Assignment 2

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Download all python codes from

```
https://github.com/Digjoy12/Signal−Processing/tree
    /main/Assignment_2/Code
```

and latex codes from

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https://github.com/Digjoy12/Signal−Processing/
    blob/main/Assignment_2/main.tex
```

Problem

(Matrix - Q2.60) Find the matrix $\mathbf{X}$ so that

$$\mathbf{X}\begin{pmatrix}1 & 2 & 3\\4 & 5 & 6\end{pmatrix} = \begin{pmatrix}-7 & -8 & -9\\2 & 4 & 6\end{pmatrix}$$

Solution

Let,

$$\mathbf{A} = \begin{pmatrix}1 & 2 & 3\\4 & 5 & 6\end{pmatrix} \tag{0.0.1}$$

$$\mathbf{B} = \begin{pmatrix}-7 & -8 & -9\\2 & 4 & 6\end{pmatrix} \tag{0.0.2}$$

Now, multiplying $\mathbf{A}^\top$ on both sides,

$$\mathbf{X}\mathbf{A}\mathbf{A}^\top = \mathbf{B}\mathbf{A}^\top \tag{0.0.3}$$

$$\implies \mathbf{X} = \mathbf{B}\mathbf{A}^\top(\mathbf{A}\mathbf{A}^\top)^{-1} \tag{0.0.4}$$

Therefore,

$$\mathbf{X} = \begin{pmatrix}-7 & -8 & -9\\2 & 4 & 6\end{pmatrix}\begin{pmatrix}1 & 4\\2 & 5\\3 & 6\end{pmatrix}(\mathbf{A}\mathbf{A}^\top)^{-1} \tag{0.0.5}$$

$$= \begin{pmatrix}-50 & -122\\28 & 64\end{pmatrix}\left[\begin{pmatrix}1 & 2 & 3\\4 & 5 & 6\end{pmatrix}\begin{pmatrix}1 & 4\\2 & 5\\3 & 6\end{pmatrix}\right]^{-1} \tag{0.0.6}$$

$$= \begin{pmatrix}-50 & -122\\28 & 64\end{pmatrix}\left[\begin{pmatrix}14 & 32\\32 & 77\end{pmatrix}\right]^{-1} \tag{0.0.7}$$

$$= \begin{pmatrix}-50 & -122\\28 & 64\end{pmatrix}\begin{pmatrix}\frac{77}{54} & \frac{-16}{27}\\ \frac{-16}{27} & \frac{7}{27}\end{pmatrix} \tag{0.0.8}$$

$$= \begin{pmatrix}1 & -2\\2 & 0\end{pmatrix} \tag{0.0.9}$$

Now, verifying the solution

$$L.H.S = \mathbf{X}\begin{pmatrix}1 & 2 & 3\\4 & 5 & 6\end{pmatrix} \tag{0.0.10}$$

$$= \begin{pmatrix}1 & -2\\2 & 0\end{pmatrix}\begin{pmatrix}1 & 2 & 3\\4 & 5 & 6\end{pmatrix} \tag{0.0.11}$$

$$= \begin{pmatrix}1-8 & 2-10 & 3-12\\4+0 & 4+0 & 6+0\end{pmatrix} \tag{0.0.12}$$

$$= \begin{pmatrix}-7 & -8 & -9\\2 & 4 & 6\end{pmatrix} \tag{0.0.13}$$

$$= R.H.S \tag{0.0.14}$$

Hence the matrix $\mathbf{X}$ is $\begin{pmatrix}1 & -2\\2 & 0\end{pmatrix}$