

1	REGISTRATION NUMBERS
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i. Daniel Karume	SCT211-0072/2022
iii. Ian Dancun	SCT211-0005/2022
iv. Peaches Njenga	SCT211-0004/2022
v. Sandrah Lewa	SCT211-0090/2022

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i. Joan Kinoti	SCT211-0042/2022
ii. Melanie Minayo	SCT211-0043/2022
iii. Moses Odeny	SCT211-0099/2022
iv. Ephraim Shikanga	SCT211-0077/2022

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i. Chrispin Maina Nguru	SCT211-0006/2022
ii. Meshack Otieno Ouma	SCT211-0765/2022
iv. Mike Kevin Mugambi	SCT211-0011/2022
v. Benedict Waweru	SCT211-0032/2022

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i. Kaigu Ann Wangari	SCT211-0772/2022
iii. Joy Leila Kendi	SCT211-0091/2022
iv. Hans Matere Walubengo	SCT211-0080/2022
v. Levi Mutugi Mutharimi	SCT211-0067/2022

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i. Horris Maina	SCT211-0704/2022
ii. Sajjad Gedow	SCT211-0065/2022
iii. George Githigi	SCT211-0460/2022
v. Emmanuel Yator	SCT211-0622/2022

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i. Joseph Ngure	SCT211-0008/2022
ii. Macharia Maurice	SCT211-0010/2022
iv. King'ori Florence Wangechi	SCT211-0063/2022
v. Theuri Bonface Karue	SCT211-0573/2022

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i. Jany Muong	SCT211-0848/2018
ii. Joram Kireki	SCT211-0079/2022
iv. Josphat Waweru Thumi	SCT211-0003/2022
v. Akech Atem	SCT211-0535/2022

**8**

i. Rotich Kibet Asbel	SCT211-0087/2022
ii. Eliud Marierie	SCT211-0094/2022
iii. Moses Muiruri Njau	SCT211-0002/2022
iv. Collins Sifa Kasena	SCT211-0066/2022

**9**

i. Ian Ndolo Mwau	SCT211-0034/2022
ii. David Nzambuli	SCT211-0068/2022
iii. Maureen Mukami	SCT211-0052/2022
iv. Pharis Kariuki	SCT211-0033/2022

**10**

i. James Moseti	SCT211-0095/2022
ii. Christine Odegi	SCT211-0093/2022
iii. Gift Nestah	SCT211-0071/2022
iv. Sandrah Wendy	SCT211-0047/2022
v. Adrian Baraka	SCT211-0022/2022

**11**

i. Joseph Muema	SCT211-0039/2022
ii. Jayden Mathenge	SCT211-0030/2022
iii. Kelly Kasina	SCT211-0038/2022
iv. Brian Kipng'eno	SCT211-0078/2022

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i. Lelgo Isaac Kipng'eno	SCT211-0074/2022
ii. Ian Karanja	SCT211-0461/2022
iii. Samuel Ruoti	SCT211-0542/2022
iv. Alfred Warui Kahenya	SCT211-0023/2021

**13**

i. Amy Njeri	SCT211-0010/2021
ii. Teddy Muli	SCT211-0023/2022
iii. Collins Omollo	SCT211-0021/2022
iv. Kimberly Njoroge	SCT211-0060/2022
v. Anthony Muturi	SCT211-0016/2022

**14**

i. Kimani Owen Mwangi	SCT211-0591/2021
ii. Kitavi Duncan	SCT211-0031/2021
iii. Douglas Kimani	SCT211-0085/2022

**15**

i. Joseph Kirika	SCT211-0061/2022
ii. Irke Konzolo	SCT211-0081/2022
iii. Felix Ombongi	SCT211-0017/2022
iv. Allan Canon	SCT211-0019/2020

**16**

i. Mwenda Kanyi	SCT211-0012/2022
ii. Moses Mwai	SCT211-0029/2022
iii. Tyrese Muigai	SCT211-0457/2022
iv. Kristian Karani	SCT211-0533/2022

**17**

i. Joyjane Githinji	SCT211-0024/2022
ii. Jeddy Awuor	SCT211-0027/2022
iii. Nixon Gitonga	SCT211-0698/2022
iv. Collins Mutugi	SCT211-0051/2022

**18**

i. Richard Kawenze	SCT211-0053/2022
ii. Victor Mulila	SCT211-0049/2022
iii. Ken Mutuku	SCT211-0050/2022
iv. John Kabuthi	SCT211-0055/2022

