MODEL ANSWER.

Name:____________________________________

Matric No:________________Section:_____

الجامعة الإسلامية العالمية ماليزيا

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

MID-TERM EXAMINATION
SEMESTER II, 2015/2016 SESSION
KULLIYYAH OF ENGINEERING

Programme : ENGINEERING   Level of Study : UG 2

Time : 8:00pm-10:00 pm   Date : 17/03/2016

Duration : 2 Hours

Course Code : ECE 2133   Section(s) : 1 & 2

Course Title : **Electronic Circuits**

This Question Paper consists of **Twelve (12)** 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 answer.**
- **Do not use your own sheet.**
- **Useful formulas and values are given in page 10.**
- A total mark of this examination is **60**.
- This examination is worth **30%** of the total assessment.
- For drawing you may use pencil
- Answer **ALL** questions.

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

	Q 1a	Q 1b	Q 2	Q 3	Total Marks
Marks	10	10	20	20	60
Marks Obtained					

Q.1 [20 marks]

(a) Derive the transfer function of the circuit shown in **Fig. 1(a).** **(10 marks)**

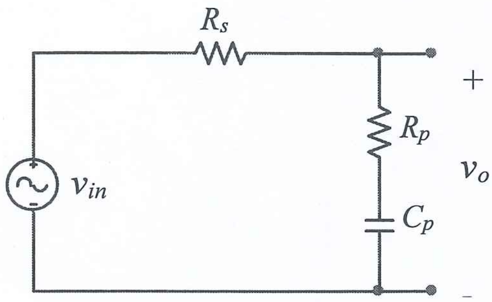


Fig. 1(a)

Transfer function $T(s) = \frac{v_o(s)}{v_{in}(s)} = \frac{Z_p}{Z_p + Z_s}$

$Z_s = R_s$.

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

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

$\therefore$ ~~T(s)~~ $Z_p = \frac{1 + sC_pR_p}{sC_p}$

$\therefore T(s) = \frac{Z_p}{Z_p + Z_s} = \frac{\frac{1 + sC_pR_p}{sC_p}}{\frac{1 + sC_p(R_p + R_s)}{sC_p}}$

$= \frac{1 + sC_pR_p}{1 + sC_p(R_p + R_s)}$ ←

$= \frac{1 + s\tau_p}{1 + s\tau_s}$ $\tau_p = C_pR_p$, $\tau_s = C_p(R_p + R_s)$

(b) Draw the Bode magnitude and phase plots of the following transfer function:

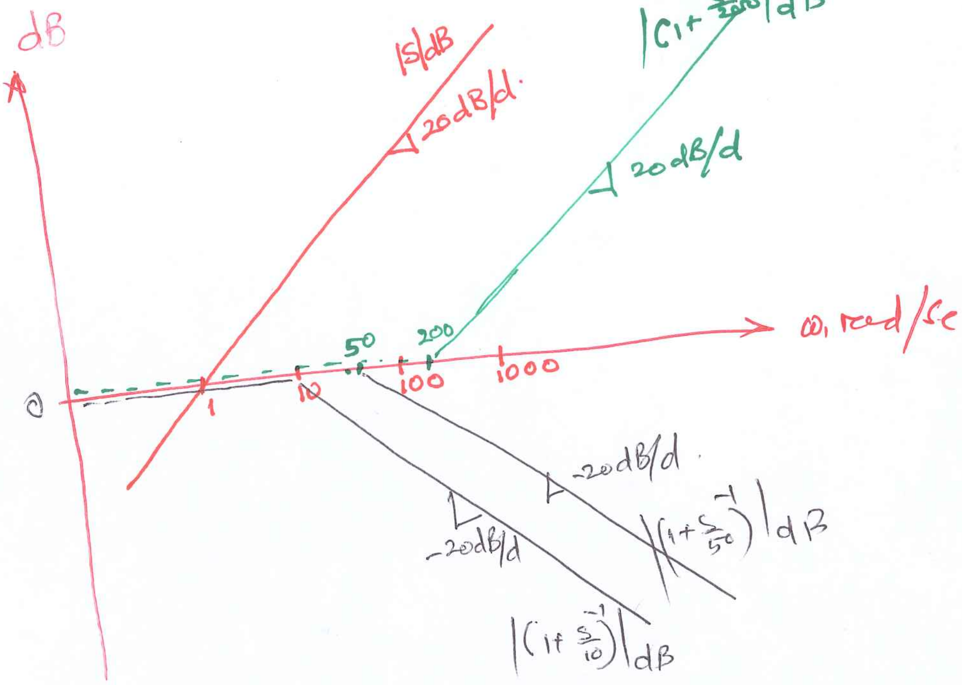
$$T(s) = 10^6 \frac{s(s+200)}{(s+10)(s+50)}$$ **(5+5 marks)**

