Name:_______________________________

Matric No:______________Section:_____

Lecturer's Name:

الجامعة الإسلامية العالمية ماليزيا

INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA

MID-TERM EXAMINATION
SEMESTER 1, 2019/2020 SESSION
KULLIYYAH OF ENGINEERING

Programme	: ENGINEERING	Level of Study	: UG 2
Time	: 5:20 pm-6:50 pm	Date	: 23/10/2019
Duration	: 1 Hour 30 Minutes		
Course Code	: EECE 2313	Section(s)	: 1, 2
Course Title	: **Electronic Circuits**		

This Question Paper consists of **Eight (8)** Printed Pages (including cover and two blank pages) with **Three (3)** Questions.

<u>INSTRUCTION(S) TO CANDIDATES</u>

DO NOT OPEN UNTIL YOU ARE ASKED TO DO SO

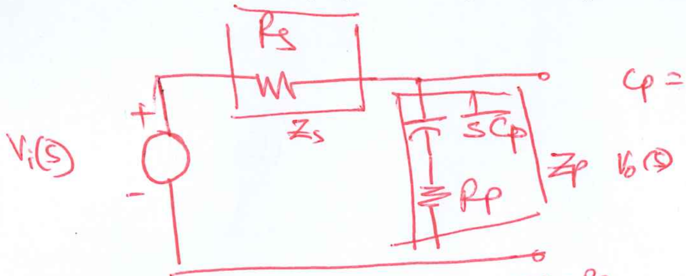
- **Use only pen for writing the answer**
- **Do not use your own paper sheet and no extra paper will be provided**
- A total mark of this examination is **50**
- This examination is worth **30%** of the total assessment
- For drawing, you may use a pencil
- Answer **<u>ALL THREE (3)</u>** questions
- **Answer on the question paper**

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

	Question 1	Question 2	Question 3	Total Marks
Marks	20	20	10	50
Marks Obtained				

Q.1 [20 marks]

(a) An RC-circuit 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 $R_s = 4.5$ kΩ, $R_p = 1.5$ kΩ, $C_1 = 80$ pF and $C_2 = 20$ pF. **(6+2 marks)**



$C_p = \frac{C_1 \times C_2}{C_1 + C_2}$

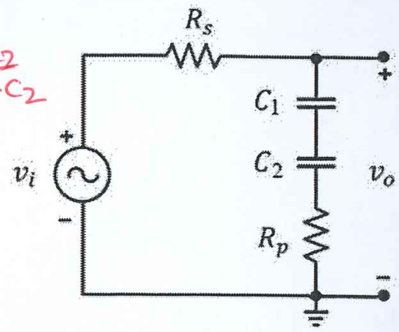


Fig. 1(a)

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

$C_p = \frac{80 \times 20}{80 + 20} = 16\text{pF}$

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

$\therefore T(s) = \frac{V_o}{V_i} = \frac{Z_p}{Z_s + Z_p} = \frac{\frac{1 + sC_pR_p}{sC_p}}{\frac{1 + sC_p(R_p + R_s)}{sC_p}} = \frac{1 + sC_pR_p}{1 + sC_p(R_p + R_s)} = \frac{1 + s\tau_1}{1 + s\tau_2}$

$\tau_1 = C_pR_p \quad \tau_2 = C_p(R_p + R_s)$

$f_1 = \frac{1}{2\pi C_pR_p} = \frac{1}{2\pi\, 16\text{p} \times 1.5\text{K}} = 6.631\ \text{MHz}.$

$f_2 = \frac{1}{2\pi C_p(R_p + R_s)} = \frac{1}{2\pi\, 16\text{p}(1.5 + 4.5)} = 1.657\ \text{MHz}.$

