CENG315 Assignment 2 - Math basics & 2D Transformations

Q1) For given vectors i=(0.8, 0.6, 0), j=(-0.6, 0.8, 0), and k=(1, 0, 0) in 3D space; find the results of the following. (i · i means the dot product between i and i, i × i means the cross product between i and i)

Answer1)

a) **i . j**
b) **i . k**
c) **i x k**
d) **i x i**
e) **||i × k||**
f) **2i → k (**projection of 2i onto k**)**

Q2) Two vectors in the plane, i & j, have the following properties: i · i = 1, i · j = 0, j · j = 1

a) Is there a vector k, that is not equal to i, such that: k · k = 1, k · j = 0? What is it? Are there many vectors with these properties?
b) Is there a vector k such that: k · k = 1, k · j = 0, k · i = 0? Why not?
c) If i and j were vectors in 3D, how would the answers to the above questions change?

Q3) For three points on the plane (x1, y1), (x2, y2) and (x3, y3) show that the determinant of

$$\begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix}$$

is proportional to the area of the triangle whose corners are the three points. If these points lie on a straight line, what is the value of the determinant? Does this give a useful test to tell whether three points lie on a line? Why do you think so?

Q4) The equation of a line in the plane is ax + by + c = 0. Given two points on the plane, show how to find the values of a, b, c for the line that passes through those two points. You may find the answer to question 3 useful here.

Q5) Give three different composite 2D transforms so that each one achieves the given transformations below. (Use any number of translations, scales, or rotations for a composite transformation. Use t(x,y) for translation, s(x,y) for scale, and r(alpha) for rotation. Positive rotation is counter-clockwise. Note that order of transformations is important.)