CIV_ENV 201-0: CORNERSTONE DESIGN

Northwestern University · McCormick School of Engineering · Winter Quarter 2027 · DRAFT

Course Information	
Meetings	Mon/Wed/Fri 9:00–9:50 am
Units	1.00
Corequisite	CIV_ENV 301-1 Cornerstone Design Lab (Thursday 2:00–3:20 pm)
Prerequisites	Junior standing in Civil & Environmental Engineering
Instructor	Eric Garcia, PhD, PE Email: ericvincent.garcia@northwestern.edu Office Hour: By Appointment (Tech A222)

Course Description

Explore how civil and environmental engineers define problems, evaluate alternatives, and develop sustainable, ethical design solutions. Learn key components of engineering infrastructure systems and practice them using industry-standard modeling and analysis tools. Through integrated lab work and a team-based infrastructure project, students develop schematic designs supported by technical, economic, and community considerations.

How CIV_ENV 201 and 301-1 work together. CIV_ENV 201 (MWF) holds lectures, software labs, quizzes, and project work sessions, and grades all project work. CIV_ENV 301-1 (Thursday) is the professional practice studio, with guest speakers and design charettes where students and reviewers give teams feedback on their project. Juniors enroll in both courses. See the CIV_ENV 301-1 syllabus for its requirements.

Learning Outcomes

By the end of the course, students will be able to:

Outcome	ABET Student Outcome
Apply the civil engineering design process to define an infrastructure problem, its stakeholders, and its constraints.	1, 2
Apply fundamental analysis and design methods in structural, geotechnical, environmental, water resources, transportation, architectural, and construction engineering.	1
Generate design alternatives and select among them using explicit technical, economic, environmental, and social metrics.	2, 6
Use a professional design tool and an analysis tool to model and justify a schematic design.	1, 7
Communicate a design through a written PER, drawings, and oral presentations, and respond professionally to review comments.	3
Identify ethical, legal, equity, and sustainability responsibilities in engineering decisions.	4
Function effectively on a design team, including planning work, sharing responsibility, and giving peer feedback.	5

Course Structure

The quarter is organized into four modules. Each module includes lectures, a quiz, and software labs or homework. Quizzes are quantitative and assume prerequisite coursework.

Module	Weeks	Focus	Quiz
1. Design Basics	1–2	Design process and practice, PERs and 30% design, demand, capacity, and uncertainty (L1–L3)	Quiz 1, Fri Jan 15
2. Sustainability, Ethics & Community	2–4	Sustainability and resilience, engineering economics and carbon, water and wastewater treatment design, ethics, equity, and community (L4–L7)	Quiz 2, Fri Jan 29
3. Design Decisions	4–6	Alternatives and metrics; architectural, structural, and geotechnical design; codes, standards, and performance-based design (L8–L12)	Quiz 3, Fri Feb 12
4. Communication & Infrastructure Development	7–10	Technical reports and drawing sets, hydrology and hydraulics, transportation, construction, cost estimating, scheduling, infrastructure systems (L13–L19)	Quiz 4, Fri Mar 5 (L13–L18)

Software

Software is organized in three tiers so that every student builds real proficiency in a few tools rather than brief exposure to many. Complete the Week 1 software experience survey by Tue Jan 5 and install QGIS **before the Week 1 Friday lab**; install your design and analysis tools once your team's zone is set (Jan 11). Class time is for learning, not installing. Several tools run on Windows only; Mac users should use

Tier 1 — Site context (everyone): QGIS

Free, open-source GIS for project site maps, existing conditions, land use, and watershed context.

Tiers 2 and 3 — Design and analysis tools (set by project zone)

Each team's project zone (see Term Project) determines its design tool and analysis tool, so teams know their software by Week 2 and have most of the quarter to build proficiency. Civil 3D and Revit are free to students through the Autodesk Education program. Short demo videos of every tool are posted so all students see the full range.

Zone	Design tool	Analysis tool	Example projects
Water	Civil 3D	SWMM, HEC-RAS, or EPANET	Viaduct or street flooding, green infrastructure retrofit, culvert or channel, water main replacement
Structures & Buildings	Revit	SAP2000	Pedestrian bridge, building retrofit or addition, transit station canopy
Transportation	Civil 3D	SUMO	Intersection or corridor redesign, bike/pedestrian connection, transit access

