1) $M1, M2$: $I_D = 25\mu A$

$$I_D = \frac{\mu_p C_{ox}}{2}\left(\frac{W}{L}\right)_1 V_{OV}^2$$

$$V_{OV} = \sqrt{\frac{2I_D}{\mu_p C_{ox}(W/L)_1}}$$

$$= \sqrt{\frac{2(25\times10^{-6})}{60\times10^{-6}(100)}} = 0.091\,V$$

2) Total voltage required to keep $M1$ in active is

$$V_{OV} = 0.091\,V$$

Total voltage across diode connected $M2$ is

$$V_t + 2V_{OV} = 0.5 + 2(0.091) = 0.683V$$

$$10\mu A = \frac{\mu_p C_{ox}}{2}\left(\frac{W}{L}\right)_2 (2V_{OV})^2$$

$$\left(\frac{W}{L}\right)_2 = \frac{10(2)}{60}\frac{1}{(2(0.091))^2} = 10$$

=

3) $A_V = G_m R_o$

$$G_m = g_{m1,2} = \sqrt{2 I_{D1} \mu_p C_{ox} \left(\frac{W}{L}\right)_1} = 5.48 \times 10^{-4} S$$

$$R_o = r_{o_{dp}} \,||\, r_{o_{mir}}$$

$r_{o\,dp}$:

$$r_{o2} = r_{o2A} = \frac{8}{25 \times 10^{-6}} = 320\,k\Omega$$

answer is same as source degenerated CS amplifier

$$r_{o\,dp} = r_{o2A}(1 + g_{m2} r_{o2}) + r_{o2}$$

$$= 32 \times 10^4 (1 + 5.48 \times 10^{-4} (32 \times 10^4)) + 32 \times 10^4$$

$$= 596000\,\Omega \approx 56\,M\Omega$$

$r_{o\,mir}$:

Since transistors match, answer is same as diff pair

$$R_o = \frac{56 \times 10^6}{2} = 28.4\,M\Omega$$

~~$A_V = G_m R_o \approx 5.48 \times 10^{-4} (298{,}000) = 163$~~

$$A_V = G_m R_o = 5.48 \times 10^{-4} (28 \times 10^6) =$$

$$= 15{,}550 \quad (83\,dB)$$