



MACHAKOS UNIVERSITY

University Examinations for 2019/2020 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

THIRD YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

EEE 309: ANALOGUE ELECTRONICS II

DATE: 25/11/2020

TIME: 8.30-10.30 AM

INSTRUCTIONS

Answer Question One and Any Other Two Questions

QUESTION ONE (30 MARKS).

- a) Determine the open circuit impedance matrix of the two-port network shown in Fig.Q1(a).

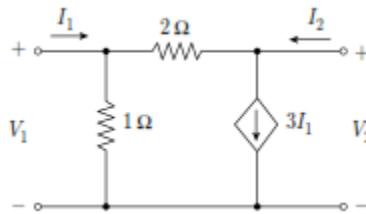


Fig.Q1(a).

(5 marks)

- b) An NMOS transistor has parameters $V_{TN} = 0.4 \text{ V}$, $k_n' = 100 \mu\text{A/V}^2$, and $\lambda = 0.02 \text{ V}^{-1}$.
- Determine the width-to-length ratio W / L such that $g_m = 0.5 \text{ Ma/V}$ at $I_{DQ} = 0.5 \text{ mA}$ when biased in the saturation region.
 - Calculate the required value of V_{GSQ} .
 - Repeat part (i) and (ii) for $I_{DQ} = 0.15 \text{ mA}$.

(8 marks)

- c) A transistor used in common emitter configuration has the following set of h parameters when d.c. operating point is $V_{CE} = 5 \text{ V}$ and $I_C = 1 \text{ mA}$. $H_{ie} = 1700 \Omega$; $h_{re} = 1.3 \times 10^{-4}$; $h_{fe} = 38$; $h_{oe} = 6 \times 10^{-6}$ siemens and a.c load as seen by the transistor is $r_L = 2 \text{ K}\Omega$. Determine:
- Input impedance;
 - Current gain;
 - Voltage gain. (6 marks)
- d) Consider a non-inverting amplifier with $R_1 = 6.8 \text{ k}\Omega$, $R_2 = 47 \text{ k}\Omega$ and an op-amp with $A_{OL} = 2 \times 10^4$.
- What is the closed-loop gain?
 - Determine the percent difference between the actual gain and the ideal gain. (4 marks)
- e) An inverting amplifier has closed-loop voltage gain of -25. The op-amp used has a low-frequency, open-loop gain of 2×10^4 and has a unity-gain bandwidth of 10^6 Hz .
- What is the 3dB frequency $f_{3\text{-dB}}$ of the op-amp and the 3 dB frequency $f_{3\text{-dB}}$ of the closed-loop amplifier?
 - Using the results of part (i), what is the magnitude of the voltage gain for the open-loop and closed-loop amplifiers at $f = 0.25 f_{3\text{-dB}}$ and at $f = 5f_{3\text{-dB}}$ (7 marks)

QUESTION TWO (20 MARKS)

- a)
 - What is the Barkhausen criterion?
 - Describe the two conditions for sustained oscillation. (6 marks)
- b) Determine the output impedance for the given network with the following Parameters
 $C_S = 10 \mu\text{F}$, $C_E = 20 \mu\text{F}$, $C_C = 1\mu\text{F}$, $R_S = 1 \text{ k}\Omega$,
 $R_1 = 40 \text{ k}\Omega$, $R_2 = 10 \text{ k}\Omega$, $R_E = 2 \text{ k}\Omega$, $R_C = 4 \text{ k}\Omega$,
 $R_L = 2.2 \text{ k}\Omega$, $\beta = 100$, $r_o = \infty \Omega$ and $V_{CC} = 20 \text{ V}$ (14 marks)

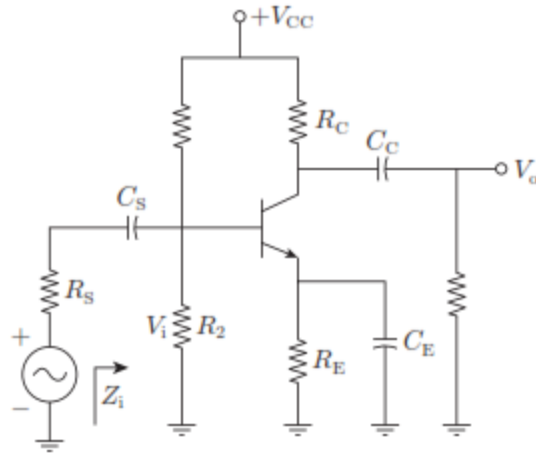


Fig.Q3 (b)

QUESTION THREE (20 MARKS)

- a) Calculate the operating frequency and feedback fraction for Hartely oscillator shown in Fig.Q3(a). The mutual inductance between the coils is $M = 20\text{mH}$. (5 marks)

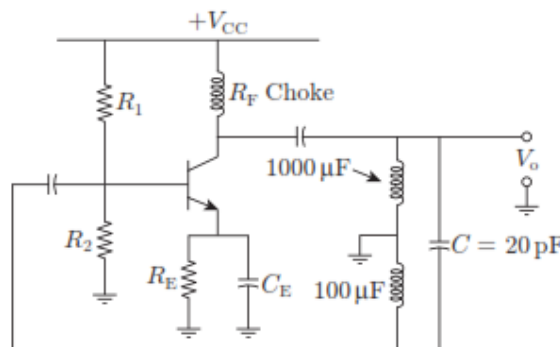


Fig.Q3(a)