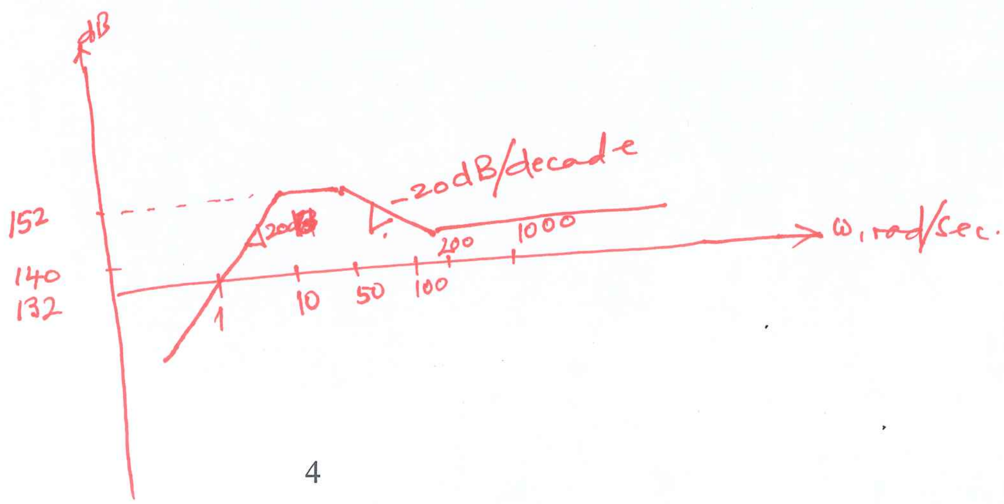
$$T(s) = \frac{10^6 \times s \times 200\left[1+\frac{s}{200}\right]}{10\left[1+\frac{s}{10}\right] 50\left[1+\frac{s}{50}\right]} = \frac{4\times10^6\, s\left(1+\frac{s}{200}\right)}{\left(1+\frac{s}{10}\right)\left(1+\frac{s}{50}\right)}$$

Corner frequencies,

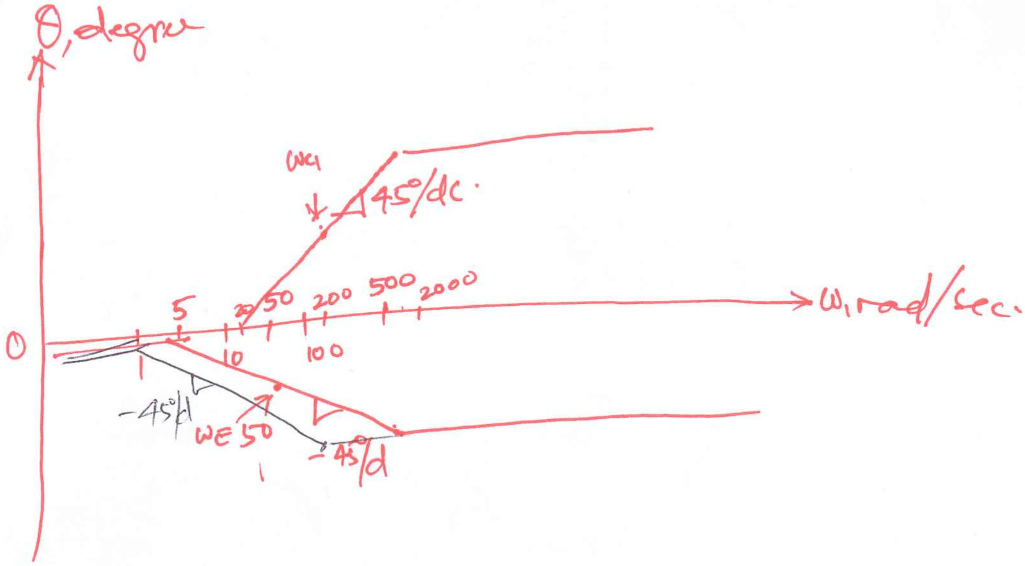
ω_{c1} = 200 rad/sec. ω_{c2} = 10 rad/sec ω_{c3} = 50 rad/sec.

