Instructor: B WYVILL

Duration: 50 mins.

Attempt as many question parts as you can in the time. Total out of 20.

Closed Book, calculators are permitted. Show all of your working.

Question 1 .... *(7 points)*

(a) In a viewing system the eye is placed at $(0, 8, 6)$ looking at the origin and the up vector is (0 1 0). Find the coordinate system $(\mathbf{u}, \mathbf{v}, \mathbf{w})$ for viewing and calculate the rotation matrix that will align the viewing system with the $(\mathbf{x}, \mathbf{y}, \mathbf{z})$ world system. `4`

(b) Show that the above is a rotation matrix. (Even if you don't calculate the above matrix - show this symbolically). `2`

(c) Write down the cartesian coordinates corresponding to the following homogeneous coordinates : $(12, 16, 10, 2)$ and $(24, 32, 20, 4)$ `1`

Question 2 .... *(7 points)*

(a) Joe Hackquick is trying to build a model of a snake based on a generalized cylinder around a cubic spline. He iterates along the spline and at each new position calculates a new Frenet frame using vectors based on the first and second derivatives of the cubic. Suddenly, at a point of inflection of the curve, the cylinder collapses to a point. Why does this happen? Describe how the problem could be solved using the method of rotation minimizing frames. `3`

(b) How many basis functions are needed to find the points of a single segment 3D cubic B-spline curve segment? `1`

(c) How are points on a B-spline curve segment in modelling space calculated, given the basis functions, B_i and the correct number of control points, P_i? `1`

(d) The basis functions for a Bezier curve are : `2`

$$Q(t) = (1 - t)^3 P_1 + 3t(1 - t)^2 P_2 + 3t^2(1 - t)P_3 + t^3 P_4$$

Derive an expression for the tangent vectors in terms of the control points.

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Question 3 .... *(7 points)*

(a) Having failed to model a snake, Joe Hackquick gets a new job as a pirate. He is trying to sneak up on another ship, and cannot be seen provided he stays south of a particular line defined by an implicit equation. He knows his position as an (x, y) coordinate. Show how he finds out which side of the line his ship is positioned.

$\boxed{2}$

(b) Joe left a silver coin in a very flat part of the desert. Standing on a 100m high hill, 200m west of the coin he looks due east to watch the sun rise. Given that in Joe's world the Phong light model holds, sketch a graph of the intensity he observes at the centre of the coin as the sun rises until it is directly overhead. State any assumptions you make.

$\boxed{2}$

(c) The reflection vector from a surface is $R(0, -1, 0)$ to a surface whose normal is $N(\frac{-1}{sqrt(2.0)}, \frac{1}{srqt(2.0)}, 0)$. Calculate the direction to the light source.

$\boxed{2}$

(d) Bonus Question: answer a) At which US university was the first computer graphics teapot made?
or b) Joe Hackquick thinks he knows the answer to life the universe and everything, but he is only half right. What is joe's answer?

$\boxed{1}$

END