MT3

MATH/FA 1020 Math In Art, Section L03
Mid-Term Exam, 11 March 2008

Time 60 minutes

NAME_____ Student Id#_____

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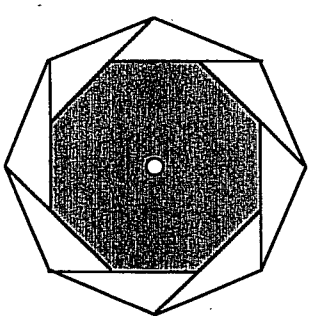
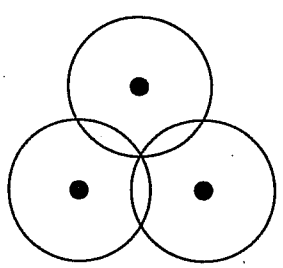
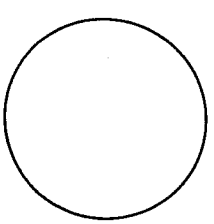
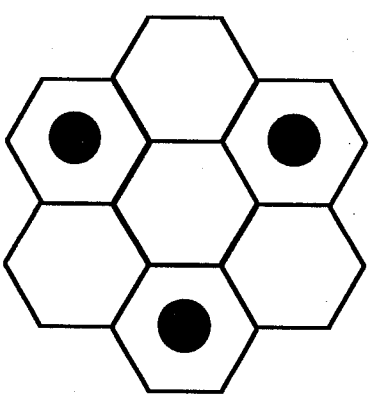
1. For each of the following designs given below, identify all the symmetries of the design.



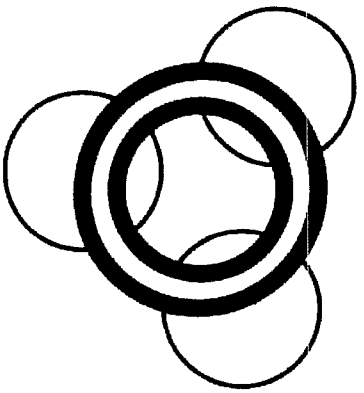
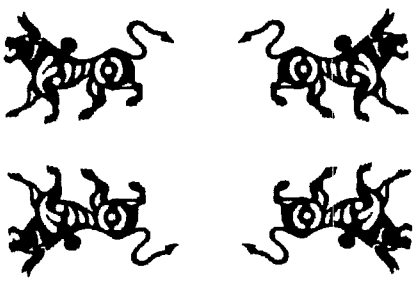
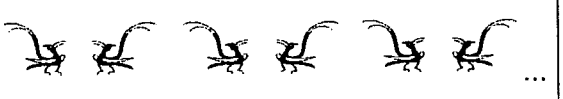




