UNIVERSITI MALAYSIA PERLIS

Peperiksaan Akhir Semester Pertama
Sidang Akademik 2020/2021

Disember 2020

DMT 231 – Analogue Electronics
[Elektronik Analog]

Masa: 3 jam

Please make sure that this question paper has **FOURTEEN (14)** printed pages including this front page before you start the examination.
*[Sila pastikan kertas soalan ini mengandungi **EMPAT BELAS (14)** muka surat yang bercetak termasuk muka hadapan sebelum anda memulakan peperiksaan ini.]*

This question paper has **TWO (2)** parts.
*[Kertas soalan ini mempunyai **DUA (2)** bahagian.*

Part A : This part has **FOUR (4)** questions. Answer all questions (80 marks).
*[**Bahagian A** : Bahagian ini mengandungi **EMPAT (4)** soalan. Jawab semua soalan (80 markah).]*

Part B : This part has **TWO (2)** questions. Answer any **ONE (1)** question (20 marks).
*[**Bahagian B** : Bahagian ini mengandungi **DUA (2)** soalan. Jawab mana-mana **SATU (1)** soalan (20 markah).]*

Each question contributes **TWENTY (20)** marks.
*[Setiap soalan menyumbang **DUA PULUH (20)** markah.]*

List of equation is given in **Appendix.**
*[Senarai persamaan-persamaan diberikan pada **Lampiran.**]*

Dicetak oleh Unit Peperiksaan & Pengijazahan, Bahagian Pengurusan Akademik, Pusat Pengurusan Akademik, UniMAP

Part A
[Bahagian A]
Answer all questions.
[Jawab semua soalan.]

Question 1
[Soalan 1]

(a) State **TWO (2)** conditions for Bipolar Junction Transistor (BJT) as amplifying device.
*[Nyatakan **DUA (2)** keadaan untuk Transistor Simpangan Dwipolar (BJT) sebagai peranti penguat.]*

(2 Marks/ *Markah*)

(b) Identify $i_C = (\beta / 1+ \beta)^* i_E$ by using these 2 parameters:
[Kenalpasti $i_C = (\beta / 1+ \beta)^* i_E$ dengan menggunakan 2 parameter ini:]

$$i_E = i_B + i_C \quad ; \quad i_C = \beta i_B$$

(3 Marks/ *Markah*)

(c) Referring to **Figure 1**.
*[Merujuk **Rajah 1.**]*

(i) Write the equation for base current, I_B for the amplifier circuit.
[Tuliskan persamaan bagi arus tapak, I_B bagi litar penguat.]

(2 Marks/ *Markah*)

(ii) Sketch the small-signal equivalent circuit for the circuit.
[Lakarkan litar setara isyarat-kecil untuk litar.]

(6 Marks/ *Markah*)

(iii) Label the small-signal equivalent circuit in **(c)(ii)**.
*[Labelkan litar setara isyarat-kecil dalam **(c)(ii)**.]*

(2 Marks/ *Markah*)

(iv) Write the equation for output voltage, υ_o and input voltage, υ_s.
[Tulis persamaan bagi voltan keluaran, υ_o dan voltan masukan, υ_s.]

(3 Marks/ *Markah*)

(v) Write the equation for small signal voltage gain, A_v.
[Tulis persamaan bagi gandaan voltan isyarat kecil, A_v.]

(2 Marks/ *Markah*)

