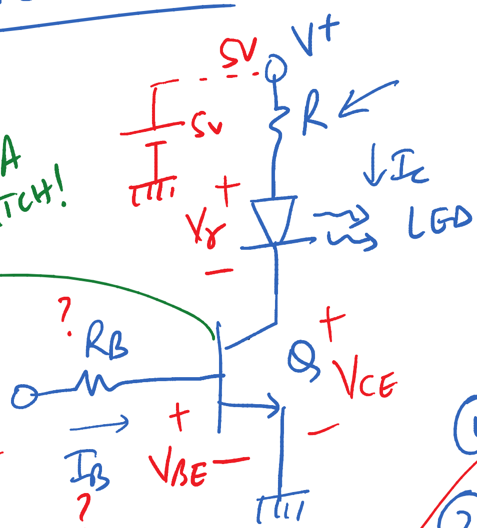
Tuesday, February 12, 2013
4:04 PM

LECTURE -27

APPLICATION



TRANSISTOR IS BEING USED AS A SWITCH!

5V

LED

1. LARGER TURN ON VOLTAGE THAN STANDARD P-N DIODE
2. NEEDS LARGER CURRENT

LED REQUIREMENT

1. $V_\gamma \rightarrow$ LED TURN-ON VOLTAGE
2. $I_{\gamma(MIN)} \rightarrow$ MIN. CURRENT REQUIRED TO GET THE DESIRED/SPECIFIED LUMINOSITY
3. $I_{\gamma(MAX)} \rightarrow$ CANNOT EXCEED $I_{\gamma(MAX)}$

$\therefore$ WE NEED A CURRENT LIMITING RESISTOR

$I_{C(REQD)} = 12mA$

$\beta = 50 \leftarrow$ ACTIVE REGION

$V_{BE(ON)} = 0.7V$

$V_\gamma = 1.5V$

$V_{CE(SAT)} = 0.2V$

$V_I = 0V$ Q IS OFF $I_B = 0$ $I_C = 0$ LED IS OFF

$V_I = 5V$ Q IS ON TRANSISTOR IS DRIVEN INTO SAT. — GOAL

$$V_{CE} = V_{CE(SAT)} = 0.2V$$

KVL CE LOOP

$$-5 + I_C R + V_\gamma + V_{CE(SAT)} = 0$$

$$R = \frac{5 - V_\gamma - V_{CE(SAT)}}{I_C} = \frac{5 - (1.5 + 0.2)}{12m}$$

$= 2.75\,J$

Wednesday, February 13, 2013
11:03 AM

$I_C = \beta I_B$ → ONLY VALID IN ACTIVE REGION

IN SATURATION

$I_C = \beta_{FORCED} I_B$

$\beta_{FORCED} < \beta(\text{ACTIVE})$

?? CHOOSE

$\beta = 50$

SAY $\beta_{FORCED} = 20$ [CHOICE]

