KOLEJ YAYASAN PELAJARAN JOHOR

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FINAL EXAMINATION

COURSE NAME	:	**ELECTRONIC CIRCUIT**
COURSE CODE	:	**DEE 1073**
EXAMINATION	:	**JANUARY 2024**
DURATION	:	**2 HOURS 30 MINUTES**

INSTRUCTION TO CANDIDATES/
ARAHAN KEPADA CALON

1. This examination paper consists of **FOUR (4)** questions. /
   *Kertas soalan ini mengandungi **EMPAT (4)** soalan.*

2. Candidates are not allowed to bring any material to examination room except with the permission from the invigilator. The formula was attached at the back of the question paper. /
   Calon tidak dibenarkan untuk membawa sebarang bahan/nota ke bilik peperiksaan tanpa arahan/kebenaran daripada pengawas. Rumus dilampirkan di belakang kertas soalan peperiksaan.

3. Please check to make sure that this examination pack consists of: /
   Pastikan kertas soalan peperiksaan ini mengandungi:
   i. Question Paper /
      Kertas Soalan
   ii. Answering Booklet /
      Buku Jawapan
   iii. Attachment 1 /
      Lampiran 1
   iv. Attachment 2 /
      Lampiran 2
   v. Attachment 3 /
      Lampiran 3

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO /
JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIBERITAHU

This examination paper consists of **12** printed pages including front page
*Kertas soalan ini mengandungi **12** halaman bercetak termasuk muka hadapan*

This examination paper consists of **FOUR (4)** questions. Answer **ALL** the questions in the Answer booklet.
*Kertas soalan ini mengandungi **EMPAT (4)** soalan. Jawab **SEMUA** soalan dalam buku jawapan.*

QUESTION 1/ *SOALAN 1*

a) Draw the transfer curve using shorthand method for **Figure 1(a).** The graph is given in the **Attachment 1**.

(10 marks/ *markah*)

b) Solve the value of I_{DQ} and V_{GSQ} using the universal curve given in the **Attachment 2**.

(5 marks/ *markah*)

c) Using answer in question (b), solve value of V_{DS}, V_S, V_G and V_D.

(9 marks/ *markah*)

d) If the value of R_S increased, what happen to Q-point?

(1 marks/ *markah*)

*a) Lukiskan lengkuk pindah menggunakan kaedah terengkas bagi **Rajah 1(a).** Graf diberikan di **Lampiran 1**.*

*b) Selesaikan nilai I_{DQ} and V_{GSQ} menggunakan lengkuk universal yang diberikan dalam **Lampiran 2**.*

c) Selesaikan nilai V_{DS}, V_S, V_G and V_D dengan menggunakan jawapan pada soalan b.

d) Jika jumlah R_S meningkat, apakah akan terjadi terhadap titik - Q?

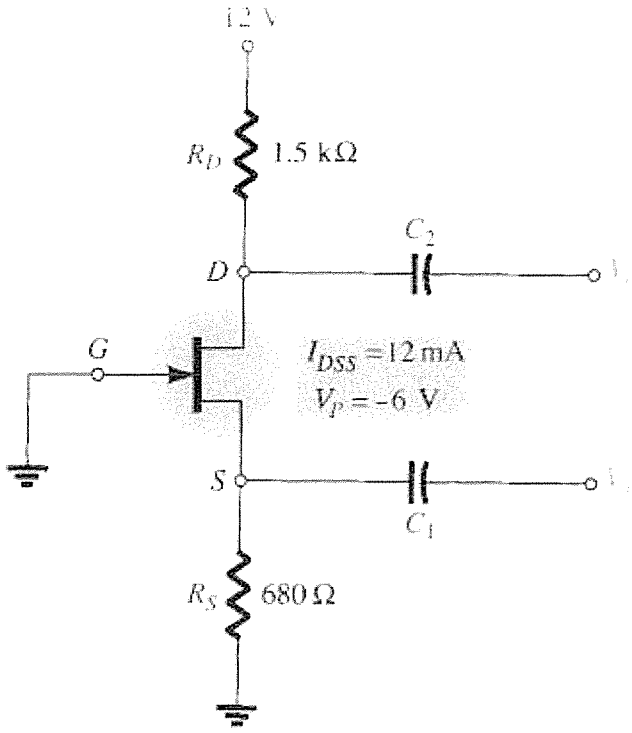


Figure 1(a) / *Rajah 1(a)*

QUESTION 2/ *SOALAN 2*

a) Solve the value of transconductance, g_{mo} for a JFET having device parameters I_{DSS} = 12 mA and Vp = -4 V.

