The Open University of Sri Lanka
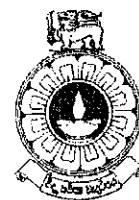
Faculty of Engineering Technology

Department of Electrical & Computer Engineering

General Instructions

1. Read all instructions carefully before answering the questions.

2. This question paper consists of **Five (5)** questions in **Four (4)** pages.

3. Answer **All** the questions.

4. Answer for each question should commence from a new page.

5. Relevant charts are provided.

6. This is a Closed Book Test **(CBT)**.

7. Answers should be in clear hand writing.

8. Do not use red colour pens.

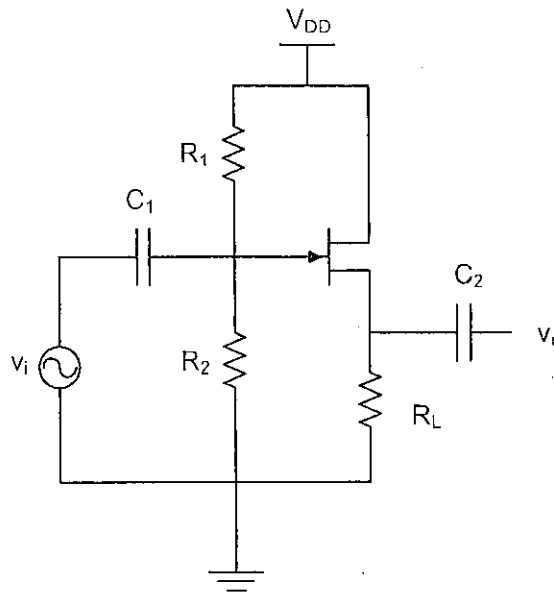Q1. Consider the circuit in the Figure-Q1 with Si transistors.
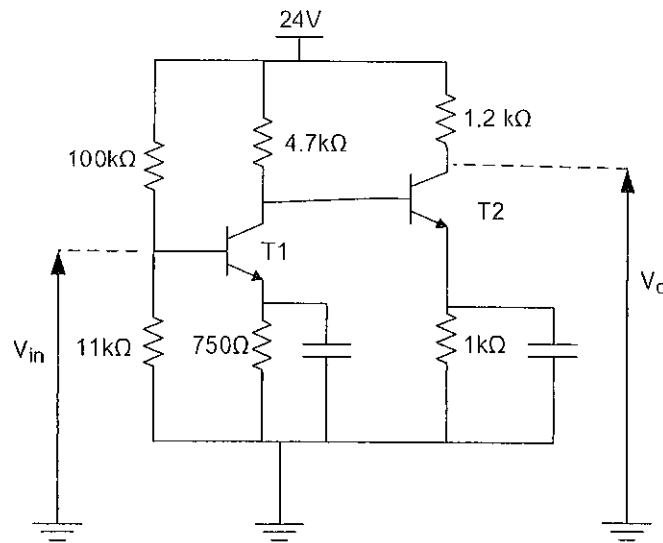
Figure-Q1

T1: $\beta = h_{fe} = 100, h_{ie} = 1k\Omega$ **T2:** $\beta = h_{fe} = 60, h_{ie} = 1.4k\Omega$
You may assume that the effect from h_{oe} and h_{re} are negligible.

(a) Find the quiescent values of V_{CE1}, I_{C2}, V_{C2} and V_{CE2}. **(8 Marks)**

(b) Draw the low frequency equivalent circuit. **(6 Marks)**

(c) Find the mid band voltage gain $\dfrac{V_o}{V_{in}}$. **(6 Marks)**

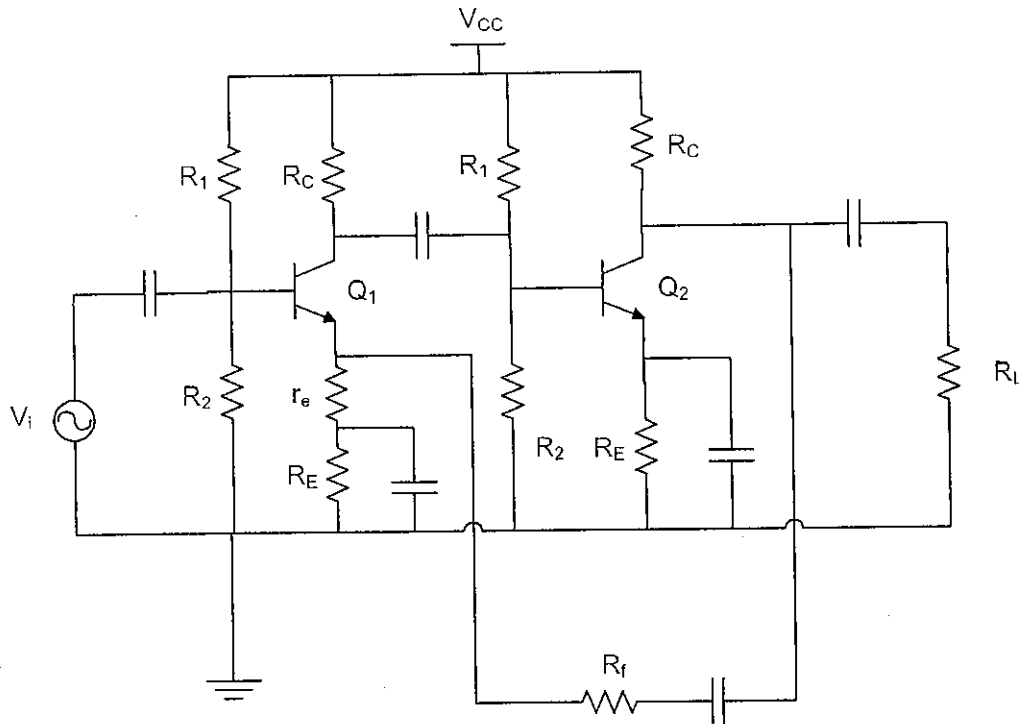Q2. Consider the circuit diagram in Figure-Q2.

