

## CHAPTER

# 6

## ANALYSIS OF BIPOLAR TRANSISTORS AT LOW FREQUENCY

### 6.1 Introduction

In the case of amplifiers at low frequency applications, or the audio range which covers frequency range between 20 Hz to 20 kHz, transistors must be biased such that they operate in the linear or active region as discussed previously in Chapter 4. We will investigate the behavior of this transistor by constructing its model which is a low frequency model or also referred to as the small signal a,c model. Such models introduce parameters and relationships which contain a lot of information about the behavior of the transistor in the situation under consideration. Furthermore, it enables us to predict and calculate important properties such as current and voltage gain as well as input and output resistance of the designed amplifiers.

This chapter will investigate specifically the small signal h-parameter hybrid model of bipolar transistor on its own and when used as an amplifier. Other models in this category include  $\pi$  model, y-parameter model and z-parameter model are not discussed here.

## 6.2 The h-Parameter Hybrid Model

The behavior of a device such as a transistor may be determined by two voltages and two currents. We will choose two of the four quantities as independent variables and express the other two in terms of the two chosen independent variables. To illustrate this, refer to Figure 6.1 which shows a transistor with two voltages,  $v_{be}$  and  $v_{ce}$  and two currents  $i_b$  and  $i_c$ . From here, a model or equivalent circuit for the transistor or other devices may be derived.

In order to find the hybrid model at low frequency, we must assume that the changes around operating point are small. Operating point values and constant voltages or currents such as collector voltage source are not included in the model derivation and calculations as we are only investigating small changes around the operating point.

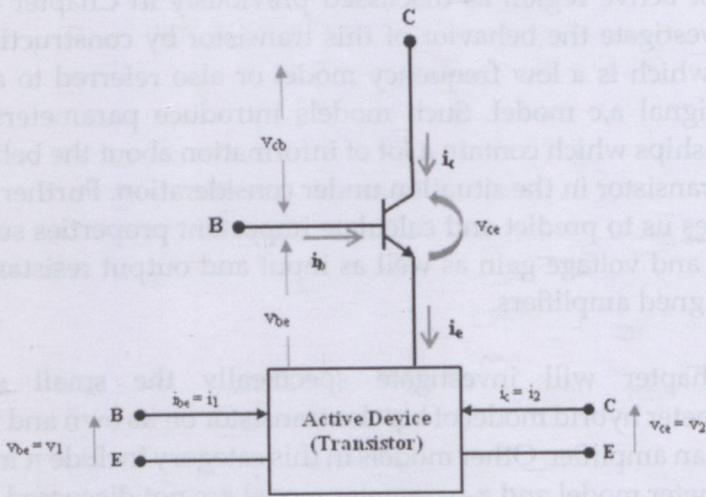


Figure 6.1: Variables in a Transistor.