# UNIVERSITI MALAYSIA PERLIS

Peperiksaan Akhir Semester Pertama
Sidang Akademik 2018/2019

Oktober 2018

## 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.**]*



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

**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) State **THREE (3)** basic types of BJT amplifiers that you know.
*[Nyatakan **TIGA (3)** jenis penguat BJT asas yang kamu tahu.]*

(3 Marks/ *Markah*)

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

(4 Marks/ *Markah*)

(d) Refer to **Figure 1**, assume $\beta = 50$ and $I_E = 2.2$ mA. Determine;
*[Rujuk **Rajah 1**, andaikan $\beta = 50$ dan $I_E = 2.2$ mA. Tentukan;]*

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

(2 Marks/ *Markah*)

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

(2 Marks/ *Markah*)

(iii) base voltage, $V_{BB}$.
*[voltan asas, $V_{BB}$.]*

(3 Marks/ *Markah*)

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

(2 Marks/ *Markah*)



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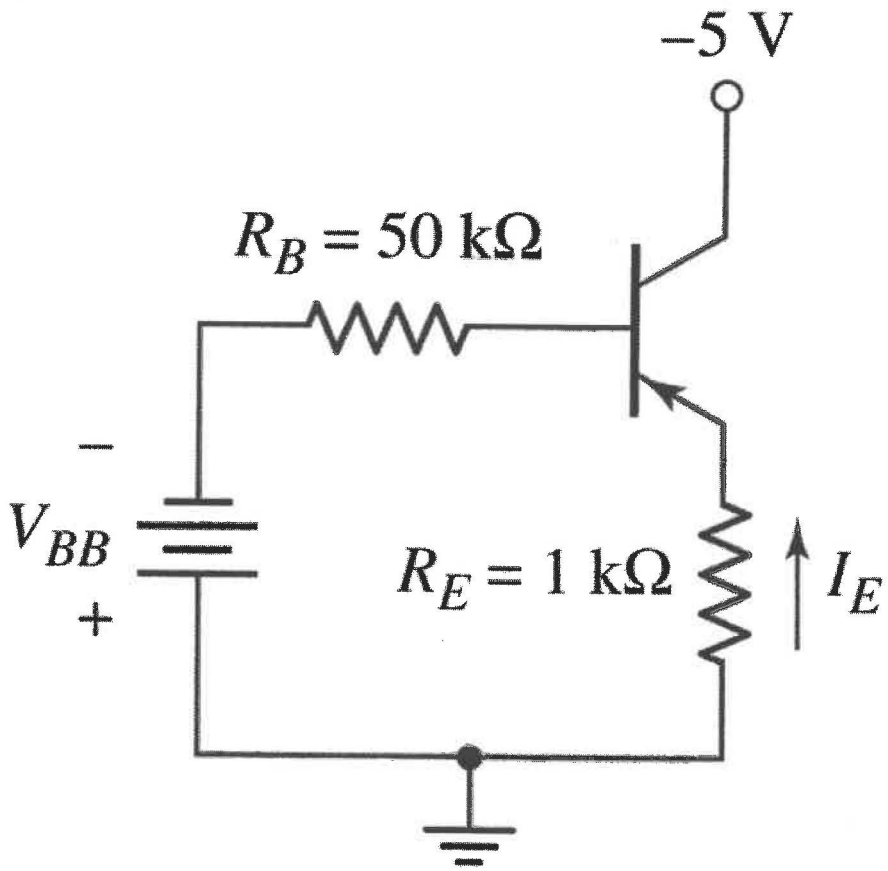


**Figure 1**
***[Rajah 1]***

**Question 2**
***[Soalan 2]***

(a) State **THREE (3)** types of Field Effect Transistor (FET).
*[Nyatakan **TIGA (3)** jenis-jenis Transistor Kesan Medan (FET).]*

(3 Marks/ *Markah*)

(b) Sketch the structure and symbol for the both channels Junction Field Effect Transistor (JFET).
*[Lakarkan struktur dan simbol bagi kedua-dua saluran Simpang Transistor Kesan Medan (JFET).]*

(4 Marks/ *Markah*)

(c) **Figure 2** show JFET amplifier for common source circuit.
***[Rajah 2** menunjukkan penguat JFET untuk litar sumber biasa.]*

