

# AGRICULTURAL MECHANICS

## Purpose

The Missouri State Agricultural Mechanics CDE shall reflect the agricultural mechanics instruction provided contestants in Missouri secondary agriculture departments. Specifically, the skill and problem solving activities shall reflect the competencies included in the Missouri Agricultural Mechanics curriculum. Agricultural Mechanics competencies shall include the areas of agricultural machinery, small engine power, tractor power, agricultural electrification, woodwork and carpentry, concrete and plumbing, metal fabrication, soil and water management, and repair and maintenance. The written examination, skill activities, and problem solving activities will be conducted to assess the participants' knowledge of these agricultural mechanics competencies. Agricultural Mechanics competency profiles are available through the Instructional Materials Laboratory.

## Objectives

The overall purpose of the Agricultural Mechanics CDE is to motivate contestants to greater learning by providing an opportunity to apply classroom knowledge in a competitive situation and to promote state-of-the-art Agricultural Mechanics programs within the State of Missouri. Contestants in the Agricultural Mechanics CDE should have developed competencies in the following areas. A detailed list of competencies is included at the end of these Guidelines on the “Ag Mechanics Systems Competencies Lists”.

### Electrical Systems (Circuits and Motors)

The contestant should be able to perform the competencies identified in the Missouri Agricultural Structures II Curriculum, Unit D, Agricultural Structures I Curriculum, Unit B, Competency Number 7, and the following specific competencies not in the curriculum that pertain to electrical motors: selecting motors based on the type of application; interpreting motor nameplate data; interpreting motor wiring connection diagrams; servicing electric motors; connecting motor drives; identifying motors and motor parts; and identifying methods of providing motor protection. References for electric motors are listed in the National FFA Career Development Events, Agricultural Mechanics Section.

### Metal Fabrication Systems

The contestant should be able to perform the arc welding and oxy-acetylene welding/cutting competencies identified in the Missouri Agricultural Science I and II Curriculum materials; Agricultural Construction Unit A, Competencies 1 to 4; and the Agricultural Construction Unit B, Competencies 1 to 10. Plasma arc cutting and oxy-propylene welding/cutting may also be used. Knowledge of Metals and Project Construction is also required.

### Structural Systems

The contestant should be able to perform the competencies identified in the Missouri Agricultural Construction Curriculum, Units C, D, & E; Agricultural Science I Curriculum, Tool Sharpening and Reconditioning; Agricultural Science I, Woodworking Unit; Material Selection, Plan Reading, and Interpretation Unit; Agricultural Power I, Units B and C; Agricultural Science II Curriculum, Tool Sharpening and Reconditioning and Cold Metal Work, Power Tools Unit.

Missouri Agricultural Structures Curriculum I, Units A and B; Agricultural Structures Curriculum II, Units A, B, and E.

### Agricultural Machinery Systems

The contestant should be able to perform the competencies identified in the Missouri Agricultural Machinery Curriculum and the Missouri Agricultural Power II Curriculum. Subtopics include operating and maintaining: power units; primary tillage equipment; secondary tillage equipment; planting equipment; chemical applicators; harvesting equipment; and materials and handling equipment, principles of operation; testing and analyze the multi-cylinder components; servicing a multi-cylinder engine; and servicing the power train.

### Small Engine Systems

The contestant should be able to perform the competencies identified in the Missouri Agricultural Power I Curriculum. Subtopics include: principles of operation, using measuring tools, using shop tools and equipment; selecting engine parts and fasteners; using a service manual; testing and analyzing a single cylinder engine system; and servicing a single cylinder engine.

### Environmental and Natural Resource Systems

The contestant should be able to perform the following competencies in addition to those identified in the current curriculum: describing principles involved in appropriate conservation and/or land use planning; reading legal land descriptions; determining land area; determining the percent of slope or grade; leveling a leveling instrument; using a hand level; taking rod readings; measuring distances with tapes or instruments; laying out corners using instruments; recording field notes for differential and profile leveling; laying out foundations, footings, and batter boards; laying out a contour line; measuring crop residue on the land; determining soil losses; and determine the cubic feet of dirt to move. The contestant should also be able to perform the competencies identified in the Missouri Agricultural Advanced Crop Production Unit C, "Soil Conservation." References for Soil and Water Management are listed in the National FFA Career Development Events Bulletin, Agricultural Mechanics Section.