(5 marks/ *markah*)

b) Solve the value of Z_i, Z_o and A_v for circuit in **Figure 2(b)**. Given, I_{DSS} = 10 mA,Vp = -6 V, and rd = 40 kΩ.

(20 marks/ *markah*)

a) Selesaikan nilai bagi kealiran *pindah, g_{mo} untuk JFET yang mempunyai parameter I_{DSS} = 12 mA dan Vp = -4 V.*

c) *b) Selesaikan nilai bagi* of Z_i, Z_o *dan* A_v untuk *litar dalam* ***Rajah 2(b)****. Diberikan* I_{DSS} = 10 mA, Vp = -6 V, and rd = 40 kΩ.

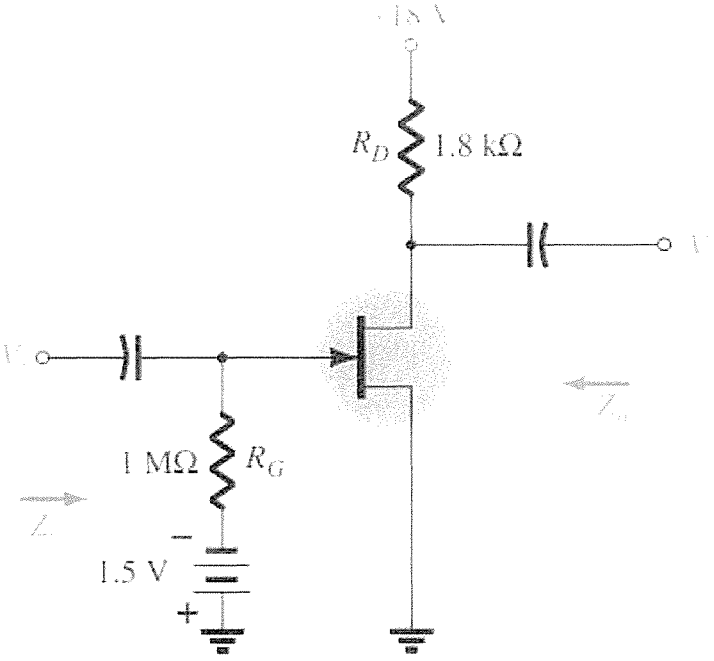


Figure 2(b) / *Rajah 2(b)*

QUESTION 3/ *SOALAN 3*

Differential operation involves the use of opposite-polarity inputs. Common-mode operation involves the use of the same-polarity inputs. Common-mode rejection ratio (CMRR) compares the gain for differential inputs to that for common inputs.

a) Solve the CMRR (in dB) for the circuit measurements of V_d = 1 mV, V_o = 120 mV, V_C = 1 mV, and Vo = 20 μV.

(8 marks/ *markah*)

b) Solve the output voltage for **Figure 3(b)**. Given V_1 = 50 sin(1000t) mV and V_2 = 10 sin(3000t) mV.

(5 marks/ *markah*)

c) Solve the output voltage, V_o for the op-amp circuit in **Figure 3(c)**. Given V_1 = 12 mV and V_2 = 18 mV.

(12 marks/ *markah*)

Operasi pembezaan melibatkan penggunaan masukan kutub berlawanan. Operasi mod biasa melibatkan penggunaan masukan kutub sama. Nisbah penolakan mod biasa (CMRR) membandingkan gandaan bagi masukan pembezaan terhadap masukan biasa.

a) *Selesaikan nilai CMRR (dalam dB) bagi ukuran litar Vd = 1 mV, V_o = 120 mV, V_C = 1mV, dan Vo = 20 μV.*

b) *Selesaikan voltan keluaran bagi* ***Rajah 3(b)****. Diberi V_1 = 50 sin(1000t) mV dan V_2 = 10 sin(3000t) mV.*

c) *Merujuk kepada litar penguat kendalian dalam* ***Rajah 3(c)****, kirakan voltan keluaran, V_o. Diberi V_1 = 12 mV dan V_2 = 18 mV.*

