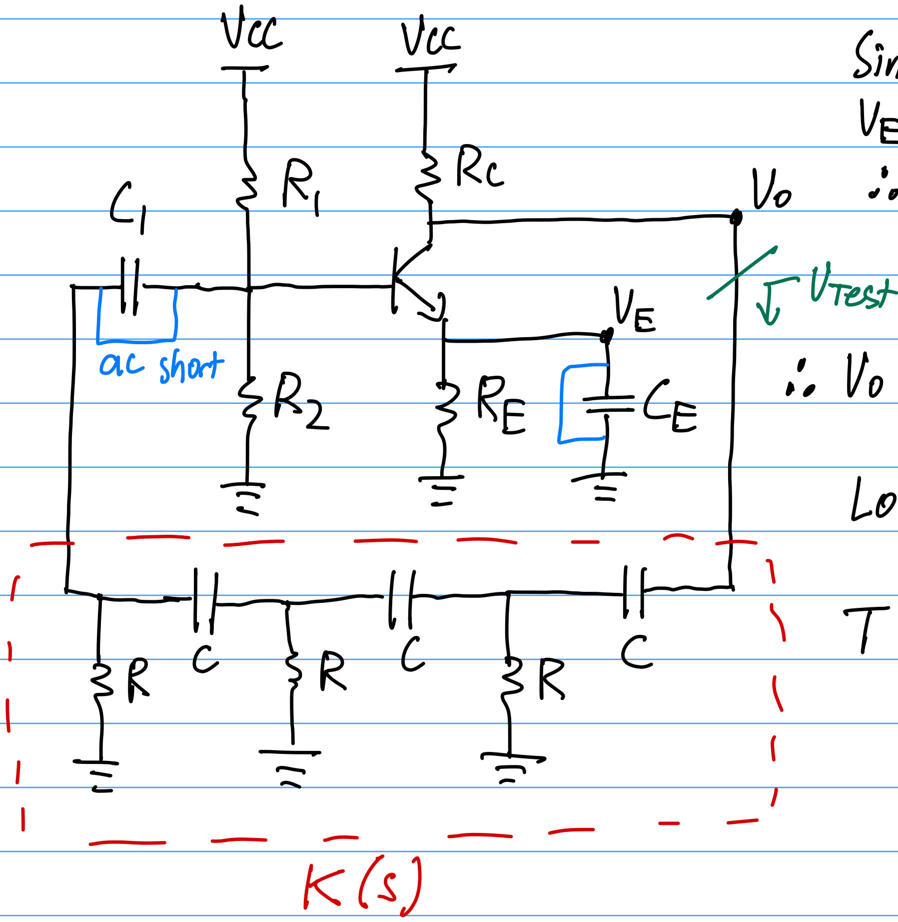


Since $C_E$ is large, $V_E \approx$ ac ground
∴ Amp. is a basic CE stage in AC analysis.

$$\therefore V_o = V_{Test}\, K \times (-g_m R_C)$$

$$\text{Loop gain} = -\frac{V_o}{V_{test}}$$

$$T = g_m R_C K$$

(a) Set $T(j\omega) = -1$ using K from the question.

$$g_m R_C \frac{(j\omega RC)^3}{(j\omega RC)^3 + 6(j\omega RC)^2 + 5j\omega RC + 1} = -1$$

Cross-multipy & simplify $j^2 = -1$.

$$-j\, g_m R_C\, \omega^3 R^3 C^3 = -(-j\omega^3 R^3 C^3 - 6\omega^2 R^2 C^2 + 5j\omega RC + 1)$$

$$= j\omega^3 R^3 C^3 + 6\omega^2 R^2 C^2 - 5j\omega RC - 1.$$

Take real parts.

$$0 = 6\omega^2 R^2 C^2 - 1$$

$$\omega^2 = \frac{1}{6R^2C^2}$$

$$\therefore \omega = \frac{1}{\sqrt{6}\,RC} \qquad \therefore f_{osc} = \frac{1}{2\pi\sqrt{6}\,RC}.$$

(b) Take imag. parts from the equation above.

$$-g_m R_C w^3 R^3 C^3 = w^3 R^3 C^3 - 5wRC$$
$$0 = (1 + g_m R_C) w^3 R^3 C^3 - 5wRC$$

Subst $w = \dfrac{1}{\sqrt{6}\,RC}$

$$0 = (1 + g_m R_C)\left(\frac{1}{\sqrt{6}\,RC}\right)^3 R^3 C^3 - 5\left(\frac{1}{\sqrt{6}RC}\right) RC$$

$$= \frac{(1 + g_m R_C)}{6\sqrt{6}} - \frac{5}{\sqrt{6}}$$
$$= 1 + g_m R_C - 30$$
$$g_m R_C = 29.$$

$\therefore$ Min $g_m$ is $\dfrac{29}{R_C}$.