# MA1005: MATHEMATICS AND ARTS

**Effective Term**
Semester A 2022/23

## Part I Course Overview

**Course Title**
Mathematics and Arts

**Subject Code**
MA - Mathematics

**Course Number**
1005

**Academic Unit**
Mathematics (MA)

**College/School**
College of Science (SI)

**Course Duration**
One Semester

**Credit Units**
3

**Level**
B1, B2, B3, B4 - Bachelor's Degree

**Medium of Instruction**
English

**Medium of Assessment**
English

**Prerequisites**
Nil

**Precursors**
Nil

**Equivalent Courses**
Nil

**Exclusive Courses**
GE1349 Manifold Mirrors: The Crossing Paths of the Arts and Mathematics

## Part II Course Details

**Abstract**
This course aims to bridge the gap between the arts/humanities and mathematics. By providing a historical overview of key moments of interaction between arts and mathematics, it will introduce students to the basic mathematical concepts and

techniques that artists have used, including: symmetry, conics and polyhedra, perspective, and projective geometry. Students will propose an artistic project that is closely integrated with mathematics. The main focus of the course will be on the hands-on application of mathematical ideas in the creation of artistic projects. This project-based approach will provide students with basic mathematical literacy. It will also encourage them to discover for themselves the relationship between arts and mathematics.

**Course Intended Learning Outcomes (CILOs)**

| | CILOs | Weighting (if app.) | DEC-A1 | DEC-A2 | DEC-A3 |
|---|---|---|---|---|---|
| 1 | Describe basic mathematical concepts that are relevant to art | 35 | x | x | x |
| 2 | Apply mathematical concepts and techniques appropriately | 30 | x | x | |
| 3 | Generate and articulate a personal insight about the role of mathematics in the arts based on their integration of historical materials, mathematical understanding, and artistic creation. | 35 | x | x | |

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

**Teaching and Learning Activities (TLAs)**

| | TLAs | Brief Description | CILO No. | Hours/week (if applicable) |
|---|---|---|---|---|
| 1 | Lectures | Lectures about the history of mathematics in the arts and the basic concepts and techniques used. | 1, 3 | 26 hours in total |
| 2 | Tutorials | Tutorials that develop a more in-depth understanding of the mathematical concepts, including short programming exercises, with the aim of ensuring the student’s mathematical literacy. | 1, 2 | 7 hours in total |

| | | | | |
|---|---|---|---|---|
| 3 | Project presentation and class critique | Project presentation and class critique to help students apply their ideas in their creative work, and to articulate their own evolving sense of the place of mathematics n the arts. | 2, 3 | 6 hours in total |

**Assessment Tasks / Activities (ATs)**

| | ATs | CILO No. | Weighting (%) | Remarks (e.g. Parameter for GenAI use) |
|---|---|---|---|---|
| 1 | Presentation of one or more artworks with a strong mathematical component. | 1 | 30 | Students will discuss how mathematics interacted with arts/humanities, They will be assessed based on the theoretical depth of their analysis as well as their historical and mathematical accuracy. |
| 2 | Production of an artistic project | 2, 3 | 70 | Students are assessed on the extent of their application of mathematical concepts in their creative work and on the clarity and accuracy of their presentation. |

**Continuous Assessment (%)**

100

**Examination (%)**

0

**Additional Information for ATs**

100% Coursework (30% Homework assignment + 70% Final project (presentation and/or written project))

All students’ work will be individually assigned.

**Assessment Rubrics (AR)**

**Assessment Task**

1. Identification of mathematical structure in existing artworks

**Criterion**

Ability to identify mathematical structure in art pieces

**Excellent (A+, A, A-)**

High

**Good (B+, B, B-)**

Significant

**Fair (C+, C, C-)**
Moderate

**Marginal (D)**
Basic

**Failure (F)**
Not even reaching marginal levels

---

**Assessment Task**
2. Production and presentation of an artwork

**Criterion**
Capacity to articulate mathematical notions within a self-produced artwork

**Excellent (A+, A, A-)**
High

**Good (B+, B, B-)**
Significant

**Fair (C+, C, C-)**
Moderate

**Marginal (D)**
Basic

**Failure (F)**
Not even reaching marginal levels

---

# Part III Other Information

**Keyword Syllabus**

Space and geometry; vectors, angles, and motions of the plane; planar symmetry: rosettes, whirls, friezes and wallpapers; symmetry in art: rugs, Chinese lattices, the work of Escher; aesthetic trade-offs; homothecies, similarities and affinities; conics and their eclosion in baroque art; mathematics and music: the geometry of canons, symmetry in music; perspective; drawing systems; projective and hyperbolic geometry; non-Euclidean symmetries; rule-driven creation.

**Reading List**

**Compulsory Readings**

| | Title |
|---|---|
| 1 | Bruter, Claude. Mathematics and Art. Springer, 2002. |
| 2 | Cromwell, Peter. R. Polyhedra. Cambridge University Press. 1999 |
| 3 | Cucker, Felipe. Manifold Mirrors: The Crossing Paths of the Arts and Mathematics. Cambridge University Press, 2013. |
| 4 | Emmer, Michele (Ed). The Visual Mind: Art and Mathematics. Cambridge: MIT Press, 1993. |
| 5 | Emmer, Michelle (Ed). The Visual Mind: Art and Mathematics: Vol. 2., MIT Press 2005. |
| 6 | Kalajdzievski, Sasho. Math and Art: An Introduction to Visual Mathematics. Chapman and Hall, 2008. |
| 7 | Kappraff, Jay. Connections, The Geometric Bridge between Art and Science. World Scientific Pub Co Inc. 2002 |

| | |
|---|---|
| 8 | Kinsey, L. Christine and Teresa E. Moore. Symmetry, Shape and Space. Key College. 2006 |
| 9 | Pedoe, Dan. Geometry and the Visual Arts. Dover Publications. 2011 |
| 10 | Washbourn, Dorothy K. and Donald W. Crowe, Symmetries of Culture: Theory and Practice of Plane Pattern Analysis. University of Washington Press. 1991 |
| 11 | Weyl, Hermann. Symmetry. Princeton University Press. 1983 |


**Additional Readings**


| | **Title** |
|---|---|
| 1 | Art section of the Math Archives http://archives.math.utk.edu/topics/artMusic.html |
| 2 | Computer Generated Art http://www.math.brown.edu/~banchoff/art/PAC-9603/welcome.html |
| 3 | Leonardo on line http://www.leonardo.info/ |
| 4 | Mathematics across the curriculum at Dartmouth College http://www.dartmouth.edu/~matc/math5.geometry/ |
| 5 | Nexus network journal http://www.nexusjournal.com/ |