Gate

- b) For the network shown in Fig.Q3 (b) with the parameters $R_S = 1\text{ k}\Omega$, $R_1 = 40\text{ k}\Omega$, $R_2 = 10\text{ k}\Omega$, $R_E = 2\text{ k}\Omega$, $R_C = 4\text{ k}\Omega$, $R_L = 2.2\text{ k}\Omega$, $C_S = 10\text{ }\mu\text{F}$, $C_C = 1\text{ }\mu\text{F}$, $C_E = 20\text{ }\mu\text{F}$, $\beta = 100$, $r_o = \infty\Omega$, $V_{CC} = 20\text{ V}$ with the addition of $C_{be} = 35\text{ pF}$, $C_{bc} = 4\text{ pF}$, $C_{ce} = 1\text{ pF}$, $C_{wi} = 6\text{ pF}$, and $C_{wo} = 8\text{ pF}$. Determine f_{Hi} and f_{Ho} . (15 marks)

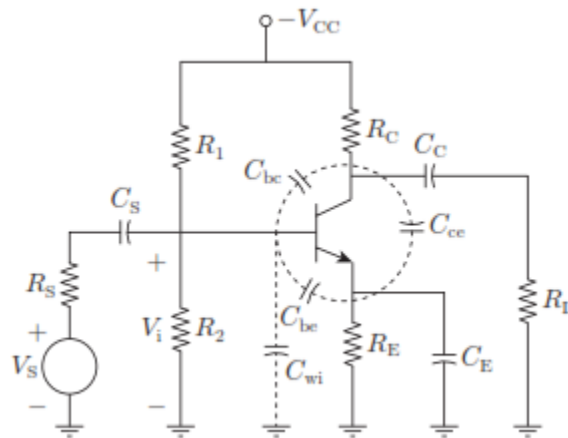
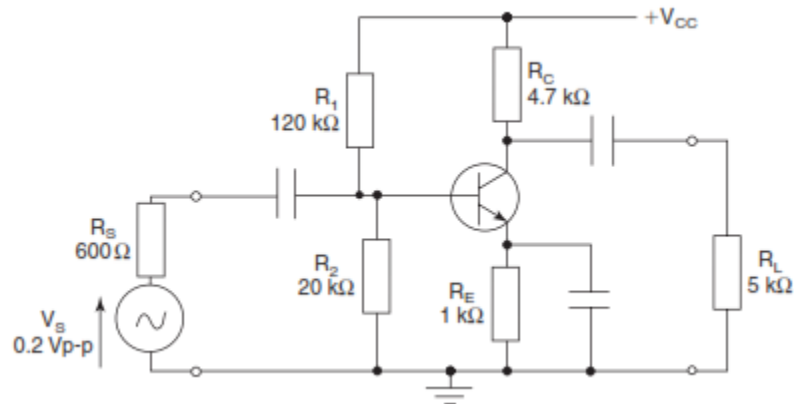


Fig.Q3 (b)

QUESTION FOUR (20 MARKS)

- a) The transistor used in the circuit of Fig.Q4 (a) has the the following h-parameters: $h_{ie} = 2 \text{ k}\Omega$; $h_{oe} = 60 \text{ }\mu\text{S}$; $h_{fe} = 100$. Calculate
- the amplifier current gain;
 - the actual power delivered to the external load;
 - The turns ratio required for a matching transformer in order to maximize the power delivered to the load.
- (10 marks)



FigQ4(a)

- b) The parameters of the transistor in the circuit in Fig.Q4 (b) are $\beta = 150$ and $V_A = \infty$.

- i. Determine R_1 and R_2 to obtain a bias-stable circuit with the Q-point in the center of the load line.
- ii. Determine the small-signal voltage gain $A_v = v_o/v_s$. (10 marks)

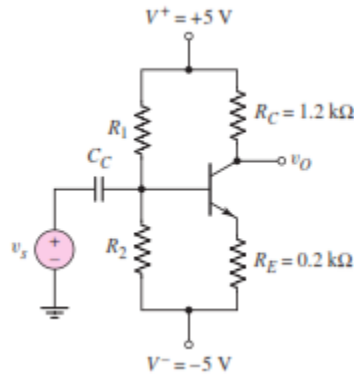


Fig.Q4 (b)

QUESTION FIVE (20 MARKS)

- a) Calculate the efficiency of the amplifier circuit shown in Fig.Q5 (a). The input voltage applied is such that it produces a base-current of 10 mA peak, the transistor's base-emitter voltage is equal to 0.7V and β is equal to 40. (12 marks)

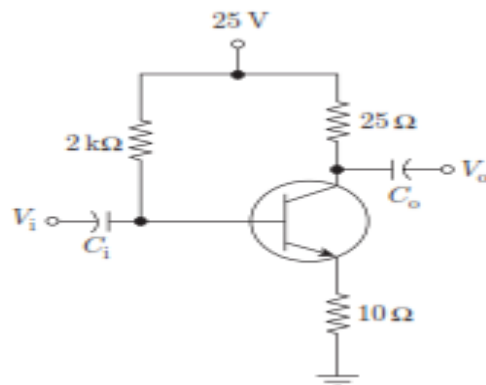


Fig.Q5 (a)

- c) What is the AC power delivered to the speaker in the circuit shown in the Fig.Q5 (a)? The value of the quiescent base current is 8 mA and the input signal results in a peak-to-peak base current swing of 8 mA. The output characteristics of the transistor are shown in Fig.Q5 (b). (8 marks)

