Structural Engineering
Subject Code: 010120
Course & Unit Descriptions

Course Description:

Students will develop skills in utilizing different construction materials and methods. Students will be able to prepare sites by using mapping and surveying methods along with soils evaluation. Learners will discover the different forms of designing and planning for a project. Students will learn skills in metal fabrication, electricity, concrete and masonry, plumbing, and basic building construction. Students will learn other critical components of structural engineering including safety, business law and regulations.

Unit: Safety

Students will identify and demonstrate proper safety procedures and protocols in the workplace. Students will administer first aid and handle emergency responses.

Benchmark: 4.1 Safety Procedures
Level 1: Follow safety procedures in general situations with basic tools and equipment, evaluate work environment and seek assistance to rectify the problem
Level 2: Follow safety procedures in specific situations with specialized tools and equipment, evaluate situation and take corrective action

Indicators
4.1.01 Demonstrate knowledge of safety rules and regulations
4.1.02 Interpret safety signs and symbols
4.1.03 Model safe attitudes and behaviors (e.g., lifting, climbing)
4.1.04 Identify safety hazards and take corrective measures
4.1.05 Use safety equipment in accordance with established procedures
4.1.06 Follow established procedures for the administration of first aid and contact emergency medical personnel when necessary

Academic Standards
English: Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing). (Reading Process B, 8-10; Reading Process B, 11-12)

Unit: Design & Estimate

Students will design and construct architectural plans using different types of drawings and designs. Students will construct a budget, determine project needs and prepare for construction.

Benchmark: 4.10 Design and Estimate
Level 1: Utilize elements and principles of design for an agricultural application
Level 2: Design a basic agricultural application for a desired outcome

Indicators

4.10.01 Identify, interpret and use symbols, lines, dimensions, views, sections, site plans, floor plans, specifications, common scales, detail drawings and abbreviations on drawings and prints
4.10.02 Complete a site inventory and analysis (e.g., physical conditions, design needs, code requirements, environmental impact, utilities requirements)
4.10.03 Develop a program list, including intended use, budget, economics, customer wants and needs, and maintenance
4.10.04 Apply principles of balance, proportion and scale, focal point, emphasis, rhythm, harmony and unity in creating a design
4.10.05 Apply the elements of line, form, texture and color in creating a design
4.10.06 Incorporate principles of design (e.g., space, scale, proportion, order) and apply organizational and spatial principles to a design
4.10.07 Calculate the space requirements and compute various attributes, including length, angle measurement, surface area and volume
4.10.08 Prepare sketches, drawings, prints, specifications and construction details
4.10.09 Use design-drawing tools including Computer Aided Design (CAD) software and other industry-specific software
4.10.10 Identify construction documents, common scales and specifications and select materials used in construction/fabrication
4.10.11 Estimate material, construction and equipment needs and costs
4.10.12 Establish the sequential steps of construction/installation

Academic Standards

English: Produce functional documents that report, organize and convey information and ideas accurately, foresee readers' problems or misunderstandings and that include formatting techniques that are user friendly. (Writing Applications C, 11-12)
Math: Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions. (Number G, 8-10)
Social Studies: Use appropriate data sources and geographic tools to analyze and evaluate public policies (Geography C, 11-12)

Unit: Site Preparation

Students will evaluate a worksite by using surveying, mapping, and soils evaluating practices.

