1. (a) Describe in detail, the scan-line polygon fill algorithm for concave polygons. Include in your answer descriptions of all the structures used and methods of dealing with special cases such as vertices and horizontal edges. 

   [20 marks]

(b) Describe how and why you would optimise the algorithm in (a) if you wanted to cater for simple polygons only. 

   [10 marks]

(c) What is clipping and what is it used for? Describe the Sutherland-Hodgeman polygon algorithm. Include in your answer an example demonstrating the different stages of the algorithm. What are the limitations of the Sutherland-Hodgeman polygon clipping algorithm? 

   [20 marks]

2. (a) Given a line with gradient \( m \) such that \( 0 \leq m \leq 1 \), explain how you would derive the equations used in Pitteway’s midpoint line drawing algorithm. 

   [10 marks]

(b) Describe the midpoint line algorithm using pseudo code. 

   [10 marks]
(c) Describe Wu and Rokne’s double step midpoint line drawing algorithm and explain how it can be modified to display antialiased lines. 

[10 marks]

(d) The parametric polar equation of an ellipse is:

\[
\begin{align*}
x &= x_c + r_x \cos \theta \\
y &= y_c + r_y \sin \theta
\end{align*}
\]

where \(x_c\) and \(y_c\) represent the centre of the circle and \(r_x\) and \(r_y\) represent the semimajor and semiminor axes respectively. Using the above equations, present a routine that efficiently scan converts an ellipse, given the centre points and semimajor and semiminor axes as parameters.

[10 marks]

(e) What is the 2D viewing pipeline? Describe briefly each of the steps of the 2D viewing pipeline.

[10 marks]

3 (a) Briefly describe the differences between parallel, oblique and perspective projections.

[5 marks]

(b) Describe the transformations required to perform a normalised perspective projection.

[15 marks]

(c) Consider writing an animation which rotates two similar objects about their central point, along the \(z\)-axis. Assume that each object’s model co-ordinates are loaded from the same single 3D object file. The first object is to be rotated at the centre of the scene and the other object is to be placed at world co-ordinates \((20, 0, 0)\). Assume the camera is placed at world co-ordinates \((0, 0, 8)\) and the direction of the camera is along the negative \(z\)-axis in a right handed system. Describe the transformations required to display the entire scene. Moreover, describe, by means of pseudo code, how the scene would be animated.

[30 marks]