University of Swaziland
Faculty of Science
Department of Electrical and Electronic Engineering
Main Examination 2014

Title of Paper : **Analogue Design II**

Course Number : **EE323**

Time Allowed : **3 hrs**

Instructions :

1. **Answer any four (4) questions**
2. **Each question carries 25 marks**
3. **Useful information is attached at the end of the question paper**

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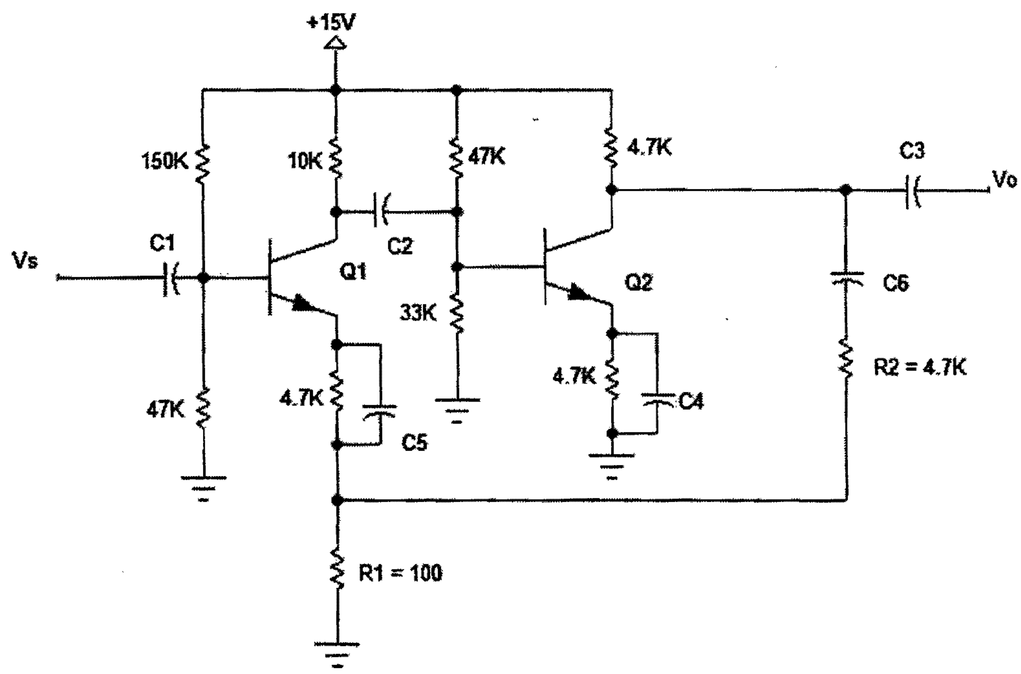
The paper consists of five (6) pages

Question 1

(a) Calculate A_f, R_{of} and R_{if} for the figure below. Assume $R_s = 0,\ h_{fe} = 50, h_{ie} = 1.1\ K\Omega, h_{re} = h_{oe} = 0$ and identical transistors. (15 Marks)



The capacitor values are: C1= C2 = C6 = 5μF, C4 = C5 = 50μF, C3 = 10μF

(b) Consider a general negative feedback system with parameters $A = 1 \times 10^6$ and $A_f = 100$. If the magnitude of A decreases by 20 %, show that the corresponding percentages change in A_f is 0.002%. (5 Marks)

(c) List (without explanation) 5 possible advantages of negative feedback. (5 Marks)

Question 2

(a) Determine the expression for A_f in the voltage series or series shunt feedback and then calculate the value of A_f given the A= 100, $R_1 = 10K\Omega,\ R_2 = 20\ k\Omega\ and\ \beta = 0.3$. Show that the approximated value of A_f is equal to the exact value of A_f . Refer to Fig. Question 2 a (5 Marks)

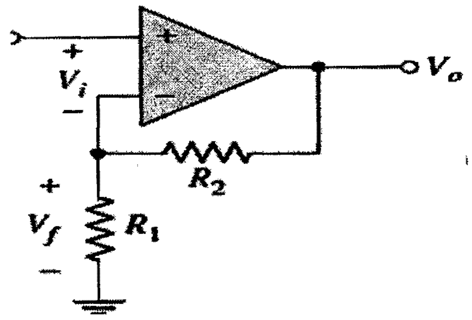


Figure. Question 2a

(b) Consider the N-channel MOSFET amplifier in Fig. Question 2b given below. $V_{DD} = 5\ V, R_L = 2\ K\Omega, K = 1\ mA/V^2$, $V_T = 1V$. Ignore r_d of the MOSFET and C_C is the input coupling capacitor (Assume it is infinitely large). $i_{DS} = \frac{K}{2}((v_{GS} - V_T)^2$

(i) Derive an expression for the transistor bias point V_{GSQ} as a function of V_{DD}, R_a and R_b? (3 Marks)

(ii) Determine the required ratio R_a / R_b such that the MOSFET $g_m = 1\ mA/V$. Recall that $g_m = \frac{\partial I_{DS}}{\partial V_{GS}}$ (8 Marks)

