UNVERSITY OF SWAZILAND

MAIN EXAMINATION – SEMESTER I NOV/DEC 2010

FACULTY OF SCIENCE

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

TITLE OF THE PAPER: ANALOGUE DESIGN I

COURSE CODE: EE321

TIME ALLOWED: 3 HOURS

INSTRUCTIONS:

1. **THERE ARE FIVE QUESTIONS IN THIS PAPER. ANWSER ANY FOUR OF THEM. EACH QUESTION CARRIES 25 MARKS**
2. **IF YOU THINK NOT ENOUGH DATA HAS BEEN GIVEN IN THE QUESTION YOU MAY ASSUME ANY REASONABLE VALUES.**

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

THIS PAPER CONTAINS SIX PAGES INCLUDING THIS PAGE.

Question 1

Using the circuit below, determine the following parameters. Taking $V_{BE} = 0.7V$.

(a)

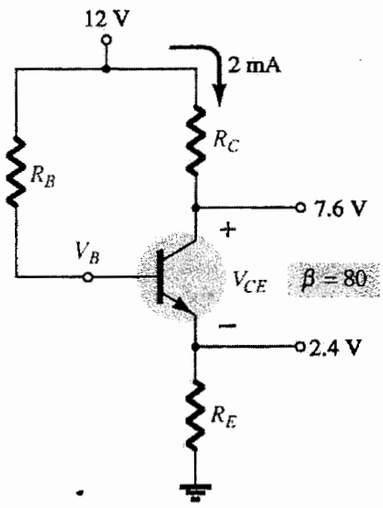
(i) R_C (3 marks)

(ii) R_E (3 marks)

(iii) R_B (5 marks)

(iv) V_{CE} (2 marks)

(v) V_B (2 marks)



(b) Design an emitter-biased network at $I_{C_Q} = \frac{1}{2} I_{C_{sat}}$ and $V_{CE_Q} = \frac{1}{2} V_{CC}$. Use $V_{CC} = 20V$, $I_{C_{sat}} = 10mA$, $\beta = 120$, and $R_C = 4R_E$.

(10 marks)

Question 2

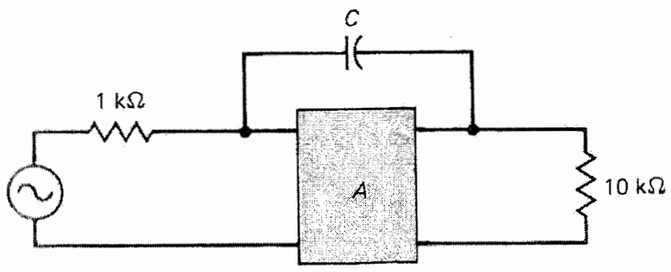
(a) An amplifier has an input power of 2 mW and an output power of 345 mW. What is its decibel power gain? (2 marks)

(b) Define f_T. (2 marks)

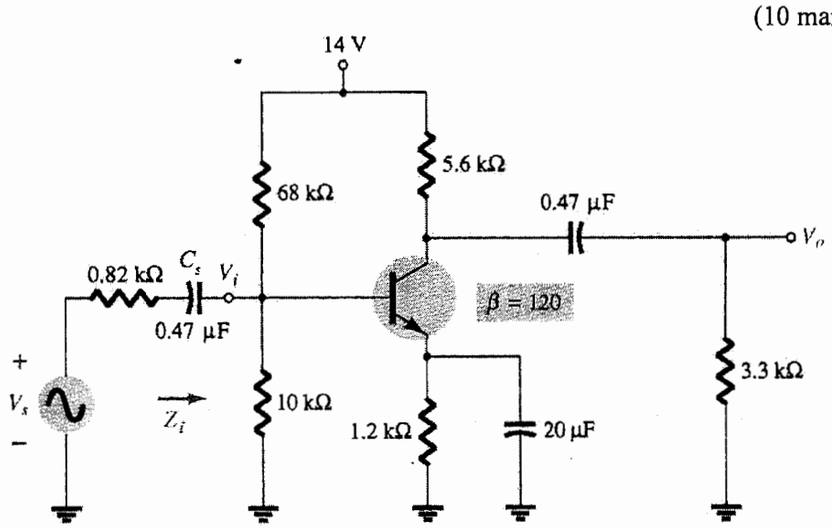
(c) A transistor has $f_T = 250MHz$. What is the value of C_π for $I_E = 10mA$ and $V_T = 26mV$? (3 marks)

