Please read the following instructions carefully:

1. Answer one question in Section A.
2. Answer all questions in Section B.
3. Use diagrams where necessary to assist in your explanations.
4. Non-programmable calculators are allowed.
5. This paper consists of 2 pages.
Section A

Question 1
Answer only one part. Either Matrix or Quaternion

(a) Matrix
Construct a matrix to rotate 300° (clockwise) around the axis specified by
(8, 4, 3) → (9, 8, 3)
Rotate the point (6, 15, 7) around this axis.

(b) Quaternion
Construct a quaternion to rotate 300° (clockwise) about the axis (1, 4, 0).
Use the quaternion to rotate (−2, 11, 4) around this axis.

Section B

Question 2
Write down the Phong lighting equation for a single colour light source and object (black and white model).
Now calculate the viewed intensity of a point on an object given the following attributes:

- The object is not emissive at all.
- The ambient light intensity is 0.9.
- The object has an ambient coefficient of 0.25.
- The object has a diffuse reflection coefficient of 0.3.
- The object has a specular reflection coefficient of 0.45.
- The shininess (specular highlight) factor is 25.
- The intensity of the incoming light (both specular and diffuse) is 0.7.
- The point we are considering is (15, 12, 4).
- The normal at the surface is (0.48, 0.64, 0.6).
- The light is positioned at (20, 20, 20).
- The viewer is positioned at (10, 7, 13).
Question 3
Derive the endpoints of a Bézier curve.

Question 4
Write down pseudocode for the Bresenham line drawing algorithm. Explain why the algorithm is efficient and the reasoning behind the algorithm.

You need only discuss the case where the line lies in the first quadrant, and the gradient of the line is less than 1.

Question 5
Provide a short discussion which contrasts loop subdivision surfaces and $\sqrt{3}$ subdivision surfaces.

Question 6
Explain how sphere tracing can be used to construct CSG objects.

Question 7
Provide a brief discussion on one of the following:

- Screen-Space Ambient Occlusion
- Deferred Rendering

Question 8
You are required build an interactive walkthrough of the University of Johannesburg, both indoor and outdoor scenes. Describe which advanced lighting techniques (such as radiosity, photon mapping, ambient occlusion etc.) you will select to render the scene. Explain the techniques you have selected and refer to the performance and/or quality of the selected techniques. Your explanation must provide sufficient detail concerning how the algorithms are implemented to justify any comments concerning performance and/or quality.