Name:
Student ID Number:
Section Number: 01/02/03/04 A/B
Lecturer: Dr Jamaludin/Dr Azni Wati/Dr Jehana Ermy/Prof Md Zaini
Table Number:

UNIVERSITI TENAGA NASIONAL
The National Energy University

College of Engineering
Department of Electronics and Communication Engineering

Test 1

SEMESTER 2, ACADEMIC YEAR 2017/2018

Subject Code	:	**EEEB273**
Course Title	:	**Electronics Analysis & Design II**
Date	:	**18 November 2017**
Time Allowed	:	**2 hours**

Instructions to the candidates:

1. Write your Name and Student ID Number. Indicate your Section Number and Lecturerôs Name. Write also your Table Number.
2. **Write all your answers using pen**. **DO NOT USE PENCIL** except for the diagram.
3. **ANSWER ALL QUESTIONS. Show clearly** all your calculations. Every value **must** be written with its correct Unit.
4. **WRITE YOUR ANSWER ON THIS QUESTION PAPER.**

NOTE: DO NOT OPEN THE QUESTION PAPER UNTIL INSTRUCTED TO DO SO.

☺ **GOOD LUCK!** ☺

Question Number	Q1(a)	Q1(b)	Q2	Q3(a)	Q3(b)	Q4	Total
Marks							

QUESTION 1 [35 marks]

(a) (i) **Draw** the ***npn*** BJT Wilson and Cascode current sources with clear details of the transistors $\boldsymbol{Q_n}$ placements. **[10 marks]**

(ii) **Clearly explain and compare** the current sources in **part a(i)** in terms of their output current (I_O) stability. **[5 marks]**

(b) (i) **Figure 1** shows a BJT **three-transistor** current source. **Derive** the expression of $\boldsymbol{I_O}$ in terms of $\boldsymbol{I_{REF}}$, β and β_3. **[10 marks]**

(ii) For V^+ **= 10** V and V^- **= 0 V**, **design** the circuit such that $\boldsymbol{I_O}$ **= 0.7 mA**. The transistors parameters are: $\beta = \beta_3 = 80$, $V_{BE}(on) = 0.7$ V and $V_A = \infty$. **[10 marks]**

Answers for Question 1

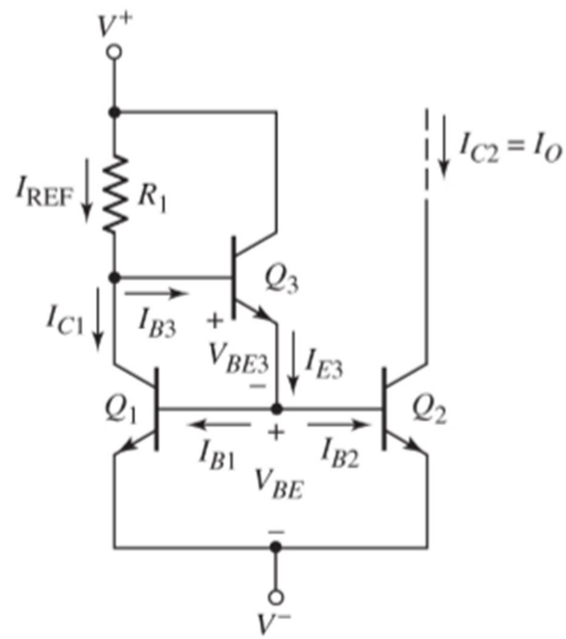

Figure 1

Answers for Question 1 (Continued)

<u>QUESTION 2 [20 marks]</u>

The circuit in **Figure 2** has the following parameters:

V^+ **= 1.8 V** and V^- **= −1.8 V.**

V_{TN} **= 0.5 V**, k'_n **= 80** μ**A/V**^{2}, and λ **= 0**.

Design the circuit such that I_O **= 0.15 mA,** I_{REF} **= 0.5 mA** and transistor M_2 remains biased in the saturation region for $V_{DS2} \geq$ **1 V**. **[20 marks]**

<u>Answers for Question 2</u>

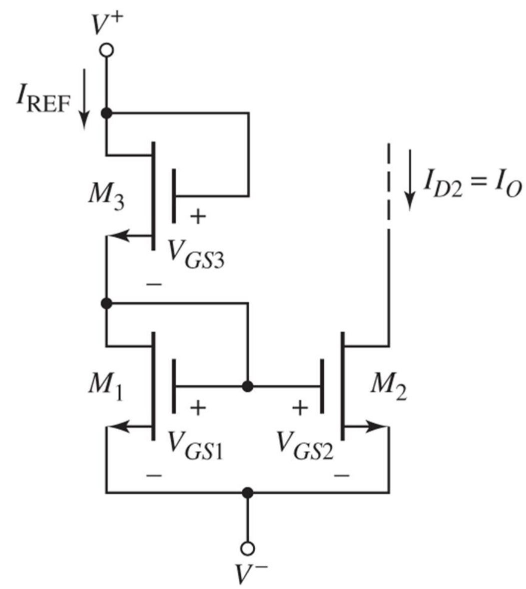

Figure 2

Answers for Question 2 (Continued)

QUESTION 3 [25 marks]

(a) The differential amplifier in **Figure 3** is biased with a three-transistor current source as shown. The transistor parameters are: $\boldsymbol{\beta = 40}$, $\boldsymbol{V_{BE}(on) = 0.6}$ **V, and** $\boldsymbol{V_{A4} = V_{A5} = \infty}$. **Determine** $\boldsymbol{R_1}$ if $\boldsymbol{V_{CE4} = 1.8}$ **V**. **[20 marks]**

