

NATIONAL UNIVERSITY OF IRELAND, GALWAY  
OLLSCOIL NA hÉIREANN

SEMESTER I (WINTER) 2002 EXAMINATION

FOURTH YEAR SCIENCE (INFORMATION TECHNOLOGY)

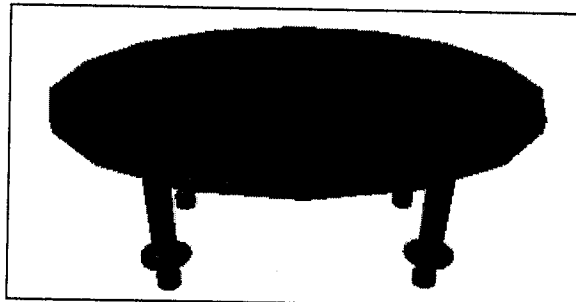
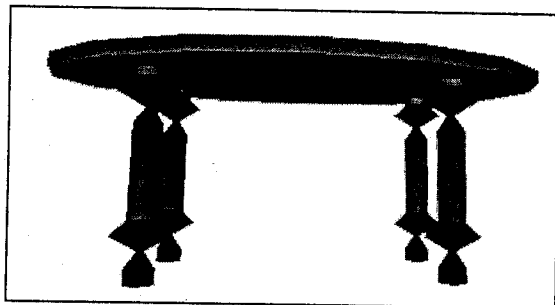
CT404 GRAPHICS AND IMAGE PROCESSING

Prof. P. Nixon  
Prof. G. Lyons  
Dr. S. Redfern

Time allowed: **TWO** hours

Answer **ANY THREE** questions  
All questions carry equal marks

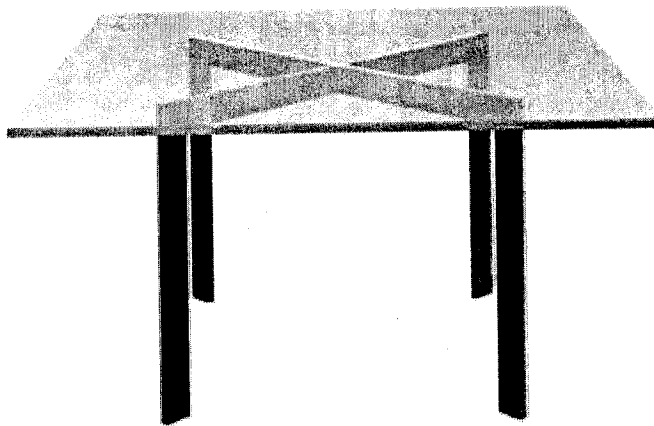
- Q.1. (a) In the context of two-dimensional vector graphics, describe two separate approaches for determining whether a point is inside a polygon.
- (b) Describe the difference between parallel projection and perspective projection in 3-dimensional graphics. Give some examples of applications in which each might typically be used.
- (c) The table pictured below (viewed from two angles) was created by cloning an extruded leg shape, and then stretching a cylinder along one axis to make the elongated table-top. Write VRML code to create an object similar to this. Note that the most useful VRML nodes are summarised on the final page of this exam paper.



**Q.2.** (a) In the context of three-dimensional graphics, discuss 3 techniques used for each of the following: (i) hidden surface removal, (ii) surface shading.

(b) What is keyframe animation? Explain how, in the VRML language, the various Interpolator nodes work in conjunction with the TimerSensor node in order to provide keyframe animation.

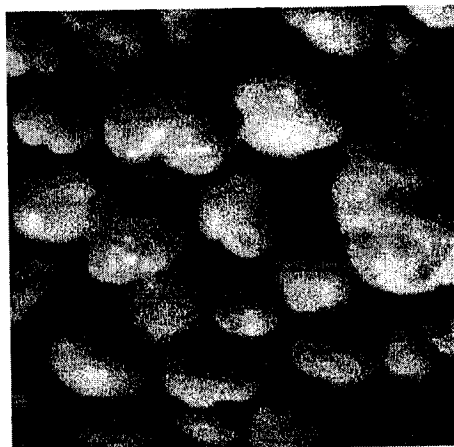
(c) Write VRML code to produce a model similar to the glass-topped table pictured below. Note that the most useful VRML nodes are summarised on the final page of this exam paper.



