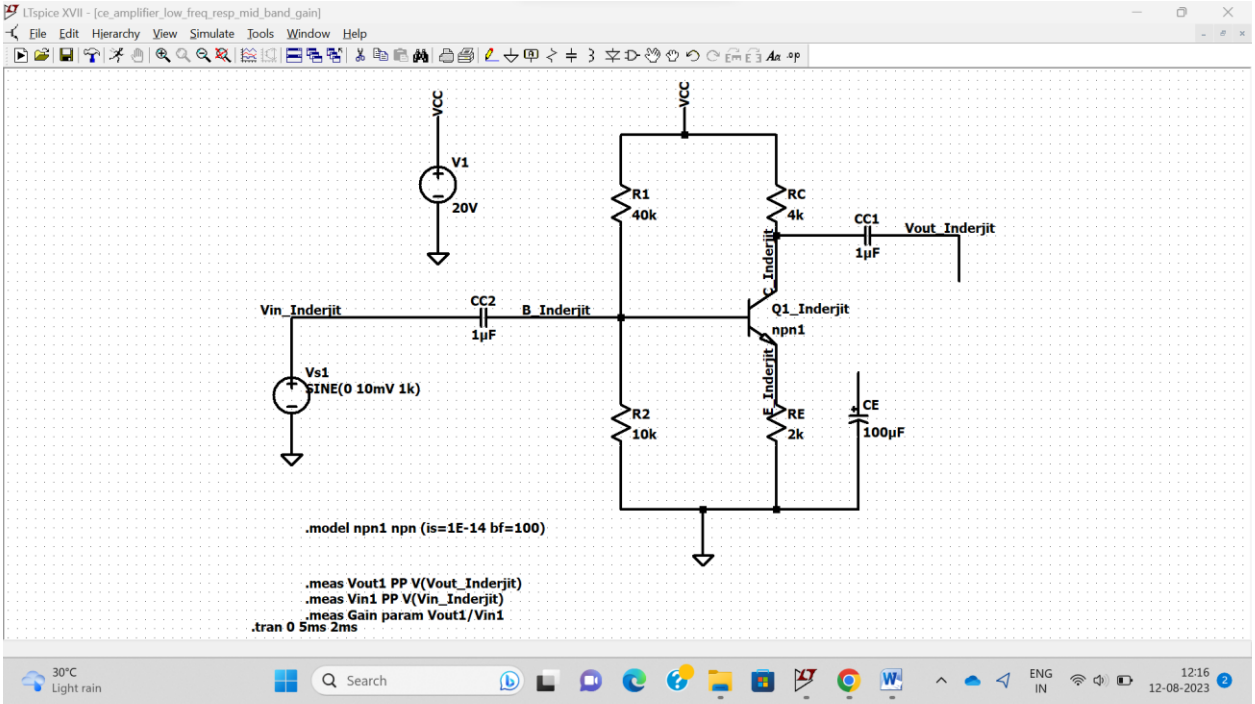
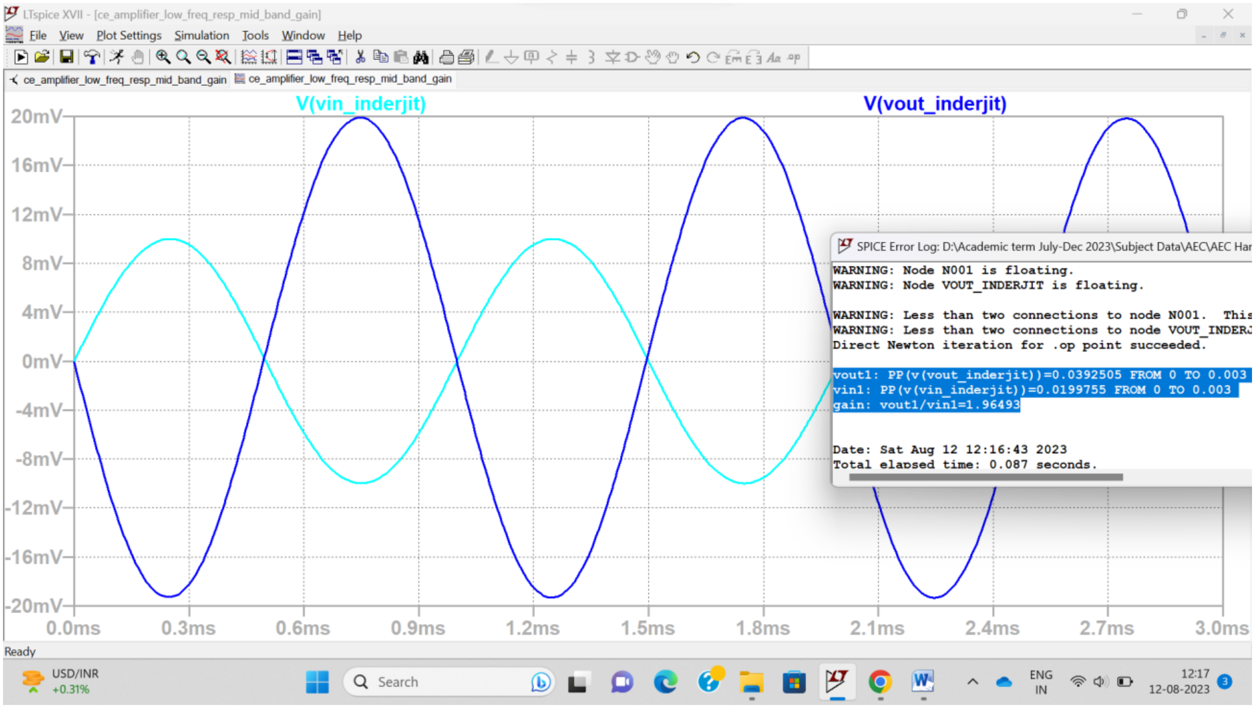