Benchmark: 4.11 Surveying and Mapping

Level 1: Interpret maps/topographic site plans
Level 2: Use surveying equipment to construct a basic site plan

Indicators

4.11.01 Identify civil drafting symbols and abbreviations
4.11.02 Read maps, topographic site plans, deeds and/or aerial/satellite imagery
4.11.03 Perform site measurements
4.11.04 Integrate map and surveying data in Geographic Information System (GIS) or Computer Aided Design (CAD)

Academic Standards

English: Use multiple resources to enhance comprehension of vocabulary. (Vocabulary F, 8-10; Vocabulary E, 11-12)
Math: Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions. (Number G, 8-10)
Social Studies: Use appropriate data sources and geographic tools to analyze and evaluate public policies. (Geography C, 11-12)

Benchmark: 5.1 Soils
Level 1: Determine and analyze the physical, biological and chemical properties of soils and other plant growing media
Level 2: Utilize knowledge of soil characteristics and soil information resources to overcome any existing soil use limitations

Indicators
5.1.01 Classify soil types based on composition (e.g., aggregate size, organic matter, texture)
5.1.02 Inventory soils and determine land use capabilities
5.1.03 Interpret soil survey data to implement conservation practices
5.1.04 Select techniques that reduce soil erosion and compaction based on soil and land properties (e.g., no till, subsurface and watershed drainage)
5.1.05 Evaluate soil limitations (e.g., wildlife/wetlands habitats, septic systems, drainage, agriculture and socioeconomic considerations, preservation easements)
5.1.06 Explain current and historical interactions between human activities and soils (e.g., wetlands use, urbanization, desertification, finite resources, habitat change, climate change)

Academic Standards
English: Use multiple resources to enhance comprehension of vocabulary. (Vocabulary F, 8-10; Vocabulary E, 11-12)
Math: Describe and interpret rates of change from graphical and numerical data. (Algebra J, 8-10)
Science: Describe the finite nature of Earth's resources and those human activities that can conserve or deplete Earth's resources. (Earth and Space Sciences D, 9-10)
Social Studies: Use appropriate data sources and geographic tools to analyze and evaluate public policies. (Geography C, 11-12)

Benchmark: 5.4 Contaminants
Level 1: Determine the presence of contaminants and follow reporting procedures
Level 2: Assess affected area, determine the source and type of contaminant, and respond appropriately

Indicators
5.4.03 Identify, comply with and implement contaminant control, remediation and prevention practices (e.g., biological, radiological, sanitation, buffer strips for run-off)

Academic Standards
English: Use multiple resources to enhance comprehension of vocabulary. (Vocabulary F, 8-10; Vocabulary E, 11-12)
Math: Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision. (Measurement E, 8-10)
Science: Describe how human activities can impact the status of natural systems. (Life Sciences G, 9 -10)
Social Studies: Evaluate the consequences of geographic and environmental changes resulting from governmental policies and human modifications to the physical environment. (Geography B, 11-12)

Unit: Brick, Block and Concrete

Students will estimate and order the amount of materials needed for a project. Students will demonstrate proper finishing techniques for curing.

Benchmark: 4.1 Safety Procedures
Level 1: Follow safety procedures in general situations with basic tools and equipment, evaluate work environment and seek assistance to rectify the problem
Level 2: Follow safety procedures in specific situations with specialized tools and equipment, evaluate situation and take corrective action

Indicators
4.1.01 Demonstrate knowledge of safety rules and regulations
4.1.04 Identify safety hazards and take corrective measures
4.1.05 Use safety equipment in accordance with established procedures

Academic Standards
English: Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing). (Reading Process B, 8-10; Reading Process B, 11-12)

Benchmark: 4.13 Brick, Block, and Concrete
Level 1: Identify tools and materials and calculate amounts needed for a project using brick/paver, block, stone or concrete
Level 2: Construct a project using brick/paver, block, stone or concrete

Indicators
4.13.01 Describe physical properties of brick/paver, mortar, block, cement, and concrete
4.13.02 Explain chemical reactions within and between materials
4.13.03 Describe air ratio and slump
4.13.04 Identify layout and elevations using measurements to scale
4.13.05 Estimate construction and material cost for brick/paver, mortar, block, stone and concrete
4.13.06 Lay out and construct forms and reinforce using steel, wire and other materials
4.13.07 Mix, place and finish concrete and mortar
4.13.08 Install footers, lintels, sills, poured walls, floors and accessories
4.13.09 Install gravel and sand pads
4.13.10 Install cut masonry (e.g., brick/paver, stone, concrete)
4.13.11 Install joints and cure concrete
4.13.12 Identify the composition of concrete and describe the chemical reaction of curing
4.13.13 Select curing, coloring and texturing additives for a specific purpose

