

## **Agriculture, Food, and Natural Resources (AFNR) Frameworks 2021**

### **Section 7 – Power, Structural, and Technical Systems (PST) Pathway Frameworks**

#### **Introduction**

The Power, Structural, and Technical Systems (PST) pathway encompasses the study of agricultural equipment, power systems, alternative fuel sources, precision technology, as well as woodworking, metalworking, welding, and project planning for agricultural structures. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application, and management of power, structural, and technical systems in AFNR settings.

#### **Section Contents**

<b>Section 7 – Power, Structural, and Technical Systems (PST) Pathway Frameworks.....</b>	<b>1</b>
Introduction.....	1
Recommended PST Courses and Pathway Sequence.....	2
Recommended Work-Based Learning (WBL) and SAEs within PST.....	3
Recommended Social-Emotional Learning (SEL) and FFA Opportunities within PST.....	4
MN.PST.01: Physics and Engineering Principles within PST; PST Fabrication and Metals.....	5
MN.PST.02: AFNR Tool Operations and Maintenance.....	6
MN.PST.03: AFNR Transportation, Engines, and Electricity.....	8
MN.PST.04: AFNR Construction and Woods.....	10
MN.PST.05: AFNR Technology.....	12
MN.PST.06: AFNR Biotechnology and Energy.....	14
Secondary/Multidisciplinary AFNR Pathways that Align with PST.....	15

## Recommended PST Courses and Pathway Sequence

Students concentrating on the PST pathway should complete a sequence of at least two courses within the following course offerings based their career goals and interests.

Introductory Courses	Intermediate Courses	Advanced Courses
01 Principles of Ag., Food, and Natural Resources	61 Agricultural Physics (Physics or Math Credit)	13 Agricultural Education, Research, and Development
02 Advanced Principles of Ag., Food, and Natural Resources	62 Agricultural Manufacturing	72 Creative Power Systems Design (Art Credit)
03 Principles of AFNR Biology (Science-Elective Credit)	63 Advanced Agricultural Manufacturing	73 Ag. Fabrication and Repair Operations (Simulated WBL: School Business)
04 Advanced Principles of AFNR Biology (Science-Elective Credit)	64 Agricultural Construction	74 Specialty and Emerging Power Systems Topics
60 Agricultural Power Systems Technology	65 Advanced Agricultural Construction	93 Extended/ Summer AFNR Work-Based Learning (SAE) and Leadership (FFA)
	66 Agricultural Electricity and Plumbing	94 Agricultural Leadership Development
	67 Agricultural Transportation and Operations	95 Agricultural Career Seminar
	68 Advanced Agricultural Transportation and Operations	96 Advanced Agricultural Career Seminar
	69 Agricultural Small Engines	97 AFNR Work Experience: Immersion SAE (Adv. Internship/Placement, Entrepreneurship, Research)
	70 Agricultural Engineering	
	71 Agricultural Engineering and Physics (Physics or Math Credit)	

## Recommended Work-Based Learning (WBL) and SAEs within PST

A Supervised Agricultural Experience (SAE) is a student-led, instructor-supervised, Work-Based Learning (WBL) experience that results in measurable outcomes within a predefined, agreed upon set of AFNR Technical Standards and Career Ready Practices aligned to a Career Plan of study. SAE teaches technical skills and knowledge within the psychomotor domain of learning. SAE includes both experiential learning (i.e., pre-WBL) and WBL (federally defined as sustained interactions with industry or community professionals in real workplace settings, to the extent practicable, or simulated environments, at an educational institution that foster in-depth, firsthand engagement with the tasks required in a given career field, that are aligned to curriculum and instruction; Sec. 3 [20 U.S.C. 2302] 55).

SAE/WBL is a required component of an AFNR program, first established in the Smith-Hughes Act (1917) and reinforced in each of the federal Perkins Career and Technical Education (CTE) Acts (1984 – I; 1990 – II; 1998 – III; 2006 – IV; 2018 – V, Public Law No. 115-224). Minnesota also requires WBL/SAE as a component of CTE Program Approval (Minn. R. 3505). Table 1 has example SAE opportunities within this pathway, as defined by the National Council for AFNR Education, Perkins V legislation, and the Minnesota Department of Education.

