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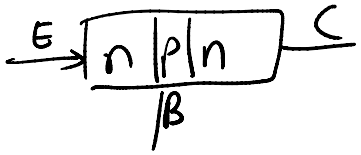
LECTURE - 24

npn TRANSISTOR

SUMMARY → DESIGN OPTIMIZATION



(1) $n+$ $\quad I_E \simeq I_{En}$

$$\gamma = \frac{I_{En}}{I_{En} + I_{Ep}}$$ NEAR UNITY

(2) NARROW BASE WIDTH, LIGHT BASE DOPING

$\alpha_F \rightarrow$ NEAR UNITY!

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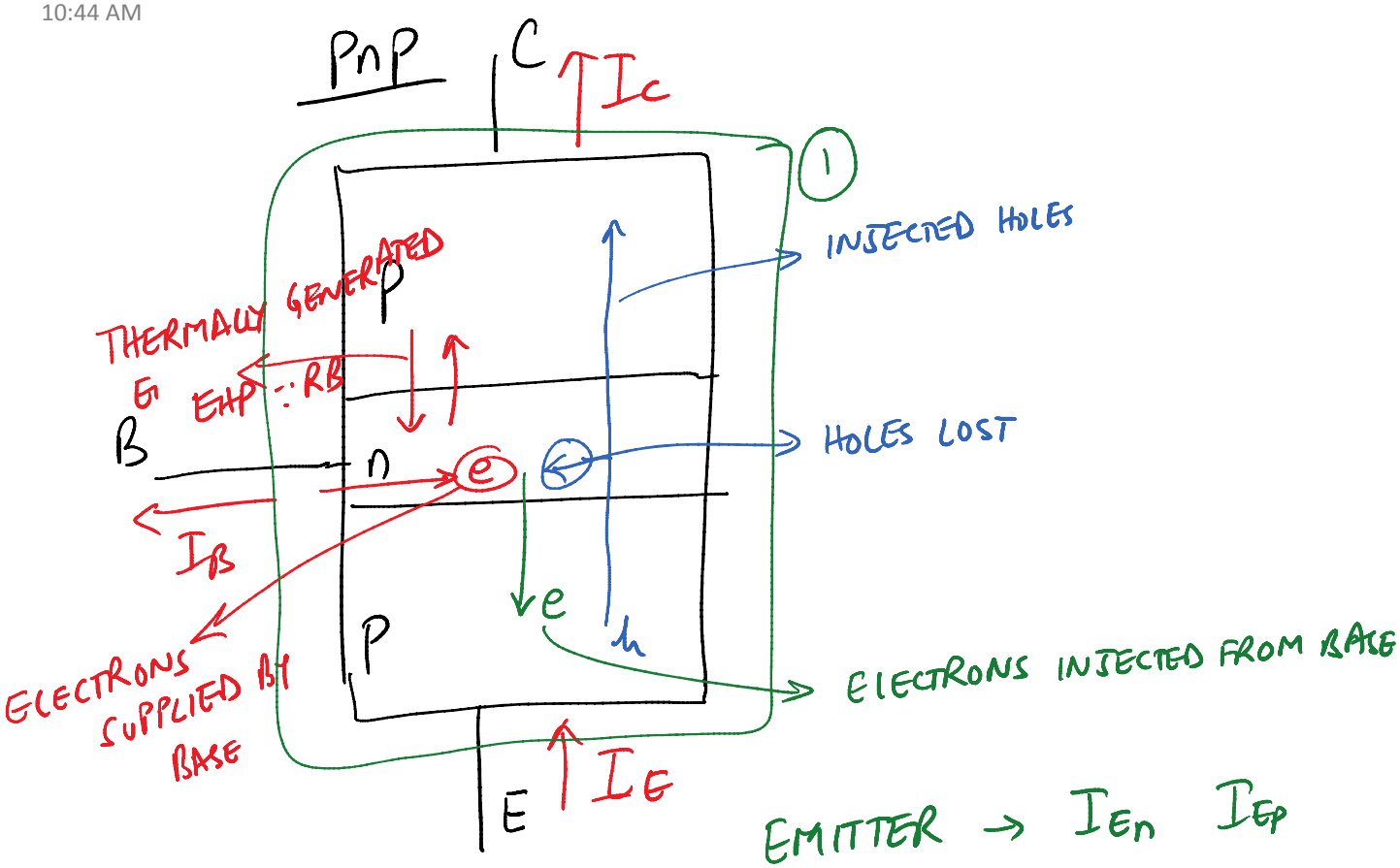

