Single Stage Transistor amplifier.

In the previous chapter (Biasing & stablization) we saw how proper biasing a raises the strength of a transistor & thus acts as an ampr.

Almost all electronic equipments must include means for amplifing electrical signal.

For example, radio receivers amplify weak signals sometime few mv to to untill they are strong enough to fill the room with sound. The transducers in medical field amplify (μV) to (mv).

Amplification may be

i) single stage or
ii) Multi stage.

Single stage amplifier with proper Biasing ckt -

The circuit for single stage transistor ampr is shown in figure.

Here voltage devider biasing is used because it is better among all the above.

When only one transistor with associated circuitry is used for amplifying a weak signal, the circuitary is known as single stage transistor ampr.

→ Although the practical ampr consist of no. of stages, yet such a complex circuit can be conveniently split into separate single stages.

→ By analzing carefully only a single stage & using single stage analysis repeatedly, we can effectively analyze the complex circuit.

How transistor amplifies.

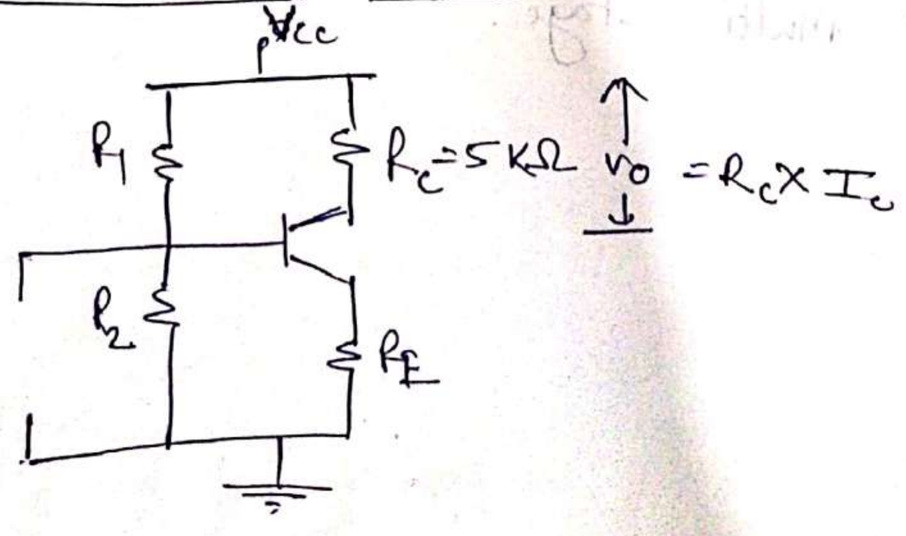
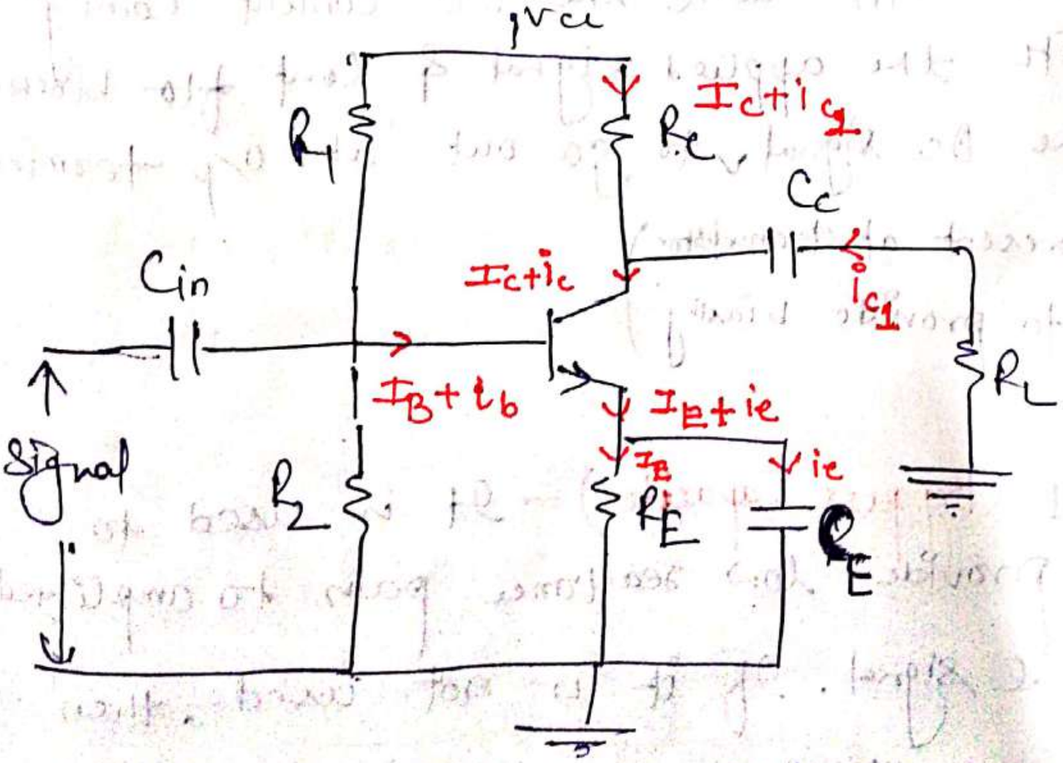


