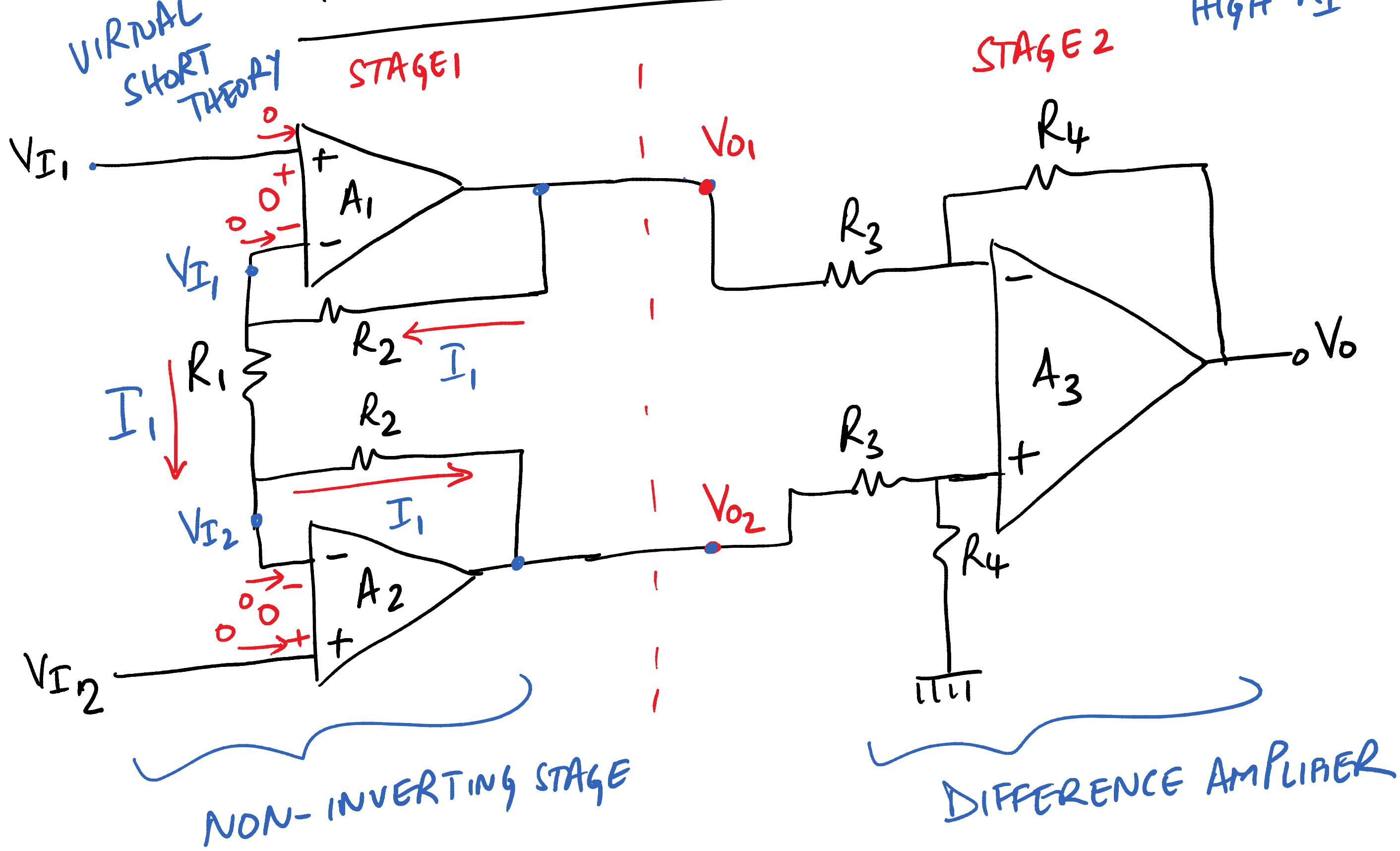
Wednesday, April 10, 2013
10:54 AM

LECTURE - 42

DIFFERENCE AMPLIFIER

↳ NOT POSSIBLE TO GET HIGH GAIN AND HIGH R_I

INSTRUMENTATION AMPLIFIER → HIGH GAIN AND HIGH R_I ✓



$$I_1 = \frac{V_{I_1} - V_{I_2}}{R_1}$$

$$I_1 = \frac{V_{o_1} - V_{o_2}}{2R_2 + R_1}$$

$$V_{o_1} - V_{o_2} = \frac{2R_2 + R_1}{R_1}\left(V_{I_1} - V_{I_2}\right)$$

$$\underline{V_{o_1} - V_{o_2}} = \frac{2R_2 + R_1}{R_1}\left(V_{I_1} - V_{I_2}\right)$$

