computer graphics:

Q: What is Computer Graphics?
A: Computer Graphics is the branch of computer science that deals with creating, manipulating, and displaying visual content such as images, animations, and special effects. It enables computers to generate visual representations of data and models. It combines hardware and software techniques to create realistic or illustrative scenes. Applications include movies, games, simulations, and design.

Basic Concepts

Q: What are the basic input and output devices used in computer graphics?
A: Input devices include keyboard, mouse, scanner, digitizer, light pen, touch panel, data glove, and voice input systems. These help in entering commands, drawings, or data into the computer. Output devices include monitors, printers, plotters, and projectors, which display or print the graphical results. Together, they enable user interaction and visualization.

Q: What is the Graphics Pipeline?
A: The graphics pipeline is the sequence of steps used to convert 3D models into 2D images on the screen. It includes stages such as modeling, transformation, lighting, clipping, and rasterization. Each stage processes data to progressively transform geometry into pixels. It is fundamental to rendering in modern GPUs.

Types of Computer Graphics

Q: What are the main types of computer graphics?
A: There are two main types: Raster Graphics and Vector Graphics. Raster graphics are pixel-based images, such as bitmaps and digital photos, which depend on resolution. Vector graphics use mathematical equations to represent shapes, lines, and curves, and can be scaled without losing quality. Both are widely used in different applications like design and animation.

Applications

Q: Mention some applications of computer graphics.
A: Computer graphics are used in CAD for engineering design, in digital art and animation for creative works, and in games and movies for realistic visuals. They also support presentations, educational tools, and scientific visualization. In research and medical fields, graphics help in visualizing complex data and simulations.

Pixel and Resolution

Q: What is a pixel?
A: A pixel, short for "picture element," is the smallest unit of a digital image or display. Each pixel represents a single color value and, when combined with many others, forms an image. The quality of an image depends on the number and arrangement of pixels. More pixels generally mean higher image clarity.

Q: What is resolution?
A: Resolution refers to the total number of pixels that make up an image or display, often expressed as

width × height (e.g., 1920×1080). Higher resolution images show more detail and smoother edges. In computer graphics, resolution affects image quality, file size, and rendering performance.

Q: What is aspect ratio?
A: Aspect ratio is the ratio of an image's width to its height, such as 16:9 or 4:3. It determines the shape and proportional dimensions of the image or screen. Maintaining the correct aspect ratio ensures images are not stretched or squashed when displayed.

Colour Models

Q: What are the main colour models used in graphics?
A: Common colour models include RGB, CMYK, and HSV/HSL. RGB (Red, Green, Blue) is used for displays where colors are created by light. CMYK (Cyan, Magenta, Yellow, Black) is used for printing. HSV/HSL represents colours in terms of hue, saturation, and value or lightness, useful for intuitive color editing.

Lighting and Shading

Q: What are the types of lighting?
A: Lighting in computer graphics simulates how light interacts with objects. The main types are ambient (overall soft light), diffuse (scattered light giving matte appearance), and specular (bright highlights from shiny surfaces). Proper lighting enhances realism and depth perception in rendered scenes.

Q: What are the types of shading?
A: Shading determines how colors and light appear on a surface. The main types are Flat Shading (one color per polygon), Gouraud Shading (smooth shading using vertex colors), and Phong Shading (calculates light per pixel for realistic highlights). Each technique balances realism and computational cost.

Rendering

Q: What is rendering?
A: Rendering is the process of generating a final 2D image from a 3D model using lighting, materials, and shading. It simulates how light interacts with objects to produce realistic visuals. Rendering can be done in real-time (games) or offline (movies). It's the final step in the graphics pipeline.

Q: What are the main rendering methods?
A: The key rendering methods are Rasterization, Ray Tracing, and Radiosity. Rasterization converts 3D objects into pixels efficiently for real-time applications. Ray tracing simulates light paths for realism, while radiosity calculates diffuse inter-reflections. Each method suits different performance and realism needs.

Q: What are the types of rendering?
A: Rendering is mainly of two types: Real-time Rendering and Offline Rendering. Real-time rendering focuses on speed and interactivity, used in games and VR. Offline rendering prioritizes high-quality visuals, used in movies and architectural visualization. The choice depends on the application requirements.

Animation

Q: What is animation in computer graphics?
A: Animation is the technique of creating the illusion of motion by displaying a sequence of images or frames in quick succession. Each frame shows a slight change in position or shape. Computer animation allows lifelike movement in films, games, and simulations using mathematical models and timing controls.

Q: What are the main animation techniques?
A: Common animation techniques include Keyframe Animation, Tweening, and Physics-based Animation. Keyframe animation defines important frames manually, while tweening automatically generates intermediate frames. Physics-based animation uses real-world physics for realistic motion, like gravity or collisions.

Major Areas

Q: What are the major areas of computer graphics?
A: The major areas include 2D Graphics, 3D Graphics, and Image Processing. 2D graphics involve drawing charts, diagrams, and GUIs. 3D graphics include modeling, texturing, and rendering of 3D objects. Image processing focuses on analyzing and enhancing digital images for clarity or recognition.