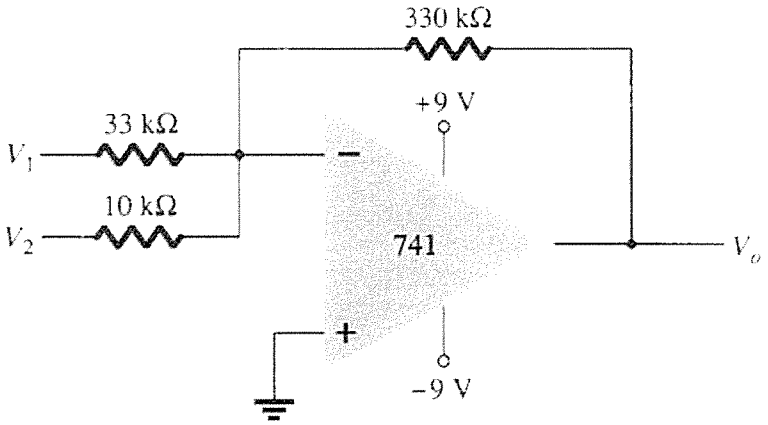


Figure 3(b) / *Rajah 3(b)*

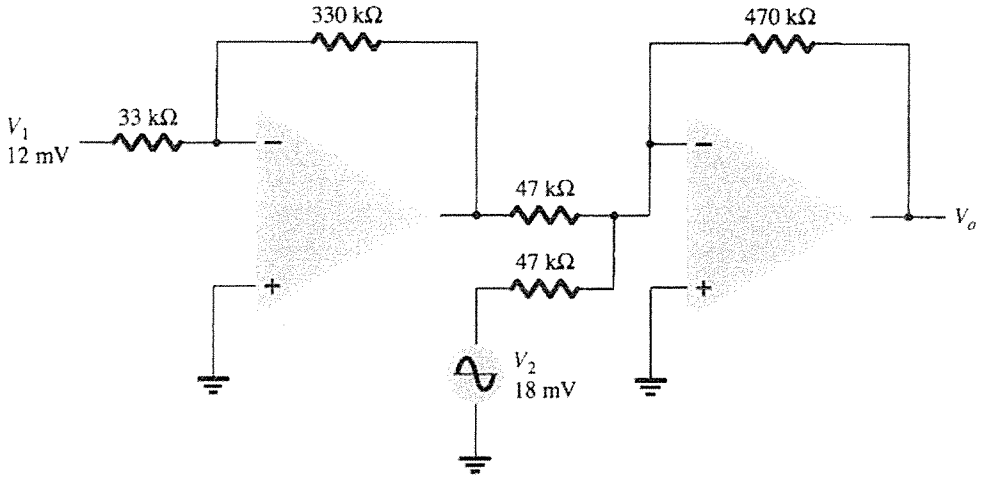


Figure 3(c) / *Rajah 3(c)*

QUESTION 4/ *SOALAN 4*

Power Amplifier can be categorized into several classes. Each class will be different in their operating cycle and efficiency. Based on Class B Power Amplifier circuit in **Figure 4**, solve the value of:

a) the peak input voltage, $V_{i(p)}$.

(3 marks/ *markah*)

b) the peak voltage across the load, $V_{L(p)}$.

(1 marks/ *markah*)

c) the peak load current, $I_{L(p)}$.

(3 marks/ *markah*)

d) the direct current, I_{DC}.

(3 marks/ *markah*)

e) the input power, $P_{in(dc)}$.

(3 marks/ *markah*)

f) the output power, $P_{o(ac)}$.

(2 marks/ *markah*)

g) the power dissipated by each output transistor, P_Q.

(4 marks/ *markah*)

h) the circuit efficiency, %η.

(3 marks/ *markah*)

i) the maximum input power, $P_{in(max)}$.

(1.5 marks/ *markah*)

j) the maximum output power, $P_{o(max)}$.

