THE OPEN UNIVERSITY OF SRI LANKA
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

FINAL EXAMINATION - 2012

ECX6330 – ELECTRONIC SYSTEMS

ANSWER ANY FIVE QUESTIONS

ADHERE TO THE USUAL NOTATIONS

Date : 21st March 2012 ***Time: 9.30am-12.30pm***

Q1.

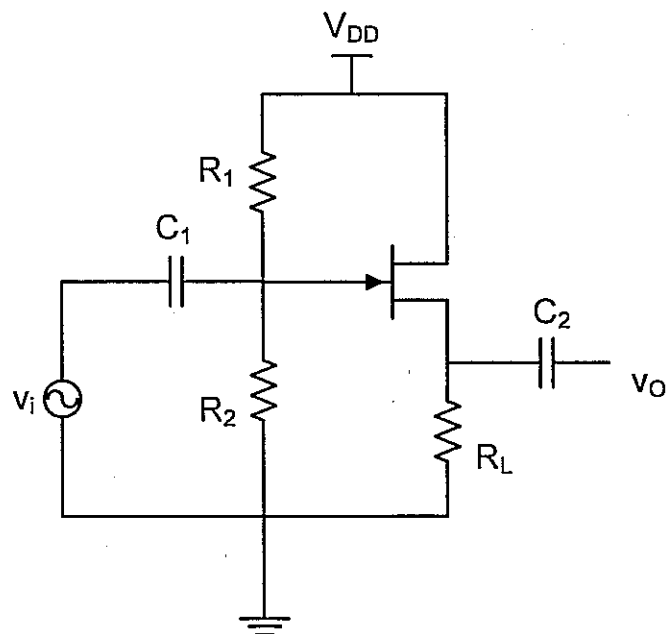


Figure –Q1

a)

i. Draw the high frequency ac equivalent circuit for the above circuit in Figure-Q1. **(6 Marks)**

ii. Find expressions for the voltage gain(A_v),input impedance (Z_{in}) and the output impedance (Z_O). **(10 Marks)**

b) Hence, show that the low frequency voltage gain of the above transistor amplifier is $\frac{\mu}{\mu+1}$, where $\mu = \frac{g_m}{g_d}$. (State all your assumptions) **(4 Marks)**

Q2.