(b) **Redesign** the differential amplifier circuit of **Figure 3** if a **Widlar current source** is used as biasing circuit **instead**. **Draw** the complete differential amplifier circuit. **[5 marks]**

Answers for Question 3

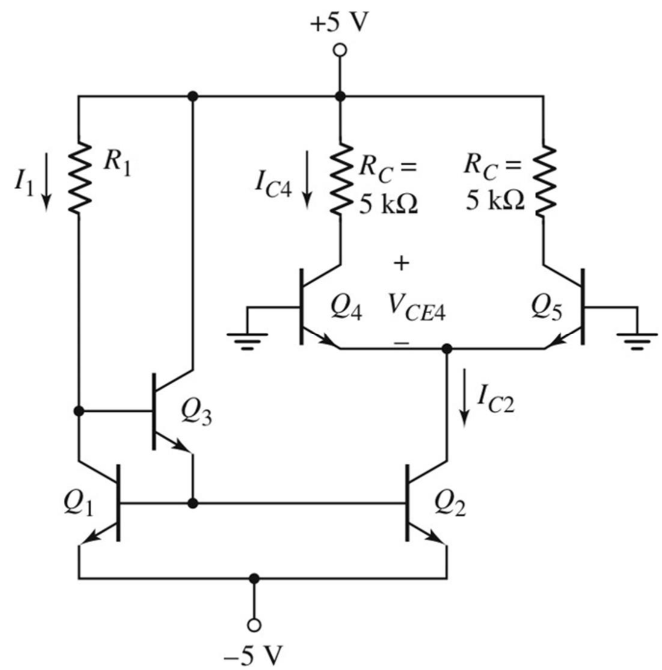

Figure 3

Answers for Question 3 (Continued)

QUESTION 4 [20 marks]

Figure 4 has the transistor parameters of β **= 120**, V_{BE}**(on) = 0.7 V**, $V_A = \infty$ for Q_1 and Q_2, and V_A = **100 V** for Q_3 and Q_4. Given that I_Q **= 4 mA**.

(a) **Determine** the differential-mode input resistance (R_{id}) of the differential amplifier.

[6 marks]

(b) **Determine** the differential-mode voltage gain (A_d) of the differential amplifier. Output is **one-sided** taken at collector of Q_2. **[6 marks]**

(c) **Determine** the output of the differential amplifier (v_O) if the inputs are v_1 **= 1.25 sin** ωt **mV** and v_2 **= 0.9 sin** ωt **mV**. Given that A_{cm} **= -0.09912.** **[8 marks]**

Answers for Question 4

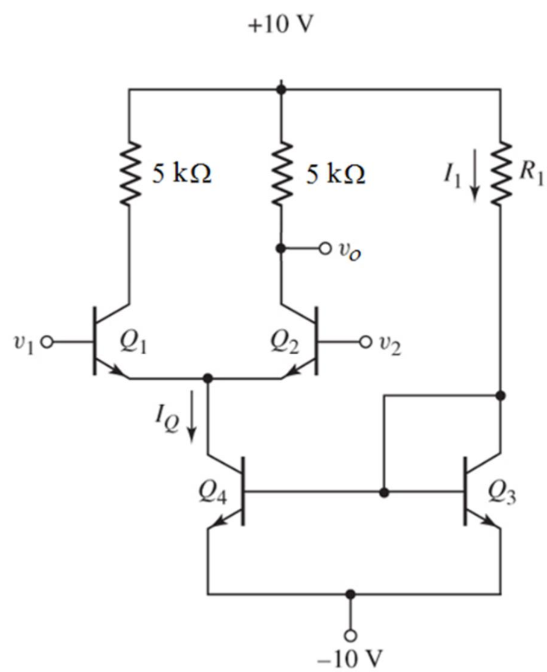

Figure 4

Answers for Question 4 (Continued)

BASIC FORMULA FOR TRANSISTOR

BJT

$$i_C = I_S e^{v_{BE}/V_T} \text{ ;npn}$$

$$i_C = I_S e^{v_{EB}/V_T} \text{ ;pnp}$$

$$i_C = \alpha i_E = \beta i_B$$

$$i_E = i_B + i_C$$

$$\alpha = \frac{\beta}{\beta + 1}$$

;Small signal

$$\beta = g_m r_\pi$$

$$g_m = \frac{I_{CQ}}{V_T}$$

$$r_\pi = \frac{\beta V_T}{I_{CQ}}$$

$$r_o = \frac{V_A}{I_{CQ}}$$

$$V_T = 26 \text{ mV}$$

MOSFET

;N – MOSFET

$$v_{DS}(\text{sat}) = v_{GS} - V_{TN}$$

$$i_D = K_n [v_{GS} - V_{TN}]^2$$

$$K_n = \frac{k_n'}{2} \cdot \frac{W}{L}$$

;P – MOSFET

$$v_{SD}(\text{sat}) = v_{SG} + V_{TP}$$

$$i_D = K_p [v_{SG} + V_{TP}]^2$$

$$K_p = \frac{k_p'}{2} \cdot \frac{W}{L}$$

;Small signal

$$g_m = 2\sqrt{K_n I_{DQ}} \quad \text{;N - MOSFET}$$

$$g_m = 2\sqrt{K_p I_{DQ}} \quad \text{;P - MOSFET}$$

$$r_o \cong \frac{1}{\lambda I_{DQ}}$$

Quadratic formula :

$$Ax^2 + Bx + C = 0 \quad \rightarrow \quad x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$$