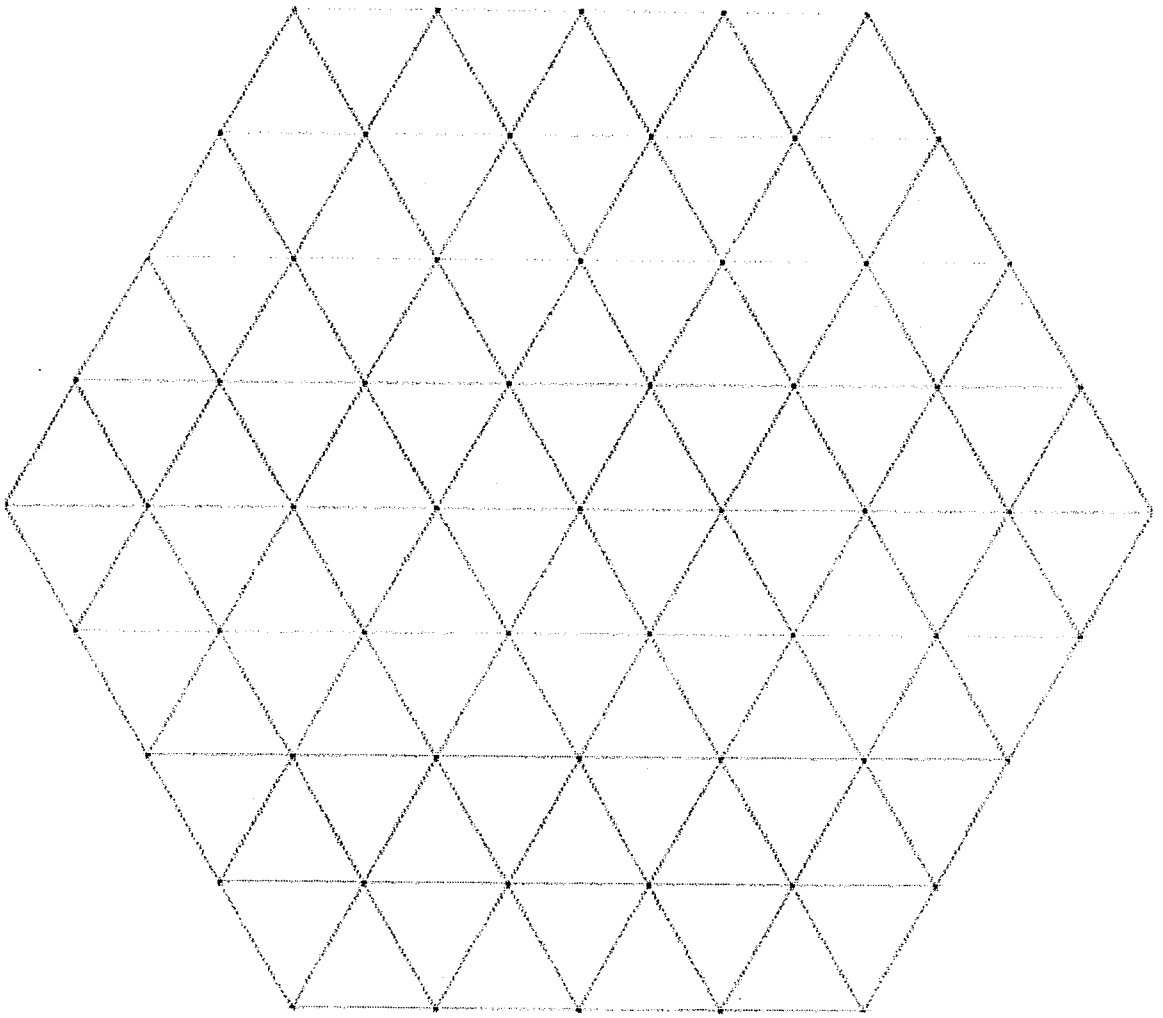
[14 points] **4.** Find the group of symmetries for each of the three objects shown below. If you claim a rotational symmetry, indicate the center of the rotation and the angle of rotation. If there are reflections, show the line of reflection. If there are translational symmetries show or describe the vectors of translation, drawing **precisely** at least one of them. [In all three cases the object is defined by the (black or gray) coloured points.]

OBECT	THE GROUP OF SYMMETRIES
	
	
 [This is a Frieze pattern and it extends without end both to the left and to the right.]	

4. Find the group of symmetries for each of the three objects shown below. If you claim a rotational symmetry, indicate the center of the rotation and the angle of rotation. If there are reflections, show the line of reflection. If there are translational symmetries show or describe the vectors of translation.
(The first diagram represents a crop circle. In the second and the third graphics we use tattoos preserved on a 3000-years-old Altai mummy.)

OBECT	THE GROUP OF SYMMETRIES
	
	
 [This is a Frieze pattern (the pattern extends without bounds both to the left and to the right).	

