Date: 11/10/2020

AHSANULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Department of Computer Science and Engineering
Program: B.Sc. in Computer Science and Engineering
Semester Final Examination, Fall-2019

Part A

Year: 4th **Course No: CSE4203**

Semester: 2nd **Course Name: Computer Graphics**

Time: 2 (Two) hours **Full marks: 40**

Use Single answer script

Instructions:	i)	Answer script should be hand written and should be written in A4 white paper. You must submit the hard copy of this answer script to the Department when the university reopens.
	ii)	Write down Student ID, Course number, and put your signature on top of every single page of the answer script
	iii)	Write down page number at the bottom of every page of the answer script.
	iv)	Upload the scan copy of your answer script in PDF format at the respective site of the course at **google classroom** using institutional email within the allocated time. Uploading clear and readable scan copy is your responsibility and must be covered the full page of your answer script.
	v)	You must avoid **plagiarism,** maintain **academic integrity, and ethics**. You are not allowed to take any help from another individual and if taken so can result in stern disciplinary actions from the university authority

Part A

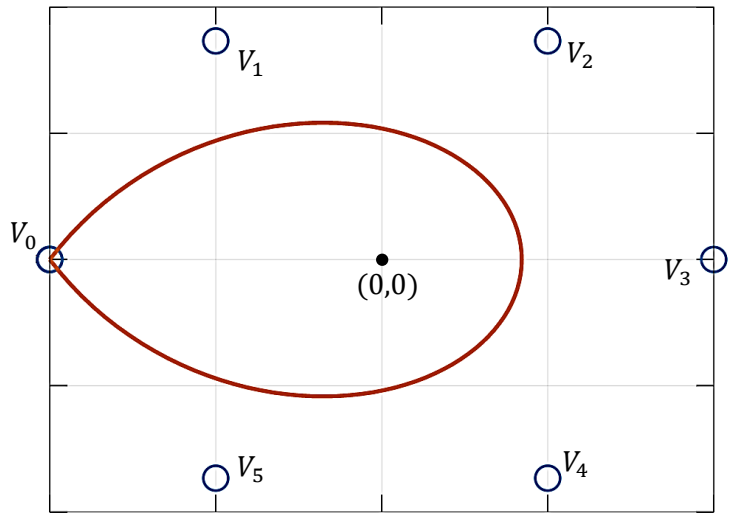
Instructions:	i)	Before uploading rename the PDF file as **CourseNo_StudentID_PartNo** e.g.Math2207_180107001_partA.pdf
	ii)	There are **5 (Five) Questions, Answer any 4 (Four)**
	iii)	Marks allotted are indicated in the **right margin**
	iv)	Necessary **charts/tables** are attached at the end of the question paper
	v)	Assume any reasonable data if needed
	vi)	Symbols and characters have their usual meaning

Question 1. [Marks: 10]		
	AB is a line in 3D space where the points A and B are $(1, 1, -1)$ and $(3, 2, -2)$ respectively. Suppose we transformed AB to $A'B'$ such that $A'B'$ coincides with X-axis and the point A' is located at $(1, 0, 0)$. What are the coordinates of point B'?	
Question 2. [Marks: 10]		
a)	Suppose we have four pixels which are $P_0(5, 7), P_1(8, 12), P_2(5, 12)$, and $P_3(7, 8)$ on a raster plane. Will there be any common pixel(s) if we rasterize two distinct lines from P_0 to P_1, and from P_2 to P_3 respectively? If yes, determine the coordinates of the common pixel(s). Show your calculations and plot the lines.	**[7]**
b)	Why perspective projection is a non-affine transformation? Show that, the $(3, 3)$ and $(3, 4)$ entries of the 3D perceptive matrix are $(n + f)$ and $-nf$ respectively where n and f are the distance of the near and far clipping plane from the origin respectively. Note that (i, j) entry of a matrix stands for its i^{th} row and j^{th} column.	**[3]**
Question 3. [Marks: 10]		
a)	Consider a clipping rectangle which has width and height of 10 and 7 units respectively. Its lower left corner is located at $(3, 1)$. Also consider a line which has a starting point at $(1, 2)$, length = 20 units, and slope = 1. Determine all the line-edge intersecting points (if any) with respect to the clipping rectangle using Cyrus-Beck algorithm. Show your steps and calculations (assume any necessary data).	**[8]**
b)	Show that, in case of midpoint line drawing algorithm, we can successively update the decision variable by adding $(y_1 - x_1) - (y_0 - x_0)$ for each selection of a northeast pixel. Here, (x_0, y_0) and (x_1, y_1) are two endpoints of the line.	**[2]**

Question 4. [Marks: 10]

a) A 2D Bezier curve Q is situated inside a regular hexagon $V_0V_1V_2V_3V_4V_5$ (see the following figure). The control points are chosen from the vertices of the hexagon. If Q has the same starting and ending point V_0, what are the coordinates at $Q\left(\frac{1}{2}\right)$? Given that, the vertices V_0, V_1 and V_2 are $(-1,0), (-1,\frac{\sqrt{3}}{2})$ and $(1,\frac{\sqrt{3}}{2})$ respectively. **[5]**