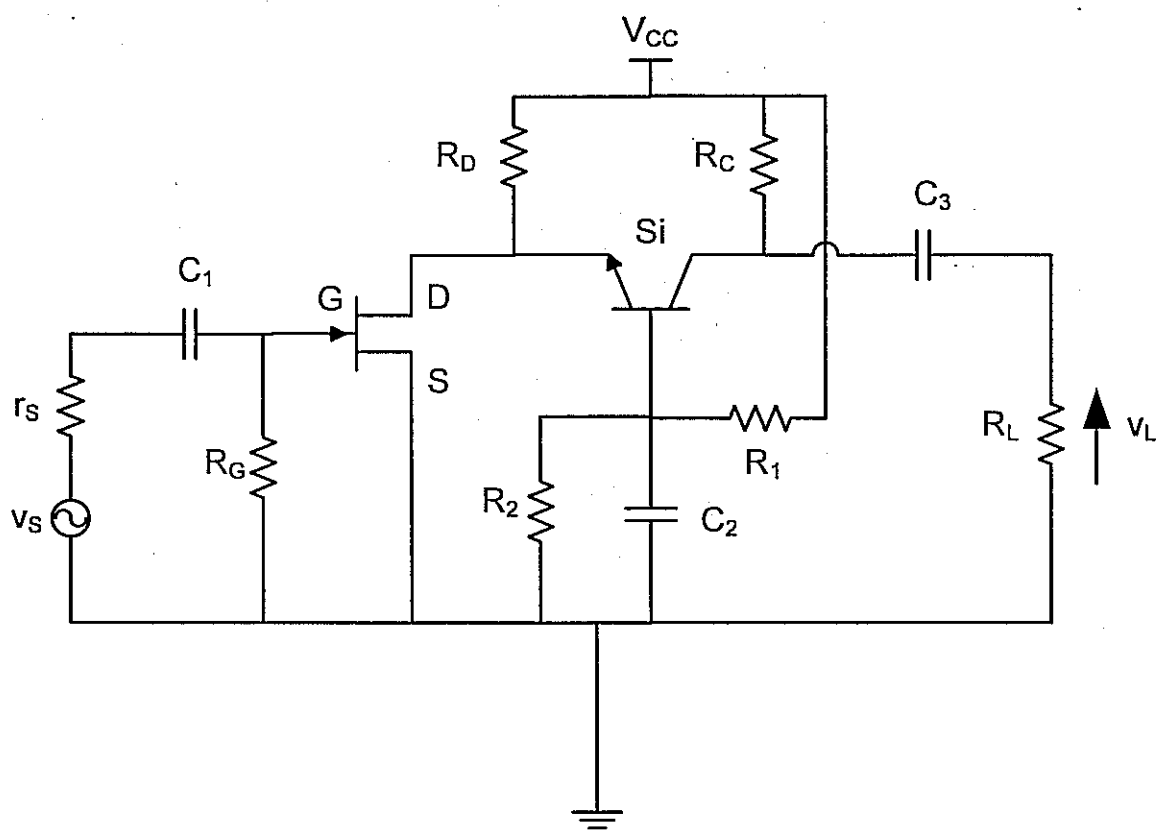


Figure –Q2

$V_{CC} = 12V,\ g_m = 80mS,\ r_d = 100k\Omega,\quad h_{oe} = 0.2\mu S,\quad h_{rb} = 4 \times 10^{-5},\quad h_{fb} = -0.99,$
$h_{ib} = 20\Omega,\quad R_1 = R_2 = R_C = 10k\Omega,\quad R_L = 500k\Omega,\ r_S = 500\Omega,\quad R_G = 1M\Omega,\quad R_D = 1k\Omega,$
$C_1 = 0.15\mu F,\ C_2 = 6\mu F,\ C_3 = 0.5\mu F.$

(a) Find V_{DS}. **(2Marks)**

(b) Draw the low frequency ac equivalent h-parameter model for the above circuit in Figure-Q2. **(4Marks)**

(c) Find the mid-band voltage gain $\frac{v_L}{v_S}$. **(6Marks)**

(d) Find the lower cutoff frequency for the above amplifier. **(8Marks)**

Q3.

