1. Show by vector method that the diagonals of a parallelogram bisect each other. (5)

   Also conversely, show that a plane quadrilateral whose diagonals bisect each other is a parallelogram.

2. Show that the inverse of an even permutation is an even permutation and the inverse of an odd permutation is an odd permutation. (5)

3. Show that the ring M_2 of all 2×2 matrices

$$\begin{bmatrix} 2a & 0 \\ 0 & 2b \end{bmatrix}$$ contains divisors of zero but does not contain the unity, if $a, b \in Z$, the set of integers. (5)

4. Show that the set $S = \{0, 1, 2, 3, 4, 5, 6, 7\}$ is a ring under the addition and multiplication modulo 8. (5)

   Also show that the ring is commutative but is not an integral domain.