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**Q.3.** (a) What is meant by histogram manipulation? What is it used for? In your answer, refer to circumstances where two different types of histogram manipulation would be beneficial. Present an algorithm for histogram equalisation.

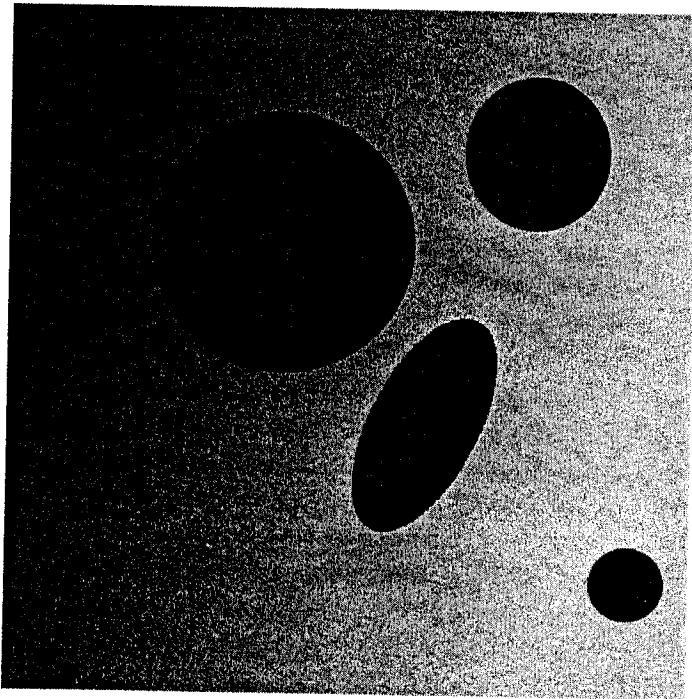
(b) Briefly outline a set of image processing procedures that should successfully count the number of distinct objects in a scene such as the one below.



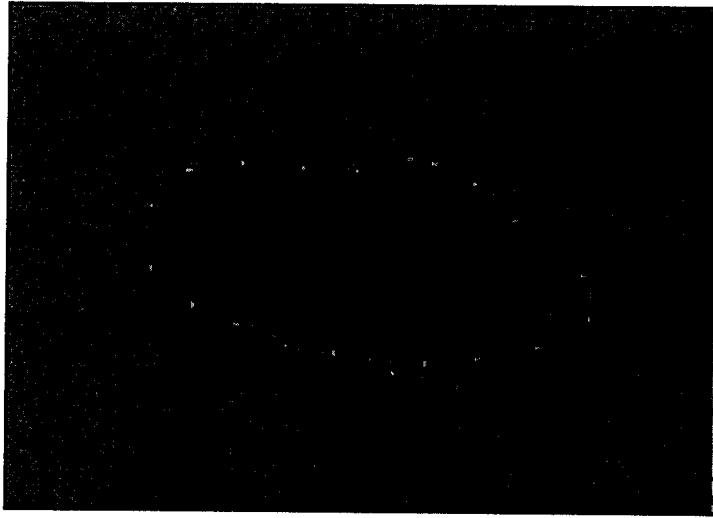
**Q.4.** (a) Describe the morphological processes of erosion and dilation. Compare the four operations (i) opening, (ii) closing, (iii) thinning and (iv) thickening. When might each of these four operations be useful?

(b) Present a suitable and robust set of image processing algorithms to be used in an industrial vision system, for identifying, measuring and classifying “apples” and “pears” in images like the one shown below. The system should be able to fully automatically:

- Cope with a gradient in the image background and noise
- Identify and count apples (fairly circular objects)
- Identify and count pears (fairly elongated oval objects)
- Estimate their sizes (in pixels) as accurately as possible



**Q.5.** (a) (i) Discuss the image processing technique called active contours. (ii) Present a suitable set of optimisation constraints (sometimes called energy factors) for accurately tracing the outline of a bubble such as the one shown below, using active contours.



(b) The image below was produced using a wide-angle lens. Describe how geometric rectification (often called decalibration) could be applied to this image in order to produce a geometrically un-distorted output image.

