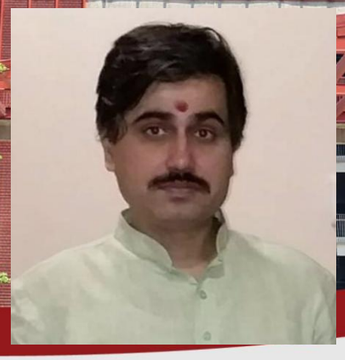
Analog Electronic Circuits
(UEC301)

By



Dr.Mayank Kumar Rai
Associate Professor,
ECED,TIET,Patiala

Thapar Institute of Engineering & Technology
(Deemed to be University)
Bhadson Road, Patiala, Punjab, Pin-147004
Contact No. : +91-175-2393201
Email : info@thapar.edu

THAPAR INSTITUTE
OF ENGINEERING & TECHNOLOGY
(Deemed to be University)

Subject: Analog Electronic Circuits (UEC301)

Faculty name: Dr. Mayank Kumar Rai (Associate Professor & Course Coordinator)

Topic of today's Lecture : Small Signal Model and Operation of BJT-II

Key points

- ✓ **Early Effect In BJT**
- ✓ **Early Effect based Low frequency small signal model of BJT**
- ✓ **Low frequency small signal operation under the influence of Early effect**

Contents of this lecture are based on the following books:

- *Jacob Milman & and C.C.Halkias,* ***"Integrated Electronics Analog and Digital Circuit and Systems"****Second Edition.*
- *Adel S. Sedra & K. C. Smith,* ***"MicroElectronic Circuits Theory and Application"*** *Fifth Edition.*
- *Robert L. Boylestad & L. Nashelsky,* ***"Electronic Devices and Circuit Theory"*** *Eleventh Edition.*

Early Effect In BJT

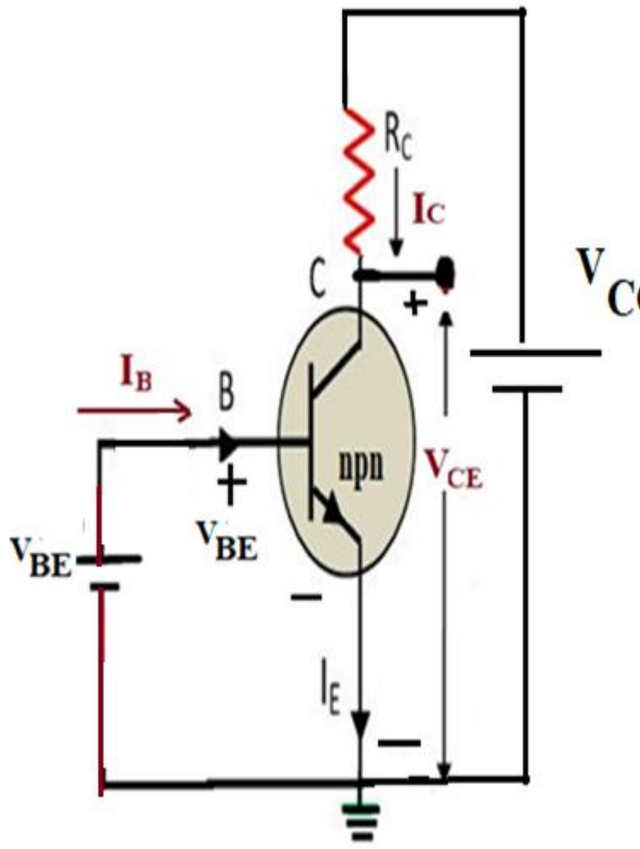


Figure 1:Common emitter configuration based CKT.