(1.5 marks/ *markah*)

*Penguat Kuasa boleh dikategorikan kepada beberapa kelas. Setiap kelas akan berbeza dari segi kitaran operasi dan kecekapan Berdasarkan litar Penguat Kuasa Kelas B dalam **Rajah 4**, kirakan:*

a) voltan puncak merentasi masukan, $V_{i(p)}$.

b) voltan puncak merentasi beban, $V_{L(p)}$.

c) arus puncak pada beban, $I_{L(p)}$.

d) arus terus, I_{DC}.

e) kuasa masukan, $P_{in(dc)}$.

f) kuasa keluaran, $P_{o(ac)}$.

g) kuasa yang dilesapkan oleh setiap keluaran transistor, P_Q.

h) kecekapan litar, %η.

i) kuasa masukan maksimum $P_{in(max)}$.

j) kuasa keluaran maksimum $P_{o(max)}$.

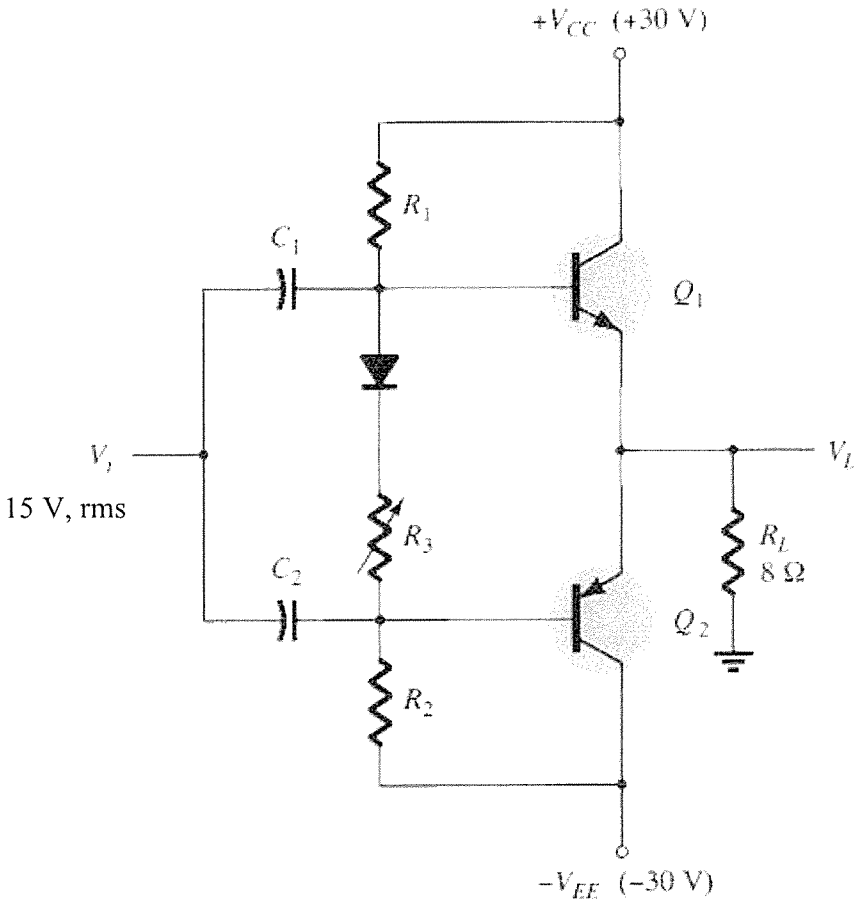


Figure 4 / *Rajah 4*

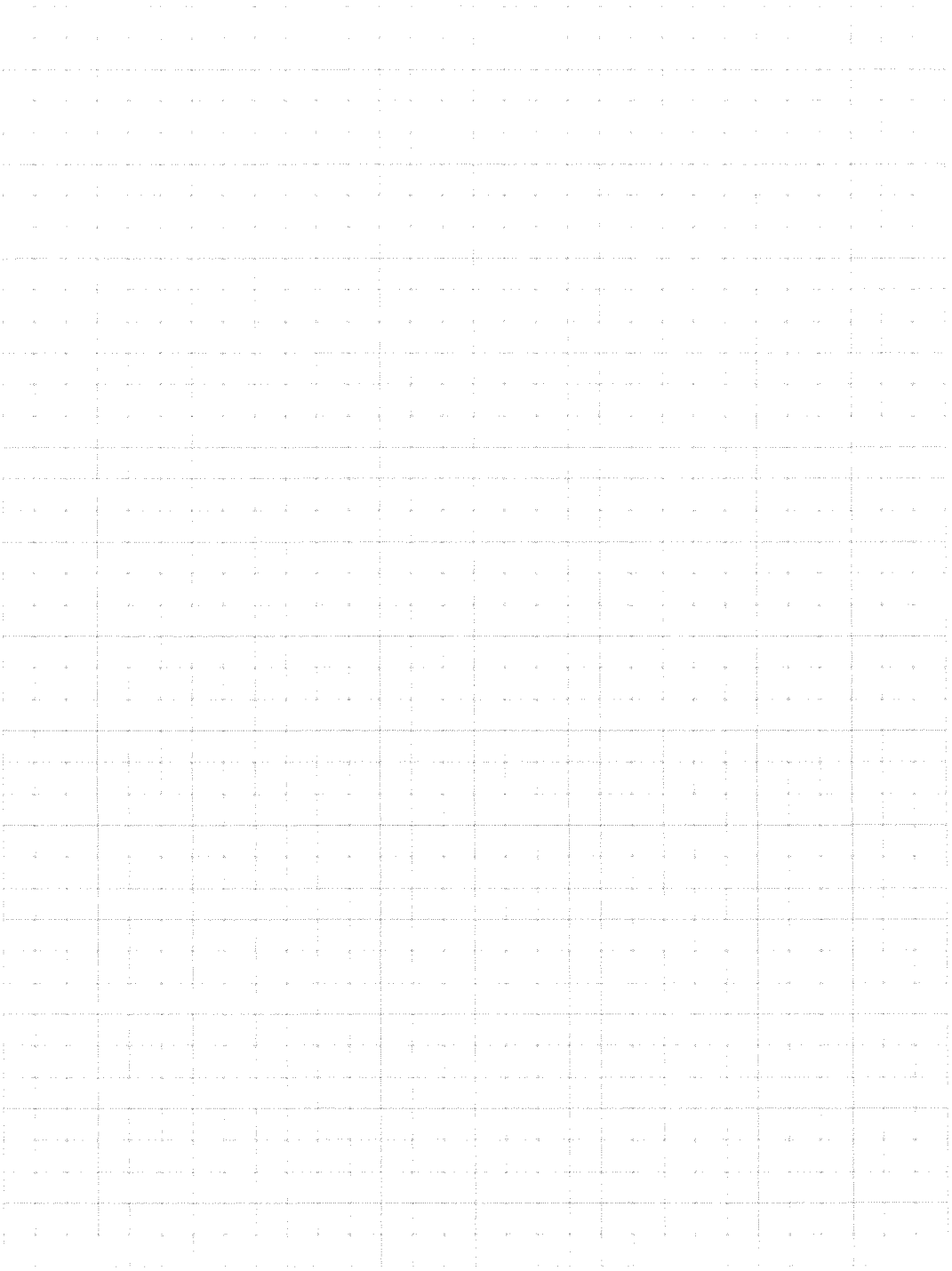
[100 MARKS/ *MARKAH*]

END OF QUESTION PAPER/ *KERTAS SOALAN TAMAT*

Attachment 1 / *Lampiran 1*

Name / *Nama* :.....