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

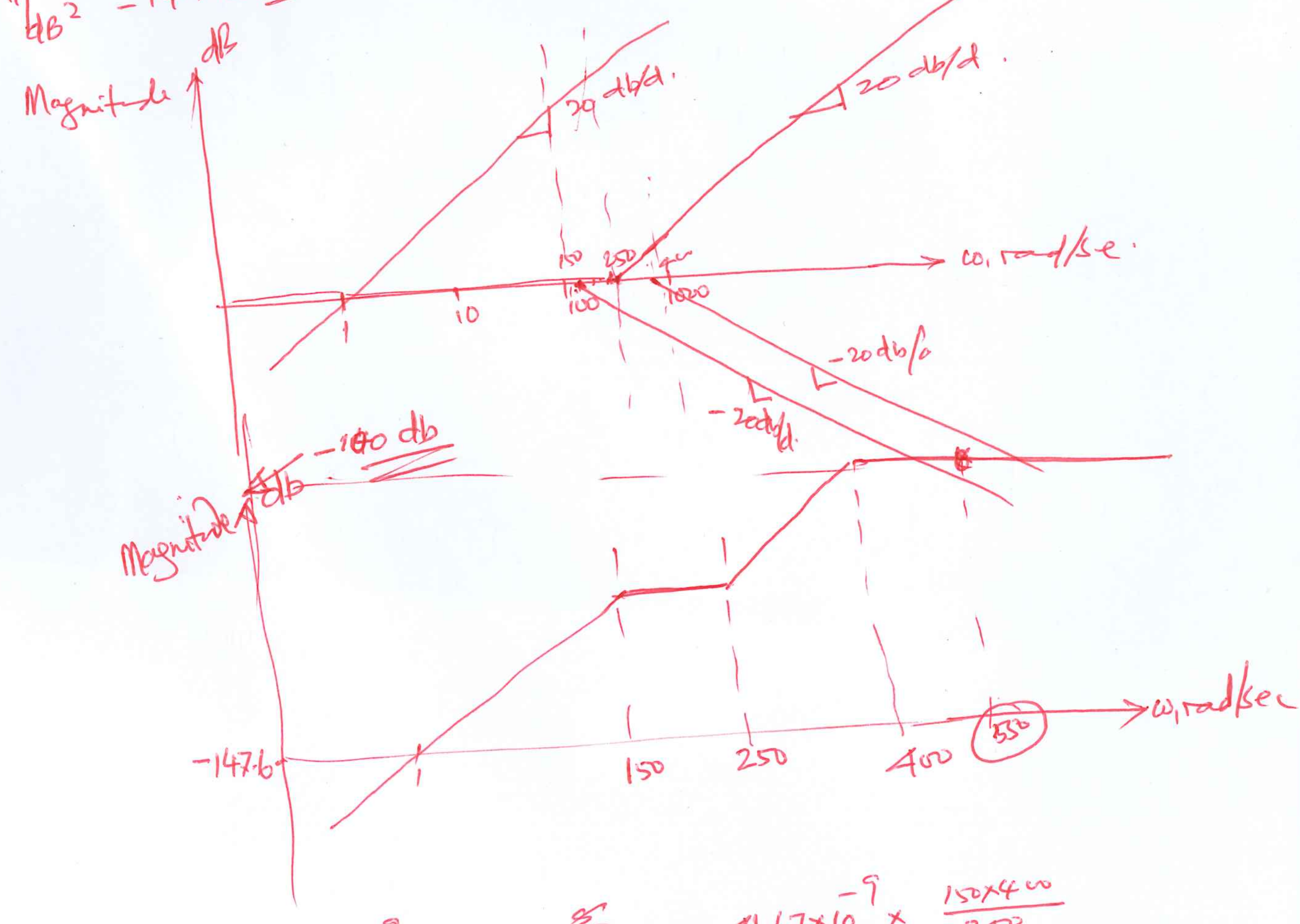
(8 marks)

$$T(s) = \frac{10^{-5}s(s+250)}{(s+150)(s+400)}$$

Determine the magnitude and phase at s = 550 rad/Sec, using the solution from the graph of the question Q1.(b). **(4 marks)**

$$T(s) = \frac{10^{-5}\, 250\, s(1+s/250)}{150\times 400\,(1+\frac{s}{150})(1+\frac{s}{400})} = 41.67\times10^{-9}\,\frac{s(1+s/250)}{(1+s/150)(1+s/400)}$$

