Step-1

We have to find the examples of 2 by 2 matrices such that the given condition is obeyed by trial and error method.

Step-2

(a) $A^2 = -I$, A having only real values.

Let $A = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$

$$A^2 = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}\begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}$$

$$= \begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix}$$

$$= -\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$$

$$= -I$$

Step-3

(b) $B^2 = 0$, although $B \neq 0$

Let $B = \begin{pmatrix} 0 & 0 \\ 1 & 0 \end{pmatrix}$

$$B^2 = \begin{pmatrix} 0 & 0 \\ 1 & 0 \end{pmatrix}\begin{pmatrix} 0 & 0 \\ 1 & 0 \end{pmatrix}$$

$$= \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}$$

$$= \text{null matrix}$$

Step-4

(c) $CD = -DC$, not allowing the case $CD = 0$

Let $C = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$ and $D = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$

$$CD = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \cdot \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$$

$$= \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$$

$$DC = \begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix} \cdot \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$$

$$= \begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}$$

$$= -\begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$$

$$= -CD$$

Step-5

(d) $EF = 0$, although E or F are zero

Let $E = \begin{pmatrix} -1 & 1 \\ -1 & 1 \end{pmatrix}$ and $F = \begin{pmatrix} -1 & 1 \\ -1 & 1 \end{pmatrix}$

$$EF = \begin{pmatrix} -1 & 1 \\ -1 & 1 \end{pmatrix} \begin{pmatrix} -1 & 1 \\ -1 & 1 \end{pmatrix}$$

$$= \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}$$

$$= \text{null matrix.}$$