$$V_o = \frac{R_4}{R_3}\left(V_{o_2} - V_{o_1}\right)$$

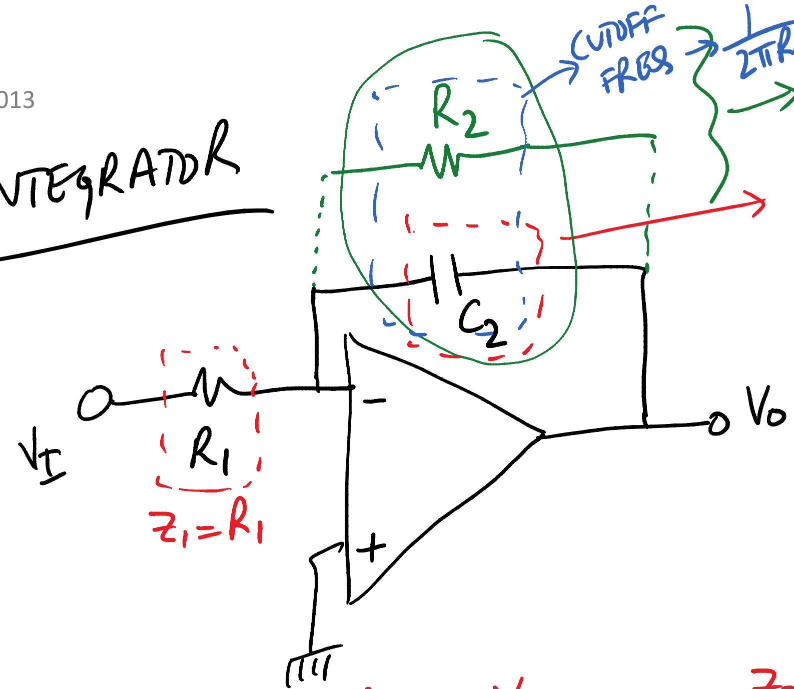
$$\boxed{\therefore\ V_o = \frac{R_4}{R_3}\left(\frac{2R_2 + R_1}{R_1}\right)\underbrace{\left(V_{I_2} - V_{I_1}\right)}}$$

* SINCE INPUT STAGE IS NON INVERTING
$R_I = \infty$

* V_o DEPENDS ON R_1 → GAIN IS VARIED USING ONLY R_1

Wednesday, April 10, 2013
11:04 AM

INTEGRATOR



CUTOFF FREQ → $\frac{1}{2\pi R_2 C_2}$ → LOW PASS FILTER

$Z_2 = \frac{1}{sC_2} = \frac{1}{j\omega C_2}$

$s \rightarrow j\omega$ → COMPLEX FREQ. $j2\pi f$

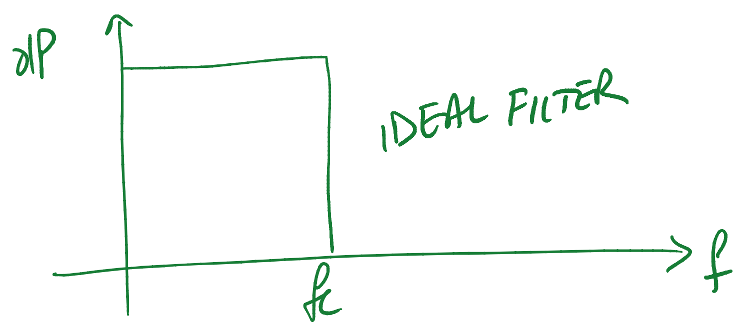
$$A_v = \frac{V_o}{V_I} = -\frac{Z_2}{Z_1} = -\frac{1}{sR_1C_2}$$

