MACHAKOS UNIVERSITY

University Examinations for 2021/2022

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

THIRD YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONICS ENGINEERING)

EEE 309: ANALOGUE ELECTRONIC II

DATE: 17/12/2021 **TIME: 11:00 – 1:00 PM**

INSTRUCTIONS

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

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Design a 4-resistor bias circuit for a BJT amplifier with the following parameters: $I_C = 750\ \mu A$, $V_{CE} = 5$ V, $\beta = 100$, $V_{CC} = 15$ V, $V_{BE} = 0.7$ V. (10 marks)

b) A transistor used in common emitter configuration has the following set of h parameters when d.c. operating point is $V_{CE} = 5$ V and $I_C = 1$ mA. $H_{ie} = 1700\ \Omega$; $h_{re} = 1.3 \times 10^{-4}$; $h_{fe} = 48$; $h_{oe} = 9 \times 10^{-6}$ siemens and a.c load as seen by the transistor is = $r_L = 2\ K\Omega$. Determine:

i. Input impedance;

ii. Current gain;

iii. Voltage gain. (6 marks)

c) i. A power transistor has thermal resistance $\theta = 300\ ^oC/W$. If the maximum junction temperature is 95 ^oC and the ambient temperature is 35 ^oC, determine the maximum permissible power dissipation.

ii. If a heat sink is used with the above transistor, the value of θ is reduced to 65 $^oC/W$. Calculate the maximum permissible power dissipation.

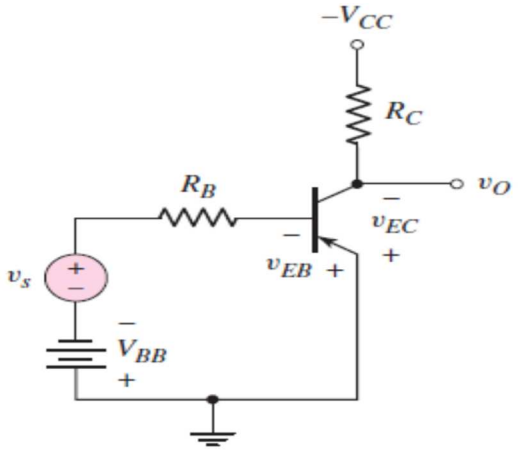
(4 marks)

d) For the circuit in Fig.Q1 (d), $\beta = 100$, $V_A = \infty$, $V_{CC} = 10$ V, $R_B = 50$ kΩ.

i. Determine V_{BB} and R_C such that $I_{CQ} = 0.5$ mA and the Q-point is the center of the load line;

ii. Find the small-signal parameters g_m, r_π, and r_o;

iii. Determine the small-signal voltage gain $A_v = V_o/V_s$.



(8 marks)

e) An amplifier has an open-loop gain of 1000 and a feedback ratio of 0.04. If the open-loop gain changes by 10% due to temperature, find the percentage change in gain of the amplifier with feedback. (2 marks)

QUESTION TWO (20 MARKS)

a) i. An inverting amplifier with resistors $R_1 = 5.6$ kΩ and $R_2 = 120$ kΩ is fabricated using an op-amp with an open-loop gain of 10^5. Determine the percentage difference between the actual gain and the ideal gain.

ii. An non-inverting amplifier with resistors $R_1 = 6.8$ kΩ and $R_2 = 47$ kΩ is fabricated using an op-amp with an open-loop gain of 2×10^4. Determine the percentage difference between the actual gain and the ideal gain.

(10 marks)

b) i. The circuit in Fig.Q2 (b) is a first – order low-pass active filter. Show that the voltage transfer function is given by

$$A_v = \frac{-R_2}{R_1} \cdot \frac{1}{1 + j\omega R_2 C_2}$$

ii. What is the voltage gain at dc ($\omega = 0$)?

iii. At what frequency is the magnitude of the voltage gain a factor of $\sqrt{2}$ less than the dc value? (This is the – 3 dB frequency)

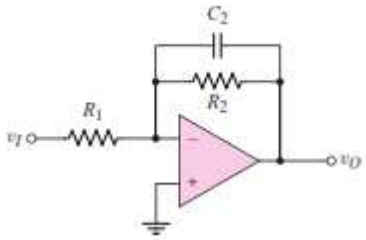


Fig.Q2 (b)

(10 marks)

QUESTION THREE (20 MARKS)

a) Derive the expression for the resonance frequency of the Phase Shift oscillator shown in Fig.Q3 (a).

