University of Central Lancashire UCLan Department of Computer Science	**UCLan Coursework Assessment Brief**	2022-2023
	Module Title: Computer Graphics	
	Module Code: CO2409	Level 5
	Game Entities	This assessment is worth 40% of the overall module mark

RELEASE DATES AND HAND IN DEADLINE

Assessment release date: 22nd February 2023
Assessment deadline date and time: **Saturday 29th April 2023, before 20:00**
Upload to Google Drive or similar and email a link to lsnoel@uclan.ac.uk.
Ensure the files are publicly accessible or it might be counted as late.

Please note that this is the final time you can submit – not the time to submit!
Your feedback and mark for this assessment will be provided 15 working days later.

THE BRIEF / INSTRUCTIONS

OVERVIEW

The use of shaders is a core technique used to render real-time 3D scenes. With languages such as HLSL, a programmer can transform, light and texture models exactly as they wish. The flexibility of shaders also allow for a wide range of advanced and unusual rendering effects.
You are to create a DirectX 11 program that displays 3D models using HLSL shaders. You may base your program on a lab project.

To **pass the assignment (40%-45%)** you must:

- Understand the operation of the program and extend it to demonstrate three shader techniques
- Write a short report discussing your implementation

To get further marks **(up to 85%)** you must:

- Add more advanced shaders for better lighting and other graphical effects
- Improve the architecture of the program to manage a more complex scene
- Extend the report to cover your additional implementation

Marks beyond this will be awarded for the use of more advanced techniques relevant to the module material.
This is an individual project and no group work is permitted.

STARTING POINT

You should use a lab project as a starting point for your assignment. However, you will need to use a lab that supports loading models from files (week 16 onwards).

Alternatively you can provide your own code but this is only advised for those who are very comfortable with the material.

Assignment Tasks – To Achieve a Pass

BASIC REQUIREMENTS

- Put a textured floor and teapot in a 3D scene using per-pixel lighting.
    - Models can be found in recent labs. Or source them yourself.
    - Light the models with diffuse and specular lighting from **two** point lights, calculated per-pixel.
    - One of the lights should pulsate on and off, whilst the other light should gradually change colour.
    - Include ambient light and attenuation in your lighting equations.

- Add a textured sphere model to the scene, but using different shaders:
    - The vertex shader must constantly move the **vertices** in some way to produce some kind of pulsating or "wiggle" effect
    - The pixel shader must constantly scroll the texture coordinates and tints the sphere texture to a fixed colour.
    - No lighting calculations are required on the sphere but you can include lighting if you wish.

- Add a textured cube to the scene, again using different shaders.
    - The texture on the cube should tinted to a bright colour. When the user presses a certain key the tint colour should change. You can choose any colours and any key you like. Perform the keypress code in the scene update function (you can't test for keypresses in shaders)
    - Any method to achieve this will be accepted, but it is easiest to pass a colour from C++ to the pixel shader and multiply it by the texture colour.

- Write a short report explaining the implementation of your techniques:
    - Describe the overall process of using shaders in a graphics application. ***You must use references to back up this section.***
    - Explain the specific techniques used in your shaders
    - Discuss improvements or extensions you could make

Assignment Tasks – For Further Marks

Note: Once you have satisfied the basic requirements, it is not necessary to address the remaining tasks in the order given. You may attempt any of the additional tasks in any order you wish.

ADVANCED LIGHTING SHADERS

- Extend the lighting calculations to use specular maps, normal mapping and parallax mapping.
    - Use appropriate textures from the labs or elsewhere.

- Support directional and/or spot lights
    - Change the light setup from two point lights to a different combination of lights, e.g. one point light and one directional light; or one point, one directional and one spotlight.
    - The lighting setup and data will need to be updated
    - The lighting calculations will change in all shaders involving lighting. You will need to think carefully how to adapt the lighting equations to support these light types. Spot lights are more challenging

- Marks will also be awarded for supporting advanced lighting techniques in conjunction with the other basic shader effects, e.g. normal mapping together with changing texture colours. A good implementation will contain various shaders demonstrating combinations of techniques. You may add other shader techniques if you wish
- To demonstrate your additional shader techniques, either add further models, or add further controls to the program.
- Document any new shaders or controls that you add or you may not receive marks for them.

