

## 48-175, 62-175 Descriptive Geometry

Spring Semester 2021 • 6 units • Wednesdays 2:20–3:50 (Remote)

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**Course assistant:** TBD

**Office Hours:** TBD

## Syllabus

### DESCRIPTIVE GEOMETRY

Descriptive geometry deals with physical space, the kind that you have been used to since birth. Things you can see around you have geometry; and even things that you cannot do so too. All these things concern geometric objects almost always in relationship—that is, next to, above, below, intersecting with, occluding, hidden by and so on—to one another that sometimes requires us to make sense of it all—in other words, when we try to solve geometric problems albeit in architecture, engineering, or the sciences. In fact, descriptive geometry has proved itself to be practically useful; it has been one of the most important factors in the design of scientific apparatus, engineering systems and architectural structures.

Descriptive geometry started with Gaspard Monge (1746-1818). He discovered (invented!?) the principles at the tender age of 18, working as a military engineer on the design of fortifications, which were made of stones accurately cut to fit one onto another so that a wall or turret so constructed was self-supporting and strong enough to withstand bombardment. Monge's descriptive geometry system was declared classified and a military secret and it was not until many years later around 1790s (when Monge was a Professor at the Beaux Arts) that it became declassified and a part of French engineering and architectural education and then adopted virtually universally.



Descriptive geometry is constructive—that is, one uses conventional mechanical drawing tools: namely, compass, ruler, protractor, divider, triangles etc to construct solutions to geometric problems.

Descriptive geometry deals with manually solving problems in three-dimensional geometry through working with two-dimensional planes using these basic mechanical tools. This course is mainly about the techniques of manually solving three-dimensional geometry problems.

### LEARNING OUTCOME

In this course students will:

- Learn how to constructively solve practical three-dimensional geometry problems

## THE COURSE AND COURSE SCHEDULE

The course starts off with an introduction to some practical constructions just to get a sense of what one can accomplish using mechanical tools before going into details of orthographic projections and culminating in some useful applications such as casting shades and shadows and the development of surfaces. Course topics include:

### Basic Constructions

#### **Practical methods in 2-Dimensional Geometry** —Some examples—

- Measurements: lengths and area
- Constructions relating to conic sections
- Constructions based on projective mapping

### Descriptive Geometry Proper

#### **Basic Concepts of 3-Dimensional Descriptive Geometry**

Points; Projection Planes; Orthographic Projection; Views; Auxiliary Views

#### **Lines in 3-Dimensional Geometry**

Intersecting lines; Skewed lines; Point view of a line; Parallel lines; Perpendicular lines; True Length of a line; Axonometric views;

#### **Planes in 3-Dimensional Geometry**

Representation; Points and lines on a plane; Edge View of a plane; Normal view of a plane; Dip of a plane;

#### **3-Dimensional Spatial Relations on Lines**

Examples—line parallel to plane; distances between lines, between planes;

#### **Intersections**

Piercing point of line and plane; line of intersection; dihedral angle; visibility;

#### **Rotations in 3-Dimensional Space**

Rotating a point about a line, a line about a line, a plane about a line; dihedral angle by rotation

#### **Location of points and tangent planes on Solids and Surfaces**

Basic techniques for locating points, piercing points, and tangent planes for common solids—examples—prisms, pyramid, cone, cylinder, sphere, and possibly oblique solids.

#### **Shades and shadows**

Based on parallel rays of light

#### **Intersection of geometric surfaces and solids**

Of more value to engineers than to architects—though problems such as the intersection of roof geometry might be of value

**Development of surfaces**

Planar unfolding of common solids, and solids with warped surfaces (useful for sheet metal work)

**Axonometric and Perspective Projections**

Based on orthographic projections – method of vanishing points

Topics in the unshaded boxes—namely, the first ten and the last—will be covered in this course; development of surfaces will only be covered if time permits. Topics in boxes 2-10 constitute the bulk of descriptive geometry. The first topic gives a tasty morsel of what constructive geometry is all about.

**COURSE RESOURCE**

The course material will be on Canvas. Any subsequent reference to ‘Canvas’ refers to the course Canvas website.

The class will be **conducted entirely remotely** through Zoom. The meeting link will be announced in Canvas. Links for each class in this course are provided in the Syllabus section on Canvas.

‘Jump to Today’ tab in the section will help find the class link. Please refer to the section below on Using Zoom

**GRADING**

Let me frank — I *dislike* grades. They make some people feel very good about themselves and they make others feel less good. Sadly, they are a necessary evil. Grades do not often say much about you other than if you are smart and you do not get a good grade, then you simply didn’t make the effort.

Learning should be fun, fulfilling and thoroughly enjoyable. In other words, make an effort.

That’s what my attempt at grading reflects.

Grades are based on the normal scale:

<b>A</b>	90-100	Excellent
<b>B</b>	80-90	Good
<b>C</b>	70-80	Fair
<b>D</b>	60-70	Pass
<b>R</b>	<60	Sorry

Normally in a course like this, grade is based on assignments and exams comprising time-limited constructions.

- **I DO NOT GRADE ON A CURVE.** If you all get A’s, that is wonderful. If you all get R’s, that’s just the way it is. BUT ... I am **human** ... and if you **make an effort**—it might just push your grade slightly upwards.

**TEXTBOOK AND ANYTHING ELSE**

I have prepared a course text, which will be placed on a cloud server.

