Lecture 17 – Introduction to BJT’s

Bipolar Junction Transistors

BJT Structure (NPN)
- Collector
- Base
- Emitter

BJT Operation
- B-E Junction (Forward Bias)
- C-B Junction (Reverse Bias)
- Drift vs. Diffusion

BJT Symbol and Currents (i_B, i_C, i_E)

BJT Current Gain (β, h_{FE})

Useful BJT Relationships
- Gain Equations
- Current Ratios
- Typical β (Beta) Values
- Typical α (Alpha) Values

BJT DEMO

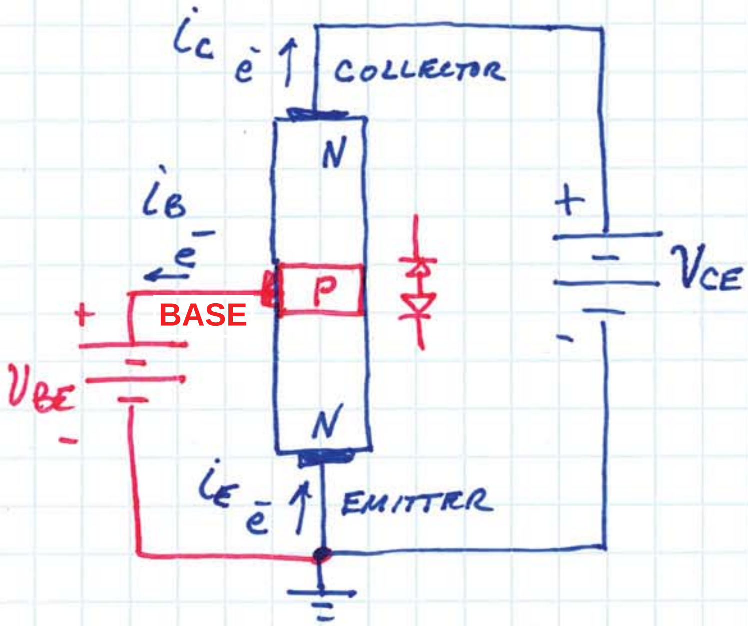
Lab5 Prep – Beta Meter

ECE 2201 — LEC 17 — BITAR

INTRO TO BJT'S

(BIPOLAR JUNCTION TRANSISTORS)

• STRUCTURE: WILLIAM SHOCKLEY'S REVENGE



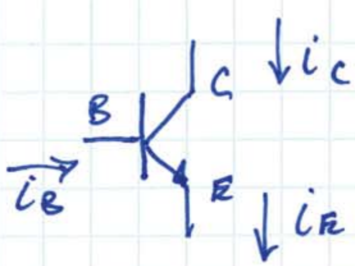
- NPN STRUCTURE
- THIN BASE, LIGHTLY DOPED
- HEAVILY DOPED EMITTER

* DEVICE IS OFF w/ ONE PN JUNCTION REVERSE BIASED (C-B)

• OPERATION:

1. FORWARD BIAS B-E JUNCTION (DIODE)
2. ELECTRONS FLOW FROM E to B BUT!
3. MOST ELECTRONS AT CONDUCTION BAND ENERGY LEVEL TAKE TIME TO FALL TO VALENCE BAND ENERGY LEVEL IN BASE.
4. MOST WILL DIFFUSE INTO COLLECTOR!!!
5. BE FORWARD BIASED, CB REVERSE BIASED.

• SYMBOL AND CURRENTS:



CONVENTIONAL CURRENT DIRECTION SHOWN

$$i_E = i_B + i_C$$

KCL! SUPERNODE! ALWAYS TRUE!!

$$i_C = \beta i_B$$

(BETA)

CURRENT GAIN! BETA

* BJT IS FUNDAMENTALLY A CURRENT GAIN AMPLIFIER!!