6. Following the idea suggested by the first three figures, create your own Escher-style artwork in the triangulr tiling of the plane given below (you may add "⁚", the eye, by free hand



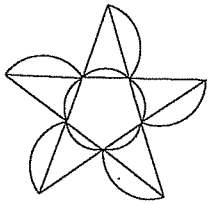
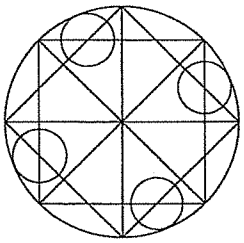
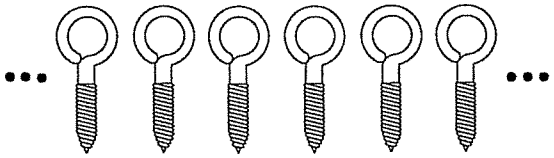
7. (a) Give the first ten members of the Fibonacci sequence.

(b) Give the recursive relation connecting the three consecutive Fibonacci numbers F_n, F_{n+1} and F_{n+2}.

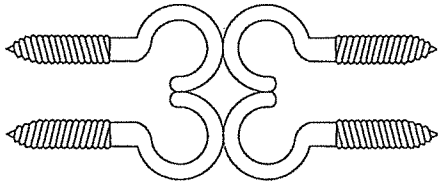
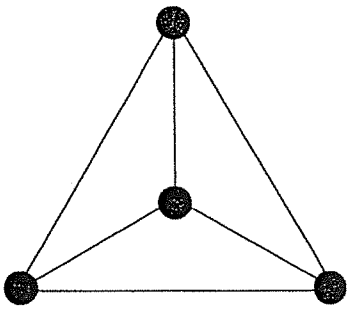
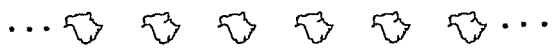
(c) You are given that $F_{18} = 2584$ and $F_{21} = 10946$. Without actually listing the Fibonacci sequence, find the values of F_{19} and F_{20}.

(d) Now list the sequence complete upto F_{21} and verify whether your answers agree.

[10] 5. Find the group of symmetries for each of the three objects shown below. Be sure to indicate in the object any centers of rotation, lines of reflection or vectors of translation. If you are indicating a rotation, be sure to include to angle of rotation.

OBJECT	SYMMETRIES
	
	
 This is a Frieze pattern. It continues infinitely in both directions.	

[10] 6. Find the group of symmetries for each of the three objects shown below. Be sure to indicate in the object any centers of rotation, lines of reflection or vectors of translation. If you are indicating a rotation, be sure to include to angle of rotation.

OBJECT	SYMMETRIES
	
	
 This is a Frieze pattern. It continues infinitely in both directions.	

3. Explain how each of the following is related to the golden ratio ϕ.

[2] (a) golden rectangle

[2] (b) golden acute triangle

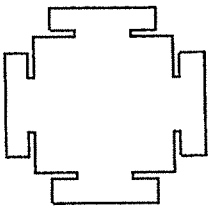
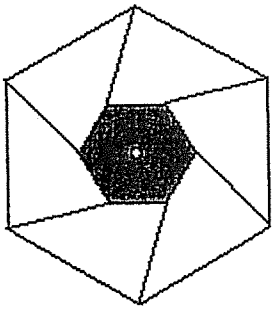
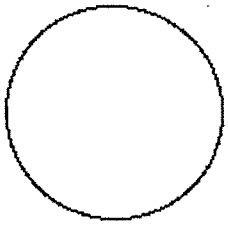
[2] (c) regular pentagon

(d) [bonus/2] Fibonacci numbers

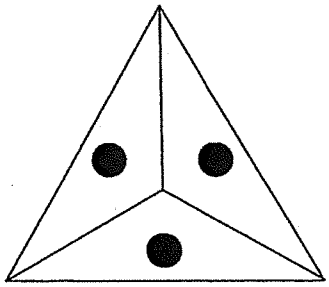
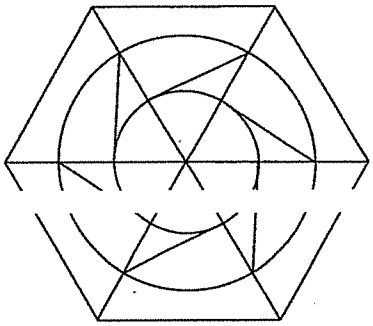
[3] 4. (a) What are the Fibonacci numbers? (Give a definition)

[3] (b) Given that $f_{13} = 233$ and $f_{15} = 610$ find f_{14}.