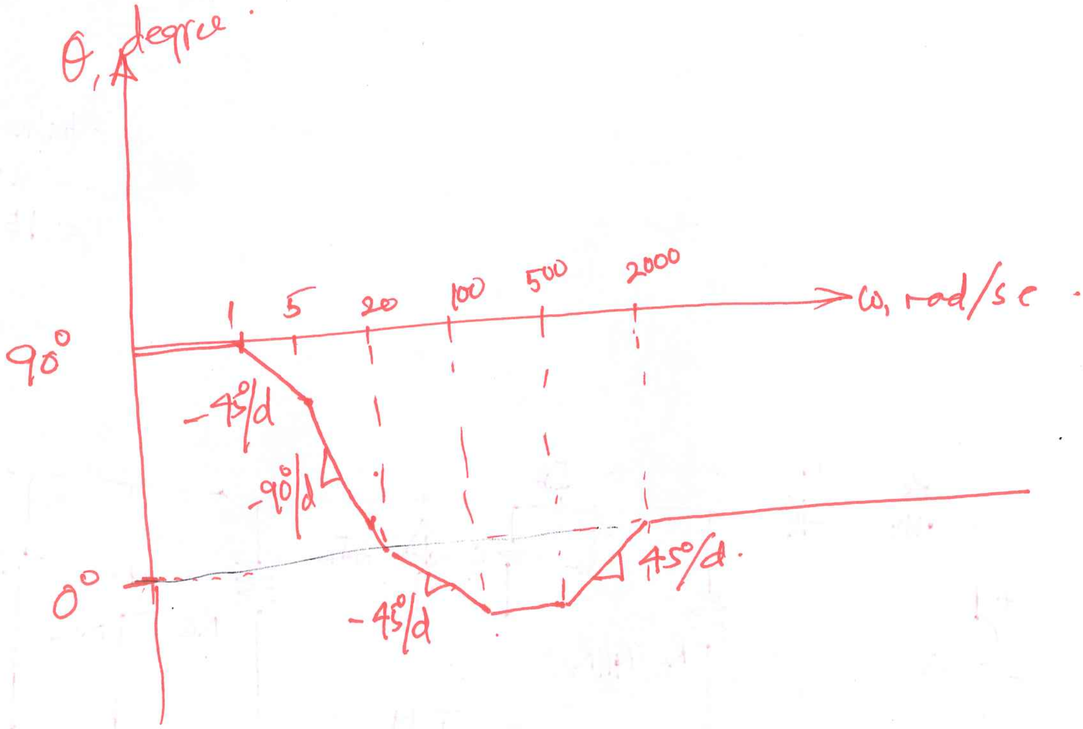
Magnitude Plot





Phase


θ, degree
ω, rad/sec.
0
5
10
20
50
100
200
500
2000
45°/dc.
-45°/d
-45°/d
ωE 50


θ, degree
ω, rad/sec
90°
0°
1
5
20
100
500
2000
-45°/d
-90°/d
-45°/d
45°/d

Q.2 [20 marks]