**Table 1. Examples of WBL/SAE Curricula and Programs within PST**

SAE Program Area	Examples, Non-Exhaustive
Experiential Learning (Foundational SAE; Pre-WBL)	<ul style="list-style-type: none"> <li>● Career exploration</li> <li>● Job shadowing in the fabrication industry</li> <li>● Ag issues in the alternative fuels industry</li> <li>● Field trip to a local equipment dealer</li> <li>● Community learning experiences</li> </ul>
Internship (Placement SAE; Immersion WBL)	<ul style="list-style-type: none"> <li>● Working at a custom fabrication business</li> <li>● Working for a renewable energy company</li> <li>● Placement with a local agricultural construction company</li> </ul>
Apprenticeship (Placement SAE; Immersion WBL)	<ul style="list-style-type: none"> <li>● More than 450 hours in an internship, combined with coursework</li> <li>● Contact the Minnesota Department of Education (MDE) for support</li> </ul>
Entrepreneurship (Entrepreneurship SAE; Immersion WBL)	<ul style="list-style-type: none"> <li>● Custom trailer fabrication</li> <li>● Equipment repair business</li> <li>● Wind energy business</li> </ul>
Research (Research SAE; Immersion WBL)	<ul style="list-style-type: none"> <li>● Hydraulic pressure of various lubricants</li> <li>● Emission control effects of diesel engines</li> <li>● Ethanol fuel impacts on small engines</li> <li>● Structural integrity of various materials used in construction</li> </ul>
School-Based Enterprise (School-Based SAE; Simulated WBL)	<ul style="list-style-type: none"> <li>● Power Systems SBE WBL</li> <li>● Metal Fabrication SBE WBL</li> <li>● Animal Production/School Farm Operations SBE WBL</li> </ul>
FFA Work-Based Learning and SAE Proficiency Award Areas	<ul style="list-style-type: none"> <li>● Agricultural Mechanics Design and Fabrication</li> <li>● Agricultural Mechanics Repair and Maintenance</li> <li>● Agricultural Services</li> </ul>

## Recommended Social-Emotional Learning (SEL) and FFA Opportunities within PST

The National FFA Organization (FFA) is a student-led, instructor-supervised, Career and Technical Student Organization (CTSO) that results in measurable outcomes within a predefined, agreed upon set of AFNR Social-Emotional Standards and Career Ready Practices aligned to a Career Plan of study. FFA teaches social-emotional and leadership skills and knowledge within the affective domain of learning. FFA includes programs that provide essential employability skills such as critical thinking, consensus building, communication, teamwork, and leadership. FFA was founded in 1928 and is federally defined as intracurricular (i.e., within the curriculum; cf. extracurricular: external, co-curricular: alongside) and an integral part (i.e., necessary to form the whole) of School-Based AFNR Education (Public Law No. 116-7).

Leadership/FFA is a required component of an AFNR program, formalized in the FFA Federal Charter in 1950 (Public Law No. 116-7) and reinforced in federal Perkins CTE Acts (1984 – I; 1990 – II; 1998 – III; 2006 – IV; 2018 – V, Public Law No. 115-224). Minnesota also requires leadership/FFA as a component of CTE Program Approval (Minn. R. 3505). Table 2 has example FFA opportunities with this pathway, as defined by the National Council for AFNR Education, Perkins V legislation, Department of Education, and the Minnesota FFA Association.