**19**

i. Nyaga Joy Christine	SCT211-0572/2022
ii. Geoffrey Chege	SCT211-0002/2019
iii. Edwin Owino	SCT211-0725/2021
vi. Natasha Wangui	SCT211-0057/2022
v. Vincent Ochieng'	SCT211-0070/2022

**20**

i. John Kibet	SCT211-0455/2022
ii. Lynn Omae	SCT211-0092/2022
iii. Favian Mokaya	SCT211-0022/2021
iv. Lee Thiong'o	SCT211-0536/2022
v. Joseph Njenga	SCT211-0040/2022

**21**

i. Kenneth Ruto	SCT211-0029/2021
ii. Montell Luseno	SCT211-0588/2021
iii. Fidel Castro	SCT211-0100/2022
iv. Kelvin Mwenda	SCT211-0062/2022

**22**

ii. Faith Mosonik	SCT211-0044/2022
ii. Javan Otieno	SCT211-0098/2022
Jacob John Kasunzu	SCT211-0089/2022
Methusella Nyongesa Misiko	SCT211-0069/2022

**23**

ii. Zawadi Muthoni Kiarie	SCT211-0462/2022
iv. Njoroge Kanyagia	SCT211-0009/2022
iii. Hilda Mwangi	SCT211-0026/2022
v. Neema Ogao	SCT211-0086/2022

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iii. Gatmach Yuol Nyuon	SCT211-0504/2021
iv. Newton Luttah	SCT211-0512/2021
v. Rebecca Shirievo	SCT211-0538/2022
v. Derrick Gacheru	SCT211-0004/2021

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v. Rihaz Yusuf	SCT211-0037/2021
v. Theophilus Korir	SCT211-0018/2022
v. Dalvin Calvin	SCT211-0452/2022
v. Terry Mutheu	SCT211-0073/2022

## **ICS 2311 Computer Graphics**

Please attempt these questions in the assigned groups and submit before stipulated deadline. The deadline is Midnight of **7<sup>th</sup> April 2025** to [jkuatnotes7@gmail.com](mailto:jkuatnotes7@gmail.com)

The email subject should be : GROUP X: ICS 2311 where X is the question you are answering that corresponds to the group

**Prepare slides to present your work to the class as all work must be presented**

**An Extra requirement:**

**Can you attempt to regenerate your work component that has programming in Python Programming? Please share what**

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**you achieve too in the zipped file on the folder**

**Any work submitted after the deadline will not be marked and will earn no mark ...not even a zero**

**NB: In addition to having all programs in the write up, also attach all the programs as Text file such as notepad for ease of us running them as we mark.**

**Where a YouTube video is asked for please ensure the video is public and share the link as you submit your work . Explain as you record the video what is happening.**

**Ensure that the programs have comments that aid us understanding your logic.**

**For each given program give the code and the output in your submission**

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For easier understanding you can refresh through reading of the attached chapters of Hearn, Baker and Carithers book called Computer Graphics with Open GL and other books shared on the Piazza page

**I am a member of each of the group, feel free to post the questions and interactions on the piazza and indicate your question. I suggest the class creates a shared dropbox or folder so that all can see each other solution**

**All class members, should go through all the questions as a reading guide and focus on their question. However, understanding parts of other questions is Key.**

**Yours : Dr. Karanja Mwangi**  
**[jkuatnotes7@gmail.com](mailto:jkuatnotes7@gmail.com)**

### **Group 1**

1. The French engineer Pierre Bézier while doing the design of Renault automobile bodies , he came up with Bézier-Spline Curve Functions . Describe them , How are they implemented in Open GL .
2. With aid of an example illustrate the 2D and 3D Bézier-Spline Curve in Open GL
3. Describe how to clip a Bézier curve against a screen rectangle. (Create a youtube video to illustrate this and share the link.