$T|_{dB} = -147.6$ dB

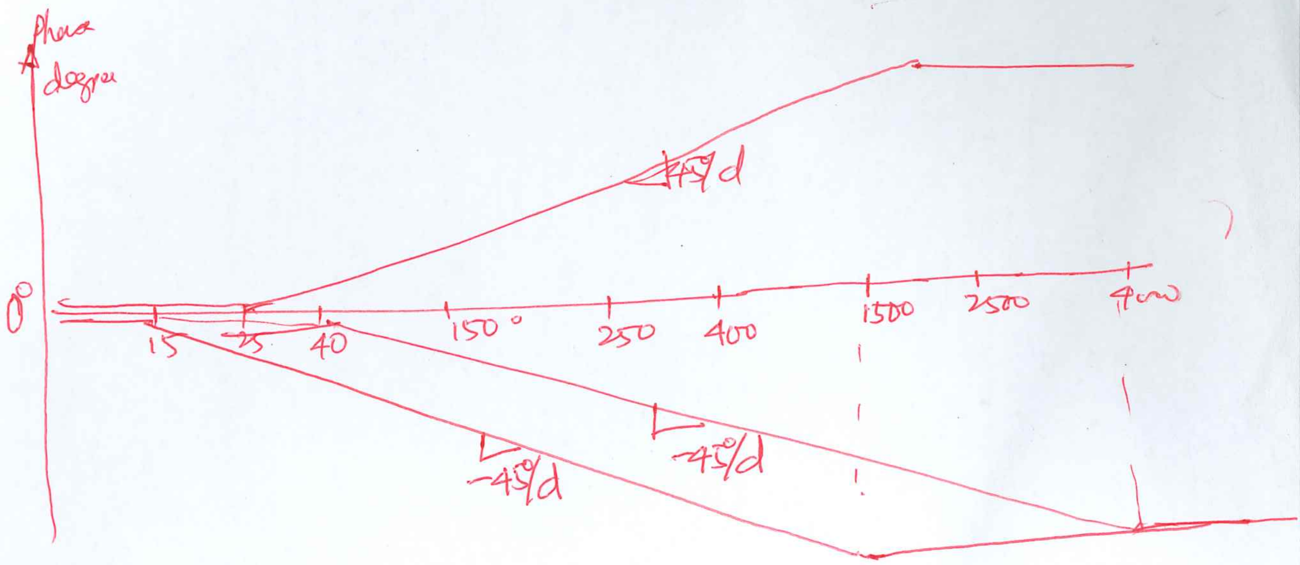


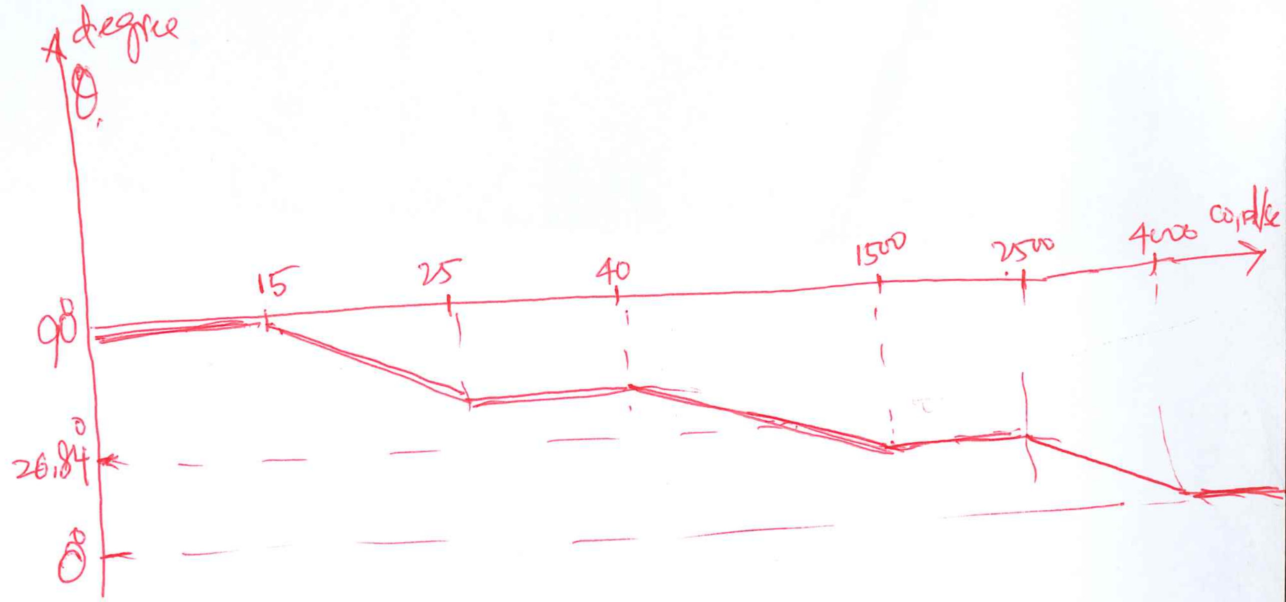
$$T(s)|_{550} = 41.67\times10^{-9}\cdot\frac{s\times\frac{s}{250}}{\frac{s}{150}\times\frac{s}{400}} = 41.67\times10^{-9}\times\frac{150\times400}{250} = 41.67\times10^{-9}\times 240$$

