UNIVERSITY OF DUBLIN

TRINITY COLLEGE

Faculty of Engineering, Mathematics and Science
School of Computer Science and Statistics

BA Mod. (Computer Science) Trinity Term 2011
BA Mod (CSLL)
SS Examination

CS4052 Computer Graphics

Wednesday 18th May Luce Lower 14.00 – 17.00

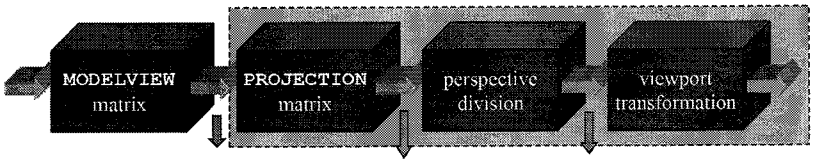
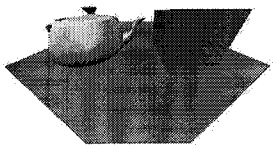
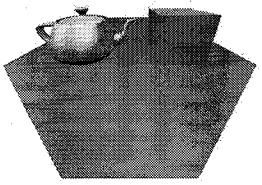
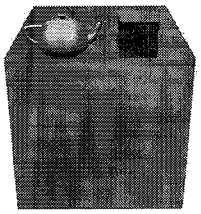
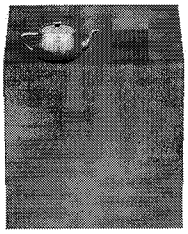
Prof. Carol O'Sullivan

Instructions

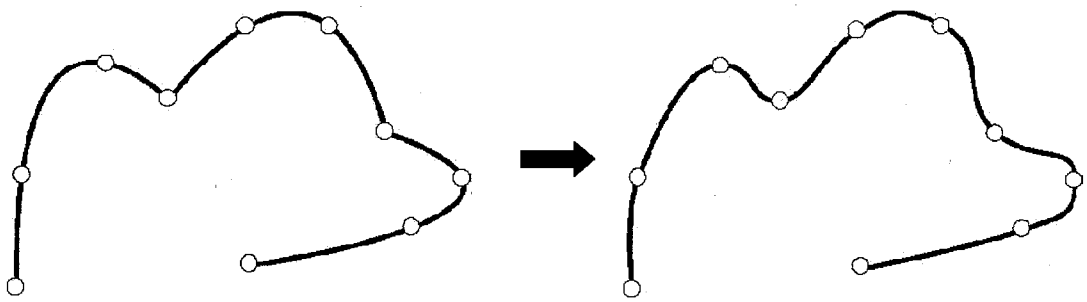
Answer any four questions.

All questions are worth 25 Marks

Question 1 **Marks**

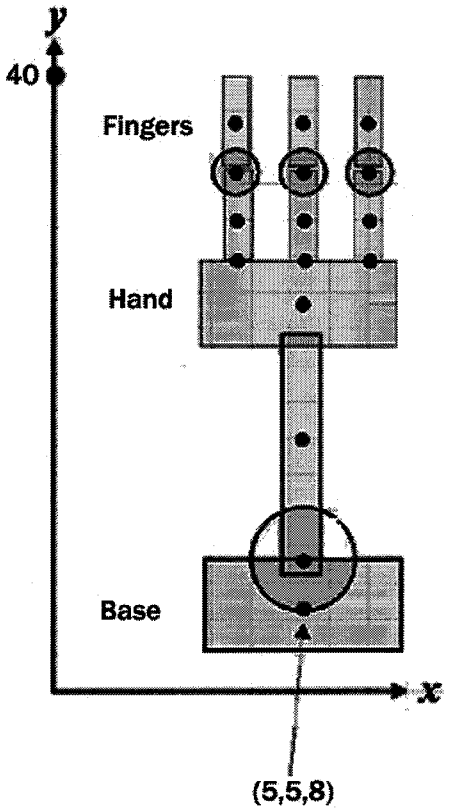
(a)	 What does the above diagram represent? Briefly explain each of the four components, and describe the inputs and outputs to/from each.	(10)
(b)	(i) (ii)   (iii) (iv)   Consider images (i)-(iv) above. Each of them shows a perspective view rendered in OpenGL, of exactly the same scene. The scene consists of: a teapot, radius 0.5, and a cube, edge-length 0.8, both sitting on a cube of edge-length 4.0. Explain in detail what is causing the differences between the images, and when you might want to use each type of view. Give very rough estimates of the viewing parameters that are being used to create each image, and provide the OpenGL (or similar Graphics API) code that would be used to set the camera parameters and render each view.	(15)