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

(5 Marks/ *Markah*)

(ii) Based on **2(c)(i)**, derive the equation for Vi and $V_o$.
*[Berdasarkan **2(c)(i)**, dapatkan persaman untuk Vi dan Vo.]*

(6 Marks/ *Markah*)

(iii) Derive the equation for small-signal voltage gain, $A_v = v_o / v_i$.
*[Dapatkan persamaan untuk voltan isyarat-kecil, $A_v = v_o / v_i$.]*

(2 Marks/ *Markah*)



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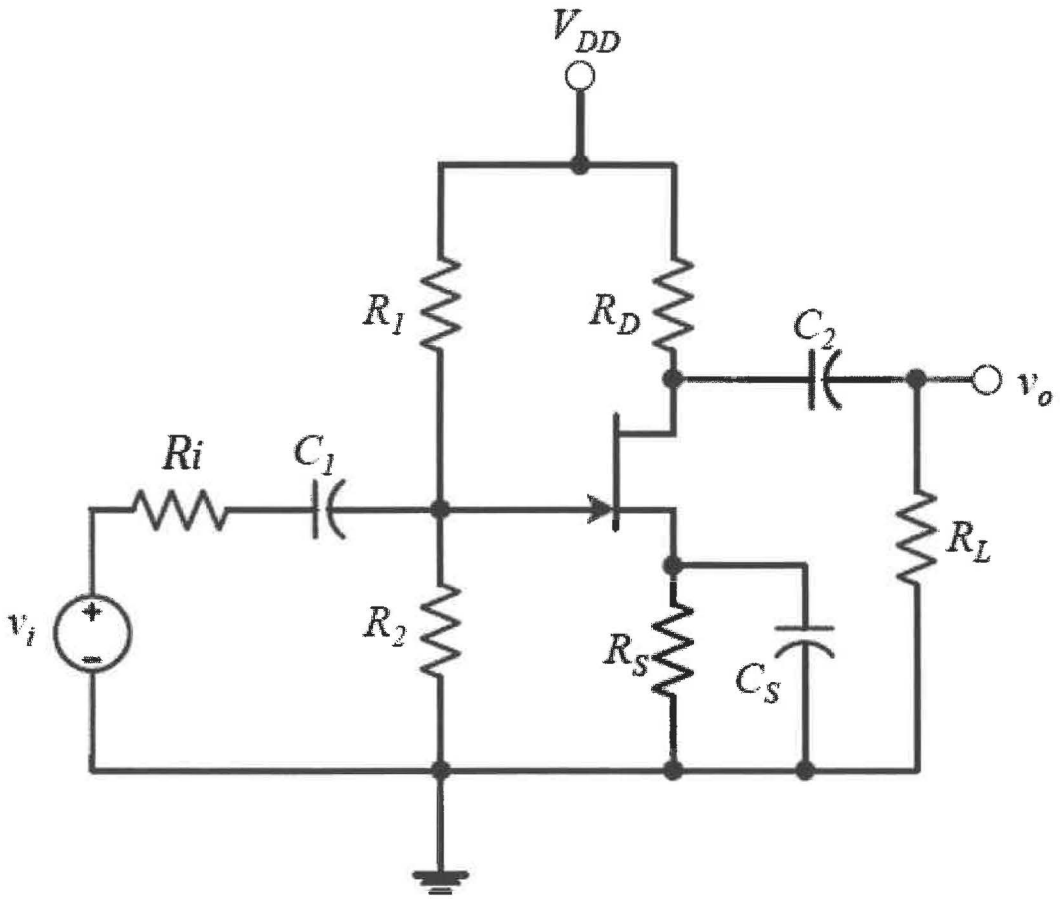


**Figure 2**
***[Rajah 2]***

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**Question 3**
***[Soalan 3]***

(a) **Figure 3** show a cascaded configuration as part of a multistage amplifier. The circuit elements transistor $Q_1$ and $Q_2$ are $\beta_1 = \beta_2 = 100$, $V_{BE(ON)} = 0.7$ V and $V_A = \infty$. Calculate;
*[**Rajah 3** menunjukkan konfigurasi terlatar sebagai sebahagian daripada penguat berbilang tahap. Elemen-elemen transistor $Q_1$ dan $Q_2$ adalah $\beta 1 = \beta 2 = 100$, $V_{BE(ON)} = 0.7$ V dan $V_A = \infty$. Kirakan;]*

