

Tutorial Letter 101/3/2018

Computer Graphics COS3712

Semesters 1 and 2

School of Computing

This tutorial letter contains important information
about your module.

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1 INTRODUCTION

Dear Student

Greetings to you and welcome to the Computer Graphics module. We hope that you find it interesting and exciting.

COS3712 is a final year undergraduate (i.e. third year) semester module. We are obliged to offer a course that is comparable in standard to what other universities in the world offer in CG(Computer Graphics) at this level. As the School of Computing, we opted for a CG programming course using WebGL, which is based on OpenGL a state-of-the-art and widely used public domain graphics API, (application programming interface).

COS3712 is not primarily a programming module. The theory of CG, including its mathematical foundations (linear algebra), is the primary focus. A certain amount of practical programming is included in COS3712 to illustrate how the theory is applied.

The prescribed book that we use covers some of the linear algebra applicable to CG in Chapter 4, as well as in two appendices at the end of the textbook. Additional notes on linear algebra are also available as an additional resource on myunisa.

2 PURPOSE AND OUTCOMES

2.1 Purpose

Students who successfully complete this module will be equipped with knowledge of the fundamental principles and techniques of modern Computer Graphics. They will be able to use these ideas, methods and tools to write and implement graphics applications of medium complexity.

This module presents a top-down, programming-oriented approach to computer graphics with an emphasis on applications programming. Areas covered include Application Programming Interfaces (API's), three dimensional graphics, interactive graphics, as well all aspects of the computer graphics pipeline

2.2 Outcomes

For this module, there are several outcomes that we hope you will be able to accomplish by the end of the course:

Specific outcome 1: Demonstrate an understanding of graphics systems, models, architectures and API's.

Specific outcome 2: Demonstrate an understanding of the basic principles involved in programming two-dimensional graphics applications.

Specific outcome 3: Demonstrate an understanding of how to develop user input and interaction in computer graphics applications.

Specific outcome 4: Demonstrate an understanding of how geometric objects and transformations can be used in 3-Dimensional Computer graphics.

Specific outcome 5: Demonstrate an understanding of 3-dimensional programming techniques and concepts, including viewing, lighting, shading and discrete techniques.

Specific outcome 6: Demonstrate an understanding of the four major tasks of the graphics pipeline including modeling, geometry processing, rasterization and fragment processing.

3 LECTURER(S) AND CONTACT DETAILS

3.1 Lecturer(s)

Please see the COSALL tutorial letters for the telephone numbers of the lecturers on this module. You may also get lecturers' details from the **welcome page** of this module (**COS3712-18-S1** or **COS3712-18-S2**) on **myUnisa**.

When you contact the Lecturer, please do not forget to always include your student number. This will help the Lecturers to assist you.

Please note that this module is an online module. We would like you to make use of the discussions forums as much as possible for queries.

3.2 Department

The School of Computing can be contacted as follows:

Telephone number: +27 11 670 9200

E-mail: computing@unisa.ac.za

3.3 University

To contact the University, you should follow the instructions in the **Study @ Unisa** brochure. Remember to have your student number available when you contact the University.

You may also try one of the following options:

- For students residing in SA, send an sms to 32695
- E-mail study-info@unisa.ac.za

4 RESOURCES

4.1 Prescribed books

Prescribed book for COS3712 is:

Angel, Edward. Shreiner, Dave(2015). *Interactive Computer Graphics: A Top-Down Approach with WebGL*. Seventh edition. Pearson Education: Boston

Please consult the list of official booksellers and their addresses in *Study @ Unisa*.

4.2 Recommended books

Cunningham's OpenGL notes

The University of South Africa has permission to distribute the notes (preprint of a book) written by Prof. Steve Cunningham. These notes served as the prescribed book for this module previously. They provide a slightly different, but compatible perspective on the subject and are worth consulting:

Cunningham, Steve. (2002). *Computer Graphics: Programming, Problem Solving, and Visual Communication*. Pre-print. **Myunisa\Additional resources\OpenGLNotes.pdf**

4.3 Electronic reserves (e-reserves)

No electronic reserves

4.4 Library services and resources information

For brief information, go to www.unisa.ac.za/brochures/studies

For detailed information, go to the Unisa website at <http://www.unisa.ac.za/> and click on **Library**.

