

SULIT

UNIVERSITI MALAYSIA PERLIS

Peperiksaan Semester Pertama
Sidang Akademik 2015/2016

Oktober 2015

DMT 231 – Analogue Electronics
[Elektronik Analog]

Masa : 3 jam

Please make sure that this question paper has **SEVENTEEN (17)** printed pages including this front page before you start the examination.

*[Sila pastikan kertas soalan ini mengandungi **TUJUH BELAS (17)** muka surat yang bercetak termasuk muka hadapan sebelum anda memulakan peperiksaan ini.]*

This question paper has **TWO** Sections; **TWO** questions in **Section A** and **FOUR** questions in **Section B**. Answer **ALL** questions in **Section A** and any **THREE** questions in **Section B**.

*[Kertas soalan ini mengandungi **DUA** Bahagian; **DUA** soalan dalam **Bahagian A** dan **EMPAT** soalan dalam **Bahagian B**. Jawab **SEMUA** soalan dalam **Bahagian A** dan mana-mana **TIGA** soalan dalam **Bahagian B**.]*

List of equations are given in **Appendix A**.

*[Senarai persamaan diberikan pada **Lampiran A**.]*

SECTION A

Question 1

[Soalan 1]

Power amplifiers are generally classified according to the percent of time the output transistors are conducting.

[Penguat-penguat kuasa dikelaskan secara umum mengikut peratus masa masukan pengaliran transistor-transistor.]

- (a) With the aid of collector current, i_C versus time, ωt , state and define **FOUR** (4) principal classifications of power amplifiers.

[Dengan bantuan ciri arus pemungut, i_C melawan masa, ωt , nyatakan dan takrifkan EMPAT (4) pengelasan utama penguat-penguat kuasa.]

(8 Marks/ Markah)

- (b) **Figure 1a** shows the Class B power amplifier which consists of complementary pair electronic devices, Q_n and Q_p .

[Rajah 1a menunjukkan penguat kuasa Kelas B yang terdiri daripada pasangan lengkap peranti elektronik, Q_n dan Q_p .]

Briefly describe the amplifier operation when $v_I = 0$, $v_I < 0$ and $v_I > 0$.

[Huraikan secara ringkas operasi penguat apabila $v_I = 0$, $v_I < 0$ dan $v_I > 0$.]

(6 Marks/ Markah)

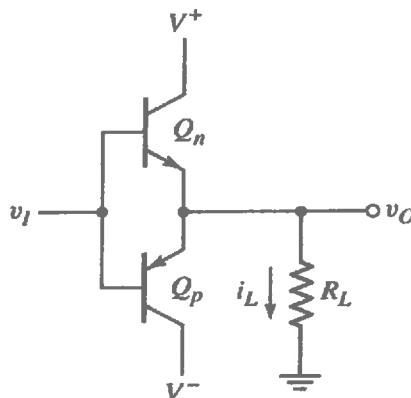


Figure 1a
[Rajah 1a]

....3/-

(c) **Figure 1b** shows the transfer characteristics of a class B power amplifier.

[Rajah 1b menunjukkan ciri-ciri perpindahan sebuah penguat kuasa kelas B.]

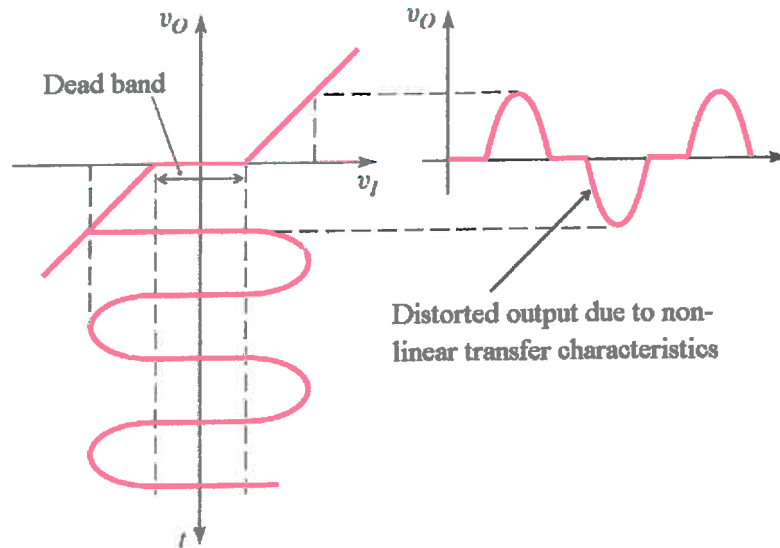


Figure 1b
[Rajah 1b]

(i) Define the dead band.

