UNIVERSITY OF ESWATINI

SUPPLIMENTERY EXAMINATION, FIRST SEMESTER

JANUARY 2019

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

TITLE OF PAPER:	ANALOGUE ELECTRONICS II
COURSE CODE:	EEE421
TIME ALLOWED:	THREE HOURS

INSTRUCTIONS:

1. There are four questions in this paper. Answer all questions. Each question carries 25 marks.
2. If you think not enough data has been given in any question you may assume any reasonable values.
3. Some useful formulas are given in the last page.

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

THIS PAPER CONTAINS SEVEN (6) PAGES INCLUDING THIS PAGE

QUESTION ONE *(25 marks)*

A differential amplifier circuit is shown in Figure-Q1. Assume that the $V_{BE} = 0.6V$ and the transistors are matched with $\beta = 100$.

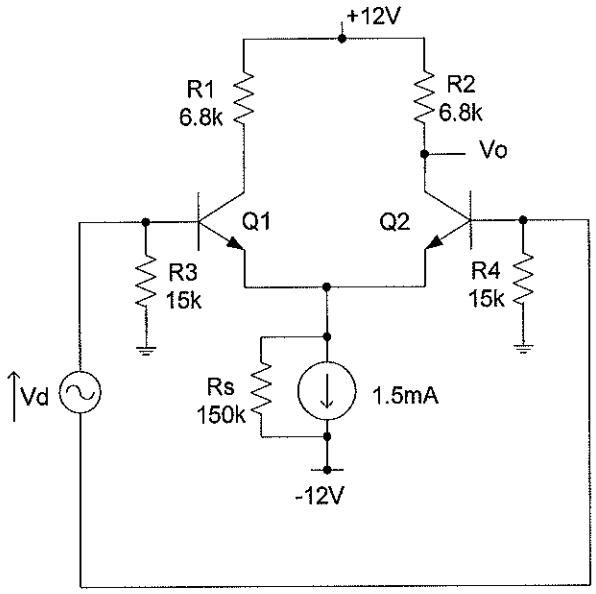

Figure-Q1

(a) Find the following under the quiescent conditions.

(i) Collector voltage of Q_2.

(ii) Base voltage of Q_1 and Q_2.

(6 marks)

(b) Draw the differential half circuit for ac signals and calculate the differential voltage gain $\frac{v_o}{v_d}$ deriving any formula you use.

(7 marks)

(c) Draw the common mode half circuit for ac signals and find the common mode gain at the output v_o. Hence calculate the CMRR in dB. Derive any formula you use.

(7 marks)

(d) Find the differential input resistance and the differential output resistance.

(5 marks)

QUESTION TWO *(25 marks)*

(a) A Widlar current source is shown in Figure-Q2(a). The transistors Q_1 and Q_2 are matched and of high gain type.

(i) Find a relationship between I_o, R, R_S and V_{CC}.

(6 marks)

(ii) Design this current source for $I_o = 125\mu A$, when $V_{CC} = 12V$. Assume that for the transistors, when $V_{BE} = 0.6V$, the $I_C = 0.8mA$.

(5 marks)

(iii) What is the output resistance R_o, if the $V_A = 80V$ and the $\beta = 100$?

(2 marks)

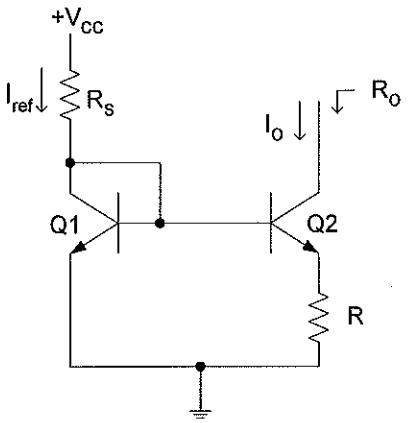

Figure-Q2(a)

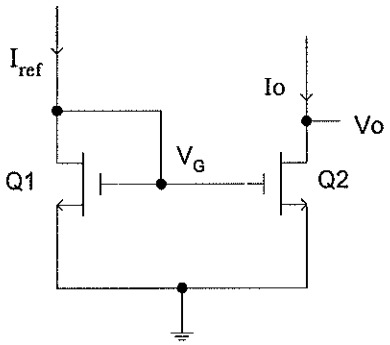

Figure-Q2(b)

(b) Consider the current mirror shown in Figure-Q2(b). Some of the process parameters of the devices are given below.

$L_1 = L_2 = 5\mu m$ $W_1 = 20\mu m$ $W_2 = 70\mu m$ $V_t = 2V$

$\mu C_{ox} = 50\frac{\mu A}{V^2}$ $V_A = 80V$

(i) Find the value of V_G for an output current of $I_{ref} = 150\mu A$.