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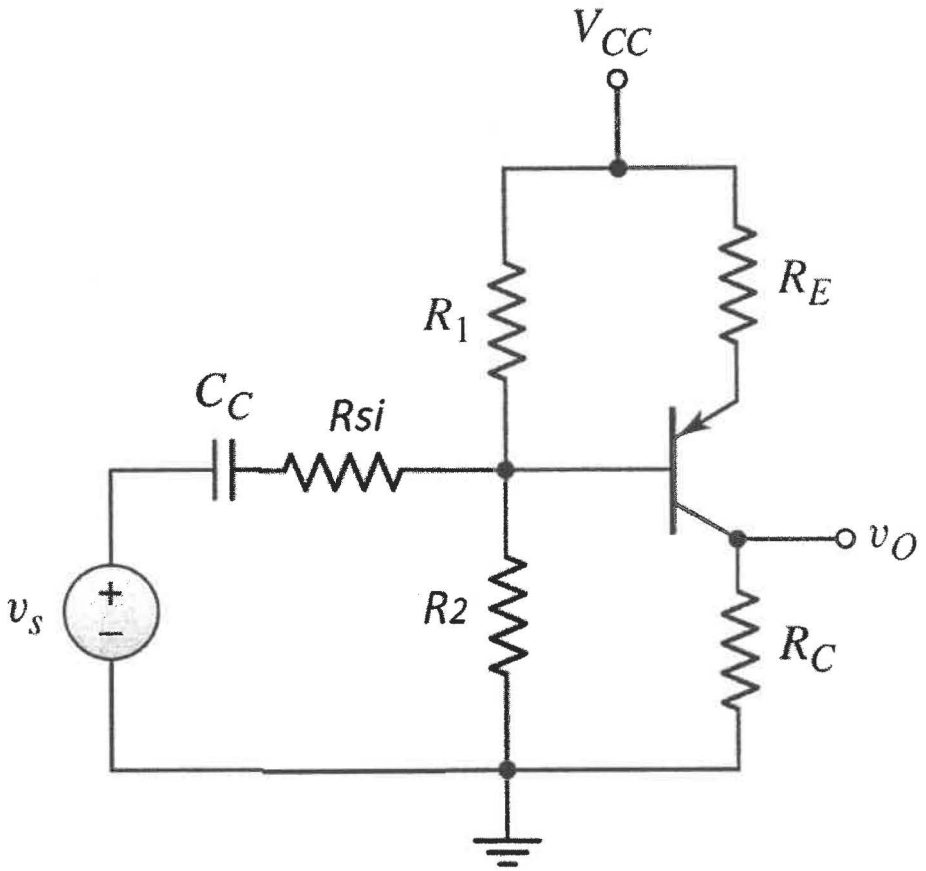

Figure 1
[Rajah 1]

Question 2
[Soalan 2]

(a) Refer to **Figure 2**, identity the type of amplifier configuration for the amplifier circuit.
*[Rujuk **Rajah 2**, kenalpasti jenis tatarajah penguat bagi litar penguat.]*

(1 mark/ *Markah)*

(b) For the amplifier circuit in **Figure 2,** assume the transistor parameters are $\beta = 75$, $V_{BE(on)} = 0.7$ V, $V_T = 26$ mV and $V_A = 80$ V. Evaluate:
*[Untuk litar penguat dalam **Rajah 2,** andaikan parameter transistor adalah $\beta = 75$, $V_{BE(on)} = 0.7$ V, $V_T = 26$ mV dan $V_A = 80$ V. Nilaikan:]*

(i) base current, I_{BQ}.
[arus tapak, I_{BQ}.]

(2 Marks/ *Markah*)

(ii) collector current, I_{CQ} and emitter-collector voltage, V_{CEQ}.
[arus pemungut, I_{CQ} dan voltan pemancar-pemungut, V_{CEQ}.]

(3 Marks/ *Markah*)

(iii) transconductance, g_m.
[trankonduktan, g_m.]

(2 Marks/ *Markah*)

(iv) diffusion resistance, r_π and output resistance, r_o.
[rintangan resapan, r_π dan rintangan keluaran ,r_o.]

(2 Marks/ *Markah*)

(c) Sketch and label small-signal equivalent circuit for circuit configuration shown in **Figure 2**.
*[Lakarkan dan labelkan litar setara isyarat-kecil bagi tatarajah litar yang ditunjukkan dalam **Rajah 2**.]*

(6 Marks/ *Markah*)

(d) Evaluate small-signal voltage gain, A_v.
[Nilaikan voltan gandaan isyarat-kecil, A_v.]