[Takrifkan jalur mati.]

(1 Mark/ Markah)

(ii) State the non-linear characteristic shown in **Figure 1b**.

[Nyatakan ciri tak lurus yang ditunjukkan dalam Rajah 1b.]

(1 Mark/ Markah)

(iii) With the aid of circuit diagram, briefly describe the way to overcome the non-linear characteristic stated in (c)(ii).

[Dengan bantuan gambarajah litar, huraikan secara ringkas cara mengatasi ciri tak lurus yang dinyatakan dalam (c)(ii).]

(4 Marks/ Markah)

SULIT

Question 2

[Soalan 2]

Figure 2 shows the Darlington configuration of multistage amplifier. The circuit elements are $V_{CC} = 10\text{ V}$, $R_1 = 300\text{ k}\Omega$, $R_2 = 125\text{ k}\Omega$, $R_C = 2.7\text{ k}\Omega$ and $R_{E2} = 1\text{ k}\Omega$.

[Rajah 2 menunjukkan tatarajah Darlington bagi penguat berbilang tahap. Elemen-elemen litar adalah $V_{CC} = 10\text{ V}$, $R_1 = 300\text{ k}\Omega$, $R_2 = 125\text{ k}\Omega$, $R_C = 2.7\text{ k}\Omega$ dan $R_{E2} = 1\text{ k}\Omega$.]

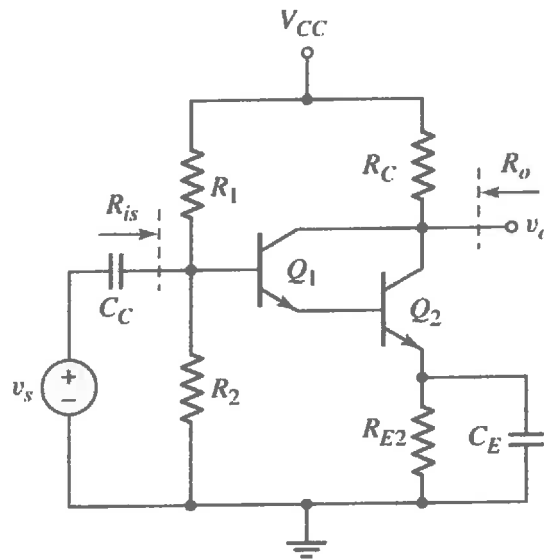


Figure 2
[Rajah 2]

- (a) Given that the early voltages, $V_{A1} = V_{A2} = \infty$, common-emitter current gains, $\beta_1 = \beta_2 = 105$, thermal voltages, $V_{T1} = V_{T2} = 26\text{ mV}$, base-emitter voltages, $V_{BE(ON)1} = V_{BE(ON)2} = 0.7\text{ V}$ and the Q-point values of base currents, $I_{BQ1} = 0.15\text{ }\mu\text{A}$ and $I_{BQ2} = 15\text{ }\mu\text{A}$. Determine:

[Diberikan voltan-voltan awal, $V_{A1} = V_{A2} = \infty$, gandaan-gandaan arus pemancar sepunya, $\beta_1 = \beta_2 = 105$, voltan-voltan terma, $V_{T1} = V_{T2} = 26\text{ mV}$, voltan-voltan tapak-pemancar, $V_{BE(ON)1} = V_{BE(ON)2} = 0.7\text{ V}$ dan nilai-nilai arus tapak titik-Q, $I_{BQ1} = 0.14\text{ }\mu\text{A}$ dan $I_{BQ2} = 14.4\text{ }\mu\text{A}$. Tentukan:]