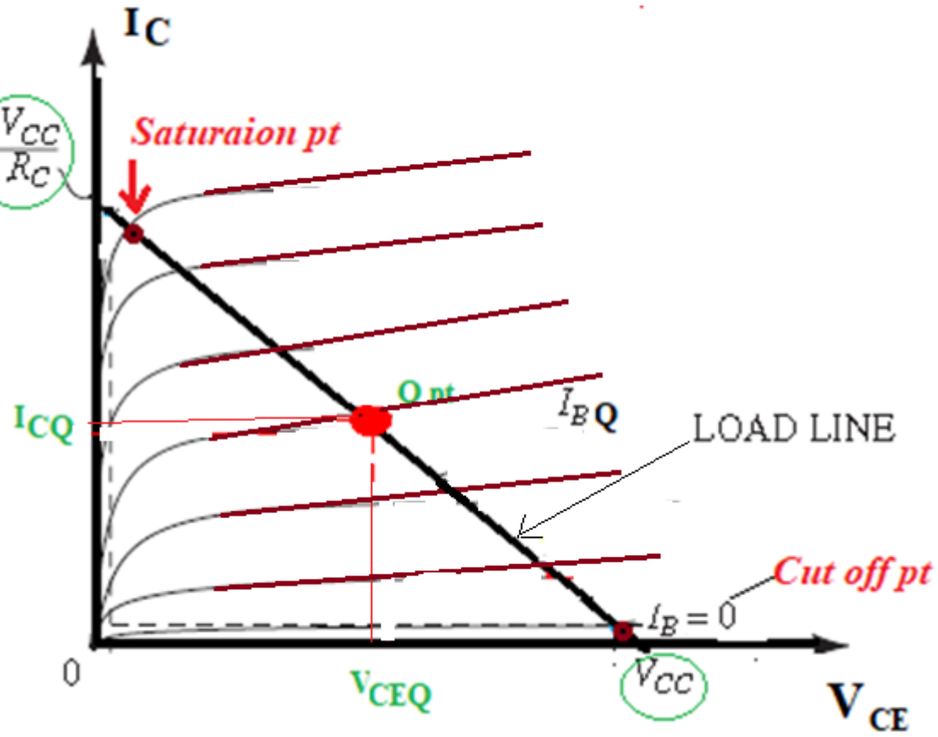


Figure2: Output Char.

Early Effect In BJT