Question 2 **Marks**



(a)	Given 10 points, as shown in the figure above, explain how you would create a smooth curve that interpolates them. What types of curve would you use to achieve the results shown on the left and on the right? How would you create and render both of the curves above in OpenGL (or similar graphics API)? – provide short code samples.	(10)
(b)	The Hermite blending functions are used to generate points on a curve as follows: $P(t) = (2t^3 - 3t^2 + 1)P_1 + (-2t^3 + 3t^2)P_4 + (t^3 - 2t^2 + t)R_1 + (t^3 - t^2)R_4$ (i) Explain how Bezier curves are related to Hermite curves, (ii) Derive the change of basis matrix from Hermite to Bezier (iii) Give the general form of the Bernstein polynomials	(15)

Question 3 **Marks**

(a)	 For the above object, roughly estimate the positions of the various joints shown in the hierarchy above. Provide the OpenGL (or similar Graphics API) code necessary to: – Move the whole assembly to the right by 5 units – Scale the base unit only by 4 – Bend the hand unit by 45 degrees towards you (Right handed system) Followed by: – An animation loop during which the 3 fingers each flex in turn (as if playing a piano).	(18)
(b)	Explain how transformations can be *composed*. Illustrate your answer by showing how an object centred at an arbitrary point C=(cx,cy,cz) can be rotated (about its centre) by 80 degrees around the Z axis, and translated by a distance 5 in the direction (1,1,1). Provide sample OpenGL (or similar Graphics API) code that would achieve this transformation.	(7)

Question 4 **Marks**

(a)	(i) What factors determine the colour of an object at any given point? (ii) Explain the difference between local and global illumination of a point (iii) Explain the difference between view dependent and view independent solutions for determining the illumination of a point (iv) What is meant by non-photorealistic rendering and how might it be achieved for an object?	(10)
(b)	Ray tracing of an object requires calculating the intersection of that object with each ray. Give the parametric equation for a ray with the eye at (*x0, y0, z0*) looking at (*x1, y1, z1*), then find the intersection of a ray with eye-point (1, 2, 3) and lookat point (9, 12, 13) with the x = 5 plane.	(10)
(c)	What factors make ray-tracing computationally expensive?	(5)

Question 5 **Marks**

Given vectors $\boldsymbol{u}$= (4, 11, 23) and $\boldsymbol{t}$ = (3, -2, -7), and point p = (3,-2,5)	
(a) Find the magnitude of the vector $\boldsymbol{u}$ and normalise it	(2)
(b) Find the dot product between $\boldsymbol{u}$ and $\boldsymbol{t}$	(2)
(c) Find a vector $\boldsymbol{v}$ that is perpendicular to the plane defined by $\boldsymbol{u}$ and $\boldsymbol{t}$, using a right-handed coordinate system	(5)
(d) Determine whether the point P is on the same side of this plane as indicated by the positive direction of vector $\boldsymbol{v}$	(5)
(e) Find a new vector $\boldsymbol{w}$ that is mutually orthogonal to $\boldsymbol{u}$ and $\boldsymbol{v}$, and normalise all three vectors	(5)
(f) Define point p with respect to this new coordinate system	(6)

Question 6 **Marks**

(a)	Describe a "hot topic" in Computer Graphics today. Explain why it is an important topic, what its real-world/industry applications are, and what research is being performed relating to this topic.	(10)
(b)	Imagine you have been asked to animate a human-like character for a TV commercial. Give a detailed overview of how you would go about doing this, and the methods you would employ.	(8)
(c)	Now imagine that your commercial is a great success. As a result you have been commissioned to create an interactive game based on the character you created, who now needs to be implemented as an intelligent agent. Describe the important factors you need to consider when implementing the behaviour of this agent.	(7)