(4 Marks/ *Markah*)

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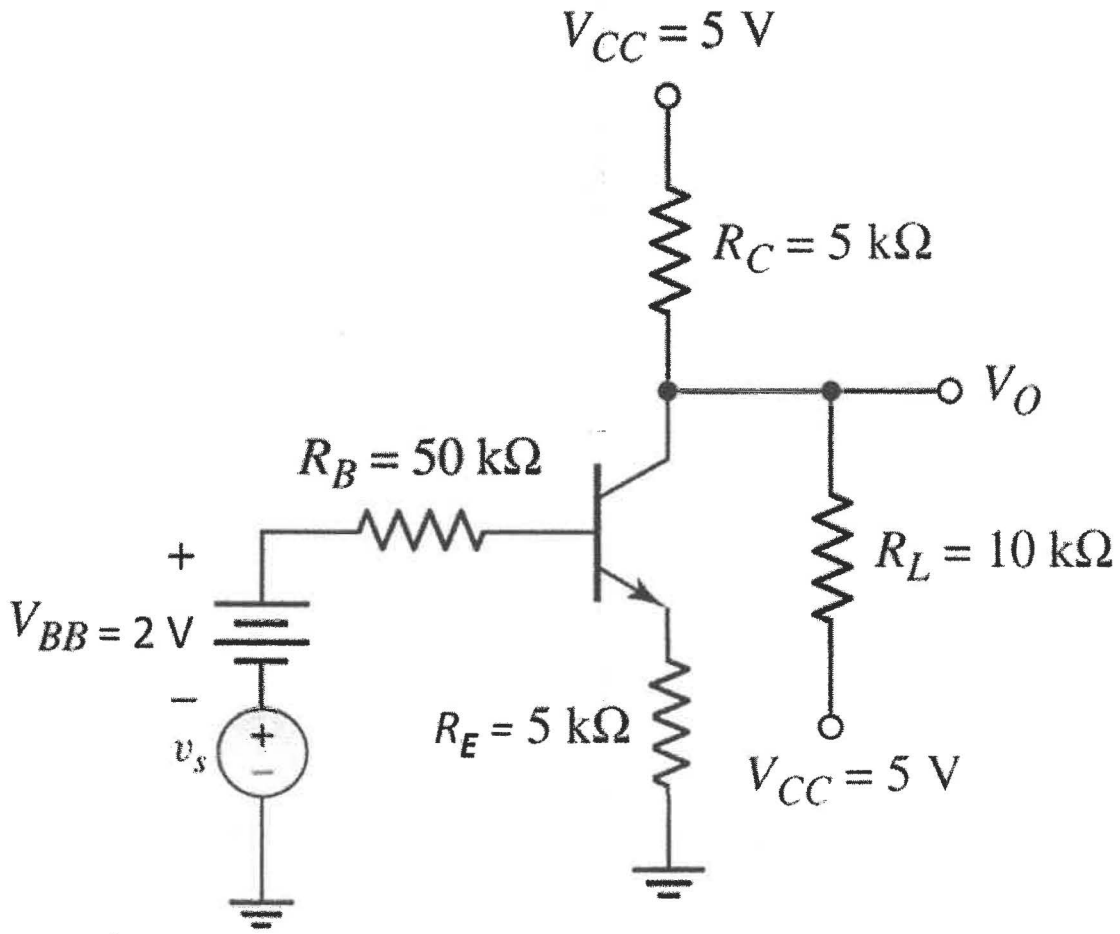

Figure 2
[Rajah 2]

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Question 3
[Soalan 3]

(a) State **THREE (3)** types of Metal Oxide Semiconductor Field Effect Transistor (MOSFET) amplifier.
*[Nyatakan **TIGA (3)** jenis Separa Pengalir Oksida Logam Transistor Kesan Medan (MOSFET).]*
(3 Marks/ *Markah*)

(b) State **TWO (2)** advantages of Field Effect Transistor (FET) device.
*[Nyatakan **DUA (2)** kelebihan peranti Transistor Kesan Medan (FET).]*
(2 Marks/ *Markah*)

