UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2021/2022

COURSE NAME	:	COMPUTER GRAPHICS
COURSE CODE	:	BIM 20603
PROGRAMME CODE	:	BIM
EXAMINATION DATE	:	JANUARY / FEBRUARY 2022
DURATION	:	3 HOURS
INSTRUCTION	:	1. ANSWER **ALL** QUESTIONS.
		2. THIS FINAL EXAMINATION IS CONDUCTED ONLINE AND OPEN BOOK.

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

Q1　(a)　Creating realistic 3D objects in computer graphics require conformation to the mathematics and physics rules of real-world. 3D objects must also contain sufficient information about their geometry and surface properties. Describe creation of realistic 3D objects with respect to the property of surface texture.

(8 marks)

(b)　Illustrate **TWO (2)** of the most common projection types. Your illustrations should include fundamental elements of the projection with their respective labels.

(4 marks)

(c)　In your own terms, why oblique and orthographic projections are necessary for 2D and 3D drawings?

(4 marks)

(d)　'Scene Graph' is a method in computer graphics to simplify monotonous designing tasks by grouping complex objects in a hierarchical data structure. You are required to build a simulation of a moving drone. The drone consists of main body frame, processing unit, lights, camera and four propellers. Construct a scene graph to represent this drone. Your answer must be demonstrated in a hierarchical form and have correct root, leaf and intermediate nodes and correct parent-child node relationship.

(6 marks)

Q2　(a)　What are differences between techniques in spatial partitioning?

(6 marks)

(b)　You are required to design a symmetrical rocket via combination of primitive objects of two cones, a cylinder and a hemisphere by using revolve spline-based technique.

(i)　Based on information above, draw a 2D curve that equivalent to the required shape using the proposed technique.

(3 marks)

(ii)　Complete your spline in **Q2(b)(i)** to unleash its full 3D form.

(3 marks)

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(iii) Name the substantially simpler alternative technique to design the final object as in **Q2(b)(ii)**.

(2 marks)

(c) In 2D and 3D graphics, vector is used to define both the magnitude and scalar of vertices. These information are useful to extract features and for further analyses within an image.

(i) Write vector V in component and equation forms if D and E are $(7,10)$ and $(-3,-4)$, respectively. Next, compute both magnitude and direction of $V = \overrightarrow{DE}$.

(6 marks)

(ii) Points D and E are now transformed into a 3D space, with z-coordinates of D and E are 9 and -3, respectively. Calculate the transformed vector V (in component form), its magnitude and direction.

(5 marks)

(iii) Given 3D vectors of $S = (-17,-54,23)$ and $T = (46,85,-62)$. Find the cross product of $\overrightarrow{U}$.

(4 marks)

Q3 (a) **Figure Q3(a)** demonstrates an input polygon and a clip window of a 2D object design. Illustrate both the output polygon and clipped regions of this input image.
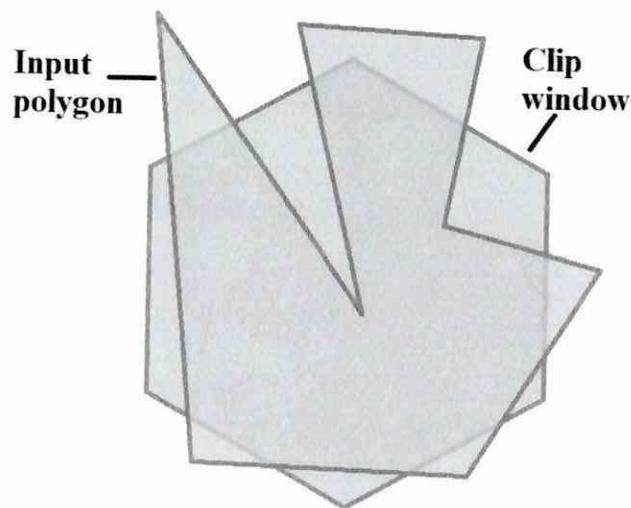

Figure Q3(a)

(6 marks)

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(b)   Most first person-based digital games in the late 90's rendered their graphic objects within the viewing volume of the player via perspective and orthographic projections. In your own terms, describe how these situations are not ideal for exhibiting output graphics?

