Name: MODEL ANSWER

Matric No:_______________Section:_____

الجامعة الاسلامية العالمية ماليزيا

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

MID-TERM EXAMINATION
SEMESTER II, 2014/2015 SESSION
KULLIYYAH OF ENGINEERING

Programme : ENGINEERING Level of Study : UG 2

Time : 8:00pm-10:00 pm Date : 19/03/2015

Duration : 2 Hours

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

Course Title : **Electronic Circuits**

This Question Paper consists of **Seven (7)** 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 7.**
- 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 2a	Q 2b	Q 3	Total Marks
Marks	8	12	10	10	20	60
Marks Obtained						

Q.1 [30 marks]

(a) Define transfer function. Find the transfer function of the following circuit. What should be maximum gain? **(8 marks)**

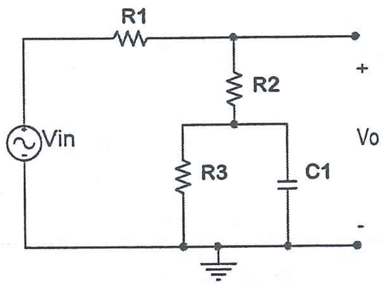
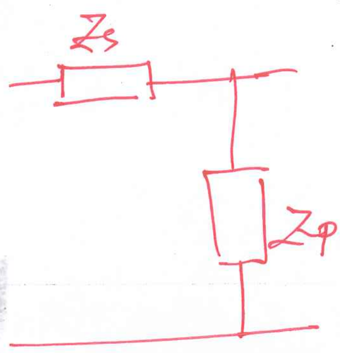


Fig. 1(a)



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

$$Z_s = R_1$$

$$Z_p = R_2 + R_3 \| \frac{1}{sC_1}$$

$$= R_2 + \frac{R_3 \frac{1}{sC_1}}{R_3 + \frac{1}{sC_1}} = R_2 + \frac{R_3}{1 + \frac{1}{sC_1} R_3 C_1 s} =$$

$$= \frac{(R_2 + R_3) + R_2 R_3 C_1 s}{1 + R_3 C_1 s}$$

$$Z_p + Z_s = R_1 + R_2 + \frac{R_3}{1 + R_3 C_1 s} = \frac{(R_1 + R_2 + R_3) + (R_2 + R_1) R_3 C_1 s}{1 + R_3 C_1 s}.$$

$$\therefore T(s) = \frac{Z_p}{Z_s + Z_p} = \frac{(R_2 + R_3) + R_2 R_3 C_1 s}{(R_1 + R_2 + R_3) + (R_1 + R_2) R_3 C_1 s}.$$

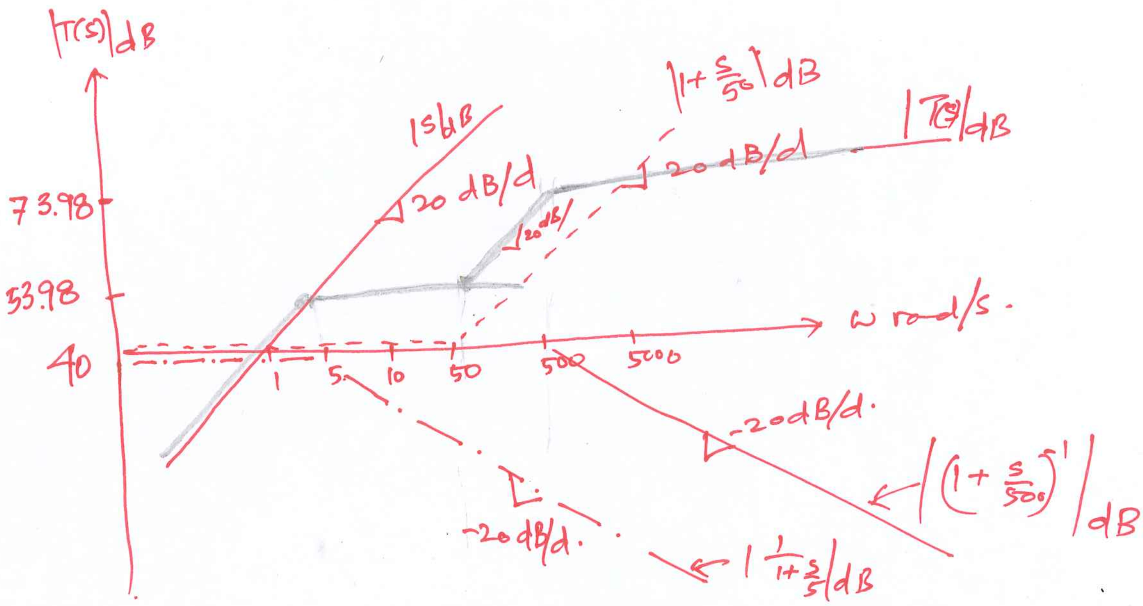
$$|T(s)|_{max} = \frac{R_2 + R_3}{R_1 + R_2 + R_3} = \frac{R_2 + R_3}{R_1 + R_2 + R_3}$$