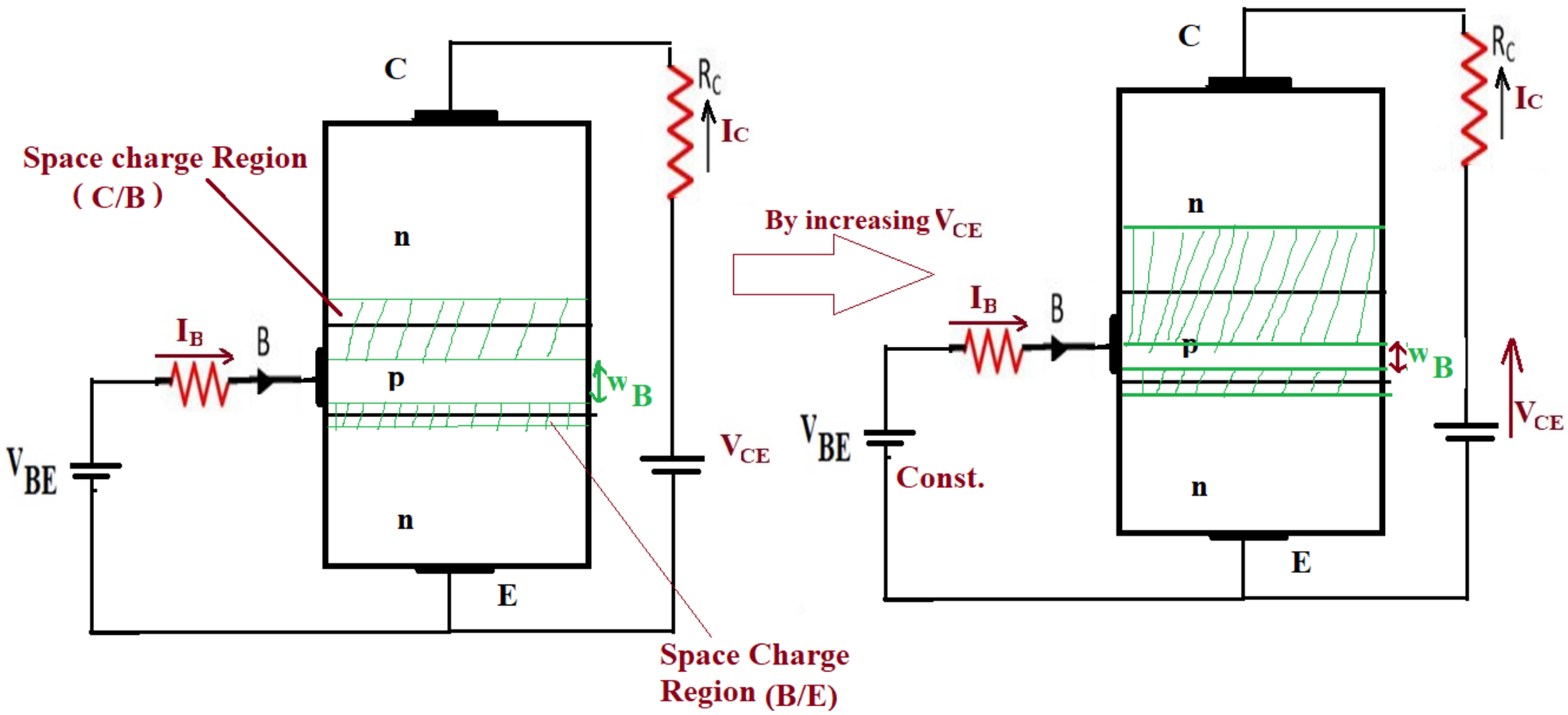
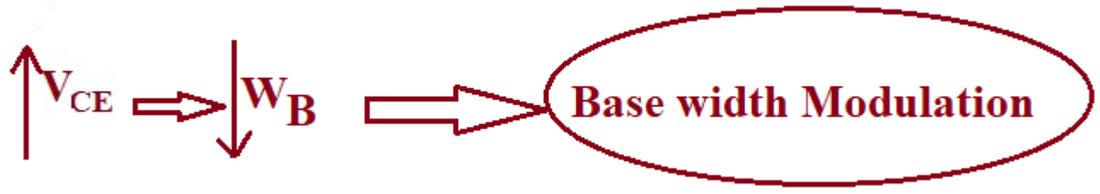