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

(ii) the quiescent current for $Q_1$, $I_{BQ1}$ and $I_{CQ1}$.
*[arus sepi bagi transistor $Q_1$ , $I_{BQ1}$ dan $I_{CQ1}$.]*
(2 Marks/ *Markah*)

(iii) the quiescent current for $Q_2$, $I_{BQ2}$ 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 $r_{\pi 2}$.]*
(2 Marks/ *Markah*)

(v) transconductance, $g_{m1}$ and $g_{m2}$
*[trankonduktan, $g_{m1}$ dan $g_{m2}$.]*
(2 Marks/ *Markah*)

(b) Sketch and label the AC equivalent circuit for multistage amplifier circuit shown in **Figure 3**.
*[Lakar dan labelkan litar setara AU untuk litar penguat berbilang tahap yang ditunjukkan dalam **Rajah 3**.]*
(4 Marks/ *Markah*)

(c) Determine the small-signal voltage gain, $A_v$.
*[Tentukan gandaan voltan isyarat-kecil, $A_v$.]*
(4 Marks/ *Markah*)

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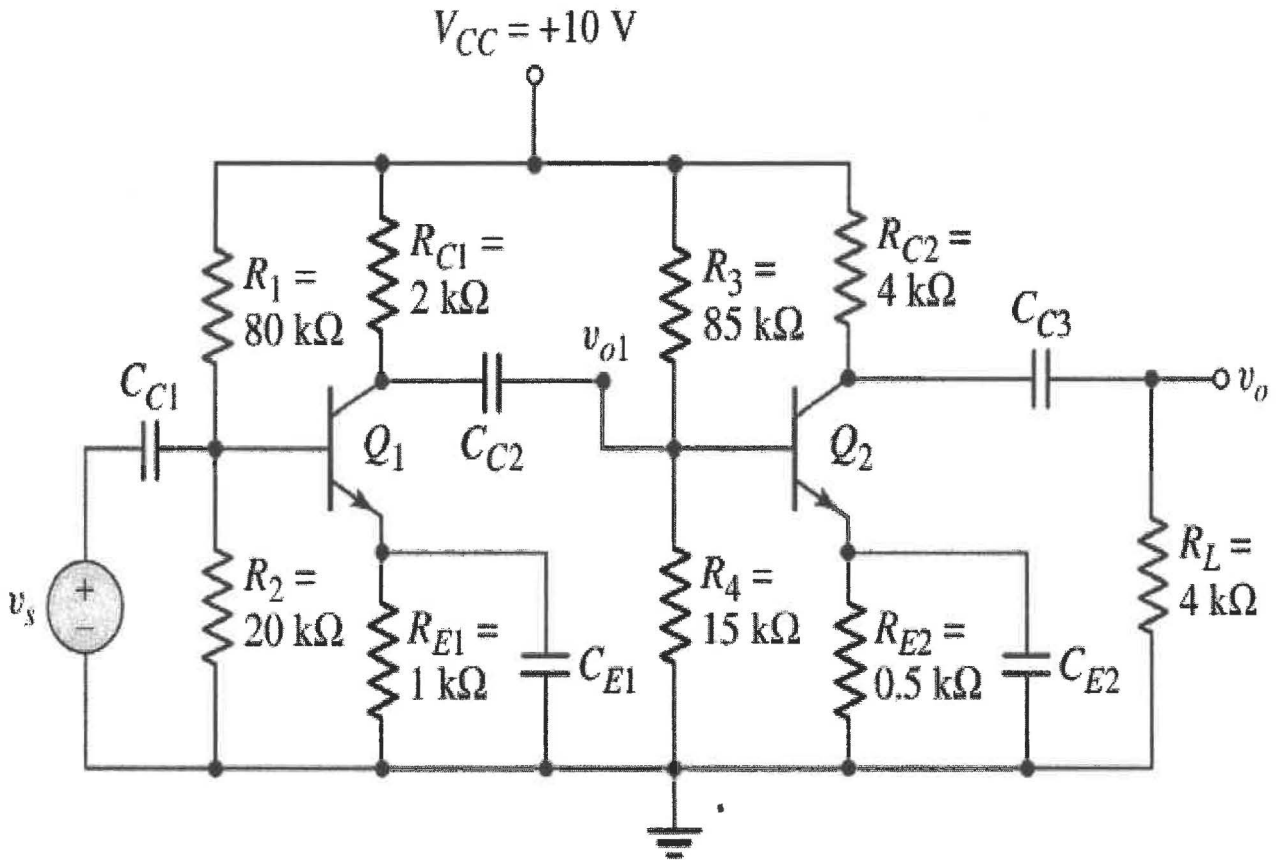