....5/-

- (i) the Q-point values of collector currents, I_{CQ1} and I_{CQ2} .
[nilai-nilai arus pemungut titik-Q, I_{CQ1} dan I_{CQ2} .]
(2 Marks/ Markah)
- (ii) transconductances, g_{m1} and g_{m2} .
[trankonduktan-trankonduktan, g_{m1} dan g_{m2} .]
(2 Marks/ Markah)
- (iii) base-emitter input resistances, $r_{\pi1}$ and $r_{\pi2}$.
[rintangan-rintangan masukan tapak-pemancar, $r_{\pi1}$ dan $r_{\pi2}$.]
(2 Marks/ Markah)
- (b) Sketch and label the AC equivalent circuit for the multistage amplifier circuit in **Figure 2**.
*[Lakar dan labelkan litar setara A.U. untuk litar penguat berbilang tahap dalam **Rajah 2**.]*
(5 Marks/ Markah)
- (c) Determine the value of small-signal voltage gain, A_v for the multistage amplifier circuit in **Figure 2**.
*[Tentukan nilai gandaan voltan isyarat-kecil, A_v untuk litar penguat berbilang tahap dalam **Rajah 2**.]*
(9 Marks/ Markah)

SECTION B

Question 3

[Soalan 3]

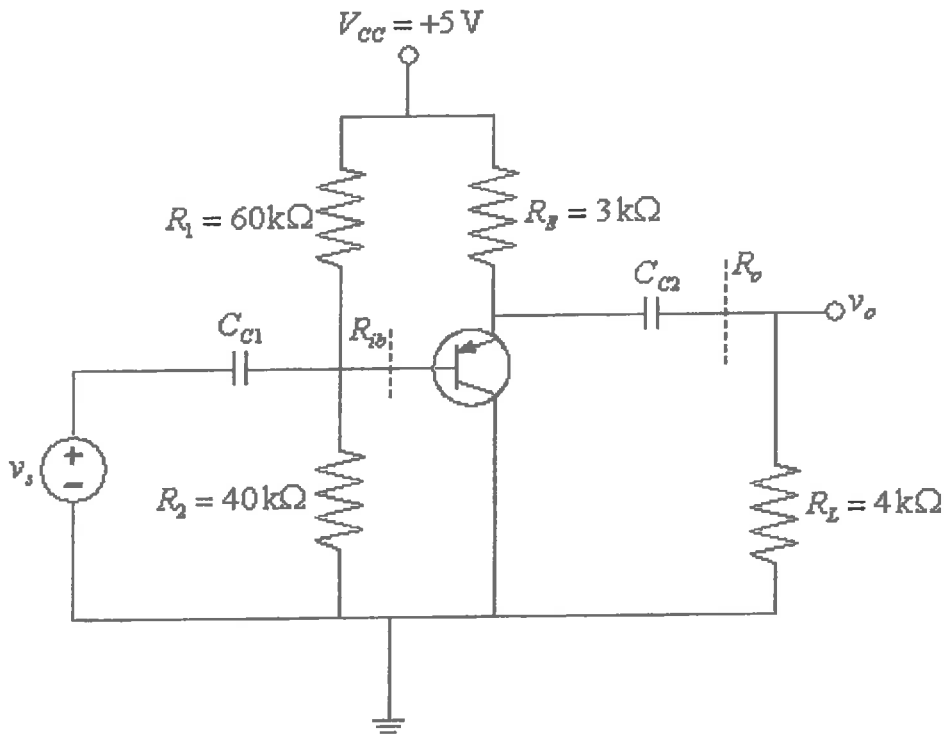


Figure 3

[Rajah 3]

Refer to the amplifier circuit shown in **Figure 3**. The transistor parameter are $\beta = 100$ and $V_A = 125 \text{ V}$. Given $V_T = 0.026$ and $V_{EB(ON)} = 0.7 \text{ V}$.

[Rujuk kepada litar penguat yang ditunjukkan dalam **Rajah 3**. Parameter transistor ialah $\beta = 100$ dan $V_A = 125 \text{ V}$. Diberi $V_T = 0.026$ dan $V_{EB(ON)} = 0.7 \text{ V}$.]

- (a) State the function of coupling capacitor, C_{C1} in the amplifier circuit shown in **Figure 3**.

[Nyatakan fungsi pemuat gandingan, C_{C1} di dalam litar penguat yang ditunjukkan dalam **Rajah 3**.]

(1 Mark/ Markah)

....7/-

(b) Determine the Quiescent – point values for:

[Tentukan nilai titik Quiescent untuk:]

(i) base current, I_{BQ} .

[arus tapak, I_{BQ} .]

(4 Marks/ Markah)

(ii) collector current, I_{CQ} .

[arus pemungut, I_{CQ} .]

(2 Marks/ Markah)

(iii) emitter current, I_{EQ} .

[arus pemancar, I_{EQ} .]

(2 Marks/ Markah)

(iv) emitter – collector voltage, V_{ECQ} .