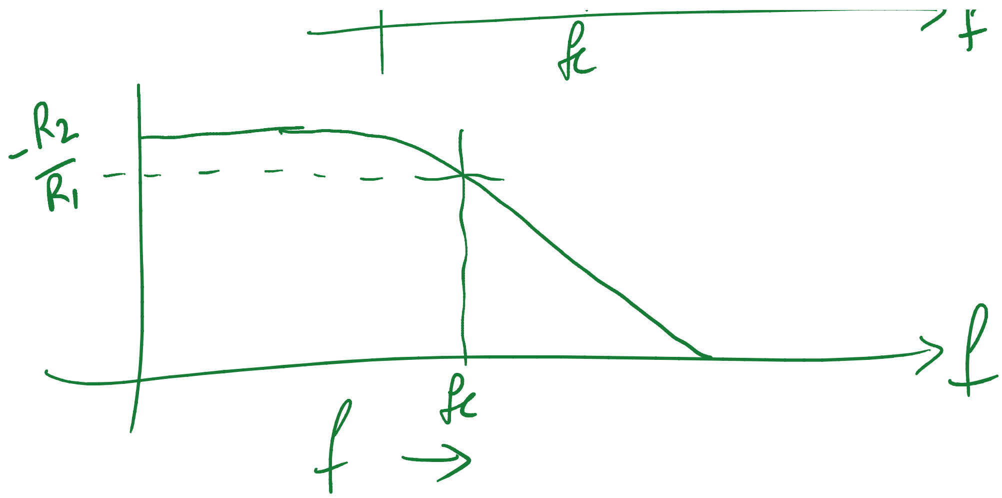
V_c → VOLTAGE ACROSS CAPACITOR AT $t=0$

$$V_o = -\frac{1}{sR_1C_2} V_I$$

$$\frac{d}{dt} \rightarrow s \rightarrow \quad \frac{1}{s} = \int$$

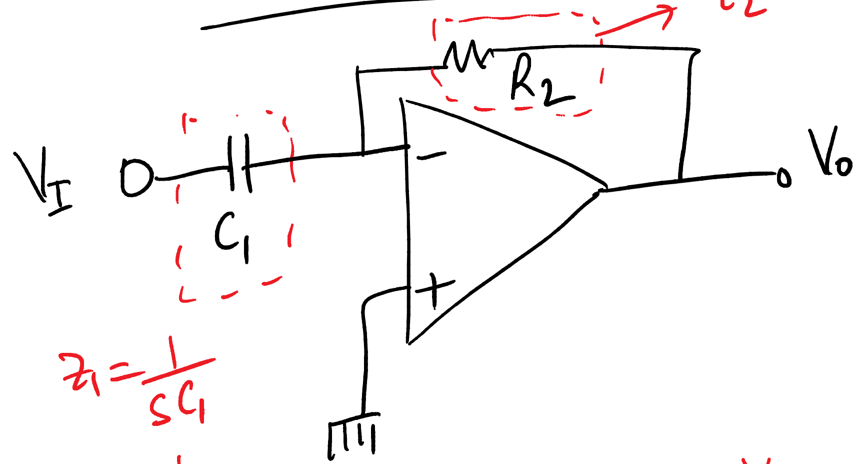
$$\boxed{v_o = V_c - \frac{1}{R_1C_2}\int_0^t V_I(t)\, dt}$$




