1. (a) Distinguish between real-time and off-line computer graphics. How does computer graphics exploit human visual capabilities to achieve visual realism? [4]

   (b) What are the principal elements of a graphics system and what are the roles of an application model and a graphics kernel? [4]

   (c) What is meant by rasterization? Explain why standard frame-buffers store colour, transparency and depth information. [7]

   (d) i. Specify the 3D rotation matrix that rotates points about the z-axis by θ degrees.

   ii. Specify the rotation matrix that takes the negative z-axis onto the positive z-axis.

   iii. Give the set of rotations required to rotate a point about an arbitrary axis $(a, b, c)^T$ which passes through the origin.

   iv. What further homogeneous transformations would be required if the arbitrary axis in (iii) passed through a point (e, f, g) instead of the origin?

   Give a set of OpenGL transformation statements which implements a rotation of θ degrees, about axis $(a, b, c)^T$ which passes through point (e, f, g).

   [10]