UNIVERSITI MALAYSIA PERLIS

Peperiksaan Semester Pertama
Sidang Akademik 2017/2018

Oktober 2017

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 **SIX (6)** questions. Answer any **FIVE (5)** question. Each question contribute 20 marks.
*[Kertas soalan ini mengandungi **ENAM (6)** soalan. Jawab mana-mana **LIMA (5)** soalan. Setiap soalan menyumbang 20 markah.]*

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

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Question 1
[Soalan 1]

(a) Sketch and label the symbols of Bipolar Junction Transistor (BJT). Write the equation for each current flow.
[Lakar dan labelkan simbol-simbol bagi Transistor Simpangan Dwipolar (BJT). Tuliskan persamaan bagi setiap aliran arus.]

(4 Marks/ *Markah*)

(b) BJT has 3 operation region which is cutoff, active and saturation. With the aid of diagram, explain **ALL** the operation regions.
*[BJT mempunyai 3 kawasan operasi iaitu pemotongan, aktif dan tepu. Dengan bantuan gambarajah, terangkan **SEMUA** kawasan operasi.]*

(6 Marks/ *Markah*)

(c) Sketch and label the I-V characteristics curve for BJT.
[Lakar dan label lengkungan sifat IV bagi BJT.]

(3 Marks/ *Markah*)

(d) Refer to **Figure 1**. Write the equation for;
*[Rujuk **Rajah 1**. Tuliskan persamaan bagi;]*

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

(1 Mark/ *Markah*)

(ii) quiescent collector current, I_{CQ}.
[arus pemungut sepi, I_{CQ}.]

(1 Mark/ *Markah*)

(iii) quiescent emitter, I_{EQ}.
[arus pemancar sepi, I_{EQ}.]

(1 Mark/ *Markah*)

(iv) quiescent emitter-collector voltage, V_{CEQ}.
[voltan pemungut-pemancar sepi , V_{CEQ}.]

(1 Mark/ *Markah*)

(v) sketch and label the DC load line for the circuit.
[lakar dan label garis beban AT untuk litar tersebut.]

(3 Marks/ *Markah*)

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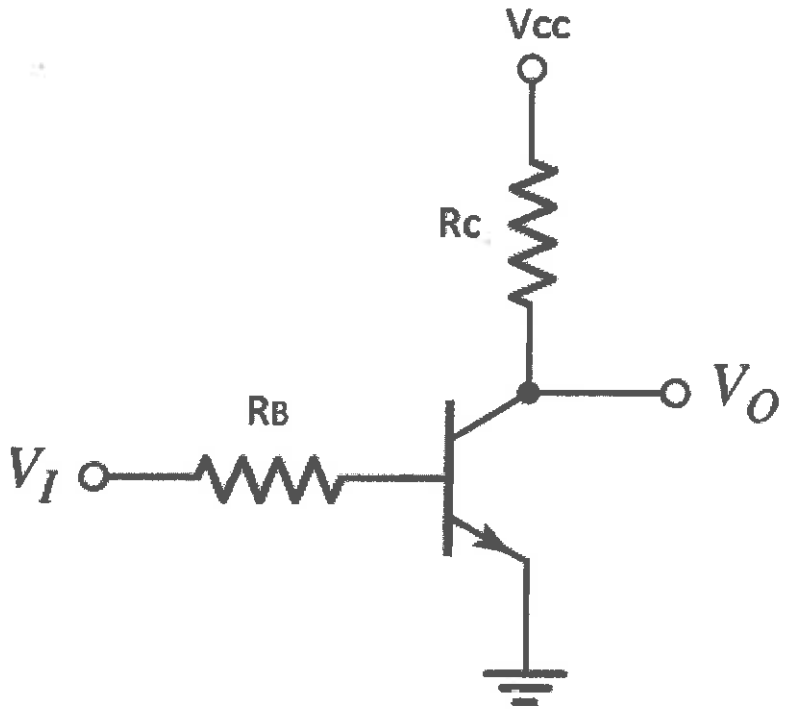

