifier shown in FigQ1 (d) operates from a dc source and an applied sinusoidal signal generates peak base current of 9 mA. Calculate

i. Quiescent current $I_{CQ}$;

ii. Quiescent voltage $V_{CEQ}$;

iii. The efficiency of the amplifier.

Assume $\beta = 50$ and $V_{BE} = 0.7$ V




**FigQ1 (d)**

(8 marks)

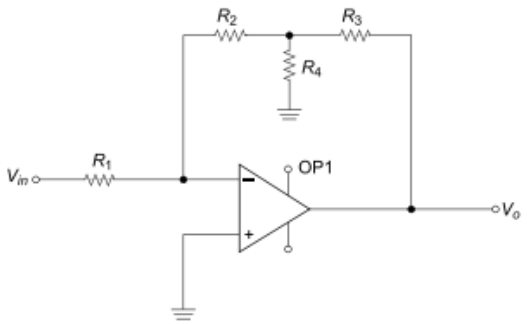
## QUESTION TWO (20 MARKS)

a) i. An op-amp with an open-loop gain of $A_v = 7 \times 10^3$ is to be used in an inverting op-amp circuit. Let $R_1 = 10$ kΩ and $R_2 = 100$ kΩ. If the output voltage $v_o = 7$ V, determine the input voltage and the voltage at the inverting terminal of the op-amp.

ii. If the output voltage $v_o$ = - 5 V and the voltage at the inverting terminal of the op-amp is 0.2 m, what is the input voltage and the value of $A_v$?

(7 marks)

b) For the circuit shown in FigQ2, find output voltage $V_o$.




**FigQ2**

(13 marks)

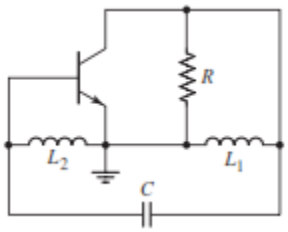
**QUESTION THREE (20 MARKS)**

a) i. Sketch the general characteristics of a low-pass filter, a high-pass filter, and a band-pass filter;

ii. State the Barkhausen criterion for oscillations.

(7 marks)

b) Derive the expression for the frequency of oscillation for the Hartley oscillator in FigQ3.



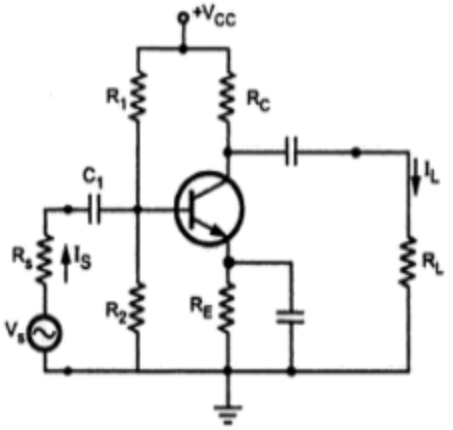

**FigQ3**

(13 marks)

**QUESTION FOUR (20 MARKS)**

a) Consider a CE amplifier in FigQ4 (a) with Rs = 1kΩ, R1 = 50 kΩ, R2 = 2Ω, RC = 1 kΩ, RL = 1.2 kΩ, hie = 1.1 kΩ, hoe = 25 μA/V and hre = 2.5×10-4. Determine

i. Current gain Ai;
ii. Input impedance Zin;
iii. Voltage gain Av
iv. Overall input impedance Zin'

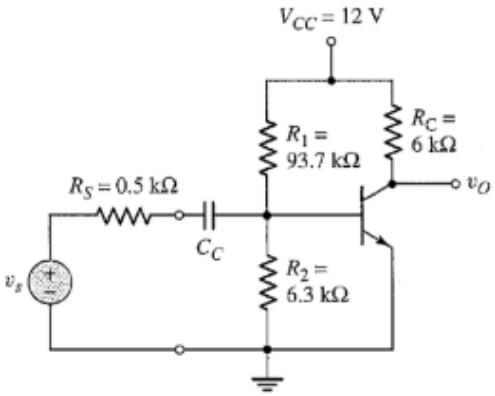



**FigQ4 (a)**

(8 marks)

b) The the circuit shown in FigQ4 (b), determine the small-signal
   i. voltage gain;
   ii. input resistance;
   iii. output resistance.
   Assume the transistor parameters are: ß=100, $V_{BE}$ (on) =0.7V, and $V_A$ =100V.

(12 marks)




**FigQ4 (b)**

**QUESTION FIVE (20 MARKS)**

(a) Determine the voltage gain, input, and output impedance with feedback for voltage-series feedback having A = -100, $R_i$ = 10 kΩ, and $R_o$ = 20 kΩ_for feedback of β = 0.1.

(6 marks)

(b) i. Given that an amplifier has a bandwidth of 300 KHz and a voltage gain of 100 calculate the new bandwidth and gain when 10% negative feedback is introduced.

ii. Determine the gain bandwidth product before and after feedback.
iii. Calculate the amount of feedback if the bandwidth is limited to 800 KHz.

(8 marks)

**(c)** An amplifier with open loop voltage gain of 1000 delivers 10 W of power and output at 10% second harmonic distortion when the input is 10 mV. If 40dB negative feedback is applied and output power is to remain at 10 W, determine

i. the required input signal $V_s$ and

ii. the second harmonic distortion with feedback.

(6 marks)