(c) **Figure 3** show a MOSFET transistor with $K_n = 1$ mA/V^2, $V_{TN} = 2$ V, $\lambda = 0$, $R_1 = 300$ kΩ, $R_2 = 200$ kΩ, $R_D = 3$ kΩ and $R_s = 2$ kΩ.
*[**Rajah 3** menunjukkan satu transistor MOSFET dengan $K_n = 1$ mA/V^2, $V_{TN} = 2$ V dan $\lambda = 0$, $R_1 = 300$ kΩ, $R_2 = 200$ kΩ, $R_D = 3$ kΩ and $R_s = 2$ kΩ.]*

(i) Evaluate gate voltage, V_G.
[Nilaikan voltan pintu, V_G.]
(1 Mark/ *Markah*)

(ii) Evaluate gate-source voltage, V_{GS}.
[Nilaikan voltan pintu sumber, V_{GS}.]
(3 Marks/ *Markah*)

(iii) Evaluate quiescent point (Q-point) values of I_{DQ} and V_{DSQ}.
[Nilaikan nilai-nilai titik sepi (titik-Q) bagi I_{DQ} dan V_{DSQ}.]
(4 Marks/ *Markah*)

(iv) Evaluate transconductance, g_m.
[Nilaikan transkonduktan, g_m.]
(1 Mark/ *Markah*)

(v) Sketch the small- signal equivalent circuit for the circuit.
[Lakarkan litar setara isyarat-kecil untuk litar.]
(4 Marks/ *Markah*)

(vi) Evaluate small-signal voltage gain, $A_v = v_o / v_i$
[Nilaikan gandaan voltan isyarat-kecil, $A_v = v_o / v_i$]
(2 Marks/ *Markah*)

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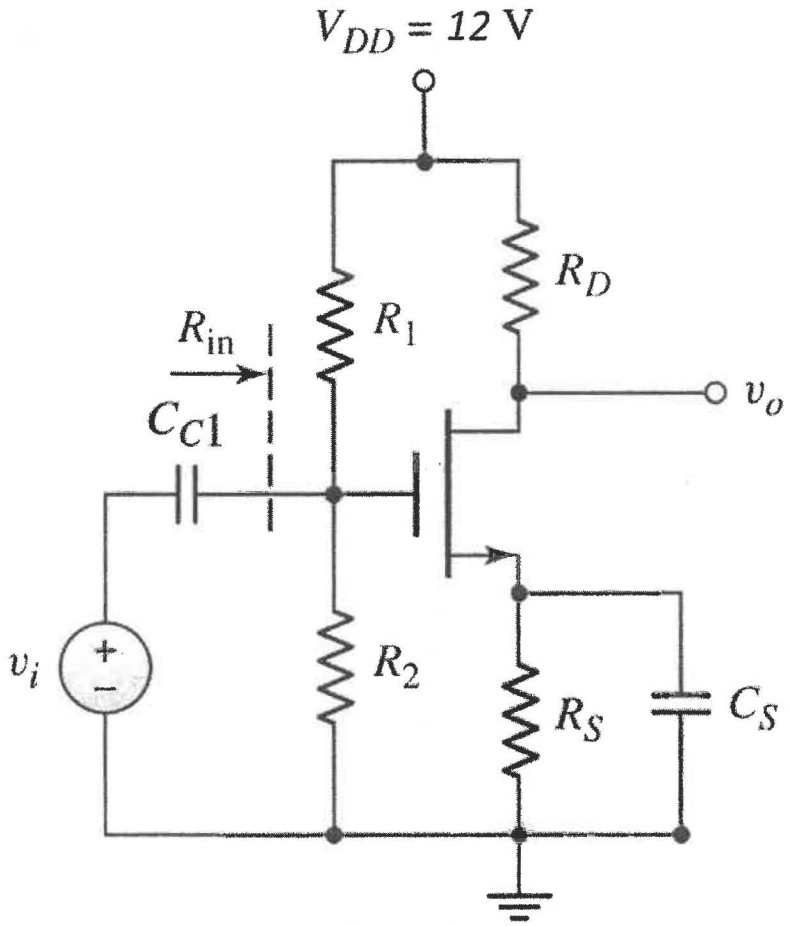