### **Group 2**

1. using OpenGL, write a program that draws a circle using Bresenham circle drawing algorithm: The parameters for the circle are as follows – the radius should be 6 Centimeters and the starting point coordinates are (3,5)



- a. Draw the same circle at start coordinates (-1,-1) and fill it with Cyan shade (hint RGB #00ffff)
2. Using a working example , Write an OpenGL routine to split a concave polygon, using the vector method as described in Chapter 2 of our reading Text (**Hearn, Baker and Carithers book called Computer Graphics with Open GL**)

### **Group 3**

There are various Computer Graphics Data structures : Read on them and how they are implemented

1. BSP Trees -
2. Scene Graphs

Page 261 - Data Structures for Graphics of the Book :Fundamentals of Computer Graphics Third Edition

([https://piazza.com/class\\_profile/get\\_resource/kp2du2rm59l1rh/kp2e3s498wi7b6](https://piazza.com/class_profile/get_resource/kp2du2rm59l1rh/kp2e3s498wi7b6))

Exercise to submit

1. Diagram a scene graph for a bicycle programming language of your choice
2. Illustrate how BSP tree can be used to create a Koch triangles

### **Group 4**

1. using OpenGL, write a program that draws a circle using Midpoint circle drawing algorithm: The parameters for the circle are as follows – the radius should be 3 Centimeters and

the starting point coordinates are (0,2).

write a program to rotate the Circle 60 degrees and fill it with purple shade (hint RGB #800080)

2. Using a working example , Write an OpenGL routine to split a concave polygon, using the rotational method as described in Chapter 2 of our reading Text (**Hearn, Baker and Carithers book called Computer Graphics with Open GL**)

### **Group 5**

1. Using OpenGL, write a program that draws a line using Gupta-Sproull algorithm line drawing algorithm: The parameters for the line are as follows –the starting point (20, 10) and ending coordinates (30, 18).
  - a. What is Line rasterization and the anti-aliasing
    - i. Describe using your line drawn above how is Gupta-Sproull anti-aliasing
2. Using OpenGL, write a program that draws a line using Xiaolin Wu's line algorithm line drawing algorithm: The parameters for the line are as follows –the starting point (15, 10) and ending coordinates (23, 18).
  - i. Demonstrate using the example the Xiaolin Wu's line algorithm does anti-aliasing

### **Group 6**

Next week there is freshers Bash in Juja , they have heard you are the computer graphic Guru. The organizers want a banner written : **JKUAT ROCKS (the words JKUAT in green and OCKS**

~~in Red) ....they also prefer a brown background (might be~~

*ugly but client is always right!)*

**a.** Demonstrate how this can be achieved Using OpenGL( you may use TrueType and OpenType fonts if need be)

**b.** If your client complains that the text size is small how would you increase? please demonstrate with a working code

### **Group 7**

A survey was carried out in Gachororo about youth preference on fruits. 150 youth were interviewed about their fruits of preference as follows

Fruit:	Ovacad o	Orange	Banana	Kiwifruit	Mango s	Grapes
People:	36	41	19	28	30	16

- a) Write an OpenGL program that displays the bar chart. Input to the program is to include the data points and the labeling required for the x and y axes. The data points are to be scaled by the program so that the graph is displayed across the full area of a display window. (reading Chapter on Graphics Output Primitives in the book will help)
- Ensure that each bar has the color that closely resembles the ripe fruit under consideration
  - label your x axis as well in black and Y axis in Red
- b) Suppose we wish to start the graph at point (5,5) on the display window, demonstrate how this would be achieved using your question case example

### **Group 8**

A survey was carried out in Gachororo about average youth daily earnings and reported as follows

Day:	Mon	Tue	Wed	Thurs	Fri	Sat
KSh:	590	850	940	1070	800	1020

- a) Write an OpenGL program that displays the line graph . Input to the program is to include the data points and the labeling required for the x and y axes. The data points are to be scaled by the program so that the graph is displayed across the full area of a display window. (reading Chapter on Graphics Output Primitives in the book will help)
- i. In the first case the data points are to be displayed as **asterisks** joined with straight-line segments, and the x and y axes are to be labeled according to input specifications
  - ii. In the second case , increase the width of the line to 2 and use small boxes as data marks
  - iii. In the third case the draw the line using the blue color and data points as small circles in red and the chart background to be cream (#FFFDD0)

## **Group 9**

Using the data provided in Question for group 7 , Write a program to draw a pie chart ( the pie chart should represent the percentages) .

- i. The output of the program should have the name of the pie chart, and the names of the intervals. Each section label is to be displayed outside the boundary of the pie chart near the corresponding pie section.

