Name:______________________________

Matric No:______________ Section:_____

الجامعة الإسلامية العالمية ماليزيا

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

MID-TERM EXAMINATION
SEMESTER II, 2017/2018 SESSION
KULLIYYAH OF ENGINEERING

Programme	: ENGINEERING	Level of Study	: UG 2
Time	: 8:00 pm-10:00 pm	Date	: 25/10/2018
Duration	: 2 Hours		
Course Code	: EECE 2313/ ECE 2133	Section(s)	: 1, 2
Course Title	: **Electronic Circuits**		

This Question Paper consists of **Six (6)** Printed Pages (Including Cover and a blank page) with **Three (3)** Questions.

INSTRUCTION(S) TO CANDIDATES

DO NOT OPEN UNTIL YOU ARE ASKED TO DO SO

- **Use only pen for writing the answer.**
- **Do not use your own paper sheet and no extra paper will be provided**
- A total mark of this examination is **60**.
- This examination is worth **30%** of the total assessment.
- For drawing you may use a pencil
- Answer **ALL THREE(3)** questions
- **Answer on the question paper**

Any form of cheating or attempt to cheat is a serious offence which may lead to dismissal.

	Question 1	Question 2	Question 3	Total Marks
Marks	20	20	20	60
Marks Obtained				

Q.1 [20 marks]

(a) Consider the circuit as shown in **Fig. 1(a)**, derive the expression (step by step) for the voltage transfer function $T(s) = v_o(s)/v_i(s)$. Find the corner frequencies of the circuit if $R_s = 3\ k\Omega$, $R_p = 9\ k\Omega$ and $C_p = 10$ nF **(6+2 marks)**

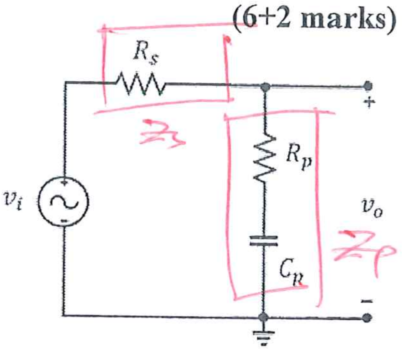


Fig. 1(a)

$T(s) = \frac{V_o(s)}{V_i(s)} = \frac{Z_p}{Z_p + Z_s}$

$Z_p = R_p + \frac{1}{sC_p} = \frac{1 + sC_pR_p}{sC_p}$

$Z_p + Z_s = R_p + \frac{1}{sC_p} + R_s = \frac{1 + sC_p(R_p + R_s)}{sC_p}$

$\therefore T(s) = \frac{(1 + sC_pR_p)/sC_p}{[1 + sC_p(R_p + R_s)]/sC_p} = \frac{1 + sC_pR_p}{1 + sC_p(R_p + R_s)}$

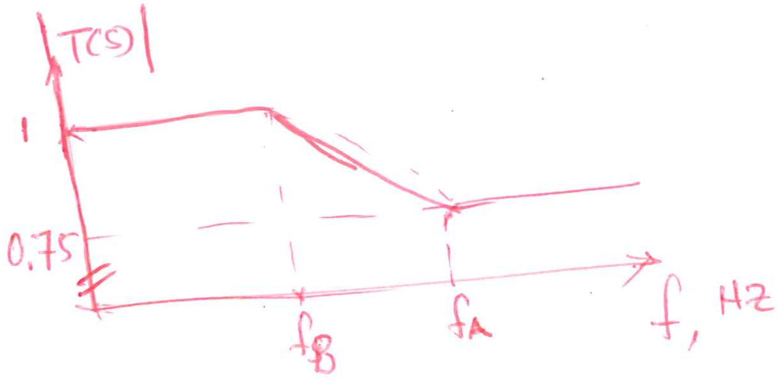
$= \frac{1 + s\tau_A}{1 + s\tau_B}$

$\tau_A = C_pR_p = 9k \times 10n = 90\mu s.$

$\therefore f_A = \frac{1}{2\pi\tau_A} = 1.77\ KHz$

$\tau_B = C_p(R_p + R_s)C_p = 12k \times 10n = 120\mu s$

$f_B = \frac{1}{2\pi\tau_B} = 1.326\ KHz$



(b) Draw the Bode plot (magnitude and phase) of the following transfer function.

