**The Hong Kong Polytechnic University**

**COMP4422 Computer Graphics**

**Group Project: Animated 3D Scene & Storytelling**

**(Due date: 1st Dec 2025 (Monday), 23:59)**

## 1. Project Overview

In this project, you will design and animate a 3D scene featuring animated objects that tell a compelling story through their interactions, movements, and visual effects. This project emphasizes object animation, storytelling through visual composition, and applying advanced rendering techniques to create engaging narratives. You will work in groups of three, fostering collaboration and creativity while mastering fundamental WebGL techniques.

**Sample Story Ideas:**

- A mechanical clock tower with moving gears and pendulums marking the passage of time
- A weather transformation scene showing seasons changing through environmental objects
- An underwater scene with animated coral, fish, and treasure chests
- A space journey showing planets, asteroids, and spacecraft moving through the cosmos
- A factory assembly line with conveyor belts, robotic arms, and manufactured products
- A musical performance with animated instruments playing together
- A natural phenomenon (tornado, aurora, waterfall) with dynamic environmental effects

## 2. Project Requirements

### 2.1. Task Overview

1. **Create a 3D Scene with Multiple Objects:** Develop a scene containing at least 5-8 distinct 3D objects that serve your narrative;
2. **Animate Object Interactions:** Implement animations showing objects moving, rotating, transforming, and interacting with each other in meaningful ways;
3. **Apply Visual Effects:** Enhance your scene with lighting effects, particle systems, shaders, and other visual techniques to create atmosphere and mood;
4. **Develop a Narrative:** Create a clear story or theme that emerges from the animated objects and their interactions;
5. **Technical Execution:** Apply computer graphics techniques for realistic or stylized visuals, smooth animations, and engaging viewer experience

***Bonus Opportunity (10% additional marks):*** *Implement animated 3D characters (humanoid, robot, animal, or creature) with articulated movements. This requires additional effort in hierarchical modeling and skeletal animation.*

### 2.2. Documentation and Presentation

1. **Report** (max. 20 pages), include the following content:
   - **First Page or Cover Page (Workload Declaration)**: Attach a table detailing each member's name, SID, and contributions.
   - **Story/Concept**: Describe the narrative or theme you are presenting through your animated scene. Explain how object interactions convey your story.
   - **Scene Design:** Present your 3D scene layout, explaining object placement, spatial relationships, and composition choices that support your narrative
   - **Object Models:** Showcase the 3D objects in your scene with details on modeling approaches, geometric complexity, and design rationale
   - **Visuals & Rendering Techniques:** Present images from multiple camera angles, highlighting:
     - Textures and materials applied to objects
     - Lighting techniques (ambient, directional, point lights, spotlights)
     - Shading approaches (Phong, Blinn-Phong, custom shaders)
     - Visual effects (shadows, reflections, fog, bloom)
     - Include code snippets supporting your descriptions
   - **Interactive Elements** (if applicable): Describe user interaction features such as camera controls, triggering specific animations, or manipulating objects
   - **Animation**: Detail all animated elements in your scene:
     - Object transformations (translation, rotation, scaling)
     - Timing and synchronization between objects
     - Animation techniques used (keyframe interpolation, procedural animation, physics-based motion)
     - How animations contribute to storytelling
     - Include relevant code snippets demonstrating animation implementation
   - **Discussion:** Highlight any five noteworthy technical aspects deserving evaluation. Examples:
     - Advanced shader effects (custom vertex/fragment shaders)
     - Particle system implementation
     - Hierarchical transformation systems for complex object relationships
     - Shadow mapping or lighting techniques
     - Procedural animation algorithms
     - Performance optimization strategies
     - Time-based animation synchronization
     - Physics simulation approaches
   - **Conclusion**: A 50-word summary of the project. Include a publicly accessible URL to your WebGL animation, and the URL to the presentation video.
   - **Reference** (optional): Cite any external resources, 3D models, textures, algorithms, or code libraries used.
     Warning! Don't include the whole source code in the report.

2. **Presentation**:
   - A 10-minute walkthrough of your animation, highlighting key technical achievements and storytelling elements.

### 2.3. Assessment Criteria (Total 100%)

**Part A: Implementation Requirement (60 Marks)**

You are required to use WebGL to implement the primary code for the scene and animation. Other frameworks, such as Three.js, or game engines (even those utilizing WebGL) are not permitted. However, you are allowed to use tools for creating 3D models, textures, sounds, and voiceovers.

