
Civil Engineering and Architecture Detailed Outline

Unit 1: Overview of Civil Engineering and Architecture (23 days)

Lesson 1.1: History of Civil Engineering and Architecture

Concepts:

1. Many features of ancient structures are seen in modern buildings.
2. Architectural style is often an important key to understanding how a community or neighborhood has developed and the aesthetic customs that have formed over time.
3. The multiple architectural styles that have been developed throughout history are an indication of changing needs of people and society and uses for space.
4. Visual design principles and elements constitute an aesthetic vocabulary that can be used to describe buildings and may contribute to their function, location, or time period.

Performance Objectives

It is expected that students will:

- Connect modern structural and architectural designs to historical architectural and civil engineering achievements.
- Identify three general categories of structural systems used in historical buildings.
- Explain how historical innovations have contributed to the evolution of civil engineering and architecture.
- Identify and explain the application of principles and elements of design to architectural buildings.
- Determine architectural style through identification of building features, components, and materials.
- Create a mock-up model depicting an architectural style or feature using a variety of materials. .

Lesson 1.2: Careers in Civil Engineering and Architecture

Concepts:

1. Civil engineers and architects apply math, science, and discipline-specific skills to design and implement solutions.
2. Civil engineering and architecture careers are comprised of several specialties and offer creative job opportunities for individuals with a wide variety of backgrounds and goals.
3. Civil engineers are problem solvers involved in the design and construction of a diverse array of projects in a wide range of disciplines including structural, environmental, geotechnical, water resources, transportation, construction and urban planning.
4. Architects primarily focus on designing the interior and exterior “look and feel” of commercial and residential structures meant for human habitation.
5. An effective method for brainstorming possible solutions involves a collaboration of many stakeholders with a variety of skills coming together in an organized meeting called a charrette.

Performance Objectives

It is expected that students will:

- Identify the primary duties, and attributes of a civil engineer and an architect along with the traditional path for becoming a civil engineer or architect.
- Identify various specialty disciplines associated with civil engineering.
- Participate in a design charrette and recognize the value of using a charrette to develop innovative solutions to support whole building design.
- Understand the relationship among the stakeholders involved in the design and construction of a building project.

Unit 2: Residential Design (55 days)

Lesson 2.1: Building Design and Construction

Concepts:

1. Many residential structures are constructed with wood framing systems and are built using standard practices.
2. A variety of roof shapes and materials are available for residential structures to address aesthetic preferences, carry design loads, and meet environmental challenges.
3. Designers design, modify, and plan structures using 3D architectural software.
4. Architects and engineers use a variety of views to document and detail a building project on construction drawings.

Performance Objectives

It is expected that students will:

- Identify typical components of a residential framing system.

- Recognize conventional residential roof designs.
- Model a common residential roof design and detail advantages and disadvantages of that style.
- Use 3D architectural software to create a small building.

Lesson 2.2: Cost and Efficiency Analysis

Concepts:

1. The combination of concrete and rebar, called reinforced concrete, is an important component of residential foundations.
2. Accurately determining the cost and quantities for a construction project can ensure a successful building project providing a high quality structure with less material and financial waste.
3. An effective residential structure should include methods for adequate heating and cooling.
4. R-value and U-factor measurements are used to select materials that with ensure a structure is properly insulated.

Performance Objectives

It is expected that students will:

- Apply basic math skills to calculate the quantity and cost of concrete needed to pour the pad for a small building.
- Create a cost estimate for a small construction project, including a detailed cost break-down.
- Calculate the heat loss through one wall of a conditioned building.
- Calculate the heat loss for a building envelope with given conditions appropriate for the project.
- Apply principles of sustainable design to a small project.

Lesson 2.3: Residential Design

Concepts:

1. Responsible designers maximize the potential of the property, minimize impact on the environment, and incorporate universal design concepts in order to create an attractive and functional space.
2. Responsible designers anticipate the needs and requirements of the users.
3. Codes are created to protect the health and safety of the public, dictate the minimum requirements that must be met in a building project, and constrain the location of structures, utilities, building construction, and landscape components placed on a site.
4. Appropriate flow rate, pressure, and water quality are necessary for effective water supply and use.