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

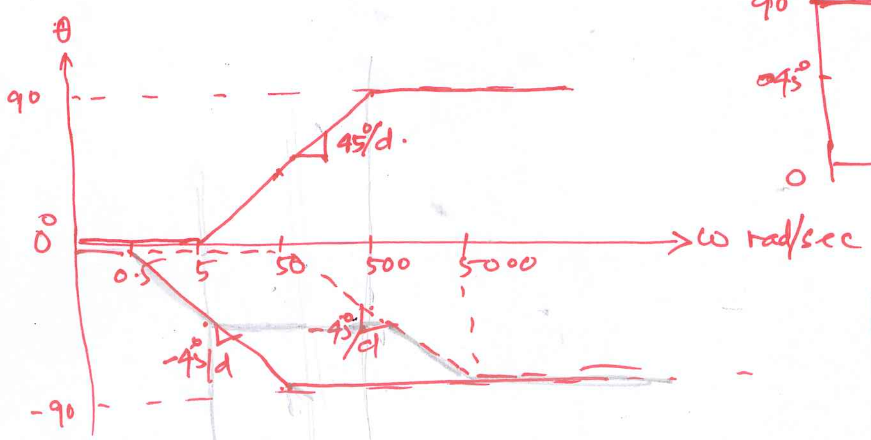
$$T(s) = 5000\frac{s(s+50)}{(s+5)(s+500)}$$ **(12 marks)**

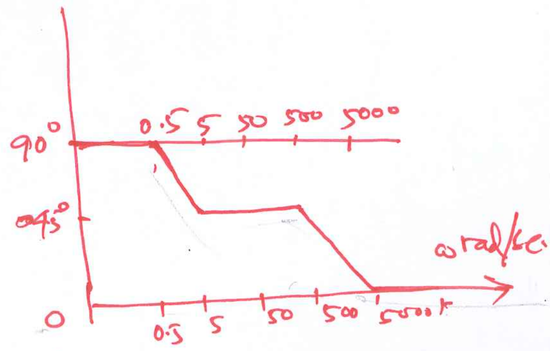
$$= \frac{5000 \times s \cdot 50\left(1+\frac{s}{50}\right)}{5\left(1+\frac{s}{5}\right)\cdot 500\left[1+\frac{s}{500}\right]}$$

$$= \frac{100\, s\left(1+\frac{s}{50}\right)}{\left(1+\frac{s}{5}\right)\left(1+\frac{s}{500}\right)}$$



Magnitude.





Phase.

Q.2 [20 marks]

(a) Draw the small signal equivalent circuit diagram of the MOSFET amplifier circuit shown in **Fig. 2(a)** and find the midband voltage gain $A_v = \frac{v_o}{v_i}$ of the amplifier. If C_C = 10μF and $C_{C2} = \infty$ then find the corner frequency due to C_C. The transistor parameters are g_m=0.5 mA/V and $r_o = \infty$. **(10 marks)**

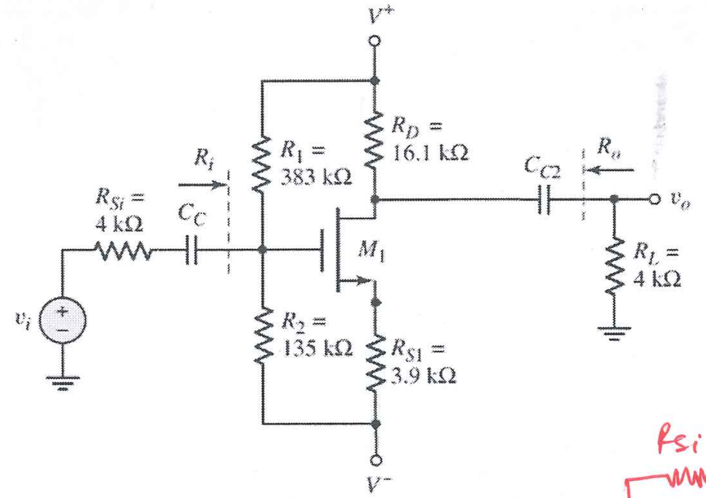
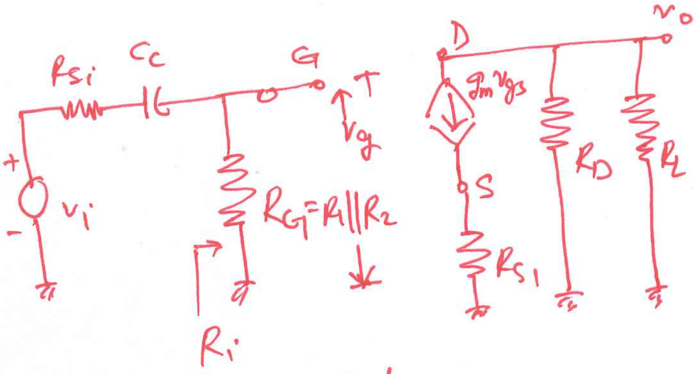