(8 marks)

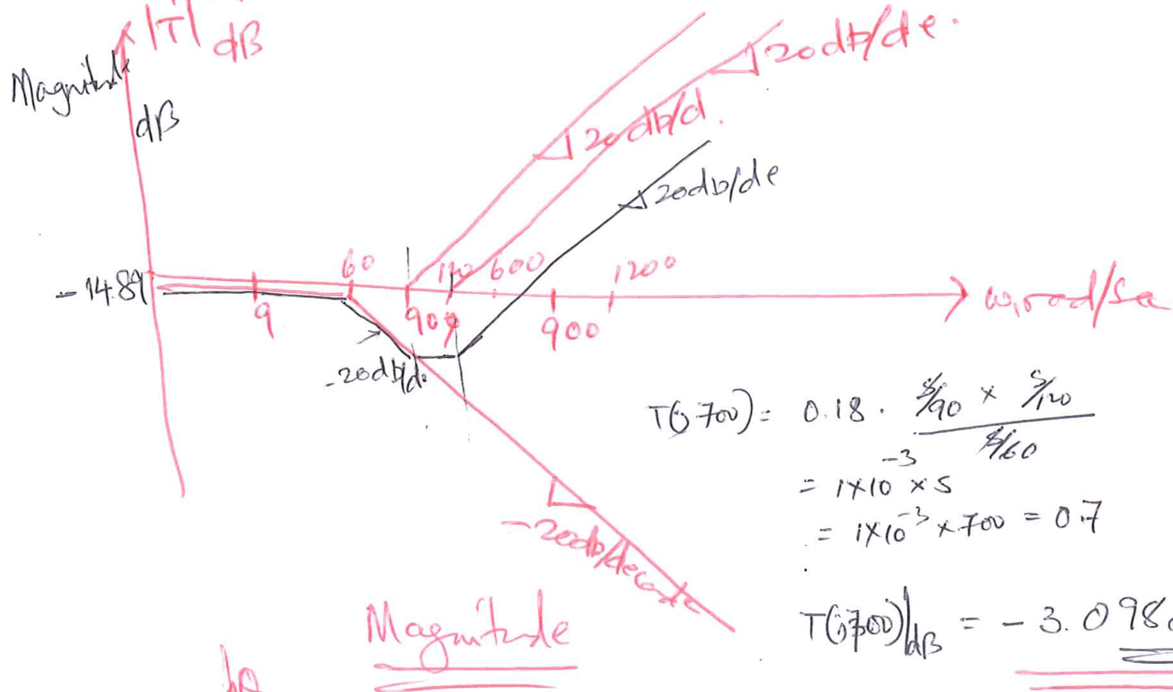
$$T(s) = \frac{10^{-3}(s+90)(s+120)}{(s+60)}$$

(c) Determine the magnitude and phase at $s = 700$ rad/Sec, using the solution from the graph of the question Q1.(b).

(4 marks)

$$T(s) = \frac{10^{-3}\, 90\,(1+\frac{s}{90})\, 120\,(1+\frac{s}{120})}{60\,[1+\frac{s}{60}]} = 0.18\, \frac{(1+\frac{s}{90})(1+\frac{s}{120})}{(1+\frac{s}{60})}$$

