Name:

Student ID Number:

Section:

Lecturer: Dr Azni Wati/ Dr Jehana Ermy/ Dr Jamaludin

Table Number:

UNIVERSITI TENAGA NASIONAL

College of Engineering

Department of Electronics and Communication Engineering

Test 2

SEMESTER 2, ACADEMIC YEAR 2015/2016

Subject Code	:	**EEEB273**
Course Title	:	**Electronics Analysis & Design II**
Date	:	**9 January 2016**
Time Allowed	:	**1 hour 45 minutes**

Instructions to the candidates:

1. Write your Name and Student ID number. Circle Lecturer for your section.
2. Write all your answers using pen. **DO NOT USE PENCIL** except for the diagram.
3. **ANSWER ALL QUESTIONS.**
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	Q2	Q3	Total
Marks				

Question 1 **[40 marks]**

Figure 1 shows a **MOSFET** differential amplifier with active load circuit biased with constant current source I_Q. It is given that $V^+ = 10$ **V**, $V^- = -10$ **V**, and $I_Q = 0.23$ **mA**.

Also, the **NMOS** transistor parameters are: $V_{TN} = 1$ **V**, $k'_n = 100\ \mu A/V^2$ **and** $\lambda_n = 0.015\ V^{-1}$, and the **PMOS** transistor parameters are: $V_{TP} = -1$ **V**, $k'_p = 80\ \mu A/V^2$ **and** $\lambda_p = 0.01\ V^{-1}$. Given that the transistorsô aspect ratios $(W/L)_{1-2} = 5$ and $(W/L)_{3-6} = 10$.

(a) **State** the function of each transistor M_1 to M_6 in the **Figure 1**. [6 marks]

(b) **Determine** the maximum **common-mode voltage input,** v_{cm}**(max),** that can be applied such that the transistors are **still biased in saturation region**. [8 marks]

(c) **Draw the ac equivalent circuit** for the differential-mode input ($v_1 = +v_d/2$ and $v_2 =$ ï $v_d/2$). **Indicate** the resultant ac currents in all transistors. [6 marks]

(d) **Determine** the output resistance Ro in the **Figure 1**. [8 marks]

(e) **Calculate** the differential-mode voltage gain (A_d) of the diff-amp. [8 marks]

(f) **Comment** how the output resistance of the diff-amp can be changed. [4 marks]

Answers for Question 1

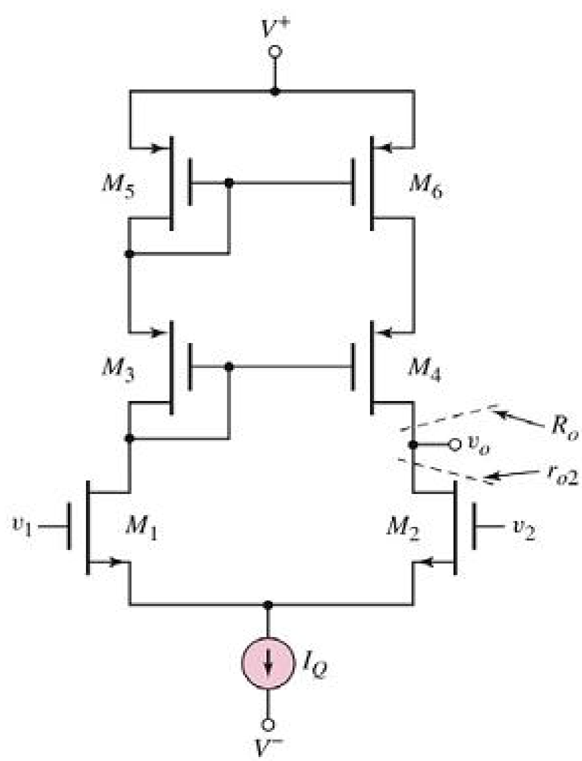

Figure 1

Answer for Question 1 (Cont.)

Answer for Question 1 (Cont.)

Answers:

Question 2 **[30 marks]**

The circuit in **Figure 2** shows a **Darlington** pair emitter-follower configuration. Assume β **= 120** for all **NPN** transistors and β **= 90** for all **PNP** transistors. Let V_{A7} **= 60 V for** Q_7, V_{A11} **= 120 V for** Q_{11}, and $V_A = \infty$ **for all other transistors.**

Given that $R_3 = 200\ \Omega$, $R_4 = 5\ k\Omega$, $I_{C7} = I_{C11} = 0.25$ mA, and $I_{C8} = 1$ mA.

