Department of Computer Science and Engineering
BRAC University

Set B

Examination: Semester Final
Duration: 1 hour 45 minutes

Semester: Spring 2025
Full Marks: 40

CSE 423: Computer Graphics

Name:	ID:	Section:

[Answer the following questions. Understanding the questions is part of your examination. So, do not ask for any clarification of the questions.]

Question 1 [CO2]

a. Rachel, a game developer, is customizing magical glow effects in a fantasy game using a shader editor that supports both HSL and HSV color models. She notices that while the same Hue value gives similar colors in both, adjusting Saturation and Lightness/Value produces different results. **Create** a labeled diagram that visually represents the **HSL** color model. **Describe** the key differences between **HSL** and **HSV** in how they define and control color. Additionally, **identify** whether the HSL and HSV color models use the same formula for calculating Hue. **[1+2+1]**

b. In a 3D modeling software, Rachel is applying color to a rectangular panel. The rectangle is defined by the vertices A(−400, 500), B(400, 500), C(400, 300), and D(−400, 300). Let point P be the centroid of the rectangle. The color at vertex A is specified using the **HSV** color model with values (45°, 0.8, 0.9), and the color at vertex C is defined in the **CMY** model with values (0.3, 0.4, 0.2). Using **Gouraud shading**, **compute** the interpolated color at point **P** and **express** the result in the **RGB** color model. **[6]**

Question 2 [CO3]

a. Matt Murdock is on a mission and hides behind his **glossy red sports car** at night. An enemy is nearby, and the only light source is an **orange** streetlamp. To spot the enemy without revealing his position, Matt considers using one of three small mirrors with shininess values of **1, 20, and 50**. He also notices that parts of his red car appear to have **orange highlights** under the street lamp. **Which mirror** should Matt use to best locate the enemy? **Justify** your choice using Phong's reflection model. In addition, **state** the reason why the red car displays orange highlights under the orange street lamp. **[2+2]**

b. Matt Murdock is now designing the lighting for a 3D simulation inside a small room, with the **xy** plane acting as the floor. A perfect **sphere** with a radius of **1 unit** and shininess **5** is placed in the room with its center at (4, 5, 5). To give an 80s feel, he decides to use only **grayscale** light sources. He placed a **backlight** at (0, 8, 8) with source intensity 0.9, diffuse coefficient 0.5, and specular coefficient 0.6. Matt is also trying to place a **floor light** at (4, 2, 3) with source intensity 0.8, diffuse

coefficient 0.4, and specular coefficient 0.7. All sources have a sphere of influence of 5 units. The ambient light intensity and coefficient are **both** 0.4. Can you help Matt by **calculating** the total reflected light intensity at the **very topmost point of the sphere**, if he places the camera at the point (6, 3, 7)? Use the Phong Reflection Model to **calculate** this intensity. **[6]**

[Hint. Calculate the attenuation factor first.]

Question 3 [CO2]

a. A designer is creating a technical drawing of a mechanical part. In the drawing, the front face of the object is shown in true shape and size, while the depth is represented along lines receding at 45° to the horizontal, and the depth dimensions are kept at full scale. **Identify** which type of parallel projection is being used, and **justify** your answer with **two** characteristics of this projection type. **What** would change in the drawing if the depth axis were scaled to half its actual length? **[3+2]**

b. While studying late at night for the CSE423 final, you realize it is gently raining outside through your glass window. The window is standing at **z = -250**. You look through the window down at a flower shop across the street, where a flower, for its unique colour, catches your attention. If a line segment is drawn starting from one side of the shop, **(100, 100, -350)**, and ending at the other side **(500, 80, -350)**, the flower's position, **P**, falls on this line segment's **80%** of the way. From where you are standing, the x and y coordinates of your eye are **(60, 200)**. The **z distance** between you and the glass window is **1/5th** of the **z** distance between the window and the flower. Find the flower's projected coordinate, **P'**, on the window. **[5]**

Question 4 [CO1]

a. A point on the **Bézier** curve is given by the equation: $s = r1 + t(r2 - r1)$. From this equation, **derive** the ***basis*** matrix of the Bézier curve. **[4]**

b. You are going to draw an **enclosed** boundary using **3 cubic Bézier** curves joined together to form a **single smooth composite curve**. You have already decided upon the control points for the **first** and **second** Bézier curves. Coordinates of the First Bézier curve (Curve P): $\mathbf{P_0}$ (0, 0), $\mathbf{P_1}$ (2, 3), $\mathbf{P_2}$ (4, 3), $\mathbf{P_3}$ (6, 0), and the Second Bézier curve (Curve Q): $\mathbf{Q_0}$ (?, ?), $\mathbf{Q_1}$ (14, −3), $\mathbf{Q_2}$ (16, −3), $\mathbf{Q_3}$ (18, 0)

You want to insert the last Bézier curve (**Curve R**) between them such that the entire 3-curve segment is $\mathbf{C^1}$ continuous. **Evaluate** the **first** control point $\mathbf{Q_0}$ of the **Second** Bezier curve and the 4 control points- $\mathbf{R_0}$, $\mathbf{R_1}$, $\mathbf{R_2}$, $\mathbf{R_3}$ of the **last** Bézier curve (Curve R). **[6]**

********** **The End** **********