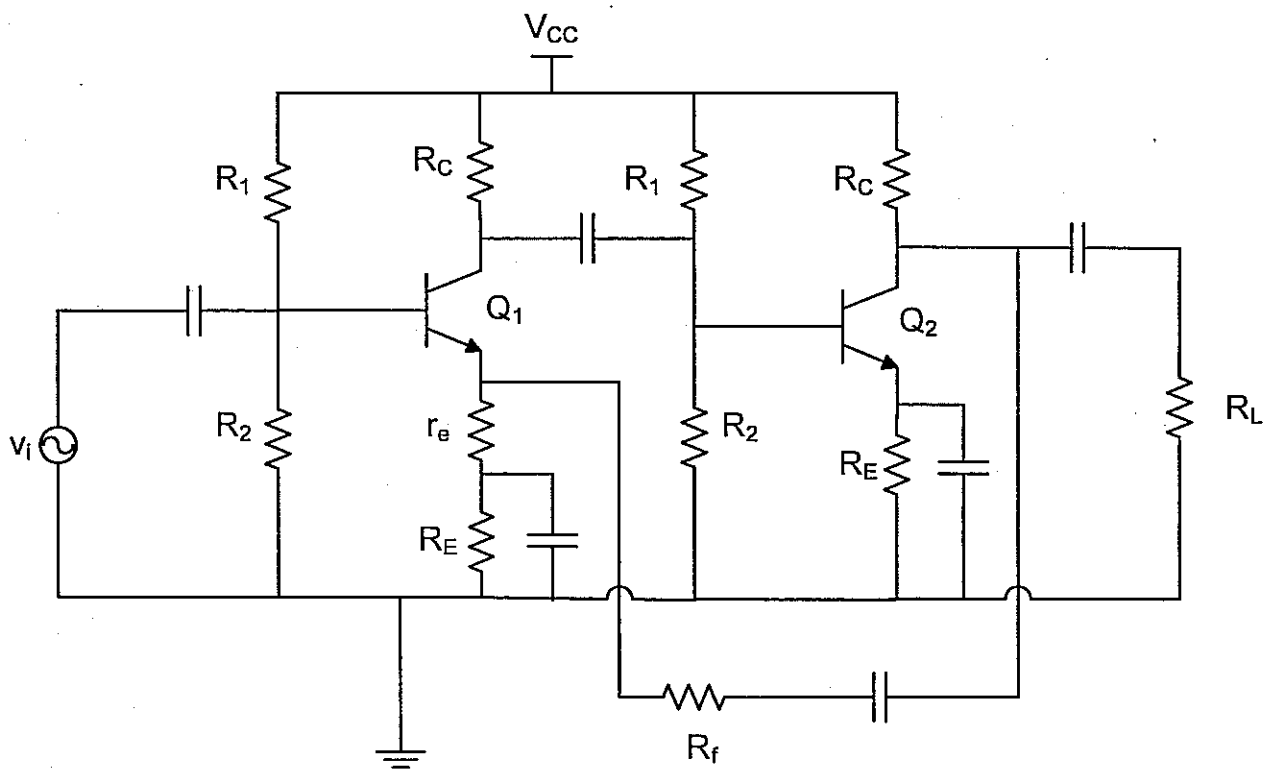


Figure –Q3

$V_{CC} = 10V$, $R_1 = 10k\Omega$, $R_2 = 2.2k\Omega$, $R_C = 3.6k\Omega$, $R_E = 1k\Omega$, $r_e = 100\Omega$, $R_L = 10k\Omega$, $R_f = 4.7k\Omega$, Both transistors Q_1 and Q_2 are identical and have $h_{fe} = 100$, $h_{ie} = 1.2k\Omega$.

a) Identify the type of feedback used. **(2Marks)**
b) Considering the circuit in Figure-Q3 excluding the feedback, calculate the voltage gain and the input impedance. **(10Marks)**
c) Calculate the feedback ratio. **(4Marks)**
d) Calculate the overall voltage gain with the feedback. **(4Marks)**

Q4.

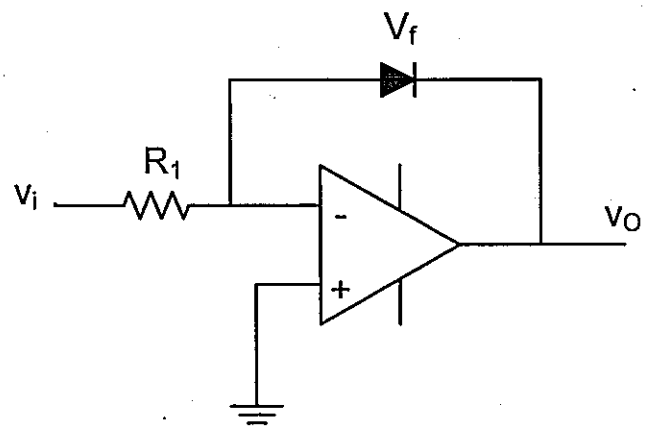


Figure –Q4

a) Show that the circuit in Figure-Q4 can provide an input output relationship $v_o \propto \ln(v_i)$ so that this is a logarithmic amplifier. **(8Marks)**

b) An amplifier has a voltage gain of 10^4 and poles at 10^5&10^6.

i. Write the closed loop transfer function and analyse the stability of this amplifier for different feedback factors. **(4Marks)**

ii. Calculate the Q factor and the bandwidth. **(4Marks)**

iii. Explain a method to improve the stability. **(4Marks)**

Q5.

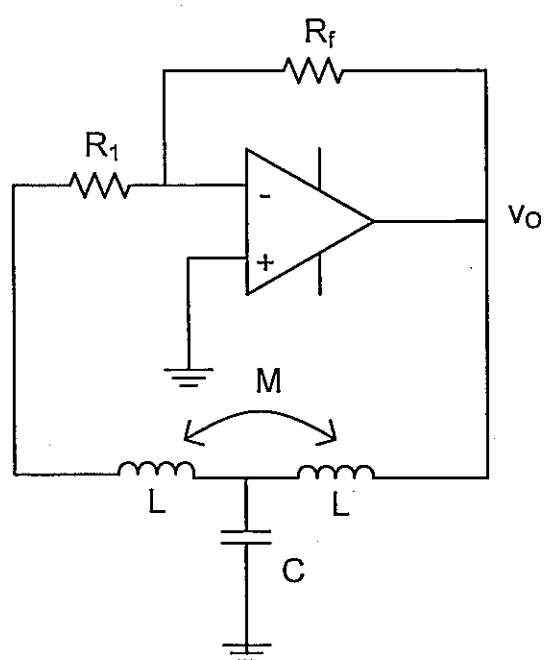


Figure –Q5

Note: Here M refers to the mutual inductance.

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

b) Derive an expression for the feedback ratio β of the above oscillator in Figure-Q5. **(8Marks)**

c) Hence find an expression for the frequency of oscillation. **(8Marks)**

Q6.