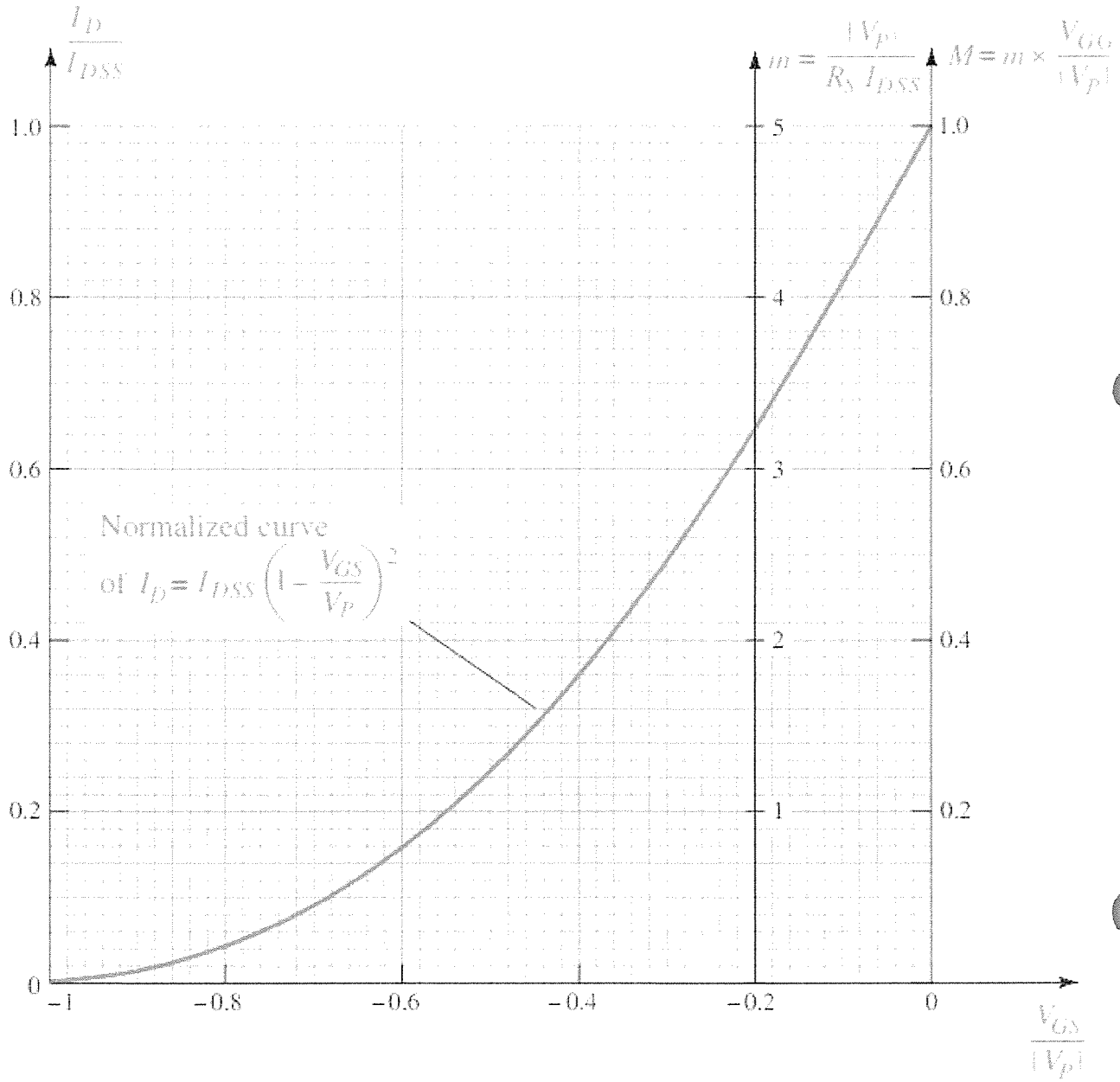
Lecturer / *Pensyarah* :.....



Attachment 2 / *Lampiran 2*

Name / *Nama* :.....

Lecturer / *Pensyarah* :.....



Attachment 3 / Lampiran 3

Formula / Rumus

JFET:

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

$$I_D = I_{DSS}|_{V_{GS}=0\text{ V}}, \quad I_D = 0\text{ mA}|_{V_{GS}=V_P}, \quad I_D = \left.\frac{I_{DSS}}{4}\right|_{V_{GS}=V_P/2}, \quad V_{GS} \cong 0.3V_P|_{I_D=I_{DSS}/2}$$

$$V_{GS} = V_P\left(1 - \sqrt{\frac{I_D}{I_{DSS}}}\right)$$

$$P_D = V_{DS}I_D$$

$$r_d = \frac{r_o}{(1 - V_{GS}/V_P)^2}$$

MOSFET (enhancement):

$$I_D = k(V_{GS} - V_T)^2$$

$$k = \frac{I_{D(on)}}{(V_{GS(on)} - V_T)^2}$$

JFETs/depletion-type MOSFETs:

Fixed-bias configuration: $V_{GS} = -V_{GG} = V_G$

Self-bias configuration: $V_{GS} = -I_D R_S$

Voltage-divider biasing: $V_G = \frac{R_2 V_{DD}}{R_1 + R_2}$

$$V_{GS} = V_G - I_D R_S$$

Enhancement-type MOSFETs:

Feedback biasing: $V_{DS} = V_{GS}$

$$V_{GS} = V_{DD} - I_D R_D$$

Voltage-divider biasing: $V_G = \frac{R_2 V_{DD}}{R_1 + R_2}$

$$V_{GS} = V_G - I_D R_S$$

$$g_m = y_{fs} = \frac{\Delta I_D}{\Delta V_{GS}}$$

$$g_{m0} = \frac{2I_{DSS}}{|V_P|}$$

$$g_m = g_{m0}\left[1 - \frac{V_{GS}}{V_P}\right]$$

$$g_m = g_{m0}\sqrt{\frac{I_D}{I_{DSS}}}$$

$$r_d = \frac{1}{y_{os}} = \left.\frac{\Delta V_{DS}}{\Delta I_D}\right|_{V_{GS}=\text{constant}}$$

$$\text{CMRR} = 20 \log_{10} \left| \frac{A_d}{A_c} \right|$$

Inverting amplifier:

$$\frac{V_o}{V_i} = -\frac{R_f}{R_1}$$

Noninverting amplifier:

$$\frac{V_o}{V_i} = 1 + \frac{R_f}{R_1}$$

Unity follower:

$$V_o = V_1$$

Summing amplifier:

$$V_o = -\left(\frac{R_f}{R_1}V_1 + \frac{R_f}{R_2}V_2 + \frac{R_f}{R_3}V_3\right)$$

Integrator amplifier:

$$v_o(t) = -\frac{1}{RC}\int v_1(t)\,dt$$

$$\text{Slew rate (SR)} = \frac{\Delta V_o}{\Delta t} \qquad \text{V}/\mu\text{s}$$

Constant-gain multiplier:

$$A = -\frac{R_f}{R_1}$$

Noninverting constant-gain multiplier:

$$A = 1 + \frac{R_f}{R_1}$$

Voltage-summing amplifier:

$$A = -\left[\frac{R_f}{R_1}V_1 + \frac{R_f}{R_2}V_2 + \frac{R_f}{R_3}V_3\right]$$

Voltage buffer:

$$V_o = V_1$$

Low-pass active filter cutoff frequency:

$$f_{\text{OH}} = \frac{1}{2\pi R_1 C_1}$$

High-pass active filter cutoff frequency:

$$f_{\text{OL}} = \frac{1}{2\pi R_1 C_1}$$

$P_i(\text{dc}) = V_{CC} I_{CC}$

$P_o(\text{ac}) = V_C(\text{rms}) I_C(\text{rms})$

$= I_C^2(\text{rms}) R_C$

$= \dfrac{V_C^2(\text{rms})}{R_C}$

$P_o(\text{ac}) = \dfrac{V_{CE}(\text{p}) I_C(\text{p})}{2}$

$= \dfrac{I_C^2(\text{p})}{2R_C}$

$= \dfrac{V_{CE}^2(\text{p})}{2R_C}$

$P_o(\text{ac}) = \dfrac{V_{CE}(\text{p-p}) I_C(\text{p-p})}{8}$

$= \dfrac{I_C^2(\text{p-p})}{8} R_C$

$= \dfrac{V_{CE}^2(\text{p-p})}{8R_C}$

$\% \eta = \dfrac{P_o(\text{ac})}{P_i(\text{dc})} \times 100\%$

Transformer action:

$$\frac{V_2}{V_1} = \frac{N_2}{N_1}$$

$$\frac{I_2}{I_1} = \frac{N_1}{N_2}$$

$$I_{\text{dc}} = \frac{2}{\pi} I(\text{p})$$

$$P_i(\text{dc}) = V_{CC}\left(\frac{2}{\pi} I(\text{p})\right)$$

$$P_o(\text{ac}) = \frac{V_L^2(\text{rms})}{R_L}$$

$$\text{maximum } P_o(\text{ac}) = \frac{V_{CC}^2}{2R_L}$$

$$\text{maximum } P_i(\text{dc}) = V_{CC}(\text{maximum } I_{\text{dc}}) = V_{CC}\left(\frac{2V_{CC}}{\pi R_L}\right) = \frac{2V_{CC}^2}{\pi R_L}$$

$$\text{maximum } P_{2Q} = \frac{2V_{CC}^2}{\pi^2 R_L}$$

Harmonic distortion:

$$\%\ n\text{th harmonic distortion} = \%\ D_n = \frac{|A_n|}{|A_1|} \times 100\%$$

Heat sink:

$$\theta_{JA} = \theta_{JC} + \theta_{CS} + \theta_{SA}$$