**Figure 3**
***[Rajah 3]***

**Question 4**
***[Soalan 4]***

(a) Power amplifiers are generally classified according to the percent of time the output transistors are conducting.
*[Penguat kuasa-penguat kuasa dikelaskan secara umum mengikut peratus masa masukan pengaliran transistor.]*

(i) List **FOUR (4)** types classification of power amplifiers.
*[Senaraikan **EMPAT (4)** kelas penguat-penguat kuasa.]*

(4 Marks/ *Markah*)

(ii) From **Question 4a(i)** sketch and label all class of power amplifiers.
*[Daripada **Soalan 4a(i)** lukis dan labelkan semua kelas penguat-penguat kuasa.]*

(4 Marks/ *Markah*)

(b) **Figure 4(a)** show an operation of Class B power amplifier consists of complementary pair electronic devices. Find the condition of devices A, B and $V_o$ when;
***[Rajah 4(a)** menunjukkan operasi Kelas B penguat kuasa terdiri daripada peranti elektronik pasangan pelengkap. Cari keadaan peranti A, B dan $V_o$ apabila;]*

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

(2 Marks/ *Markah*)

(ii) $Vi > 0$.
*[$V_i > 0$.]*

(2 Marks/ *Markah*)

(iii) $Vi < 0$.
*[$V_i < 0$.]*

(2 Marks/ *Markah*)

(c) **Figure 4(b)** referring to complementary push pull circuit for Class B operation. Assuming the transistor is in ideal condition, identify the condition of transistor $Q_n$, $Q_p$ and $V_o$ when;
*[**Rajah 4(b)** menunjukkan litar tarik tekan pelengkap untuk operasi Kelas B. Andaikan transistor berada pada keadaan ideal, kenalpasti keadaan transistor $Q_n$, $Q_p$ dan $V_o$ apabila;]*

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

(2 Marks/ *Markah*)

(ii) $Vi > 0$.
*[$V_i > 0$.]*

(2 Marks/ *Markah*)

(iii) $Vi < 0$.
*[$V_i < 0$.]*

(2 Marks/ *Markah*)

