FACULTY OF SCIENCE

ACADEMY OF COMPUTER SCIENCE AND SOFTWARE ENGINEERING

MODULE	**GRAPHICS** IT18X77
CAMPUS	AUCKLAND PARK CAMPUS (APK)
FSAO	JUNE
DATE: 2020-06-07	**SESSION:** 08:30 - 10:30
ASSESSOR(S):	**MR. A. MAGANLAL**
MODERATOR:	**DR. D VOGTS (NMU)**
DURATION: 120 MINUTES	**MARKS:** 100

Please read the following instructions carefully:

1. Answer **all** the questions.
2. Answer questions in order.
3. Answer only in the answer sheets provided.
4. Use diagrams where necessary to assist in your explanations.
5. Non-programmable calculators are allowed.
6. Round final answers to three decimal places.
7. Write *cleanly* and *legibly*.
8. This paper contains **6** question(s).
9. This paper consists of **2** page(s).

QUESTION 1: Rotation Calculation

Answer only one part. Either **Matrix** or **Quaternion**

(a) **Matrix**

Construct a matrix to rotate 71° (clockwise) around the axis specified by

$$(-9, 18, 3) \quad \rightarrow \quad (1, 5, 6)$$

Rotate the point (4, 24, –8) around this axis.

(b) **Quaternion**

Construct a quaternion to rotate 71° (clockwise) about the axis (10, –13, 3).
Use the quaternion to rotate (13, 6, –11) around this axis.

Total: 15

QUESTION 2: Lighting Equation

Write down the Phong lighting equation for a single colour light source and object (black and white model). Now calculate the viewed intensity of a point on an object given the following attributes:

- The object has an emissive coefficient of 0.321.
- The ambient light intensity is 0.863.
- The object has an ambient coefficient of 0.52.
- The object has a diffuse reflection coefficient of 0.082.
- The object has a specular reflection coefficient of 0.597.
- The shininess (specular highlight) factor is 8.
- The intensity of the incoming light (both specular and diffuse) is 0.827.
- The point we are considering is (2, 11, 24).
- The normal at the surface is (–0.315422, –0.946267, –0.0713276).
- The light is positioned at (1, 6, 17).
- The viewer is positioned at (24, 20, –1).

Total: 15

QUESTION 3: Shading

Discuss *Gouraud shading* and ***Phong shading***. Your discussion must include the general concept of ***shading*** as well as *differences* and *advantages* between the two types of shading.

Total: 10

QUESTION 4: Rasterisation vs Ray Tracing

Discuss how ***forward shading rasterisation*** and ***naive recursive ray tracing*** *differ* in terms of application of realistic lighting. Your discussion should include how *visibility* is calculated, how reflection/refraction is computed and the relative speed of the technique.

Total: 20

~~ Assessment continues on the next page. ~~

QUESTION 5: Subdivision Surfaces

Compare and contrast *loop subdivision* and $\sqrt{3}$ ***subdivision***.

Total: 15

QUESTION 6: Application

A still image of an *aquarium* is to be rendered. The aquarium is lit by many light sources, both inside and outside the various tanks. Ray tracing was selected as a method for rendering the scene. Answer the questions that follow:

(a) **Provide** a *definition* for ***global lighting model***. **[05]**

(b) **Discuss** how ***photon mapping*** works. Your discussion must include details of how photons are created, stored and retrieved from the photon map as well as how photon mapping can be integrated into the ray tracing process. **[15]**

(c) **Discuss** why ***photon mapping*** should be used to render the scene as opposed to ***radiosity***. **[05]**

Total: 25

~~ THE END ~~