$T(s)|_{db}$ = ~~-147.6 + 47.6 = -100 dB~~

= -100 db.

Q1(b)


Phase degree
45°/d
0°
15
25
40
150
250
400
1500
2500
4000
-45°/d
-45°/d


degree
θ
90°
26.84°
0°
15
25
40
1500
2500
4000
ω, rad/s

Q.2 [20 marks]

A common emitter amplifier circuit as shown in **Fig. 2,** with the following circuit component values are, $R_S = 1.5\ k\Omega$, $R_1 = 55\ k\Omega$, $R_2 = 15\ k\Omega$, $R_E = 1.5\ k\Omega$, $R_C = 5\ k\Omega$ and $R_L = 10\ k\Omega$. The transistor has a small-signal parameters, $\beta = 120$, $r_\pi = 1.5\ k\Omega$ and $r_o = \infty$. Assume that, C_{C2} is infinity.

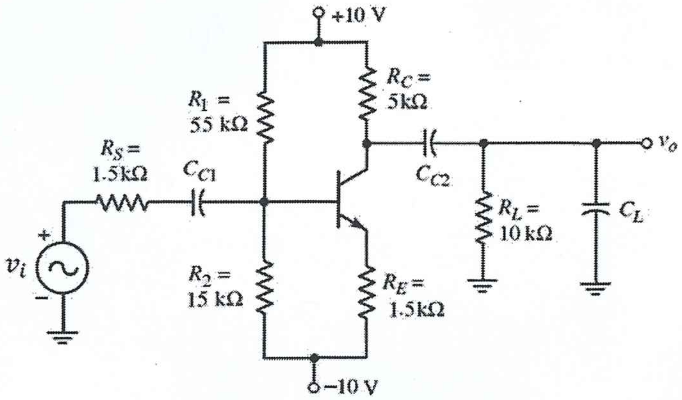


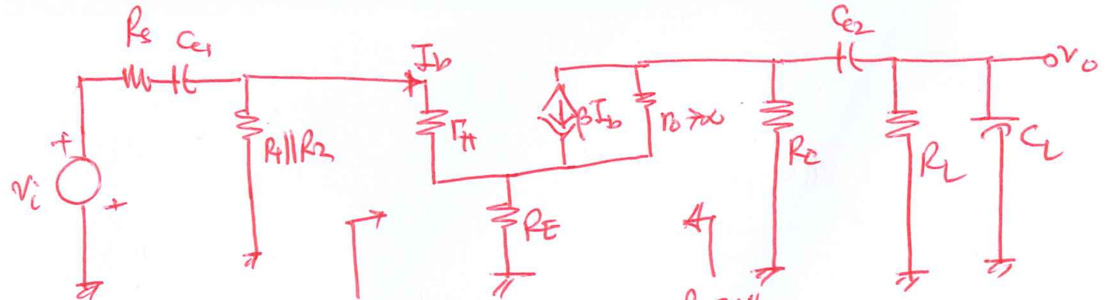
Fig. 2

i. Draw the small-signal equivalent circuit **(3 marks)**

ii. Evaluate the midband voltage gain, $A_v = \frac{v_o}{v_i}$ in dB scale. **(6 marks)**

iii. Design the circuit so that the -3dB lower corner frequency, $f_L = 200\text{Hz}$. **(7 marks)**

