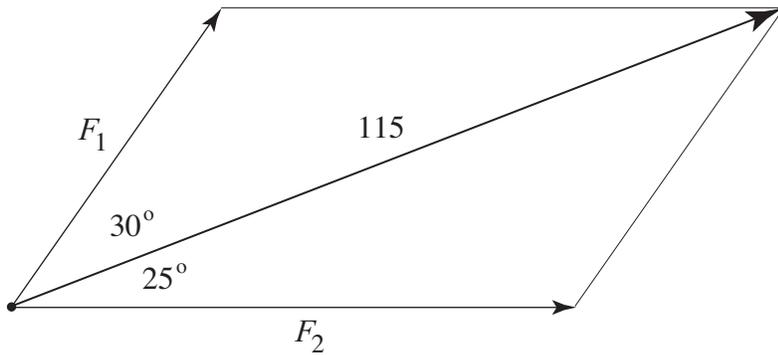


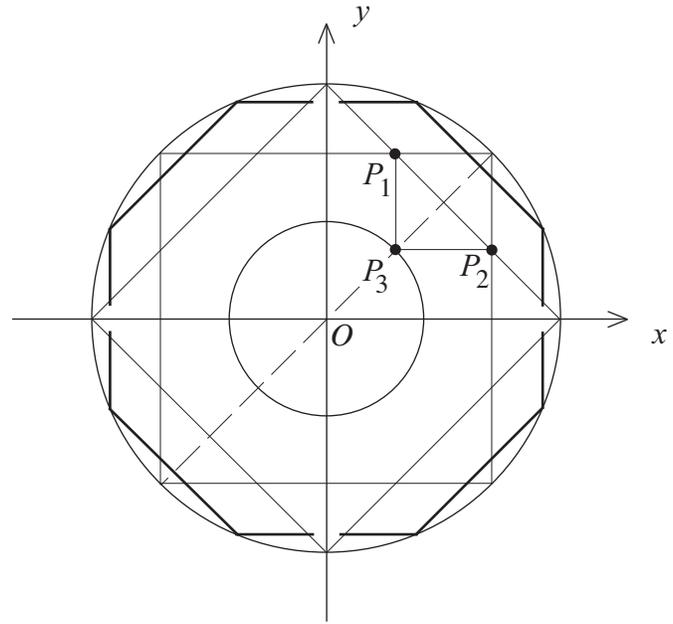
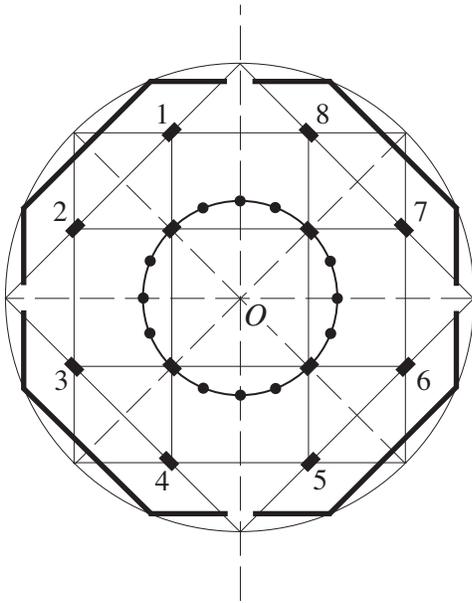
MidTerm Exam Math 10-270, March 25, 2013. Name

1. (10 pts) Complete the square for the polynomial  $-3x^2 - 7x + 2$ . (Note that you are not asked to solve  $-3x^2 - 7x + 2 = 0$ .) Work out the solution in the space provided and place your final answer into the box on the left. Use your result to answer the questions: what is the maximum value that  $-3x^2 - 7x + 2$  has and for what  $x$  is it reached. Place your final answers into the box on the right.

2. (15 pts) The figure below represents two forces  $F_1$  and  $F_2$  and their resultant of 115 pounds as well as the angles between each of the two forces and the resultant. Use the Law of Sines to determine the magnitudes of  $F_1$  and  $F_2$ . Work out your solution in the space provided and put your final answers into the box below.



