Blackboard Notes for lecture - 2

slide 6:

To figure out the component over v_{be}, we need to find out the relationship between i_b and v_{be} in this circuit branch.

Slide 7:

we know that:

$$i_B = \frac{i_c}{\beta} = \frac{I_s}{\beta} \exp(v_{BE}/V_T)$$

therefore, the component over v_{be} is a PN diode.

slide 13:

when a small perturbation is added in the input side:

$V_{in} = V_m \sin\omega t$, then

$$I_c = I_s \exp((V_o + V_{in})/V_T) = \underline{I_s \exp(V_o/V_T)} \cdot \exp\left(\frac{V_m \sin\omega t}{V_T}\right)$$

$$= I_{co} \cdot \exp\left(\frac{V_m \sin\omega t}{V_T}\right)$$

$$\approx I_{co} \cdot \left(1 + \frac{V_m \sin\omega t}{V_T}\right)$$

we use an approximation here:

$$e^x \approx 1 + x \text{, when } x \ll 1$$

$$= I_{co} + \frac{I_{co}}{V_T} V_m \sin\omega t$$

$$= I_{co} + g_m V_m \sin\omega t$$

$$= \underline{I_{co} + g_m V_{in}}$$

Slide 14:

according to $I_c = I_{c0} + g_m V_{in}$,

the circuit is therefore divided into two parts.

Slide 15:

In small-signal model:

$$i_B = \frac{g_m V_{in}}{\beta}$$

$$R = \frac{V_{in}}{i_B} = \frac{\beta}{g_m}$$

therefore: a resistor with a value of β/g_m is determined, which is different from the large-signal model that is modeled with a PN junction.