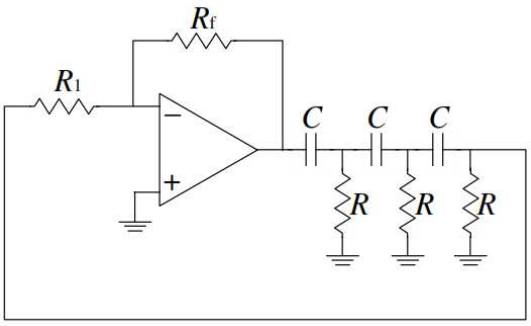


Fig.Q3 (a).

(12 marks)

.

b) i. The tuned collector oscillator circuit used in the local oscillator of a radio receiver makes use of an LC tuned circuit with L1 = 58.6 μH and C1 = 300 pF. Calculate the frequency of oscillations;

ii. Find the capacitance of the capacitor required to build an LC oscillator that uses an inductance of L_1 = 1 mH to produce a sine wave of frequency 1 GHz;

iii. A Colpitt's oscillator has the following parameters: capacitance C_1 = 0.001 μF, C_2 = 0.01 μF and inductor L = 15 μH. Determine the operating frequency and the feedback fraction for the oscillator.

(8 marks)

QUESTION FOUR (20 MARKS)

a) An amplifier has a mid-band gain of 125 and a bandwidth of 250 kHz.

i. If 4% negative feedback is introduced, find the new bandwidth and gain;

ii. If the is to be restricted to 1 MHz, find the feedback ratio. (6 marks)

b) An amplifier has a voltage gain with feedback is 100.If the gain without feedback changes by 20% and the gain with feedback should not vary more than 2%, determine the values of the open loop gain A and feedback ratio β. (6 marks)

c) An voltage – series negative feedback amplifier has a voltage gain without feedback A = 500, input resistance R_i = 3 kΩ, output resistance R_o = 20 kΩ and feedback ratio β = 0.01. Determine

i. The a voltage gain with feedback A_f;

ii. The input resistance with feedback R_{if};

iii. The output resistance with feedback R_{of}. (6 marks)

d) Explain the term positive feedback. (2 marks)

QUESTION FIVE (20 MARKS)

a) Explain the following terms:

i. Miller effect;

ii. Cutoff frequency;

iii. Cascode configuration. (6 marks)

b) For the common-emitter circuit in Fig.Q5 (a), assume the emitter bypass capacitor C_E is very large, and the transistor parameters are: $ß_o$ = 100 V_{BE} (on) = 0.7V,V_A= 8,Cμ= 2pF, and $f_τ$ = 400MHz. Determine the lower and upper 3 dB frequencies for the small-signal voltage gain. Use the simplified hybrid model for the transistor.

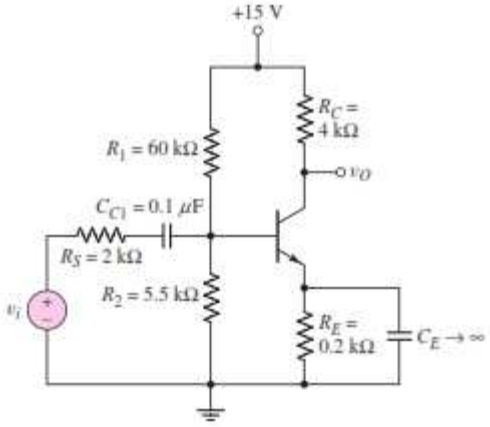


Fig.Q5 (a)

(14 marks)