Figure 1
[Rajah 1]

Question 2
[Soalan 2]

(a) State **THREE (3)** basic types of BJT amplifiers.
*[Nyatakan **TIGA (3)** jenis penguat BJT asas.]*

(1.5 Marks/ *Markah*)

(b) **Figure 2** shows a common emitter amplifier circuit with $\beta = 100$, $V_{EB(on)} = 0.7$ V, $V_T = 26$ mV and $V_A = \infty$. Determine;
*[**Rajah 2** menunjukkan satu litar penguat pemancar sepunya dengan $\beta = 100$, $V_{EB(on)} = 0.7$ V, $V_T = 26$mV dan $V_A = \infty$. Tentukan;]*

(i) Thevenin resistor, R_{TH} and Thevenin voltage, V_{TH}
[perintang Thevenin, R_{TH} dan voltan Thevenin, V_{TH} .]

(2.5 Marks/ *Markah*)

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

(2 Marks/ *Markah*)

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

(3 Marks/ *Markah*)

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

(1 Mark/ *Markah*)

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

(2 Marks/ *Markah*)

(vi) sketch small signal equivalent circuit.
[lakarkan litar setara isyarat-kecil.]

(5 Marks/ *Markah*)

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

(3 Marks/ *Markah*)

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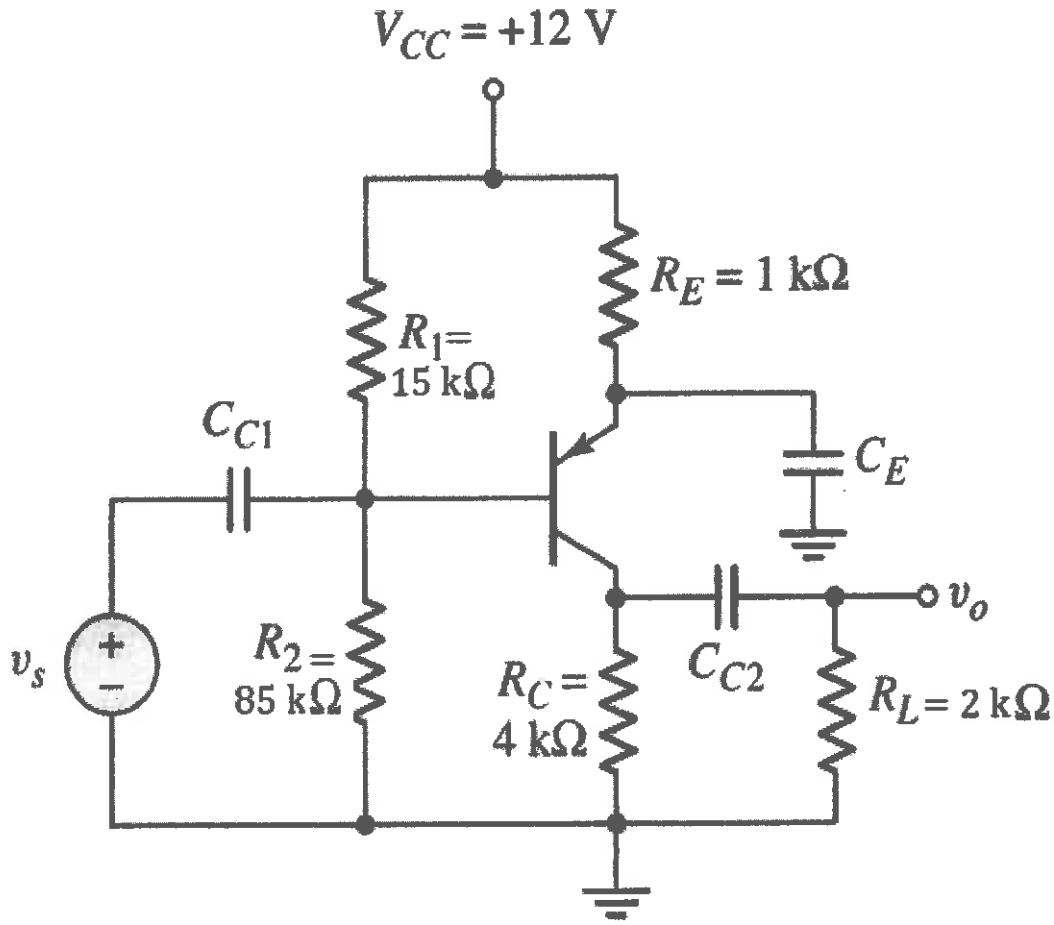