### Crosswalk with Show-Me Standards

Objectives – Students participating in the Career Development Event should be able to:		Show-Me Standards	
		Knowledge Standards (Content Areas)	Performance Standards (Goals)
1.	Agricultural Machinery: to perform the competencies identified in the Missouri Agricultural Machinery Curriculum and the Missouri Agricultural Power II Curriculum.	CA.3	1.3, 1.4, 1.6, 1.8
2.	Small Engine Power: to perform the competencies identified in the Missouri Agricultural Power I Curriculum.	MA.1, MA.2, MA.3, MA 5, MA.6	3.1, 3.2, 3.3, 3.6
4.	Agricultural Electrification: to perform the competencies identified in the Missouri Agricultural Structures II Curriculum.	SC.1, SC.4, SC.5, SC.8	4.4, 4.8
5	Woodwork & Carpentry: to perform the competencies identified in the Missouri Agricultural Construction Curriculum, Units C and E	SS.5, SS.7	
6.	Concrete & Plumbing: to perform the competencies identified in the Missouri Agricultural Structures Curriculum I, Unit B; Agricultural Structures Curriculum II, Units A and E.		
7.	Metal Fabrication: to perform the arc welding and oxy-acetylene welding competencies identified in the Missouri Agricultural Science I and II Curriculum materials; Agricultural Construction Unit A, Competencies 1 to 4; and the Agricultural Construction Unit B, Competencies 1 to 10.		
8.	Soil and Water Management: to perform the following competencies such as: describe principles involved in appropriate conservation planning; read legal land descriptions; determine land area; determine percent of slope or grade; level a leveling instrument; use of hand level; rod readings; and determine the cubic feet of dirt to move.		

Corresponding Secondary Agriculture Curriculum			
<b>Course and/or Curriculum:</b>	Agricultural Science I	<b>Unit(s):</b>	Agricultural Mechanics
	Agricultural Science II		Agricultural Mechanics
	Agricultural Machinery		
	Agricultural Power I		
	Agricultural Power II		
	Agricultural Structures I		
	Agricultural Structures II		
	Agricultural Construction		
	Advanced Crop Production		Soil Conservation

## Event Components

The Ag Mechanics CDE shall consist of the following eight (8) components:

- A. *Written Exam*
- B. *Skill Tests in Electrical Systems*
- C. *Skill Test in Metal Fabrication Systems*
- D. *Skill Test in Structural Systems*
- E. *Skill Test in Ag Machinery Systems*
- F. *Skill Tests in Small Engines*
- G. *Skill Tests in Environment and Natural Resource (including Precision Agriculture) Systems*
- H. *Team Activity*

**1. Written Exam:** Each contestant will take the Written Exam. This objective exam will cover information related to each of the six (6) Ag Mechanics Systems and will be based on the reference material listed in this document.

**2. Skills Tests in Ag Mechanics Systems:** Each contestant will complete a Skills Test in each of the following Ag Mechanics Systems. Further explanation of the competencies included in each Ag Mechanics System are included in the Ag Mechanics Systems Competency List at the end of this document. Additionally, please review the “Suggested State Ag Mechanics Activities” document found at: <http://web.missouri.edu/~schumacherl/statecon.html>

- A. Electrical Systems
  - 1. Circuits (NEC)
  - 2. Motors
  - 3. Ohms Law
  - 4. Volt Ohm Meters
  
- B. Metal Fabrication Systems
  - 1. Arc
  - 2. Mig
  - 3. Oxy Cutting
  - 4. Oxy Brazing
  - 5. Metallurgy
  - 6. Blue Prints / Mechanical drawings
  
- C. Structural Systems
  - 1. Plumbing
  - 2. Concrete
  - 3. Fence Construction
  - 4. Blue Prints / Mechanical drawings
  
- D. Ag Machinery (including tractors) Systems
  - 1. Planters/seeding
  - 2. Combines/harvesting
  - 3. Hay/Forage equipment
  - 4. Chemical/Fertilizer Application Equipment
  - 5. Materials Handling Equipment