5. When utilities are not available within a reasonable distance to be economically brought on site, substitutions must be designed and constructed.
6. Utilities and systems must be properly sized to minimize cost and appropriately serve the project and the structure occupants.
7. The design of electrical and plumbing systems must be carefully integrated into the architectural and structural design of a building.
8. Careful landscape design that takes into consideration local environmental conditions can improve energy efficiency, reduce noise, reduce water usage, reduce storm water runoff, and improve the visual impact of a building project.
9. Storm water runoff from a site often increases when the site is developed and is frequently regulated by local jurisdictions.
10. Universal Design involves the design of products and environments to be usable by all people and includes barrier free accessibility to projects that may be required by federal regulations.
11. Green or sustainable design reduces the negative impact of a project on the environment and human health and improves the performance of the project during its life-cycle.
 - a. Activity 2.3.2 – Students research green and sustainable practices that can be applied to the design of their Affordable House design project. Research includes investigation of techniques to harvest rainwater, environmentally friendly construction methods, recycling of construction wastes, reducing energy consumption, incorporating a site's natural resources into the design of the structure.
 - b. Activity 2.3.4 – Students create a proposal to gain LEED points toward LEED certification for their Affordable Home design project and explain how meeting the prerequisites and criteria for the LEED credit promotes the transformation of the homebuilding industry toward more sustainable practices.

Performance Objectives

It is expected that students will:

- Apply elements of good residential design to the design of a basic house to meet the needs of a client.
- Design a home design that complies with applicable codes and requirements.
- Incorporate sustainable building principles and universal design concepts into a residential design.
- Create bubble diagrams and sketch a floor plan.
- Identify residential foundation types and choose an appropriate foundation for a residential application.
- Calculate the head loss and estimate the water pressure for a given water supply system.
- Create sketches to document a preliminary plumbing and a preliminary electrical system layout for a residence that comply with applicable codes.

- Design an appropriate sewer lateral for wastewater management for a building that complies with applicable codes.
- Create a site opportunities map and sketch a project site.
- Choose an appropriate building location on a site based on orientation and other site-specific information.
- Calculate the storm water runoff from a site before and after development.
- Document the design of a home using 3D architectural design software and construction drawings.

Unit 3: Commercial Applications (57 days)

Lesson 3.1: Commercial Building Systems

Concepts:

1. Commercial building systems differ from residential building systems in many significant ways.
2. Codes and building regulations define and constrain all aspects of building design and construction including the structure, site design, utilities, and building usage.
3. Zoning regulations are used to control land use and development.
4. Wall, roof, floor, and framing systems for commercial facilities are chosen based on many factors.

Performance Objectives

It is expected that students will:

- Identify applicable building codes and regulations that apply to a given development.
- Classify a building according to its use, occupancy, and construction type using the International Building Code.
- Research Land Use regulations to identify zoning designations and allowable uses of property.
- Comply with specifications, regulations, and codes during a design process.
- Compare a variety of commercial wall systems and select an appropriate system for a given commercial application based on materials, strength, aesthetics, durability, and cost.
- Compare a variety of commercial low-slope roof systems and select an appropriate system for a given commercial application based on materials, strength, durability, and cost.
- Incorporate sustainable building practices, especially a green roof, into the design of a commercial building.
- Use 3D architectural design software to incorporate revisions for the redesign of a building.

- Use 3D architectural design software to create appropriate documentation to communicate a commercial building design.
- Calculate the structural efficiency of a structure.
- Use load-span tables to design structural elements.

Lesson 3.2: Structures

Concepts:

1. The purpose of a structure is to withstand all applied loads and forces and to transfer these forces to the Earth.
2. Structural engineering involves the critical analysis of forces and loads, the anticipated effect of these loads on a structure, and the design of structural elements to safely and efficiently resist the anticipated forces and loads.
3. Design loads are often dictated by building codes.
4. Structural design includes the determination of how structures disperse the applied loads.
5. The application of loads to a building results in resisting forces from the structure which can be predicted through the use of mathematics and physical science principles.

Performance Objectives

It is expected that students will:

- Identify the work of a structural engineer.
- Use building codes and other resources to calculate roof loading to a structure and select appropriate roof beams to safely carry the load.
- Analyze a simply supported beam subjected to a given loading condition to determine reaction forces, sketch shear and moment diagrams, and determine the maximum moment resulting in the beam.
- Use beam formula to calculate end reactions and the maximum moments of a simply supported beam subjected to a given loading condition.
- Use structural analysis software to create shear and moment diagrams of simply supported beams subjected to a given loading condition.
- Calculate the deflection of a simply supported beam subjected to a given loading condition.
- Use building codes and other resources to determine the required floor loading and design a structural steel floor framing system (beams and girders) for a given building occupancy.
- Identify and describe the typical usage of foundation systems commonly used in commercial construction.
- Determine the loads transferred from a steel framed structure to the ground through a foundation.
- Size a spread footing for a given loading condition.
- Check structural calculations created by others for correctness.

