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

$$\boxed{\begin{aligned} u_3 &= \tfrac{1}{2}u_1 + \tfrac{1}{2}u_2 + m_3 \\ u_4 &= \tfrac{1}{2}u_1 + \tfrac{1}{2}u_2 + m_4 \end{aligned}}$$

$$= \text{cov}\left(\tfrac{1}{2}u_1, \tfrac{1}{2}u_1\right) + \underbrace{\text{cov}\left(\tfrac{1}{2}u_1, \tfrac{1}{2}u_2\right)}_{=\varnothing}$$

$$+ \underbrace{\text{cov}\left(\tfrac{1}{2}u_1, m_4\right)}_{\varnothing}$$

$$+ \underbrace{\text{cov}\left(\tfrac{1}{2}u_2, \tfrac{1}{2}u_1\right)}_{=\varnothing} + \text{cov}\left(\tfrac{1}{2}u_2, \tfrac{1}{2}u_2\right)$$

$$+ \underbrace{\text{cov}\left(\tfrac{1}{2}u_2, m_4\right)}_{=\varnothing} + \underbrace{\text{cov}\left(m_3, \tfrac{1}{2}u_1\right)}_{}$$

$$+ \text{cov}(m_3, \cdot)$$

$$\underbrace{\text{cov}(m_3, \cdot)}_{\varnothing}$$

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

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

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

$$= \tfrac{1}{4}\sigma_u^2 + \tfrac{1}{4}\sigma_u^2 = \tfrac{1}{2}\sigma_u^2$$