E. Small Engine Systems

1. Single cylinder engines (Briggs, Kohler, Tecumseh)
2. Chain saws
3. Two-stroke engines

F. Environment and Natural Resource (including Precision Agriculture) Systems

1. Precision Agriculture
2. Surface water management (surveying)
3. Legal land description

**3. Team Activity:** Each team will be expected to complete a number of activities based on a provided scenario that may include multiple areas from each of the Ag Mechanics Systems. A scoring rubric will be provided so contestants are aware of each component of the activity they are being score on.

Example Team Activity Scenarios may be found at:

<http://web.missouri.edu/~schumacherl/statecon.html>

**Event Format**

1. **Each team will consist of four members who have qualified by participating at a district CDE.**
2. Each component of the event will be completed in the following time allotments:
  - A. Each contestant will be allowed 25 minutes to complete each of the six (6) Skills Tests with 5 additional minutes to rotate to next section.
  - B. Each contestant will be allowed 40 minutes to complete the written examination with 5 additional minutes to rotate to the next section.
  - C. Each team will be allowed 40 minutes to complete the Team Activity with an additional 5 minutes to rotate to next section.

**Event Scoring**

<b>Event</b>	<b>Points</b>
Skill Tests (6 skills at 50 pts each)	300
Written Exam	60
Team Activity	120 per team
<b>TOTAL</b>	<b>360 points per individual</b>

1. Each skill activity will be worth 50 points. The written examination will be worth 60 points. As such, an individual could earn 360 points. The team activity is worth 120 points; each team could earn a total of 1200 points. **The top three individual contestant scores will be included with the Team Activity score to calculate the team score.**

2. **Tie scores among teams should be broken using the high individual team member's score.** In case the scores are tied, the scores of the second high individual on each team should be used.

3. Contestants will be ranked on their individual scores only (not including the team activity points).

## Event Rules and Regulations

1. Each contestant will compete in each area of the CDE.
2. Work will be evaluated and scored on accuracy, workmanship, and the ability to interpret instructions, plans, and drawings.
3. Each summer at the MVATA Summer Conference the Superintendent and teachers will identify a list of potential activities and competencies that will be included in the upcoming state CDE and published in the fall.
4. Pictures or slides may be used in any area rather than actual items.
5. Students will be allowed to touch any/all items on the contest unless otherwise stated in writing at that station.
6. Problem solving may be a part of the event in any area. The use of computers may be incorporated into the solving of problems .
7. Practice metal will be provided if necessary. **DO NOT** bring metal for practice.
8. Only tools listed on Form 1 (included in following pages) will be used for tool identification, sharpening, and adjustment skill activities. The contestant should look for the major defect or improper adjustment as they complete this part of the event and indicate Useable or Non-useable under Working Condition.
9. Only parts and tools listed on Form 76 will be used for the Small Engines System Skills Test.
- 10. Duplicate samples may not be used in any identification portion of the event.**
11. Contestants shall not communicate with anyone other than the persons in charge of the CDE.
12. Each contestant must bring the following materials:

1. #2 lead pencil
2. Clean clipboard
3. Safety glasses
4. Arc or Mig welding helmet
5. Welding gloves
6. Chipping hammer
7. Calculator
8. Oxy-acetylene goggles

No contestant will be permitted to participate without the previous listed equipment.

13. A student will only be allowed to participate in the Ag Mechanics CDE one time. However, any student who participated in the state CDE prior to 2018 would be allowed to participate one additional time.
14. Only contestants and CDE workers will be allowed in the CDE area during the event. Teachers will be allowed to view the event set-up only after the event is completed. Teachers will not be allowed to communicate with the judges until event grading has been completed.
15. No CDE papers will be returned after the CDE.
16. Time allowances will be made by the CDE superintendent or assistants for equipment breakdowns or improperly functioning equipment.
17. Contestants will wear safety eye protection during all skill activities. Contestants will not be allowed to compete in an activity without their own safety glasses. Sharing of safety glasses with fellow team members or other contestants will not be allowed.