Figure 3
[Rajah 3]

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Question 4
[Soalan 4]

(a) **Figure 4** shows a two-stage common-emitter amplifier in a cascade configuration with npn transistors. The circuit elements for transistor Q_1 and Q_2 are $\beta_1 = \beta_2 = 120$, $V_{BE(ON)} = 0.7$ V and $V_A = \infty$. Evaluate:
***[Rajah 4** menunjukkan dua peringkat litar penguat pemancar-sepunya dalam satu lata tatarajah bersama transistor npn. Elemen-elemen untuk transistor Q_1 dan Q_2 adalah $\beta_1 = \beta_2 = 120$, $V_{BE(ON)} = 0.7$ V dan $V_A = \infty$. Nilaikan;]*

(i) Thevenin resistor and voltage, R_{TH} and V_{TH} for transistor Q_1.
[Rintangan Thevenin, R_{TH} dan voltan Thevenin, V_{TH} untuk transistor Q_1.]
(2 Marks/ *Markah*)

(ii) The quiescent current for transistor Q_1, I_{BQ1} and I_{CQ1}.
[Arus sepi bagi transistor Q_1, I_{BQ1} dan I_{CQ1}.]
(3 Marks/ *Markah*)

(iii) The quiescent current for transistor Q_2, I_{BQ2} and I_{CQ2}.
[Arus sepi bagi transistor Q_2, I_{BQ2} dan I_{CQ2}.]
(2 Marks/ *Markah*)

(iv) Diffusion resistance, $r_{\pi 1}$ and $r_{\pi 2}$.
[Rintangan resapan, $r_{\pi 1}$ dan $r_{\pi 2}$.]
(1 Mark/ *Markah*)

(v) Transconductance, g_{m1} and g_{m2}
[Transkonduktan, g_{m1} dan g_{m2}.]
(1 Mark/ *Markah*)

(b) Sketch and label the AC equivalent circuit for multistage amplifier circuit shown in **Figure 4**.
*[Lakar dan labelkan litar setara AC untuk litar penguat berbilang peringkat yang ditunjukkan dalam **Rajah 4**.]*
(5 Marks/ *Markah*)

(c) From answer in 4**(b)**,
*[Daripada jawapan dalam 4**(b)**,]*

(i) Write the equation for output voltage, v_o and input voltage, v_s.
[Tulis persamaan bagi voltan keluaran, v_o dan voltan masukan, v_s.]
(4 Marks/ *Markah*)

(ii) Evaluate the small-signal voltage gain, A_v.
[Nilaikan gandaan voltan isyarat-kecil, A_v.]
(2 Marks/ *Markah*)