- ii. Redraw the same Pie chart using the section colors that closely resemble the ripe fruit and put the label and the percentage near its corresponding section
- iii. How would you convert the chart background to gray scale using OpenGL code? demonstrate how this can be achieved

## **Group 10**

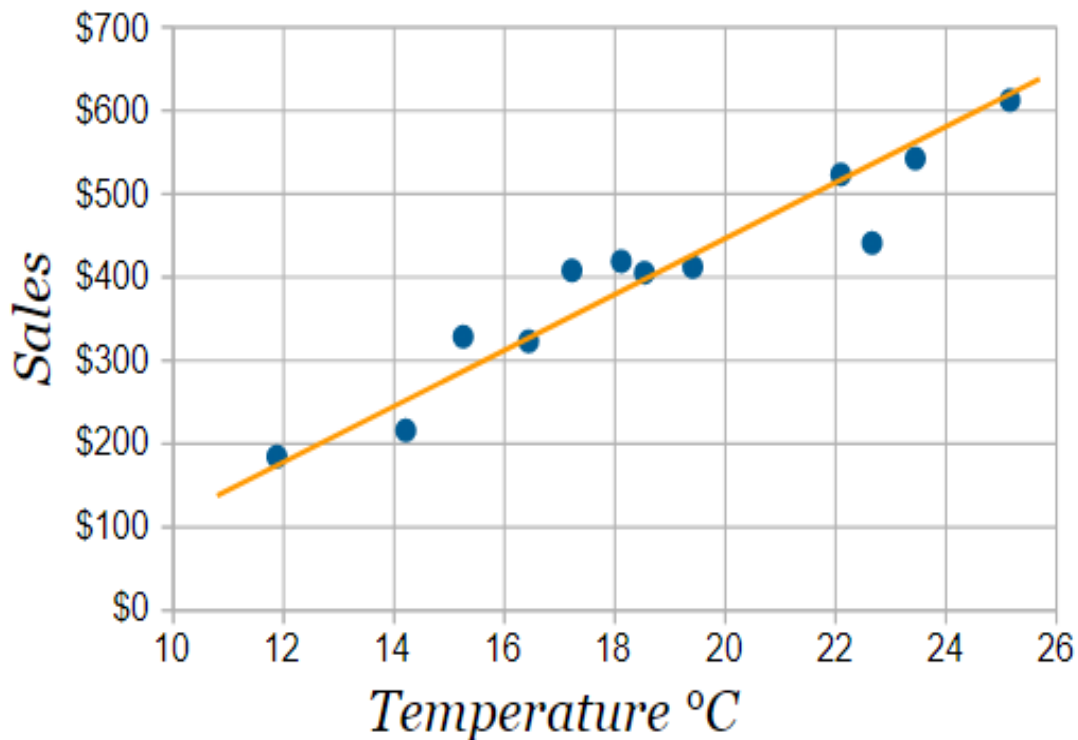
- a) Write a working algorithm for implementing a color lookup table that we discussed in class . We need to see an Implementation in the language of your choice (<https://lettier.github.io/3d-game-shaders-for-beginners/lookup-table.html>)
- b) The local ice cream shop keeps track of how much ice cream they sell versus the noon temperature on that day. Here are their figures for the last 12 days: (source <https://www.mathsisfun.com/data/scatter-xy-plots.html>) D

<b><i>Ice Cream Sales vs Temperature</i></b>	
<b>Temperature °C</b>	<b>Ice Cream Sales</b>
14.2°	\$215
16.4°	\$325
11.9°	\$185
15.2°	\$332
18.5°	\$406
22.1°	\$522
19.4°	\$412
25.1°	\$614
23.4°	\$544
18.1°	\$421
22.6°	\$445
17.2°	\$408

Using OpenGL draw the following based on the above data, attempt to replicate the output shown below where the data points are in

blue #0000FF and the line of best fit or trend line is in orange (#FFA500). Ensure that your axis are also labeled

Draw the line of best fit using the Brenshem algorithm we discussed in class.



### **Group 11**

- b) Suppose you have a system with a 12 inch by 14 inch video monitor that can display 120 pixels per inch. If memory is organized in one byte words, the starting frame buffer address is 0, and each pixel is assigned 4 bits of storage, what is the frame buffer address of the pixel with screen coordinates (x, y)?
- c) Using OpenGL Draw a figure with coordinate points A(0, 4), B(3, 4), C(4, 0), D(0, 0).



