1. a. \( A_v = -g_{mr} = -\sqrt{2\mu_p C_{ox}(W/L)}I_{sup}(\lambda_n I_{sup})^{-1} = -141 V/V \)

b. \( C_M = (1 - A_v)C_{gd} = (1 - A_v)C_{ov}W = 3.56 \text{ pF} \)

\[
C_{gs} = \frac{2}{3} WLC_{ox} + WC_{ov} = 178 \text{ fF}
\]

\[
C = C_M + C_{gs} = 3.74 \text{ pF}
\]

\[
R = R_s = 10 \text{ k}\Omega
\]

\[
\omega_{3dB} = (RC)^{-1} = 26 \text{ Mrad/s}
\]

c. \( \omega_{3dB} = (R_s C_{gs} + R_s(1 - A_v)C_{gd} + r_{gd} C_{gd})^{-1} = 21.1 \text{ Mrad/s} \)

2. a. \( v_{out} / v_{in} = (R_L / (R_L + Rout)) \Rightarrow Rout = (1 - v_{out} / v_{in})R_L / (v_{out} / v_{in}) \)

\[
Rout = \left( \frac{g_m}{\sqrt{2\mu_p C_{ox}(W/L)}} \right) \Rightarrow W = \left( \frac{L(v_{out} / v_{in})^2}{2\mu_p C_{ox}I_D} \right)^{1/2} = 147 \mu m
\]

and \( Rout = 1.17 \text{ k}\Omega \)

\( Cgs = 196.441 \text{ fF} \)

\( Cgd = 0.441 \text{ fF} \)

So with a device size of \( W/L = 147/2 \), equation 10.86 of the textbook evaluates to:

\( \Sigma \tau_c = 206 \text{ ps} \Rightarrow \omega_{3dB} = 4.83 \text{ Grad/s} \), which certainly meets the frequency response spec.

So \( W/L = 147/2 \)

b. \( W = \left( \frac{L(v_{out} / v_{in})^2}{2\mu_p C_{ox}I_D(1 - v_{out} / v_{in})^2R_L^2} \right)^{1/2} = 36.7 \mu m \)

\( Rout = 2.34 \text{ k}\Omega \)

\( Cgs = 48.9 \text{ fF} \)

\( Cgd = 0.11 \text{ fF} \)

With a device size of \( W/L = 36.7/2 \) (and other parameters as given and calculated), equation 10.86 of the textbook evaluates to:

\( \Sigma \tau_c = 377 \text{ ps} \Rightarrow \omega_{3dB} = 2.64 \text{ Grad/s} \), which meet the frequency response spec, so
W/L=36.7/2

c. \[ W = \frac{L(v_{out}/v_{in})^2}{2\mu p Cox I_D (1 - v_{out}/v_{in})^2 R_L^2} = 588 \mu m \]

Rout=0.58kΩ
Cgs=785.764fF
Cgd=1.764fF
This time \[ \Sigma \tau_c = 2.88ns \Rightarrow \omega_{3db} = 346Mrad/s \] again clears spec. So W/L=588/2.

3. The overall voltage gain of the CS-CS stage is:

\[ \frac{v_{out}}{v_s} = g_m r_o1 g_m r_o2 \left( \frac{R_L}{R_L + R_{out2}} \right) \]

\[ R_{out2} = r_o2 \]

And for the CS-CD stage:

\[ \frac{v_{out}}{v_s} = g_m r_o1 \left( \frac{R_L}{R_L + R_{out2}} \right) \]

\[ R_{out2} = g_{m2}^{-1} \]

So, whether of not one topology is better than the other depends on:

\[ g_m r_o2 \left( \frac{R_L}{R_L + r_o} \right) vs. \left( \frac{R_L}{R_L + g_{m2}^{-1}} \right) \]

We compare the unlike terms and draw conclusions accordingly:

\[ g_m r_o2 \left( \frac{R_L}{R_L + r_o} \right) = 1m.100k \left( \frac{100}{100 + 100k} \right) = 99.9m > \left( \frac{R_L}{R_L + g_{m2}^{-1}} \right) = \left( \frac{100}{100 + 1m^{-1}} \right) = 90.9m \]

\[ g_m r_o2 \left( \frac{R_L}{R_L + r_o} \right) = 1m.100k \left( \frac{10k}{10k + 100k} \right) = 9.09m > \left( \frac{R_L}{R_L + g_{m2}^{-1}} \right) = \left( \frac{10k}{10k + 1m^{-1}} \right) = 909m \]

\[ g_m r_o2 \left( \frac{R_L}{R_L + r_o} \right) = 100\mu 10M \left( \frac{100}{100 + 10M} \right) = 9.99m > \left( \frac{R_L}{R_L + g_{m2}^{-1}} \right) = \left( \frac{100}{100 + 100\mu^{-1}} \right) = 9.90m \]

\[ g_m r_o2 \left( \frac{R_L}{R_L + r_o} \right) = 100\mu 10M \left( \frac{10k}{10k + 10M} \right) = 999m > \left( \frac{R_L}{R_L + g_{m2}^{-1}} \right) = \left( \frac{10k}{10k + 100\mu^{-1}} \right) = 500m \]

In all cases, the CS-CS configuration has a higher gain.