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

Main Examination – December 2019

Title of paper: **Analogue Electronics I**

Course Number: **EEE321**

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 5 pages including this one.

This paper should not be opened until permission has been granted by the invigilator.

Question 1

a) A transistor is usually used as a *voltage-controlled current source*. Assume it is biased to operate in *active mode*, with an aid of a diagram, describe how the currents i_C, i_B and i_E are created within the transistor in terms of holes and electrons. Give the equations for these currents [10]

b) One challenge encountered in biasing a transistor is that of establishing a constant current dc current. Draw the circuit diagram for the *classical method using a single power supply* and find the expression of the current I_E [8]

c) Draw the voltage transfer characteristics (VTC) of a MOSFET transistor and explain how the value of v_{GS} in relation to V_t affects the changes in the modes of operation of the transistor. Write the values of V_{DS} and i_D in the saturation region. [7]

Question 2

a) For a full wave rectifier

i) Find the mean value of the load current and the load voltage [4]

ii) Show that its efficiency is 0.81 [6]

b) Given the circuit shown in **Figure 2** below,

i) Draw the small signal equivalent circuit [5]

ii) Find R_{in} [6]

iii) Show that it has a gain of unity hence the name "Emitter follower" [4]

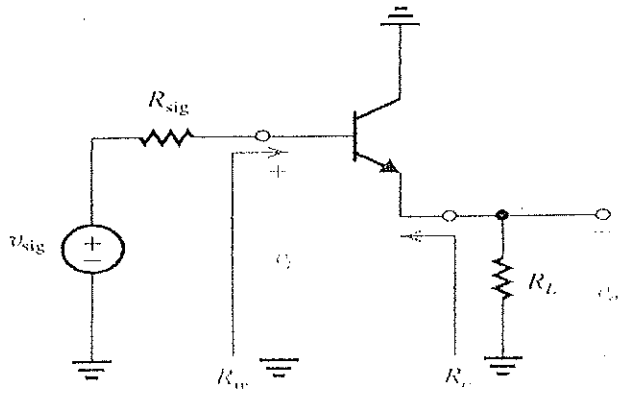

Figure 2

Question 3

a) Based on **Figure 3 a)**

i) Draw and label correctly the *Hybrid-π small-signal* model of the circuit [4]

ii) Given that $I_C = 5mA$, $\beta = 50$ and $V_T = 25mV$ calculate the parameters g_m *and* r_π [4]

iii) Find the *small-signal* voltage gain $A_v = \frac{V_{out}}{V_{in}}$; R_{in} and R_o in the circuit below, given that $R_C = 3k\Omega$ and $V_A = 10\,V$.
[5]

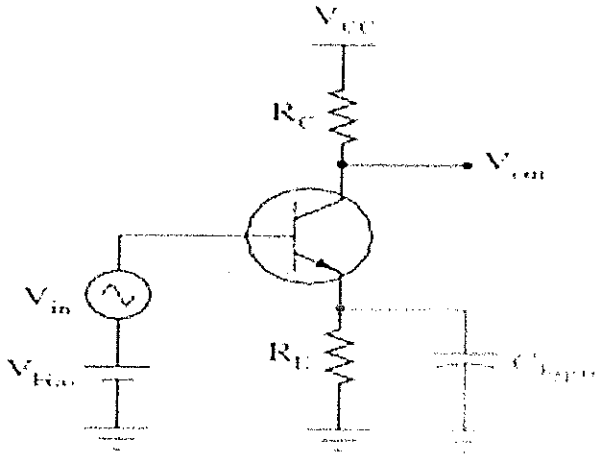

Figure 3 a)

b) Consider the Common-Source amplifier circuit, **Figure 3 b)** below. Find the following

i) The input resistance R_{in} [1]

ii) The voltage gain $G_V = \frac{v_o}{v_{sig}}$ [5]

iii) The output resistance R_{out} [2]