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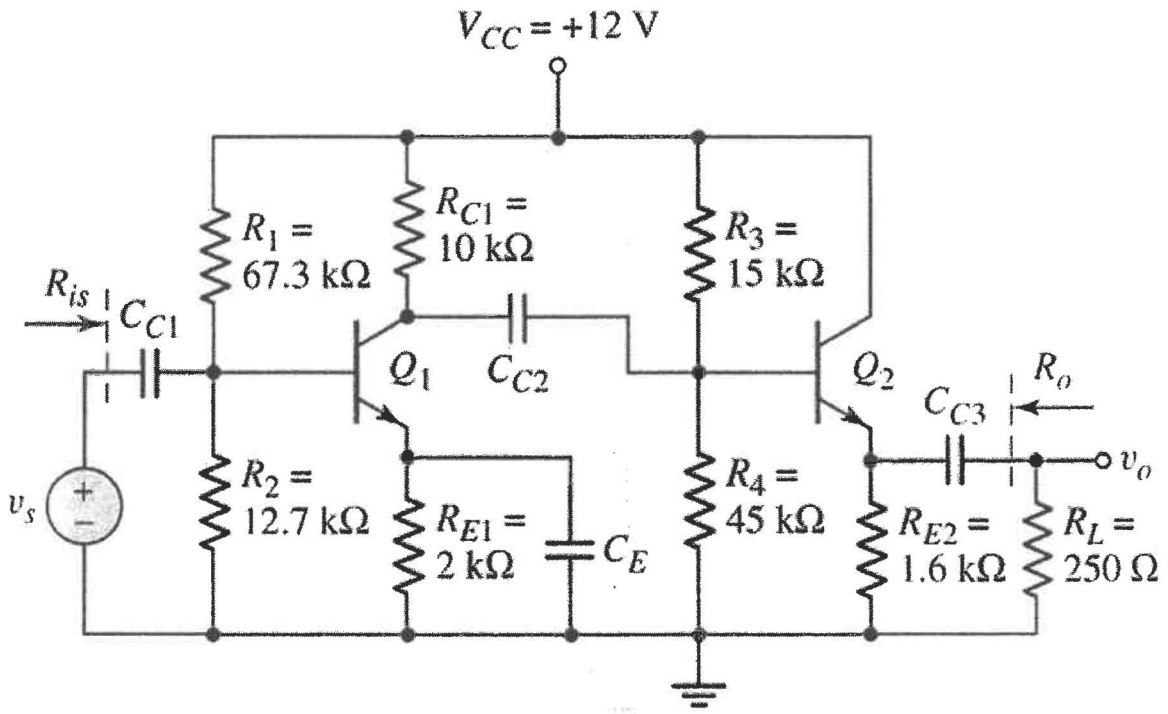

Figure 4
[Rajah 4]

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Part B
[Bahagian B]
Answer any ONE (1) question.
[Jawab mana-mana SATU (1) soalan.]

Question 5
[Soalan 5]

(a) Power amplifiers are generally classified into Class A, Class B, Class AB and Class C. Sketch and label collector current versus time for all class of power amplifiers.
[Penguat-penguat kuasa secara umum dikelaskan kepada Kelas A, Kelas B, Kelas AB dan Kelas C. Lakar dan labelkan arus pemungut melawan masa untuk kesemua kelas penguat-penguat kuasa.]

(i) Class A and Class B amplifier
[Penguat kelas A dan kelas B .]

(4 Marks/ *Markah*)

(ii) Class AB and Class C amplifier.
[Penguat kelas AB dan kelas C.]

(4 Marks/ *Markah*)

(b) **Figure 5** shows an operation of Class AB power amplifier consists of complementary pair electronic devices. State the condition of transistor Q_n, Q_p, V_o and i_{Cn} when;
***[Rajah 5** menunjukkan operasi Kelas AB penguat kuasa terdiri daripada peranti elektronik pasangan pelengkap. Nyatakan keadaan transistor Qn, Qp, V_o dan i_{Cn} apabila:]*

(i) $V_i = 0$.
[$V_i = 0$.]

(4 Marks/ *Markah*)

(ii) V_i increase.
[V_i bertambah.]

(4 Marks/ *Markah*)

(iii) V_i decrease.
[V_i berkurang.]

(4 Marks/ *Markah*)