**Basic Requirement (20%)**

**Objective:** Create a simplified solar system featuring the Sun, Earth, and Moon.

- **Object Models:** Create at least 5 distinct 3D objects with appropriate geometric detail (minimum 200 vertices per major object). Objects should have clearly defined shapes relevant to your story.
- **Basic Scene Setup:**
  - Implement a ground plane or environmental base
  - Add background elements (skybox, gradient background, or environmental backdrop)
  - Position objects thoughtfully to compose your scene
- **Basic Animation:** Implement at least 3 different types of transformations:
  - Translation (moving objects through space)
  - Rotation (spinning, orbiting, or turning objects)
  - Scaling (growing, shrinking, or pulsating objects)
- **Lighting & Shading:** Apply proper shading with at least 2 light sources (e.g., directional + point light). Use Phong or Blinn-Phong shading model
- **Texturing: Apply textures or materials to objects with appropriate mapping**
- **Camera Control:** Implement basic camera system (orbital controls or fixed cinematic view)

**Middle Level Requirement (20%)**

**Objective:** Create meaningful object interactions and enhanced visual quality.

- **Object Interaction Animation:** Implement animations where objects **interact with each other:**
  - Objects responding to other objects' movements
  - Synchronized movements showing relationships (e.g., gears turning together, planets orbiting)
  - Sequential animations creating cause-and-effect narratives
- **Hierarchical Transformations:** Use transformation hierarchies for complex object relationships (parent-child transformations enabling coordinated movements)
- **Enhanced Lighting:** Implement multiple light sources (minimum 3) with different types:

    - Proper material properties (ambient, diffuse, specular coefficients)
    - Dynamic lighting that changes during the animation
    - Appropriate light colors and intensities supporting mood
- **Visual Coherence:** Ensure all objects maintain consistent art style and contribute to the overall narrative.

**Advanced Level Requirement (20%)**

**Objective:** Apply advanced techniques to create immersive, polished experience.

- **Advanced Visual Effects (implement at least 3):**
    - Particle systems (fire, smoke, rain, snow, sparkles, magic effects)
    - Shadow techniques (shadow mapping, shadow volumes, or approximations)
    - Normal mapping or bump mapping for surface detail
    - Reflection/refraction effects (mirrors, water, glass)
    - Procedural effects (waves, ripples, deformations)
    - Post-processing (bloom, motion blur, depth of field, color grading)
    - Custom shader effects (animated textures, dissolve effects, energy fields)
    - Fog or atmospheric effects
- **Sophisticated Animation Techniques:**
    - Keyframe animation with interpolation (linear, ease-in/out, Bezier curves)
    - Procedural animation (mathematical functions creating organic motion)
    - Physics-based motion (gravity, momentum, collision response)
    - Camera cinematography (dynamic camera paths, multiple angles, smooth transitions)
- **Storytelling Excellence:**
    - Clear narrative arc with beginning, middle, and end
    - Visual storytelling through object behavior and interaction
    - Effective use of pacing, timing, and dramatic moments
    - Emotional impact or viewer engagement through visual composition
- **Interactivity (optional):**
    - User-triggered animations or scene changes
    - Interactive camera controls (fly-through, object focus)
    - Dynamic scene modifications based on user input
    - Time control (pause, speed adjustment, rewind)

**Evaluation Focus:** Technical sophistication, creative use of effects, narrative clarity, visual polish, and innovative problem-solving

**Bonus Marks (10% additional)**

- **3D Character Animation:**
    - Implement an animated 3D character (humanoid, robot, animal, or creature) with articulated body parts
    - Use hierarchical skeletal structure for realistic movement
    - Implement at least 2 distinct character animations (walking, waving, dancing, etc.)

- Character must contribute meaningfully to the story
- Properly cite if importing character models from external tools

**Part B: Report (20%) & Teamwork (5%)**

- Organization, clarity, and depth of technical analysis
- Effective communication of design rationales and storytelling decisions
- Quality of writing and explanation of CG techniques employed
- Clear code examples demonstrating key implementations
- Evidence of collaborative teamwork with balanced contributions.

**Part C: Demo Video and PPT (15%)**

- Clarity and professionalism of presentation
- Ability to convey both technical and narrative elements effectively
- Quality of demo video showcasing animation from compelling angles
- Demonstration of object interactions and visual effects
- Adherence to 10-minute time limit.