EMITTER → I_{En} I_{Ep}

COLLECTOR → $I_C \simeq I_{Cp}$

BASE → $I_B \simeq I_{Bn}$

$$\gamma = \frac{I_{Ep}}{I_{Ep} + I_{En}}$$

$$\alpha_F = \frac{I_{Cp}}{I_{Ep}}$$

$$\alpha = \alpha_0 = \frac{I_C}{I_E} = \alpha_F \gamma$$

KCL NODE 1

$$-I_E + I_B + I_C = 0$$

$$I_B = I_E - I_C$$

$$\beta = \frac{I_e}{I_B} = \frac{\alpha}{1-\alpha} \qquad \alpha = \frac{\beta}{1+\beta}$$

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DESIGN OPTIMIZATION CRITERIA

PNP

p^+ $I_E \approx I_{Ep}$ $\qquad \gamma = \dfrac{I_{Ep}}{I_{Ep} + I_{En}}$ NEAR UNITY

NARROW BASE ℓ WIDTH, LIGHT BASE DOPING!

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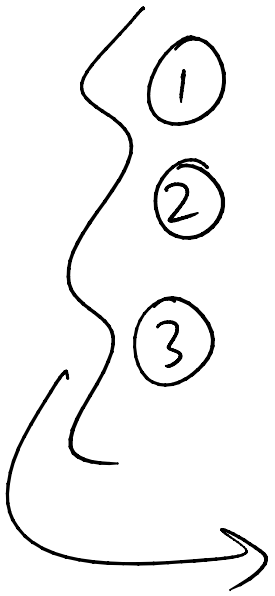
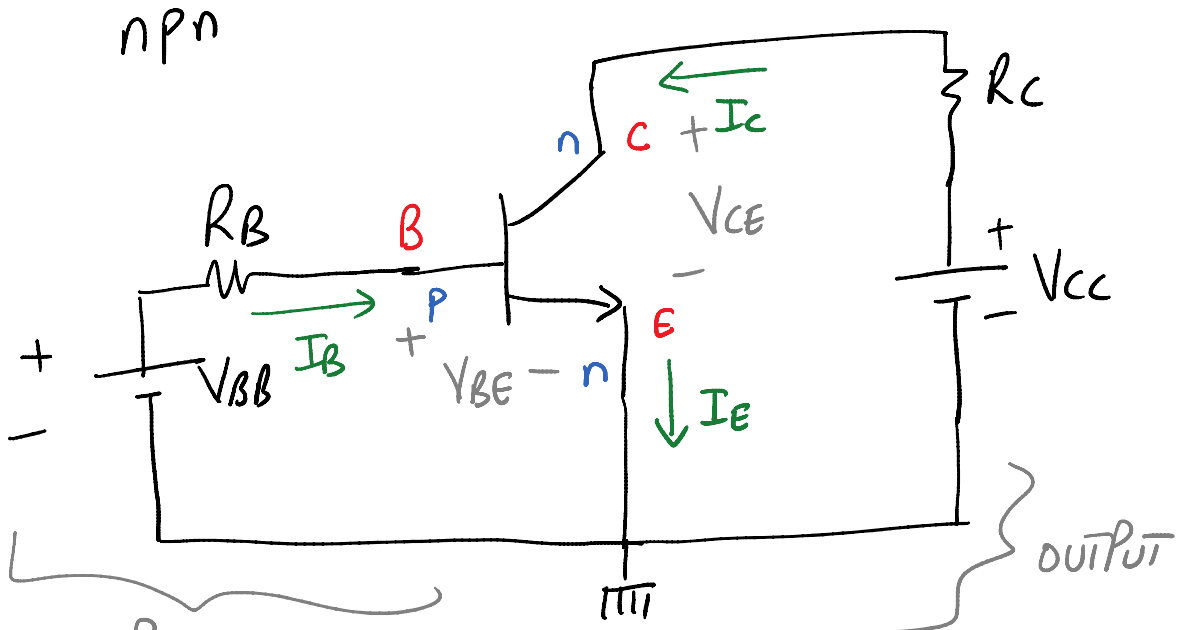
CIRCUIT CONFIGURATIONS



