REG.NO.:

VIT

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

SCHOOL OF COMPUTER SCIENCE AND ENGINEERING
CONTINUOUS ASSESSMENT TEST - II
WINTER SEMESTER 2024-2025

SLOT: D1 +TD1

Programme Name & Branch	: Integrated M. Tech. (MIC & MID), CSE
Course Code and Course Name	: CSI4005 - Augmented Reality and Virtual Reality
Faculty Name(s)	: Prof. Niha K, Prof. Durgesh Kumar, Prof. Somasundaram S K
Class Number(s)	: VL2024250502145, VL2024250502149, VL202425050215
Date of Examination	: **19-March-2025**
Exam Duration	: **90 minutes** **Maximum Marks: 50**

General instruction(s):

- Answer All Questions
- M - Max mark; CO – Course Outcome; BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)
- Course Outcomes (Type the CO statements covered in this question paper. Use the CO number as per the syllabus copy)
- CO1: Understand the fundamental of AR, VR, Mixed Reality and to design a customized solution.
- C02: Familiarize on the concepts, techniques, and reporting methods of AR and VR.
- C05: Familiarize the techniques, technologies and approaches needed for developing VR applications.

Q. No	Question	M	CO	BL
1.	Virtual Reality (VR) has significantly transformed medical training and surgical simulations. Critically analyze how the fundamental components of VR (such as hardware, software, and interaction techniques) contribute to its primary features (such as immersion, presence, and interactivity) in the context of VR-based surgical training. Analyse and illustrate how have recent advancements in VR technology improved these aspects, and what key challenges must be overcome to achieve highly realistic and effective VR surgical simulations? Support your arguments with relevant examples from VR-based healthcare applications.	10	1	2
2.	A triangular surface in a 3D scene is illuminated by a point light source positioned at L (10, 15, 20). The triangle's normal vector at a vertex is N (0.5, 0.7, 0.5), and the viewer is located at V (5, 10, 15). The surface material has the following properties: Ambient reflection coefficient (K_a) = 0.2; Diffuse reflection coefficient (K_d) = 0.7; Specular reflection coefficient (K_s) = 0.5; Phong exponent (n) = 16; Light intensity (I) = 1.0 The light source emits white light with components (R = 1, G = 1, B = 1). Using the Phong shading model, compute the final intensity (I) at the vertex for the red color channel (I_r) using the equation: $I_r = I_a + I_d + I_s$ where: • Ambient Component: $\boldsymbol{I_a = K_a \cdot I}$ • Diffuse Component: $\boldsymbol{I_d = K_d \cdot I \cdot \max(0, N \cdot L)}$	10	2	3

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	• Specular Component: $I_s = K_s \cdot I \cdot \max(0, R \cdot V)^n$ where R is the reflection vector computed as: $R = 2(N \cdot L)\, N - L$ a. Calculate the diffuse and specular components using the given values. b. Compute the total intensity I_r for the red channel.			
3.	Using the pinhole camera model, establish the relationship between the size of an image formed on the retina, the distance of the object from the eye, and the focal length of the human eye. Assume that the eye behaves as an ideal pinhole camera with a known focal length f and a retinal pixel size ps. Furthermore, using this principle, solve the following problem: • The human eye has an approximate focal length of 17mm (0.017m). • The size of a single retinal photoreceptor (ps) is 4µm (4×10^{-6} m per pixel). • A person observes an object of height h = 80cm placed 2.5m away. a. Determine the size of the image (h') formed on the retina using the pinhole camera model. b. Estimate how many retinal pixels (n) the image spans on the retina. Note: Assume that the image undergoes no lens distortions or aberrations.	10	2	3
4.	In a virtual reality (VR) environment, an object is placed at an initial position P = (2, 3, 1) in homogeneous coordinates. The object undergoes the following transformations in sequence: [i.] Scaling by a factor of $S_x = 2, S_y = 1.5, S_z = 1$. [ii.] Rotation about the Z-axis by 45°. [iii.] Translation by $T_x = 3, T_y = -2, T_z = 1$. a. Compute the final position of the object after these transformations. b. If this transformed object is used in a picking operation, determine how its coordinates would be affected in a different frame of reference where the viewer's position is offset by (1, 1, 0). c. Discuss how these transformations impact user interaction in flying navigation mode within a Virtual Environment.	10	5	3
5.	Statement: In a VR-based robotic surgery simulation, precise collision detection is crucial to ensure safe interaction between virtual surgical instruments and anatomical structures. a. Analyze the trade-off between usage of spatial partitioning techniques and GPU-based collision detection in virtual surgery as per the above statement. b. How would a haptic feedback system be integrated to enhance user experience when a collision is detected in virtual surgery as per the above statement?	10	5	4

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