MATH/FA 1020 – Math in Art

Summer 2016

Worksheet 4

Deadline:
If you are submitting this for bonus (Summer 2016 - A01 *only*), it is due on June 15th, 2016.
Objective:
There are three objectives of this worksheet. One objective is to explore Platonic solids and some related objects. The second objective is to practice the constructions associated with conics, and related objects. The third objective is to begin consideration of concepts related to the hyperbolic geometry. You are encouraged to use (translucent) colour to accentuate the objects.

1. Draw two or three solid versions of platonic solids (they may be different or the same one repeated). You may copy the line drawing that are in the notes, but you are expected to obliterate the 'back' edges. Use colour or shading to give them a 3-dimensional look.

2. Draw (or print out) a copy of a net for either the dodecahedron or the icosahedron. Visualize the folding of the object, and use colour to indicate where edges will come together. (Alternately, cut out the net, fold it, colour all of the edges, unfold it and glue it back onto the page.)

3. Look up the Archimedean solids (in the book, online, or the display outside of the science faculty office in Machray Hall.) Find a favourite; sketch it or describe it or draw its net. Give some justification as to why it is your favourite. (The justification should make it clear that you are familiar with other Archimedean solids.)

4. Create two copies of the same angle, as is necessary for the construction of a parabola. In the first, construct a parabola using tangents, done with equally spaced markings on the lines. On the second angle, alter the construction to use a different spacing for each of the lines. (For this second one, use the same measure along one of the lines, and then alter the distance and then use that new distance along the second line. The object created is known as a skew parabola.)

5. Construct a fairly large parabola. Imagine the lines tangent to the parabola form a grid. Using techniques similar to those used for morphing a drawing in perspective or on a circular grid (see pages 9 and 10 from Worksheet 3), create a drawing morphed on the grid of lines from the tangents to a parabola.

6. At the top of the page, construct a (wide) rectangle. Imagine that there is an ellipse that fits in the rectangle. Construct the tangents to the bottom of that ellipse. Use the fractions $^1/_8, ^2/_8, \ldots, ^7/_8$ in this construction.

7. Start by making a few concentric circles on a page (at least 5). The draw a line through the centre of the circles. Construct parallel lines, perpendicular to the line through the centre, equally spaced about the centre. (This is the set up for the hyperbola, done in the reverse order as was presented in class.) Construct the rectangles for each circle (passing through the 6 points of intersection of that circle and the lines). Sketch the hyperbola.

8. This is a variant on a Cardioid construction mentioned in class. Draw a small circle on the page. Pick a point on the page *not* on the circle. Draw several circles, all which have there centres on the small circle, and has a radius that passes through the chosen point. (The object this 'creates' is known as a limaçon.) If you have space, try once with the chosen point on the inside of the small circle, and another with the point on the outside.

9. Draw circles which intersect. Construct all of the lines necessary to indicate the angle between the circles. Repeat with other circles. There should be a minimum of 3 angles present. (Hint, keep track of the centres of the circles before you create them. You will need the centres to find the tangent.)

10. Draw a medium sized circle on the page. (This will be the hyperbolic plane.) Pick a minimum of three points on the circle, and construct the tangents at those points. Construct hyperbolic lines by placing the compass somewhere on the tangent and drawing the arc that passes through the point on the circle where the line is tangent. (You should create at least 4 lines from each tangent. Note why all lines centred on a tangent are, in the hyperbolic sense, parallel.)

    An addition (optional) challenge for this page is to attempt to create a line drawing in the hyperbolic plane. What relation would that drawing have to a Euclidean line drawing?