$0.18 \rightarrow -14.89\,dB$

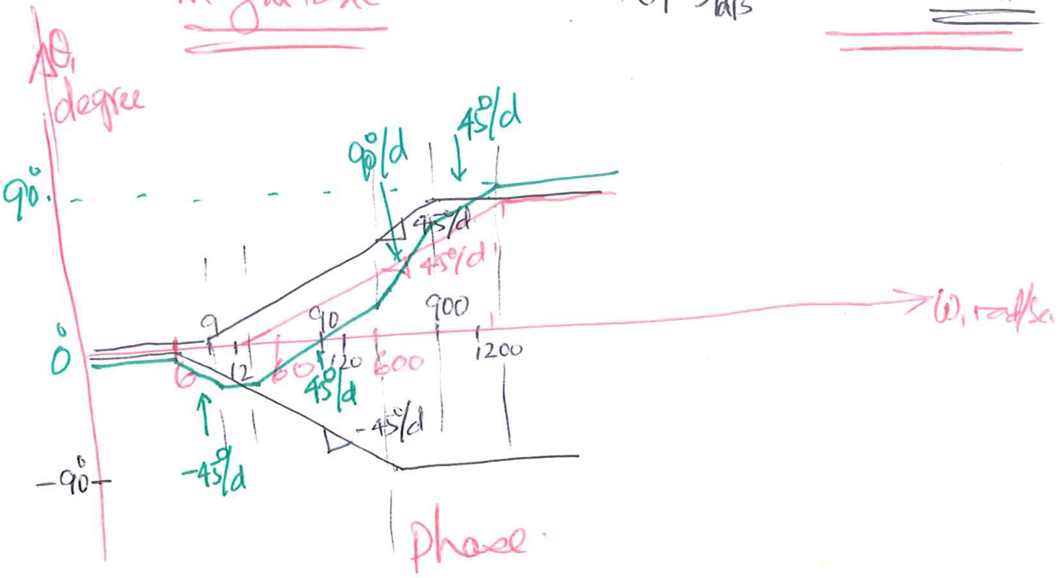


$T(j700) = 0.18 \cdot \frac{s/90 \times s/120}{s/60}$

$= 1\times10^{-3} \times s$

$= 1\times10^{-3} \times 700 = 0.7$

$T(j700)|_{dB} = -3.098\,dB.$



$$\rightarrow \theta = \tan^{-1}\frac{\omega}{90} + \tan^{-1}\frac{\omega}{120} - \tan^{-1}\frac{\omega}{60}$$

$$= 82.67 + 80.27 - 85.1 = 77.83^{\circ}$$

$\omega = 700$ rad/sec

Q.2 [20 marks]

A common source amplifier is shown in **Fig. 2,** with the following circuit component values $R_{si} = 10k\Omega$, $R_G = 40k\Omega$, $R_S = 5k\Omega$, $R_D = 10k\Omega$, ~~$R_L = 6k\Omega$~~, Design the circuit for lower corner frequency $f_L = 250Hz$ and higher corner frequency $f_H = 100kHz$. The MOSFET has a small-signal parameters, $g_m = 45$ mA/V and $r_o = \infty$.

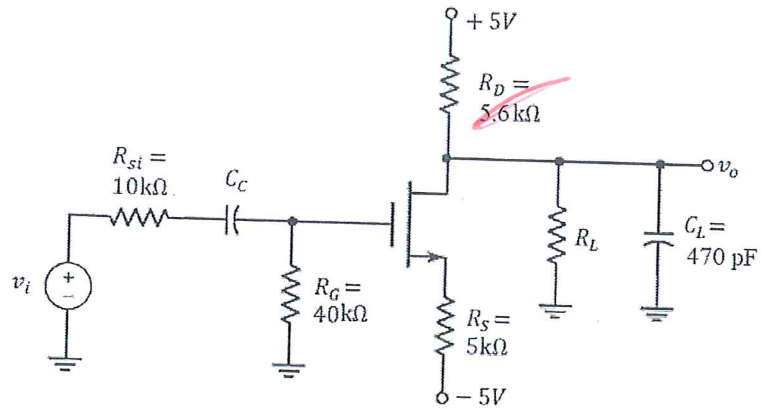


Fig. 2

(i) Draw the small signal equivalent circuit diagram of the circuit **(3 marks)**

(ii) Evaluate the midband gain, $A_v = v_o/v_i$ of the amplifier in dB scale **(7 marks)**

(iii) Determine the coupling capacitance C_C **(3 marks)**

(iv) Determine the load resistance R_L **(7 marks)**

Q.3 [20 marks]

A common emitter amplifier is shown in **Fig. 3** that operates at very high frequencies. The transistor parameters are: g_m = 40mA/V, r_π = 2.5kΩ and r_o = 25kΩ, C_π = 8pF and C_μ = 2pF. Assume that $C_{C2} = C_E = \infty$ and $C_{C1} = 3.3\mu F$.

