

NATIONAL UNIVERSITY OF SINGAPORE

FACULTY OF SCIENCE

SEMESTER 2 EXAMINATION 2001-2002

GEM1518K Mathematics in Art and Architecture

April/May 2002 — Time allowed: 2 hours

Matriculation number:

Instructions to candidates

1. This examination paper contains **twelve (12)** questions and comprises **fifteen (15)** printed pages.
2. Attempt to answer ALL questions. Answers should be written on this question paper.
3. Candidates may use calculators. However, they should lay out systematically the various steps in the calculations.

1. What is a Platonic solid? What is a deltahedron? Give at least one example of a deltahedron that is not a Platonic solid. What is the error Euclid made when he defined a Platonic solid?

2. Prove that there are only five Platonic solids and three Platonic tilings.

3. Complete this table for the Platonic solids.

Name of solid	Vertices	Edges	Faces	Sides of each face	Faces at each vertex

4. How many pentagons and hexagons are there on a football? What is the mathematical name of the shape of a football?

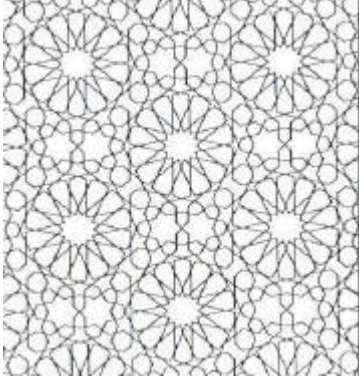
5. What is the definition of the golden ratio? Derive the numerical value. (If you don't have a calculator, you can leave the answer in exact form using roots.)

6. Show how to construct a golden rectangle.

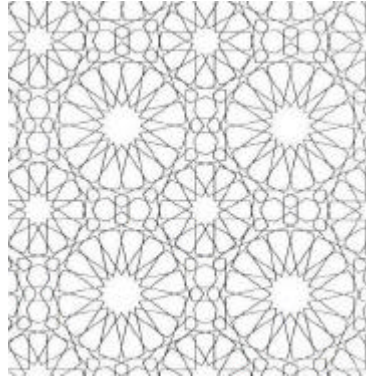
7. Use the chart in Attachment 1 to determine the symmetry type of the frieze patterns below.



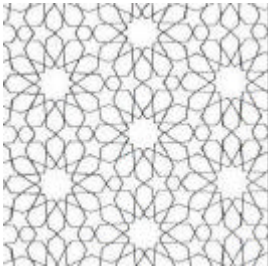
8. Use the chart in Attachment 2 to determine the symmetry type of the wallpaper patterns below.



Pattern:



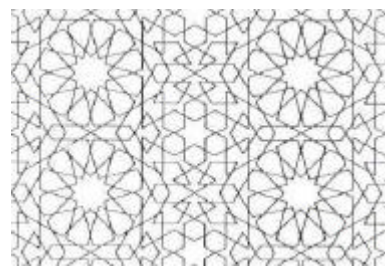
Pattern:



Pattern:



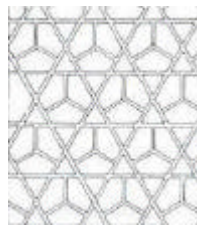
Pattern:



Pattern:



Pattern:



Pattern:

9. Draw the (3.6.3.6) Archimedean tiling.

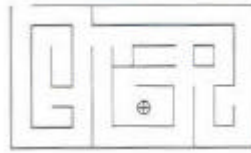
10. Show how to determine the dimensions of A4 paper. (If you don't have a calculator, you can leave the answer in exact form using roots.)

11. Show how to construct a curve with constant width, other than the circle. (Hint: Draw a Reuleaux triangle.) Give one example of why such curves are useful.

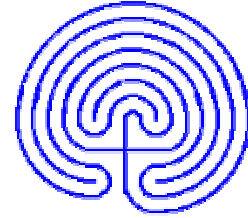
12. What is the difference between a unicursal labyrinth, a simply connected multicursal maze and a multiply connected multicursal maze? Label the three pictures. For which type will the hand-on-the-wall method always work?



Type:

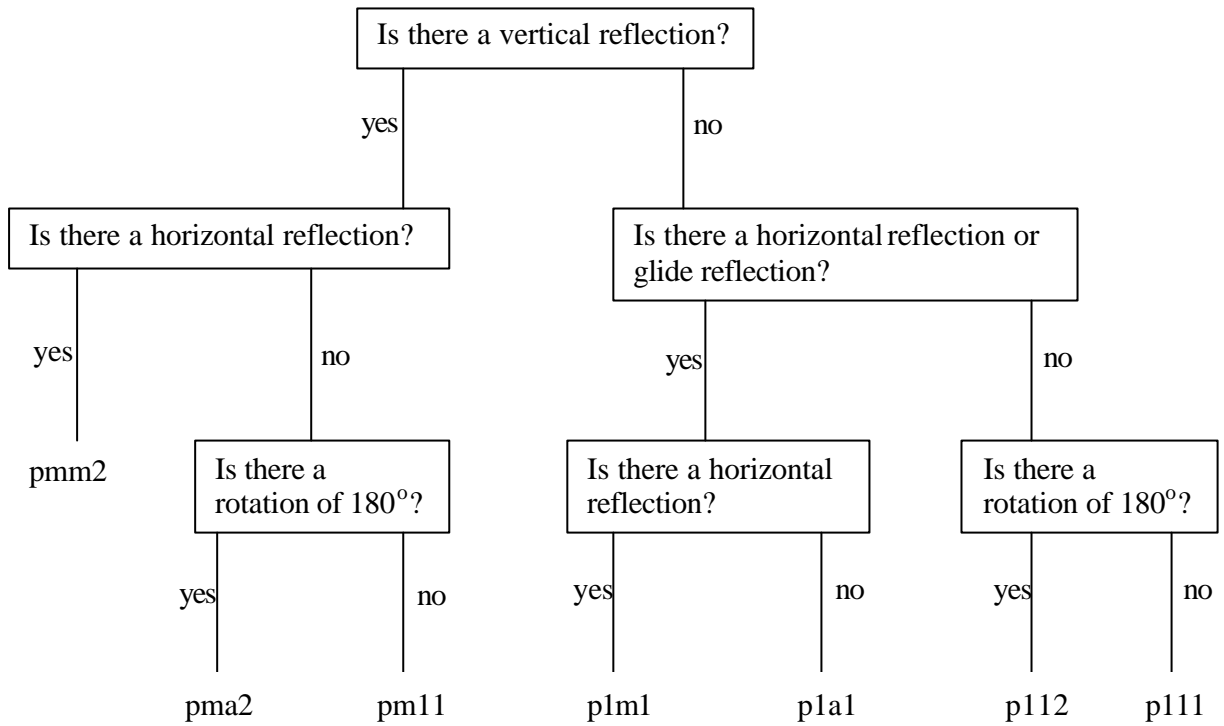


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Attachment 1: Flow chart for frieze patterns.



Attachment 2: Flow chart for wallpaper patterns.