- IMPORTANT BJT RELATIONSHIPS

  - GAIN EQS.

$$i_C = \beta i_B$$

$$i_E = (\beta+1) i_B$$

  - RATIOS:

$$\underset{\text{(BETA)}}{\beta} = \frac{i_C}{i_B}, \quad (\beta+1) = \frac{i_E}{i_B}, \quad \left(\frac{\beta}{\beta+1}\right) = \frac{i_C}{\cancel{i_B}\; i_E}$$

$$\left(\frac{\beta}{\beta+1}\right) \equiv \alpha_{\text{ALPHA}}$$

  - TYPICAL β VALUES

$\beta = 100$ (BOOK)

$\beta = 25$ POWER TRANSISTOR

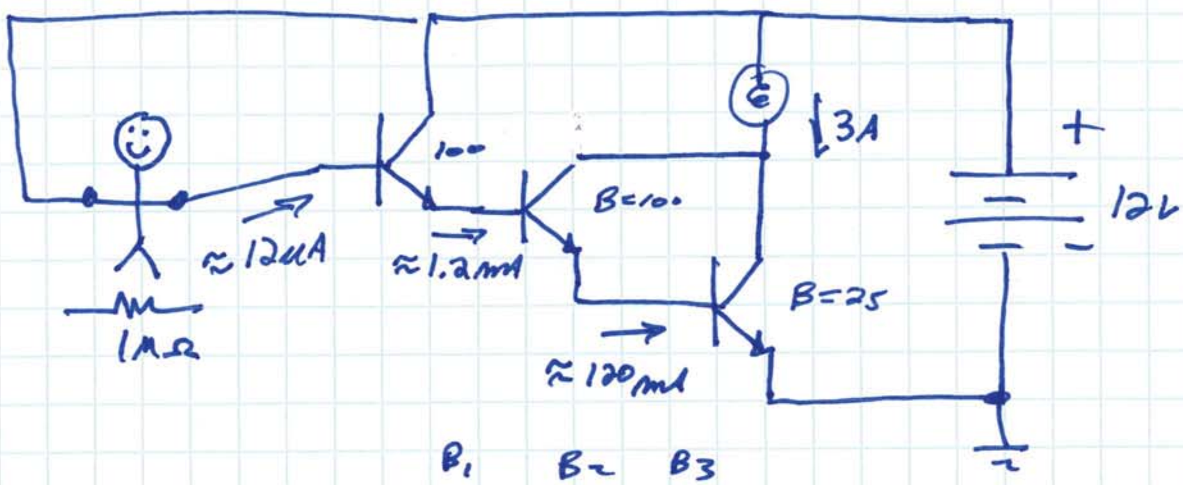
$\beta = 200$ SMALL SIGNAL TRANSISTOR

  - TYPICAL α VALUES:

$$\alpha = \frac{\beta}{\beta+1} = \frac{100}{101} = 0.99$$

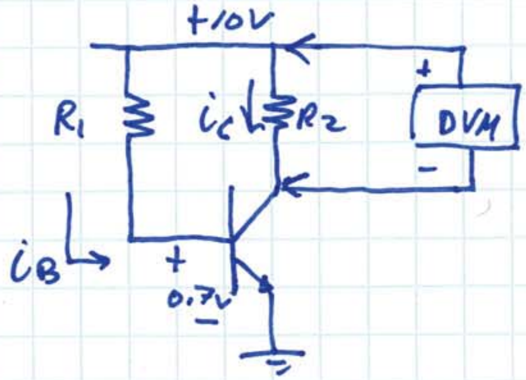
$\alpha < 1$ ALWAYS $\quad \alpha \approx 1$

BJT - DEMO



$$\underset{}{(12\mu A)}\underset{B_1}{(100)}\underset{B_2}{(100)}\underset{B_3}{(25)} = 3A$$

LAB 5B PREP BETA METER BITAR



WANT $v_{DVM} = \beta_{mV}$

KVL: $10V = R_1 \cdot i_B + 0.7V$ FOR $i_B = 10\mu A$,

$10V = R_1(10\mu A) + 0.7V$

$\therefore R_1 = 930K\Omega \approx \boxed{1M\Omega} = R_1$

$i_C = \beta(10\mu A)$

WANT $v_{DVM} = \beta_{mV} = R_2 i_C$

$1 \beta_{mV} = R_2 (\beta)(10\mu A)$

$1mV = R_2(10\mu A)$

$\therefore R_2 = \frac{1mV}{10\mu A} = \boxed{100\Omega} = R_2$

* MORE PRECISELY, $R_1 = 930K\Omega$, $R_2 = 100\Omega$

OR, $R_1 = 1M\Omega$, $R_2 = 107.5\Omega$