18. Arc welding and oxy-acetylene participants must wear appropriate clothing and shoes. (i.e. long pants, coveralls or overalls; long sleeve shirt; and leather shoes or boots) All exposed skin must be covered. **NO tennis shoes or sandals will be permitted. NO frayed clothing will be permitted.**
19. List of machinery for state CDE will be available by March 1<sup>st</sup> of the CDE year on the UMC Agricultural Engineering website (<http://web.missouri.edu/~schumacher/leon.html>) or by calling the UMC Agricultural Engineering office (573-882-2731).
20. Calculators may be used when the CDE specifies calculators may be used. (See CDE General Guidelines for specific requirements for calculators.)

## References

References for the CDE are those listed for the respective areas of the Missouri Agricultural Science I and II; Agricultural Structures; Agricultural Power I and II; Agricultural Machinery, and Agricultural Construction Curricula. References are listed in the Career Development Events Bulletin, Agricultural Mechanics Section:

1. Appropriate owner or repair manual for equipment in the CDE
2. Agriculture Mechanics Fundamentals and Applications – Delmar Publishing
3. Agriculture Mechanics for Agriculture Science 1 – IML – (available via MCCE)
4. Agriculture Mechanics for Agriculture Science 2 – IML – (available via MCCE)
5. Agriculture Structures – IML (available via MCCE)
6. Small Engine Service and Repair – IML (available via MCCE)
7. Agriculture Construction Volume 3 – IML (available via MCCE)
8. University of Missouri website (<http://web.missouri.edu/~schumacher/statecon.html>.)

All IML Materials can be found at: <https://dese.mo.gov/college-career-readiness/career-education/agricultural-education/agricultural-education>

## Forms

See following pages for Agricultural Mechanics Form 1, List 1, Form 76.

## Agriculture Mechanics Competency Lists

### Electrical Systems Competencies (Circuits and Motors)

<b>A. Electrical Circuit Competencies</b>
1. Identify the dangers and safety practices associated with electrical work.
2. Identify the terms associated with electrical work.
3. Match types and sizes of wire and their uses.
4. Identify the importance of grounding and GFCI protection.
5. Locate lights, outlets, and switches, and identify circuit protection needs.
6. Identify the symbols used in agricultural wiring plans.
7. Describe practices for running wire to an agricultural structure and wiring within the building safely.
8. Identify procedures for connecting the drop wires and branch circuit wires to the SEP.
9. Describe how to run wiring from the SEP to a junction box, lights, and receptacles.
10. Calculate cost and electrical power using Ohm's Law.
11. Describe procedures for planning and installing lighting protection.
12. Identify problems in electrical systems.
13. Demonstrate an understanding of how to work with electricity and wiring by diagramming a wiring plan for an agricultural structure, identifying sources of electrical grounding in the structure, and completing a bill of materials for the project. Wiring diagrams may include: <ol style="list-style-type: none"><li>1. Switch Light Circuit</li><li>2. Switch Leg</li><li>3. Receptacle</li><li>4. Split Receptacle</li><li>5. 3 Way Switch</li><li>6. GFCI</li><li>7. 4 Way Switch</li></ol>
<b>B. Electric Motor Competencies</b>
1. Select motors based on the type of application
2. Interpreting motor nameplate data
3. Interpreting motor wiring connection diagrams
4. Servicing electric motors
5. Connecting motor drives
6. Identifying motors and motor parts
7. Identifying methods of providing motor protection