**Table 2. Examples of SEL/FFA Curricula and Programs within PST**

FFA Program Area	Examples, Non-Exhaustive
Student Development Programs (Growing Leaders)	<ul style="list-style-type: none"> <li>● Agriscience fair or SAE open house</li> <li>● Career Day/guest speakers</li> <li>● Facility tours</li> </ul>
Community Development/Service (Building Communities)	<ul style="list-style-type: none"> <li>● Build benches/planters for community spaces</li> <li>● Servicing lawn mowers/generators for the community</li> <li>● Build community recreation options (e.g., disc golf course)</li> <li>● Build little community libraries</li> <li>● Building garages and storage building for community</li> </ul>
Literacy, Advocacy, and Safety (Strengthening Agriculture)	<ul style="list-style-type: none"> <li>● Lawn mower safety demonstrations</li> <li>● Farm/ATV/Electrical Safety Demonstrations</li> <li>● Alternative Energy Education</li> </ul>
Conferences, Conventions, and Banquets	<ul style="list-style-type: none"> <li>● InTENse</li> <li>● Horizon conference</li> </ul>
Career Development Events (CDE)	<ul style="list-style-type: none"> <li>● Ag Mechanical and Technical Systems</li> </ul>
Leadership Development Events (LDE)	<ul style="list-style-type: none"> <li>● Agricultural Issues Forum</li> <li>● Marketing Plan</li> <li>● Prepared Public Speaking</li> <li>● Extemporaneous Speaking</li> </ul>

## MN.PST.01: Physics and Engineering Principles within PST; PST Fabrication and Metals

Apply physical science principles and engineering applications to solve problems and improve performance in AFNR power, structural, and technical systems.

### **Performance Indicator MN.PST.01.01**

Apply physical science and engineering principles to design, implement, and improve safe and efficient mechanical systems in AFNR situations.

<b>Introductory Course Benchmarks</b>	<b>Intermediate Course Benchmarks</b>	<b>Advanced Course Benchmarks</b>
PST.01.01.01.a. Compare, and contrast, applications of simple machines in AFNR related mechanical systems.	PST.01.01.01.b. Perform mathematical calculations to determine the mechanical advantage of simple machines in AFNR related mechanical systems.	PST.01.01.01.c. Apply the scientific method to devise strategies to improve the efficiency of operation of AFNR related mechanical systems.
PST.01.01.02.a. Identify the tools, machines, and equipment needed to construct and fabricate a project in AFNR.	PST.01.01.02.b. Calculate the maintenance and purchase cost of tools, machines, and equipment used in AFNR.	PST.01.01.02.c. Devise and document processes to safely implement and evaluate the safe use of AFNR related tools, machinery, and equipment.
PST.01.01.03.a. Examine manuals to classify the types of safety hazards associated with different mechanical systems used in AFNR (e.g., caution, warning, danger).	PST.01.01.03.b. Select, maintain, and demonstrate the proper use of tools, machines, and equipment used in different AFNR related mechanical systems.	PST.01.01.03.c. Conduct a safety inspection of tools, machines, and equipment used in different AFNR related mechanical systems.

### **Performance Indicator MN.PST.01.02**

Apply physical science principles to metal fabrication using a variety of welding and cutting processes (e.g., SMAW, GMAW, GTAW, fuel-oxygen, plasma arc torch).

<b>Introductory Course Benchmarks</b>	<b>Intermediate Course Benchmarks</b>	<b>Advanced Course Benchmarks</b>
PST.01.02.01.a. Compare, and contrast the principles and procedures of different welding and cutting processes (e.g., SMAW, GMAW, GTAW, fuel-oxygen, plasma arc torch, CNC plasma cutting).	PST.01.02.01.b. Analyze the situation and determine the best welding and cutting process to be used in AFNR metal fabrication.	PST.01.02.01.c. Evaluate the quality of AFNR metal fabrication procedures (e.g., SMAW, GMAW, GTAW, fuel-oxygen, plasma arc torch).
PST.01.02.02.a. Compare, and contrast, the properties of different metals used in AFNR power, structural, and technical systems (e.g., malleability, conductivity, optical properties, chemical composition).	PST.01.02.02.b. Assess and select the proper electrode for use in various shielded metal arc welding situations.	PST.01.02.02.c. Construct or repair metal structures and equipment using metal fabrication procedures.



## MN.PST.02: AFNR Tool Operations and Maintenance

Operate, maintain, and repair AFNR mechanical equipment and power systems.

### ***Performance Indicator MN.PST.02.01***

Use hand and power (portable and stationary) tools commonly required in power, structural, and technical systems.