[voltan pemancar – pemungut, V_{ECQ} .]

(2 Marks/ Markah)

(c) Determine the the values of the AC (small – signal) parameters:

[Tentukan nilai parameter AC (isyarat – kecil):]

(i) Base – emitter input resistance, r_{π} .

[rintangan masukan tapak – pemancar, r_{π} .]

(1 Mark/ Markah)

(ii) transconductance, g_m .

[transkonduktan, g_m .]

(1 Mark/ Markah)

....8/-

- (iii) transistor output resistance, r_o .
[rintangan keluaran transistor, r_o]

(1 Mark/ Markah)

- (d) Determine the small – signal voltage gain, A_v .
[Tentukan gandaan voltan isyarat – kecil, A_v]

(2 Marks/ Markah)

- (e) Determine the input resistance to the base, R_{ib} and output resistance, R_o .
[Tentukan rintangan masukan ke tapak, R_{ib} dan rintangan keluaran, R_o]

(4 Marks/ Markah)

SULIT

Question 4

[Soalan 4]

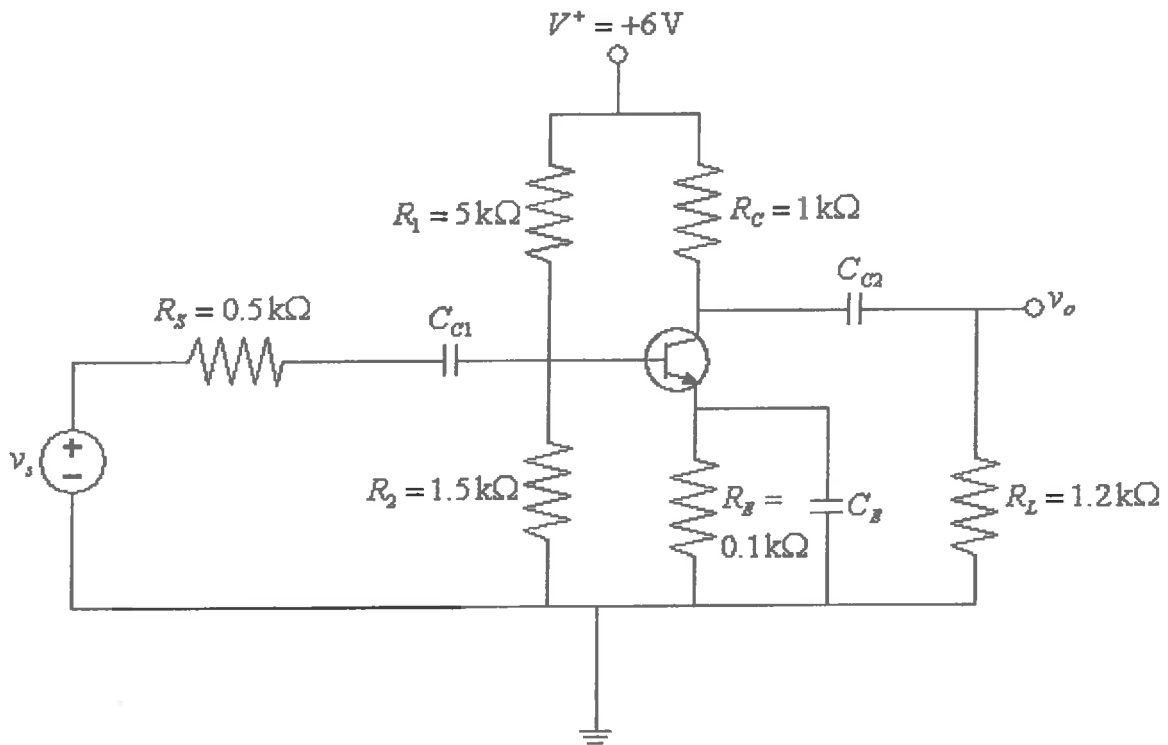


Figure 4
[Rajah 4]

Refer to the amplifier circuit shown in **Figure 4**. Given the $V_{BE(ON)} = 0.7\text{ V}$, $V_T = 0.026\text{ V}$ and the transistor parameter are $\beta = 120$ and $r_o = \infty$.

[Merujuk kepada litar penguat yang ditunjukkan dalam **Rajah 4**. Diberi $V_{BE(ON)} = 0.7\text{ V}$, $V_T = 0.026\text{ V}$ dan parameter transistor ialah $\beta = 120$ dan $r_o = \infty$.]