fig. shows a single stage transistor ampr. when a weak A.C signal given to base of transistor, a small current(I_B) starts to flow. Due to transistor action, a much larger current (β times of base current) flows through R_C. And R_C is quite high, therefor large voltage appears R_C. Thus, a weak signal applied in base circuit appears in amplified form at collector.

So basically.

$\boxed{\text{AC signal given to base}} \Rightarrow \boxed{I_B \uparrow} \Rightarrow \boxed{I_C \uparrow \text{(as } I_C = \beta I_B)} \Rightarrow \boxed{V_C \uparrow \text{(As } V_C = I_C \times R_C)}$.

Practical circuit of transistor ampr. —



Biasing Circuit - The resistance R_1 R_2 & R_E form the biasing & stablizing circuit. It provide proper operating point otherwise a part of -ve half of cycle may be cut off.

Cin (Input Capacitor) & Cout (O/p capacitor) -

Cin & Cout are coupling capacitors and they are used to couple the i/p signal to base & amplified O/p to external world.

Basically Capacitor work as S.C (Short Circuit) for AC & O.C for D.C). so, Cin block the DC content coming with the applied signal & Cout to block the DC signal to go out at O/p terminal. (present at transistor to provide biasing)

C_E (Bypass Capacitor) - It is used to provide low reactance path to amplified A.C signal. If it is not used, then amplified A.C signal flowing through R_E will cause a voltage drop, therefor v.

Base Current –

$$i_B = I_B + i_b$$

flows due to biasing circuit Basically DC Base current

flows due to A.C signal applied Basically AC Base current

Similarly.

$$i_C = I_C + i_c$$

Dc Collector current

Ac collector current

$I_C = \beta I_B$ (relation of Dc Collector current to Dc Base current).

$i_c = \beta i_c$ (relation of Ac collector " to Ac Base current).

&

$$i_E = I_E + i_e$$

Dc Emitter Current

AC Emitter current

$$I_E = I_B + I_C$$

$$i_e = i_b + i_c$$

base current is usually very small,

so. $\boxed{I_E \simeq I_C}$ $\boxed{i_e \simeq i_c}$

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D.C & A.C equivalent circuit.

In a transistor ampr. both the supplies (AC & DC) are present. DC is used for biasing purpose (& or to operate in proper operating point) & AC is used (as a signal). therefore a simple way to analyze the transistor action. split the analysis into two parts

i) AC Analysis

ii) DC Analysis.

for AC analysis, we consider all the AC sources at same time & work for A.C voltage & current

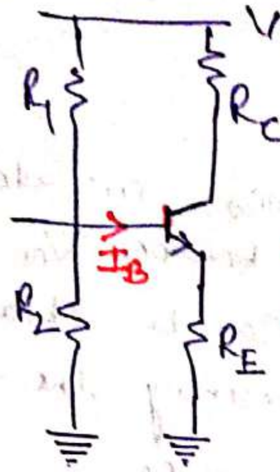
Similarly, for DC, consider all the DC source & work for DC voltage & current

i) DC Equivalent circuit —

In the DC equivalent circuit, only DC condition are to be considered i.e. it is preassumed that no signal is applied

→ for DC, capacitor work as O.C so, open all the capacitors.

