University of Swaziland
Faculty of Science
Department of Electrical and Electronic Engineering
Supplementary Examination 2016

Title of Paper : **Analogue Design II**

Course Number : **EE323**

Time Allowed : **3 hrs**

Instructions :

1. **This paper contains five (5) questions**
2. **Answer all questions**
3. **Each question carries 20 marks**

THIS PAPER SHOULD NOT BE OPENED UNTIL PERMISSION HAS BEEN GIVEN BY THE INVIGILATOR

The paper consists of six (6) pages

Question 1 [20]

a) Define the following terms: [5]

i) Feedback
ii) Sensitivity
iii) Barkhausen Criterion
iv) Oscillator
v) Power Amplifier Efficiency

b) Give the effect of negative feedback on amplifier characteristics [8]

NB: Use *increase* and *decrease* to complete the table below

Characteristics	**type of feedback**			
	Current-series	**voltage-series**	**voltage-shunt**	**current-shunt**
Gain				
Bandwidth				
Input resistance				
Output resistance				

c) Design a ***Wien-bridge oscillator*** using op-amp to generate a sinusoidal waveform of frequency ***1 KHz.*** [7]

Question 2 [20]

For a series-series feedback BJT amplifier shown in ***Figure 2.1.*** The input variable is the voltage v_1 and the output variable is the voltage v_2. Assume $\beta = 100, r_\pi = 2.5K\Omega, \alpha = \frac{\beta}{1+\beta}, r_e = \frac{\alpha}{g_m}$, $r_0 = \infty, r_x = 0, V_T = 25mV, R_1 = 100\Omega, R_2 = 1K\Omega, R_3 = 20K\Omega$ *and* $R_4 = 10K\Omega$

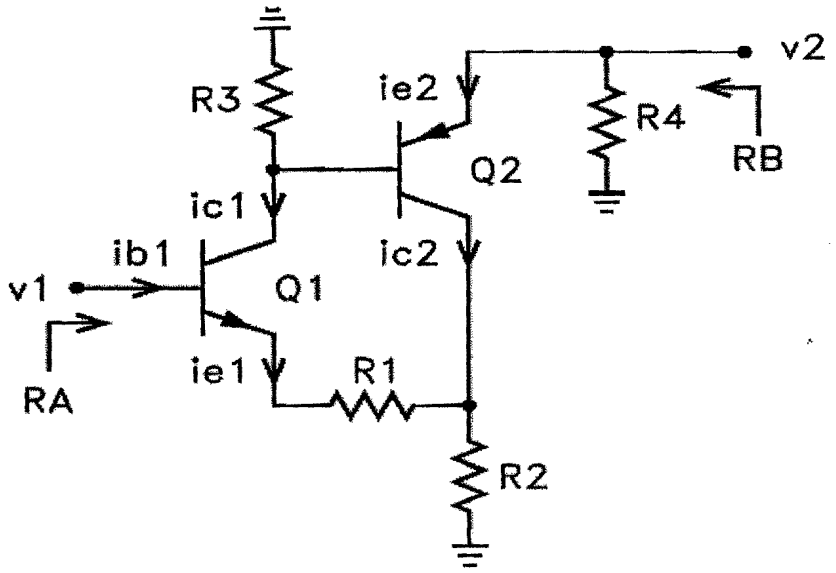

Figure 2.1

a. Redraw the circuit on ***Figure 2.1*** with the feedback path removed. [2]
NB: your diagram should be clearly labelled.

b. Calculate the:

i. Transconductance $\frac{i_{e2}}{v_1}$ [6]

ii. Voltage gain v_2/v_1 [4]

iii. Input resistance R_A [4]

iv. Output resistance R_b [4]

Question 3 [20]

a) For the circuit of ***Figure 3.1.***

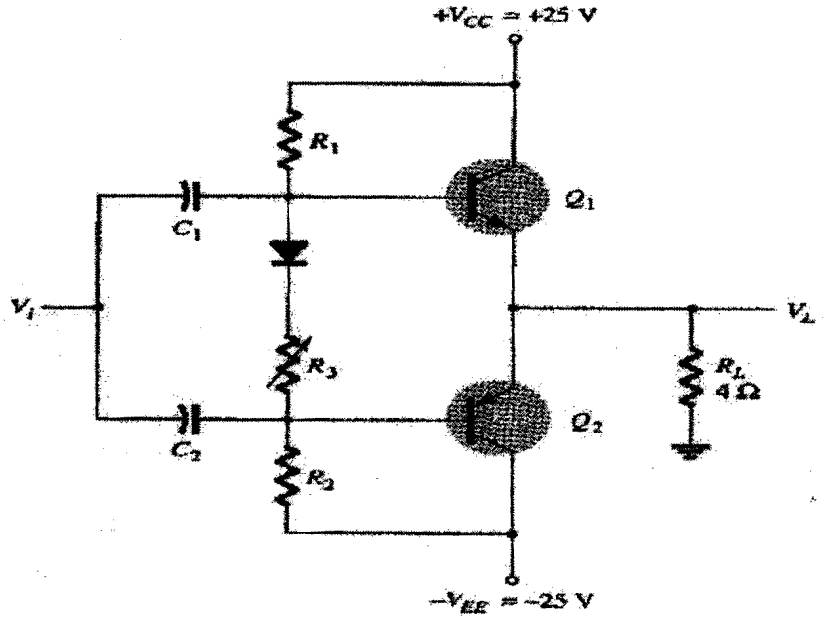

Figure 3.1

i) Calculate the:
- Output power [2]
- Input power [2]
- Power handled by each output transistor [2]
- Circuit efficiency for an input of 12 V_{rms} [1]

ii) Calculate the:
- Maximum input power [1]
- Maximum output power [1]
- Input voltage for maximum power operation [1]
- Power dissipated by the output transistors at this [1]

iii) Calculate the maximum power dissipated by the output transistors and the voltage at which this occurs [4]

b) For the Harmonic Distortion reading: $D_2 = 0.1, D_3 = 0.02, and\ D_4 = 0.01, with\ I_1 = 4\ A\ and\ R_c = 8\Omega$. Calculate the:

i) Total Harmonic Distortion [2]

ii) Fundamental power component [2]

iii) Total power [1]

