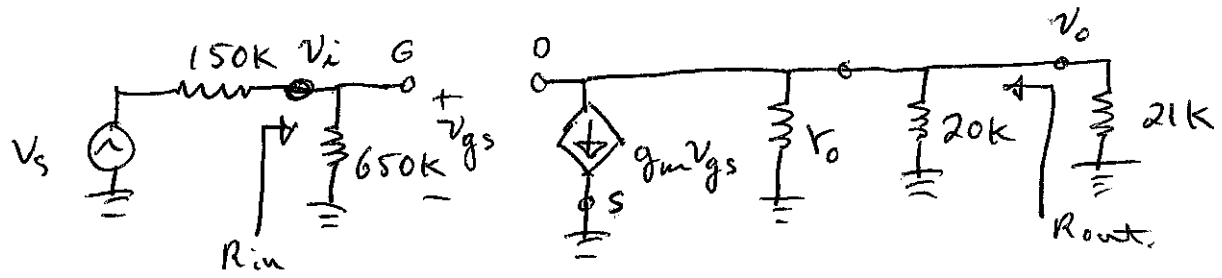
a) The mid band equivalent ckt is:



$$r_o = \frac{1}{\lambda I_D} = \frac{1}{0.01 \times 0.2 \times 10^{-3}} = 500\,k\Omega$$

$$\therefore R_{in} = 650\,k\Omega$$

$$\therefore R_{out} = 20k \,//\, 500k = 19.23\,k\Omega$$

b) $$A_v = \frac{v_o}{v_i}$$

$$v_i = v_{gs}, \quad v_o = -g_m v_{gs} R_L',$$

$$\text{with } R_L' = 500k \,//\, 20k \,//\, 21k$$

$$= 10\,k\Omega$$

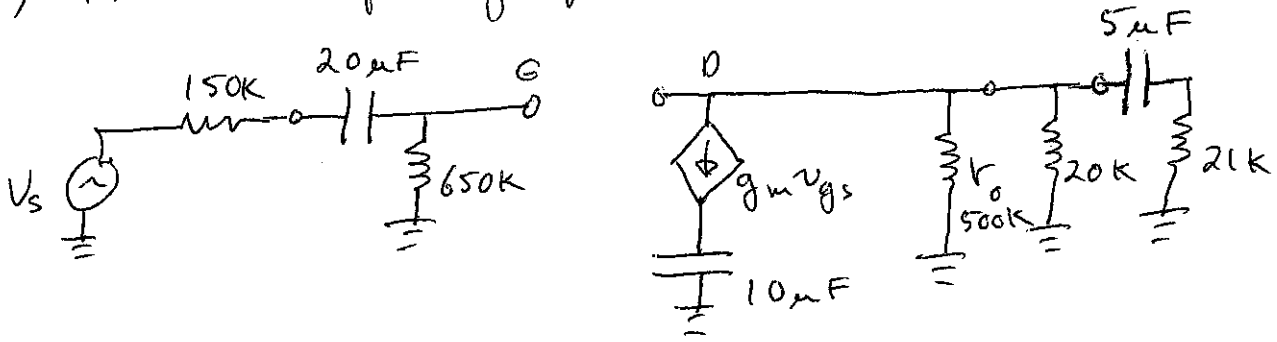
$$\therefore A_v = -g_m R_L' = -50\,V/V$$

$$G_v = \frac{V_o}{V_s}$$

$$v_{gs} = v_s \frac{650k}{150k + 650k} = 0.81\, v_s$$

$$\therefore G_V = \frac{-g_m v_{gs} R_L'}{v_s} = -0.81 g_m R_L' = -40.5 \text{ V/V}$$

c) The low frequency equivalent ckt. is:



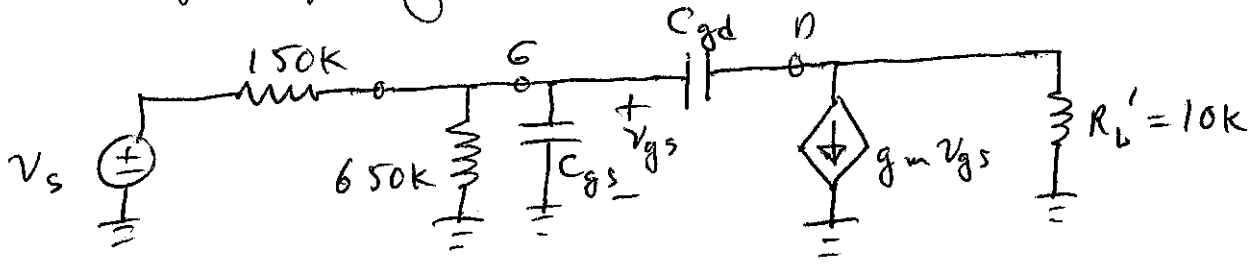
$$f_{L_{20\mu F}} = \frac{1}{2\pi(150K + 650K)\,2\times10^{-5}} = 0.01 \text{ Hz}.$$

$$f_{L_{5\mu F}} = \frac{1}{2\pi(500K \,//\, 20K + 21K)\,5\times10^{-6}} = 0.8 \text{ Hz}.$$

$$f_{L_{10\mu F}} = \frac{1}{2\pi\left(\frac{1}{g_m}\right)10^{-5}} = 79.6 \text{ Hz}.$$

$$\therefore f_L \simeq 80 \text{ Hz}$$

d) The high frequency equivalent ckt. is :



$$f_{H_{C_{gs}}} = \frac{1}{2\pi (150K // 650K)\, 2\times10^{-12}} = 653\ kHz$$

$$f_{H_{C_{gd}}} = \frac{1}{2\pi\left[(150K // 650K) + 10K + g_m\, 10K \times (150K // 650K)\right] 5\times10^{-13}}$$

($g_m = 5\times10^{-3}$)

$$= 51.1\ kHz.$$

$$\therefore f_H \simeq 51\ kHz.$$