For the constructions in this course, I expect you to use a compass, triangles, ruler, protractor, pencils, erasers, and a portable drawing board. You will be expected to manually draw for the assignment and exam.

## OFFICE HOURS

I do not normally have official office hours. Email me or use the discussion facility on Canvas.

## RECITATIONS

Past experience has shown that students benefit from recitation sessions. I will have to figure out how to incorporate this into your remote course schedule.

## FAQ

– why should I study a manually oriented geometry course when I can use design software to solve my geometry problems for me

No reason at all unless of course you want to become a good architect, designer, engineer/scientist with a visual affinity or will be working with spatial objects. Every good designer understands geometry and understands it well and constructively. Potentially if one is fortunate a good designer can get by with a combination of good smart design instincts and effective use of software. This course offers you a chance to become a great designer. Failing that it offers you the chance to become a good designer as the principles of descriptive geometry form the basis of geometry engines for design software. At the very least the course gives you an opportunity to become so. Descriptive geometry techniques are the basis of most computer graphics algorithms.

## POLICIES

All university academic and student policies as set out in <https://www.cmu.edu/policies/student-and-student-life/index.html> apply to this course.

Specifically:

- You are expected to be on time at all lectures (remotely).
- Email should only be used for crucial queries and concerns. Please direct course-related questions to me.
- In necessary circumstances where you are unable to attend class, please make sure to inform me via email and I will address the situation accordingly.

## REMOTE INSTRUCTION

This semester involves the regular use of technology during class. Research has shown that divided attention is detrimental to learning, so I encourage you to close any windows not directly related to what we are doing while you are in class. Please turn off your phone notifications and limit other likely sources of technology disruption, so you can fully engage with the material, each other, and me. This will create a better learning environment for everyone.

## USE OF ZOOM IN THE CLASS (INCLUDING USE OF VIDEO)

In our class, we will be using Zoom for synchronous (same time) sessions. See the Zoom link on Canvas.

Please make sure that your Internet connection and equipment are set up to use Zoom and able to share audio and video during class meetings.

(See <https://www.cmu.edu/computing/start/students.html> for information on the technology you are likely to need.) Let IT at CMU-Q know, as early as possible, if there is an issue with your technology set-up to sort it out.

**SHARING VIDEO:** In this course, being able to see one another helps to facilitate a better learning environment and promote more engaging discussions. The default is to expect students to have their cameras on during lectures and discussions. However, I also completely understand that there may be reasons students would not want to have their cameras on.

**Note:** You may use a background image (preferably static image) in your video if you wish; just check in advance that this works with your device(s) and internet bandwidth.

- During our class meetings, please keep your mic muted unless you are sharing with the class or your breakout group.
- If you have a question or want to answer a question, please use the chat or the “raise hand” feature (available when the participant list is pulled up). I will monitor these channels to call on students to contribute.
- Our synchronous meetings may involve breakout room discussions, and those will work better if everyone in your small group has their camera turned on. During large group debriefs, you may keep your video off.

## RECORDING OF CLASS SESSIONS

All synchronous classes will be recorded via Zoom so that students in this course (and only students in this course) can watch or re-watch past class sessions. Please note that breakout rooms will not be recorded. However, chats are recorded. We do not encourage private chats during recorded Zoom sessions, instead, we recommend that you send us emails. We will make the recordings available on Canvas as soon as reasonably possible after each class session. Recordings will live on Canvas. Please note that you are not allowed to share these recordings. **This is to protect your FERPA rights and those of your fellow students.**

## RESPECT FOR DIVERSITY

It is my intention that all students irrespective of background or perspective continue to be well served by this course, that students’ learning needs are addressed both in and out of class, and that the diversity that you bring to this class be viewed as a resource, strength, and benefit. I intend to present materials and activities that are respectful of diversity in all its forms. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups. Moreover, should any of our class meetings conflict with religious events, please let me know so that we can make suitable alternate arrangements for you.

## ACCOMMODATION FOR STUDENTS WITH DISABILITY

If you have a disability and are registered with the Office of Disability Resources, I encourage you to use their online system to notify me of your accommodations and discuss your needs with me as early in the semester as possible. I will work with you to ensure that accommodations are provided as appropriate. If you suspect that

you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, I encourage you to contact them at [access@andrew.cmu.edu](mailto:access@andrew.cmu.edu).

## **STUDENT WELL-BEING AND SUPPORT**

If you have special needs, for whatever legitimate reasons accepted by this university, I will do my best if it is within my power to help you. If not, you must contact your primary academic advisor in your home department.

Please remember that Carnegie Mellon University is deeply committed to creating a healthy and safe campus community including one that is free from all forms of sexual and relationship violence. To that end, University Health Services, the Office of Community Standards & Integrity, and the Office of Title IX Initiatives have partnered to expand their educational efforts for graduate students in this domain. There is an educational opportunity for all graduate students at Carnegie Mellon that reflects its commitment to sexual assault and relationship violence prevention as well as to your overall safety:

It is important to take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs, getting enough sleep, and taking some time to relax. This will help you achieve your goals and cope with stress.

All of us benefit from support during times of struggle. There are many helpful resources available to all students on campus. Asking for support sooner rather than later is more often helpful. If you or anyone you know is experiencing academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Seek Counseling Services on campus here to help. Consider reaching out to a friend, faculty, or family member you trust for help getting connected to the support that can help.