CG 101: Assignment #1

Due on Thursday, December 24, 2026

Question 1

Background of computer graphics: Please research the answers to the following questions:

(a) What is the purpose of computer graphics?

To encode, simulate, and communicate visual information: explaining data and concepts, designing and iterating products and spaces, creating entertainment and art, training and decision support through immersive simulation, and enabling interactive systems where visuals respond to users in real time.

(b) On which computer was the first computer graphic created?

Early vector graphics were drawn on the CRT of MIT's Whirlwind I (circa 1950), often cited as the first stored-program computer to generate a computer-controlled image; later systems like SAGE and TX-0 continued that line of work.

(c) Which film is considered the first fully computer-animated film?

Pixar and Disney's "Toy Story" (1995) is widely recognized as the first feature-length film that is entirely computer-animated.

(d) What is meant by the "uncanny valley" in the context of computer graphics? Explain this term.

The uncanny valley is the dip in human comfort and empathy that occurs when a rendered or animated character looks almost, but not perfectly, human. Small mismatches in motion, facial micro-expressions, skin shading, or eyes can trigger discomfort because the viewer's brain expects full realism but instead detects subtle errors.

Question 2

Main steps in computer graphics

(a) Name the main (abstract) steps in creating a computer graphic.

Concept and reference gathering; geometric modeling and scene layout (objects, hierarchy, cameras, lights); materials and textures; animation and simulation (if needed); rendering (visibility, shading, sampling); post-processing/compositing; output and review/iteration.

Question 2 continued on next page...

(b) What are the main processing steps in a graphics pipeline and which computa- tions take place there?

Application stage on CPU (scene update, culling, issuing draw calls); vertex processing (model/view/projection transforms, skinning, normal transforms); tessellation or geometry amplification (optional subdivision/refinement); clipping and perspective divide; rasterization (convert primitives to fragments); fragment/pixel shading (interpolate varyings, apply lighting, texturing, shading models); per-fragment tests and blending (depth, stencil, alpha, color blend); framebuffer operations and post-process passes.

Question 3

Requirements in computer graphics: Please research the answers to the following questions:

(a) Explain the difference between non-interactive and interactive computer graph- ics.

Non-interactive (offline) graphics are rendered without user control during generation—frames can take minutes or hours and maximize quality (film/VFX). Interactive graphics respond immediately to input—frame times are constrained (e.g., 16 ms for 60 fps) to maintain responsiveness (games, simulators, UI).

(b) From a computer science point of view, which requirements for computer graph- ics software systems are particularly important in order to be able to create computer graphics that are as realistic as possible? Differentiate your answers according to systems for generating non-interactive and interactive computer graphics.

For non-interactive/offline: physically based shading and global illumination; high-precision math; large memory and storage throughput; scalable parallel rendering; robust asset pipelines and versioning; sophisticated sampling/denoising for noise-free output. For interactive/real-time: strict frame budgets and low latency; level-of-detail and culling strategies; GPU-friendly data layouts; approximate-yet-plausible lighting (PBR with prebaked/probed GI, screen-space effects); temporal stability and anti-aliasing; graceful degradation under load; predictable memory and scheduling.

(c) Explain the difference between a real-time and non-real-time computer graphics.

Real-time graphics must meet per-frame deadlines (e.g., 16.7 ms at 60 Hz) so that the system can react to user input without perceptible lag. Non-real-time graphics have no such deadline; they can trade time for quality and may render frames asynchronously or in batches.

Question 3 continued on next page...

(d) In computer graphics, what is meant by "hard real time" and "soft real time"?

Hard real time: every frame must meet its deadline—missing it is a system failure (e.g., head-tracked VR at fixed refresh, safety-critical simulators). Soft real time: occasional deadline misses are tolerated with degraded quality (stutter, lowered resolution/LOD) but the system keeps running, as in most games and desktop graphics.