→ for DC, assume all the A.C source to zero.



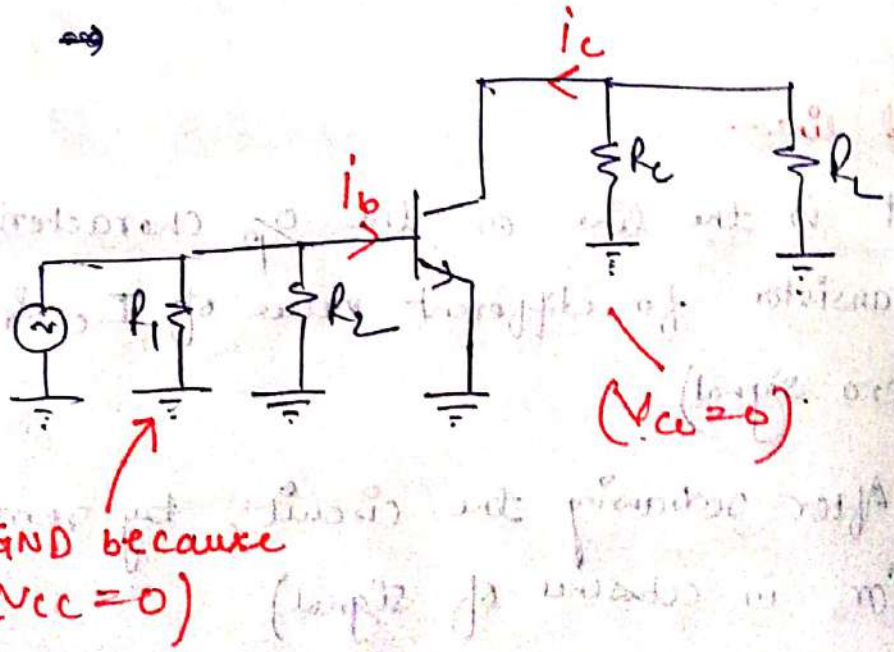
from this,
we can easily calculate DC current & voltages.

A.C. equivalent circuit –

In the AC equivalent circuit, only AC condition are to be considered

→ so DC voltage is not important in AC equivalent circuit & it can be consider zero.

→ Capacitor work as s.c for A.C



Load Line Analysis –

The o/p Characteristics are determined experimentally & indicate the relation between V_{CE} & I_C. However, the same information can be obtain in a much simpler way by representing the mathematical relation between I_C & V_{CE} graphically.

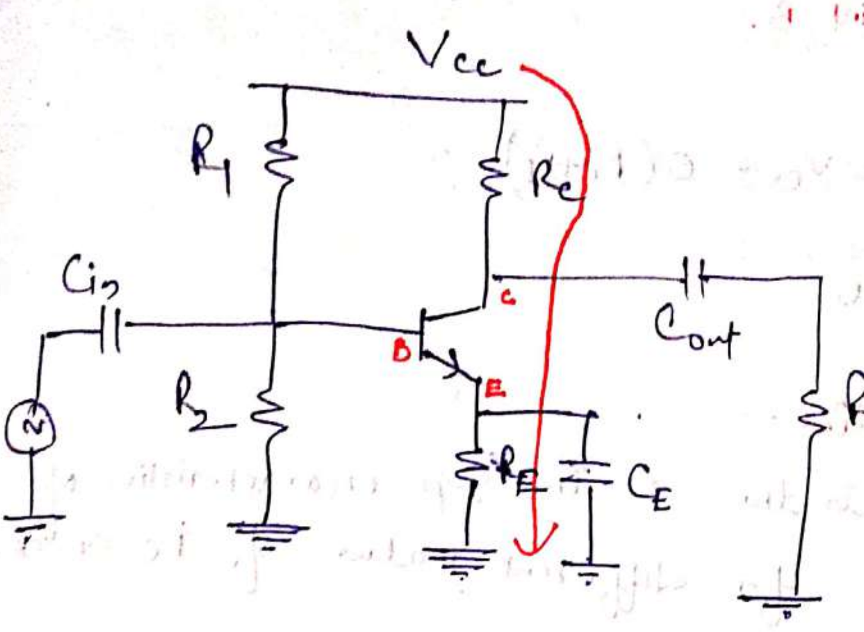
As discussed before the relationship between V_{CE} & I_C is linear so that it can be represented by straight line on the o/p char. this is known as Load Line.

