Exercise: Linear combinations of random variables

Let $\mathbf{x}$ be a random vector with mean $\mathbf{m}$ and covariance matrix Σ. Let $\mathbf{A}$ and $\mathbf{B}$ be matrices.

1. Derive the covariance matrix of $\mathbf{Ax}$.

2. Show that $\text{tr}(\mathbf{AB}) = \text{tr}(\mathbf{BA})$.

3. Derive an expression for $\mathbb{E}\left[\mathbf{x}^T \mathbf{Ax}\right]$? (Hint: use the previous question and the trace trick.)