COMPUTER SCIENCE TRIPOS Part II – 2014 – Paper 7

1 Advanced Graphics (NAD)

(*a*) Assuming that it is mapped to a square with texture co-ordinates from $(0, 0)$ to $(1, 1)$, sketch a picture of the procedural texture map generated by the following Java code. Use textual annotations to indicate the colours of the various parts of the picture. [7 marks]

```
Color BLUE = ...;  Color GREEN = ...;  Color WHITE = ...;
Color parametricTexture(double tu, double tv) {
  double r1 = 2 * Math.sqrt(  (tu - 0.25) * (tu - 0.25)
                            + (tv - 0.5)  * (tv - 0.5) );
  double r2 = 2 * Math.sqrt(  (tu - 0.75) * (tu - 0.75)
                            + (tv - 0.5)  * (tv - 0.5) );
  double f = f(r1) + f(r2);
  return (f > 0.45 && f < 0.55) ? WHITE :
          GREEN.times(f).plus(BLUE.times(1 - f));
}
private double f(double r) {
  if (0 <= r && r < 0.333)      { return 1 - 3*r*r; }
  else if (0.333 <= r && r < 1) { return 1.5*(1-r)*(1-r); }
  else                          { return 0; }
}
```

(*b*) Write brief notes that explain the following.

(*i*) Explain *Perlin Noise*, including how it differs from white noise. [3 marks]

(*ii*) Explain *Barycentric Co-ordinates*, including how they are calculated. Diagrams are encouraged. [3 marks]

(*c*) Given a ray $R(t) = O + Dt$ and a unit sphere S, initially centred on the origin and subsequently transformed by affine matrix M, where M represents the transformation of the sphere from local to world coordinates:

(*i*) state the centre of the sphere in local co-ordinates and in world co-ordinates;

(*ii*) give an expression in terms of t for the local co-ordinates of the intersections between R and S;

(*iii*) give an expression for the world co-ordinates of the same intersections; and

(*iv*) give an expression for the world co-ordinates of the normal at those intersections. [7 marks]