fc
f
$-\frac{R_2}{R_1}$
fc
f
f →

Wednesday, April 10, 2013
11:10 AM

DIFFERENTIATOR



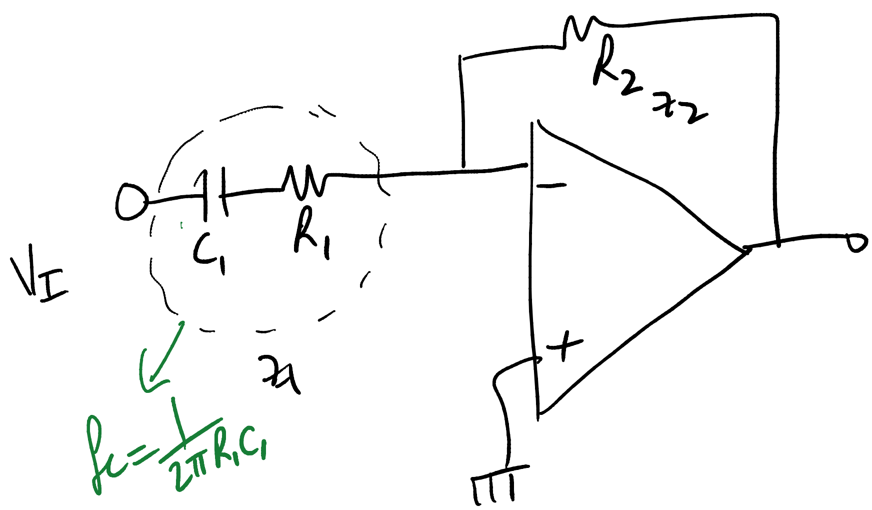
$z_2 = R_2$

$z_1 = \frac{1}{sC_1} = \frac{1}{j\omega C_1}$

$V_o = -\frac{z_2}{z_1} V_I = -sR_2C_1V_I$

$\frac{d}{dt} \to s$

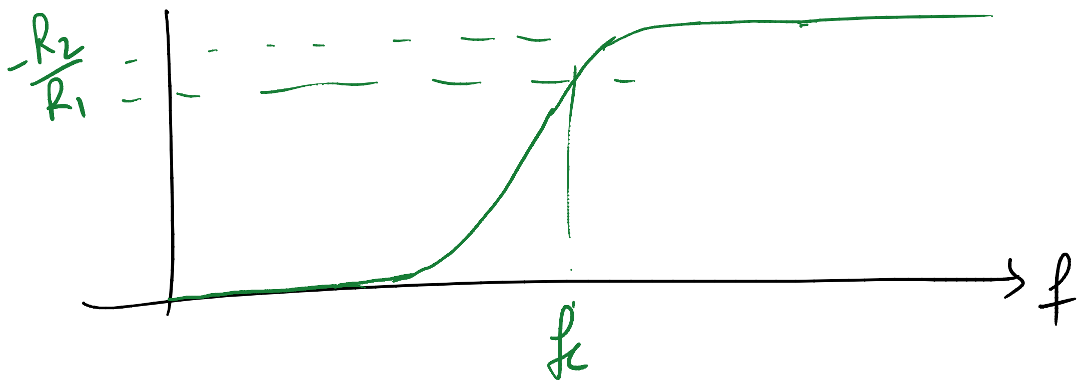
$$\boxed{v_o(t) = -R_2C_1\frac{d}{dt}v_I(t)}$$