For the BJT amplifier circuit shown in **Fig. 2(a)** with transistor parameters, $g_m = 50$ mA/V, $r_\pi = 3$ kΩ and $r_0 = \infty$,

(i) Draw the small signal equivalent circuit diagram of the amplifier **(4 marks)**

(ii) Find the lower corner frequency due to coupling capacitor C_{C1} **(5 marks)**

(iii) Find the midband voltage gain, $A_v = \dfrac{v_O}{v_S}$ of the amplifier in dB **(6 marks)**

(iv) Find the bandwidth of the amplifier **(5 marks)**

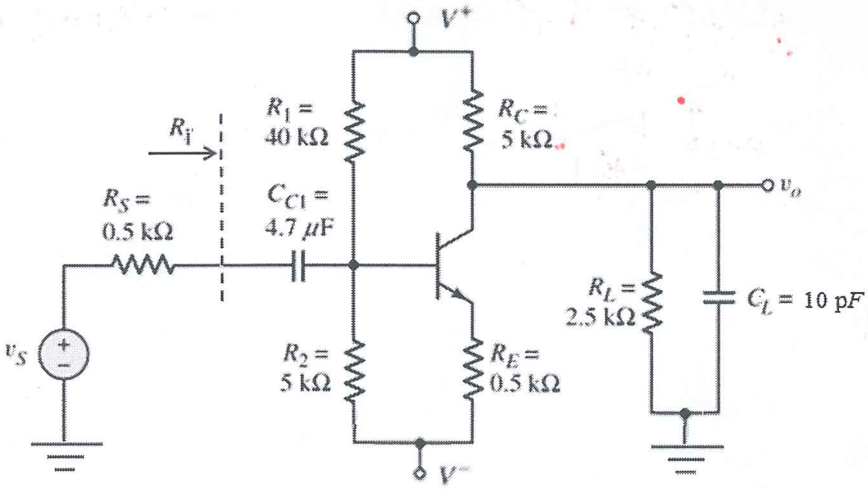
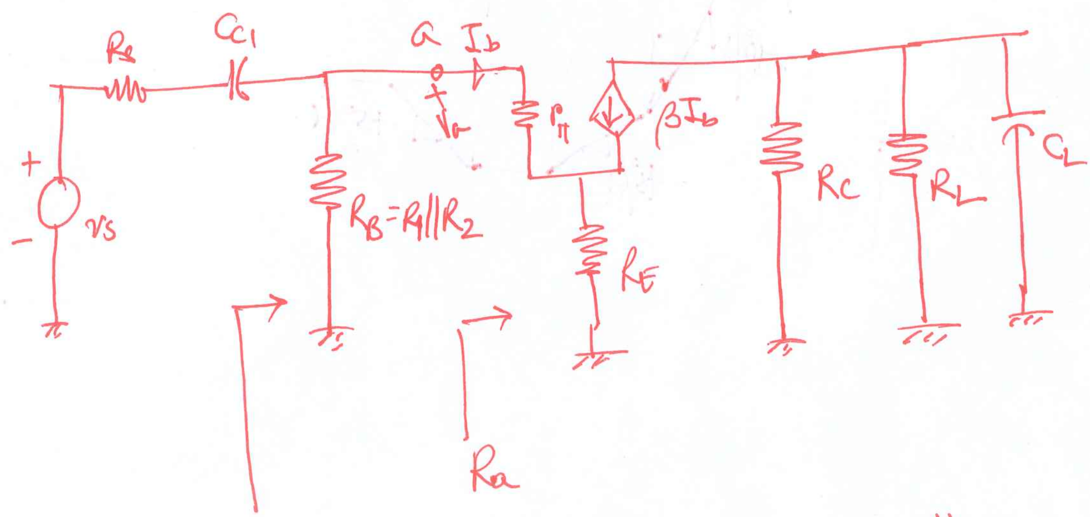


Fig. 2(a)

$\beta = g_m r_\pi$
$= 50 \times 3$
$= 150$

i)