**Submission Guidelines:**

- **Submit a zip file to Blackboard, containing:**
  - Report (MS Word or PDF)
  - Presentation PPT
  - All source files (source code, shaders, libraries, textures, models, etc.)
  - README file with setup instructions and dependency information
- **The report and PPT must contain:**
  - A publicly accessible URL to your WebGL animation (GitHub Pages, personal server, or similar)
  - URL to the presentation video (YouTube, Vimeo, or similar platform)
- Each group submits ONCE through Blackboard via a designated representative/group leader
- Marks will be deducted if markers cannot access the provided URLs
- Standard late penalty policy applies. Deadline: **1st Dec 2025 (Monday), 23:59**

**4. Technical Guidelines & Resources**

**Recommended Learning Resources:**

- WebGL2 Fundamentals: https://webgl2fundamentals.org/
- WebGL Samples: https://webglsamples.org/
- MDN WebGL Tutorial: Animation and 3D object creation guides

**Appendix I: Example Cover Page**

**COMP4422 Computer Graphics – Group Project Report**

**Project Title: Dyson Sphere of Solar System**

**Group XX**

**Workload declaration table**

| Name | SID | Key tasks |
|---|---|---|
| *Chan Tai Man | S1234567d | To draw the models of the planets, … |
| John Baker | S2341234x | … |
| Happy Chan | S2341232d | … |
| … | … | … |
| | | |
| | | |

*Group leader

**Note:**

1. The above name/sid/roles/tasks are example only. You need to fill in your own information.
2. Put this form on the first/cover page of the report.
3. the key tasks do not need to be too long, they are as precise as possible. Please refer the details to the corresponding section or figures in the report.
4. You don't need to sign the declaration form. Once submitted, we assumed that every team member agreed on the report's content and the workload declaration form.

## Appendix II: the rubrics

| Criteria | Excellent (5 marks) | Good (4 marks) | Satisfactory (3 marks) | Marginal (1-2 marks) | Fail (0 marks) |
|---|---|---|---|---|---|
| **Animation, Interactivity & Visual Quality (60%)** | Highly engaging animations with smooth, coordinated object movements. Exceptional visual effects create atmosphere. Objects interact meaningfully to tell clear story. Advanced techniques expertly applied | Mostly engaging; animations functional with minor timing issues. Good visual quality with effective object interactions. Solid technical execution of effects | Adequate animations; some interactions lack clarity. Basic visual effects present. Core requirements met but limited sophistication | Limited animation quality; unclear interactions or poor execution. Minimal visual effects. Missing key requirements or poor implementation | No animations or visuals submitted |
| **Report & Analysis (20%)** | Exceptionally clear and well-structured. Demonstrates thorough understanding of CG techniques with insightful analysis. Excellent code examples and technical depth | Mostly clear; appropriate techniques applied with minor gaps. Good technical understanding shown. Adequate code examples | Somewhat organized; basic techniques explained adequately. Some technical communication issues. Limited code examples | Poor organization; minimal technical depth or unclear explanations. Very limited understanding demonstrated | No report submitted. |
| **PPT and Presentation video (15%)** | Engaging and professional delivery. Excellent cinematography showcasing | Clear and mostly engaging. Good video quality with minor | Adequate delivery; lacks engagement. Basic video quality. Some | Unclear presentation; difficult to follow. Poor video/audio quality. | No presentation given. |

| | | | | | |
|---|---|---|---|---|---|
| | animations and interactions. Clear audio, smooth pacing, compelling narrative presentation | pacing issues. Story and technical aspects conveyed well | aspects unclear or rushed | Missing key content | |
| **Teamwork (5%)** | Exceptionally collaborative; roles well-defined and balanced. Clear evidence of integrated work and equal contribution | Good collaboration; roles mostly clear with reasonable balance. Some integration evident | Some collaboration visible; roles unclear or unbalanced. Limited integration shown | Limited collaboration; unclear contributions. Poor integration or unequal workload | No teamwork evident. |
| **BONUS: Character Animation (10%)** | Sophisticated character with smooth articulated movements. Multiple animations well-integrated into story. Excellent hierarchical implementation | Good character animation with minor issues. Clear articulation and story integration | Basic character with simple movements. Some articulation but limited sophistication | Poor character animation or minimal articulation. Weak integration | Not attempted or failed implementation |
| **Max. 100 marks** | | | | | |

- End of Group Project guideline -