1. COMMON EMITTER
2. COMMON COLLECTOR / EMITTER FOLLOWER
3. COMMON BASE

→ CHOICE BASED ON APPLICATION

COMMON EMITTER



FOR FORWARD BIASING
"ACTIVE REGION"
BE → FB
CE → RB

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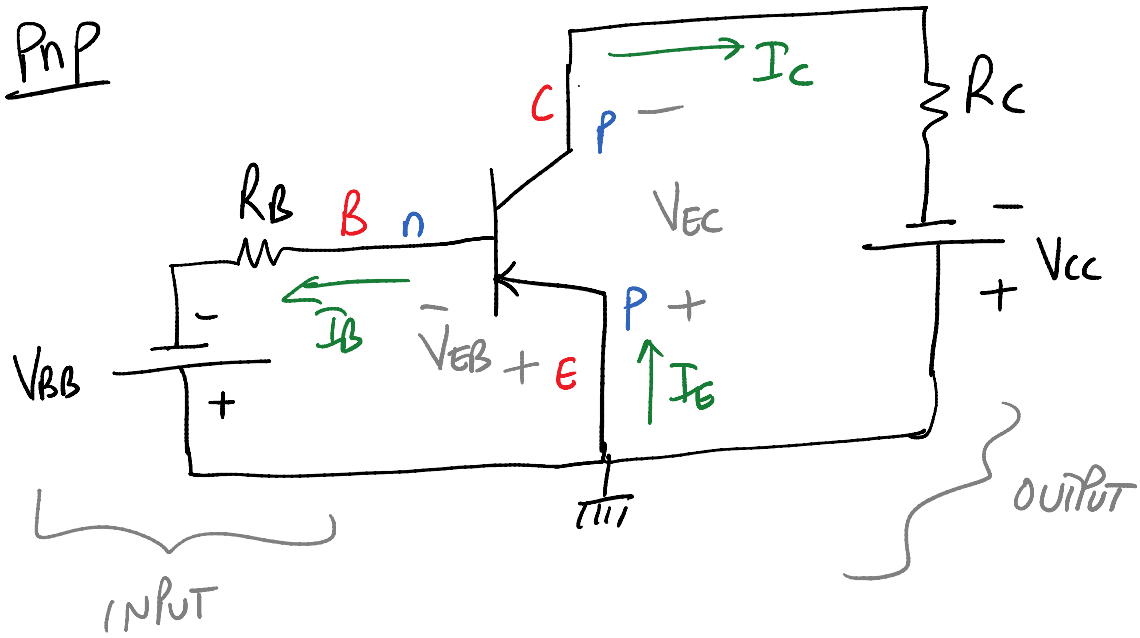