<b>Introductory Course Benchmarks</b>	<b>Intermediate Course Benchmarks</b>	<b>Advanced Course Benchmarks</b>
PST.02.01.01.a. Identify common tools used in AFNR settings.	PST.02.01.01.b. Demonstrate proper use of common tools used in AFNR settings.	PST.02.01.01.c. Effectively use common tools in AFNR settings to complete an assigned task.
PST.02.01.02.a. Utilize Metric and Standard (i.e., SAE) units of measurement.	PST.02.01.02.b. Demonstrate proficiency in the use of precision measurement tools.	PST.02.01.02.c. Utilize precision measuring equipment to perform common AFNR problem solving calculations (e.g., engine displacement, land area, CFMs moved).

### ***Performance Indicator MN.PST.02.02***

Perform preventative maintenance and scheduled service to maintain equipment, machinery, and power units used in AFNR settings.

<b>Introductory Course Benchmarks</b>	<b>Intermediate Course Benchmarks</b>	<b>Advanced Course Benchmarks</b>
PST.02.02.01.a. Maintain the cleanliness and appearance of equipment, machinery and power units used in AFNR power, structural, and technical systems to assure proper functionality.	PST.02.02.01.b. Develop a preventative maintenance schedule for equipment, machinery and power units used in AFNR power, structural, and technical systems.	PST.02.02.01.c. Devise a strategy to communicate to different audiences, preventative maintenance and service schedule for equipment, machinery and power units used in AFNR power, structural, and technical systems.
PST.02.02.02.a. Examine operator’s manuals to determine recommendations for servicing filtration systems and maintaining fluid levels on equipment, machinery and power units used in AFNR power, structural, and technical systems.	PST.02.02.02.b. Service filtration systems and maintain fluid levels on equipment, machinery, and power units in accordance with operator’s manuals.	PST.02.02.02.c. Assess and adjust equipment (e.g., belts and drives, chains, sprockets) and maintain fluid conveyance components (e.g., hoses, lines, nozzles) to ensure proper functioning.

## MN.PST.02: AFNR Tool Operations and Maintenance, Continued

Operate, maintain, and repair AFNR mechanical equipment and power systems.

### **Performance Indicator MN.PST.02.03**

Apply ecological concepts and principles to atmospheric natural resource systems.

<b>Introductory Course Benchmarks</b>	<b>Intermediate Course Benchmarks</b>	<b>Advanced Course Benchmarks</b>
PST.02.03.01.a. Research and summarize the use of equipment, machinery, and power units for AFNR power, structural, and technical systems.	PST.02.03.01.b. Analyze and calculate the cost of using equipment, machinery, and power units for AFNR power, structural, and technical systems.	PST.02.03.01.c. Perform pre-operation inspections, start-up and shut-down procedures on equipment, machinery, and power units as specified in owner's manuals.
PST.02.03.02.a. Examine and identify safety hazards associated with equipment, machinery, and power units used in AFNR power, structural, and technical systems (e.g., caution, warning, danger).	PST.02.03.02.b. Apply safety principles and applicable regulations to operate equipment, machinery, and power units used in AFNR power, structural, and technical systems.	PST.02.03.02.c. Adjust equipment, machinery, and power units for safe and efficient operation in AFNR power, structural, and technical systems.

## MN.PST.03: AFNR Transportation, Engines, and Electricity

Service and repair AFNR mechanical equipment and power systems.

### **Performance Indicator MN.PST.03.01**

Troubleshoot, service, and repair components of internal combustion engines using manufacturers' guidelines.

<b>Introductory Course Benchmarks</b>	<b>Intermediate Course Benchmarks</b>	<b>Advanced Course Benchmarks</b>
PST.03.01.01.a. Identify and classify components of internal combustion engines used in AFNR power, structural, and technical systems.	PST.03.01.01.b. Analyze and explain how the components of internal combustion engines interrelate during operation.	PST.03.01.01.c. Evaluate service and repair needs for internal combustion engines using a variety of performance tests (e.g., manuals, computer-based diagnostics).
PST.03.01.02.a. Distinguish the characteristics of spark-and-compression internal combustion engines used in AFNR power, structural, and technical systems.	PST.03.01.02.b. Utilize technical manuals and diagnostic tools to determine service and repair needs of spark-and-compression internal combustion engines used in AFNR power, structural, and technical systems.	PST.03.01.02.c. Inspect, analyze, and repair spark-and-compression internal combustion engines used in AFNR power, structural, and technical systems.