(a) **Calculate** the value of R_i of the circuit in the **Figure 2.** [10 marks]

(b) **Find** the value of R_O of the circuit in the **Figure 2.** [20 marks]

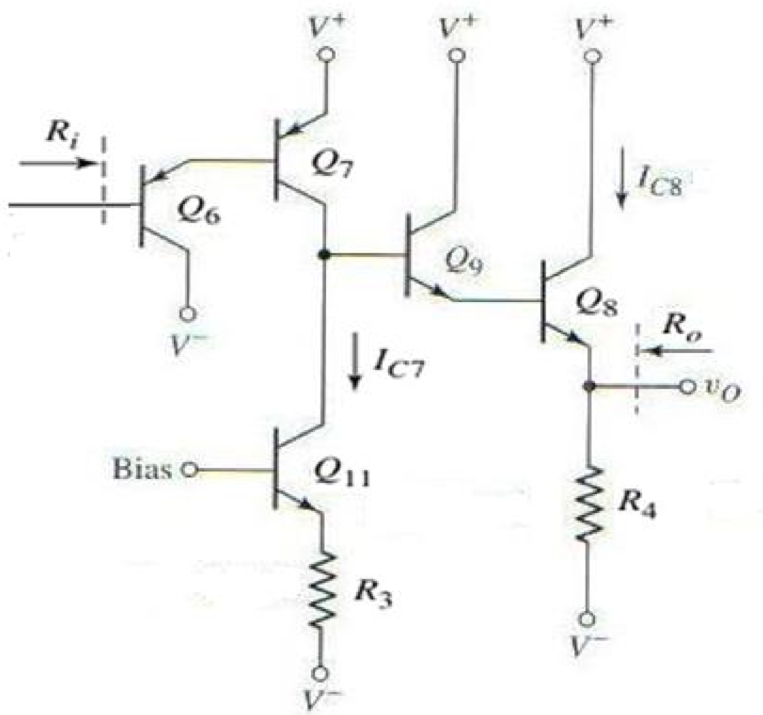

Figure 2

Answer for Question 2

Answer for Question 2 (Cont.)

Question 3 **[30 marks]**

Figure 3 shows a simplified **class-AB** output stage with BJTs. The circuit parameters are V_{CC} **= 5 Volts** and R_L **= 1 kΩ**. The saturation current is $I_S = 2 \times 10^{-15}$ **A.**

(a) When $v_I = 0$, **calculate** the value for V_{BB} that gives $i_{Cn} = i_{Cp} = 1$ **mA**. [6 marks]

(b) **Find** the power dissipated in transistors Q_n and Q_p when $v_I = 0$. [3 marks]

(c) **Determine** i_L, i_{Cn}, i_{Cp}, and v_I if $v_O = -3.5$ **V**. [12 marks]

(d) Based on answers in **part (c)**, **calculate** the power dissipated in Q_n, Q_p, and R_L.
[9 marks]

Answer for Question 3

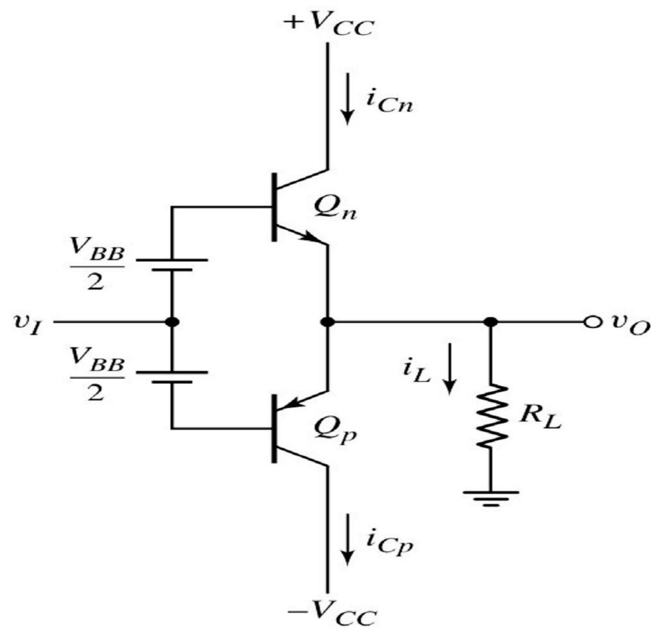

Figure 3

Answer for Question 3 (Cont.)

BASIC FORMULA FOR TRANSISTOR

BJT

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

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

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

$$i_E = i_B + i_C$$

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

$$;\text{Small signal}$$

$$\beta = g_m r_\pi$$

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

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

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

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

MOSFET

$$;\text{N}-\text{MOSFET}$$

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

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

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

$$;\text{P}-\text{MOSFET}$$

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

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

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

$$;\text{Small signal}$$

$$g_m = 2\sqrt{K_? I_{DQ}}$$

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