University of Swaziland
Faculty of Science and Engineering
Department of Electrical and Electronic Engineering

Main Examination 2017

Title of paper: **Analogue Design II**

Course Number: **EE323**

Time allowed: 3 hours

Instructions:

1. Answer any FOUR (4) questions
2. Each question carries 25 marks
3. Marks for each question are shown at the right hand margin

This paper contains 6 pages including this one.

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Question 1

a) Consider the *inverting integrator* circuit of an operational amplifier;
   i) Draw and label the circuit diagram [4]
   ii) Derive the expression for the time varying voltage across the capacitor. [4]
   iii) Derive the expression for the output voltage [2]

b) Find the output produced by a *Miller integrator* in response to an input pulse of 1V height and 1-ms with for $R = 10k\Omega$, $C = 1nF$. Draw the input and the resultant output waveform. [6]

c) For the op-amp differentiator circuit, derive the expression of the following
   i) The current [3]
   ii) The output voltage [3]

d) give the effects of feedback on amplifier characteristics, use *increase* and *decrease* to fill in the table below [3]

Characteristic	Type of feedback			
	Current-Series	Voltage -series	Voltage-shunt	Current -shunt
Gain				
Input Resistance				
Output Resistance				

Question 2

a) Describe how to find the current i_D of a MOSFET in terms of the charge Q per unit length and the electron drift velocity. Assume a small v_{DS} is applied to the transistor. [8]

b) For a 0.08 μm process technology for which $t_{ox} = 15nm$ and $\mu_n = 550cm^2/V.s$. Given that the transistor is operating in saturation with $I_D = 0.2mA$ with $\frac{W}{L} = 20$, Find
   i) C_{ox} [2]
   ii) k_n' [2]
   iii) V_{ov} [3]

c) Consider the circuit **Figure 2** below:

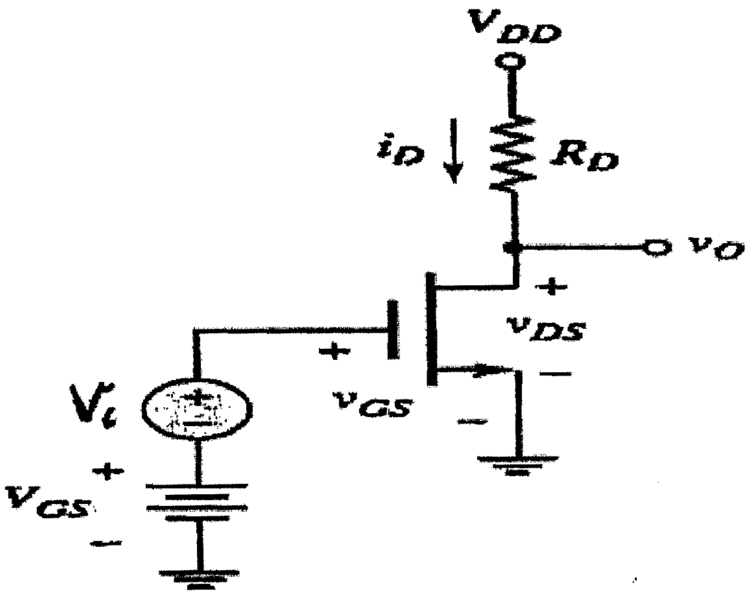

Figure 2

The transistor is specified to have $V_t = 0.4V, k_n' = 0.4mA/V^2$ $\frac{W}{L} = 10, \lambda = 0, V_{DD} = 1.8V, R_D = 17.5k\Omega$ and $V_{GS} = 0.6V$. For $v_{gs} = 0$ $(v_{ds} = 0)$, find

i) V_{OV} [2]
ii) I_D [3]
iii) V_{DS} [2]
iv) A_v [3]