For detailed information, go to <http://www.unisa.ac.za/library>. For research support and services of personal librarians, click on "Research support".

The library has compiled a number of library guides:

- finding recommended reading in the print collection and e-reserves – <http://libguides.unisa.ac.za/request/undergrad>
- requesting material – <http://libguides.unisa.ac.za/request/request>
- postgraduate information services – <http://libguides.unisa.ac.za/request/postgrad>
- finding, obtaining and using library resources and tools to assist in doing research - http://libguides.unisa.ac.za/Research_Skills
- how to contact the library/finding us on social media/frequently asked questions – <http://libguides.unisa.ac.za/ask>

5 STUDENT SUPPORT SERVICES

Please see the **Study @ Unisa brochure** for full details.

Communication with the University with Administrative Issues

You need to contact the **administrative department** (not the Lecturer) of the university directly, should you have any questions related to the topics listed below):

- address changes
- cancellations
- examination admission
- examination venues
- exemptions
- financial questions
- prescribed books
- study material
- study methods

Information regarding all these matters can be located on the Unisa website: <http://www.unisa.ac.za>

VERY IMPORTANT – Always have your student number at hand when contacting the university. When sending an e-mail, write your student number and a short description of the message in the subject line.

Communication with fellow Students

Studying through distance education can make you feel as if you are alone out there, with no support or anyone with whom to share your frustrations and/or achievements. But this need not be the case. On the myUnisa site we will be forming a “classroom” where you can discuss any topics you’d like to. You need not feel alone while doing this module; actively participate in all the discussions and feel like a real student in a real study environment.

The online *Discussion Forum* might not give you the physical contact of attending a class, but it will

- provide contact between learners and faculty
- provide cooperation between learners
- encourage active learning
- provide prompt feedback
- communicate expectations
- present diverse talents and ways of learning

Should you feel the need to form a study group in your particular area, you can add your name, contact details and the area in which you want to start the group to the forum topic related to study groups on the *Discussion Forum* to the left of this screen. Don’t just sit back and expect other students to contact you to form the group; be an active participant and be willing to take the first step by contacting them.

Support provided by the Lecturer

The *myUnisa* website will serve as your class room. You must reflect on your studies using the *Blog*, ask relevant questions using the *Discussion Forum*, test your knowledge with the *Self Assessments*, study by referring to the *Learning Units*.

E-Tutors

Please be informed that, Unisa offers online tutorials (e-tutoring) to students registered for modules at NQF level 5,6 and 7, this means qualifying undergraduate modules.

Students registered for this module will be allocated to a group of students with whom you will be interacting during the tuition period as well as an e-tutor who will be your tutorial facilitator. Once you have been allocated to a group you will receive an sms informing you about your group, the name of your e-tutor and instructions on how to log onto MyUnisa in order to receive further information on the e-tutoring process.

Online tutorials are conducted by qualified E-Tutors who are appointed by Unisa and are offered free of charge. All you need to be able to participate in e-tutoring is a computer with internet connection. If you live close to a Unisa regional Centre or a Telecentre contracted with Unisa, please feel free to visit any of these to access the internet. E-tutoring takes place on MyUnisa where you are expected to connect with other students in your allocated group. It is the role of the e-tutor to guide you through your study material during this interaction process. For your to

get the most out of online tutoring, you need to participate in the online discussions that the e-tutor will be facilitating.

There are modules which students have been found to repeatedly fail, these modules are allocated face-to-face tutors and tutorials for these modules take place at the Unisa regional centres. These tutorials are also offered free of charge, however, it is important for you to register at your nearest Unisa Regional Centre to secure attendance of these classes.

Free computer and internet access

Unisa has entered into partnerships with establishments (referred to as Telecentres) in various locations across South Africa to enable you (as a Unisa student) free access to computers and the Internet. This access enables you to conduct the following academic related activities: registration; online submission of assignments; engaging in e-tutoring activities and signature courses; etc. Please note that any other activities outside of these are for your own costing e.g. printing, photocopying, etc. For more information on the Telecentre nearest to you, please visit www.unisa.ac.za/telecentres.