(d) Define critical frequency. (2 marks)

(e) The input Miller capacitance in the figure below creates a bypass circuit on the input side. If $A = 300$ and $C = 10pF$, what is the critical frequency of this bypass circuit? (5 marks)



(f) For the network below, determine f_{L_s}, i.e. low frequency response due to the input coupling capacitor, C_s. $V_T = 26mV$ and $V_{BE} = 0.7V$. (10 marks)



(g) The two critical frequencies of an amplifier are $f_1 = 127Hz$ and $f_2 = 2.45MHz$. What is the amplifier's bandwidth? (1 mark)

Question 3

For the circuit below, taking $V_{BE} = 0.7V$ and $V_T = 26mV$. Note: $r_\pi = \beta r_e$ and $g_m = \frac{1}{r_e}$

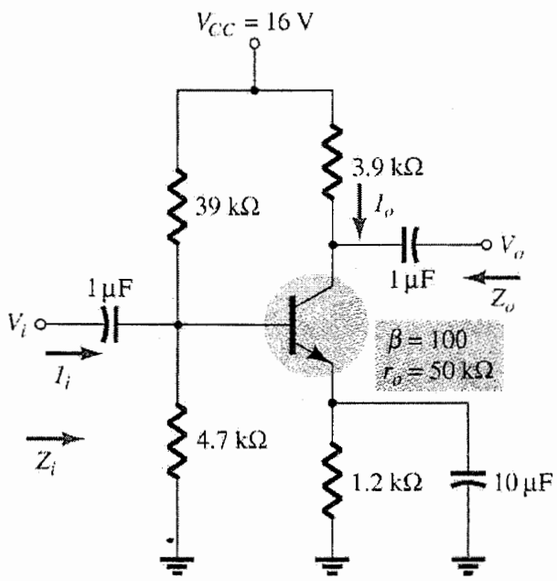
(a) Draw the small signal hybrid π model. (5 marks)

(b) Determine r_e. (5 marks)

(c) Calculate Z_i. (5 marks)

(d) Calculate Z_o. (5 marks)

(e) Calculate A_v. (5 marks)



Question 4

(a) A basic tuned common-emitter amplifier has a capacitor of $1nF$ and an inductor of $0.47\mu H$. Calculate the resonant frequency for this amplifier.

(2 marks)

(b) A 22Ω series resistor is then added to the resonant circuit. Calculate the Q factor.

(2 marks)

(c) Consider the circuit below:

(i) What circuit configuration is this, common-emitter or common-collector or common-base? (1 mark)

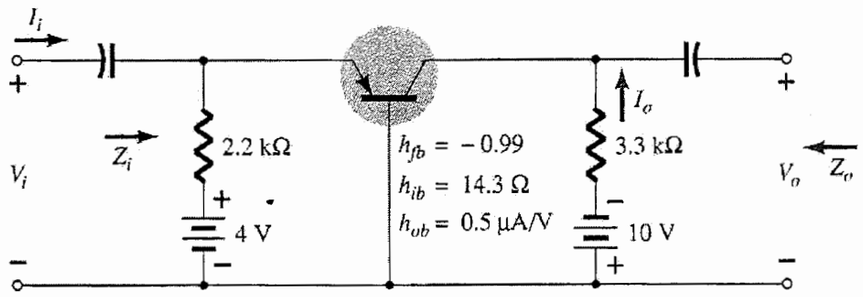
(ii) Draw the small signal hybrid model. (4 marks)

(iii) Calculate Z_i (4 marks)

(iv) Calculate Z_o (4 marks)

(v) Calculate A_v (4 marks)

(vi) Calculate A_i (4 marks)



Question 5

(a) Differentiate between an ideal and non-ideal op amp. (4 marks)

(b) Draw any non-linear op amp amplifier circuit. (4 marks)

(c) Determine the output voltage of an op amp for input voltages of $V_{i_1} = 150\mu V$ and $V_{i_2} = 140\mu V$. The amplifier has a differential gain of $A_d = 4000$ and the value of CMRR is:

(i) 100 (4 marks)
(ii) 10^5 (4 marks)

(d) Derive an expression for the voltage gain, A_v for a simple integrator op amp. (5 marks)

(e) Define op amp compensation. (2 marks)

(f) Define slew rate. (2 marks)