- (a) State the amplifier circuit configuration for the amplifier circuit shown in **Figure 4**.

[Nyatakan konfigurasi litar penguat untuk litar penguat yang ditunjukkan dalam **Rajah 4**.]

(1 Mark/ Markah)

....10/-

- (b) State the function of emitter bypass capacitor, C_E in the circuit shown in **Figure 4**.

[Nyatakan fungsi pemancar pemuat pirau, C_E di dalam litar yang ditunjukkan dalam Rajah 4.]

(1 Mark/ Markah)

- (c) Determine the Quiescent – point values for:

[Tentukan nilai titik Quiescent untuk:]

- (i) base current, I_{BQ} .

[arus tapak, I_{BQ} .]

(4 Marks/ Markah)

- (ii) collector current, I_{CQ} .

[arus pemungut, I_{CQ} .]

(2 Marks/ Markah)

- (iii) emitter current, I_{EQ} .

[arus pemancar, I_{EQ} .]

(2 Marks/ Markah)

- (iv) emitter – collector voltage, V_{ECQ} .

[voltan pemancar – pemungut, V_{ECQ} .]

(2 Marks/ Markah)

....11/-

(d) Determine the values of the small – signal parameters:

[Tentukan nilai-nilai parameter isyarat – kecil:]

(i) base – emitter input resistance, r_{π} .

[rintangan masukan tapak – pemancar, r_{π} .]

(2 Marks/ Markah)

(ii) transconductance, g_m .

[transkonduktan, g_m .]

(2 Marks/ Markah)

(e) Determine the input resistance, R_i and output resistance, R_o .

[Tentukan rintangan masukan, R_i dan rintangan keluaran, R_o .]

(2 Marks/ Markah)

(f) Determine the small – signal voltage gain, A_v .

[Tentukan gandaan voltan isyarat – kecil, A_v .]

(2 Marks/ Markah)

SULIT

Question 5

[Soalan 5]

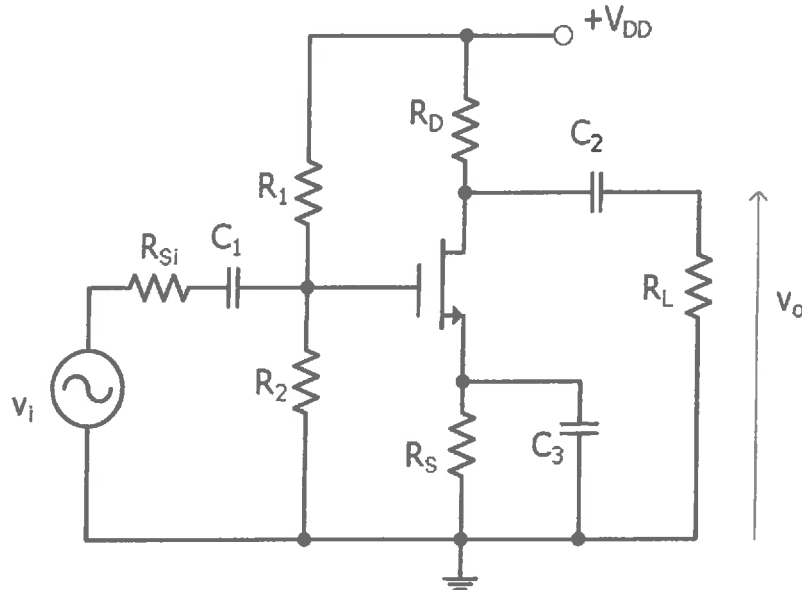


Figure 5

[Rajah 5]

For the amplifier configuration in **Figure 5**, the transistor parameters are; $V_{TN} = 2\text{ V}$, $K_n = 1\text{ mA/V}^2$ and $\lambda = 0$.

The circuit parameters are; $V_{DD} = 12\text{ V}$, $R_S = 2\text{ k}\Omega$, $R_D = 3\text{ k}\Omega$, $R_1 = 300\text{ k}\Omega$, $R_2 = 200\text{ k}\Omega$, $R_{Si} = 2\text{ k}\Omega$ and $R_L = 3\text{ k}\Omega$.

[Bagi tatarajah penguat dalam **Rajah 5**, parameter-parameter transistor adalah; $V_{TN} = 2\text{ V}$, $K_n = 1\text{ mA/V}^2$ dan $\lambda = 0$.