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CURRENT AMPLIFICATION GAIN

$$\beta = \frac{I_C}{I_B}$$

ONLY VALID FOR FORWARD ACTIVE REGION

i.e WHEN ANALYZING A CIRCUIT AND GOING FROM INPUT SIDE TO OUTPUT SIDE

3 BASIC REGIONS OF OPERATION

1. CUTOFF
2. FORWARD ACTIVE "ACTIVE"
3. SATURATION

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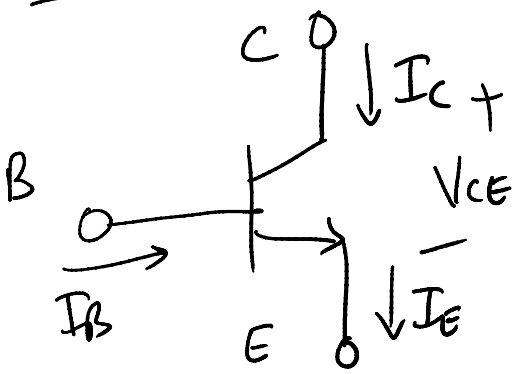
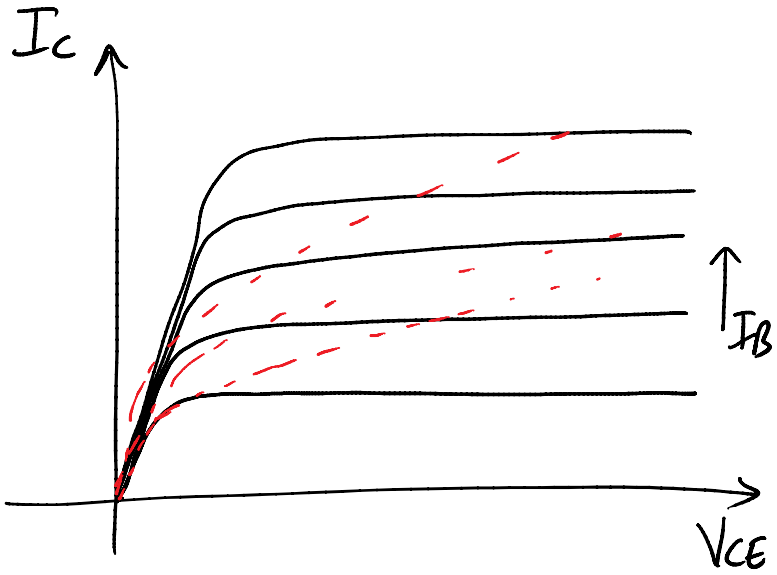
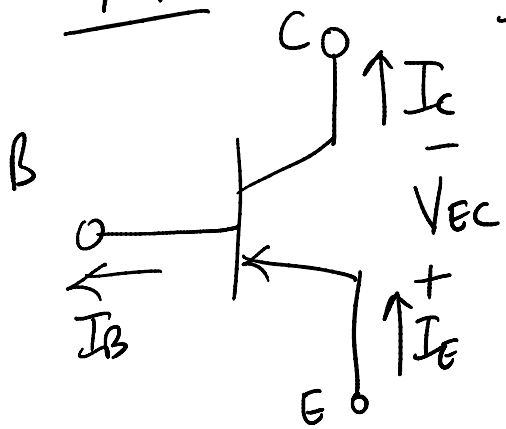
IV CHARACTERISTICS

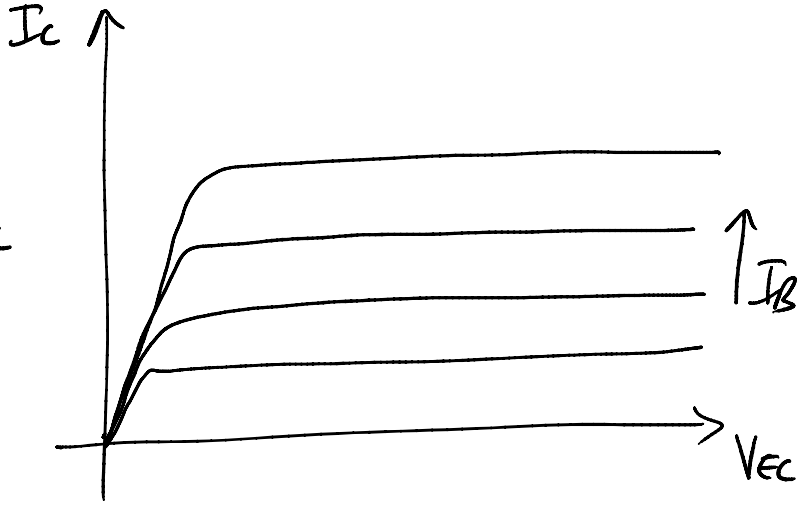
npn





PnP





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THINGS TO REMEMBER

(1) FOR CUT-OFF V_{BE} (or V_{EB}) $< V_{to}$ (TURN-ON VOLTAGE FOR PN JUNCTION)

$I_B \approx 0$ $I_C \approx 0$

(2) FOR V_{BE} (or V_{EB}) $> V_{to}$

AND

V_{CE} (or V_{EC})$_{(SATURATION)}$ $< V_{CE}$ (or V_{EC})

SPECIFICATION FOUND IN DATASHEET

ACTIVE REGION

(3) IF V_{CE} (or V_{EC}) $\leq V_{CE}$ (or V_{EC})$_{(SAT)}$

THEN SATURATION REGION