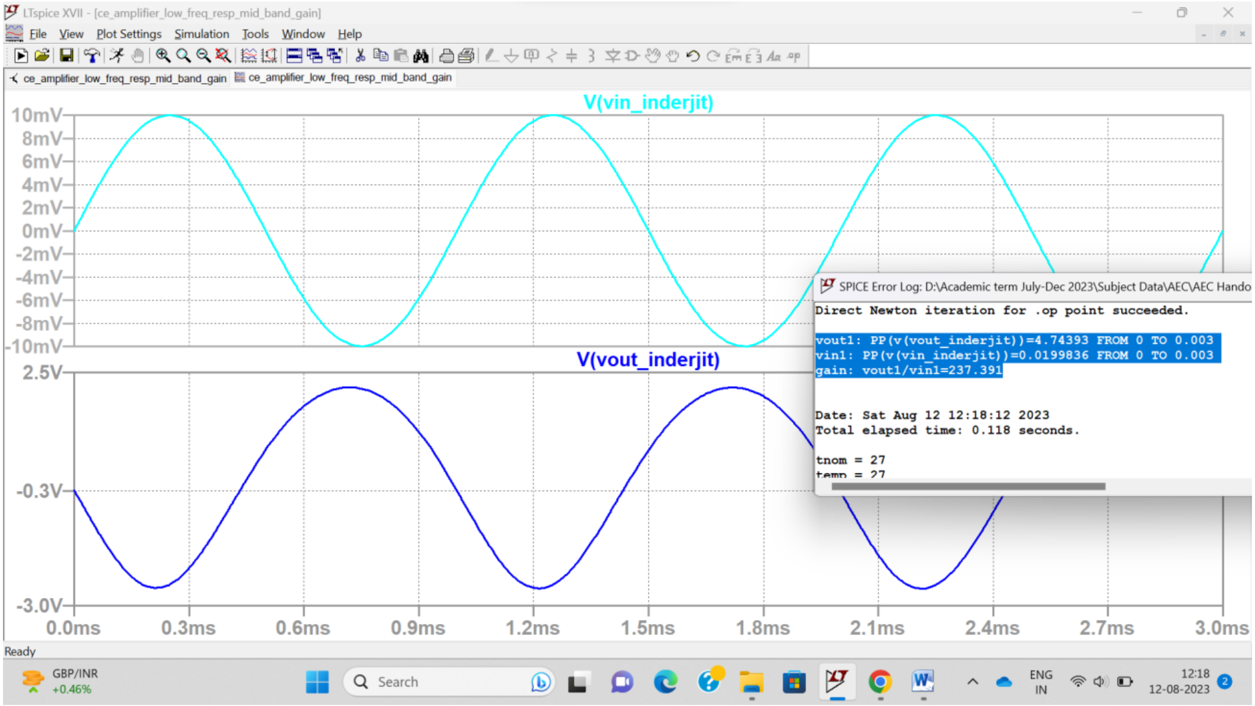
CE amplifier (numerical 12 simulation Results)