OTHER GRAPHICS TECHNIQUES

- Support a range of blending modes for some models in the scene
    - Ensure that this doesn't cause sorting problems in the scene

- Implement cube mapping of a static environment onto a complex model (not a cube).
    - Cube mapping allows an object to reflect the scene around it.
    - You can source cube map textures from the web.
      E.g. http://www.humus.name/index.php?page=Textures
    - This requirement is advanced and worth a lot of marks. You are required to research the technique yourself. Some credit will be awarded for partly working attempts.

- To demonstrate your additional techniques, either add further models, or add further controls to the program
    - Document any controls you add

IMPROVED SCENE MANAGEMENT

- Update your main C++ code to improve flexibility and robustness.
    - Encapsulate things into classes. As well as model, mesh and camera classes, create a texture class and a light class to encapsulate these scene elements. Try to make a simple convenient, but flexible interface.
    - Use arrays or container classes to help manage large numbers of models, textures.
    - Demonstrate your extensions by creating a complex scene with additional models. The model loader from the lab supports .x .obj, .fbx and many other file types.
    - For extra credit, try to remove all globals from the code, so you have a fully object-oriented solution. Doing this without harming flexibility will be credited
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- The exact approach for these improvements up to you. Marks will be awarded based on the flexibility, ease of use and robustness of your solution.
    - Well-encapsulated solutions will gain additional credit.

SUBMISSION DETAILS

Deliverables

See notes at the top of this document for submission method.

You must provide:

- Executable program of your solution
- All the source and project files required to build the executable
- Discussion / evaluation report
- All files should be sensibly named and in working order

GRADING CRITERIA

Marks will be awarded based on the learning outcomes highlighted above.
To obtain **40-45%** and a **pass,** you must:

1. Implement the **basic requirements** described above
    - Marks are awarded based on the clarity and robustness of the solution
2. Write an **implementation report** as described above
    - Marks will be awarded based on the articulation and depth of analysis presented in the document

Up to a further **13%** will be awarded for:

- **Advanced Lighting Shaders**, as described above

Up to a further **15%** will be awarded for:

- **Other Graphics Techniques**, as described above

Up to a further **12%** will be awarded for:

- **Improved Scene Management**, as described above

The marks above will be awarded based on the challenge of each task and the quality of the given solution

Further marks **over 85%** will be awarded for:

- **Addition of advanced work** relevant to the module material to extend the project. You **must** document any such additional developments or they may not gain credit

A proportion of all the implementation marks will be given over to the readability and maintainability of your source code. Higher marks are reserved for solutions that have been tweaked and polished for higher quality and more interest.

Note: Once you have satisfied the basic requirements, it is not necessary to address the remaining tasks in the order given. You may attempt any of the additional tasks in any order you wish.

LEARNING OUTCOMES

- Render 3D scenes using a modern graphic API
- Prepare and convert artwork for use in their 3D scenes.
- Understand 3D transformations & coordinate systems used to build 3D scenes.
- Manipulate lighting and material properties of rendered 3D objects.
- Use relevant mathematical techniques (e.g. vector and matrix operations) to manipulate graphics objects

HELP AND SUPPORT

- Support will be provided via Microsoft Teams and email. You will also have the opportunity to ask questions during lectures / labs. You may request a one to one meeting with a tutor during their office hours (as published on Starfish).
- For support with using library resources, please contact our subject librarian subjectlibrarians@uclan.ac.uk. You will find links to lots of useful resources in the My Library tab on Blackboard.
- If you have not yet made the university aware of any disability, specific learning difficulty, long-term health or mental health condition, please let us know. The Inclusive Support team will then contact you to discuss reasonable adjustments and support relating to any disability. For more information, visit the Inclusive Support site.

- To access mental health and wellbeing support, please complete our online referral form. Alternatively, you can email wellbeing@uclan.ac.uk, call 01772 893020 or visit our UCLan Wellbeing Service pages for more information.
- If you have any other query or require further support you can contact The Student Support Centre. Speak with us for advice on accessing all the University services as well as the Library services. Whatever your query, our expert staff will be able to help and support you. For more information, how to contact us and our opening hours visit Student Support Centre.
- If you have any valid mitigating circumstances that mean you cannot meet an assessment submission deadline and you wish to request an extension, you will need to apply online prior to the deadline.

Disclaimer: The information provided in this assessment brief is correct at time of publication. In the unlikely event that any changes are deemed necessary, they will be communicated clearly via e-mail and a new version of this assessment brief will be circulated.	Version: 2 Updated 01/09/2022