3. Rotation Exercise

Consider a vector $\mathbf{u} = x\hat{i} + y\hat{j}$ which is being rotated by angle θ in counter-clockwise direction. After rotation, the new vector $\mathbf{v} = x'\hat{i} + y'\hat{j}$is going to be:

$$\begin{aligned} x' &= xcos\theta - ysin\theta \\ y' &= xsin\theta + ycos\theta \end{aligned}$$

In matrix format this could be written as $\mathbf{v} = \mathbf{uR}$, where R is the rotation matrix:

$$\mathbf{R} = \begin{bmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{bmatrix},$$

Using this, rotate $2\hat{i} + 3\hat{j}$ counter-clockwise by 30^o.

```
% Defining the initial Vector and Angle its has to be rotated
u = [2 3];
theta = 30;
% Rotation Matrix
R = [cosd(theta) -sind(theta); sind(theta) cosd(theta)];
uR = R*u';

disp(['Rotated Vector = ',num2str(uR(1)),'i + ',num2str(uR(2)),'j'])
```

Name	Value
R	[0.8660,-0.5000;0.500...
theta	30
u	[2,3]
uR	[0.2321;3.5981]

```
>> MatrixRotation
Rotated Vector = 0.23205i + 3.5981j
```

4. Compute seismic moment (example of matrix dot product):

Seismic moment M_0 (measure of size of earthquake) can be computed from its moment tensor matrix, $\mathbf{M}$ (full description of earthquake faulting mechanism) by using the formula:

$$M_0 = \frac{1}{\sqrt{2}} \left(\sum_{ij} M_{ij}^2 \right)^{1/2} \tag{4}$$

Compute M_0 for: $\mathbf{M} = \begin{bmatrix} 1.760 & 8.040 & -1.510 \\ 8.040 & -1.820 & 0.475 \\ -1.510 & 0.475 & 0.058 \end{bmatrix} \times 10^{27}$. This is the moment tensor solution for April 25, 2015 Nepal earthquake.

Find seismic magnitude M_w from M_0 using: $M_w = \frac{2}{3}(\log_{10}(M_0) - 16.1)$

```
% Defining the moment tensor matrix M
M = [1.760 8.040 -1.510;
    8.040 -1.820 0.475;
    -1.510 0.475 0.058] * 10^27;

% Computation of the Seismic Moment
M0 = sqrt(0.5 * sumsqr(M));

% Computation of seismic magnitude Mw from M0
Mw = 2/3*(log10(M0) - 16.1);

disp(['Seismic Magnitude Mw = ',num2str(Mw)])
```

```
>> SeismicMagnitude
Seismic Magnitude Mw = 7.8824
```

Name	Value
M	[1.7600e+27,8.0400e+...
M0	8.3877e+27
Mw	7.8824