Graphics Software

Q: What are general and special-purpose graphics packages?
A: General-purpose packages like OpenGL or DirectX provide a broad set of drawing and rendering functions for creating diverse graphics applications. Special-purpose packages are designed for specific fields such as CAD, medical visualization, or business graphics. These tools simplify specialized tasks and improve productivity.

CAD (Computer-Aided Design)

Q: What is CAD?
A: Computer-Aided Design (CAD) uses computer systems to assist in creating, modifying, analyzing, and optimizing design models. It allows engineers and architects to produce precise technical drawings. CAD enhances productivity, accuracy, and visualization in mechanical, civil, and electrical design work.

Q: What is NURBS?
A: NURBS (Non-Uniform Rational B-Splines) are mathematical representations used for creating smooth and precise curves and surfaces. They are widely used in industries like automotive and aerospace design. NURBS offer flexibility and accuracy for complex 3D modeling.

Visualization

Q: What is visualization?
A: Visualization is the process of converting complex or abstract data into graphical form for easier interpretation. It uses shapes, colors, and dimensions to represent variables. For example, bar height can show quantity, color can indicate temperature, and 3D geometry can display molecular structures or terrains.

Virtual Reality (VR)

Q: What is Virtual Reality?
A: Virtual Reality is a computer-generated 3D environment that simulates real or imaginary worlds. Users can interact with these environments using devices like VR headsets and controllers. VR provides immersive experiences used in gaming, education, training, and simulations.

Raster Graphics Systems

Q: What is a raster system?
A: A raster system represents images as a grid of pixels stored in a frame buffer. Each pixel contains color and intensity information. The display refreshes these pixels rapidly to form an image. This method is common in monitors and digital image systems.

Q: What is a fixed frame buffer?
A: A fixed frame buffer is a dedicated memory space used to store pixel data for the image currently displayed. The video controller reads this buffer to update the screen continuously. It ensures stable and smooth image display in raster graphics systems.

Polygon and Polygonal Mesh

Q: What is a polygon in 3D modeling?
A: A polygon is a flat, closed shape made up of straight edges (usually triangles or quadrilaterals) used in 3D modeling. Polygons are the building blocks of 3D surfaces. They are simple to process, easy to render, and widely supported in modeling formats.

Q: What is a polygonal mesh?
A: A polygonal mesh is a collection of vertices, edges, and faces connected to form a 3D object's surface. It efficiently represents complex shapes. Advantages include fast rendering, easy editing, and compatibility with formats like .obj, .fbx, and .glTF.

Projection Models

Q: What are the main types of projection models?
A: The two main projection models are Parallel and Perspective Projection. Parallel projection maintains object size regardless of depth, ideal for technical drawings and CAD. Perspective projection simulates how objects appear smaller with distance, giving realistic depth for games and movies.

Affine Transformations

Q: What are affine transformations?
A: Affine transformations are geometric transformations that preserve lines and parallelism of shapes. They include translation, rotation, and scaling. These operations are used to move, resize, or orient objects in both 2D and 3D spaces without distortion.

Ray Tracing

Q: What is ray tracing?
A: Ray tracing is a rendering technique that simulates the path of light rays as they interact with

objects. The process includes ray generation, intersection testing, and shading for reflection, refraction, and shadows. It produces highly realistic images used in visual effects, design, and simulation.

Visibility and Occlusion

Q: What is visibility?
A: Visibility determines which parts of a 3D object are visible from a particular viewpoint or camera. It helps the rendering system avoid drawing hidden surfaces. Efficient visibility algorithms improve performance and visual accuracy.

Q: What is occlusion?
A: Occlusion occurs when one object blocks another from the viewer's sight. Handling occlusion correctly ensures realistic scene rendering. It is crucial for depth testing and correct layering in 3D graphics.

Q: What is ambient occlusion?
A: Ambient occlusion is a shading method that simulates soft shadows in corners, creases, and contact areas. It approximates how ambient light is blocked in tight spaces, enhancing depth and realism in scenes without full global illumination.

Differences between Vector and Raster Graphics:

Raster Graphics	Vector Graphics
They are composed of pixels.	They are composed of paths.
In Raster Graphics, refresh process is independent of the complexity of the image.	Vector displays flicker when the number of primitives in the image become too large.
Graphic primitives are specified in terms of end points and must be scan converted into corresponding pixels.	Scan conversion is not required.
Raster graphics can draw mathematical curves, polygons and boundaries of curved primitives only by pixel approximation.	Vector graphics draw continuous and smooth lines.
Raster graphics cost less.	Vector graphics cost more as compared to raster graphics.
They occupy more space which depends on image quality.	They occupy less space.
File extensions: .BMP, .TIF, .GIF, .JPG	File Extensions: .SVG, .EPS, .PDF, .AI, .DXF

Conclusion

Q: Summarize rendering and affine transformations.
A: Rendering converts 3D models into realistic 2D images using light, shading, and materials. It's the final stage of visualization in computer graphics. Affine transformations like translation, rotation, and scaling modify object positions while preserving geometry. Both are essential for creating and displaying dynamic, realistic graphics.