i) Draw the simplified high-frequency small signal equivalent circuit diagram and Miller equivalent circuit diagram **(3 marks)**

ii) Determine the midband gain $A_v = v_o/v_i$ **(7 marks)**

iii) Write the expression of Miller capacitance and find its value **(3 marks)**

iv) Evaluate the upper 3dB frequency (f_H) considering Miller capacitance and without considering Miller capacitance **(2 marks)**

v) Evaluate the lower 3dB frequency (f_L) **(5 marks)**

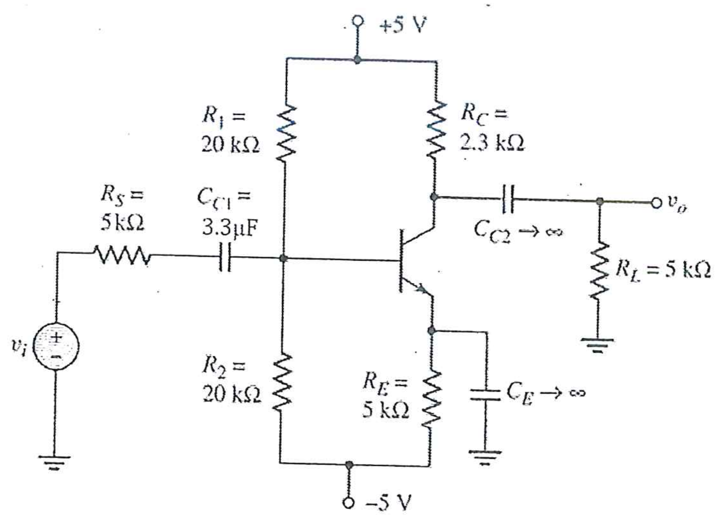
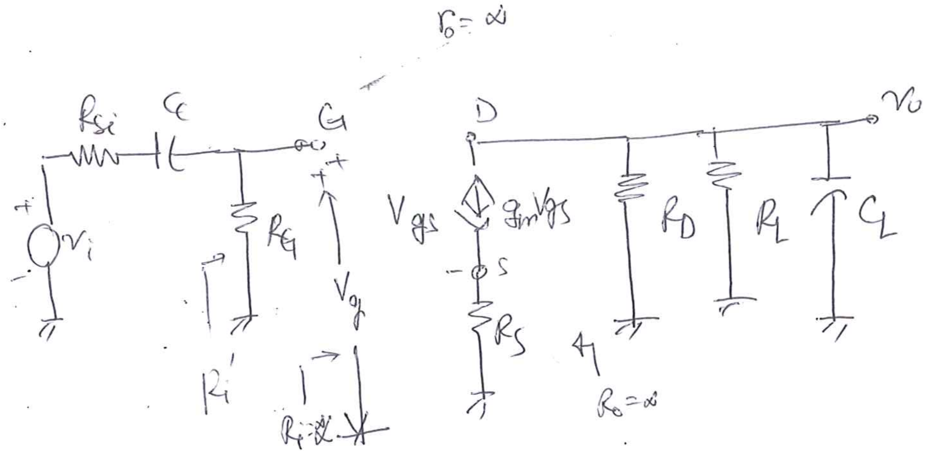


Fig. 3

Q.2.

i)



ii)

$$A_{V_A}\Big|_{midband} = \frac{v_o}{v_g} = \frac{-g_m V_{gs} R_L'}{V_{gs} + g_m V_{gs} R_s} \qquad R_L' = R_D \| R_L$$

$$= \frac{-g_m R_L'}{(1 + g_m R_s)} \qquad R_L' = ?$$

$$A_{V_m} = A_{V_A mid} \times \frac{R_i'}{R_i' + R_{si}} \qquad R_i' = R_G$$

$$= A_{V mid} \times \frac{R_G}{R_G + R_{si}} = A_{V_A mid} \times \frac{40}{40+10} = 0.8\, A_{V_A mid}$$

(iii)

$$f_L = \frac{1}{2\pi (R_{si} + R_i') C_c}$$

$$C_c = \frac{1}{2\pi f_L (R_{si} + R_G)} = \frac{1}{2\pi \times 250 \times (40+10)k} = 12.73nF$$