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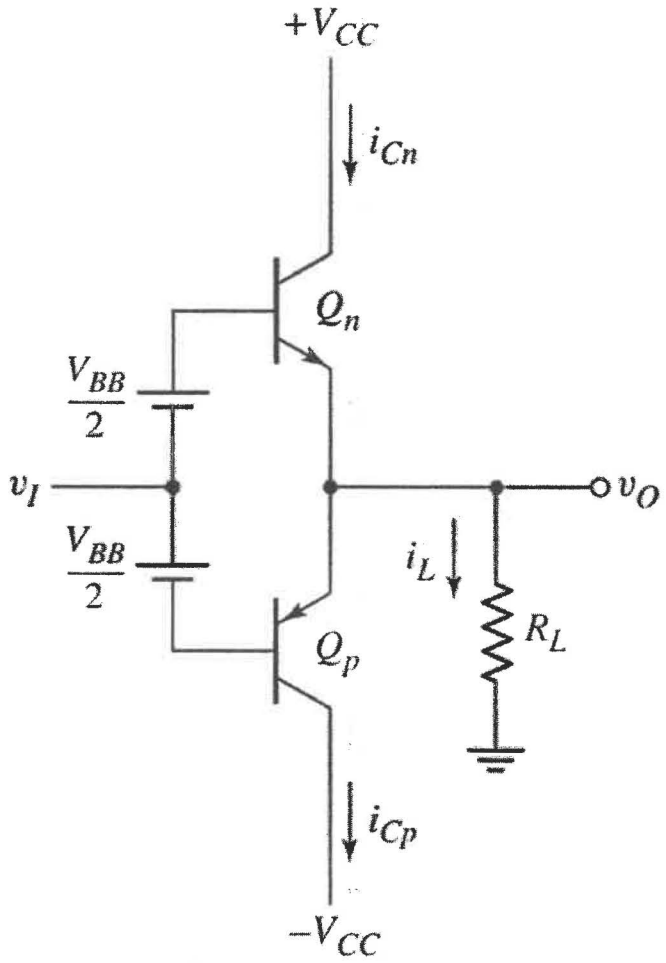

Figure 5
[Rajah 5]

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Question 6
[Soalan 6]

(a) JFET is three-terminal semiconductor device that can be used as electronically-controlled switches, amplifiers, or voltage-controlled resistors. Sketch and label:
[JFET adalah peranti semikonduktor tiga terminal yang boleh digunakan sebagai suis kawalan elektronik, penguat, atau voltan-kawalan perintang. Lakar dan labelkan:]

(i) Junction Field Effect Transistor (JFET) symbol for both channels.
[Simpang Transistor Kesan Medan (JFET) simbol bagi kedua-dua saluran.]
(4 Marks/ *Markah*)

(ii) JFET bias circuit for self-bias circuit and voltage-divider bias circuit.
[litar pincang JFET bagi litar diri-pincang dan litar pembahagi-voltan pincang.]
(4 Marks/ *Markah*)

(b) The amplifier shown in **Figure 6(a)**, the transistor parameters are I_{DSS} = *12 mA,* and $V_{GS(OFF)}$ = *-3 V*. The transfer characteristic curve is given in the **Figure 6(b)**.
*[Penguat yang ditunjukkan dalam **Rajah 6(a)**, parameter transistor adalah I_{DSS} = 12 mA dan $V_{GS(OFF)}$ = -3 V. Lengkungan sifat pindahan diberi dalam **Rajah 6(b)**.*

(i) State the type of amplifier configuration for the amplifier circuit.
[Nyatakan jenis penguat tatarajah bagi litar penguat.]
(2 Marks/ *Markah*)

(ii) Calculate gate voltage, V_G.
[Kirakan voltan pintu, V_G.]
(3 Marks/ *Markah*)

(iii) Sketch a Direct Current (DC) load line and determine the Q-point for the circuit.
[Lakarkan garis beban Arus Terus (DC) dan tentukan titik-Q untuk litar.]
(7 Marks/ *Markah*)