(4 marks)

(c)   **Figure Q3(c)** shows two polygons (A and B) with their corresponding z-values of the coordinate. Determine the output result when z-buffer method is applied to these objects.
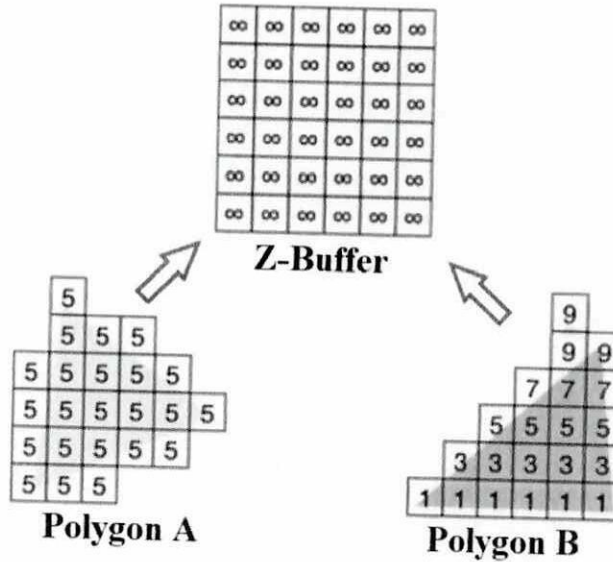

Figure Q3(c)

(6 marks)

(d)   Given a 3D scene as illustrated in **Figure Q3(d)**, write pseudocodes to represent an algorithm to fill in the correct pixel colors to the polygon surfaces when dealing with the overlapping objects in 3D space.
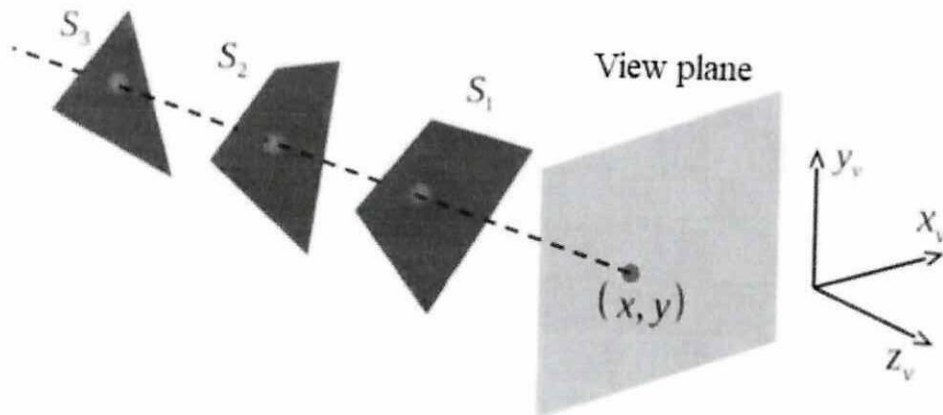

Figure Q3(d)

(8 marks)

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(e) **Figure Q3(e)** shows a camera and an octahedron, in their fixed position and orientation. With the provided vertex points, interpret how to detect the visibility status of all surfaces of this object using the front-end culling procedure.
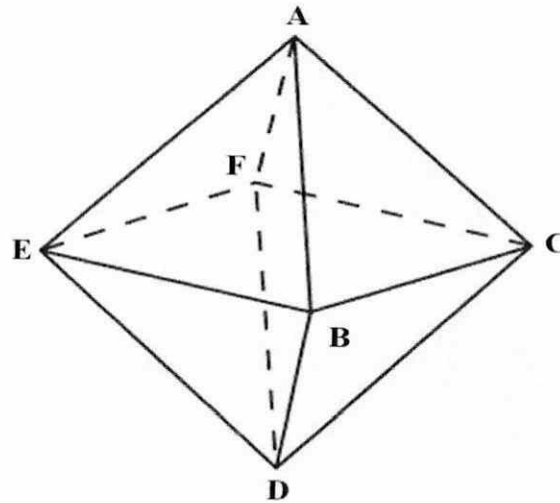

Figure Q3(e)

(4 marks)

Q4 For most materials, majority of the light that is not absorbed is reflected from the surface, and thus a material's surface reflectance properties are surely some of its most important optical attributes. This process is what we known as light transportation and contributes to what we visually perceive. Computer graphics, on the other hand, uses a simplification of accurate physical models to simulate reality to a certain extent.

(a) Discuss bump, displacement and reflection mappings. You may use diagrams, figures and equations to support your answer.

(9 marks)

(b) Lighting a 3D model in CodeBlocks/OpenGL requires a function with specific coding lines for initializing 3D rendering. Write down this dedicated function with its respective coding lines. Support your answer with comments, however and whenever necessary.

(7 marks)

- END OF QUESTIONS -

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