Step-1

Given that $(AB)x = A(Bx)$

where $x = (1,0,...,0)$ is the column vector. We have to show that the first column of AB is equal to A times the first column of B.

Step-2

By definition of product of matrices

$$(AB)x = (AB)(1,0,....0)$$
$$= (AB,0,0.....0)$$

$$Bx = B(1,0,...,0)$$
$$= (B,0,0,...,0)$$

$$A(Bx) = A(B,0,...,0)$$

Step-3

Now $(AB)x = A(Bx)$

$$\Rightarrow (AB,0,0.....0) = A(B,0,...,0)$$

and by the rule that column j of $AB = A$ times $(\text{column } j \text{ of } B)$ we have the first column of AB is equal to A times the first column of B.