### **Performance Indicator MN.PST.03.02**

Service electrical systems and components of mechanical equipment and power systems using a variety of troubleshooting and diagnostic methods.

<b>Introductory Course Benchmarks</b>	<b>Intermediate Course Benchmarks</b>	<b>Advanced Course Benchmarks</b>
PST.03.02.01.a. Compare, and contrast, basic units of electricity (i.e., volts, amps, watts, ohms) and the principles that describe their relationship (i.e., Ohm's Law, Power Law).	PST.03.02.01.b. Assess the tools used to measure the basic units of electrical circuits in AFNR power, structural, and technical systems, and perform the measurements.	PST.03.02.01.c. Analyze and design electrical circuits for AFNR power, structural, and technical systems using knowledge of the basic units of electricity.
PST.03.02.02.a. Compare, and contrast, the characteristics of electronic components used in AFNR power, structural, and technical systems (e.g., battery, resistor, diode, transistor, capacitor).	PST.03.02.02.b. Analyze and interpret electrical system symbols and diagrams.	PST.03.02.02.c. Conduct testing procedures to evaluate and repair malfunctioning electrical components and systems used in AFNR power, structural, and technical systems.
PST.03.02.03.a. Classify the uses of electrical sensors and controls in AFNR power, structural, and technical systems.	PST.03.02.03.b. Distinguish and select materials and tools used in electrical control circuit installation.	PST.03.02.03.c. Plan and install electrical control circuits and circuit boards to assure proper operation within AFNR power, structural, and technical systems.



## MN.PST.03: AFNR Transportation, Engines, and Electricity, Continued

Service and repair AFNR mechanical equipment and power systems.

### **Performance Indicator MN.PST.02.03**

Utilize manufacturers' guidelines to diagnose and troubleshoot malfunctions in machinery, equipment, and power source systems (e.g., hydraulic, pneumatic, transmission, steering, suspension).

Introductory Course Benchmarks	Intermediate Course Benchmarks	Advanced Course Benchmarks
PST.03.03.01.a. Research and summarize the applications of common types of hydraulic and pneumatic systems used in AFNR power, structural, and technical systems.	PST.03.03.01.b. Analyze and interpret hydraulic and pneumatic system symbols and diagrams used in AFNR power, structural, and technical systems.	PST.03.03.01.c. Inspect, analyze, and repair hydraulic and pneumatic system components used in AFNR power, structural, and technical systems.
PST.03.03.02.a. Compare, and contrast, operation principles and features of mechanical transmission systems used in AFNR power, structural, and technical systems (e.g., belts, chains, gears, bearings, seals, universals, drive shafts).	PST.03.03.02.b. Utilize speed, torque, and power measurements to calculate efficiency in power transmission systems used in AFNR power, structural, and technical systems.	PST.03.03.02.c. Inspect, analyze, and repair the components of power transmission systems used in AFNR power, structural, and technical systems.
PST.03.03.03.a. Identify and examine the components of suspension and steering systems used in AFNR power, structural, and technical systems.	PST.03.03.03.b. Assess and analyze vehicle and machinery performance related to suspension and steering systems used in AFNR power, structural, and technical systems.	PST.03.03.03.c. Inspect, analyze, and repair vehicle suspension and steering systems used in AFNR power, structural, and technical systems.

## MN.PST.04: AFNR Construction and Woods

Plan, build, and maintain AFNR structures or manufactured products.

### ***Performance Indicator MN.PST.04.01***

Create sketches and plans for AFNR structures or manufactured products.