6 STUDY PLAN

The table below reflects a possible study plan you could use during the semester.

Week	Theory Guide : Study Chapter	Practical Guide
1	1: Graphics systems and models	
2	2: Graphics programming	Familiarise yourself with WebGL
3	3: Interaction and Animation	
4	4: Geometric objects and transformations	Start assignment 1
5	5:: Viewing	Continue with Assignment 1
6		Complete Assignment 1
7	6:Lighting and Shading	
8	7: Discrete Techniques	Start Assignment 2
9	8: From Geometry to Pixels	Continue with Assignment 2
10		Complete Assignment 2
11	Complete Self – Assessment Exercises , Available on myunisa/additional resources	
12,13	Revision	Revision

7 PRACTICAL WORK AND WORK-INTEGRATED LEARNING

Assignments are of a practical nature and need to be completed on a computer.

8 ASSESSMENT

8.1 Assessment criteria

The assignments and examination in this module will test the following:

- Explain all computer graphics concepts using examples.
- Implement two and three dimensional computer graphics applications using Javascript and WebGL.
- Translate computer graphics problems into solutions using concepts learnt.
- Provide advantages and disadvantages of computer graphics theories and concepts.
- Differentiate between computer graphics concepts learnt.

8.2 Assessment plan

In this course you will be assessed through 2 compulsory practical assignments and a final theory examination. The assignments contribute towards a year mark. Assignments 1 and 2 contribute 50% each towards the year mark. Your year mark will then contribute **30%** towards your final mark and the examination mark **70%**.

8.3 Assignment numbers

8.3.1 General assignment numbers

Assignments are numbered consecutively, starting from 01

8.3.2 Unique assignment numbers

	Semester 1	Semester 2
Assignment 1	847604	847479
Assignment 2	743849	718131

8.4 Assignment due dates

	Semester 1	Semester 2
Assignment 1	05 March 2018	27 August 2018
Assignment 2	16 April 2018	25 September 2018

8.5 Submission of assignments

Assignments are part of the learning material for this module. As you do an assignment, read the prescribed book, do the examples and problems in the prescribed book, consult other resources, discuss the work with fellow students, or do research, you are actively engaged in learning.

- **Enquiries about assignments** must be addressed to the Assignment Section (see **Study @ Unisa**).
- Your assignments must have precisely the *same number* as those specified in this tutorial letter.

- Assignments are **submitted** via myUnisa **only** (see **my Study @ Unisa**).
- Assignments 1 and 2 must be submitted as ZIP documents.
- **Solutions** of assignments 1 and 2 will be available for download on myUnisa after the due date of the assignment.

8.6 The assignments

Assignment 1 – Semester 1 students

NB. You need to submit code for this assignment. Place all your files that would be required to execute your project in a zip folder and upload on myunisa.

Question 1

You are required to draw the following scene using WebGL:

- The scene should represent the inside of a room, with the floor and two walls visible. The viewer should be looking into the corner formed by the two walls. The floor and the walls need to be different colours.
- A shape should be suspended in the room to the left of centre (i.e. not directly between the viewer and the white, left-hand wall). The shape should be a simple, flat, polygon (of any colour - but not black or white!).
- Make the shape rotate slowly on its own vertical axis.

Question 2

Add buttons to your project to do the following:

1. Toggle rotation. Start and stop (toggle) rotation of shape.
2. Toggle(change) direction of rotation.

Add sliders to your project to do the following

1. Increase and decrease the speed of rotation of shape.
2. Zoom in/out to the centre of your room.

Assignment 2 – Semester 1 students

NB. You need to submit code for this assignment. Place all your files that would be required to execute your project in a zip folder and upload on myunisa.

Question 1

You are required to make the room created in the previous project (assignment 1) more realistic by adding lighting and material properties.

Firstly, in order for your lighting to work, you need to add vertex normal to all polygons in your scene. You should also define material properties for each polygon rather than the simple colour used in the previous project. You are required to create two different scenes. The first is a day scene in which you define a directional light whose colour is white in all its components and that has constant attenuation.