Fig. 2(a)



$v_o = -g_m v_{gs} R_L'$

$v_g = v_{gs} + g_m v_{gs} R_{S1}$

$= v_{gs}(1 + g_m R_{S1})$

$R_L' = R_L \| R_D$

$= 3.2\text{K}\Omega$

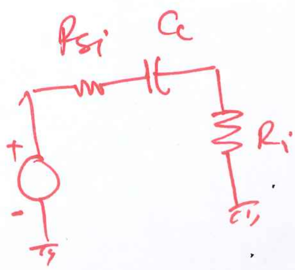
$\therefore A_{vA} = \frac{v_o}{v_g} = \frac{-g_m R_L'}{1 + g_m R_{S1}}$

$= \frac{-0.5 \times 3.2}{1 + 0.5 \times 3.9} = -0.5423$.

$R_i = R_G = 99.817\ \text{K}\Omega$.

$\therefore A_v = A_{vA} \times \frac{R_i}{R_i + R_{si}} = -0.5423 \times \frac{99.817}{99.817 + 4}$

$= -0.521$ V/V.



$\tau = (R_{si} + R_i) C_c = (99.817 + 4)_k \times 10\mu =$

$= 1.0387$

$\therefore f_L = \frac{1}{2\pi\tau} = 0.153$ Hz $= 153.3$ mHz ←

(b) Draw the small signal equivalent circuit diagram of the BJT amplifier circuit shown in **Fig. 2(b)** and find the output resistance, R_o. Given that $R_1 = 300\ \text{k}\Omega$, $R_2 = 500\ \text{k}\Omega$, $R_E = 20.0\ \text{k}\Omega$, $R_L = 10.0\ \text{k}\Omega$, $C_{c1} = \infty$, $C_{C2} = 1\mu\text{F}$ and $C_L = 10\text{pF}$.

Also find the corner frequency due to C_{C2} and C_L and hence determine the bandwidth of the amplifier.

The transistor parameters are $\beta = 120$, $r_\pi = 3\ \text{k}\Omega$ and $r_o = 100\ \text{k}\Omega$. **(10 marks)**