Figure 2
[Rajah 2]

Question 3
[Soalan 3]

(a) With the aid of diagram, explain the MOSFET operation.
[Dengan bantuan gambarajah, jelaskan operasi MOSFET.]

(4 Marks/ *Markah*)

(b) **Figure 3** show a MOSFET transistor with $K = 1\ mA/V^2$, $V_{TN} = 2V$ and $\lambda = 0$.
***[Rajah 3** menunjukkan satu transistor MOSFET dengan $K = 1mA/V^2$, $V_{TN} = 2V$ dan $\lambda = 0$.]*

(i) Calculate gate voltage, V_G.
[Kirakan voltan pintu, V_G.]

(2 Marks/ *Markah*)

(ii) Calculate gate-source voltage, V_{GS}.
[Kirakan voltan pintu sumber, V_{GS}.]

(3 Marks/ *Markah*)

(iii) Calculate quiescent point (Q-point) values of I_{DQ} and V_{DSQ}.
[Kirakan nilai-nilai titik sepi (titik-Q) bagi I_{DQ} dan V_{DSQ}.]

(4 Marks/ *Markah*)

(iv) Calculate transconductance, g_m.
[Kirakan trankonduktan, 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) Calculate small-signal voltage gain $A_v = v_o / v_i$
[Kirakan gandaan voltan isyarat-kecil, $A_v = v_o / v_i$]

(2 Marks/ *Markah*)

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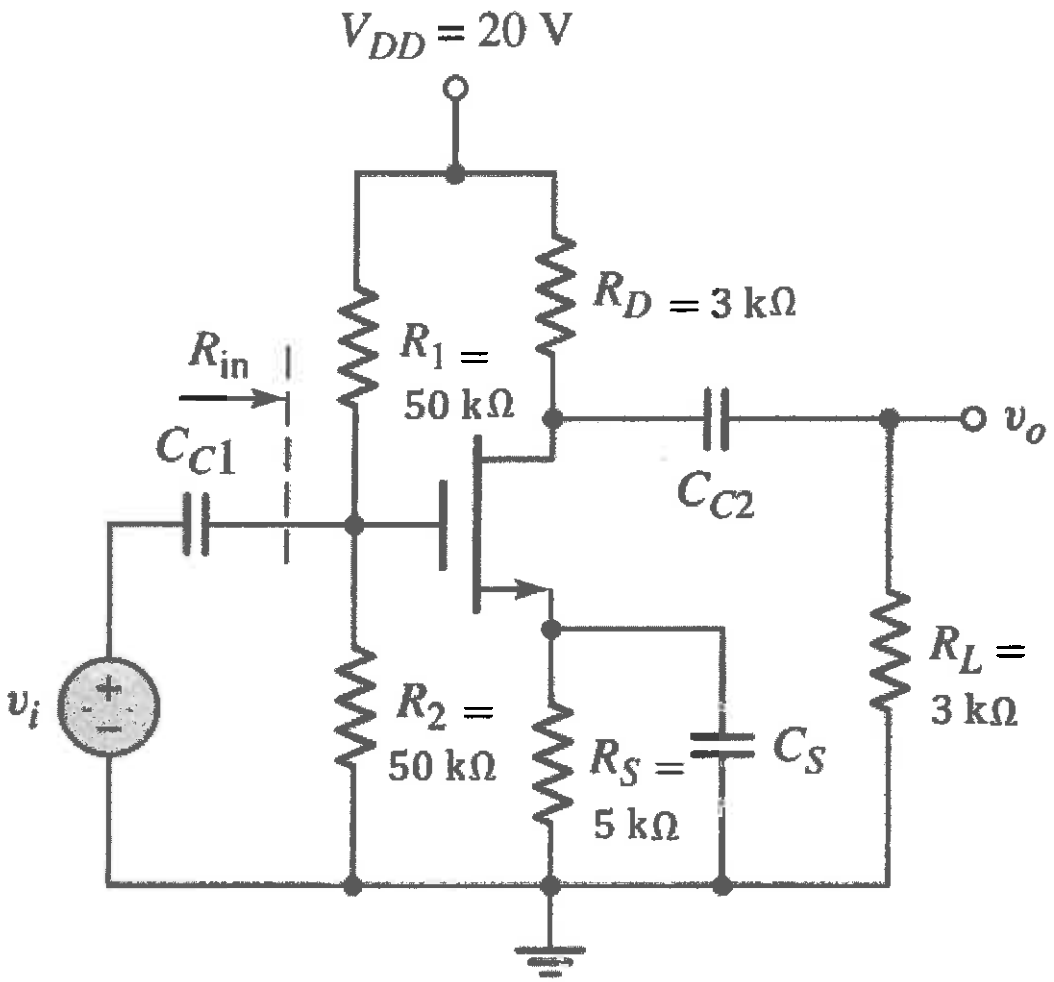