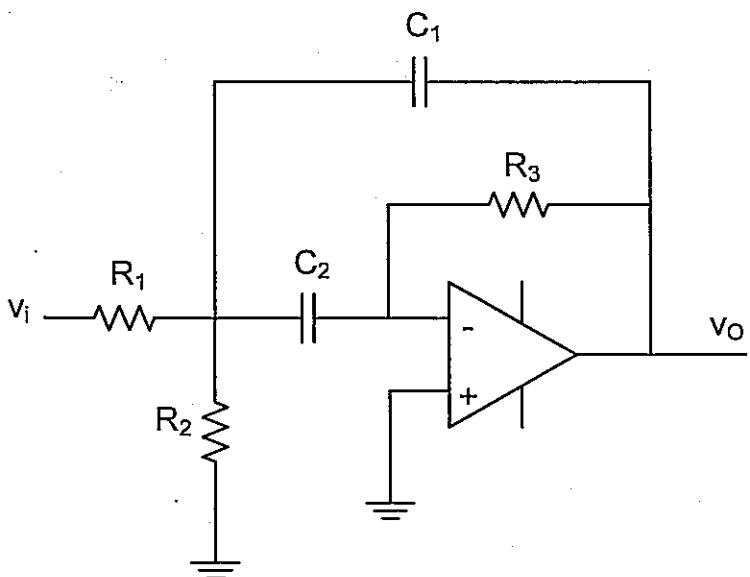


Figure –Q6(a)

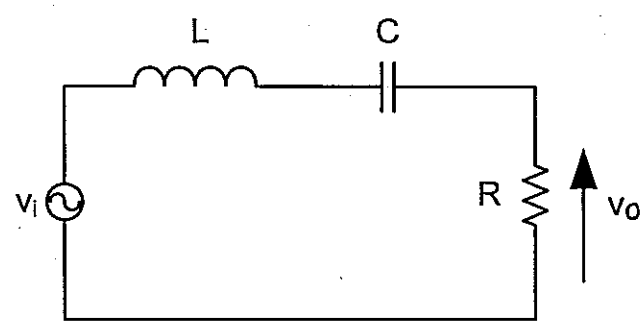


Figure –Q6(b)

a) Derive the transfer function for the circuit in Figure-Q6(a) . **(8Marks)**

b) Show that the filter effects are the same for both circuits given in Figure-Q6(a) and Figure-Q6(b). **(4Marks)**

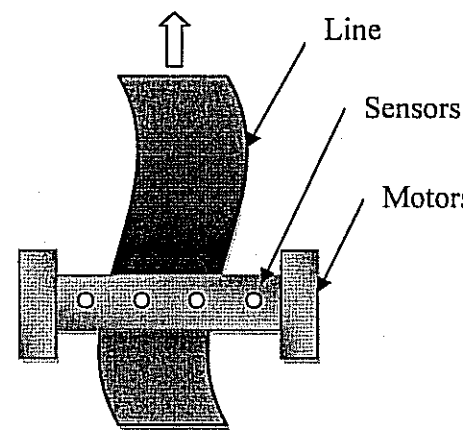
c) Find the expressions for the bandwidths of the two filter circuits. **(8Marks)**

Q7.

A line following robot is to be designed with the following specifications.

- Robot has four sensors in a fixed array with the spacing between the sensors such that at most 3 sensors will be on the line at a time. On the other hand, there can be instances with a minimum of only one outer sensor on the line.
- Whenever the center two sensors are on the line, the robot should be moved forward; otherwise turning should be carried out to align the robot with the line. When the robot meets the end of the line, it should stop.
- Robot has two independent motors (connected to wheels) to generate motion.
  - Both motors on→ Forward motion,
  - left motor on, right motor off→ Right turn,
  - left motor off, right motor on→ Left turn,
  - both motors off→ No motion.

A digital control circuit takes the sensor outputs' logic values as inputs and outputs logic signals to the motors.



a) Define the different inputs and outputs with suitable logical values. Hence, draw the truth tables, Karnaugh maps and derive the Boolean equations for the control circuit outputs of the above robot. **(10Marks)**

b) Design the circuit with NOR gates only. **(5Marks)**

c) Design the same circuit using an appropriate PLD. **(5Marks)**

Q8.

a)

i. Design a 4 bit synchronous left shift register with J-K flip-flops. **(6Marks)**

ii. Use this shift register to implement a 4bit Johnson counter with the counting sequence 0→1→3→7→15→14→12→8→0. **(4Marks)**

b) Design a sequential circuit to detect a "11011" sequence, using J-K flip-flops. **(10Marks)**