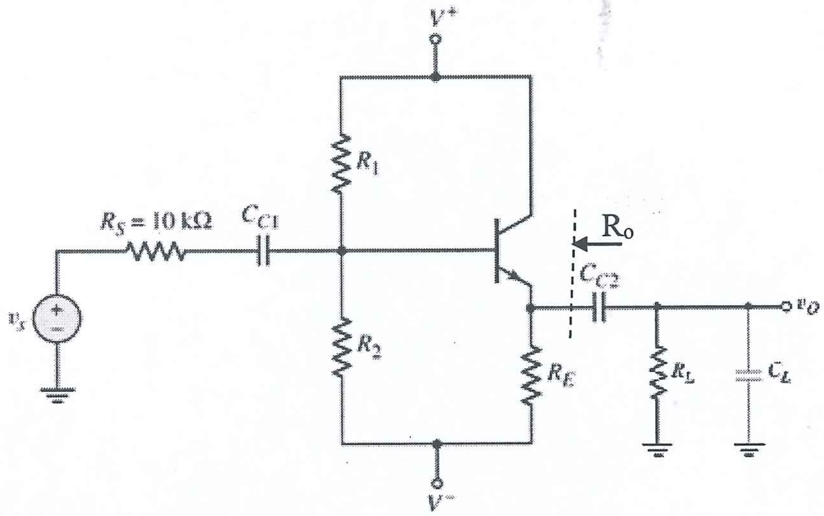
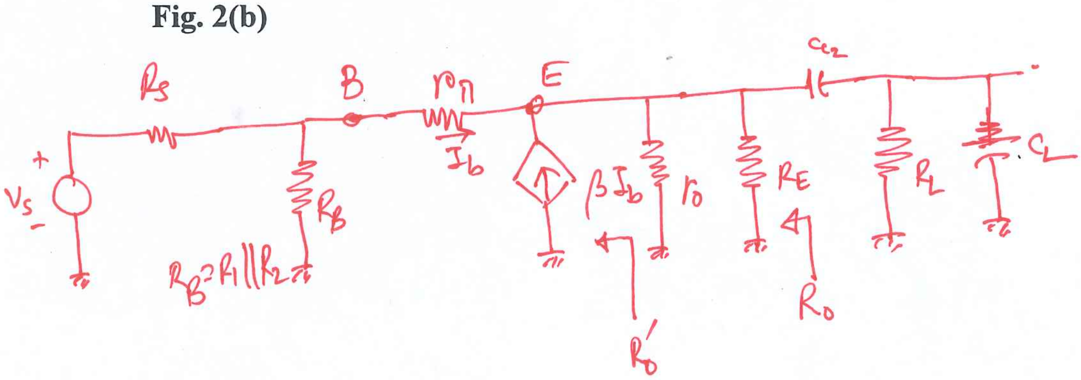
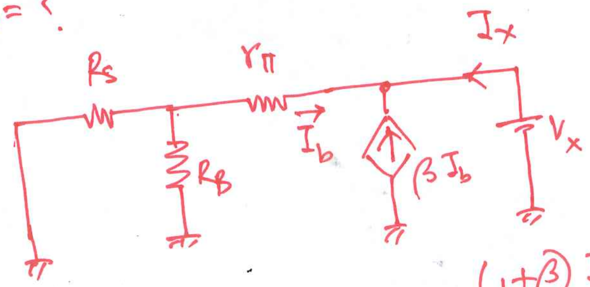


Fig. 2(b)



$R_o' = ?$

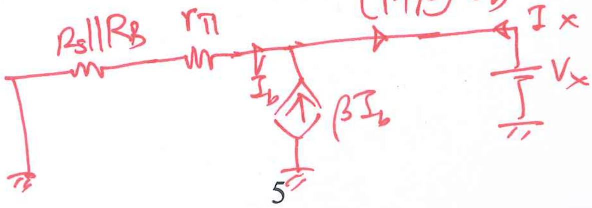


$$R_o' = \frac{V_x}{I_x}$$

$$I_x = -(1+\beta) I_b$$

$$(R_s \| R_B + r_\pi) I_b + V_x = 0$$

$$\therefore I_b = -\frac{V_x}{R_s \| R_B + r_\pi}$$

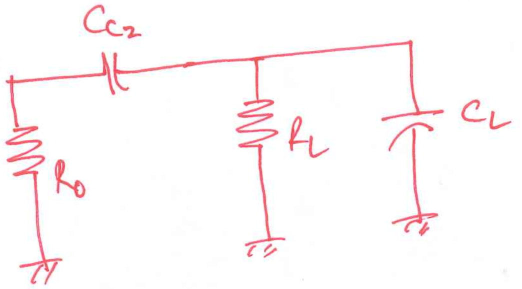


$$\therefore I_x = \frac{(1+\beta) V_x}{R_s \| R_B + r_\pi} \qquad \therefore R_o' = \frac{V_x}{I_x} = \frac{R_s \| R_B + r_\pi}{(1+\beta)}$$

$R_S \| R_B = R_S \| R_1 \| R_2 = 10 \| 300 \| 500 = 9.494\,k\Omega$.

$\therefore R_o' = \frac{9.494+3}{(1+120)} = 0.1032\,k\Omega = 103.2534\,\Omega$.

$R_o = R_o' \| r_o \| R_E = 0.10325 \| 100 \| 20 = 102.62\,\Omega$



$\tau_{cc_2} = (R_o + R_L)\, C_{c_2} = 10.1026\,ms$.

$\therefore f_{L_{cc_2}} = \frac{1}{2\pi \tau_{c_2}} = 15.754\,Hz$

$\tau_{C_L} = R_o \| R_L \times C_L = 1.01577\,ns$

$\therefore f_{H_{CL}} = \frac{1}{2\pi \tau_{CL}} = 156.683\,MHz$

$BW = f_{H_{CL}} - f_{cc_2} \simeq f_{H_{CL}} = 156.683\,MHz$

Q.3 [20 marks]

The common emitter amplifier is shown in **Fig. 3** that operated at high frequencies. The transistor parameters are: $g_m = 40$ mA/V, $r_\pi = 4$ kΩ, $r_o = 100$ kΩ, $C_\pi = 10$ pF, and $f_T = 500$ MHz.