Figure 3: NPN transistor biased in forward active region.



Early Effect.....

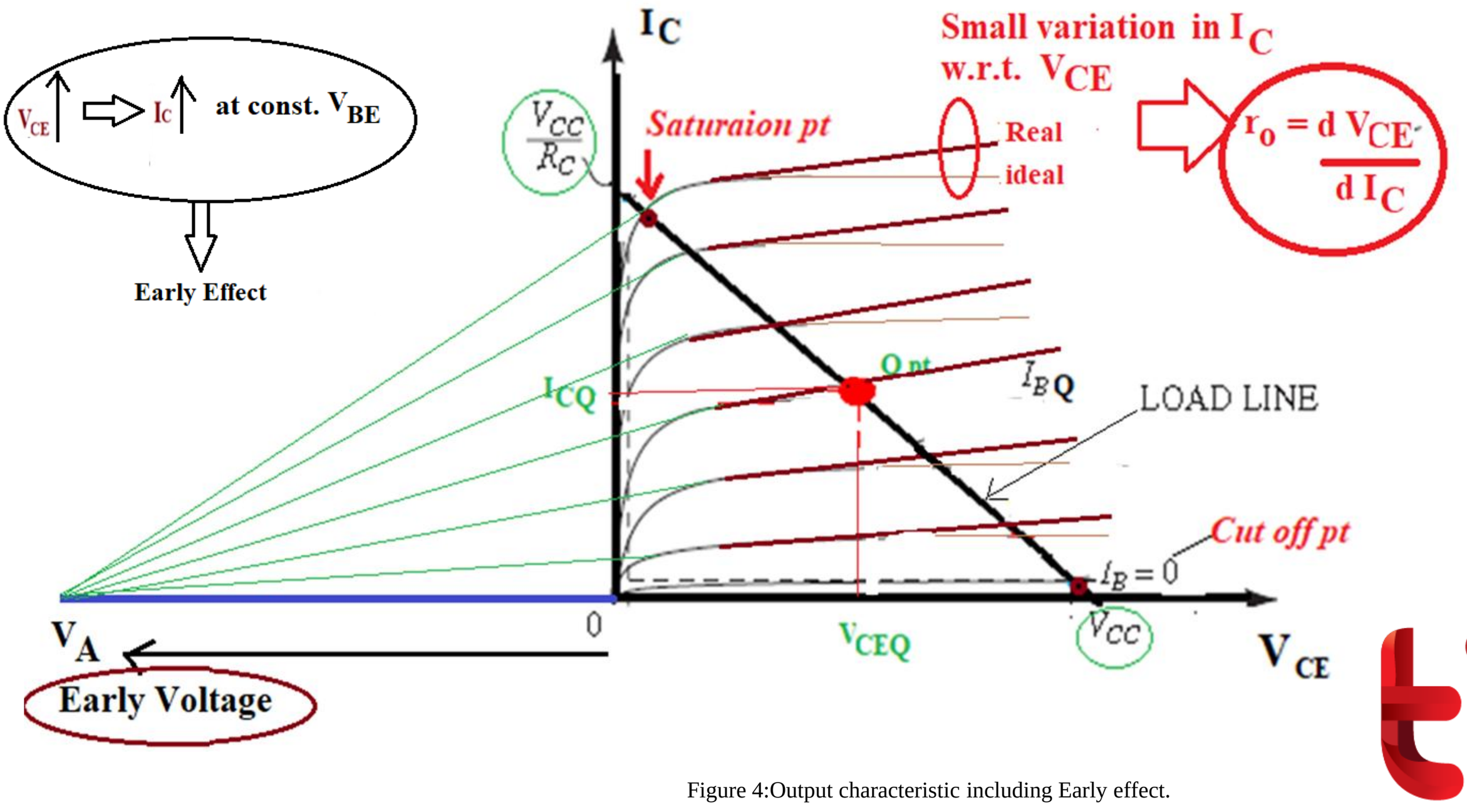


Figure 4:Output characteristic including Early effect.

Early Effect.....

Such action causes the effective width of base(W_B) to decrease. This decrease in W_B has two consequences:

(1) There is less chance for recombination within the base region. Hence α and β increase with an increase in the magnitude of I_C

(2) The current of minority carriers injected across the emitter junction increases.