Elemen-elemen litar adalah; $V_{DD} = 12\text{ V}$, $R_S = 2\text{ k}\Omega$, $R_D = 3\text{ k}\Omega$, $R_1 = 300\text{ k}\Omega$, $R_2 = 200\text{ k}\Omega$, $R_{Si} = 2\text{ k}\Omega$ dan $R_L = 3\text{ k}\Omega$.]

(a) State the circuit configuration for **Figure 5**.

[Nyatakan konfigurasi tatarajah litar dalam **Rajah 5**.]

(1 Mark/ Markah)

....13/-

- (b) State the type of DC biasing for the amplifier circuit in **Figure 5**.
[Nyatakan jenis pincang A.T untuk litar penguat dalam Rajah 5.]
(1 Mark/ Markah)
- (c) By performing DC analysis, determine the following Q-point values:
[Dengan melakukan analisa A.T, tentukan nilai-nilai titik-Q berikut:]
- (i) gate-source voltage, V_{GSQ}
[voltan pintu-sumber, V_{GSQ}]
(5 Marks/ Markah)
 - (ii) drain current, I_{DQ}
[arus saliran, I_{DQ}]
(1 Mark/ Markah)
 - (iii) drain-source voltage, V_{DSQ}
[voltan saliran-sumber, V_{DSQ}]
(2 Marks/ Markah)
- (d) Sketch and label the small-signal equivalent circuit
[Lakar dan labelkan litar setara isyarat-kecil]
(5 Marks/ Markah)
- (e) Derive and determine the value of small-signal voltage gain, A_v .
[Terbit dan tentukan nilai untuk gandaan voltan isyarat-kecil, A_v]
(5 Marks/ Markah)

Question 6
[Soalan 6]

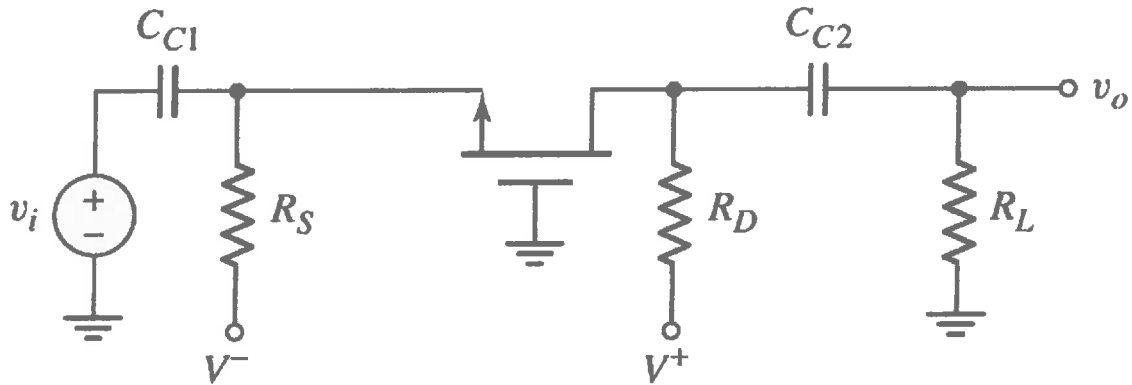


Figure 6

[Rajah 6]

For the amplifier configuration in **Figure 6**, the transistor parameters are; $V_{TN} = 1 \text{ V}$, $K_n = 3 \text{ mA} / \text{V}^2$ and $\lambda = 0$.

The circuit parameters are; $V^+ = 5 \text{ V}$, $V^- = -5 \text{ V}$, $R_S = 10 \text{ k}\Omega$, $R_D = 5 \text{ k}\Omega$, and $R_L = 4 \text{ k}\Omega$.

[Bagi tatarajah penguat dalam Rajah 6, parameter-parameter transistor adalah; $V_{TN} = 1 \text{ V}$, $K_n = 3 \text{ mA} / \text{V}^2$ dan $\lambda = 0$.

Elemen-elemen litar adalah; $V^+ = 5 \text{ V}$, $V^- = -5 \text{ V}$, $R_S = 10 \text{ k}\Omega$, $R_D = 5 \text{ k}\Omega$, and $R_L = 4 \text{ k}\Omega$.]

- (a) State the circuit configuration for **Figure 6**.

