Dot product $V_1 \bullet V_2$ and Cross product $V_1 \times V_2$ for 2 vectors

```
clear
clc
rng(50, 'v5normal');
```

Row Vector : $V_a = \begin{bmatrix} a_1 & a_2 & a_3 \end{bmatrix}$ and $V_b = \begin{bmatrix} b_1 & b_2 & b_3 \end{bmatrix}$

```
vector_a = randn(1, 3);
vector_b = randn(1, 3);
```

Vector dot product : $V_a \bullet V_b^T = \begin{bmatrix} a_1 & a_2 & a_3 \end{bmatrix} \bullet \begin{bmatrix} b_1 \\ b_2 \\ b_3 \end{bmatrix} = a_1b_1 + a_2b_2 + a_3b_3$

```
dot_prod = dot(vector_a, vector_b)
```

```
dot_prod = -3.4826
```

Vector cross product :

```
cross_prod = cross(vector_a, vector_b)
```

```
cross_prod =

    1.2835   -1.9162   -4.5930
```

How to calculate the cross product of 2 vectors? The below code shows the principle :

$$\begin{bmatrix} V_a \\ V_b \end{bmatrix} = \begin{bmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{bmatrix}, V_a \times V_b = \left[\det\left(\begin{bmatrix} a_2 & a_3 \\ b_2 & b_3 \end{bmatrix}\right) \quad -\det\left(\begin{bmatrix} a_1 & a_3 \\ b_1 & b_3 \end{bmatrix}\right) \quad \det\left(\begin{bmatrix} a_1 & a_2 \\ b_1 & b_2 \end{bmatrix}\right) \right]$$

```
vector_ab = [vector_a; vector_b];
det_vector_ab(1) = det(vector_ab(:, [2, 3]));
det_vector_ab(2) = -det(vector_ab(:, [1, 3]));
det_vector_ab(3) = det(vector_ab(:, [1, 2]));
det_vector_ab         % this vector is identical to the cross_prod
```

```
det_vector_ab =

    1.2835   -1.9162   -4.5930
```

Display the 3D vector diagram for the cross product

```
plot3([0; vector_a(1)], [0; vector_a(2)], [0; vector_a(3)], ...
```

```
'b--', 'LineWidth', 3);    % plot vector_a

hold on;

plot3([0; vector_b(1)], [0; vector_b(2)], [0; vector_b(3)], ...
'g-.', 'LineWidth', 3);    % plot vector_b

plot3([0; det_vector_ab(1)], [0; det_vector_ab(2)], [0; det_vector_ab(3)], ...
'r', 'LineWidth', 3);    % plot the cross product of vector_a and vector_b

hold off;
grid on;
box on;
xlabel('x');
ylabel('y');
zlabel('z');
view([-119, 24]);
legend('\bfV_a', '\bfV_b', '\bfVector-Cross-Prodcut = {\bfV_a} {\times} {\bfV_b}');
```