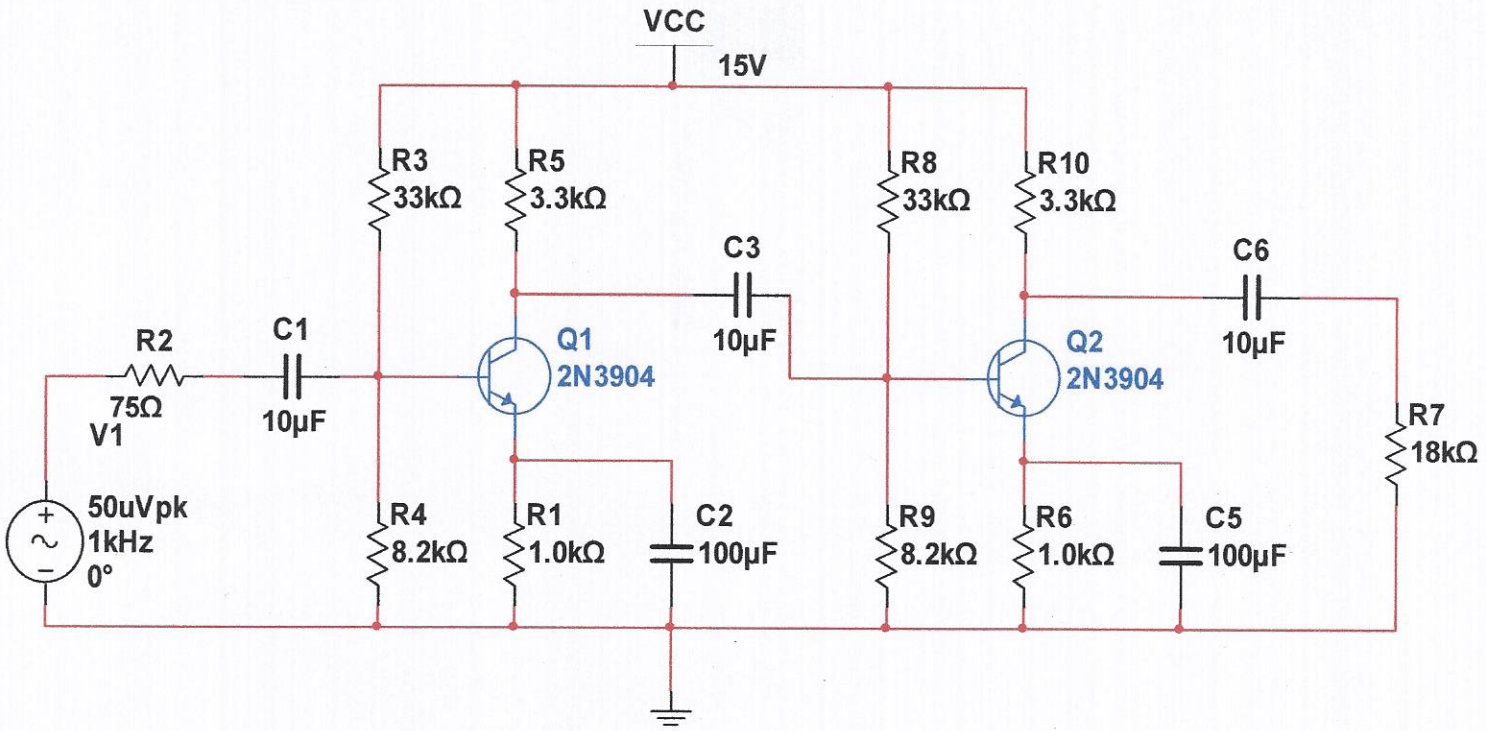
ANALOG I — LECTURE 15

Mutli-stage (two-stage Cascaded Common-Emitter) Amplifier – EXAMPLE

V(in) = 50 uV pk; Beta(dc) = Beta(AC) = 175.



