## Students are allowed to detach this formula sheet for convenience

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

$$\alpha = \frac{I_C}{I_E}$$

$$\beta = \frac{I_C}{I_R} \qquad \qquad \alpha = \frac{I_C}{I_E} \qquad \qquad \beta = \frac{\alpha}{1 - \alpha}$$

$$\alpha = \frac{\beta}{1+\beta}$$

$$r_0 = \frac{V_A}{I_C}$$

$$g_m = \frac{I_C}{V_T}$$

$$r_e = \frac{V_T}{I_E}$$

$$r_{\pi} = \frac{V_{\tau}}{I_{E}}$$

$$r_{\pi} = \frac{\beta}{q_{\pi}}$$

$$r_e = \frac{1}{g_m} \frac{\alpha}{g_m}$$

$$A_{vo} = -g_m \times (R_C||r_o)$$

$$g_m = \frac{I_C}{V_T} \qquad r_e = \frac{V_T}{I_E} \qquad r_m = \frac{V_T}{I_B} \qquad r_m = \frac{\beta}{g_m} \qquad r_e = \frac{\alpha}{g_m}$$

$$Transconductance \qquad emitter \qquad resistance \qquad r_m = \frac{\beta}{g_m} \qquad r_m = \frac{\beta}{g_m} \qquad r_m = \frac{\alpha}{g_m}$$

$$Voltage \ gain = \frac{Total \ resistance \ in \ the \ collector}{Total \ resistance \ in \ the \ emitter}$$

$$A_{vo} = \frac{g_m R_C}{1 + g_m R_E}$$

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  $I_C = I_S e^{V_{BE}/V_T}$   $f_C = \frac{1}{2\pi RC}$   $f_C = \frac{1}{2\pi \sqrt{LC}}$   $|Z_C| = \frac{1}{2\pi fC}$ 

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$$\frac{I_o}{I_{REF}} = \frac{1}{1 + \frac{2}{\beta}}$$

$$\frac{I_o}{I_{REF}} = \frac{1}{1 + \frac{2}{\beta^2}}$$

$$R_{in} \approx \frac{1}{g_m}$$

$$\frac{I_o}{I_{REF}} = \frac{1}{1+\frac{2}{\beta}} \qquad \qquad \frac{I_o}{I_{REF}} = \frac{1}{1+\frac{2}{\beta^2}} \qquad \qquad R_{in} \approx \frac{1}{g_m} \qquad \qquad \frac{I_o}{I_{REF}} = \left[\frac{1}{1+\frac{2}{\beta}}\right] \left[\frac{1+\frac{V_{CE2}}{V_A}}{1+\frac{V_{CE1}}{V_A}}\right]$$

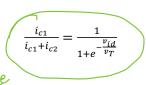
$$R_0 = [1 + g_m(R_E \parallel r_{\pi})]r_0$$

$$I_0 R_E = V_T ln \left( {^{I_{REF}}/I_0} \right)$$

$$R_{0} = [1 + g_{m}(R_{E} \parallel r_{\pi})]r_{0} \qquad I_{0}R_{E} = V_{T}ln\binom{I_{REF}}{I_{0}} \qquad R_{o} = \frac{\beta r_{o}}{2} \qquad \text{for } R_{c} = -\sqrt{be_{2}}$$

$$\sqrt{be_{1}} = -\sqrt{be_{2}}$$

$$\sqrt{\frac{i_{c1}}{i_{c1}+i_{c2}}} = \frac{1}{1+e^{-\frac{v_{id}}{v_{T}}}} \qquad A_{d} = A_{d1} - A_{d2} = -g_{m}R_{c} \qquad \text{for } R_{c} = \sqrt{\frac{i_{c2}}{i_{c1}+i_{c2}}} = \sqrt{\frac{i_{c2}}{i_{c1}+i_{c2}}}} = \sqrt{\frac{i_{c2}}{i_{c1}+i_{c2}}} = \sqrt{\frac{i_{c2}}{i_{c1}+i_{c2}}} = \sqrt{\frac{i_{c2}}{i_{c1}+i_{c2}}}} = \sqrt{\frac{i_{c2}}{i_{c1}+i_{c2}}} = \sqrt{\frac{i_{c2}}{i_{c1}+i_{c2}}} = \sqrt{\frac{i_{c2}}{i_{c1}+i_{c2}}} = \sqrt{\frac{i_{c2}}{i_{c1}+i_{c2}}} = \sqrt{\frac{i_{c2}}{i_{c1}+i_{c2}}} = \sqrt{\frac{i_{c2}}{i_{c1}+i_{c2}}} = \sqrt{\frac{i_{c2}}{i_{c1}+i_{c2$$



$$A_d = A_{d1} - A_{d2} = -g_m R_C$$

$$V_{bel} = \frac{V_{id}}{2}$$

$$R_{iCM} = (\beta + 1)(R_{EE}||\frac{r_0}{2})$$
  $A_{CM} \approx \frac{\Delta R_C}{2R_{EE}}$ 

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$$\rightarrow$$
 CMMR = 20  $\log \left| \frac{A_d}{A_{CM}} \right| dB$ 

$$|V_{OS}| = V_T \left(\frac{\Delta R_C}{R_C}\right)$$

$$|V_{OS}| = V_T \left(\frac{\Delta I_S}{I_S}\right)$$

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$$I_{OS} = I_B \left( \frac{\Delta \beta}{\beta} \right)$$

$$V_{OS} = \sqrt{\left(\frac{\Delta R_C}{R_C}\right)^2 + \left(\frac{\Delta I_S}{I_S}\right)^2} \qquad \qquad | \quad A_d = \frac{v_{C1} - v_{C2}}{v_d} = -g_m R_C$$

$$A_d = \frac{v_{C1} - v_{C2}}{v_d} = -g_m R_C$$

$$R_i = (\beta + 1)(r_e + R_E)$$

$$V_{BB} = V_{BE1} \left( 1 + \frac{R_2}{R_1} \right)$$

$$A_i = \frac{R}{2R_L} (1 + \beta)$$