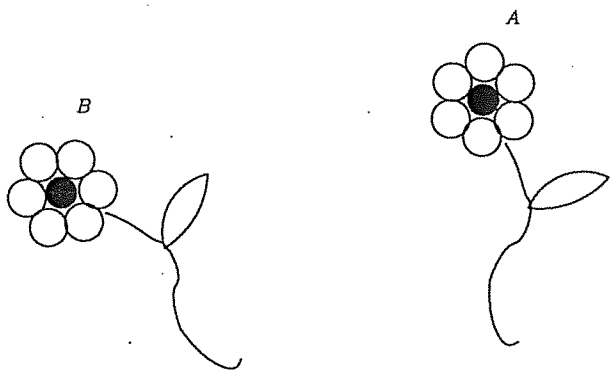
6. For each of the following designs given below, identify all the symmetries of the design.

Design D	Symmetries of D
	
N	
MOM	
	
 a circle	

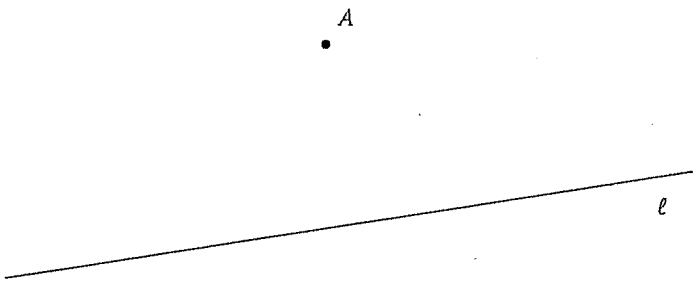
[10] 5. Find the group of symmetries for each of the three objects shown below. Be sure to indicate in the object any centers of rotation, lines of reflection or vectors of translation. If you are indicating a rotation, be sure to include to angle of rotation.

OBJECT	SYMMETRIES
	
	
 This is a Frieze pattern. It continues infinitely in both directions.	

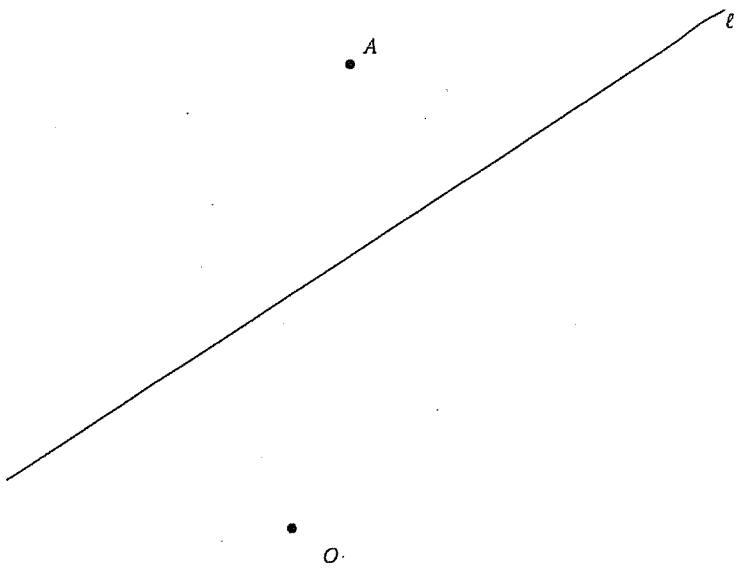
[6] 4. (a) In the diagram, if flower B is the image of flower A under a rotation, find the center (label it C) and angle (label it θ) of this rotation .



[4] (b) Find the image of the point A under the symmetry $f = \text{refl}(\ell)$.



[5] 5. (a) Given the diagram below, we define $f = refl(\ell)$ and $g = rot(O, 60°)$. Find the image of A after first applying f, then applying g.



[3] (b) Give a reasonable accurate drawing of an object that has exactly 5 symmetries (including Id). List the symmetries.