In the transistor both A.C & DC condition exist, therefore there are two type of Load line exist. AC Load line & DC Load line.

DC Load line –

It is the line on the o/p characteristics of a transistor for different value of I_C & V_{CE}. (for Zero signal)

After redrawing the circuit, by removing signal (or in absence of signal)



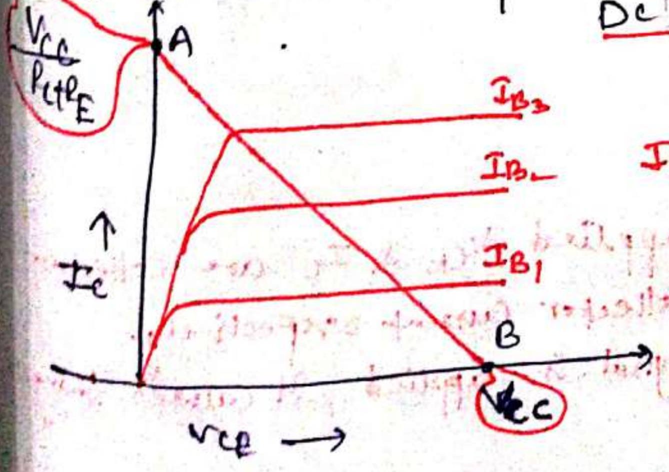
By applying KVL,

$$+V_{cc} - I_c R_c - V_{CE} - I_E R_E = 0$$

$$V_{CE} = V_{cc} - I_c R_c - I_E R_E \qquad (\because I_E \simeq I_c)$$

$$V_{CE} = V_{cc} - I_c(R_c + R_E) \quad \text{--- } ①$$

where V_{cc} & (R_c+R_E) are constant, therefor it is a first degree eq^n & can be represented by straight line on the o/p characteristics. This is known as <u>DC load line.</u>



$I_{B_3} > I_{B_2} > I_{B_1}$

for point A, $V_{CE} = 0$

so $0 = V_{cc} - I_c(R_c + R_E)$

$$\frac{V_{cc}}{R_c + R_E} = I_c$$

for point B.

$I_C = 0$

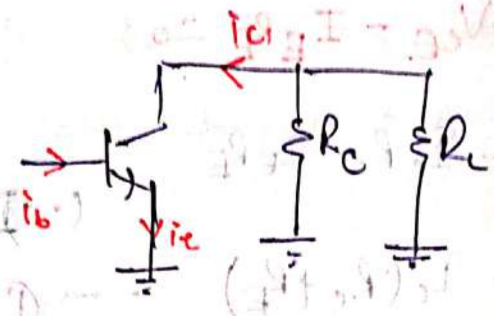
so, $V_{CE} = V_{CC} - 0(R_C + R_E)$

$V_{CE} = V_{CC}$

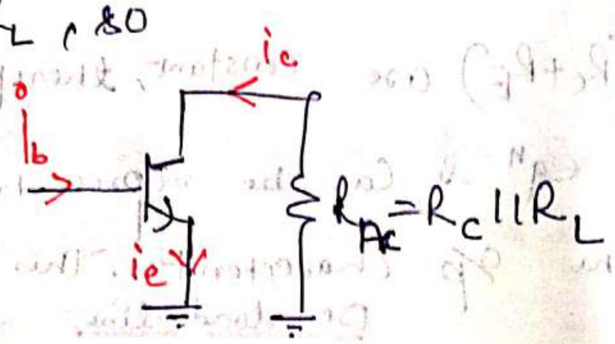
A.C. Load line —

This is the on the o/p characteristics of a transistor for different value of i_c & V_{CE}. when signal is applied.

After redrawing A.C equivalent circuit,



$R_C \parallel R_L$, so



$I_C R_{AC} - V_{CE} = 0$

When no signal is applied, V_{CE} & I_C are collector-emitter voltage & collector current respectively.

