Computer Aided Mathematics and Visualization   Name: —————————————————
Practice
26th October, 2021   Neptun code: —————————————————

1. Complete the following definition of *vectors*. Write one word in each of the gaps.

   > Let A and B are two points. A directed line segment from A to B is a vector. A vector is defined by
   >
   > its ...., and its ....

2. Select the correct answer.
   Assume we have the two-dimensional vectors $\mathbf{u} = (u_x, u_y)$ and $\mathbf{v} = (v_x, v_y)$. In any orthonormal basis, the *dot product* between $\mathbf{u}$ and $\mathbf{v}$ can be calculated as

   A. $\mathbf{u} \cdot \mathbf{v} = \sqrt{(u_x + u_y)^2 + (v_x + v_y)^2}$
   B. $\mathbf{u} \cdot \mathbf{v} = \sqrt{(u_x + v_x)^2 + (u_y + v_y)^2}$
   C. $\mathbf{u} \cdot \mathbf{v} = u_x u_y + v_x v_y$
   D. $\mathbf{u} \cdot \mathbf{v} = u_x v_x + u_y v_y$

3. Complete the following statement. Write one word or one number in the gap.

   > The *dot product* of two vectors is .... when the vectors are perpendicular to each other.

4. Select the correct answer.
   The *cross product* of two vectors, $\mathbf{u} = (u_x, u_y, u_z)$ and $\mathbf{v} = (v_x, v_y, v_z)$ is defined as

   A. a new three-dimensional vector.
   B. a new six-dimensional vector.
   C. a scalar value.
   D. a new two-dimensional vector.

5. Complete the following statement. Write one word in the gap.

   > In three dimensions, the length of *cross product* of two vectors, $\mathbf{u}$ and $\mathbf{v}$, can be interpreted geometrically as the area of the ....spanned by $\mathbf{u}$ and $\mathbf{v}$.

6. Select the correct answer.
   Which MATLAB function can we use to visualize a vector line as arrow?

   A. plot
   B. quiver
   C. linspace
   D. cross

   Recommended literature: `http://immersivemath.com/ila/index.html`, Chapter 2, 3 and 4.

- Solve the following tasks with the help of **MATLAB software!**
- **Create a separate MATLAB file (.m) for each tasks (Task 7, 8, 9)! Name each file with the respective task number!**

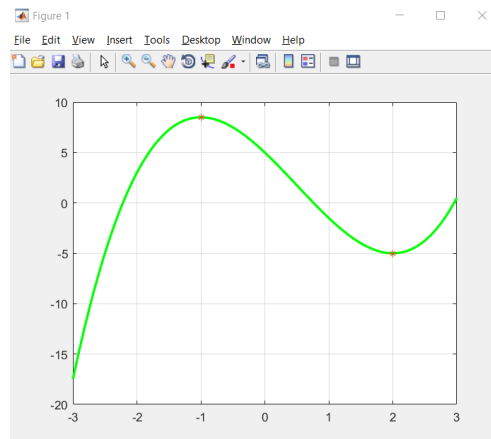7. This task should be saved as *Task7.m*. Consider the following function:

$$f(x) = x^3 - \tfrac{3}{2}x^2 - 6x + 5$$

   (a) Draw the graph of function f with green colour over the interval [-3, 3], and set the line width to 2,

   (b) Display axes grid lines,

   (c) Draw the extremums of the function f,

   (d) Select the correct answer.
   A function f always have an extreme value at the interior point c of its domain, if the function's first derivative, denoted f', is defined at c and $f'(c) = 0$.

   A. True
   B. False

   (e) Select the correct answer.
   A function f can possibly have an extreme value at the interior point c of its domain, if the function's first derivative, denoted f', is defined at c and $f'(c) = 0$.

   A. True
   B. False

   (f) Categorize the extremum points as minimum or maximum points.

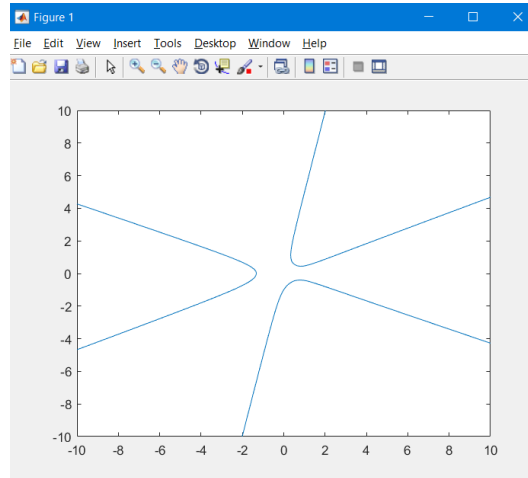Example for the expected output figure (The test will not include this part):

8. This task should be saved as *Task8.m*. Let there be a curve defined by the equation:

$$x^3 + y^3 - 5xy^2 - x + 1 = 0$$

Draw the curve with blue colour over the interval [-10, 10].

Example for the expected output figure (The test will not include this part):

9. This task should be saved as *Task9.m*. Consider the parametric curve defined as:

$$x(t) = (cos(t))^3$$
$$y(t) = (sin(t))^3$$

(a) Draw the parametric curve in blue colour. Plot at least 200 points for a *smooth* result.

(b) Draw a point on the curve where $t = \frac{\pi}{4}$.

Example for the expected output figure (The test will not include this part):