(iii) What is the voltage bias point of the output V_{outQ}? (if you cannot calculate a numerical value leave the answer in terms of the given circuit parameter values, R_a and R_b) (5 Marks)

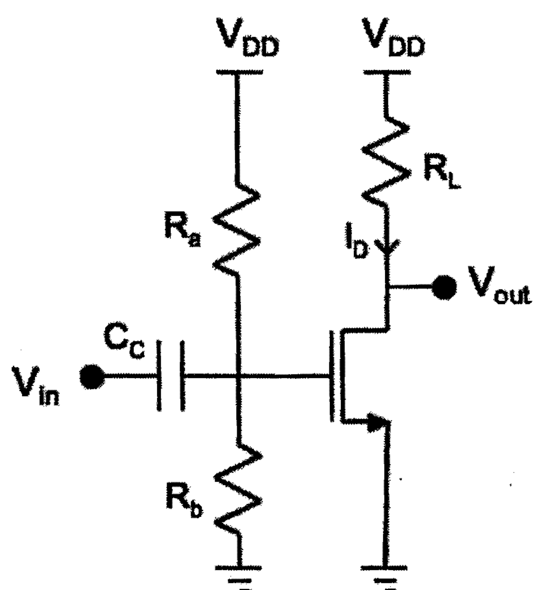


Figure Question 2b

(iv) Draw the small-signal model for the amplifier and calculate the gain $A = \frac{V_{out}}{V_{in}}$. Clearly label all the components values and small-signal voltages V_{in} and V_{out}. (4 Marks)

Question 3

(a) What is the frequency of Oscillations in the Figure below given that $C_1 = C_2 = 0.001\mu F$, L = 15μH. What is the feedback fraction? How much voltage gain does the circuit need to start oscillating? (6 Marks)

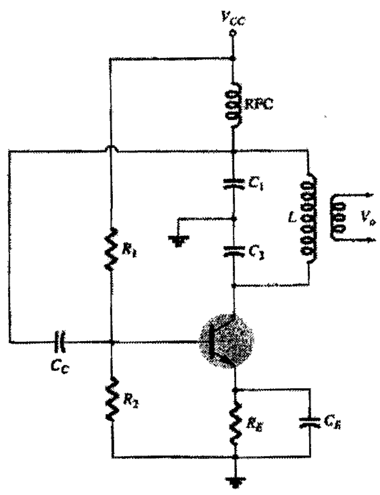


Figure Question 3a

(b) List the advantages of a crystal Oscillator? (4 Marks)

(c) In a transformer for class A amplifier, give the relationship between
  (i) The turns ratio and its primary and secondary impedances
  (ii) turns ratio and the primary and secondary voltages

In a transformer coupled Amplifier, the transformer used has a turns ration of N1:N2 = 10:1. If the source impedance is 8 K what should be the value of load impedances for maximum power transfer load? Also find the voltage if the source voltage is 10 Volts? (8 Marks)

(d) If an amplifier with negative feedback, the gain of the basic amplifier is 100 and it employs a feedback factor of 0.02. If the input signal is 40 mV, determine the voltage gain with feedback and the value of the output voltage? (7 Marks)

Question 4

(a) What are the drawbacks of the Phase Shift Oscillator? (3 Marks)

(b) A crystal has these values: L = 3 H, C_s =0.05pF, R = 2 K and C_p = 10 pF. Calculate the f_s and f_p of the crystal. Then calculate the quality factor of the crystal. (7 Marks)

(c) For the class-A amplifier shown in figure Question 4, show that the maximum efficiency for a sinusoidal input signal is 25%. Clearly state assumptions you make. For example, *ignore saturation.* (10 Marks)

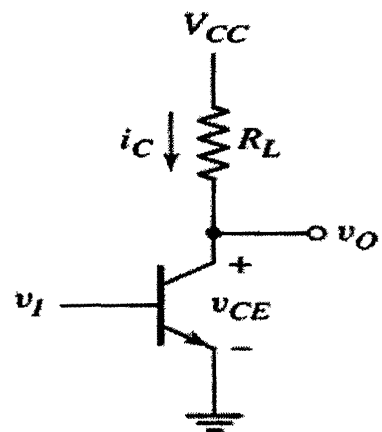


Figure Question 4c

(d) State the Barkhausen criterion for sustained oscillations in a sinusoid oscillator? (5 Marks)

Question 5

(a)A class B push-pull amplifier is supplied with V_{cc} = 40 V. The minimum voltage reached by the collector due to signals swing is $V_{min} = 8\,V$. The dissipation in both transistors total 30 W. What is the conversion efficiency of the amplifier? (10 Marks)

(b)What is an Oscillator? How does it differ from an amplifier? What are the essential parts of an Oscillator circuit? (8 Marks) (c)For the four topologies of negative feedback, indicate whether the input impedance and output impedance increases or decreases as a results of feedback. Tabulate your answer. (7 Marks)