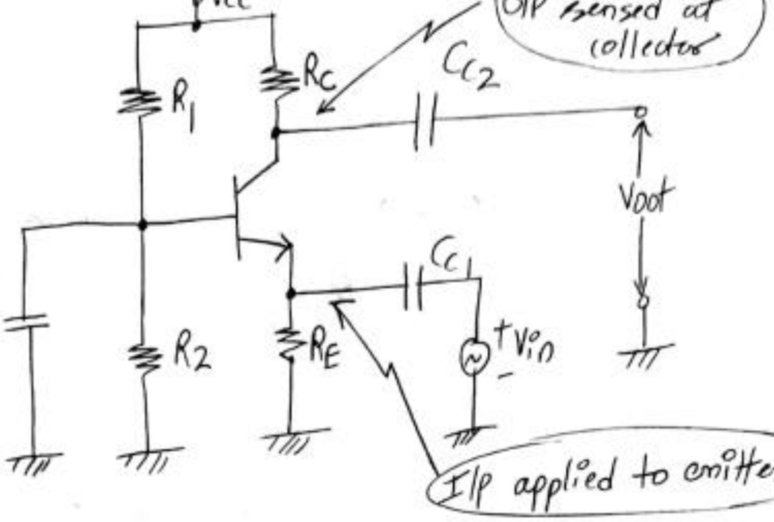
AV without CE



AV with CE connected



3] Common Base amplifier (npn BJT) :-



let says, V_{in} ↑ses ie V_E ↑ses (as $\underset{(DC)}{V_E} + \underset{(AC)}{V_{in}}$ is at E terminal)

$\underset{(DC)}{V_B}$ is a constant, as C_B blocks DC value

ie $V_{BE} = (V_B - V_E)$ ↓ses → I_B ↓ses

$I_C = \beta I_B$; if I_B ↓ses → I_C ↓ses

Also, $V_C = V_{CC} - I_C R_C$ ie If I_C ↓ses → V_C ↓ses

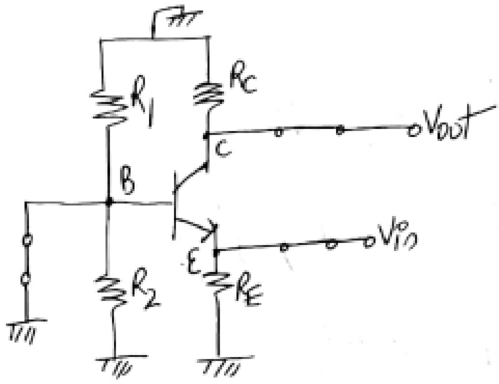
ie V_{out} ↓ses

In summary, As V_{in} ↑ses → V_E ↑ses → V_B constant → V_{BE} ↓ses → I_B ↓ses → I_C ↓ses → V_C ↑ses → ie V_{out} ↑ses

ie I/P & O/P signal in a CB amplifier are in phase with each other.

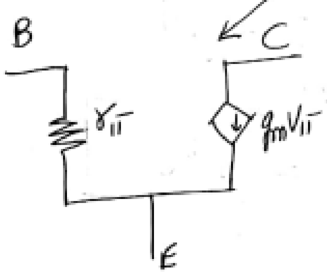
DERIVATION OF RIN and ROUT for Common Base amplifier:

AC Analysis:-



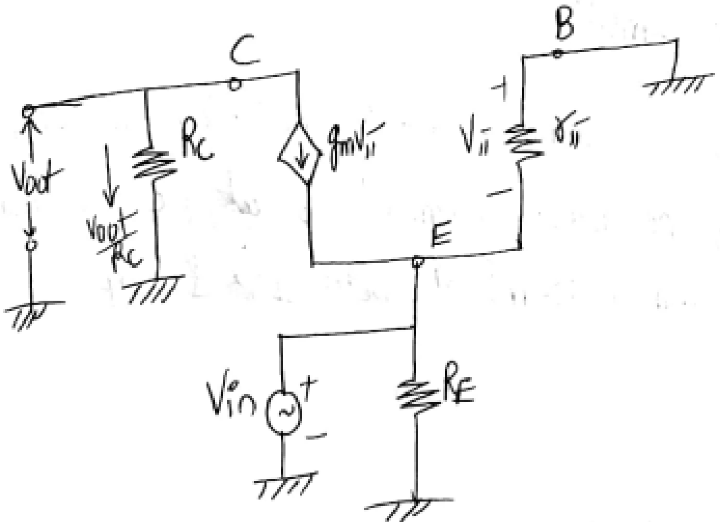
Assume
$V_A = \infty$
i.e. $r_o = \infty$