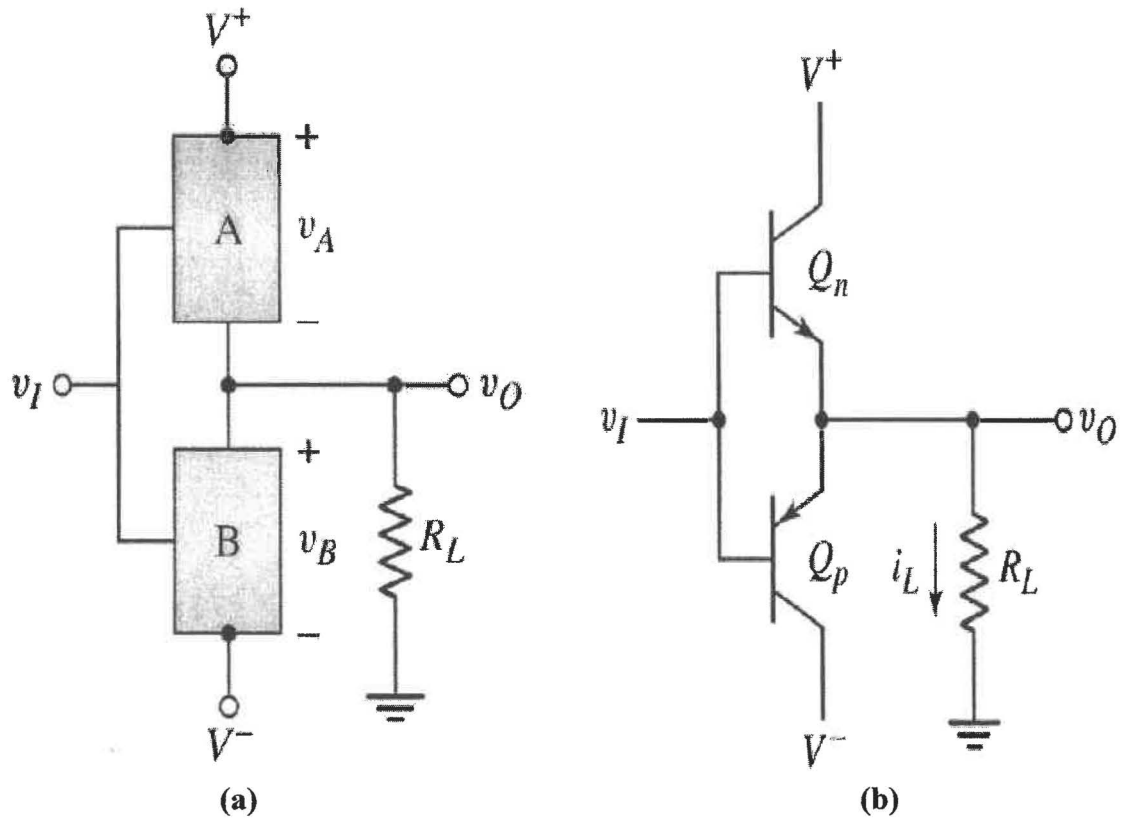


**Figure 4**
***[Rajah 4]***

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

**Question 5**
***[Soalan 5]***

(a) **Figure 5** shows a common emitter amplifier circuit with $\beta = 100$, $V_{EB(on)} = 0.7$ V, $V_T = 26$ mV and $V_A = \infty$. Evaluate;
*[**Rajah 5** menunjukkan satu litar penguat pemancar sepunya dengan $\beta = 100$, $V_{EB(on)} = 0.7$ V, $V_T = 26$mV dan $V_A = \infty$. Nilaikan;]*

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

(3 Marks/ *Markah*)

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

(3 Marks/ *Markah*)

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

(2 Marks/ *Markah*)

(iv) diffusion resistance, $r_\pi$ and output resistance, $r_o$.
*[rintangan resapan, $r_\pi$ dan rintangan keluaran, $r_o$.]*

(2 Marks/ *Markah*)

(b) Sketch small signal equivalent circuit for circuit configuration shown in **Figure 5**.
*[Lakarkan litar setara isyarat-kecil bagi konfigurasi litar yang ditunjukkan dalam **Rajah 5**.]*

(6 Marks/ *Markah*)

(c) Calculate small-signal voltage gain, $A_v$.
*[Kira isyarat-kecil gandaan voltan, $A_v$.]*

(4 Marks/ *Markah*)

