Gain of the opamp

Gain of the first stage differential pair:

* For differential mode, $\frac{V_{o1}}{V_d} = \frac{-g_{m1}}{g_{ds1}+g_{ds3}} = \frac{-3200\mu}{40\mu+40\mu}$

$$\Rightarrow \frac{V_{o1}}{V_d} = -40$$

* For common mode, $\frac{V_{o1}}{V_{cm}} = \frac{-g_{m1}}{g_{m3}}\left(\frac{1}{2g_{m1}r_{o1}+1}\right)$

$$= \frac{-3200\mu}{3200\mu}\left(\frac{1}{2\times 3200\mu\times\frac{1}{80\mu}+1}\right)$$

$$\Rightarrow \frac{V_{o1}}{V_{cm}} = -\frac{1}{81}$$

Gain of the common source amplifier,

$$\frac{V_{o2}}{V_{o1}} = -g_{m5}r_{o2} = -3200\mu \times \frac{1}{800\mu} = -40$$

Overall gain: Differential gain $= -40 \times -40 = 1600$

Common mode gain $= -\frac{1}{81} \times -40 \approx 0.5$

$$CMRR = \left| \frac{A_d}{A_{cm}} \right| = \frac{1600}{0.5} = 3200$$