In addition to this cover page, this exam should have four pages of problems labeled A–D.

Feel free to ask clarifying questions. If a problem is unclear and you cannot obtain clarification, then write your interpretation of the problem, so that I can evaluate your solution relative to your interpretation. You might be penalized, if your interpretation makes the problem much easier than it should be. Certainly you should never interpret a problem in a way that renders it trivial.

You may cite material (definitions, algorithms, etc.) that we have developed in class or in the assigned homework. You do not need to re-develop any of that material. You may not cite other material without developing it first.

Show your work, in as organized a manner as possible. Incorrect answers with solid work often earn partial credit. Correct answers without explanatory work rarely earn full credit. **Pictures often help!**

Write as if your audience is a typical classmate — not a professor. In doing so, you (hopefully) show enough detail, that I can evaluate whether you understand your arguments.

You have 60 minutes to complete this exam. Good luck. :)

A.A. In our first project, we learned only those features of the triangle rasterization algorithm that were absolutely necessary. Why is clipping at the near plane necessary?

A.B. Why is clipping at the far plane not necessary? And so why would anyone do it?

B.A. What is the swap chain? What Vulkan machinery does it involve?

B.B. We build the swap chain near the start of the program's execution. Under what circumstances do we rebuild it during execution?

C.A. Draw the scene graph that we were using around version 560, when we were rendering a landscape with many trees.

C.B. For each of the five GPU (not CPU) resources below, indicate which ones scaled *linearly* with the number of trees, and which ones were *constant* with respect to the number of trees.

processor time

memory for meshes

memory for textures

memory for scene-wide uniforms

memory for body-specific uniforms

This question is about the diffuse term in Phong lighting with a single positional light. Your answers should show specific calculations, written in math or pseudocode. The pieces should be annotated with their meanings in plain English. Remember that pictures are often helpful.

D.A. What is the diffuse term?

D.B. What is the diffuse intensity?

D.C. How is the unit direction from the fragment to the light calculated?