

Math 10270 : Final  
May 5, 2016

Name:

---

**Sign the pledge.** “On my honor, I have neither given nor received unauthorized aid on this Exam”:

---

1. (10 points.) (i) Sketch a Roman semicircular arch made up of 9 identical voussoirs.

(ii) Assuming each voussoir weighs 200 lb and the keystone is held in place without friction, find the forces acting between each pair of adjacent voussoirs.

2. (10 points.) A 'bridge' truss consists of a triangle supported at its base by two vertical forces and carries a 500 lb load at its tip as shown.

Is the horizontal beam under compression or tension? What is the magnitude of the force exerted by this beam?

3. (10 points.) (i) A Gothic arch has a span of 70ft. Find the height of the arch at its highest point.

(ii) Repeat part (i) for a Roman arch of span 70 ft.

(iii) Repeat part (i) for a Gothic acute fifth with span 70 ft.

4. (10 points.) What shape in the plane is described by the equation  $3(x + 1)^2 + 4(y + 2)^2 = 1$ ? Sketch the graph and label the major and minor axes and their lengths. Sketch also the line  $y = x$ . Find the points of intersection with the graph just drawn.

5. (10 points.) (i) Make a rough sketch of the graph of the equation  $x^2 + y^2 + (z - 3)^2 = 16$ .

(ii) Describe the intersection of this graph with the plane  $z = 5$ .

6. (10 points.) Talk about some features distinguishing classical and Renaissance architecture.

7. (10 points.) (i) Find parametric equations of the line joining the points  $(0, -2, 5)$  and  $(2, 4, 8)$ . Find the intersection of this line with the  $xz$ -plane.

(ii) Suppose that an artist's eye is at the point  $(0, -2, 5)$  and a canvas lies in the  $xz$ -plane. Sketch the perspective image of a rectangular wall with corners at  $(2, 4, 0)$ ,  $(2, 10, 0)$ ,  $(2, 4, 8)$  and  $(2, 10, 8)$ .



8. (10 points.) (i) What is hinging failure in an arch? Draw a sketch.

(ii) Give a brief statement of the Safe Theorem.

(iii) What is the relation of this to the dome of St. Peter's?

9. (10 points.) Consider the hanging truss shown.

(i) Assuming the truss to be symmetric and in equilibrium find the vertical components of the forces in each beam.

(ii) Suppose that the angle  $\theta_1$  is 40 degrees. Find the horizontal components of the forces and the angle  $\theta_2$ .

10. (10 points.) Suppose that a weightless horizontal beam as shown is 50 ft long, carries a load of 500 lb at a point 20 ft from the left edge, and is supported by vertical forces supplied by columns at either end.

Calculate the normal force, shear force and bending moment of the right-half on the left-half if the beam is cut at a distance  $x$  from its left-hand column. Sketch graphs of the shear force and bending moment as functions of  $x$ .