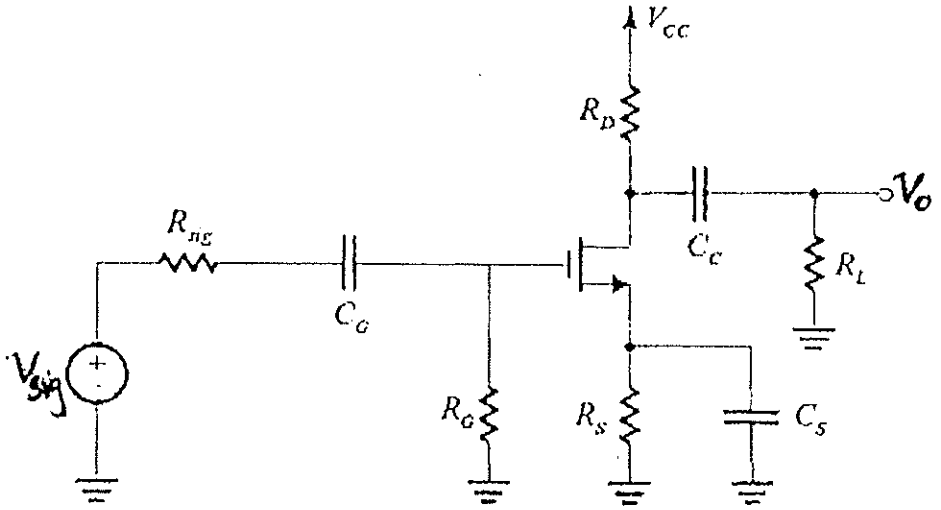

Figure 3 b)

c) List and describe two elements of a regulator [4]

Question 4

a) For the op-amp inverting integrator circuit,

i) Draw and label the circuit diagram. [3]

ii) Determine the voltage across the capacitor. [4]

iii) Determine output voltage. [2]

b) Given the half wave rectifier, **Figure 4**, below

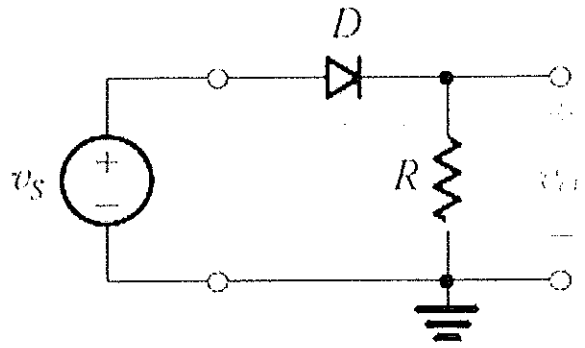

Figure 4

i) Find the RMS value of the load voltage [4]

ii) Find the RMS value of the load current [4]

iii) Given that the current $i(t) = 5\sin(2\pi 100t)$ and the voltage is $v_0 = 10\sin(2\pi 300t)$ find the values of the RMS voltage and RMS current above. [4]

iv) Show that the efficiency of the rectifier above $\eta = 0.405$ [4]

Question 5

a) In the circuit **Figure 5 a)** below

i) Identify the type of regulator. [2]

ii) Identify the four elements that make up a regulator. [4]

iii) Find the output voltage. [3]

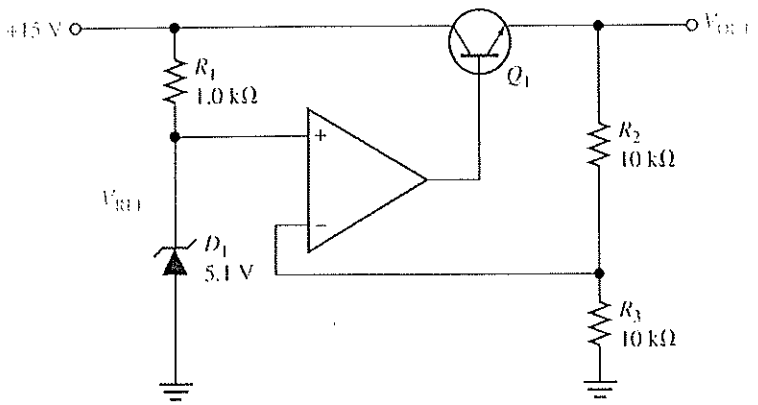

Figure5 a)

b) Describe the operation of a shunt regulator [6]

c) Given the circuit shown in **Figure 3 (b)** below, $R_1 = 100k\Omega$, $R_2 = 50\ k\Omega$, $R_C = 5k\Omega, R_E = 3k\Omega$, $\beta = 100, V_{BE} = 0.7V$

i) Calculate the following DC parameters $V_{BB}, I_B, I_E, I_C, V_C$. [7]

ii) Draw the resultant circuit, and label all the parameters correctly . [3]

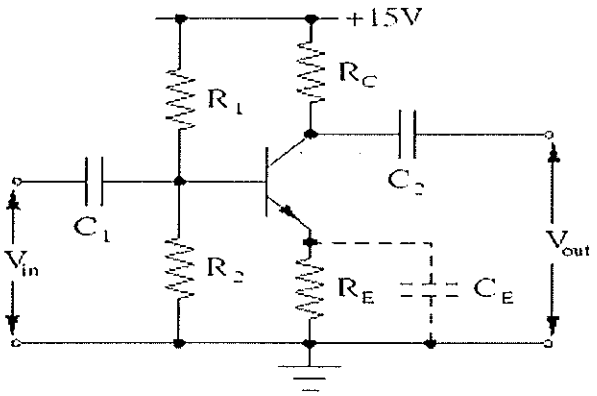

Figure 5 b)