3. (10 pts) What is the building whose octagonal plan is depicted in the diagram below on the left? What does the inner circle represent? What do the short heavy strokes represent?



What follows are problems in two dimensional coordinate geometry. Turn to the diagram on the right. Let  $R$  be the radius of the circle of the perimeter. Solve problems (a) through (e) in terms of  $R$  in the spaces provided (they suffice) and put the answers into the corresponding boxes.

a) (5 pts) The equation of the line through the points  $P_1$  and  $P_2$ .

b) (5 pts) The length of a side of the two inscribed squares.

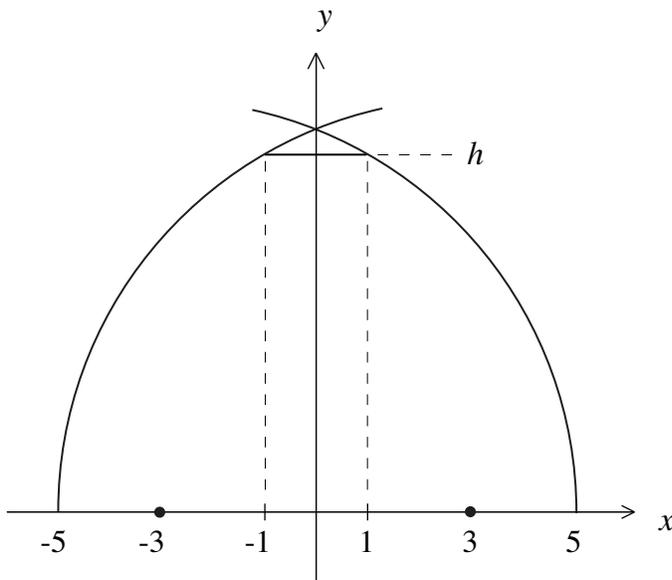
c) (5 pts) The coordinates of the point  $P_1$ .

d) (5 pts) The coordinates of the point  $P_3$ .

e) (5 pts) The radius of the inner circle.

4. (15 pts) 3. Illustrate and describe with carefully drawn diagrams the principal structural format of a Gothic cathedral. Note that “structural” refers to loads, thrusts, and other forces.

5. (15 pts) The figure shows an abstract vertical section of the inner surface of a dome in an  $xy$ -coordinate plane. The arch, in the shape of the Gothic fifth, is determined by two circular arcs. Find equations of the two circles on which the arcs lie. Insert them into the two larger boxes below (one equation into each box). The horizontal segment with  $y$ -coordinate  $h$  represents the base of the lantern of the dome. It is 2 units long. Determine  $h$  and put it into the box on the right.



6. (10 pts) What constructional strategies did Brunelleschi deploy that made it possible to build the dome of the Santa Maria del Fiore without using a massive centering structure that reached from the floor of the cathedral to support the dome? (Three well chosen sentences are enough to answer the question.)

$$\text{Formulas: } \frac{\sin \alpha}{a} = \frac{\sin \beta}{b} = \frac{\sin \gamma}{c} \quad c^2 = a^2 + b^2 - 2ab \cos \theta \quad H_0 = \frac{W}{2} \cdot \frac{1}{\tan \frac{\alpha}{2}}, \quad H_1 = W \cdot \frac{1}{\tan \frac{3\alpha}{2}},$$

$$H_2 = W \cdot \frac{1}{\tan \frac{5\alpha}{2}}, \quad P_0 = \frac{W}{2} \cdot \frac{1}{\sin \frac{\alpha}{2}}, \quad P_1 = W \cdot \frac{1}{\sin \frac{3\alpha}{2}}, \quad P_2 = W \cdot \frac{1}{\sin \frac{5\alpha}{2}}, \quad \sin \alpha = \frac{L/2}{P}, \quad \tan \alpha = \frac{L/2}{H},$$

$$L \approx 2w\sqrt{d^2 + h^2}, \quad H \approx wd\sqrt{1 + \frac{d^2}{h^2}} \quad y = mx + b \quad (x - h)^2 + (y - k)^2 = r^2$$