School of Computer Science
Faculty of Science
National University of Engineering

Midterm Exam

Topics: geometric transformations; curves and programming in Python
Subject: Computational Mathematics **Period: 2021-1**

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1. (5 pts.) Write a program that takes the four consecutive vertices of a quadrilateral and determines whether the polygon is convex or not.

2. (5 pts.) The vertices $(1, 1, 1)$, $(1, -1, -1)$, $(-1, 1, -1)$, and $(-1, -1, 1)$ form a tetrahedron with equal sides. In Example 3.24 from Chapter 3 of [1], there is another set of vertices for a tetrahedron with equal sides. Find the transformation matrix that takes the first tetrahedron to the second.

3. (3 pts.) In Example 5.3 (see [1]), the matrix $M_{\mathcal{W}\to\mathcal{C}}$ has -0.02 in the upper right corner. Show that, theoretically, this should be zero and, therefore, round-off error must explain the difference.

4. (4 pts.) Create a program to construct a uniform quadratic B-spline using the control points $(-1, 0)$, $(1, 4)$, $(3, -2)$, and $(4, 3)$ and show the parametric equation of the curve. Find the point on the curve at $t = 3.5$.

5. (3 pts.) Implement a program that uses the de Boor algorithm to verify the point on the curve at $t = 3.5$ in the previous question.

June 2, 2021

Bibliography

[1] Janke, S. J. *Mathematical Structures for Computer Graphics.* Wiley, 2015.