<b>Introductory Course Benchmarks</b>	<b>Intermediate Course Benchmarks</b>	<b>Advanced Course Benchmarks</b>
PST.04.01.01.a. Interpret and explain the meaning of symbols used in sketches of agricultural structures or manufactured products.	PST.04.01.01.b. Apply scale measurement and dimension to develop sketches of agricultural structures or manufactured products.	PST.04.01.01.c. Create sketches of an agricultural structure or manufactured products by applying principles of design (e.g., drafting software, computer-aided design).
PST.04.01.02.a. Read and interpret the parts and views of plans for agricultural structures or manufactured products.	PST.04.04.02.b. Construct plans for agricultural structures or manufactured products using current technology (e.g., drafting software, computer-aided design).	PST.04.01.02.c. Evaluate, plan, and design functional and efficient facilities or products for use in AFNR power, structural, and technical systems.

### ***Performance Indicator MN.PST.04.02***

Determine requirements, specifications, and estimate costs for AFNR structures or manufactured products.

<b>Introductory Course Benchmarks</b>	<b>Intermediate Course Benchmarks</b>	<b>Advanced Course Benchmarks</b>
PST.04.02.01.a. Summarize and categorize the information needed to complete a bill of materials and cost estimate for an AFNR structure or manufactured products.	PST.04.02.01.b. Analyze a project plan to prepare a bill of materials and an estimate of material costs.	PST.04.02.01.c. Create a project cost estimate, including materials, labor, and management for an AFNR structure or manufactured products.
PST.04.02.02.a. Research and summarize sources of industry construction and materials standards and their importance [e.g., American National Standards Institute (ANSI); Underwriters' Laboratories (UL)].	PST.04.02.02.b. Assess and analyze local building code requirements for agriculture structures or manufactured products.	PST.04.02.02.c. Design and conduct a functionality and safety assessment on an agricultural structure or manufactured products using knowledge of industry standards and local code requirements.

## MN.PST.04: AFNR Construction and Woods, Continued

Plan, build, and maintain AFNR structures or manufactured products.

### **Performance Indicator MN.PST.04.03**

Follow architectural, engineering, and mechanical plans/schematics to construct, maintain, or repair AFNR structures or products (e.g., material selection, site preparation/layout, plumbing, masonry, electrical).

<b>Introductory Course Benchmarks</b>	<b>Intermediate Course Benchmarks</b>	<b>Advanced Course Benchmarks</b>
PST.04.03.01.a. Examine the criteria in selecting materials for constructing, maintaining, and repairing AFNR structures or manufactured products.	PST.04.03.01.b. Analyze and assess samples of materials or products for quality and efficiency of workmanship.	PST.04.03.01.c. Select materials for a project based upon an analysis of the project and the quality of the materials.
PST.04.03.02.a. Summarize the characteristics needed for an ideal building site.	PST.04.03.02.b. Complete a building site analysis checklist to select an ideal building site.	PST.04.03.02.c. Assess site characteristics, identify adjustments, and demonstrate procedures for preparing a building site.
PST.04.03.03.a. Compare, and contrast, the characteristics of wood or metal products used in AFNR structures or manufactured products.	PST.04.03.03.b. Calculate costs associated with the repair and replacement of wood or metal components an AFNR structure or manufactured products.	PST.04.03.03.c. Construct AFNR structures using wood or metal materials.
PST.04.03.04.a. Compare, and contrast, the characteristics of materials used in plumbing and water systems (e.g., copper, PVC, PEX).	PST.04.03.04.b. Calculate costs associated with the repair and replacement of wood or metal components an AFNR structure.	PST.04.03.04.c. Install or repair pipes and plumbing equipment and fixtures in AFNR structures.
PST.04.03.05.a. Summarize the characteristics of the components found in concrete.	PST.04.03.05.b. Calculate volume for concrete projects.	PST.04.03.05.c. Construct, maintain, and repair AFNR structures with concrete, brick, stone, or masonry.
PST.04.03.06.a. Compare, and contrast, direct and alternating current.	PST.04.03.06.b. Assess and analyze the electrical requirements of an AFNR structure or manufactured products.	PST.04.03.06.c. Install or repair fixtures following appropriate codes and standards.
PST.04.03.07.a. Distinguish electrical circuits and the components of each.	PST.04.03.07.b. Calculate the cost of operating an electrical motor.	PST.04.03.07.c. Plan and wire electrical circuits (i.e., single pole switch, three-way switch, duplex outlet).