Next, we replace BJT by its small-signal hybrid model,



Small-signal voltage gain: $A_v = \frac{V_{out}}{V_{in}}$

we interchange B & C terminals for simplicity



ckt (b) : Small-slg equivalent ckt of CB amplifier

From ckt(b),

$$V_\pi = -V_{in}$$

KCL at 'c' node, gives

$$g_m V_\pi + \frac{V_{out}}{R_C} = 0$$

$$\text{i.e.} \quad -g_m V_{in} = \frac{-V_{out}}{R_C}$$

$$\text{i.e.} \quad \frac{V_{out}}{V_{in}} = g_m R_C$$

$$\text{i.e.} \quad \boxed{A_v = +g_m R_C}$$ ---- Small-s/g voltage gain

→ The +ve sign in gain formula indicates no phase difference betn the input and o/p signals in a Common Base ampl^r

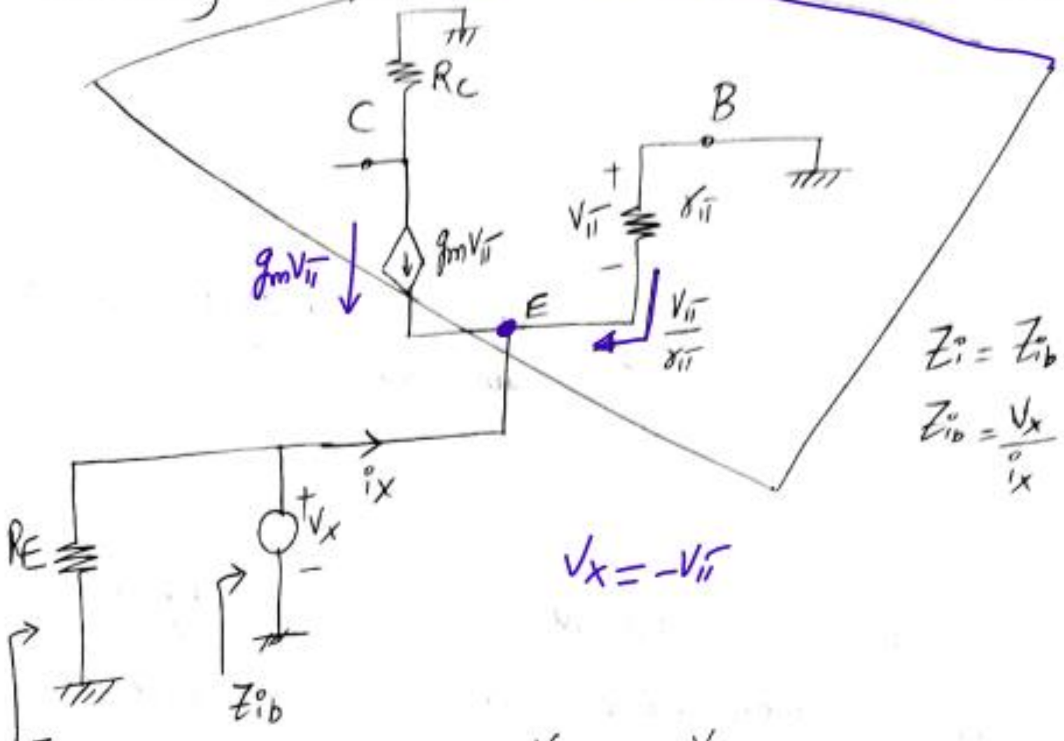
→ It is called "Common-base" amplifier since, in AC analysis, the base terminal is at ac ground & act as common terminal betn I/P & o/p.