Figure 3
[Rajah 3]

Question 4
[Soalan 4]

(a) State and sketch **FOUR (4)** types of multistage amplifier configuration that you know.
*[Nyata dan lakarkan **EMPAT (4)** jenis penguat berperingkat konfigurasi yang kamu tahu.]*
(4 Marks/ *Markah*)

(b) **Figure 4** shows a cascaded configuration as part of a multistage amplifier. The circuit elements transistor Q_1 and Q_2 are $\beta_1 = \beta_2 = 120$, $V_{BE(ON)} = 0.7$ V and $r_o = \infty$. Calculate;
*[**Rajah 4** menunjukkan konfigurasi terlatar sebagai sebahagian daripada penguat berbilang tahap. Elemen-elemen transistor Q_1 dan Q_2 adalah $\beta 1 = \beta 2 = 120$, $V_{BE(ON)} = 0.7$ V dan $r_o = \infty$. Kirakan;]*

(i) Thevenin resistor and voltage, R_{TH} and V_{TH}.
[voltan dan rintangan Thevenin , R_{TH} dan V_{TH}.]
(4 Marks/ *Markah*)

(ii) transistor Q_1 quiescent current, I_{BQ1}, I_{CQ1} and I_{EQ1}.
[arus sepi transistor Q_1 , I_{BQ1}, I_{CQ1} dan I_{EQ1}.]
(3 Marks/ *Markah*)

(iii) transistor Q_2 quiescent current, I_{EQ2}, I_{BQ2} and I_{CQ2}.
[arus sepi transistor Q_2 , I_{EQ2}, I_{BQ2} dan I_{CQ2}]
(3 Marks/ *Markah*)

(iv) transistor Q_1 and Q_2 quiescent voltage, V_{CEQ1} and V_{CEQ2}.
[voltan sepi transistor Q_1 dan Q_2, V_{CEQ1} dan V_{CEQ2}.]
(2 Marks/ *Markah*)

(c) Sketch small-signal equivalent circuit for circuit configuration shown in **Figure 4.**
*[Lakarkan litar setara isyarat-kecil bagi konfigurasi litar yang ditunjukkan dalam **Rajah 4.**]*
(4 Marks/ *Markah*)