The second is a night scene for which you have to add one “fire” light. Define “fire” light as a positional light at the centre of the room whose colour is on the red side of pure yellow. Experiment with both linear and quadratic attenuation to see which makes the more effective scene. Your program should retain all the functionality of the previous project, i.e. toggling rotation, zooming in. Add another button that will allow the user to switch between scenes.

Question 2

You are required to apply texture mapping to one wall in your room.

This part of the project covers the concept of texture mapping. In particular, we are looking at 2D texture mapping, which is the most commonly used type of texturing. Texture mapping may be applied in one of two ways using a digital image or using a procedural texture-generating function. This question explores the first option. Your task is to add texture mapping to any of one wall of your room

Assignment 1 – Semester 2 students

Question 1

In this project you have to design and construct a simple home in WebGL. The home should contain the following three objects:

- Ground – Rectangular polygon
- Assignments are numbered consecutively, starting from 01
- A house – basic requirements is a rectangular block but you are allowed to improve on the basic shape.
- Pool – any polygon shape on ground – coloured blue

Use different colours to distinguish between objects

Question 2

Add the following components to your program in question 1:

Keyboard Interactivity

Your program should allow the user to perform four operations, as described below. In all cases, the relevant key should work whether "Caps Lock" is enabled or not:

1. Start and stop (toggle) animation of the entire scene: In this context, animation takes the form of rotating the entire scene about the y-axis. Using the < R > key, the user should be able to start and stop rotation.
2. Change the direction of rotation: Using the < S > key, the user should be able to change a clockwise rotating image to one that rotates counter clockwise and vice versa. When the scene is not rotating and the key is pressed, nothing should happen.
3. Zoom in/out: The up arrow key should allow the user to zoom in (move closer to the scene), while the down arrow key should allow the user to zoom out (move away from the scene).

Menus

Create a menu with menu entries for the following operations:

1. Toggle animation.
2. Toggle direction of rotation.
3. Zoom in/out.

Assignment 2 – Semester 2 students**Question 1**

You are required to make the home created in the previous project (assignment 1) more realistic by adding lighting and material properties.

Firstly, in order for your lighting to work, you need to add vertex normals, for each component in your scene. You should also define material properties for each component rather than the simple colour used in the previous project. You are required to create two different scenes. The first is a day scene in which you define the sun as a directional light whose colour is white in all its components and that has constant attenuation.

The second is a night scene for which you have to add three garden lights in open spaces. Define each "garden" light as a positional light. The night scene should also include a moon and some stars. Do not use lights for any of these. Manipulate the emissivity of the respective materials to obtain the desired lighting effect. Your program should retain all the functionality of the previous project, i.e. toggling rotation, zooming in. Add a keyboard callback that will allow the user to switch between scenes. Use <D> to switch to day and <N> to switch to night. This should work whether "Caps Lock" is enabled or not.

Question 2

You are required to apply texture mapping to the scene.

This part of the project covers the concept of texture mapping. In particular, we are looking at 2D texture mapping, which is the most commonly used type of texturing. Texture mapping may be applied in one of two ways using a digital image or using a procedural texture-generating

function. This question explores the first option. Your task is to add texture mapping to any one polygon of your scene.

8.7 Other assessment methods

No other assessment methods on this module.

8.8 The examination

Your exam is written in May/June for semester 1 students and October/November for semester two students. UNISA will inform you of the exam date. The examinations will primarily be based on the theory covered in your textbook. Past exam papers are available on myunisa.

9 FREQUENTLY ASKED QUESTIONS

Can I use previous editions of the textbook?

No, you have to use the latest edition which is based on WebGL.

Where do I find the software for this module?

WebGL is web based and so all you need to do your assignments is a text editor like notepad and an internet browser. You will have to learn some javascript, which is not difficult if you know C++ or JAVA.

10 SOURCES CONSULTED

Angel, Edward. Shreiner, Dave(2015). Interactive Computer Graphics: A Top-Down Approach with WebGL. Seventh edition. Pearson Education: Boston

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