## Agriculture Mechanics Competency Lists (Page 2)

### Metal Fabrication Systems Competencies

<b>A. Arc /MIG Welding</b>	
1. List and demonstrate the safety procedures for arc welding.	
2. Identify the various types of metals and their properties.	
3. Prepare metals for welding by cutting, grinding, and/or cleaning.	
4. Weld in all positions with stick welder [Shielded Metal Arc Welding].	
5. Weld in all positions with MIG welder [Gas Metal Arc Welding].	
6. Weld pipe.	
7. Apply principles of arc and MIG welding by performing common welds, identifying welding equipment, and answering welding-related questions. Welds may include:	
1. Flat Butt Weld	5. Lap Weld
2. Horizontal Butt Weld	6. Pipe to Pipe Weld
3. Vertical Butt Weld	7. Pipe to Flat Weld
4. Fillet Weld	8. Square Tubing Weld
8.	
<b>B. OxyAcetylene Cutting</b>	
1. List and demonstrate the safety procedures required for using oxy-acetylene equipment.	
2. Perform in order the complete procedure for lighting, adjusting the flame, and shutdown of the torch.	
3. Select appropriate tip for the job to be performed.	
4. Perform a braze weld operation	
5. Apply principles of oxy-gas cutting and welding, by using the equipment to perform welds and cuts, identifying welding and cutting equipment, and answering questions about related equipment and procedures. Welds/cuts may include:	
1. 90 degree cut	3. Pierce a hole
2. 45 degree cut	4. Braze
<b>C. Metals</b>	
1. Select metals by design and strength.	
2. Explain how construction metal is dimensioned.	
3. Remove stress risers.	
4. Identify common metal fasteners.	
5. Identify the hardness grade of a bolt.	
6. Control heat distortion of metals.	
7. Assemble work using proper locks and fasteners.	
8. Use heat to shape metals.	
9. Use tap and die set to do threading.	
10. List steps used to control crystallization in tempering, annealing, hardening, wrinkle bending, normalizing, and welding.	
11. Apply basic metalworking skills by constructing an appropriate metalworking project.	

## Agriculture Mechanics Competency Lists (Page 3)

### Metal Fabrication Systems Competencies (Continued)

<b>D. Project Construction</b>
1. List the safety procedures for project construction.
2. Select project and design a project plan.
3. Develop a bill of materials and a projected cost list.
4. List tools needed to complete a project and list safety precautions.
5. Determine the time frame for completion of a project.
6. Interpret a project construction plan.
7. Lay out and prepare materials for cutting.
8. Determine construction design for proper hitching and balancing.
9. Determine construction design for legal specifications: width, length, weight, etc.
10. Identify and correct project defects by approved methods.
11. Perform assembly procedures.
12. Describe why a project should have a finish.
13. Determine actual cost of materials and labor for project.
14. Use hand and power tools in completing a project.
15. Demonstrate an understanding of the skills and procedures necessary to build a project by selecting an appropriate project; devising elevation drawings, a bill of materials, and a plan of procedure for the project; and applying their plan to complete the project within the allotted time.

## Agriculture Mechanics Competency Lists (Page 4)

### Structural Systems Competencies

<b>Buildings:</b>
1. Describe safety practices associated with building construction.
2. Identify types and designs of buildings and their methods of construction.
3. Identify and select building materials.
4. Identify the uses of different fasteners and fastening systems.
5. Describe how to construct a floor and subfloor.
6. Describe the purpose of walls, types of walls, supports, and siding used in agricultural buildings
7. Select a roof support system.
8. Select roofing materials
9. Identify factors affecting the heating, cooling, and ventilation of agricultural structures.
10. Demonstrate an understanding of correct building construction procedures by laying out joists and rafters, applying roofing skills, and answering questions about roofing materials. Layouts may include: Bottom/Top Plate Layout, Rafter Layout, Brace Layout, Stair Layout, Stud Wall.
<b>Concrete:</b>
1. Investigate safety in working with concrete.
2. Identify factors that affect the quality of fresh concrete.
3. Identify site preparation requirements.
4. Describe the procedure for preparing to pour a concrete slab.
5. Explain the procedure for ordering, pouring, and finishing concrete.
6. Identify factors affecting the quality of cured concrete.
7. Describe the procedure for pouring a concrete wall.
<b>Plans:</b>
1. Read and create a simple construction drawing.
2. Develop a plan of procedure and a bill of materials for a construction project.
3. Demonstrate an understanding of the importance planning has on effective work procedure by drawing a construction plan and developing a plan of procedure, a cutting bill of materials, and a purchasing bill of materials.
<b>Plumbing:</b>
1. Estimate how much water is needed for a farmstead.
2. Investigate safety practices for plumbing.
3. Identify pipe types and determine size requirements.
4. Measure, cut, and connect pipes and tubing.
5. Investigate methods of protecting water pipes against freezing.
6. Demonstrate an understanding of plumbing equipment and procedures by applying different techniques to join dissimilar types of pipe – copper, PVC, CPVC, PEX and black iron.

