CMPT385 Midterm Exam
Closed Book
November 1, 2004 In-Class
50 minutes

Please read all the questions carefully. A portion of the marks awarded will be for the style and the clarity of your answer.

1. **Geometric Transformations (30 marks)**
   a. A computer program calls these OpenGL commands in the following order:

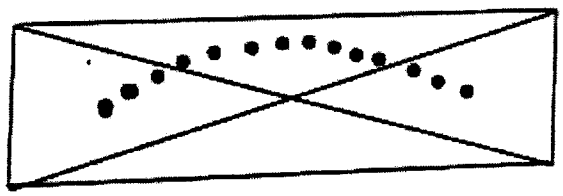
      glScale*(...);
      glRotate*(...);
      glTranslate*(...);
      ...// object is drawn

      The commands are applied to the object in the reverse order to the procedure calls. That is, the object is first translated, then rotated, then scaled. Explain why this happens in terms of the modelview matrix.

   b. Calls to glVertex*() rarely specify the fourth coordinate, i.e., a homogeneous coordinate. Explain the importance of the homogeneous coordinate system, and why the homogeneous coordinate is rarely used.

   c. Do the rotation and ~~transformations~~ translation 1) *always* commute, 2) never commute, or 3)sometimes commute? If your answer is 1, justify it with an example. If your answer is 2), justify it with a proof. If your answer is 3) justify it with two examples.

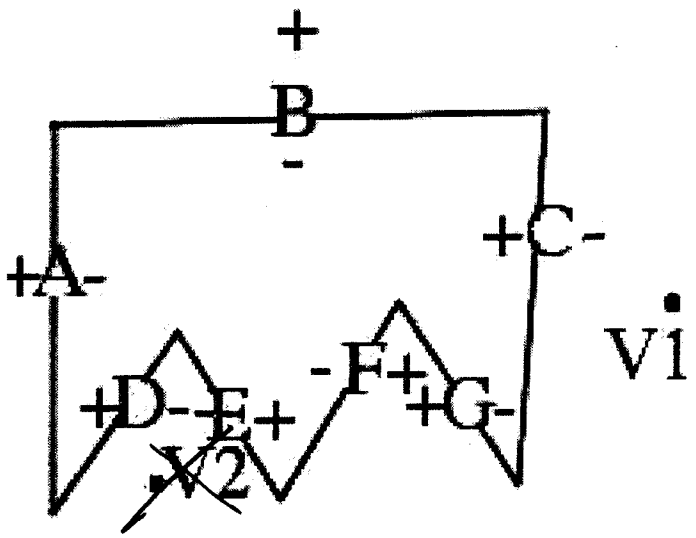
2. **Lighting** (20 marks)
   a. The three-term lighting model consists of ambient, diffuse and specular lighting. Define each term, and the key inputs needed to compute each.
   b. Consider a flat surface constructed from large triangles (as shown). A novice programmer writes an OpenGl animation. The programmer wanted the animation to depict a small spotlight traversing the path indicated by the dots. (This image is hand drawn, do not worry about minor issues). The programmer creates a spotlight, points it directly at the surface, but does not get the intended animation. Explain what the programmer actually sees, why that happens, and what the programmer needs to do to get the intended effect.



3. **Depth** (10 marks)
   a. The modelview matrix takes vertices in a virtual world and transforms them to desired positions in the virtual world. Describe the impact of the projection matrix, clipping, and the z-buffer on which vertices finally appear on screen.
   b. What is the mathematical relationship between the *view volume* and the size of the screen window?

4. **BSP Trees** (20 marks)
   a. The following polygon is intended to represent a view from the top of a set of equal sized rectangles *A, B, C, D, E, F,* and *G*. The plus (+) and minus (-) signs indicate the sign of the equation of the plane for the associated rectangle.

   Suppose the rectangles arrive at a BSP construction algorithm in the order B D F A C E G. Show the resulting BSP tree. Label arcs with + and – signs, as in class.



   b. From your BSP tree, show the order the rectangles will be drawn from viewer positions *V1* and *V2*, as shown on the diagram.

5. **Splines** (10 marks:)
   A spline can be formulated with the equation

$$Q = G * B * T$$

   a. Briefly explain the role of each variable in this formulation.
   b. Compare the relative benefits of the natural cubic spline and the uniform nonrational b-spline.

-End of Exam-2 pages