Academic Standards
Math: Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions. (Number G, 8-10)
Science: Explain how atoms react with each other to form other substances and how molecules react with each other or other atoms to form even different substances. (Physical Sciences B, 9-10)

Unit: Metal Fabrication

Students will safely demonstrate the different types of welding procedures and selection of materials based upon characteristics of the metal being used.

Benchmark: 4.1 Safety Procedures
Level 1: Follow safety procedures in general situations with basic tools and equipment, evaluate work environment and seek assistance to rectify the problem
Level 2: Follow safety procedures in specific situations with specialized tools and equipment, evaluate situation and take corrective action

Indicators
4.1.01 Demonstrate knowledge of safety rules and regulations
4.1.03 Model safe attitudes and behaviors (e.g., lifting, climbing)
4.1.05 Use safety equipment in accordance with established procedures

Academic Standards
English: Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing). (Reading Process B, 8-10; Reading Process B, 11-12)

Benchmark: 4.16 Fabricating Metal with Heat
Level 1: Join and cut ferrous metals using oxyfuel and shielded metal arc
Level 2: Join and cut ferrous metals using oxyfuel, shielded metal arc and gas-shielded metal-arc

Indicators
4.16.01 Compare and contrast metal welding operating characteristics and performance (e.g., oxyfuel, shielded metal arc, gas metal arc, flux core arc welding, gas tungsten arc welding, plasma gas, air carbon arc)
4.16.02 Determine properties, types and uses of metal
4.16.05 Identify and select the joint design and welding position
4.16.06 Compensate for the effects of expansion and contraction forces when joining metals
4.16.10 Use shielded metal-arc welding to join and wearface metals
4.16.11 Use gas shielded metal-arc welding to join metals

Academic Standards
Math: Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision. (Measurement E, 8-10)
Science: Describe the identifiable physical properties of substances (e.g., color, hardness, conductivity, density, concentration and ductility). Explain how changes in these properties can occur without changing the chemical nature of the substance (Physical Sciences C, 9-10)

Unit: Construction

Students will demonstrate the use of different construction materials to properly build a structure, insulate and roof. Students will identify the proper exterior to allow for environmental conditions.

Benchmark: 4.12 Construction
Level 1: Identify tools and materials and perform operations fundamental to construction
Level 2: Construct a scale-model to illustrate various construction components

Indicators
4.12.01 Lay out, cut, smooth, shape, and bore construction materials
4.12.02 Join similar and dissimilar construction materials (e.g., wood to wood, wood to concrete, wood to steel)
4.12.06 Lay out, cut and install roof framing (top plates, ridge boards, common rafters, prefabricated roof trusses, fascia and soffit) and roof trim accessories (drip edges, flashing and vents)
4.12.07 Lay out and install roofing material (shingles, shakes, metal)
4.12.08 Install exterior doors and window units with hardw
4.12.11 Insulate facility (i.e., draft stops, weather stripping, thermal insulation and vapor barriers)
4.12.13 Contrast surface coatings and apply under appropriate environmental conditions
4.12.15 Compare and contrast the structural properties, grades and types of construction materials (e.g., wood and wood products, metals, vinyls)

Academic Standards

Math: Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions. (Number G, 8-10)

Science: Describe the identifiable physical properties of substances e.g., color, hardness, conductivity, density, concentration and ductility). Explain how changes in these properties can occur without changing the chemical nature of the substance. (Physical Sciences C, 9-10)

Unit: Electricity

Students will identify the different types of electrical wiring and service needed for a project. Students will install the wiring and properly connect the wire to the service box.

