Introduction

- A Bipolar Junction Transistor (BJT) is a three-terminal device

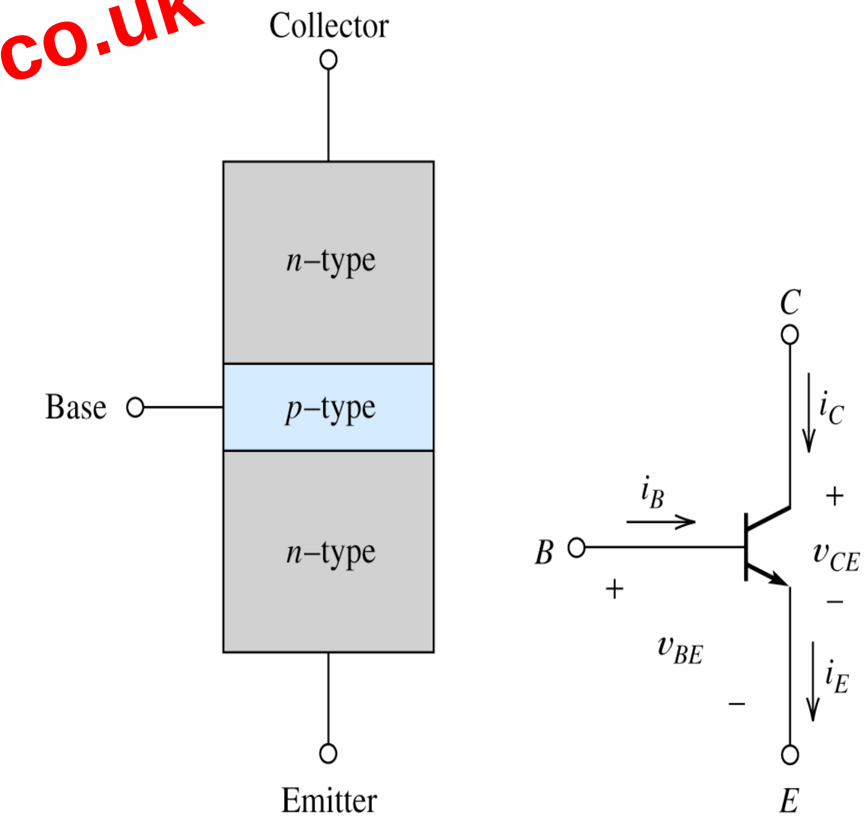
- It is constructed as layers of semiconductor materials (usually silicon)

- It is used in amplifiers and logic circuits

- BJTs are capable of producing large output currents

NPN Bipolar Junction Transistors (BJT)