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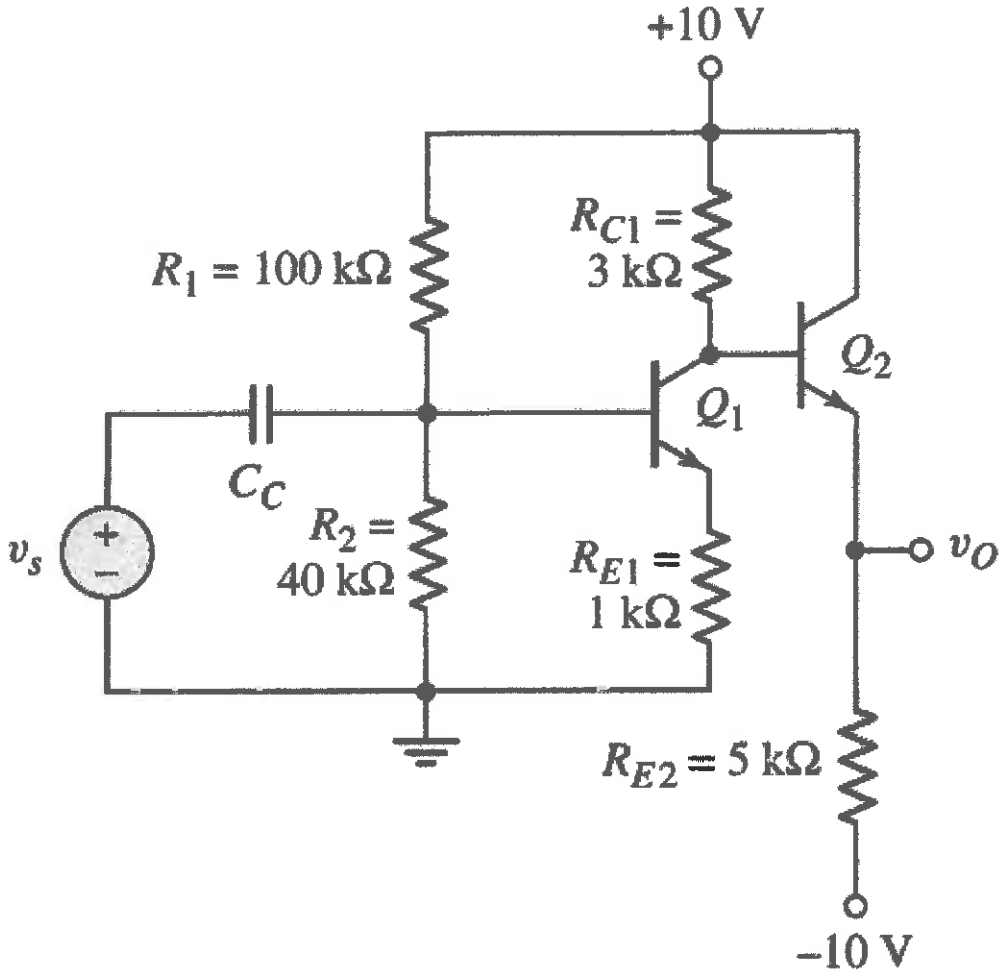

Figure 4
[Rajah 4]

Question 5
[Soalan 5]

(a) Power amplifiers are generally classified into Class A, Class B, Class AB and Class C.
[Penguat-penguat kuasa secara umum dikelaskan kepada Kelas A, Kelas B, Kelas AB dan Kelas C.]

(i) Sketch and label Class B amplifier with the aid of diagram.
[Lakar dan label Kelas B penguat dengan bantuan gambarajah.]
(2 Marks/ *Markah*)

(ii) Explain the operation of Class B amplifier by using a block diagram and a push-pull circuit.
[Terangkan operasi penguat Kelas B dengan menggunakan gambarajah blok dan litar tolak-tarik.]
(8 Marks/ *Markah*)