Input impedance: Z_i

$R_{in} = \frac{V_x}{i_x}$

$Z_i = \frac{V_x}{i_x}$

Redrawing ckt(b),



$Z_i = Z_{ib} \parallel R_E$

$Z_{ib} = \frac{V_x}{i_x}$

$V_x = -V_\pi$

From above ckt, $\underline{V_\pi = -V_x}$

KCL at 'E' node, gives

$$\rightarrow i_x + g_mV_\pi + \frac{V_\pi}{r_\pi} = 0$$

$$i_x = -V_\pi\left(g_m + \frac{1}{r_\pi}\right)$$

$$i_x = V_x\left(\frac{1 + \underbrace{g_mr_\pi}_{\beta}}{r_\pi}\right)$$

$$i_x = V_x\left(\frac{1+\beta}{r_\pi}\right)$$

$r_\pi = \frac{\beta}{g_m}$

$g_mr_\pi = \beta$

$1+\beta \approx \beta$

$\frac{\beta}{r_\pi} = g_m$

$$i_x = V_x \left(\frac{\beta}{r_\pi}\right)$$

$$\boxed{g_m = \frac{\beta}{r_\pi}}$$

$$i_x = V_x \, g_m$$

$$\boxed{\frac{V_x}{i_x} = \frac{1}{g_m}}$$

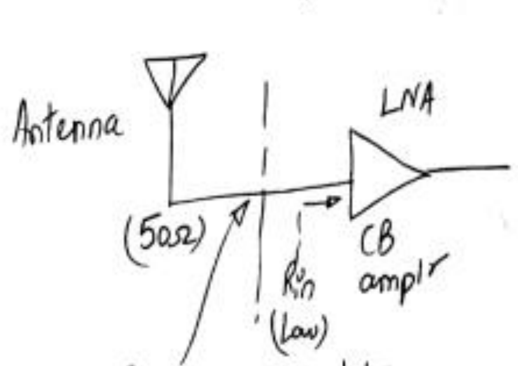
Now, $\boxed{Z_i = \frac{1}{g_m} \parallel R_E}$ Low I/p impedance in CB amplifier

or $R_{in} = \frac{1}{g_m} \parallel R_E$

Application :

↳ CB ampl^r is used to be driven by a low impedance source such as an antenna.

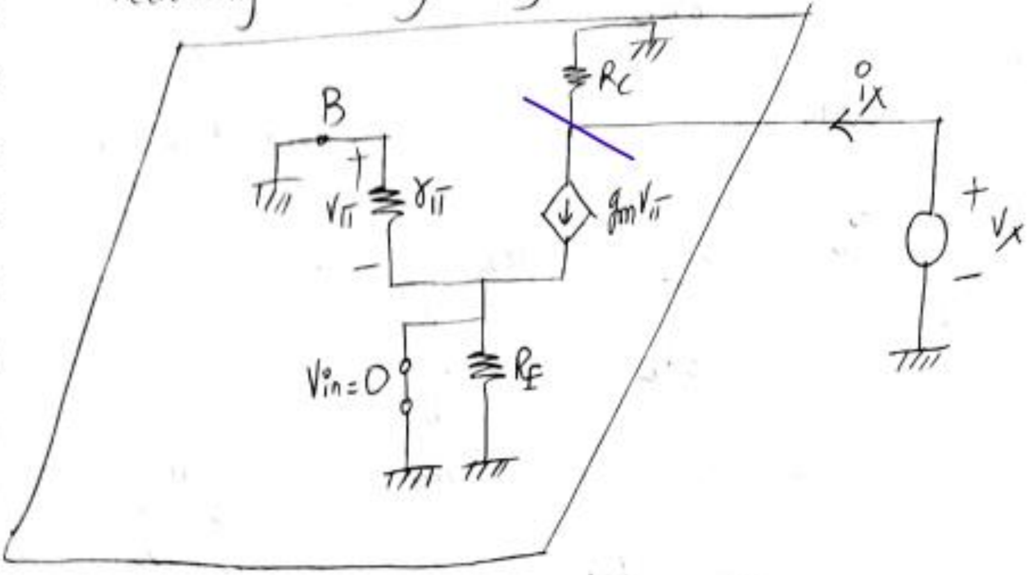
which is also of low impedance of around 50Ω



O/P impedance : Z_o or Z_{out}

$$Z_o = \frac{V_x}{i_x}$$

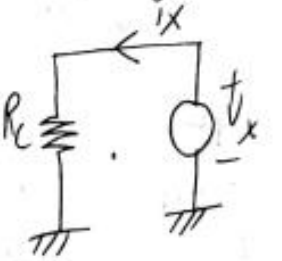
Redrawing ckt (b) by making $V_{in}=0$



Since, $V_{in}=0$ & $V_\pi = -V_{in} = 0$

ie $g_m V_\pi = 0$ ie current source $(g_m V_\pi)$ is open-circuited

ckt reduces to



$$R_{out} = \boxed{Z_o = \frac{V_x}{i_x} = R_C}$$ --- O/P impedance of CB ampl