## MN.PST.05: AFNR Technology

Use control, monitoring, geospatial, and other technologies in AFNR power, structural, and technical systems.

### **Performance Indicator MN.PST.05.01**

Apply computer and other technologies (e.g., robotics, CNC, UAS) to solve problems and increase the efficiency of AFNR systems.

<b>Introductory Course Benchmarks</b>	<b>Intermediate Course Benchmarks</b>	<b>Advanced Course Benchmarks</b>
PST.05.01.01.a. Research and categorize computer technologies used to solve problems and increase efficiency in AFNR systems.	PST.05.01.01.b. Analyze data using computer programs and other current technologies used in AFNR systems.	PST.05.01.01.c. Solve problems and calculate changes in efficiency using computer technologies for AFNR systems.
PST.05.01.02.a. Examine and summarize the specific intent of technologies used to solve problems and increase the efficiency of AFNR systems [e.g., robotics; unmanned aircraft systems (UAS); computer numerical control machine (CNC)].	PST.05.01.02.b. Calculate the change in efficiency after using technologies in AFNR systems.	PST.05.01.02.c. Solve problems and evaluate changes in efficiency and create recommendations for the use of technologies in AFNR systems [e.g., robotics; unmanned aircraft systems (UAS); computer numerical control machine (CNC)].

### **Performance Indicator MN.PST.05.02**

Prepare and use electrical drawings to design, install, and troubleshoot electronic control systems in AFNR settings.

<b>Introductory Course Benchmarks</b>	<b>Intermediate Course Benchmarks</b>	<b>Advanced Course Benchmarks</b>
PST.05.02.01.a. Examine and categorize electrical control system components used in AFNR systems (e.g., transistors, relays, HVAC, logic controllers).	PST.05.02.01.b. Analyze schematic drawings for electrical control systems used in AFNR systems.	PST.05.02.01.c. Design schematic drawings for electrical control systems used in AFNR systems.
PST.05.02.02.a. Differentiate between the purpose of electrical sensors and controls used in AFNR power, structural, and technical systems.	PST.05.02.02.b. Interpret maintenance schedules for electrical control systems used in AFNR power, structural, and technical systems.	PST.05.02.02.c. Troubleshoot electrical control system performance problems found in AFNR power, structural, and technical systems.
PST.05.02.03.a. Research and summarize the importance of AFNR power, structural, and technical control systems using programmable logic controllers (PLC) or other computer-based systems.	PST.05.02.03.b. Assess the functions of AFNR power, structural, and technical control systems using programmable logic controllers (PLC) in agricultural production and manufacturing.	PST.05.02.03.c. Develop and implement AFNR power, structural, and technical control systems using programmable logic controllers (PLC) or sensor-based technologies, other computer-based systems.



## MN.PST.05: AFNR Technology, Continued

Use control, monitoring, geospatial, and other technologies in AFNR power, structural, and technical systems.

### **Performance Indicator MN.PST.05.03**

Apply geospatial technologies to solve problems and increase the efficiency of AFNR systems.

Introductory Course Benchmarks	Intermediate Course Benchmarks	Advanced Course Benchmarks
PST.05.03.01.a. Research and summarize the impact of utilizing geospatial technologies [i.e., global positioning system (GPS); geographic information system (GIS); remote sensing; telematics] in AFNR systems.	PST.05.03.01.b. Analyze and interpret trends in data collected utilizing geospatial technologies.	PST.05.03.01.c. Collect data and create maps utilizing geospatial technologies.
PST.05.03.02.a. Examine the components of precision technologies used in AFNR systems.	PST.05.03.02.b. Analyze and calculate the economic impact of utilizing precision technologies (e.g., GPS/GIS) in AFNR systems.	PST.05.03.02.c. Install, maintain, and service instrumentation and equipment used for precision technologies (i.e., GPS receivers, yield monitors, remote sensors) used in AFNR systems.

## MN.PST.06: AFNR Biotechnology and Energy

Use control, monitoring, geospatial, and other technologies in AFNR power, structural, and technical systems.