## Agriculture Mechanics Competency Lists (Page 5)

### Ag Machinery Systems Competencies (including Tractors)

<b>A. Following Safety Procedures</b>
1. Demonstrate safe machinery operation practices
2. Demonstrate safe procedures for servicing, repairing, calibrating and adjusting agricultural machinery
<b>B. Operating and Maintaining Power Units (Tractors)</b>
1. Demonstrate the uses of machinery operator manuals
2. Size and select unit
3. Service and repair unit
4. Calibrate and adjust unit
5. Check and service charging and starting systems
6. Check and service comfort systems
7. Check and service hydraulic systems
8. List steps to prepare machinery for post season storage
9. List steps to follow after removing machinery from post season storage
10. Explain principles of hitching and ballasting
<b>C. Operating and Maintaining Machinery Including:</b>
1. Tillage Equipment
2. Planting/Seeding Equipment
3. Harvesting Equipment
4. Hay/Forage Equipment
5. Chemical/Fertilizer Application Equipment
6. Materials & Handling Equipment
1. Demonstrate the uses of machinery operator manuals
2. Size and select equipment
3. Service and repair equipment
4. Calibrate and adjust equipment
5. List steps to prepare machinery for post season storage
6. List steps to follow after removing machinery from post season storage
7. Explain principles of hitching and ballasting

## Agriculture Mechanics Competency Lists (Page 6)

### Small Engines Systems Competencies

<b>A. Explaining Principles of Operation</b>
1. Explain the operating principles of a two-cycle engine
2. Explain the operating principles of a four-cycle engine
3. Identify safety procedures to follow when servicing & repairing a single cylinder engine
<b>B. Using Measuring Tools</b>
1. Demonstrate the use of a micrometer
2. Demonstrate the use of a dial caliper
3. Demonstrate the use of a telescoping gauge
4. Demonstrate the use of a dial indicator
5. Demonstrate the use of a torque wrench
6. Demonstrate the use of a reject gauge (GO-NO GO gauge)
7. Demonstrate the use of a feeler gauge
<b>C. Using Shop Tools and Equipment</b>
1. Demonstrate the use of shop hand tools
2. Demonstrate the use of shop power tools
3. Demonstrate the use of cleaning equipment
<b>D. Selecting Engine Parts and Fasteners</b>
1. Identify parts of an engine
2. Select, install, or assemble parts
3. Select correct engine fasteners
<b>E. Using a Service Manual</b>
1. Interpret & apply a service manual
2. Select oils, fuels, & lubricants
<b>F. Testing and Analyzing a Single Cylinder Engine System</b>
1. Test & analyze a carburetion system
2. Test & analyze a compression system
3. Test & analyze an ignition system
4. Test & analyze a fuel injection system
5. Test & analyze an electrical system
6. Test & analyze a lubrication system
7. Test & analyze a governor system
<b>G. Servicing a Single Cylinder Engine</b>
1. Clean, adjust, and/or repair a carburetor
2. Service & adjust an electrical system
3. Grind & adjust valves
4. Recondition or replace cylinders & pistons
5. Service & repair a lubrication system
6. Clean & service a cooling system
7. Clean & service an air intake & exhaust system
8. Service & repair a mechanical starting system
9. Prepare engine for winter storage

## Agriculture Mechanics Competency Lists (Page 7)

### Environment and Natural Resource Systems Competencies

<b>Soil and Water Management Competencies</b>
1. Describing principles involved in appropriate conservation and/or land use planning
2. Reading legal land descriptions
3. Determining land area
4. Determining the percent of slope or grade
5. Leveling a leveling instrument
6. Using a hand level
7. Taking rod readings
8. Measuring distances with tapes or instruments
9. Laying out corners using instruments
10. Recording field notes for differential and profile leveling
11. Laying out foundations, footings, and batter boards
12. Laying out a contour line
13. Measuring crop residue on the land
14. Determining soil losses
15. Determine the cubic feet of dirt to move.