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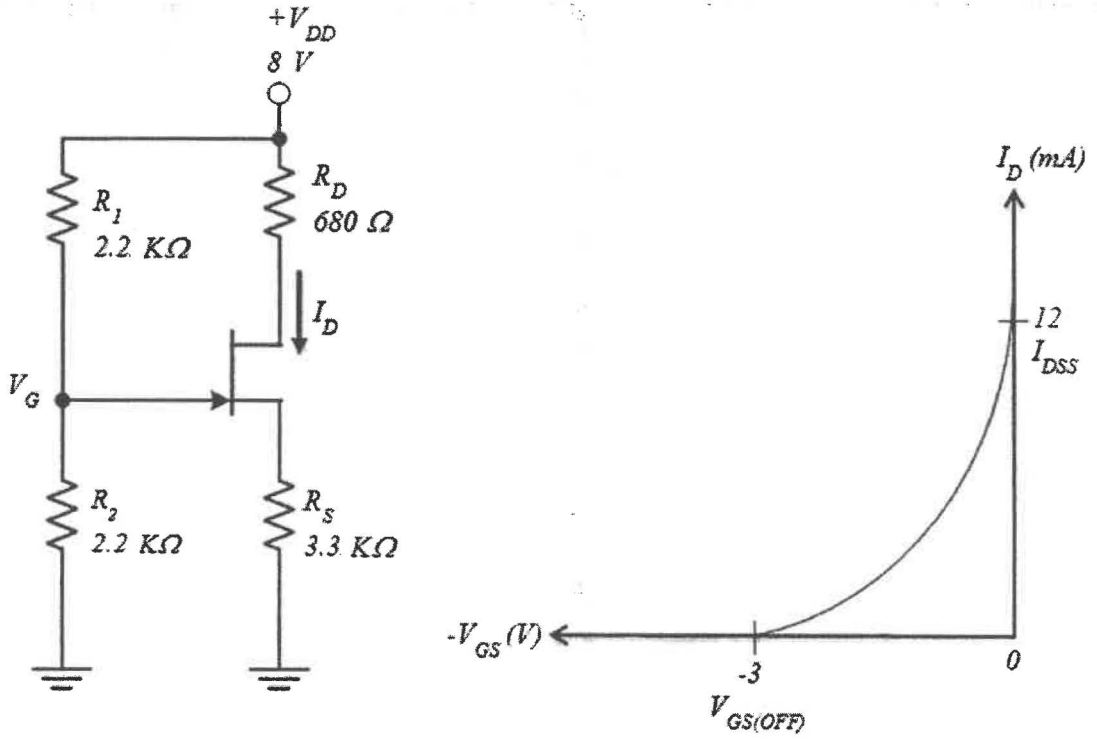

Figure 6
[Rajah 6]

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Appendix

[Lampiran]

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

2. $g_m = 2K_n(V_{GS} - V_{TN})$

3. $g_m = \frac{2I_{DSS}}{|V_P|}\left(1 - \frac{V_{GS}}{V_P}\right)$

4. $A_v = -g_m R_C\left(\frac{r_\pi}{r_\pi + R_D}\right)$

5. $A_v = -g_m\left(\frac{R_1 \parallel R_2 \parallel r_\pi}{(R_1 \parallel R_2 \parallel r_\pi) + R_S}\right)(R_C \parallel r_o)$

6. $A_v = -\frac{\beta R_C}{r_\pi + (1+\beta)R_E}\left(\frac{R_i}{R_i + R_S}\right)$

7. $A_v = \frac{(1+\beta)(r_o \parallel R_E)}{r_\pi + (1+\beta)(r_o \parallel R_E)}\left(\frac{R_i}{R_i + R_S}\right)$

8. $A_v = g_m\left(\frac{R_C \parallel R_L}{R_S}\right)\left(\frac{r_\pi}{1+\beta} \parallel R_E \parallel R_S\right)$

9. $A_v = -g_m(r_o \parallel R_D)$

10. $A_v = \frac{-g_m(r_o \parallel R_D \parallel R_L)}{1 + g_m R_S}$

11. $A_v = -g_m(r_o \parallel R_D \parallel R_L)\left(\frac{R_i}{R_i + R_{Si}}\right)$

12. $A_v = \frac{g_m(r_o \parallel R_S \parallel R_L)}{1 + g_m(r_o \parallel R_S \parallel R_L)}\left(\frac{R_i}{R_i + R_{Si}}\right)$

13. $A_v = \frac{g_m(r_o \parallel R_D \parallel R_L)}{1 + g_m R_{Si}}$

14. $A_v = -g_m(r_o \parallel R_D \parallel R_L)$

15. $A_v = \frac{g_m(r_o \parallel R_S \parallel R_L)}{1 + g_m(r_o \parallel R_S \parallel R_L)}$

16. $I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2$

17. $I_D = K_N(V_{GS} - V_{TN})^2$

18. $I_D = K_p(V_{SG} - V_{TP})^2$

19. $V_{DS(sat)} = V_{GS} - V_{TN}$

20. $V_{SD(sat)} = V_{SG} - V_{TP}$