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

(ii) Find the value of Cμ. **(3 marks)**

(iii) Find the value of Miller capacitance. **(4 marks)**

(iv) Evaluate the upper 3dB frequency (f_H) considering Miller capacitance **(4 marks)**

(v) Evaluate the upper 3dB frequency (f_H) without considering Miller capacitance. **(4 marks)**

(vi) How do you evaluate the the upper 3dB frequency? **(2 mark)**

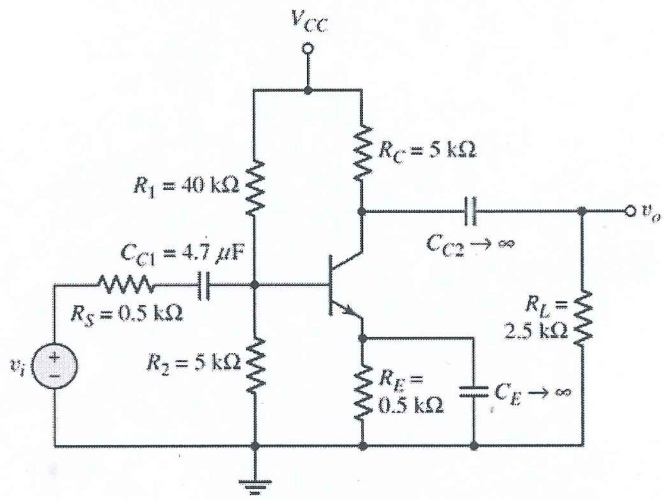
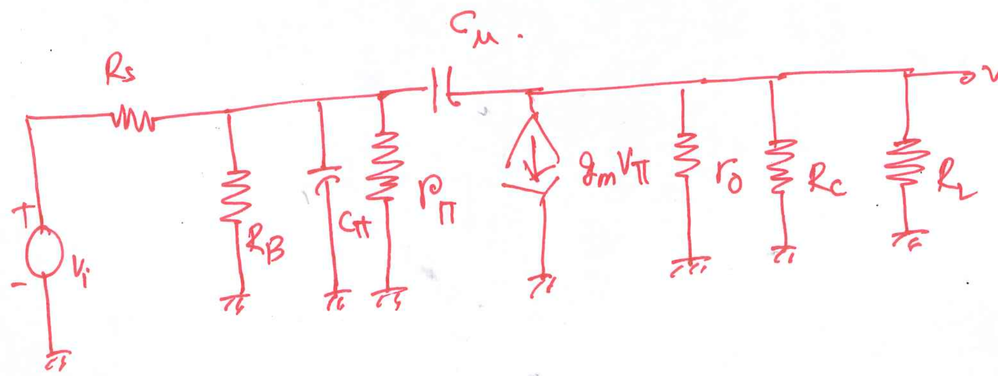


Fig. 3

(i)



(ii)

$$f_T = \beta f_\beta = \frac{\beta}{2\pi r_\pi (C_\mu + C_\pi)} = \frac{g_m r_\pi}{2\pi r_\pi (C_\mu + C_\pi)}$$

$$= \frac{g_m}{2\pi (C_\mu + C_\pi)}$$

$$C_\mu + C_\pi = \frac{g_m}{2\pi f_T} = \frac{40m}{2\pi \times 500M} = 12.73\ pf.$$

$$C_\mu = 12.73 - C_\pi = 12.73 - 10 = 2.73\ pf \leftarrow$$

(iii)

$$A_{VA} = -\frac{g_m V_\pi \times r_o \| R_C \| R_L}{V_\pi} = -g_m r_o \| R_C \| R_L$$

$$= -40m \times 5 \| 100 \| 2.5k$$

$$= -65.57$$

$$C_M = C_\mu [1 + |A_{VA}|] = 2.73pf \times [1 + 65.57]$$

$$= 181.746\ pf \leftarrow$$

(iv)

$$C_T = C_\pi + C_M = 191.746\ pf.$$

$$R_{eq} = R_s \| R_1 \| R_2 \| r_\pi$$

$$= 0.5 \| 40 \| 5 \| 4$$

$$= 0.404\ k\Omega.$$

$$\tau_M = C_T \times R_{eq}$$

$$= 191.746p \times 0.4040$$

$$= 77.47\ ns.$$

$$\therefore f_{H_M} = \frac{1}{2\pi \tau_M} = 2.054\ MHz$$

(v)

$$C_T = C_\pi = 10\ pf \qquad \tau = C_\pi \times R_{eq} = 4.04\ ns.$$

$$\therefore f_H = \frac{1}{2\pi\tau} = 39.39\ MHz.$$

(vi) upper dB freq is 2.054 MHz due to Miller effect.