Question 4 [20]

Figure 4.1 shows a series-shunt amplifier in which the three MOSFETs are sized to operate at $|V_{ov}| = 0.2\ V$. Let $|V_t| = 0.5V\ and\ |V_A| = 10\ V$. The current source utilizes single transistors and thus have output resistances equal to r_0.

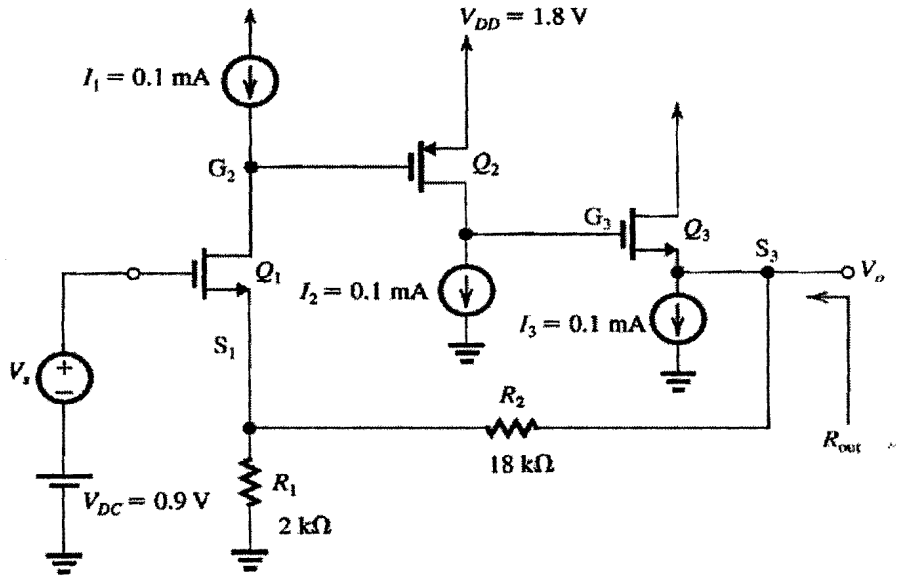

Figure 4.1

a) Assume the loop gain to be large, what do you expect the closed loop voltage $\frac{v_o}{v_s}$ to be approximately? [1]

b) If V_s has a zero dc component, find the dc voltages at nodes $S_1, G_2, S_3, and\ G_3$ [4]

c) Find the open – loop gain circuit. Calculate the gain of each of the three (3) stages and the overall voltage gain, A [15]

Question 5 [20]

a) Fill in the blank(s) with appropriate word(s) [10]

i) A MOSFET is a _____ controlled _____ carrier device.

ii) Enhancement type MOSFETs are normally _____ devices while depletion type MOSFETs are normally _____ devices.

iii) The Gate terminal of a MOSFET is isolated from the semiconductor by a thin layer of _____ .

iv) The MOSFET cell embeds a parasitic _____ in its structure.

v) The gate-source voltage at which the _____ layer in a MOSFET is formed is called the _____ voltage.

vi) The thickness of the _____ layer remains constant as gate source voltage is increased beyond the _____ voltage.

b) Determine the small-signal voltage gain, input and output resistances of a common-source amplifier. For the circuit shown in ***Figure 5.1***, the parameters are: $V_{DD} = 10V, R_1 = 70.9K\Omega, R_2 = 29{,}1K\Omega \; and \; R_D = 5K\Omega$. The transistor parameters are: $V_{TN} = 1.5V, K_n = 0.5mA/V^2, and \; \lambda = 0.01V^{-1}$. Assume $R_{si} = 4K\Omega$ and $g_m = 2k_n(V_{GSQ} - V_{TN})$

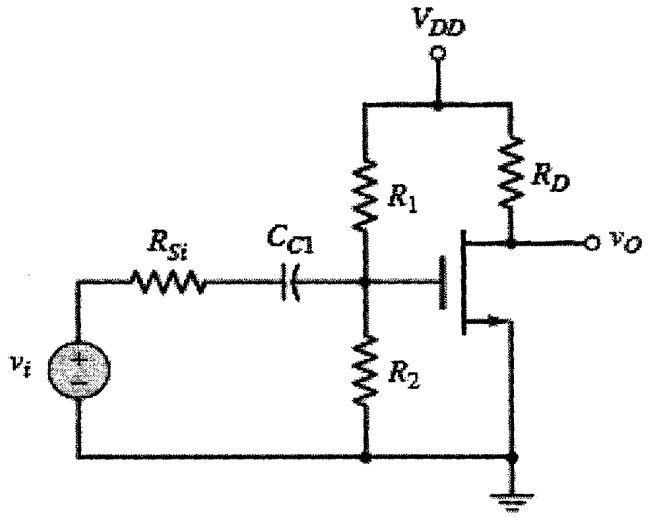

Figure 5.1