Lesson 3.3: Services and Utilities

Concepts:

1. When utilities are not available within a reasonable distance to be economically brought on site, substitutions must be designed and constructed.
2. Utilities and systems must be properly sized to minimize cost and appropriately serve the project.
3. Responsible designers anticipate the needs and requirements of the users.
4. The design of mechanical systems impact the architectural and structural design of a building.
5. Energy codes are designed to conserve natural resources, reduce operating costs, protect the environment and create healthier living and working spaces. They dictate the minimum requirements for the building envelope, lighting, mechanical systems, and service water heating for commercial facilities.
6. The design of internal systems is documented with construction drawings specific to each system.

Performance Objectives

It is expected that students will:

- Interpret and apply code requirements and constraints as they pertain to the installation of services and utilities.
- Read and understand HVAC construction drawings for a commercial project.
- Apply criteria and constraints to size and locate the new utility service connections for a commercial facility.
- Modify system designs to incorporate energy conservation techniques.

Lesson 3.4: Site Considerations

Concepts:

1. Land surveying is used for many purposes during the design and construction of a project including establishing the topography of a site, setting control points, and establishing the location of project features.
2. Engineers must consider parking requirements, pedestrian access, ingress and egress, landscaping, storm water management, and site grading when creating a site design.
3. Ingress and egress, parking, pedestrian, and handicapped access must be planned to efficiently and safely move traffic, goods, and people.
4. The characteristics of soils present on a site impact the design and construction of improvements to a property.
5. Codes determine the type, sizing, and placement of site features such as parking lots, entrance and exit roads, pedestrian and handicapped access, and storm water facilities.

6. The surface conditions and topography of a site affect the quantity and quality of storm water runoff and the design of the storm water management system.
7. A soil can be classified according to its grain size and plasticity which impact the characteristics the soil will exhibit.

Performance Objectives

It is expected that students will:

- Use differential leveling to complete a control survey to establish a point of known elevation for a project.
- Design appropriate pedestrian access, vehicular access and a parking lot for a commercial facility.
- Analyze a site soil sample to determine the United Soil Classification System designation and predict soil characteristics important to the design and construction of a building on the site.
- Estimate the increase in storm water runoff from a commercial site and create a preliminary design for a storm water storage facility.
- Apply Low Impact Development techniques to a commercial site design reduce the impact of development on storm water runoff quantity and quality.
- Follow specifications and codes during a design process.
- Given 3D architectural design software, document a commercial site design.

Unit 4: Commercial Building Design (35 Days)

Lesson 4.1: Commercial Building Design Problem

Concepts:

1. People work in teams to produce solutions to complex problems.
2. A legal description of property is used to identify real estate in a legal transaction and can be found in a deed, mortgage, plat or other purchase documents.
3. The selection of a site and the project being planned are interrelated. A site should be thoroughly research to determine whether it is compatible with the project to be built.
4. Legal, physical, and financial conditions as well as the needs of the surrounding community should be taken into consideration when determining the viability of a project.
5. Detailed planning and management of a project is essential to its success.

Performance Objectives

It is expected that students will:

- Work individually and in groups to produce a solution to a team project.
- Research codes, zoning ordinances and regulations to determine the applicable requirements for a project.

- Identify the boundaries of a property based on its legal description.
- Perform research and visit a site to gather information pertinent to the viability of a project on the site.
- Identify the criteria and constraints, and gather information to promote viable decisions regarding the development of their solution.
- Create an architectural program, a project organization chart, and a Gantt chart and hold project progress meetings to help manage the team project.
- Communicate ideas while developing a project using various drawing methods, sketches, graphics, or other media collected and documented.
- Investigate the legal, physical, and financial requirements of a project and consider the needs of the community to determine project viability.
- Apply current common practices utilized in Civil Engineering and Architecture to develop a viable solution in their project.
- Develop an understanding of how software is used as a tool to aid in the solution and then the communication of a project.

Lesson 4.2: Commercial Building Design Presentation

Concepts:

1. Critiques and reviews are used to inform and provide suggestions for improvement.
2. Presentations and displays of work provide the means to effectively promote the implementation of a project.
3. A well-done presentation will enhance the quality of a team's project.

Performance Objectives

It is expected that students will:

- Assemble and organize work from a commercial project to showcase the project in an effective and professional manner.
- Create visual aids for a presentation that include the appropriate drawings, renderings, models, documentation, and the rationale for choosing the proposal for project development.
- Conduct an oral presentation to present a proposal for the design and development of a commercial building project.