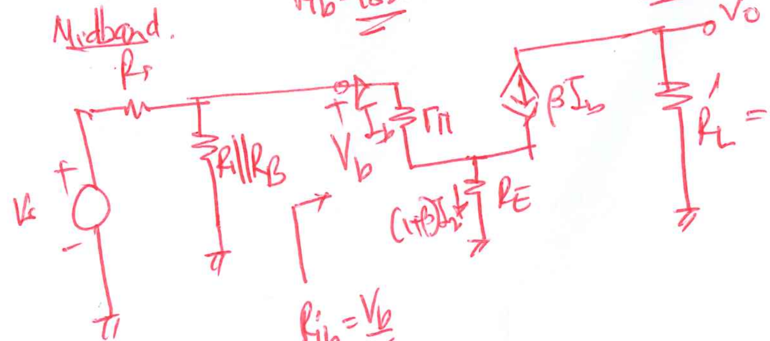
iv. If, $C_L = 10\ nF$ determine the -3dB upper corner frequency, f_H. **(4 marks)**



$R_{ib} = 183K$

$R_o = \infty$

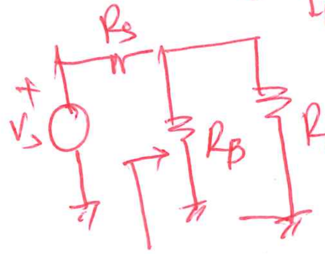
Midband.



$R_L' = R_C \| R_L = 5 \| 10 = 3.33\ K$

$\beta = g_m r_\pi$

$R_{ib} = \frac{V_b}{I_b}$



$R_{ib} = \frac{V_b}{I_b} = \frac{r_\pi (I_b) + R_E (1+\beta) I_b}{I_b}$

$= r_\pi + R_E(1+\beta)$

$= 1.5 + 1.5(1+120)$

$= 183K$

$R_i = R_B \| R_{ib} = 55 \| 15 \| 183$

$= 11.073 K\Omega$

(*Space for answer to the question **Q.2***)

$$A_{VA} = \frac{v_o}{v_b} = \frac{-\beta I_b R_L'}{r_\pi I_b + R_E(1+\beta) I_b}$$

$$= \frac{-\beta R_L'}{r_\pi + R_E(1+\beta)} = -\frac{120 \times 3.333K}{183K}$$

$$= -2.186$$

$$A_V = A_{VA} \frac{R_i}{R_i + R_S} = -2.186 \times \frac{11.073K}{(11.073 + 1.5)K}$$

$$= -1.925 \text{ V/V}$$

$$= \underline{5.689 \text{ dB}}$$

$$f_L = \frac{1}{2\pi C_{C1}(R_S + R_i)}$$

$$\therefore C_{C1} = \frac{1}{2\pi f_L (R_S + R_i)} = \frac{1}{2\pi \times 200 \times (1.5 + 11.073)K}$$