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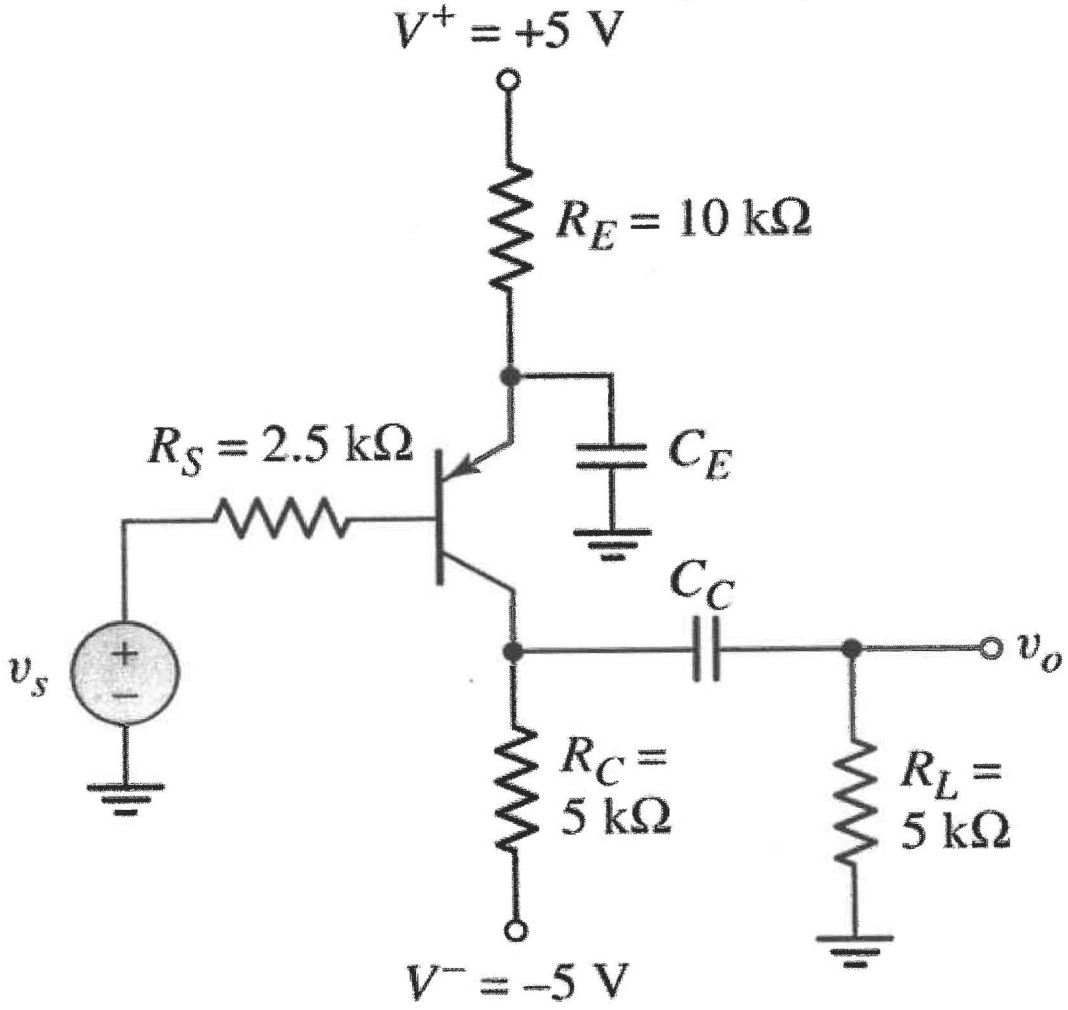


**Figure 5**
***[Rajah 5]***

**Question 6**
***[Soalan 6]***

**Figure 6** show the PMOS common-drain amplifier circuit. Given $R_1$ = 850 kΩ, $R_2$ = 350 kΩ, $R_S = R_D$ = 4 kΩ, $V_{DD}$ = 10 V, λ = 0.05 $V^{-1}$, $V_{TP}$ = -1.2 V and $K_p$ = 0.6 mA/$V^2$.
***[Rajah 6** menunjukkan litar punca-sepunya PMOS. Diberi $R_1$ = 850 kΩ, $R_2$ = 350 kΩ, $Rs = R_D$ = 4 kΩ, $V_{DD}$ = 10 V, λ = 0.05 $V^{-1}$, $V_{TP}$ = -1.2 V dan $K_p$ = 0.6 mA/$V^2$.]*

(a) Derive the equation and calculate;
*[Dapatkan persamaan dan kirakan;]*

(i) gate voltage, $V_G$.
*[ voltan pintu, $V_G$.]*

(2 Marks/ *Markah*)

(ii) source-to-gate voltage, $V_{SG}$.
*[ voltan sumber-pintu, $V_{SG}$.]*

(3 Marks/ *Markah*)

(iii) drain current, $I_{DQ}$.
*[arus longkang $I_{DQ}$.]*

(2 Marks/ *Markah*)

(iv) source -to- drain voltage, $V_{SD}$.
*[voltan sumber-longkang, $V_{SD}$.]*

(3 Marks/ *Markah*)

(b) Sketch small signal equivalent circuit for circuit configuration shown in **Figure 6.**
*[Lakarkan litar setara isyarat-kecil bagi konfigurasi litar yang ditunjukkan dalam **Rajah 6.**]*

(4 Marks/ *Markah*)