Figure-Q2

(a) Draw the high frequency equivalent circuit for the single stage amplifier shown in Figure-Q2. **(7 Marks)**

(b)   Clearly stating all your assumptions, find an expression for the voltage gain, A_v.

(8 Marks)

(c)   Hence show that the low frequency voltage gain for this amplifier is $\frac{\mu}{\mu+1}$, where

$\mu = \frac{g_m}{g_d}$.   **(5 Marks)**

Q3.

Figure-Q3

For the amplifier circuit shown in Figure-Q4, $V_{CC} = 10\,V$, $R_1 = 10k\Omega$, $R_2 = 2.2k\Omega$, $R_C = 3.6k\Omega$, $R_E = 1k\Omega$, $r_e = 100\Omega$, $R_L = 10k\Omega$ and $R_f = 4.7k\Omega$. Both transistors Q1 and Q2 are identical and have $h_{fe} = 100$, $h_{ie} = 1.2k\Omega$.

(a) Identify the type of feedback used.   **(2Marks)**

(b) Consider the circuit in Figure-Q3 without the feedback. Calculate the voltage gain and the input impedance.   **(10Marks)**

(c) Calculate the feedback ratio.   **(4Marks)**

(d) Hence calculate the overall voltage gain with feedback.   **(4Marks)**

Q4.

(a) Starting from the first principles, derive the Barkhousen criteria for oscillations to occur.   **(4Marks)**

(b) Stating all your assumptions, derive an expression for the feedback factor for the circuit in Figure-Q4.   **(4Marks)**

(c) Derive an expression for the forward gain.   **(6Marks)**

(d) Hence find the frequency of oscillation ($C = 100\mu F$, $L_1 = L_2 = 10mH$, $R_1 = R_2$).   **(6Marks)**
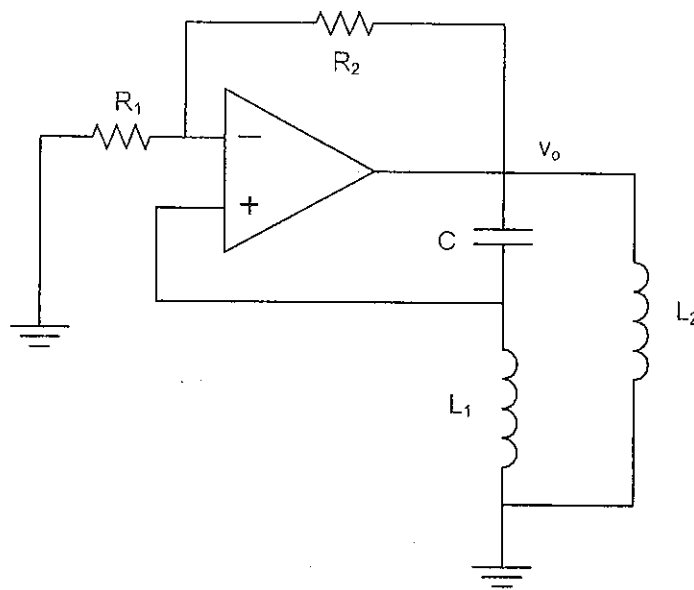
Figure-Q4

Q5.

(a) A certain electronic medical thermometer has a frequency response given by $\frac{2}{(1+j\omega)(1+3j\omega)}$. Using a suitable frequency domain analysis, calculate the minimum time the doctor must wait after placing the thermometer on the patient, to have an accurate static reading. **(5 Marks)**

(b) Derive the time domain behaviour of the above thermometer and justify your answer to (a). **(4 Marks)**

(c) Above thermometer static reading taken on a patient in 20 different trials are given by 99.07, 99.54, 100.25, 100.24, 100.18, 99.50, 99.61, 99.86, 100.23, 99.94, 99.32, 100.48, 100.37, 99.90, 100.04, 100.04, 100.09, 100.39, 99.82, 100.79 Fahrenheit.

  i. Determine how well the above readings fit to a random Normal distribution.
    (3 Marks)
  ii. Determine the mean and the variance for the above Normal fit. **(4 Marks)**
  iii. Hence, determine the accuracy of the above thermometer with a confidence level of 97%. **(4 Marks)**