# **INFO6028 – Graphics 1 - Mid-term Exam – Fall 2022**

Thursday, November 10th, 2022

Instructor: Michael Feeney

## The exam format:

* You may use any resources you feel are necessary to complete the exam, but you are to answer the questions **on your own**. I will be looking for plagiarism (i.e. copying) very carefully. There is *no possible way* that the specific code to answer these questions, or the output to the screen, would be very similar to the look of another student’s code. Remember, this is a test and there are very clear policies about cheating on tests.   
  + <http://www.fanshawec.ca/admissions/registrars-office/policies/cheating-policy>
  + <http://www.fanshawec.ca/sites/default/files/assets/Ombuds/cheating_flowchart.pdf>
* The questions are ***NOT*** of equal weight. There are five (5) pages with four (4) questions
* The answers may be one or a combination of the following:
  + Short answer (in your own words)
  + Snippets of code
  + Complete running solutions
* CLEARLY indicate which answer goes to which question. My suggestion is that you place each answer in its own folder, named “Question\_01”, “Question\_02” and so on (or something equally clear). Another option is to create a Visual Studio solution and add a number of projects – one per question – to it. If I can’t make heads or tails of what question is what, I probably won’t even mark it.
* Place any written answers into a Word, RTF, or text file. Again, *clearly* indicate which question you are answering.
* If you are combining answers (which is likely), please indicate this with a “readme” file or some note (*not* buried in the source code somewhere).
* For applications: if it doesn’t build and run, *it’s like you didn’t answer it*. I’ll correct trivial, obvious problems (like you clearly missed a semicolon, etc.), but you need to be sure that it compiles and/or runs.
* You have until **11:59 PM** on **Thursday, November 10th, 2022** to submit all your files to Fanshawe Online.   
    
  **NOTE:** Although this may “look and feel” like a project, it isn’t, it’s an **exam**, so there is **no concept of “late marks**”; if you don’t submit your files by 11:59 PM, you don’t get any marks at all. *Don’t Be Late submitting.*

(Also be **SURE** that you are actually submitting the correct files)

|  |
| --- |
| Since I’m suspecting most of you will be working from home, I’ll be on zoom (from my home office) from approximately **9:30 AM to 4:00 PM**, then again in the evening from about **7:30 PM to 10:30 PM**, in case you have any questions. I’ll also be watching discord and having my e-mail open as well. Or you can call me: 519-494-7569.  Here’s the zoom link:  <https://fanshawec-ca.zoom.us/j/96757095854?pwd=NXJ1M00wUWUyY0M0Q0xOVyt4RCtWUT09>  Meeting ID: 967 5709 5854, Passcode: 77283928  (Note: it’s the same link as my usual office hours) |

* There is also a **SkyPirateModels.7z** file you will need. It’s available on FOL with the mid-term.

## Questions:

**“It’s a *sky* pirate life (and death) for me!”** *(one more time!)*



You are going to recreate a few scenes from some “sky pirate” battles.

These are just like regular sea going pirates, except that they use WAY more impractical flying craft that are basically (super heavy) ship hulls, hanging under blimp or zeppelin gas bags.

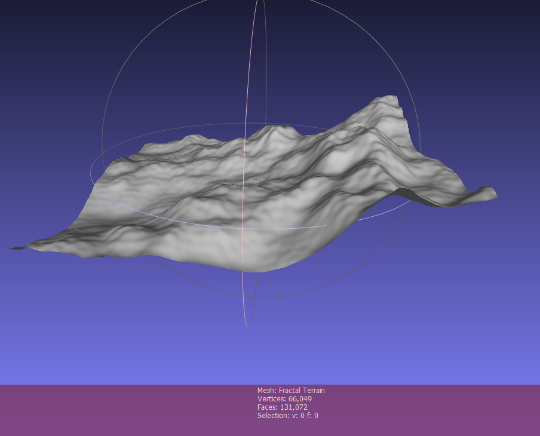
In this exam, you will assume these pirates live in a place that has a bunch of relatively small islands, surrounded by water, like the Earth’s Caribbean islands (near Dominica), the islands near Fiji, or maybe the islands near Indonesia.

In this exam, you will need a number of different models:

* An island model (just 1 this time, but from the same “terrain to island converter” program)
* A light house (Lighthouse\_Combined\_xyz\_n.ply)
* A run down house (Old\_House\_Combined\_xyz\_n.ply)
* A sky pirate ship (Sky\_Pirate\_Decimated\_Cannons\_Combined\_xyz\_n.ply)
* A small factory building (Small\_Factory\_3d\_model\_xyz\_n.ply)
* A small wooden house (Wood\_House\_xyz\_n.ply)
* Several trees (palm-centred\_xyz\_n.ply, tree1\_xyz\_n.ply, tree3\_xyz\_n.ply, and Trees\_xyz\_n.ply)

1. (5 marks) Using MeshLab, generate a SINGLE island, in the following way:

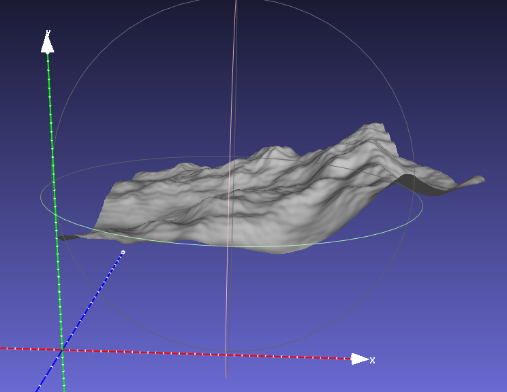
* Open MeshLab (without opening a model). This will open it with an empty “project”
* Choose “Filters”, then “Create New Mesh Layer”, then “Fractal Terrain”
* In the “Fractal Terrain” dialog box, choose “**Hybrid multifractal terrain**” (“Algorithm” dropbox.)
* Change the “Max Height” to **0.5**.



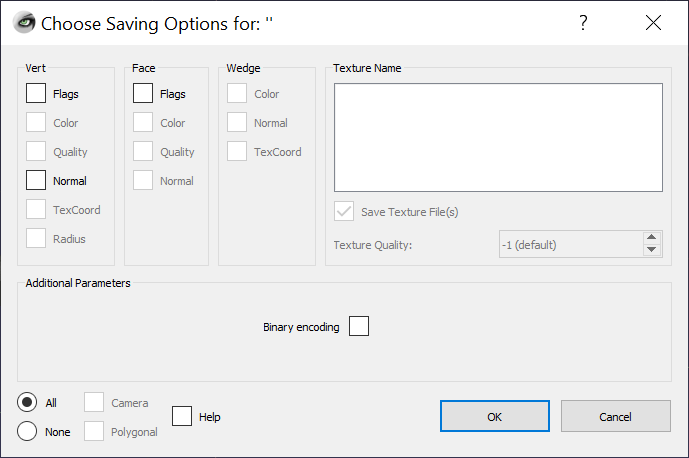
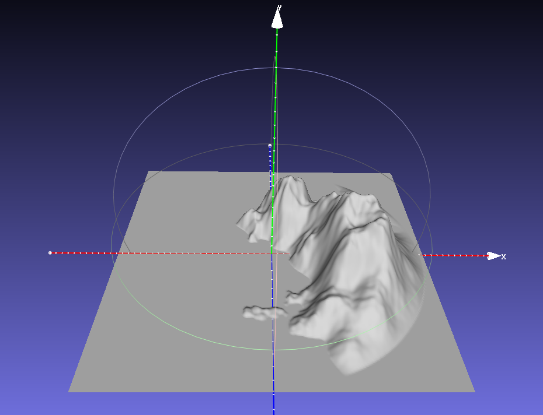
* ***Use the first 4 numbers of your STUDENT NUMBER for the “Seed” value (the default is 2.0).*** Note: It seems that really large numbers (like your entire 8 digit student number, make the terrain ‘blocky’)

With a “Seed” value of 2.0, you will get this 🡪

MeshLab assumes that “up” is “z”, so we need to adjust this. Turn on the “axis” drawing by choosing “Render”, “Show Axis” to make this clear (if you want).



* Choose “Filters”, “Normals, Curvature, and Orientation”, then “Transform: Rotate”.
* Type in “-90” in the “Rotation Angle”, leaving the “Rotation on:” set to “X axis”, and click “Apply”, which will get you this 🡪   
    
  *(Note that you might have to rotate the window so the Y axis (the green line) is facing upward, which isn’t the default I think...)*
* Save this model with JUST xyz and NOT in binary form (“File”, “Export Mesh As…”, uncheck the “Binary encoding”, and choose OK.



🡨 Like this, with nothing checked.

* Download and compile the “Terrain\_to\_Island\_Converter” project and convert the mesh you made into an island. This takes the model file name as an input and generate an “island” mesh (like the one on the right 🡪) called “output.ply”.
* You will use this model as the island your pirates live on!

A few notes about the format of the models:

* We’ve been using models that have xyz & normals & RGBA & UV coordinates.
* **However, the models here only have xyz & normals.**
* This exam doesn’t assume you’ve using textures (since we just learned them), but the code in class assumes that the files contain them.
* There are a number of ways to get around this including:
  + Generating the additional items in MeshLab (or something else).   
    (You could even paint the items in MeshLab if you want, though I don’t recommend it)
  + Altering your code to simply add or ignore these values.
  + Make some utility that loads the “xyz + normals” format and saves them in whatever format your code requires.
* What I’m saying is that it’s a very reasonable assumption that you can take these slightly (really trivially) different files and load them.