ANALYSIS PROCESS

- NEED TO KNOW "LOAD" ON STAGE 1 (LEFTMOST STAGE). LOAD ON STAGE 1 IS $R_{IN(TOTAL)_2}$: $R_{IN(TOTAL)}$ FOR SECOND STAGE.

- SO FOR STAGE 2: (dc ANALYSIS):

$$V_{B_2} = \left(\frac{R_9}{R_8+R_9}\right) V_{CC}; \quad \boxed{V_{B_2} = 2.98\,V_{dc}}; \quad V_{E_2} = 2.98\,V_{dc} - 0.7; \quad \boxed{V_{E_2} = 2.285\,V_{dc}}$$

$$I_{E_2} \cong I_{C_2} = V_{E_2}/R_6; \quad \boxed{I_{E_2} \cong I_{C_2} = 2.285\,mA}; \quad r'_{e_2} = \frac{25\,mV}{I_{E_2}}; \quad \boxed{r'_e = 10.94\,\Omega}$$

- FINALLY, FOR STAGE 2: "AC ANALYSIS - START"

$$R_{IN(BASE)_2} = \beta_{AC_2} \cdot r'_{e_2}; \quad R_{IN(BASE)_2} = (175)(10.94\,\Omega)$$

$$\boxed{R_{IN(BASE)_2} = 1.915\,k\Omega}$$

$$R_{IN(TOTAL)_2} = R_8 \parallel R_9 \parallel R_{IN(BASE)_2}; \quad \boxed{R_{IN(TOTAL)_2} = 1.483\,k\Omega}$$

$$R_{C_2} = R_{10} \parallel R_7 \quad (= R_L); \quad R_{C_2} = 3.3k\Omega \parallel 18k\Omega; \quad \boxed{R_{C_2} = 2.789\,k\Omega}$$

- NOW, STAGE 1:

- dc ANALYSIS (STAGES ARE IDENTICAL, SEE STAGE 2 CALCULATIONS).

- $R_{C_1} = R_5 \parallel R_L$ ← R_L IS $R_{IN(TOTAL)2}$!

$= 3.3\text{k}\Omega \parallel 1.483\text{k}\Omega$; $\boxed{R_{C_1} = 1.023\text{k}\Omega}$

- $R_{IN(BASE)_1} = 1.915\text{k}\Omega$ (SAME AS STAGE 2)
- $R_{IN(TOTAL)_1} = 1.483\text{k}\Omega$ (SAME AS STAGE 2)

— GAINS

$$A_{v_1} = \frac{R_{C_1}}{r'_{e_1}} = \frac{1.023\text{k}\Omega}{10.94\Omega} ; \quad \boxed{A_{v_1} = 93.5}$$

$$A_{v_2} = \frac{R_{C_2}}{r'_{e_2}} = \frac{2.789\text{k}\Omega}{10.94\Omega} ; \quad \boxed{A_{v_2} = 255}$$

$$A'_{v(TOTAL)} = A_{v_1} \cdot A_{v_2} \cdot ATTN^{-1}$$

$$ATTN = \frac{R_A + R_{IN(TOTAL)_1}}{R_{IN(TOTAL)_1}} = \frac{75\Omega + 1.483\text{k}\Omega}{1.483\text{k}\Omega}$$

$$ATTN = 1.05^{-6} ; \quad \boxed{(ATTN^{-1}) = 0.9519}$$

$$\therefore A'_{v(TOTAL} = A_{v_1} \cdot A_{v_2} \cdot ATTN^{-1}$$

$$= (93.5)(255)(0.9519) ; \quad \boxed{A'_{v(TOTAL)} = 22694}$$

$$V_{OUT} = V_{in} \cdot A'_{v(TOTAL)}$$

$$= 50\text{mV} \cdot 22694 ; \quad \boxed{V_{OUT} = 1.135\ V_{PK}}$$

$$GAIN(dB) = 20\log_{10} A'_{v(TOTAL)}$$

$$A'_{v(TOTAL)|_{dB}} = 20\log_{10}(22694) ; \quad \boxed{A'_{v(TOTAL)|_{dB}} = 87.1\,dB}$$