$A_v = -\frac{z_2}{z_1}$

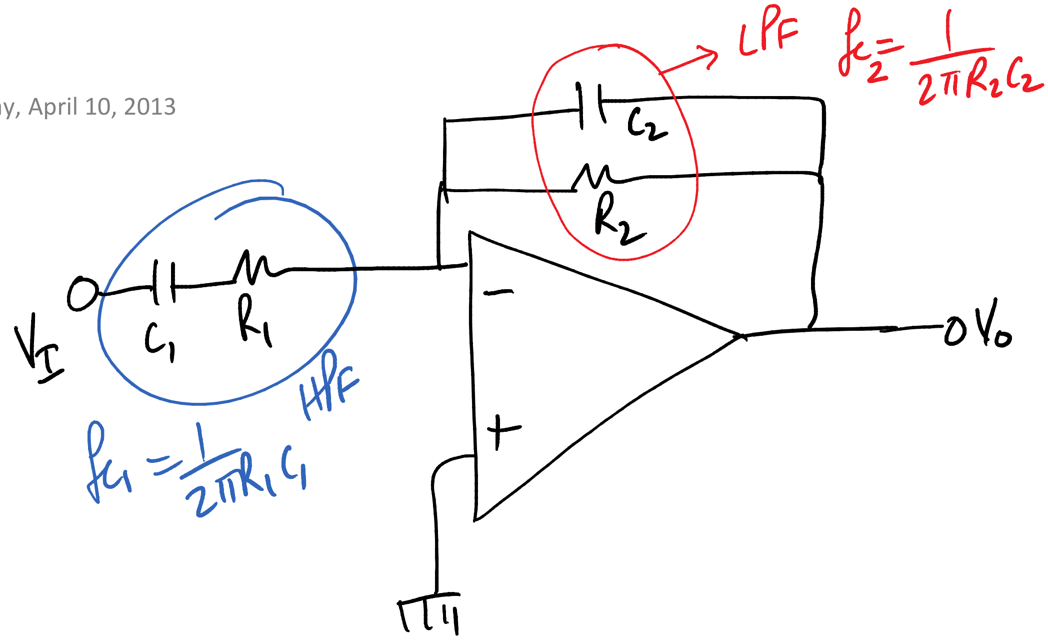
$f_c = \frac{1}{2\pi R_1C_1}$

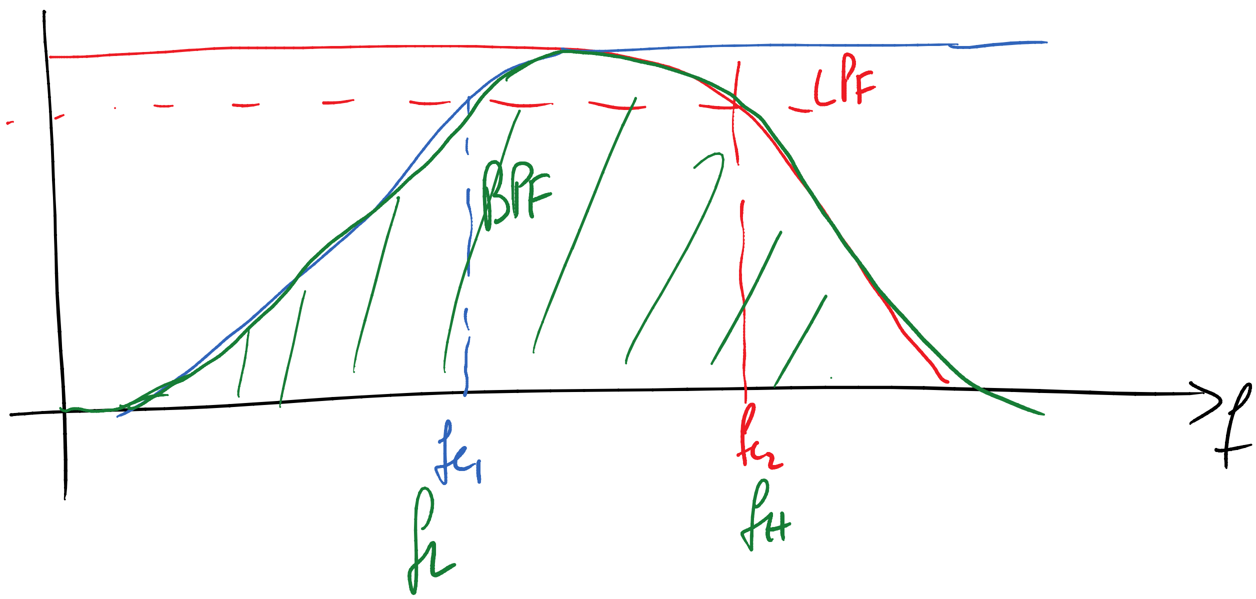
HIGH PASS FILTER



$-\frac{R_2}{R_1}$
f
f_c

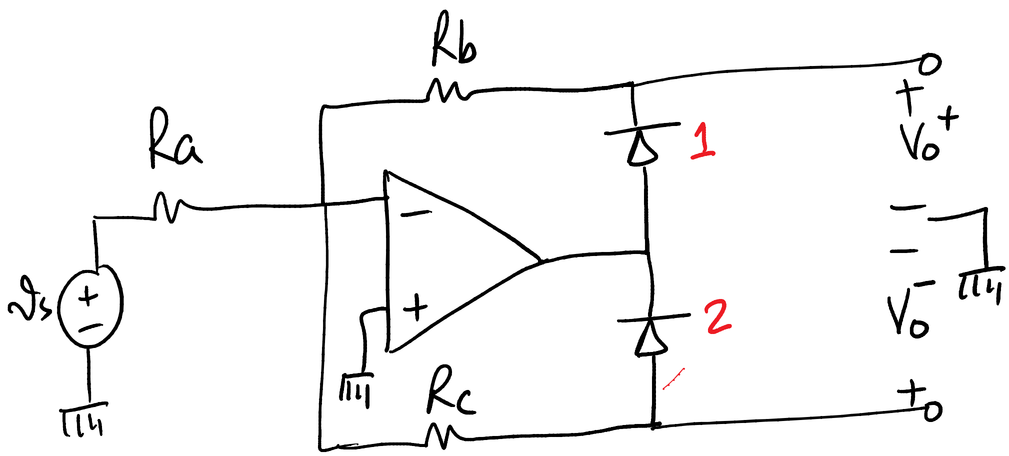
Wednesday, April 10, 2013
11:14 AM





Wednesday, April 10, 2013
11:16 AM

HALF WAVE RECTIFIER OP-AMP CIRCUIT



$\vartheta_s > 0$ DIODE 2 IS ON DIODE 1 IS OFF

CURRENT FLOWS THROUGH Rc

(NEGATIVE)

