1.)

$$\mathbb{E}(S_{xy}) = \mathbb{E}\left(\frac{1}{n-1}\cdot\sum_{i=1}^{n}(x_i-\bar{x})(y_i-\bar{y})\right)$$

$$= \frac{1}{n-1}\sum_{i=1}^{n}\mathbb{E}\left((x_i-\bar{x})(y_i-\bar{y})\right)$$

$$= \frac{n}{n-1}\left(\mathbb{E}(x_1y_1) - \mathbb{E}(x_1\bar{y}) - \mathbb{E}(\bar{x}y_1) + \mathbb{E}(\bar{x}\bar{y})\right)$$

$$= \frac{n}{n-1}\left(\mathbb{E}(x_1y_1) - \left(\frac{1}{n}\mathbb{E}(x_1y_1) + \frac{n-1}{n}\mathbb{E}(x_1y_2)\right) - \left(\frac{1}{n}\mathbb{E}(x_1y_1) + \frac{n-1}{n}\cdot \mathbb{E}(x_2y_1)\right) + \frac{n}{n^2}\mathbb{E}(x_1y_1) + \frac{n^2-n}{n^2}\mathbb{E}(x_1y_2)\right)$$

$$= \frac{n}{n-1}\left(\mathbb{E}(x_1y_1)\cdot\left(1-\frac{1}{n}-\frac{1}{n}+\frac{1}{n}\right) - \mathbb{E}X_1\,\mathbb{E}Y_2\left(\frac{n-1}{n}+\frac{n-1}{n}+\frac{n-1}{n}\right)\right)$$

$$= \frac{n}{n-1}\left(\mathbb{E}(x_1y_1)\left(\frac{n-1}{n}\right) - \mathbb{E}X_1\,\mathbb{E}Y_2\left(\frac{n-1}{n}\right)\right)$$

$$= \frac{n}{n-1}\cdot\frac{n-1}{n}\cdot\left(\mathbb{E}(XY) - \mathbb{E}X\,\mathbb{E}Y\right)$$

$$= \mathbb{E}XY - \mathbb{E}X\,\mathbb{E}Y = \mathbb{K}(X,Y)$$