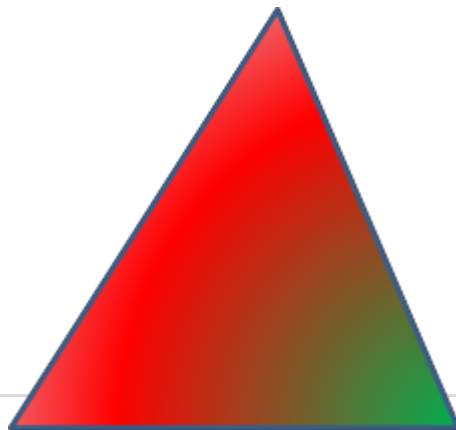
- i. Apply the translation with distance 2 towards X axis and 2 towards Y axis. Obtain the new coordinates of the square.
- ii. The translated figure should have a green border line and cream inner shading
- iii. write an openGL program to rotate the translated figure on Rotation angle =  $\theta = 55^\circ$  and show the output

## **Group 12**

- a) Using a working example, prove that the multiplication of transformation matrices for each of the following sequences is commutative:
  - i. Two successive rotations.
  - ii. Two successive translations.
  - iii. Two successive scalings.
- b) Using openGL, draw a triangle with vertices (-1,6 ; 2,0; -4,9)

Write a program

- i. Rotate the triangle with a rotation of -45 degrees
- ii. Vary the shading of the rotated triangle to have a mix of the three primary colors (Below is a hint of how the color shades should look like in the rotated triangle ....Any color shade fashion will suffice ).. a soft-fill algorithm can achieve this



### **Group 13**

- a) Using OpenGL, Write a boundary-fill procedure to fill an 8-connected region of your choice.
- b) Use the midpoint method and symmetry considerations to scan convert the parabola
$$y = 50 - x^2$$
over the interval  $-4 \leq x \leq 4$   
Show the working of the method and implement it using OpenGL  
(read the chapter on Implementation Algorithms for Graphics Primitives and Attributes)

### **Group 14**

1. How would you set the color of OpenGL display to green and change the fill color to have texture? Do a demonstration example with the circle with parameter starting coordinates (-3,1) and radius of 4 cm and texture type of the circle of your choice ( mention in the write up what you used)

### **Group 15**

1. Using Open GL , draw an Ellipse with centre as (-2,2) given by

$$\frac{(x-2)^2}{36} + \frac{(y+1)^2}{25} = 1$$

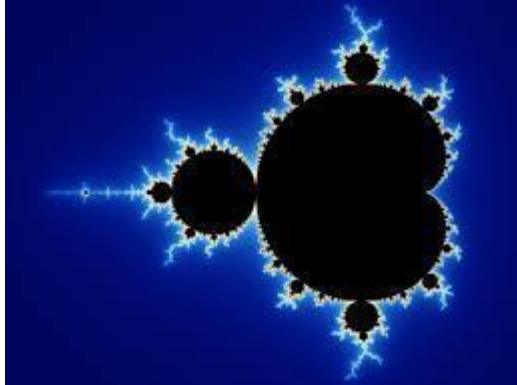
- a. Apply the flood-fill algorithm to fill the interior ellipse with cyan Color
- b. Apply shear parameter 2 on X axis and 2 on Y axis and find out the new coordinates of the Ellipse drawn above and plot the resulting figure using OpenGL
- c. Develop an algorithm for antialiasing elliptical boundaries above
  - a. Using Open GL write a program to boundary fill of the the ellipse in (b) with color Green

### **Group 16**

1. Describe using a working examples, the relationship between the following coordinate systems in the graphics (OCS - object coordinate system WCS - world coordinate system VCS - viewing coordinate system CCS - clipping coordinate system NDCS - normalized device coordinate system DCS - device coordinate system)
  - b) Why do we need homogeneous coordinates?
2. Our good Class member Kiguta , is a fan of Chess. He has lost his chessboard. Write a program in OpenGL that implements a 8 by 8 chessboard. He prefers brown and white color instead of black and white. Help him out!