(c) From question **6(b)**, determine;
*[Daripada soalan **6(b)**, tentukan;]*

(i) transconductance, $g_m$.
*[trankonduktan, $g_m$.]*

(2 Marks/ *Markah*)

(ii) output resistance, $r_o$
*[rintangan keluaran ,$r_o$.]*

(2 Marks/ *Markah*)

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

(2 Marks/ *Markah*)

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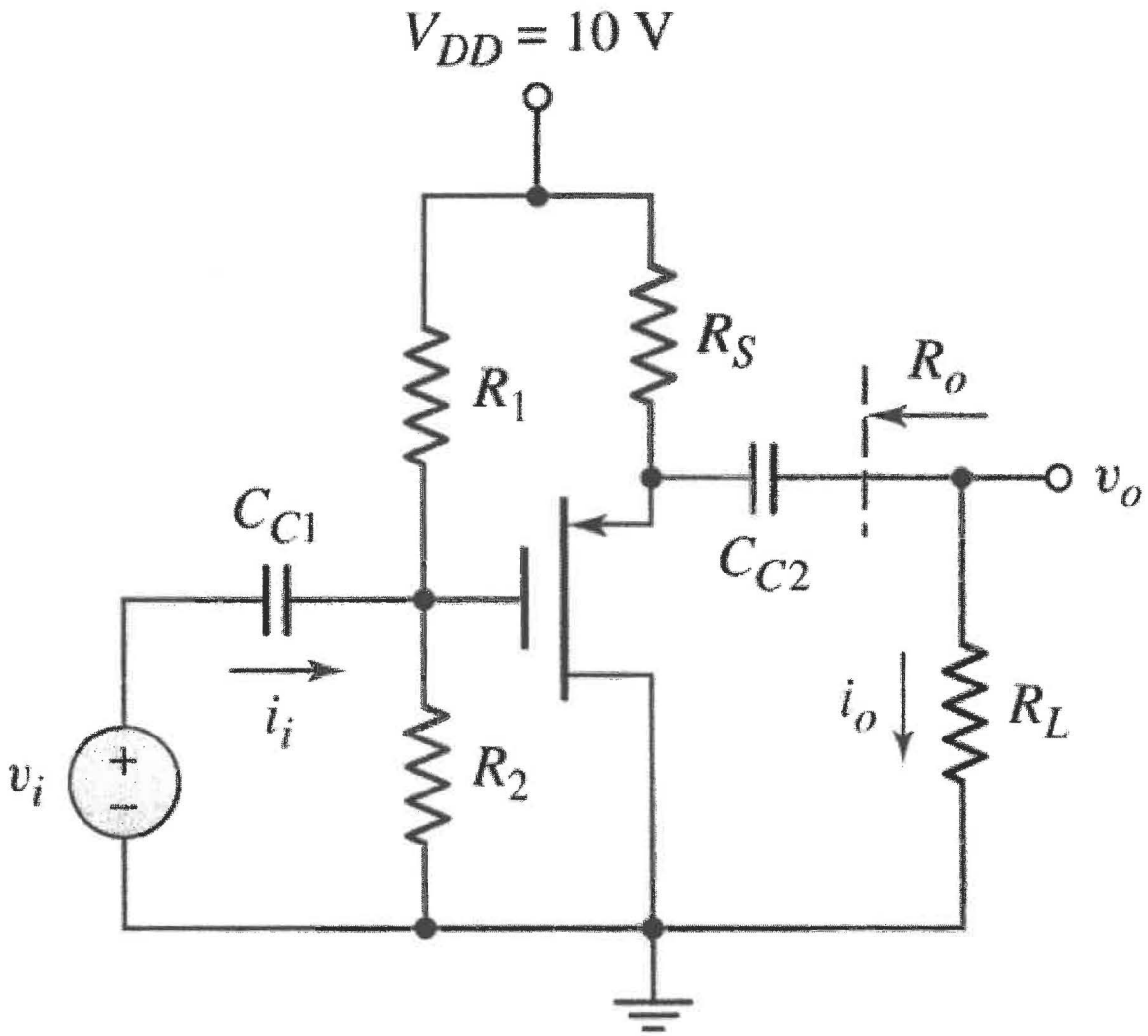


**Figure 6**
***[Rajah 6]***

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