2002 Paper 7 Question 9

Advanced Graphics

(a) A disc is a finite, planar, circular object. Describe an algorithm to find the point of intersection of an arbitrary ray with an arbitrary disc in three dimensions. Ensure that you describe the parameters used to define both the ray and the disc. [6 marks]

(b) Given the above algorithm and an algorithm to find the intersection of an arbitrary ray with a finite-length *open* cylinder, a programmer has two choices for implementing an algorithm to find the intersection with a finite-length *closed* cylinder. She could simply use the finite-length open cylinder primitive and two disc primitives. Alternatively she could implement the finite-length closed cylinder as a primitive in its own right by adding extra code to the open cylinder algorithm. Compare the two alternatives in terms of efficiency and accuracy. [4 marks]

(c) Describe the situations in which it is sensible to use a winged-edged data structure to represent a polygon mesh and, conversely, the situations in which a winged-edged data structure is not a sensible option for representing a polygon mesh. What is the minimum information which is required to successfully draw a polygon mesh using Gouraud shading? [4 marks]

(d) Derive the formula of and sketch a graph of $N_{3,3}(t)$, the third of the quadratic B-spline basis functions, for the knot vector $[\,0\,0\,0\,1\,3\,3\,4\,5\,5\,5\,]$. [6 marks]