But when signal is applied, It causes changes to take place.

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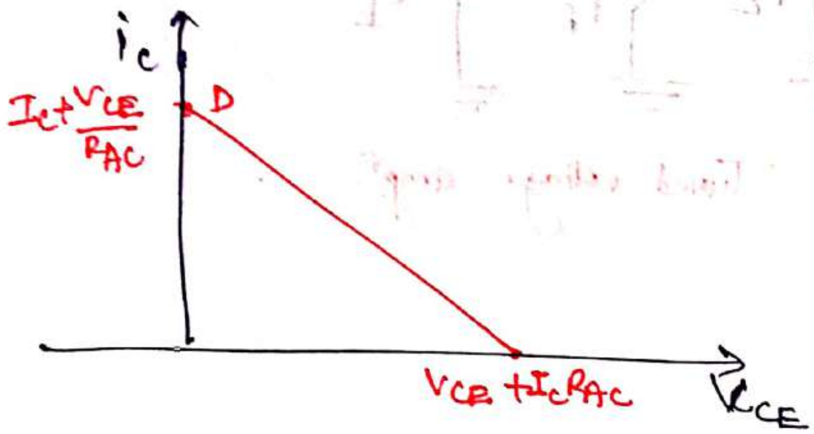
→ Max collector current due to A.c signal $= I_c$

→ Max the swing of A.c collector-emitter voltage $= I_c R_{AC}$

→ Total max collector emittor voltage $= V_{CE} + I_c R_{AC}$

→ Max the swing of Ac collector current $= V_{CE}/R_{AC}$

→ Total max collector current $= I_c + V_{CE}/R_{AC}$



Tuned voltage Amplifier –

Tuned ampr is used to amplify a narrow band of frequencies.

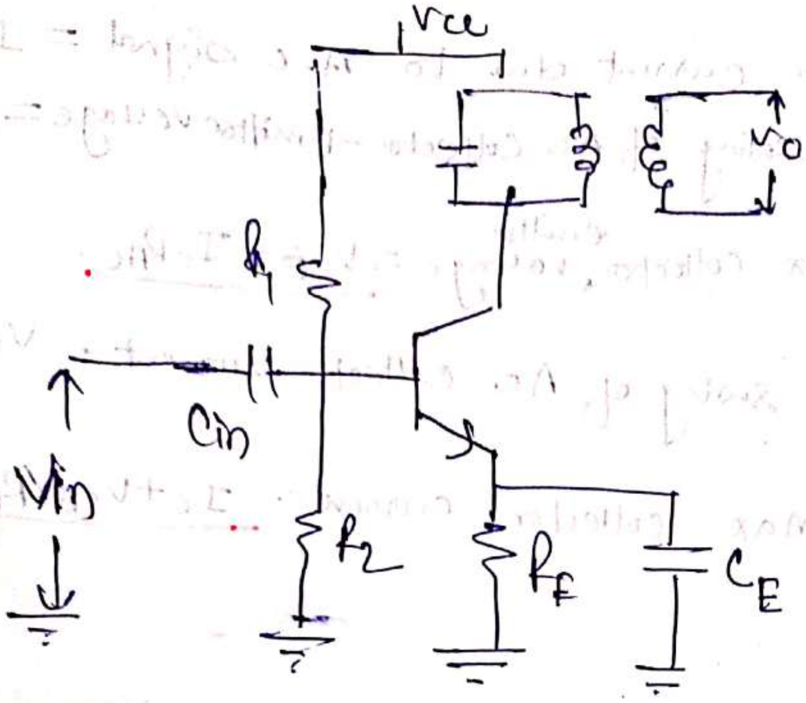
Commonly used for RF (30KHz to 300MHz).

Radio freq are generally single and tuned ampr allow the desired freq. while rejecting others.

It may be

i) Single tuned voltage ampr

ii) Double tuned voltage ampr



Tuned voltage ampr.

→ After Completing the chapter try these questions

Q i) Draw the single stage CE (Common Emitter) ampr.

Q ii) what is load line?

Q iii) Explain DC load line.

Q iv) Explain A.C load line.

Q v) what is requirement of multistage ampr?

Q vi) Differentiate b/w A.C load line & DC load line

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