(b) **Figure 5** shows Class AB amplifier operation using enhancement-mode MOSFET and the transistors are matched. Given V_{DD} = 10 V, R_L = 20 Ω, K = 0.20 A/V^2, |VT| = 1 V and I_{DQ} is increased 20 percent of the load current when *Vo = 5 V.*
*[**Rajah** 5 menunjukkan peringkat penguat kuasa menggunakan MOSFET mod peneguhan dan transistor-transistor adalah sepadan. Diberi V_{DD} = 10 V, R_L = 20 Ω, K = 0.20 A/V^2, |VT| = 1 V. I_{DQ}, adalah bertambah sebanyak 20 peratus daripada arus beban apabila Vo = 5 V.]*

(i) State the class of power amplifier configuration in **Figure 5**.
*[Nyatakan kelas bagi konfigurasi penguat dalam **Rajah** 5.]*
(2 Marks/ *Markah*)

(ii) Determine the quiescent drain current, I_{DQ}.
[Tentukan arus longkang sepi, I_{DQ}.]
(2 Marks/ *Markah*)

(iii) Calculate the gate-to-source voltage, V_{GSn} of M_n transistor.
[Kirakan voltan pintu sumber, V_{GSn} bagi transistor M_n.]
(2 Marks/ *Markah*)

(iv) Calculate the source-to-gate voltage, V_{SGp} of M_p transistor.
[Kirakan voltan sumber pintu, V_{GSn} bagi transistor M_p.]
(2 Marks/ *Markah*)

(v) Determine the input voltage, υ_I.
[Tentukan voltan masukan, υ_I.]
(2 Marks/ *Markah*)

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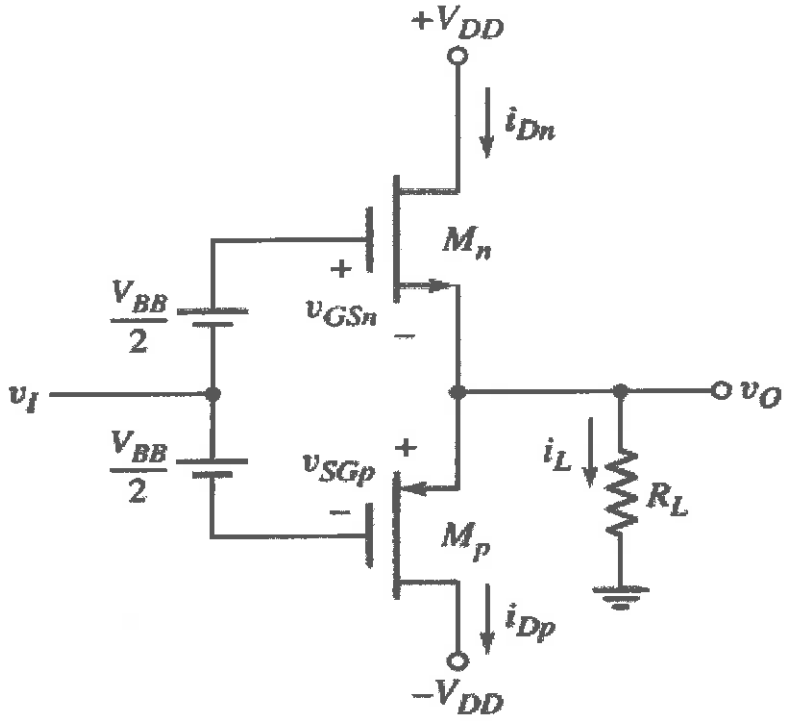

Figure 5
[Rajah5]

Question 6
[Soalan 6]

(a) Define the following terms:
[Takrifkan terma-terma berikut:]

(i) Depletion mode of MOSFET.
[Ragam susutan bagi MOSFET.]

(2 Marks/ *Markah*)

(ii) Enhancement mode of MOSFET.
[Ragam peningkatan bagi MOSFET.]

(2 Marks/ *Markah*)

(b) Sketch and label the transfer characteristic curve (depletion and enhancement) for MOSFET.
[Lakar dan labelkan lengkungan sifat pindahan (pengurangan dan penambahan) bagi MOSFET.]