Question 3

a) State four properties of feedback [4]
b) State the four feedback topologies [4]

c) Consider the circuit **Figure 3 a)** below

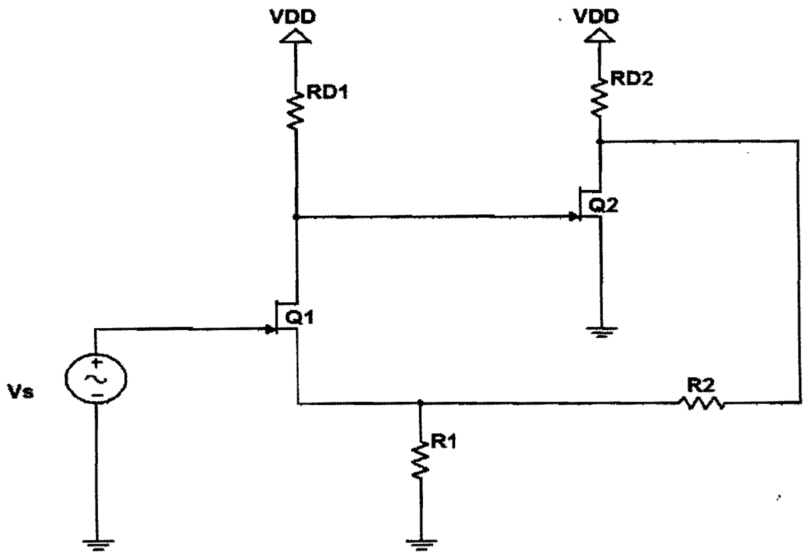

Figure 3 a)

i) Draw the A circuit [3]

ii) Draw the β circuit [3]

iii) Find

a) The gain $A_f = \frac{V_O}{V_S}$ [4]

b) The output resistance R_{out} [3]

d) **Figure 3b)** shows an op amp circuit with voltage series through R_1 and R_2 . The open loop gain of the op - amp is $A = 10^4$ and input impedance is $100k\Omega$. Find the *gain* and *input impedance* of the amplifier with feedback [4]

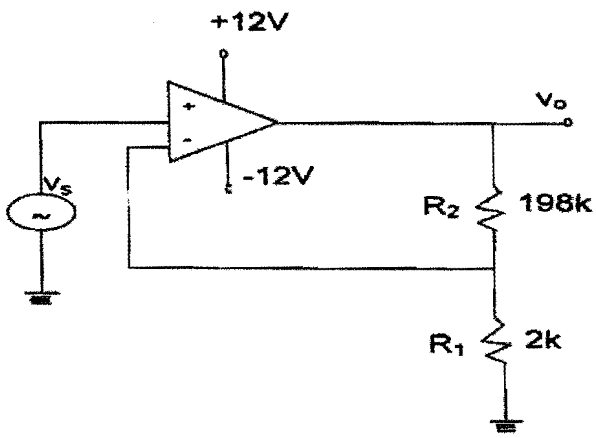

Figure 3 b)

Question 4

a) Consider the circuit below **Figure 4 a)**, $V_{CC} = 10\ V, I = 100mA, R_L = 100\Omega$ and the output voltage is $8V - peak$ sinusoid. Find

i) The power delivered to the load [2]

ii) The average power drawn from the supplies [2]

iii) The power conversion efficiency [2]

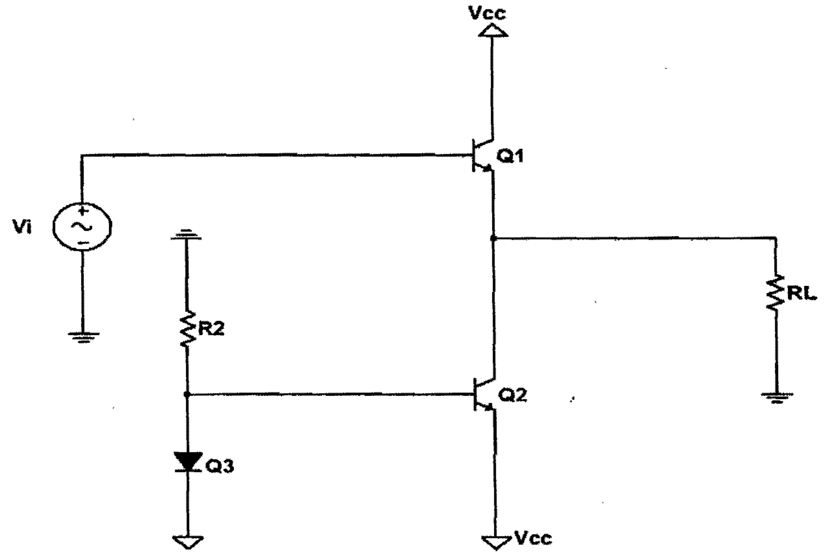

Figure 4 a)

b) For the class B output stage amplifier show that the power conversion efficiency η is approximately 78% [7]

c) For the circuit below **Figure 4 b)**, find

i) The open loop gain $A_v = \frac{V_o}{V_i}$ [5]

ii) The feedback factor β [4]

iii) The overall gain $A_f = \frac{V_o}{V_s}$ [3]