(4 marks)

(ii) Calculate the value of I_o, for the I_{ref} given in (i) above.

(4 marks)

(iii) When $V_o = 15V$, estimate the output current I_o for the value of I_{ref} in (i) above.

(4 marks)

QUESTION THREE *(25 marks)*

A circuit of a cascode BJT amplifier is shown in Figure-Q3.

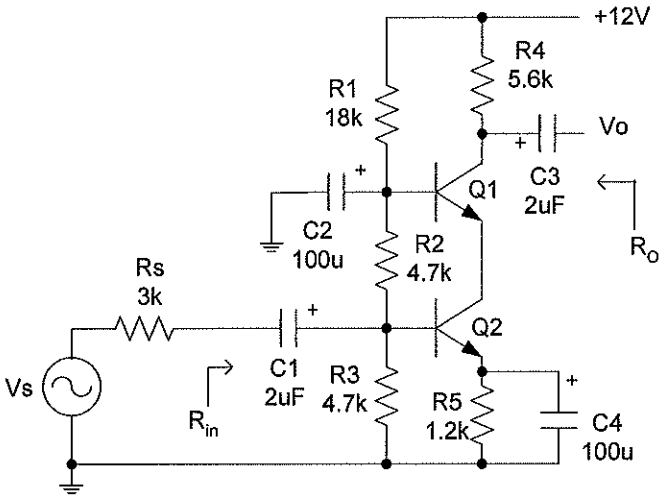

Figure-Q3

(i) Find the quiescent collector currents. Hence find the collector and emitter voltages of each transistor assuming that the transistors are of high gain.

(10 marks)

(ii) Find an expression for the mid-band gain $\frac{v_o}{v_s}$, and calculate its value. Neglect the effect of r_o and assume that the $\beta = 100$.

(10 marks)

(iii) Estimate the values of R_{in} and R_o.

(5 marks)

QUESTION FOUR ***(25 marks)***

(a) An oscillator circuit is shown in Figure-Q4(a). You may assume usual notation.

(i) Write an expression for the forward gain A.

(3 marks)

(ii) Derive and expression for β and simplify $A\beta$.

(6 marks)

(iv) Find component values for a frequency of oscillation of $25KHz$. Assume that the $C = 1nF$.

(6 marks)

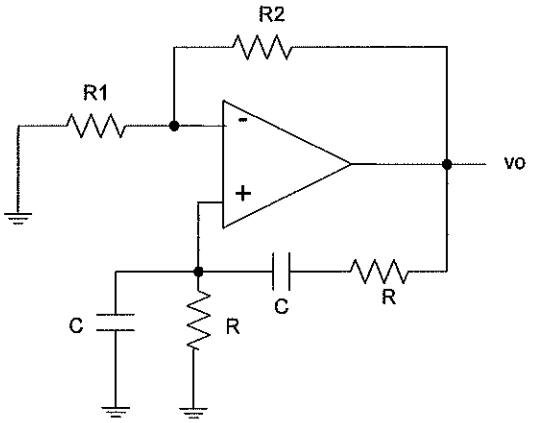

Figure -Q4(a)

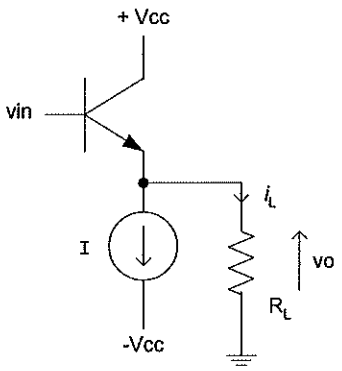

Figure -Q4(b)

(b) Consider the Class A power amplifier shown in Figure-Q4(b).

(i) Derive an expression for the conversion efficiency and find its maximum value.

(6 marks)

(ii) Assume that the $V_{CC} = 12V$, $I = 100mA$, $R_L = 100\Omega$ and the peak value of the output signal is $10V$. Calculate the power delivered to the load and the conversion efficiency.

(4 marks).

1. SOME USEFUL MOSFET EQUATIONS

$i_D = \mu_n C_{ox} \frac{W}{L} \left[(v_{GS} - v_t) v_{DS} - \frac{1}{2} v_{DS}^2 \right]$ in triode region

$i_D = \frac{1}{2} \mu_n C_{ox} \frac{W}{L} (v_{GS} - v_t)^2$ in saturation region

$i_D = \frac{1}{2} \mu_n C_{ox} \frac{W}{L} (v_{GS} - v_t)^2 (1 + \lambda v_{DS})$ in saturation region with Channel Modulation effect

$V_A = \frac{1}{\lambda}$

2. Unless otherwise stated $V_{BE(ON)} = 0.6V$ and $V_T = 0.025V$.