(4 Marks/ *Markah*)

(c) **Figure 6(a)** shows the NMOS common-source circuit and **Figure 6(b)** referring to the DC equivalent circuit. Given $R_1 = 30\ k\Omega$, $R_2 = 20\ k\Omega$, $R_D = 20\ k\Omega$, $V_{DD} = 5V$, $V_{TN} = 1V$ and $K_n = 0.1\ mA/V^2$.
***[Rajah 6(a)** menunjukkan litar punca-sepunya NMOS dan **Rajah 6(b)** merujuk kepada litar setara AT. Diberi $R_1 = 30\ k\Omega$, $R_2 = 20\ k\Omega$, $R_D = 20\ k\Omega$, $V_{DD} = 5V$, $V_{TN} = 1\ V$, $K_n = 0.1\ mA/V^2$ dan $\lambda = 0$.]*

(i) Determine the drain current, I_D.
[Tentukan arus longkang, I_D.]

(2 Marks/ *Markah*)

(ii) Calculate the drain-to-source voltage, V_{DS}.
[Kirakan voltan longkang-sumber, V_{DS}.]

(3 Marks/ *Markah*)

(iii) Evaluate the power dissipated in the transistor.
[Nilaikan kuasa terlesap pada transistor.]

(3 Marks/ *Markah*)

(iv) Sketch and label the dc load line
[Lakar dan labelkan garis beban AT.]

(4 Marks/ *Markah*)

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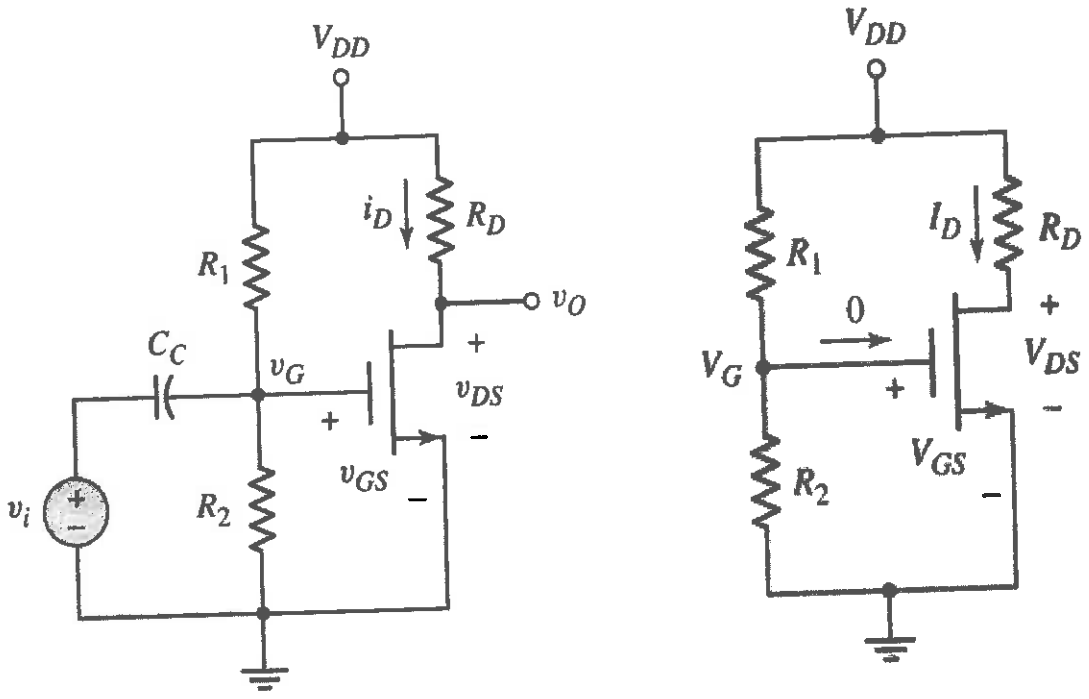

Figure 6
[Rajah 6]

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

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