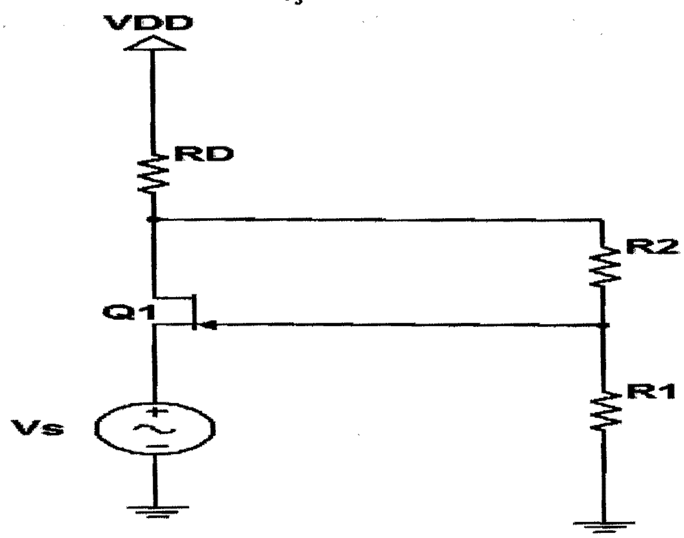

Figure 4 b)

Question 5

a) Consider the Common-source amplifier circuit, **Figure 5** below.
Find

i) The input resistance R_{in} [2]

ii) The voltage gain G_V [5]

iii) The output resistance R_{out} [3]

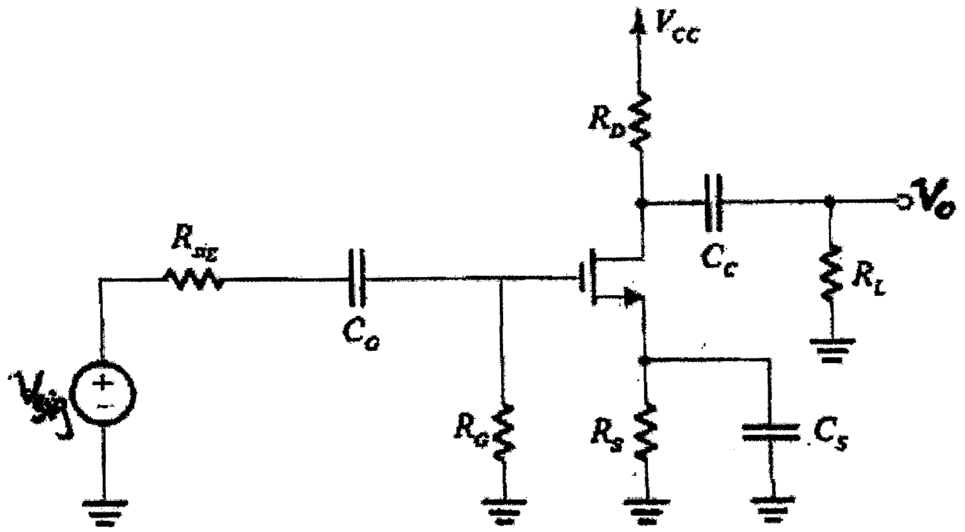

Figure 5

b) Design a **Wien-bridge oscillator** using op-amp to generate a sinusoidal waveform of frequency **1 KHz.** [8]

c) List three advantages of a crystal Oscillator [3]

d) A crystal has these values: $L = 3H, C_s = 0.05pF, R = 2k\Omega,$ and $C_p = 10pF$. Calculate the f_s and f_p of the crystal. [4]