Benchmark: 4.14 Electrical

Level 1: Identify tools and materials, draw a wiring diagram of a circuit and install the circuit
Level 2: Develop a schematic that illustrates the kind, number and location of outlets and switches in a wiring system and install the design

Indicators

4.14.01 Describe the theory of producing electricity (relationship between amperes, volts and watts; ohms law)
4.14.02 Compare and contrast AC and DC electrical systems and system components
4.14.03 Measure amperage of AC and DC electrical systems and system components
4.14.04 Calculate service requirements for electrical systems
4.14.05 Describe distribution system components
4.14.06 Determine the type of branch circuits needed in a wiring system
4.14.07 Determine the kind, size, number and location of wiring system components (e.g., outlets, switches, lights, wire, circuit breakers, motors, etc.)
4.14.08 Prepare and connect wires, with appropriate fasteners and anchors, to receptacles, switches and fixtures to standards of the electrical industry
4.14.09 Explain the color-coding of electrical connections
4.14.10 Install and identify over-current protective devices
4.14.11 Install and service low-voltage systems (e.g., control systems and lighting systems)
4.14.12 Calculate horsepower requirements and install electric motors (e.g., single phase, three phase, etc.)

Academic Standards

Math: Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions. (Number G, 8-10)

Science: Describe the identifiable physical properties of substances (e.g., color, hardness, conductivity, density, concentration and ductility). Explain how changes in these properties can occur without changing the chemical nature of the substance. (Physical Sciences C, 9-10)

Unit: Plumbing Systems

Students will identify water needs and water quality for a project. Students will install and troubleshoot plumbing and protect it from freezing or mechanical damage.

Benchmark: 4.15 Water Distribution Systems

Level 1: Identify tools and materials, design a water supply line with fixture and install
Level 2: Design and install a basic water/wastewater distribution system using multiple zones

Indicators
4.15.01 Calculate daily water needs
4.15.02 Identify the common components of a water distribution system and describe their functions
4.15.04 Calculate water demand for specific applications
4.15.05 Detect, test and repair problems in the water supply system
4.15.06 Install and secure waste/drain lines and vents
4.15.07 Install water supply and treatment systems with both plastic and metal components
4.15.09 Describe the types and sources of contamination in water supplies (i.e., fuel storage tanks, septic systems, pesticide mixing areas, hazardous waste, manure storage, livestock yard, and silage effluent) and methods for disinfecting water
4.15.10 Protect pipes from freezing and mechanical damage

Academic Standards
Math: Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent, and explain solutions. (Number G, 8-10)
Science: Describe the finite nature of Earth's resources and those human activities that can conserve or deplete Earth's resources. (Earth and Space Sciences D, 9-10)

Unit: Laws and Regulations

Students will identify the required permits and licenses need to build and complete a project. Students will comply with all local, state, and federal regulations.

Benchmark: 3.10 Business Regulation, Law and Related Issues
Level 1: Identify and describe government regulations and societal issues related to a specific business enterprise or environmental project
Level 2: Determine the impact of government regulations and societal issues on an environmental project or the performance of a business enterprise

Indicators
3.10.03 Identify local, state and federal regulations relative to compliance
3.10.05 Adhere to business-related documentation requirements
3.10.06 Identify governmental agencies and non-governmental organizations that impact agricultural/environmental issues
3.10.07 Research history, politics and policies related to issues
3.10.08 Assess the impact of issues affecting the industry and recommend solutions

Academic Standards
English: Demonstrate comprehension of print and electronic text by responding to questions (e.g., literal, inferential, evaluative and synthesizing). (Reading Process B, 8-10; Reading Process B, 11-12)
Math: Construct convincing arguments based on analysis of data and interpretation of graphs. (Data Analysis F, 8-10)
Social Studies: Evaluate the consequences of geographic and environmental changes resulting from governmental policies and human modifications to the physical environment. (Geography B, 11-12)