1. What is meant by the term *aliasing*? *The appearance of one frequency as another, lower frequency.*

   Show how aliasing can arise in

   (a) a static picture (spatial aliasing)

   (b) a moving picture (temporal aliasing)

   Static picture. Spatial frequency (such as a chess board) undersampled. Undersampling arises when the pixel-decided sampling rate drops below one sample per square on the board.

   Moving picture. Rotating object with a regular pattern, such as a wagon wheel. Undersampling occurs when the frame-rate determined sampling rate is less than the angle of rotation within the frame, from one instance of the pattern (wheel spoke) to another.

   Outline how to reduce the effect of aliasing for

   (a) a static picture

   (b) a moving picture

   Static picture. Area sampling, explained.

   Moving picture. Need to average the contribution within the time interval. Summarise the principles of Cook's method.

   State the Nyquist Sampling Theorem, and say what this means in terms of the resolution needed to display a picture adequately.

   A sampled frequency can be accurately reconstructed iff the sample rate is at least double that frequency.

2. Describe in detail each of the following lighting models

   (a) specular reflection

   (b) diffuse reflection

   (c) ambient lighting

(a) Straight from notes. Key points are the directionality and the independence of surface colour.

(b) Straight from notes. Key points are surface colour and uniform scattering asumption.

(c) Straight from notes. Key points are assumption of a constant amount to be added, to simulate contribution from scattered light in the environment; and the reduction in contrast, helpful for objects facing away from light sources.

Show how

   (a) constant shading

   (b) Gouraud shading

   (c) Phong shading

are computed, and give their strengths and weaknesses.

(a) Straight from notes. Simple and Fast. Reveals polygonal facets.

(b) Straight from notes. Fast. Shows the curvature of the surface.

(c) Straight from notes. Shows highlights. Slower.

Outline two methods for adding surface detail to a model.

Straight from Notes. Texture mapping, bump mapping etc

3. Outline three kinds of data structure suitable for implementing a mesh surface model. Describe the problems of each.

(Variations no longer covered.)

Give details of an algorithm to remove hidden surfaces suitable for a mesh surface being output to a raster scan display.

Scan-line method, as described in the notes. Basically compute left and right intersections of each triangle with the scan line. Can assume that spans in between have the same ordering; hence compute 3D depth information only at these intersections. Note that the method fits well with Gouraud/Phong shaders.

Describe a hardware technique that can be used to help solve the hidden surface problem.
z-buffer. Have an image memory and a depth (z) buffer. Render each triangle. Check the depth of each pixel against the depth in the z-buffer. Update the image buffer iff the new triangle is closer at that pixel. Fast (because of hardware support: every triangle has to be fully rendered, unlike with scan-line methods.)

4. Define the term *radiosity.*

energy emitted per unit area per unit time.

Give an overview of the basic radiosity method (you need not go into the details of the computation of form-factors).

Divide the surfaces into (large-ish) patches, initially assumed to have constant radiosity. Assume energy equilibrium. Calculate the radiosity of one patch by considering the contributions received from all other patches, including light-source patches. Gives one equation in terms of all other patches in the system. Produce a set of simulataneous equations, one for each patch. Solve by numerical approximation technique. Now have the radiosity of each patch in the model. Choose a viewpoint/direction. Render the view by Gouraud shading the patches.

Compare radiosity to ray-tracing as a method of rendering pictures.

Basic differences are: (for radiosity) physical modelling of the light is better, in particular surface-to-surface interactions; very heavy calculation to solve the radiosity equations; fast to render each view. Ray-tracing has the converse properties though it is still not a fast rendering method, even with techniques to assist with finding ray/surface intersection.

5. Make notes on each of the following:

   (a) the human eye's response to colour
   (b) the CIE chromaticity diagram
   (c) the CMY and CMYK colour model
   (d) the HSV colour model

   All in the notes.

   (a) Consider the 3-colour model of vision

   (b) Draw the diagram and explain it.

   (c) Additive colour explained.

   (d) Explain what it is and its virtue as more user-understandable.

   How do colour displays take advantage of the human eye?

   Primary answer is that they exploit the 3-colour model. That is, colours which have a certain 3-colour stimulus are indistinguishable.