$$\begin{bmatrix} \frac{1}{2}\bar{\sigma}_u^2 & \frac{1}{2}\bar{\sigma}_u^2 & 1\bar{\sigma}_u^2 & \frac{1}{2}\bar{\sigma}_u^2 & \frac{1}{2}\bar{\sigma}_u^2 \\ \frac{1}{2}\bar{\sigma}_u^2 & \frac{1}{2}\bar{\sigma}_u^2 & \frac{1}{2}\bar{\sigma}_u^2 & \bar{\sigma}_u^2 & \frac{1}{2}\bar{\sigma}_u^2 \\ \frac{1}{2}\bar{\sigma}_u^2 & \frac{1}{2}\bar{\sigma}_u^2 & \frac{1}{2}\bar{\sigma}_u^2 & \frac{1}{2}\bar{\sigma}_u^2 & \bar{\sigma}_u^2 \end{bmatrix} = \begin{bmatrix} \frac{1}{2} \\ \frac{1}{2} \\ \frac{1}{2} \end{bmatrix}$$

A

$$cov(u_3, u_4) = cov\left(\left[\frac{1}{2}u_1 + \frac{1}{2}u_2 + m_3\right], \left[\frac{1}{2}u_1 + \frac{1}{2}u_2 + m_4\right]\right)$$

$$= cov(\tfrac{1}{2}u_1, \tfrac{1}{2}u_1) + \underbrace{cov(\tfrac{1}{2}u_1, \tfrac{1}{2}u_2)}_{=0} + \underbrace{cov(\tfrac{1}{2}u_1, m_4)}_{=0}$$

$$+ \underbrace{cov(\tfrac{1}{2}u_2, \tfrac{1}{2}u_1)}_{=0} + cov(\tfrac{1}{2}u_2, \tfrac{1}{2}u_2) + \underbrace{cov(\tfrac{1}{2}u_2, m_4)}_{=0}$$

$$+ \underbrace{cov(m_3, \tfrac{1}{2}u_1) + cov(m_3, \tfrac{1}{2}u_2) + cov(m_3, m_4)}_{=0}$$

$$= cov(\tfrac{1}{2}u_1, \tfrac{1}{2}u_1) + cov(\tfrac{1}{2}u_2, \tfrac{1}{2}u_2)$$

$$= \tfrac{1}{4} cov(u_1, u_1) + \tfrac{1}{4} cov(u_2, u_2)$$

$$= \tfrac{1}{4} var(u_1) + \tfrac{1}{4} var(u_2)$$

$$= \tfrac{1}{4} \bar{\sigma}_u^2 + \tfrac{1}{4} \bar{\sigma}_u^2 = \tfrac{1}{2} \bar{\sigma}_u^2$$