### **Group 17**

- a. Discuss the concept of Mandelbrot Set as used in Fractal geometry methods in computer graphics
- b. How would the image below be drawn using Open GL ..Describe the how using the code



- c. Create a YouTube video Illustrate using step by step how a 3D Mandelbrot Set Can be achieved in Blender. share the link

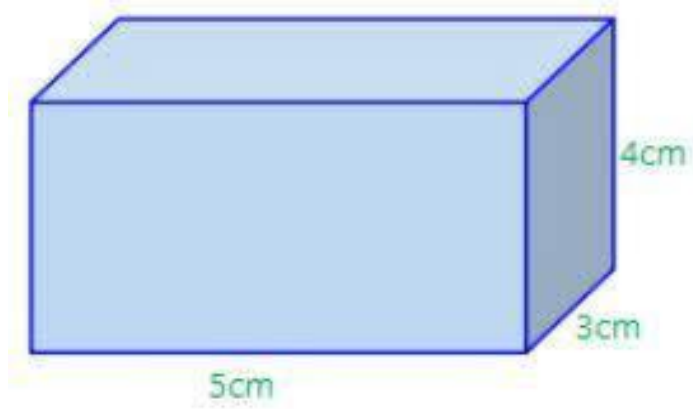
### **Group 18**

- 1.. Describe two ways of Generating Polyhedra in OpenGL namely using 1/. surface tessellation (Platonic solids ) and 2./ using the Glut libraries (GLUT Library of Polyhedron Functions)
2. Illustrate with Open GL how to construct the Pot...the famous PoT [https://www.sjbaker.org/wiki/index.php?title=The History of The Teapot](https://www.sjbaker.org/wiki/index.php?title=The_History_of_The_Teapot)

### **Group 19**

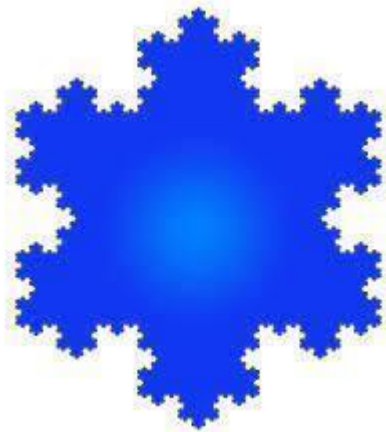
1. Illustrate with working example the concept of 3D clipping and viewing

2. Illustrate how the Cohen-Sutherland and Cyrus-Beck are applied in 3D clipping of the image below using Open GL



### **Group 20**

1. Describe the Concept of Koch Curve as applied in fractal geometry methods
2. Illustrate how one can generate the famous Koch 2D snowflake shown below in blue on OpenGL



3. illustrate Creating a 3D fractal Koch snowflake shape model in sequence in an environment of Blender environment (Create a

YouTube video and offer the link for the process

### **Group 21**

1. Illustrate the routine to split a concave polygon, using the rotational method We need to see OpenGL implementation
2. With aid of working examples, describe the following shading techniques as applied in Computer graphics: We need to see OpenGL implementation
  - a) Gouraud Shading model
  - b) Phong Shading Model
  - c) FACETED Shading

### **Group 22**

- a) Describe the Hilbert's Curve
- b) Write a program in open GL to create a sample Hilbert Curve
- c) Attempt to create a blender animation for the Hilbert curve created above (Please do a YouTube video for step by step approach and final product)

## **Group 23**

1. Using OpenGL draw a filled polygon with the following dimensions (8,4;2,4;0,8;3,12;7,12;10,8) hint (GL POLYGON function ) might be useful

- a. Write a function to fill the polygon above in Red (#FF0000.)
- b. write program to scale up (scaling) the polygon by a factor of 2
- c. Write a procedure to fill the interior of a given polygon with shades of asterisks

## **Group 24**

a) Create a YouTube video Illustrate using step by step how the two shading methods can be achieved in Blender for a circle of radius 3 starting from the center . share the link

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- a) Phong Shading model
- b) Gouraud Shading model

## **Group 25**

There are various Computer Graphics Data structures: Read on them and how they are implemented

### 1. Triangular Meshes

Page 261 - Data Structures for Graphics of the Book :Fundamentals of Computer Graphics Third Edition

([https://piazza.com/class\\_profile/get\\_resource/kp2du2rm59l1rh/kp2e3s498wi7b6](https://piazza.com/class_profile/get_resource/kp2du2rm59l1rh/kp2e3s498wi7b6))

Exercise to submit

1. Illustrate how you would build a Egyptian pyramid with  $b=7\text{cm}$ ,  $l=4\text{cm}$ ,  $h=3\text{cm}$  as the using a set of triangular meshes. Show the implementation in OpenGL and also blender



