# General Formulae – For In-Semester Exam

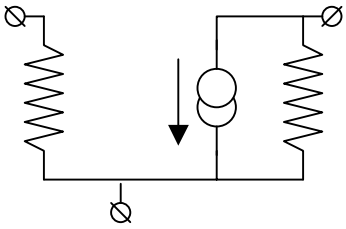
General: $\frac{kT}{q} = 0.0258$ volts at room temperature (300° K).

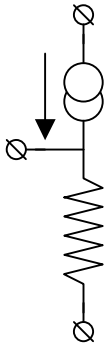
$$R = \frac{\rho l}{A} \qquad C = \frac{\varepsilon A}{t}$$

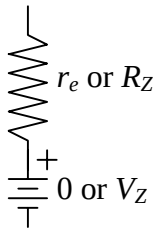
Biasing: $I_C = h_{FE}\, I_B$

$$I_C = \frac{h_{FE}\,(V_{BB} - V_{BE} + R_{BB} I_{CBO})}{R_{BB} + (1 + h_{FE})\,R_E} \qquad I_{COPT} = \frac{V_{CC} - V_{CESAT}}{R_{DC} + (1-\gamma)\left|Z_{AC}\right|}$$

Bipolar Transistor and Diode SS Models:








For BJTs: $r_e = \frac{kT}{qI_E}$, $g_m = \frac{I_C}{\frac{kT}{q}} = \frac{\alpha}{r_e}$, $r_\pi = r_b = (1 + h_{fe})\,r_e$, $\alpha = \frac{h_{fe}}{1 + h_{fe}}$, and

$$r_o = \frac{V_A + V_{CEQ}}{I_{CQ}}$$

| Stage Type | Sign of Gain | Qual. Gain | G(s) | Qual. $z_{in}$ | $Z_{in}$ | Qual. $z_{out}$ | $Z_{out}$ |
|---|---|---|---|---|---|---|---|
| Common Emitter | - | high | $\frac{-\alpha Z_C}{r_e + Z_E}$ | high | $R_{BB} \parallel [(1 + h_{fe})(r_e + Z_E)]$ | high | $Z_C$ |
| Common Base | + | high | $\frac{\alpha Z_C}{r_e + Z_1}$ | low | $r_e + Z_1$ | high | $Z_C$ |
| Common Collector (Emitter Follower) | + | < 1 | $\frac{Z_E}{r_e + Z_E}$ | high | $R_{BB} \parallel [(1 + h_{fe})(r_e + Z_E)]$ | low | $Z_E \parallel [r_e + Z_S/(1 + h_{fe})]$ |

Notes: 1.) $Z_{BG}$ is the entire source impedance of the signal driving the base of the Common Collector stage.

2.) $Z_1$ is the impedance of any passive components in series with the input.