Early Effect based Low frequency small signal models of BJT

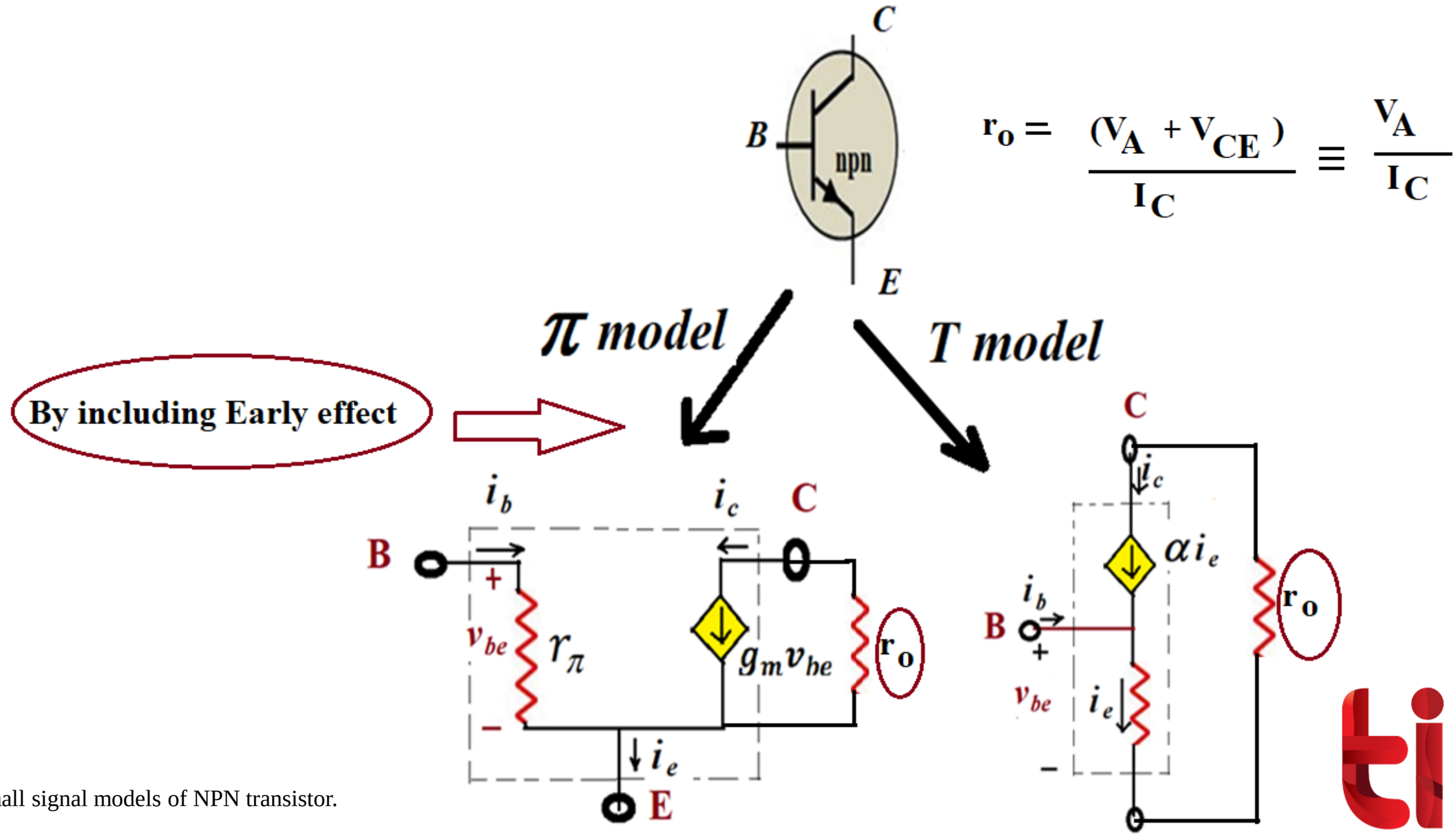


Figure 5:Small signal models of NPN transistor.

Low frequency small signal operation under the influence of Early effect

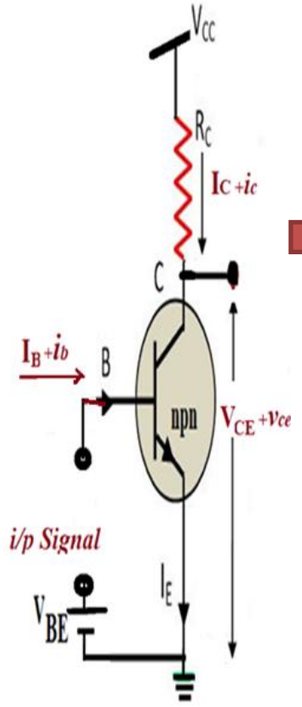


Figure 6:The amplifier CKT.

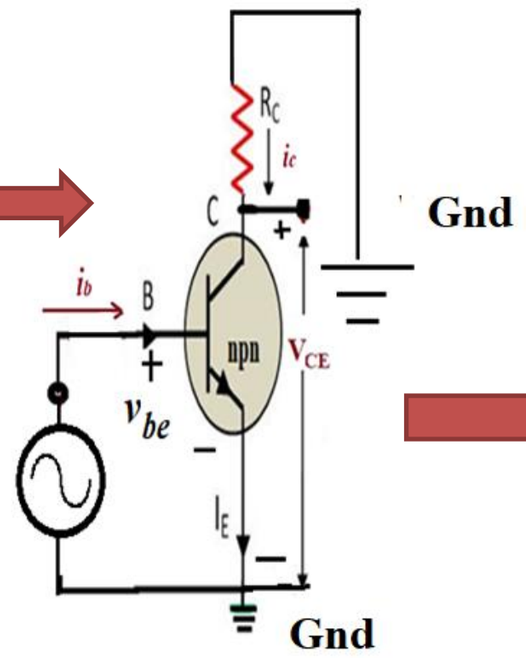


Figure 7:The amplifier CKT with dc sources eliminated.