Hint: a regular hexagon has symmetric property.



b) Assume, $ABCD$ is a 2D rectangle and the vertices are $A(1,1), B(7,1), C(7,7)$, and $D(1,7)$. Introduce shear on $ABCD$ to obtain $A'B'C'D'$ such that $A'D'$ and $B'C'$ both create 45 degree with X-axis. Determine the composite transformation matrix to perform this task. Perform all the multiplications and plot $A'B'C'D'$. **[5]**

Question 5. [Marks: 10]

a) Consider the following parameters for an orthographic ray-tracing. **[7]**

Camera frame: the viewpoint $\boldsymbol{e}$ is $(5, 0, 0)$, and the viewing direction is downward.
Image plane: $l = -10, r = 10, t = 10, b = -10$
Raster image resolution: 10×10
Sphere: centered at $\boldsymbol{e}$ with a radius of 7 units.

Determine the ray-sphere intersection points (if any) for a ray (with length=10 units) originated at $(5, 5)$ pixel on the raster screen. Which of the two intersecting points is valid to be visible from $\boldsymbol{e}$?

b) What is the importance of barycentric coordinate system? Discuss the mechanism to determine a point P's barycentric coordinates (α, β, γ) based on a given triangle's cartesian coordinates of its vertices (V_1, V_2, V_3) with appropriate example. **[3]**

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AHSANULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Department of Computer Science and Engineering
Program: B.Sc. in Mechanical Engineering
Semester Final Examination, Fall-2019

Part-B (Open book exam)

Year: 4th **Course No: CSE4203**

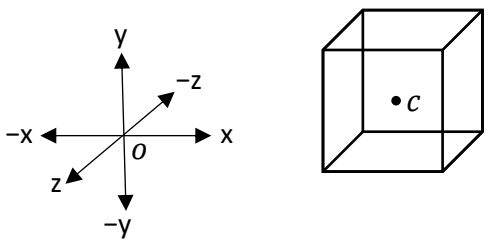
Semester: 2nd **Course Name: Computer Graphics**

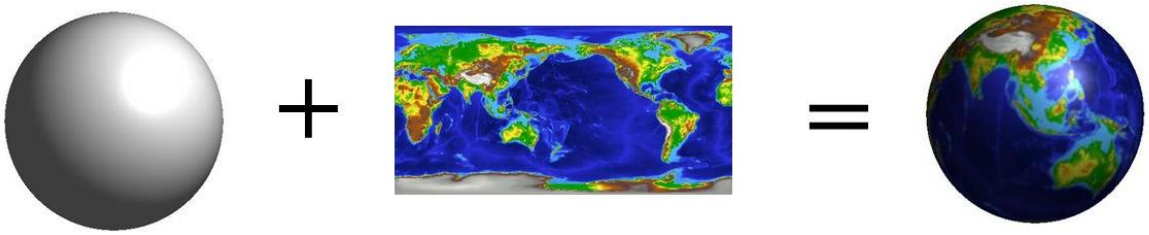
Submission deadline: Next day 6.30 pm **Full marks: 20**

Use Single answer script

Instructions:	i)	Before uploading rename the PDF file as **CourseNo_StudentID_PartNo** e.g.Math2207_180107001_partB.pdf
	ii)	**Answer all the Questions**
	iii)	Marks allotted are indicated in the **right margin**
	iv)	Necessary **charts/tables** are attached at the end of the question paper
	v)	Assume any reasonable data if needed
	vi)	Symbols and characters have their usual meaning

Question 1. [Marks: 10]

a)	Suppose we have a 3D cube having edges of 10 units each and is situated in the canonical coordinate system (see the following figure). The center of the cube is placed at $C(0, 0, -20)$. The eye of a camera frame is placed on one of the upper right corners of the cube which is nearest to origin $O(0, 0, 0)$. What are the coordinates of the cube's center point with respect to the camera frame if the eye looks at it? Explain your solution elaborately. 	**[4]**

b)	Considering the same scenario described in *PART-B question no. 1(a)*, if the camera changes its viewing directions to the other seven corners of the square for seven individual times, calculate their coordinates with respect to the frame. Explain your solution elaborately for seven individual cases.	**[6]**
Question 2. [Marks: 10]		
a)	Propose a method to rasterize an ellipse centered at $(4, 2)$ with major and minor axis of length 6 and 3 units respectively. You must utilize the concepts of midpoint circle drawing algorithms and linear transformations. Show your calculations and plot the pixels of the ellipse based on your proposed method.	**[6]**
b)	Suppose we have a texture of a world map (figure – ii) and we want to apply texture mapping on a 3D sphere or globe (figure – i). Figure – (iii) shows the output. Present a method to perform this task. Your answer must include the technique of achieving the 3D vertices of the globe's mesh, and your algorithm to perform UV mapping. You do not need to show any calculations using numerical values.  *(i) 3D sphere (globe)* *(ii) texture* *(iii) output of the texture mapping*	**[4]**