Royal Melbourne Institute of Technology  
School of Computer Science and Information Technology  
INTE1113/2033 (IT543) 3D Web Technologies  

Semester 1 2002

**Date:** Thursday 4th July  
**Time:** 1:45pm to 4:00pm  
**Duration:** 2 hours  
**Number of Pages:** 5

**Instructions to Candidates**

This examination accounts for 50% of the total marks for the subject.

This examination totals 120 marks (or 1 mark per minute).

Answer all questions: 1 to 6.

Marks for each question are shown.

This examination is closed book.

Calculators having programs or stored data are not permitted.

**Question 1**

Consider the following VRML source:

```
#VRML V2.0 utf8

Shape
{
  geometry Sphere
  {
    radius 2.0
  }

  appearance Appearance
  {
    material Material { diffuseColor 0.0 0.0 1.0 }
  }
}
```

(a) Describe what this would look like in a VRML viewer.

(b) Describe the purpose of the `Shape` node.

(c) Describe the purpose of the `Appearance` node.

(d) Give the VRML source for a red box with a width of 2 units, a height of 3 units, and a depth of 1 unit. Include a header and appropriate comments.

\[4+3+3+10 = 20 \text{ marks}\]
Question 2

The VRML Transform node is used for translating, scaling and rotating shapes in three dimensions. For the following illustrations give the required VRML Transform, omitting the children. Assume a right-handed co-ordinate system, with the z axis pointing out of the page.

(a)  

(b)  

(c)  

(d)  

(4+4+4+8 = 20 marks)
Question 3

VRML is designed for web-based, real-time interactive three dimensional content.
(a) Describe the use and benefits of using DEF, USE and PROTO.
(b) Describe the advantages of JPEG images for VRML textures.
(c) Describe the advantages of PNG images for VRML textures.
(d) Describe the benefit and use of the VRML LOD node. Include a description of the fields of the LOD
node: center, range and level.

(6+3+3+8 = 20 marks)

Question 4

Some shapes such as spheres, cones and cylinders are built into VRML. Others may be constructed from
lines and faces, as necessary. Consider the following two dimensional shape:

![Diagram of a two-dimensional shape]

Assume that the object is flat, that is, $z = 0$.
(a) Write the VRML code for an IndexedLineSet node. Include the coord and coordIndex fields.
(b) Write the VRML code for an IndexedFaceSet node. Include the coord, coordIndex, ccv, convex
and solid fields as necessary.
(c) Are the face(s) in your IndexedFaceSet convex? Explain why, or why not.
(d) Explain your choice of TRUE or FALSE for the solid field of your IndexedFaceSet node.

(10+10+5+5 = 30 marks)
Question 5

Lighting and materials affect the appearance of shapes in VRML.

(a) Describe the lighting used in each of the VRML scenes above.

(b) Give the VRML Material node for each of the spheres above.

(6+6 = 12 marks)
Question 6

Transformations in VRML may be nested, forming a hierarchy of shapes and relative transformations between them. Consider the following example of a robot arm consisting of three joints connecting three segments:

```vrml
DEF SHOULDER Transform
{
  children
  [  
    DEF UPPER_ARM Shape { ... }
    DEF ELBOW Transform
    {
      children
      [  
        DEF LOWER_ARM Shape { ... }
        DEF WRIST Transform
        {
          children
          [  
            DEF HAND Shape { ... }
          ]
        ]
      ]
    }
  ]
}
```

(a) How are the position and orientation of other nodes affected by applying a rotation to the SHOULDER node?

(b) How are the position and orientation of other nodes affected by applying a rotation to the WRIST node?

(c) The pitch of the lower arm relative to the upper arm can be adjusted by rotating around the x axis. Write a VRML OrientationInterpolator node for animating the elbow joint as follows:

```
angle
90
60
30
0.0 2.0 t
```

(d) Using the following time sensor, write the remaining VRML source for animating the elbow. You may assume that the time sensor is triggered elsewhere.

```vrml
DEF TIMER TimeSensor
{
  cycleInterval 2.0
  loop TRUE
}
```

(2+2+8+6 = 18 marks)

THE END