$R_B = R_1 \| R_2 = 40 \| 5$
$= 4.44$ kΩ

ii) $R_a = \frac{v_a}{i_b} = \frac{r_\pi I_b + (1+\beta) I_b R_E}{I_b} = r_\pi + (1+\beta) R_E$

$= 3 + (1+150)0.5 = 78.5K$

$R_i = R_1 \| R_2 \| R_a = 40 \| 5 \| 78.5 = 4.206 K\Omega$

$\tau = C_E \times (R_i + R_s) = 4.7\mu \times (4.206 + 0.5)K$

$= 22.12 ms.$

$\therefore f_L = \frac{1}{2\pi\tau} = 7.195 Hz$ ←

(iii) $A_{vA} = \frac{v_o}{v_a} = \frac{-\beta I_b R_L'}{[r_\pi + (1+\beta) R_E] I_b}$ $R_L' = R_C \| R_L = 1.67K$

$= -\frac{\beta R_L'}{r_\pi + (1+\beta) R_E} = -\frac{150 \times 1.67K}{78.5K}$

$= -3.185$

$\therefore A_v = A_{vA} \times \frac{R_i}{R_i + R_s} = -3.185 \times \frac{(4.206)}{(4.206+0.5)}$

$= -2.846 = 9.086 dB$

iv) $\tau_H = C_L \times R_L' = 10p \times 1.67K = 16.7 ns$

$f_H = \frac{1}{2\pi\tau_H} = 9.53 MHz$

$BW = f_H - f_L \simeq f_H = 9.53 MHz$ ←

Q.3 [20 marks]

The common drain amplifier is shown in **Fig. 3** that operated at high frequencies. The transistor parameters are: $g_m = 2.2$ mA/V, $r_o = 100$ kΩ, $C_{gs} = 10$ pF, and $C_{gd} = 1$ pF.

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

(ii) Draw the Miller equivalent circuit diagram. **(2 marks)**

(iii) Calculate the value of Miller capacitance. **(5 marks)**

(iv) Evaluate the higher corner frequency (f_{HM}) considering Miller capacitance **(4 marks)**

(v) Evaluate the higher corner frequency (f_H) without considering Miller capacitance. **(4 marks)**

(vi) Which frequency is considered for determining bandwidth of the amplifier out of above two corner frequencies? Justify. **(2 mark)**