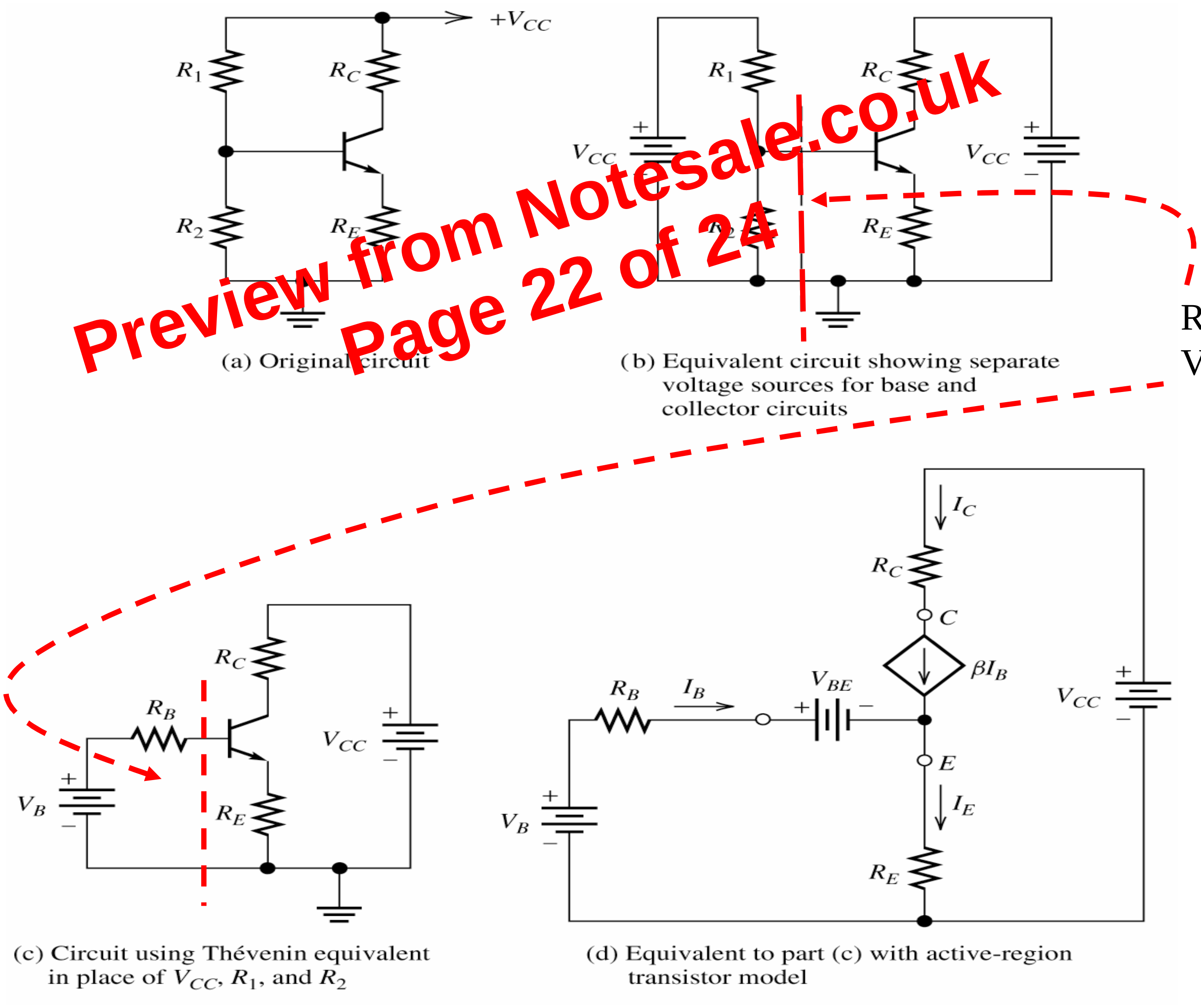
- A layer of p-type material between two layers on n-type material
- Each PN junction forms a diode but current in one junction affect the other
- Three layers are called:
    - Emitter
    - Base
    - Collector
- With the voltages applied, a small current from the base causes much larger currents to flow from the collector to the emitter



(a) Physical structure (b) Circuit symbol

The *npn* BJT.

Analysis of the Four-Resistor Bias Circuit



(a) Original circuit

(b) Equivalent circuit showing separate voltage sources for base and collector circuits

(c) Circuit using Thévenin equivalent in place of V_{CC}, R_1, and R_2

(d) Equivalent to part (c) with active-region transistor model

R_B – Thevenin resistance
V_B – Thevenin voltage

Example

Find I_C and V_{CE} for $\beta = 100$ and $\beta = 300$. Assume $V_{BE} = 0.7$ V.

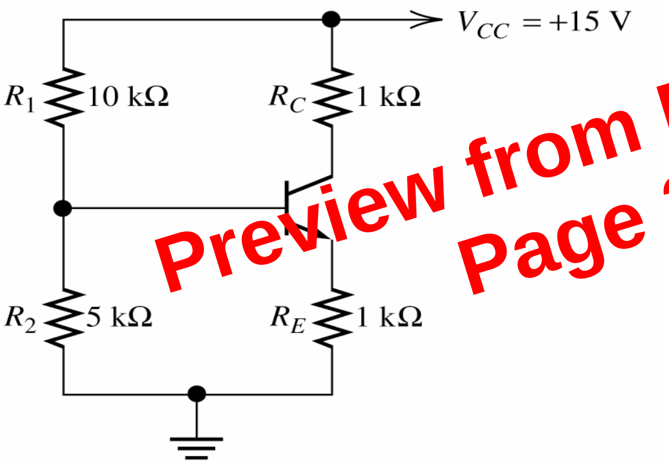


Figure 13.23 Circuit for Example 13.7.

$$V_B = V_{CC}\frac{R_2}{R_1 + R_2} = 5V$$

$$R_B = \frac{1}{1/R_1 + 1/R_2} = R_1 \| R_2 = 3.33k\Omega$$

$$I_B = \frac{V_B - V_{BE}}{R_B + (\beta + 1)R_E} = 41.2\mu A$$

For β = 100, $I_C = \beta I_B = 4.12mA$

$$V_{CE} = V_{CC} - R_C I_C - R_E I_E = 6.72V$$

For β = 300, $I_B = 14.1$ μA, $I_C = 4.24$ mA, and $V_{CE} = 6.51$ V

This configuration has a Q-point almost independent of β