1. (30 marks) Create a day time scene where the pirates are “at rest”, specifically:

* There should be one large point light, or a directional light, to illuminate the entire scene with something that looks like “daylight”.
* The pirate base is made up of a few buildings, placed on the island model.
  + 1. Note that the scale of the island should be “appropriate”, so the island should be MUCH larger than the buildings or ship.
    2. Place the “Small Factory” at the highest point of your island (that it will fit).
       - This will be where the sky pirate ship will dock: we’ll assume that the two round things are docking locations.
    3. Place the “Lighthouse”:
       - If your island has multiple mountains, place this on the next tallest point (the “Small Factory” is already on the highest).
       - If your island has one, large mountain, place this in the water, a little ways from the shore.
    4. Place the “Old House” and the “Wood House” at relatively “flat” locations around your island. They can be “clustered together” or far apart, but if they are close to each other, there should be an appropriate distance between them (for someone to walk).
    5. Place and at least one instance of each of the tree model on the island, as well.
    6. Place the camera above the island, looking down at it, and just far enough away that you can see all the buildings and trees.
    7. Pick whatever colours you’d like for the houses, as long as it looks like “wood” – which could be some “brown wood” colour, or maybe the pirates painted them with bright colours! Like they are from Nova Scotia or parts of Spain or something!  
         
       They better *not* be boring white or grey or something, though...

1. (40 marks) Create a scene of the Sky Pirate ship coming home and docking, at night:

* Remove the “sunlight” you used in question 2 (either the large point light or the directional)
* Place the “Sky Pirate” (ship) model near and above the “Small Factory”. The idea is that the pirate ship about to “dock” with the tall towers on the factory.
* Place small, reddish-yellow-orange lights (sort of like firelight) point lights, inside each of the three (3) buildings, so they look like they are lit up from the inside. It’s OK if there is a *little* light spilling out from the buildings, but not much.
* In the ship model, you will notice that there is a “main” deck (where the guns and some barrels are), with two, smaller decks above this – there are ladders leading between these two decks). Notice that there are two small areas between the decks, just “behind” the sets of ladders; at the front of the ship, there are three boxes, and at the back of the ship, there’s a lot more boxes as well as some barrels, stacked on one side.
  + Place two, small “firelight” lights (like the ones you used for the buildings), in each of these two “between the decks” areas. Sort of like if there was a lantern hanging from the upper deck. They should be bright enough to *just* illuminate the decks.
* Place a small, bright white light at the top of the light house. This should be a fair bit brighter than the “firelight” in the buildings, so should be lighting up more than just the top of the light house.
* Place a spotlight to light up the pirate ship. This light should come from (approximately) from one of the upper windows of the “Small Factory”, and point up and “at an angle” to illuminate the “balloon” (air bag) part of the pirate ship. It should be large enough to light up the balloon portion of the ship, but (ideally) nothing else, though it’s OK if there’s a *little* light spilling onto the ship portion. The light should have a fairly “crisp” edge to it (the penumbra).
* If you need to, adjust the camera to see this scene.
* To “move” the sky pirate ship, simply add a small value to the position of the ship over time. If you want it to move in some sort of specific direction, then here’s a simple way to do that:
  + Take the point you want the ship to go to (xyz).
  + Take the point where the ship starts (xyz).
  + Subtract one from the other to get a distance between these points, then normalize (glm::normalize) or divide this distance and divide by a large number – until the resulting value is very small – this will be the change in position each frame.
  + Each frame, add this small value to the position of the ship and like magic, it will fly!
  + If it’s moving to slowly, increase this value. If it’s too fast, then decrease it.
  + I’m not worried about the *actual* speed as long as it moves gradually enough to see it.   
    I’m assuming it would fly as fast as a blimp or zeppelin would (not a rocket ship).
  + There’s a number of ways to tell when the pirate ship should stop:
    - Compare it’s distance to its end point each frame and when that distance is <= to some distance, stop moving it (or set that small movement amount to zero)
    - Count how many frames or seconds have elapsed. Remember, it’s moving that small amount/frame, so you can figure out how many frames that is.
* Note I’m not looking for super precise physics here, just movement so the spot can follow it.

1. (20 marks) The sky pirate flies away. Keep the lighting the same with the exception of the spot light.

* Place the camera to the “left” (port) side, and slightly “behind” the pirate ship, like in a “3rd person view” in a video game. The camera should be looking “down” at the “Small Factory” model.
  + To clarify: as the ship flies away, the camera moves with the ship, but continues to look at the factory.
* Make the pirate ship slowly fly, in a straight line, from where it was in question 3, away from the island. You should move it along a path that makes if fly over as much of the island as possible.
* Place the spotlight at the front of the ship, looking directly down, and in front of the ship, approximately at a 20-30 degree angle toward the front – the idea is the light is illuminating where the ship is about to fly over, so it’s not directly “forward” and not directly “down”.
* The spot light should move with the ship (so what it’s shining on should change as well).

That’s it! You’re done! Have some rum or tea or beer (or whatever pirates drink) to celebrate!