2. Find $\left.\dfrac{d^2y}{dx^2}\right|_{(x,y)=(1/2\,,\,1)}$ if y is a differentiable function of x satisfying the equation:

$$\sin(\pi x y) = \frac{1}{x} - \frac{1}{y}$$

$$\Downarrow \ d/dx$$

$$\cos(\pi x y)\cdot\pi\cdot(y + xy') = -\frac{1}{x^2} + \frac{1}{y^2}y'$$

$$\boxed{(x,y) = (\tfrac{1}{2}, 1)}$$

$$\underbrace{\cos\left(\frac{\pi}{2}\right)}_{0}\cdot\pi\cdot\left(1 + \frac{1}{2}\cdot y'\right) = -4 + y'$$

$$\Downarrow$$

$$\boxed{y' = 4 \text{ at } (x,y) = (\tfrac{1}{2}, 1)}$$

$$d/dx$$

$$-\sin(\pi x y)\cdot(\pi\cdot(y + xy'))^2 + \cos(\pi x y)\cdot\pi\cdot(y' + y' + xy'')$$

$$= \frac{2}{x^3} - \frac{2}{y^3}\cdot(y')^2 + \frac{1}{y^2}\cdot y''$$

$$\boxed{(x,y) = (\tfrac{1}{2}, 1),\ y' = 4}$$

$$-\underbrace{\sin\left(\frac{\pi}{2}\right)}_{1}\cdot\left(\pi\cdot\left(1 + \frac{1}{2}\cdot 4\right)\right)^2 + \underbrace{\cos\left(\frac{\pi}{2}\right)}_{0}\cdot\pi\cdot\left(4 + 4 + \frac{1}{2}y''\right)$$

$$= 16 - 2\cdot 16 + y''$$

$$\Downarrow$$

$$\boxed{y'' = 16 - 9\pi^2 \text{ at } (x,y) = (\tfrac{1}{2}, 1)}$$