(1)

$$\Sigma_1(\varphi) = \frac{y}{(1-x)^2+y^2}$$

$$\int_0^x \frac{\pi}{2}(x+y)\,dy = \left[\frac{\pi}{2}xy + \frac{\pi}{4}y^2\right]_0^x$$

$$= \frac{\pi}{2}x^2 + \frac{\pi}{4}x^2$$

$$= \frac{3\pi}{4}x^2$$

$$\frac{3\pi}{4}\int_0^{\frac{1}{2}} x^2\,dx = \frac{3\pi}{2}\left[\frac{1}{3}x^3\right]_0^{\frac{1}{2}}$$

$$= \frac{3\pi}{4} \times \frac{1}{3} \times \frac{1}{8}$$

$$A = \left[\frac{1}{2}(x^2+y^2)\left(2\tan^{-1}\left(\frac{y}{x}\right) - \sin\left(2\tan^{-1}\left(\frac{y}{x}\right)\right)\right) + \frac{1}{2}\left((1-x)^2+y^2\right)\left(2\tan^{-1}\left(\frac{y}{1-x}\right) - \sin\left(2\tan^{-1}\left(\frac{y}{1-x}\right)\right)\right] \times 0.5$$

$$\text{Area circles} = \frac{\pi(x^2+y^2)}{4} + \frac{\pi((1-x)^2+y^2)}{4}$$

$$= \frac{\pi}{4}\left[x^2+y^2+(1-x)^2+y^2\right]$$

$$= \frac{\pi}{4}\left[x^2+y^2+1+x^2-2x+y^2\right]$$

$$= \frac{\pi}{4}\left[1+2x^2+2y^2-2x\right]$$