(iv)

$$C_L = \frac{1}{2\pi f_H R_L'} \qquad R_L' = \frac{1}{2\pi C_L f_H} = \frac{1}{2\pi \times 470n \times 100k}$$

$$= 3.386\,k\Omega = R_D \| R_L$$

$$\frac{1}{R_L} + \frac{1}{R_D} = \frac{1}{R_L'} = 295.3 \times 10^{-6} \qquad R_L = 5.12k\Omega$$

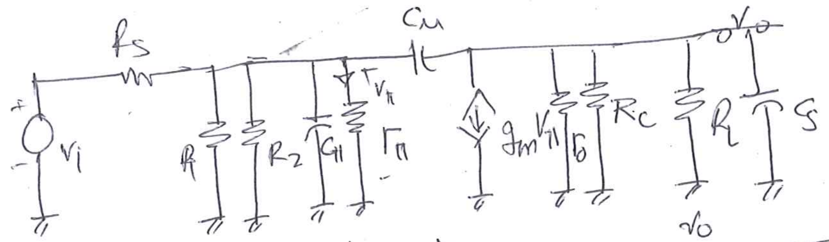
(iii)

$$A_{V_A mid} = \frac{-g_m R_L'}{1 + g_m R_S} = \frac{45m \times 3.386k}{1 + 45m \times 5k} = 0.674$$

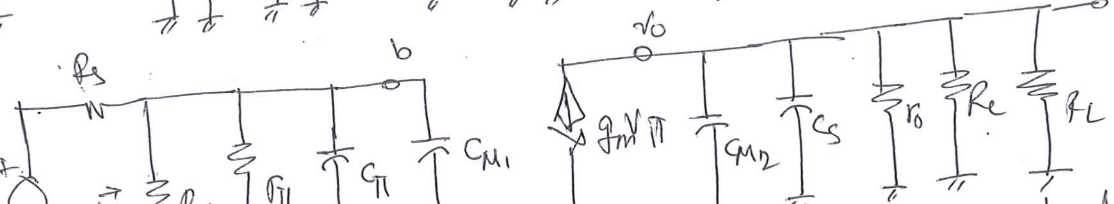
$$A_V = 0.8 \times 0.674 \approx 0.54 \text{ V/V} = -5.36dB$$

Q.3

i



High freq.



Miller equivalent

$R_L' = r_o || R_L || R_C$
$= 25 || 2.3 || 5$
$= 1.482 k\Omega$.

ii) $A_{VA}|_m = + \frac{v_o}{v_b} = \frac{-g_m V_\pi R_L'}{V_\pi} = -g_m R_L'$

$= -40m \times 1.482k$
$= -59.28$ V/V.

$R_i' = R_1 || R_2 || r_\pi = 20 || 20 || 2.5 = 2k\Omega$.

$A_{vm} = A_{VA} \times \frac{R_i'}{R_i' + R_s} = -59.28 \times \frac{2}{2+5}$.

$= -16.94$ V/V $= 24.576$ dB.

(iii) $C_{M_1} = C_\mu (1 + |A_{VA}|) = 2p(1 + 59.28) = 120.56$ pF

$C_{M_2} = C_\mu \left(1 + \left|\frac{1}{A_{VA}}\right|\right) = 2p\left(1 + \frac{1}{59.28}\right) = 2.034$ pF

can be neglected compared to C_{M_1} effect.

(iv) $f_H = \frac{1}{2\pi C_{eq} R_{eq}}$

$R_{eq} = R_s || R_1 || R_2 || r_\pi = 5 || 20 || 20 || 2.5 = 1.4286k$.

$f_{H miller} = \frac{1}{2\pi R_{eq} (C_\pi + C_{M_1})} = \frac{1}{2\pi\, 1.4286 (8 + 120.56)p}$

$= 866.58$ KHz

$f_{H without miller} = \frac{1}{2\pi R_{eq} C_\pi} = \frac{1}{2\pi \times 1.4286k \times 8p} = 13.93$ MHz

(v) $f_L = \frac{1}{2\pi (R_s + R_i) C_{C1}} = \frac{1}{2\pi \times (5+2)k \times 3.3\mu} = 6.89$ Hz