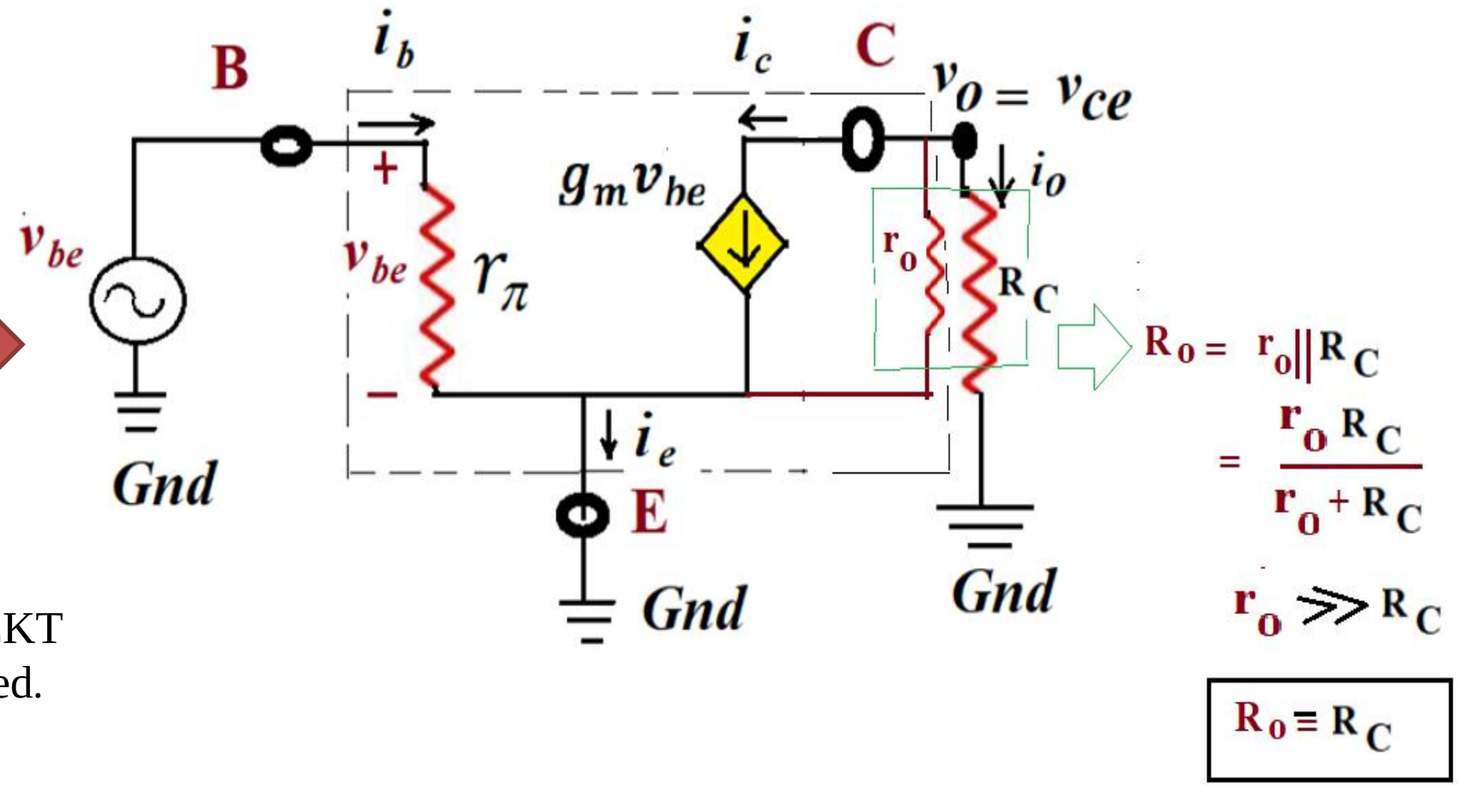


Figure 8:Small signal equivalent CKT of Fig.6.

Voltage gain

$$i_0 + i_c = 0$$

$$i_0 = -i_c$$

$$v_o = i_0 R_O = -i_c (r_o \| R_C) \equiv -g_m v_{be} R_C$$

$$\text{Voltage gain, } A_v = \frac{v_{ce}}{v_{be}} \equiv -g_m R_C$$

Thank You