$$= 63.29 \text{ nF}$$

$$f_H = \frac{1}{2\pi C_L R_L'} = \frac{1}{2\pi \times 10n \times 3.33K}$$

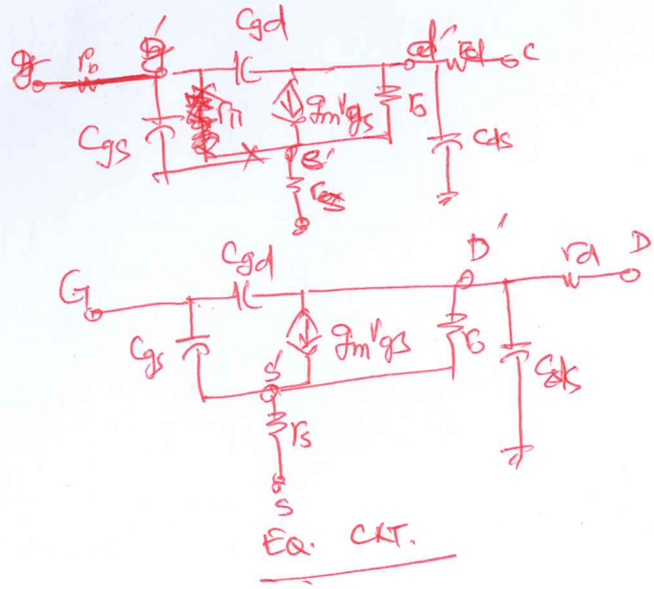
$$= 4.78 \text{ KHz}$$

Q.3 [10 marks]

(a) Draw the detail high-frequency model of a MOSFET and mention the name of each parameter. **(2 marks)**

(b) A short-circuit MOSFET current amplifier as shown in **Fig. 3(b).**

i) Determine step by step the unity gain bandwidth or f_T of the MOSTET. **(6 marks)**



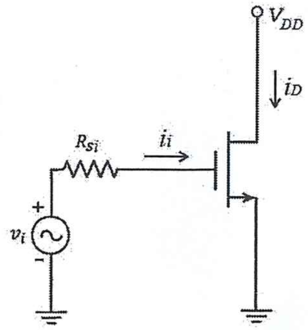
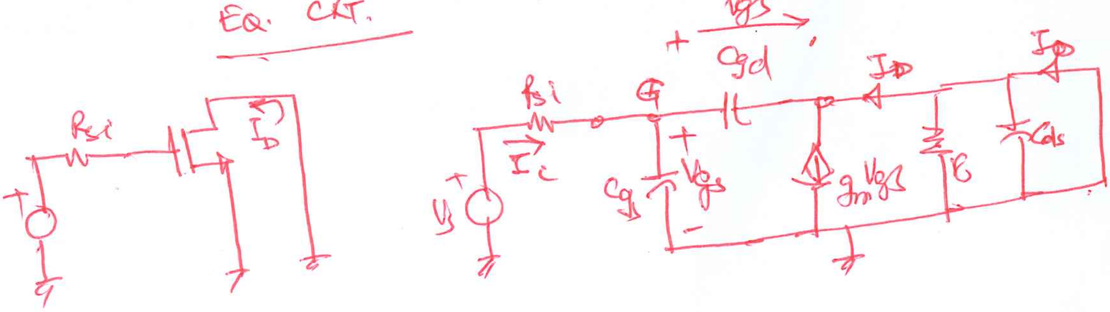


Fig. 3(b)



$$I_i = sC_{gs}V_{gs} + sC_{gd}V_{gd}$$

$$I_D = g_m V_{gs} - sC_{gd}V_{gs}$$

$$\therefore A_I = \frac{I_D}{I_i} = \frac{g_m V_{gs} - sC_{gd}V_{gs}}{sV_{gs}(C_{gs}+C_{gd})} = \frac{g_m - sC_{gd}}{s(C_{gs}+C_{gd})}$$

$$\simeq \frac{g_m}{s(C_{gs}+C_{gd})} = \frac{g_m}{j\omega(C_{gd}+C_{gs})}$$

$$A_I = 1 = \left|\frac{g_m}{\omega_T(C_{gs}+C_{gd})}\right| \Rightarrow \therefore \omega_T = \frac{g_m}{C_{gs}+C_{gd}}$$

$$\therefore f_T = \frac{1 \cdot g_m}{2\pi(C_{gs}+C_{gd})}$$

ii) Calculate the bandwidth of the amplifier for current gain equal 15. Assume that, the MOSFET parameter are, $g_m = \frac{15mA}{V}$, $C_{gs} = 12pF$ and $C_{gd} = 5pF$ **(2 marks)**

$f_T = BW.\ Gain$

$f_T = \frac{g_m}{2\pi(C_{gd}+C_{gs})} = \frac{15m}{2\pi(12+5)p} = 140{,}43\ MHZ$

$\therefore f_T = BW \times Gain \Rightarrow BW = \frac{f_T}{Gain} = \frac{140{,}43\ MHz}{15}$

$= 9{,}362\ MHZ$

END OE QUESTION