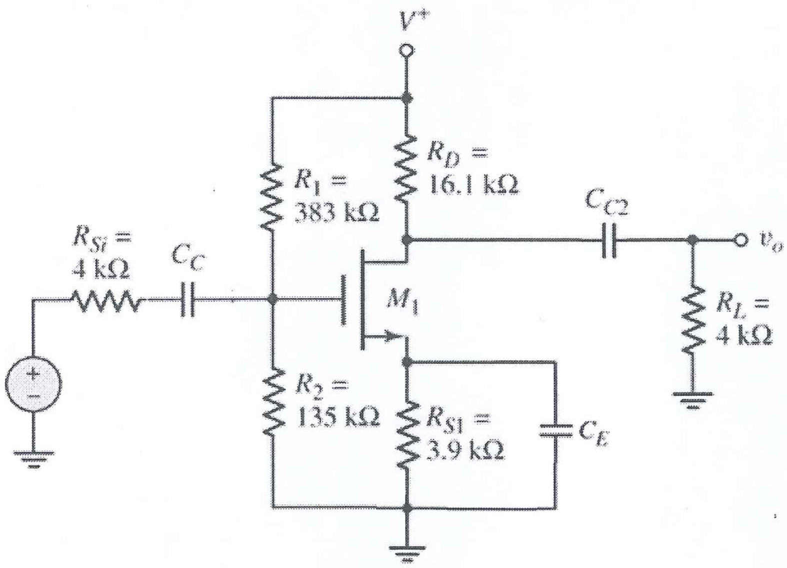
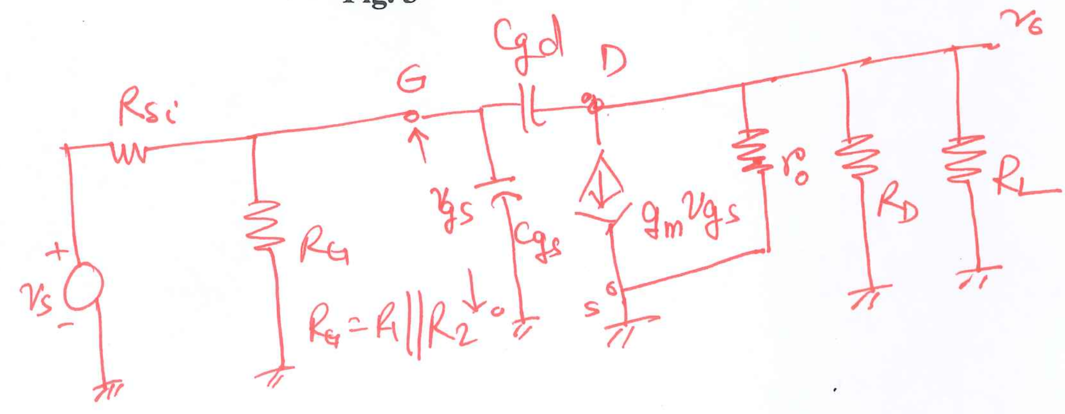
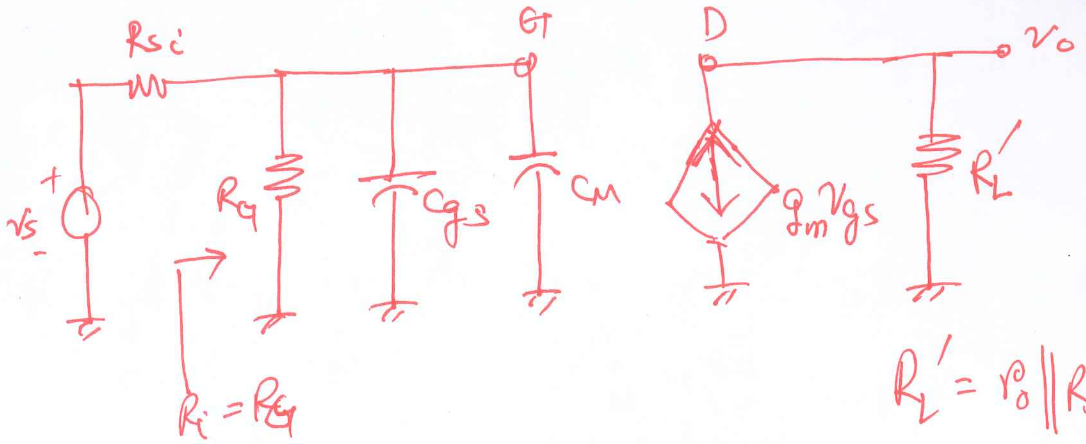


Fig. 3

i)



ii)



$R_L' = r_o \| R_D \| R_L$
$= 3.1045 k\Omega$

(iii) $C_M = C_{gd}(1 - A_{vA})$

$$A_{vA} = \frac{-g_m v_{gs} R_L'}{v_{gs}} = -g_m R_L'$$

$$\therefore C_M = C_{gd}\left[1 + g_m R_L'\right] = 1p \times \left[1 + 2.2 \times 100 \| 16.1 \| 4\right]$$
$= 7.83pF$ $= 7.83pF$

$R_{eq} = R_{si} \| R_G = 4 \| 383 \| 135 = 3.846 k\Omega$.

iv) $C_T = C_{gs} + C_M = 10p + 7.83p = 17.83p$

$\tau_M = R_{eq} C_T = 68.57 ns$.

$f_{HM} = \frac{1}{2\pi \tau_M} = 2.32 MHz$.

v) $C_T = C_{gs}$

$\tau_H = R_{eq} C_{gs} = 38.46 ns$

$\therefore f_{H_{C_{gs}}} = 4.14 MHz$

vi) $f_H = 2.32 MHz$ after this frequency voltage gain starts to drop below 3dB.