Tool	Use in this course	Access	Walkthroughs for class and homework
QGIS (Tier 1)	Site map, existing conditions, data layers	Free · Win/Mac	QGIS download QGIS Training Manual A Gentle Introduction to GIS Chicago Data Portal (site data) USGS National Map Downloader
Civil 3D (Tier 2)	Site, grading, alignments, pipe networks	Free edu license · Windows	Autodesk Education software access Civil 3D tutorials (Getting Started, Surfaces, Pipe Networks)
Revit (Tier 2)	Building/structure massing, BIM model, drawing set	Free edu license · Windows	Autodesk Education software access Revit Help: Get Started
EPA National Stormwater Calculator (on-ramp to SWMM)	Site runoff and green infrastructure options	Free · web app	National Stormwater Calculator
EPA SWMM (Tier 3)	Stormwater runoff and conveyance; extends Rational Method	Free · Windows	SWMM download, manuals, and applications manual
HEC-RAS (Tier 3)	Open-channel hydraulics, floodplains, bridge hydraulics	Free · Windows	HEC-RAS download and documentation
EPANET (Tier 3)	Water distribution networks (pressure, flow)	Free · Windows	EPANET download and user manual
SAP2000 (Tier 3) **SkyCiv** (alternative)	Structural analysis of frames and bridges	Dept. License · Windows	SAP2000 product page and tutorials
SUMO (Tier 3)	Traffic simulation for corridors and intersections	Free · Win/Mac	Eclipse SUMO SUMO Tutorials
EC3 (optional, L5 homework)	Embodied carbon comparison of materials	Free account · web	Building Transparency EC3

Term Project

Design a renovation or replacement for an existing piece of infrastructure. Teams of 2-3 identify their own project: a real piece of infrastructure (for example, a bridge, street corridor, stormwater system, water main, park or plaza, or public building). Teams justify the need and demand for the project with respect to ethics, equity, economy, environment, resilience, and existing design issues; develop and compare alternatives using explicit metrics; and carry a selected alternative to a schematic design supported by a design model and an analysis. Written deliverables follow a PER and 30% Design report format, and the finished project is intended to be something students can discuss in internship and job interviews.

Choosing a project

Every project has a **primary area**, which places it in a zone and sets its design and analysis tools, and may have a **secondary area** that the PER addresses qualitatively. For example, a viaduct flooding project is primarily Water, with Transportation secondary for closures and detours.

A good project is a real, accessible site in the Chicago region; has data available (e.g., Chicago Data Portal, IDOT, MWRD); fits a 10-week scope; involves more than one discipline.

Process. Each student submits an idea card before Charette 1 (Thu Jan 7). At Charette 1, idea cards are posted in a gallery organized by zone and students form teams around the ideas that interest them. Teams then test their top two candidates in a stakeholder scope check: seniors, the TA, and the instructor play

stakeholders (for example, a city engineer, nearby resident, business owner, regulator, or utility manager) and question each team from that perspective. After Charette 1, the instructor may adjust team membership and may so each zone can be supported. Teams commit to a project and zone in the project selection memo (Mon Jan 11).

Design charettes and feedback

Teams present their work at four design charettes in CIV_ENV 301-1 (Charettes 2–5). Charettes are working design reviews, not performances: teams give a short pitch with printed boards/sheets or slides, then senior students, the TA, the instructor, and invited reviewers rotate through teams for feedback conversations. Senior feedback is advisory and does not affect junior grades; presentations are scored by the instructor and TA. After each charette, teams submit a **feedback response log** (one page) listing the feedback received and what the team changed, or why it chose not to, just as engineers respond to review comments on a design submittal.

Milestones

Deliverable	Content
Software experience survey	Prior tool experience and zone interests
Idea card	One per student: what and where, photo or map, what is wrong (condition, capacity, safety, equity, resilience), who is affected, likely data sources
Project selection memo + team contract	Half-page memo: project, zone, primary and secondary areas, tools, data sources; team contract (roles, meetings, communication, conflict process)
Site context map	QGIS map of project site and existing conditions
Charette 2: Problem & Concepts	Problem statement, stakeholders, constraints, need and demand, initial concepts
Problem & Concepts brief	2–3 page brief incorporating Charette 2 feedback, with feedback response log
Peer evaluation 1	Confidential team evaluation
Feedback response log (Charette 3)	Response to alternatives and metrics feedback
PER memo + Charette 4	5–8 page Preliminary Engineering Report: alternatives, metrics, decision matrix, selected alternative, preliminary analysis
Feedback response log (Charette 4)	Response to PER design review feedback
Charette 5: Schematic Design	Schematic design, analysis results, cost and schedule summary
Final Schematic Design Report	Updated PER plus design model drawings, analysis results, cost estimate, CPM schedule, and Charette 5 feedback response log
Peer evaluation 2	Confidential team evaluation

Assessment

All project work, including charette presentations, is graded in CIV_ENV 201.

Component	Weight
Quizzes (4, quantitative)	20%
Software labs and homework	20%
Project written deliverables: Problem & Concepts brief 5%, PER memo 15%, Final Schematic Design Report 20%	40%

Component	Weight
Charette presentations (scored by instructor and TA): Charette 2 3%, Charette 4 4%, Charette 5 8%	15%
Feedback response logs (Charettes 2–5)	5%
Teamwork: idea card, team contract, and two peer evaluations	5%
Total	**100%**