$$\therefore \; V_o^- = -\frac{R_c}{R_a}\vartheta_s$$

$$V_o^+ = 0$$

$\vartheta_s < 0$ DIODE 1 IS ON, DIODE 2 IS OFF

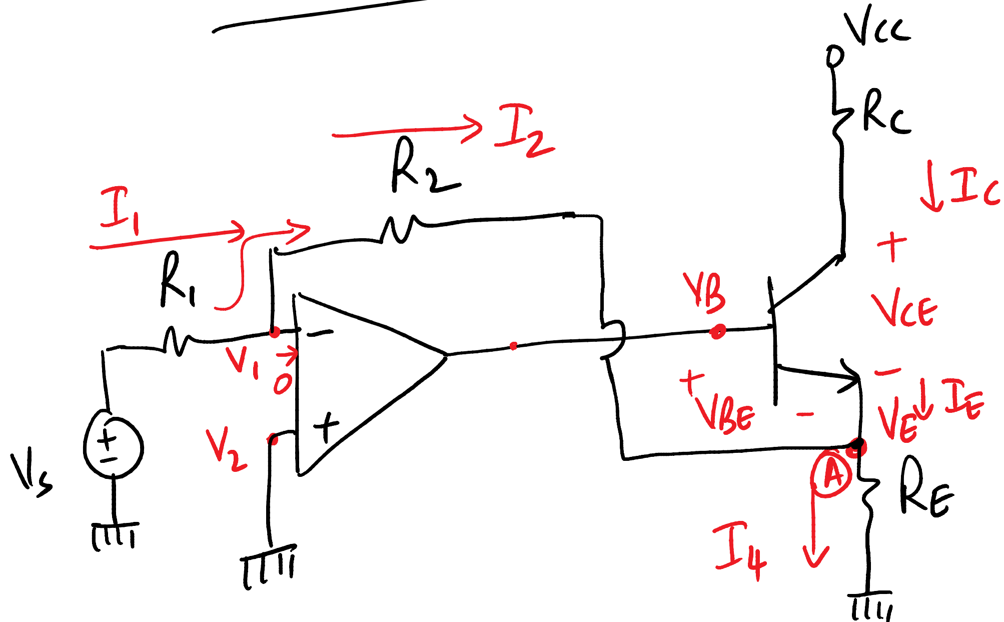
CURRENT FLOWS THROUGH Rb

$$\therefore \; V_o^+ = \frac{-R_b}{R_a}\vartheta_s \quad \text{(POSITIVE)}$$

$$V_o^- = 0$$

Wednesday, April 10, 2013
11:20 AM

VOLTAGE TO CURRENT OP-AMP CIRCUIT



* SINCE INPUT VOLTAGE IS GIVEN TO THE NEGATIVE TERMINAL ∴ $V_s < 0$ (REQUIREMENT) FOR PROPER BIASING OF TRANSISTOR

VIRTUAL GROUND THEORY $V_1 = 0$

$V_2 = 0$

$$I_1 = \frac{V_s}{R_1}$$

$$I_2 = \frac{0 - V_E}{R_2}$$

$$I_1 = I_2$$

$$\frac{V_s}{R_1} = -\frac{V_E}{R_2}$$

$$\boxed{V_E = -V_s \frac{R_2}{R_1}}$$

KVL BE LOOP

$$-V_B + V_{BE(ON)} + V_E = 0$$

OUTPUT OF OPAMP $\leftarrow$ $V_B = V_{BE(ON)} + V_E$

$$I_4 = \frac{V_E}{R_E}$$

KCL NODE (A)

$$I_E + I_2 = I_4$$

$$I_E = I_4 - I_2$$

ASSUMING OPERATION IN ACTIVE REGION

O/P CURRENT! $\leftarrow$ $\boxed{I_C} = \alpha I_E$

KVL CE LOOP

$$V_{CE} = V_{CC} - I_C R_C - V_E$$