### **Performance Indicator MN.PST.06.01**

Apply biotechnology principles, techniques, and processes to produce biofuels renewable energy sources (e.g., fermentation, transesterification, methanogenesis, wind energy, solar power, geothermal).

<b>Introductory Course Benchmarks</b>	<b>Intermediate Course Benchmarks</b>	<b>Advanced Course Benchmarks</b>
PST.06.01.01.a. Examine and synthesize the need for biofuels (e.g., cellulosic bioenergy).	PST.06.01.01.b. Analyze the impact of the production and use of biofuels on the environment.	PST.06.01.01.c. Evaluate and support how biofuels could solve a global issue (e.g., environmental, agricultural).
PST.06.01.02.a. Differentiate between biomass and sources of biomass.	PST.06.01.02.b. Assess the characteristics of biomass that make it useful for biofuels production.	PST.06.01.02.c. Conduct a review of the technologies used to create biofuels from biomass and weigh the pros and cons of each method.
PST.06.01.03.a. Research and explain the process of fermentation and its potential applications.	PST.06.01.03.b. Correlate the relationship between the process used to produce alcohol from biomass and fermentation.	PST.06.01.03.c. Produce alcohol and co-products from biomass.
PST.06.01.04.a. Define and summarize the process of transesterification and its potential applications.	PST.06.01.04.b. Analyze and document the process used to produce biodiesel from biomass.	PST.06.01.04.c. Produce biodiesel and co-products from biomass.
PST.06.01.05.a. Examine the process of methanogenesis and its potential applications.	PST.06.01.05.b. Analyze and describe the process used to produce methane from biomass.	PST.06.01.05.c. Produce methane and co-products from biomass.
PST.06.01.06.a. Research and identify renewable and nonrenewable energy sources used in AFNR.	PST.06.01.06.b. Assess the environmental impacts of renewable and nonrenewable energy sources used in AFNR.	PST.06.01.06.c. Design and implement methods to evaluate the efficiency of renewable and nonrenewable energy sources.
PST.06.01.07.a. Compare, and contrast, the pathways of delivery for renewable and nonrenewable energy sources in an AFNR enterprise or business.	PST.06.01.07.b. Calculate the costs of using renewable and nonrenewable energy sources in an AFNR enterprise or business.	PST.06.01.07.c. Devise a strategy to incorporate the use of selected energy sources in an ANFR enterprise or business.
PST.06.01.08.a. Summarize methods and compare, and contrast, units used to benchmark energy use of AFNR structures (e.g., EUIs, BTUs).	PST.06.01.08.b. Convert energy utilized in an AFNR structure to an energy utilization index (e.g., convert CCF, KWH to Btu consumption per square foot).	PST.06.01.08.c. Apply energy benchmarking data to examine and select methods to conserve energy in AFNR structures.
PST.06.01.09.a. Identify the basic mechanical components of a photovoltaic, wind turbine, or geothermal system.	PST.06.01.09.b. Measure and test energy output generated from solar power and wind energy systems.	PST.06.01.09.c. Design solar and wind energy systems to meet stand alone and off grid energy use applications.



## Secondary/Multidisciplinary AFNR Pathways that Align with PST

### Section 8: Agribusiness Systems (ABS).....135

A secondary or multidisciplinary AFNR pathway, often integrating standards or cumulating from coursework from the AFNR animal, plant, natural resources, and power systems pathways—encompassing the study of agribusinesses and their management including, but not limited to, record keeping, budget management (cash and credit), business planning, and sales and marketing. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the planning, development, application, and management of agribusiness systems in AFNR settings.

### Section 10: Biotechnology Systems (BS).....174

A secondary or multidisciplinary AFNR pathway—often integrating standards or cumulating from coursework from the AFNR animal, plant, and natural resources pathways—encompassing the study of using data and scientific techniques to solve problems concerning living organisms with an emphasis on applications to agriculture, food, and natural resource systems. Students completing a program of study in this pathway will demonstrate competence in the application of principles and techniques for the development, application, and management of biotechnology systems in AFNR settings.