*[Nyatakan tatarajah litar pada **Rajah 6**.]*

(1 Mark/ Markah)

....15/-

(b) By performing DC analysis, determine the following Q-point values:

[Dengan melakukan analisa A.T, tentukan nilai-nilai titik-Q berikut:]

(i) gate-source voltage, V_{GSQ}

[voltan pintu-sumber, V_{GSQ}]

(5 Marks/ Markah)

(ii) drain current, I_{DQ}

[arus saluran, I_{DQ}]

(1 Mark/ Markah)

(iii) drain-source voltage, V_{DSQ}

[voltan saluran-sumber, V_{DSQ}]

(2 Marks/ Markah)

(c) Sketch and label the small-signal equivalent circuit

[Lakar dan labelkan litar setara isyarat-kecil]

(5 Marks/ Markah)

(d) Derive and determine the value of small-signal voltage gain, A_v .

[Terbit dan tentukan nilai untuk gandaan voltan isyarat-kecil, A_v]

(6 Marks/ Markah)

-ooOoo-

SULIT

(DMT231)

Appendix A

[Lampiran A]

1. $g_m = \frac{I_{CQ}}{V_T}$
2. $r_{\pi} = \frac{\beta V_T}{I_{CQ}}$
3. $r_o = \frac{V_A}{I_{CQ}}$
4. $g_m = 2K_n(V_{GS} - V_{TN})$
5. $g_m = \frac{2I_{DSS}}{|V_P|} \left(1 - \frac{V_{GS}}{V_P}\right)$
6. $A_v = -g_m R_C \left(\frac{r_{\pi}}{r_{\pi} + R_D}\right)$
7. $A_v = -g_m \left(\frac{R_1 \parallel R_2 \parallel r_{\pi}}{(R_1 \parallel R_2 \parallel r_{\pi}) + R_S}\right) (R_C \parallel r_o)$
8. $A_v = -\frac{\beta R_C}{r_{\pi} + (1 + \beta)R_E} \left(\frac{R_i}{R_i + R_S}\right)$
9. $A_v = \frac{(1 + \beta)(r_o \parallel R_E)}{r_{\pi} + (1 + \beta)(r_o \parallel R_E)} \left(\frac{R_i}{R_i + R_S}\right)$
10. $A_v = g_m \left(\frac{R_C \parallel R_L}{R_S}\right) \left(\frac{r_{\pi}}{1 + \beta} \parallel R_E \parallel R_S\right)$
11. $A_v = -g_m(r_o \parallel R_D)$
12. $A_v = \frac{-g_m(r_o \parallel R_D \parallel R_L)}{1 + g_m R_S}$
13. $A_v = -g_m(r_o \parallel R_D \parallel R_L) \left(\frac{R_i}{R_i + R_{Si}}\right)$
14. $A_v = \frac{g_m(r_o \parallel R_S \parallel R_L)}{1 + g_m(r_o \parallel R_S \parallel R_L)} \left(\frac{R_i}{R_i + R_{Si}}\right)$
15. $A_v = \frac{g_m(r_o \parallel R_D \parallel R_L)}{1 + g_m R_{Si}}$
16. $A_v = -g_m(r_o \parallel R_D \parallel R_L)$
17. $A_v = \frac{g_m(r_o \parallel R_S \parallel R_L)}{1 + g_m(r_o \parallel R_S \parallel R_L)}$
18. $I_D = I_{DSS} \left(1 - \frac{V_{GS}}{V_P}\right)^2$
19. $I_D = K_N(V_{GS} - V_{TN})^2$
20. $V_{DS(sat)} = V_{GS} - V_{TN}$
21. $A_P = \frac{P_L}{P_{in}}$
22. $P = \frac{V^2}{R}$
23. $P_L = \frac{V_L^2}{R_L}$
24. $P_{in} = \frac{V_{in}^2}{R_{in}}$
25. $A_P = \frac{V_L^2}{V_{in}^2} \left(\frac{R_{in}}{R_L}\right)$

SULIT

(DMT231)

$$26. A_v = \frac{V_L}{V_{in}}$$

$$27. A_p = A_v^2 \left(\frac{R_{in}}{R_L} \right)$$

$$28. P_{DQ} = I_{CQ} V_{CEQ}$$

$$29. V_{c(max)} = I_{CQ} R$$

$$30. I_{c(max)} = \frac{V_{CEQ}}{R_c}$$

$$31. P_{om(max)} = (0.7071 I_c)(0.7071 V_c)$$

$$32. P_{om(max)} = 0.5 I_{CQ} V_{CEQ}$$