* IF $\beta_{FORCED} \uparrow$ ∨ $I_B \downarrow$ $R_B \uparrow$

NEED TO INCREASE I_B AND DECREASE R_B

∴ $\beta_f \downarrow\downarrow$

$\frac{I_C}{I_B} = \beta_{FORCED} = 20$ $I_C = 12mA$

$I_B = 0.6mA$

KVL BE LOOP

$-V_I + I_B R_B + V_{BE(ON)} = 0$

$R_B = \frac{V_I - 0.7}{0.6m} = 7.17\,K\Omega$

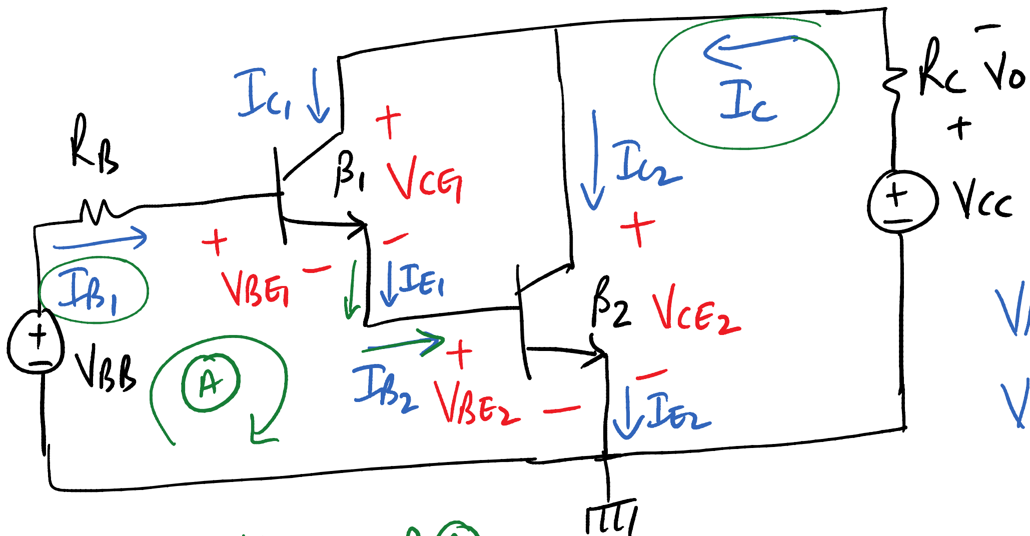
$$P_T = I_B V_{BE(on)} + I_C V_{CE} = (0.6m)(0.7) + (12m)(0.2)$$

$$= \underline{\underline{2.82mW}}$$

Wednesday, February 13, 2013
11:07 AM

DARLINGTON AMPLIFIER AND ANALYSIS

$\beta_{OVERALL}$??



$V_{BE} = 0.7\ v = V_{\gamma o}$

$V_{BE_1} = V_{BE_2} = V_{\gamma o}$

KVL LOOP (A)

$$-V_{BB} + I_{B_1} R_B + V_{BE_1} + V_{BE_2} = 0$$

$$I_{B_1} = \frac{V_{BB} - 2V_{\gamma o}}{R_B}$$

ASSUME ACTIVE REGION!

$$I_{C_1} = \beta_1 I_{B_1} = \left(\frac{\beta_1}{R_B}\left(V_{BB} - 2V_{\gamma o}\right)\right)$$

$$I_{C_2} = \beta_2 I_{B_2} = \beta_2 I_{E_1} = \beta_2 \frac{I_{C_1}}{\alpha_1}$$

$$= \frac{\beta_2 \beta_1}{\alpha_1 R_B}\left(V_{BB} - 2V_{\gamma o}\right)$$

β_1 ___ = α_1

$$\overline{\alpha_1 R_B}$$

$$\frac{\beta_1}{1+\beta_1} = \alpha_1$$

$$I_{C_2} = \frac{\beta_2 (1+\beta_1)}{R_B} (V_{BB} - 2V_{BE})$$

$$I_C = I_{C_1} + I_{C_2} = \frac{\{\beta_1 + \beta_2 (1+\beta_1)\}}{R_B} (V_{BB} - 2V_{BE})$$

$$= \frac{\{\beta_1 + \beta_2 + \beta_1 \beta_2\}}{R_B} (V_{BB} - 2V_{BE})$$

Wednesday, February 13, 2013
11:14 AM

$$\beta_{DUAL} = \frac{I_{C_1} + I_{C_2}}{I_{B_1}} = \frac{\beta_1 I_{B_1} + \beta_2 I_{B_2}}{I_{B_1}}$$

$$= \frac{\beta_1 I_{B_1} + \beta_2 I_{E_1}}{I_{B_1}} = \frac{\beta_1 I_{B_1} + \beta_2 \frac{I_{C_1}}{\alpha_1}}{I_{B_1}}$$

$$= \frac{\beta_1 I_{B_1} + \beta_2 (1+\beta_1) I_{B_1}}{I_{B_1}} = \beta_1 + \beta_2 + \beta_1 \beta_2$$

IF THE TRANSISTORS ARE IDENTICAL

$$\beta_1 = \beta_2 = \beta$$

$$\boxed{\beta_{DUAL} = \beta + \beta + \beta^2 = \beta(2+\beta) \approx \beta^2}$$

* TRANSISTORS MUST BE IN THE ACTIVE REGION!