

APPROVED PATHWAY:

1. Includes minimum of three secondary-level credits.
2. Includes a work-based element.
3. Consists of a sequence:
 - Introductory-level.
 - Technical-level.
 - Application-level courses.
4. Supporting documentation includes Articulation Agreement(s), Certification, Program Improvement Plan and a Program of Study.
5. Technical-level and Application-level courses receive .5 state-weighted funding in an approved CTE pathway.



ENGINEERING CAREER CLUSTER DESIGN

Engineering and Applied Mathematics Pathway

CIP CODE 14.0101

INTRODUCTORY LEVEL

Title	Code	Credit
*Introduction to Engineering Chemistry	03101	1 credit

Title	Code	Credit
Production Blueprint Reading	21108	.5 credit

TECHNICAL LEVEL

Must choose **ONE** of the following boxed courses.

Title	Code	Credit
**Engineering Design	21006	1 credit
**Drafting / CAD	21107	1 credit

Title	Code	Credit
Principles of Applied Engineering	41320	1 credit
Robotics	21009	1 credit
Foundations of Electronics	21201	1 credit

APPLICATION LEVEL

Title	Code	Credit
Emerging Technologies	21053	1 credit
Digital Electronics	21008	1 credit
Computer Integrated Manufacturing	21010	1 credit
Project Management	41350	.5 credit
Materials Science and Engineering	41355	.5 credit
Civil Engineering and Architecture	21012	1 credit

Title	Code	Credit
Aerospace Engineering	21013	1 credit
Particular Topics in Engineering	21015	1 credit
Engineering Design and Development	21007	1 credit
Workplace Experience in Engineering	41048	.5 credit
Workplace Experience	21048	1 credit

- * Required for pathway approval
- ** Must offer 21006 or 21107, but not both in this pathway

KANSAS STATE CAREER CLUSTER COMPETENCY PROFILE

ENGINEERING & APPLIED MATHEMATICS PATHWAY (C.I.P. 14.0101)

STUDENT _____

Rating Scale:

- 3 - Proficient Achievement
- 2 - Limited Achievement
- 1 - Inadequate Achievement
- 0 - No Exposure

ENGINEERING CLUSTER

Graduation Date _____

I certify that the student has received training in the areas indicated.

Instructor Signature _____

Instructor Signature _____

Instructor Signature _____

Instructor Signature _____

COMMON CAREER TECHNICAL CORE – CAREER READY STANDARDS

(To be taught in all courses in the approved pathway)

1. Act as a responsible and contributing citizen and employee
2. Apply appropriate academic and technical skills
3. Attend to personal health and financial well-being
4. Communicate clearly, effectively and with reason
5. Consider the environmental, social and economic impacts of decisions
6. Demonstrate creativity and innovation
7. Employ valid and reliable research strategies
8. Utilize critical thinking to make sense of problems and persevere in solving them.
9. Model integrity, ethical leadership and effective management
10. Plan education and career path aligned to personal goals
11. Use technology to enhance productivity
12. Work productively in teams while using cultural/global competence

COMMON CAREER TECHNICAL CORE –

STEM CLUSTER STANDARDS (To be taught in all courses in the approved pathway)

1. Apply engineering skills in a project that requires project management, process control and quality assurance.
2. Use technology to acquire, manipulate, analyze and report data.
3. Describe and follow safety, health and environmental standards related to science, technology, engineering and mathematics (STEM) workplaces.
4. Understand the nature and scope of the Science, Technology, Engineering & Mathematics Career Cluster and the role of STEM in society and the economy.
5. Demonstrate an understanding of the breadth of career opportunities and means to those opportunities in each of the Science, Technology, and Engineering & Mathematics Career Pathways.
6. Demonstrate technical skills needed in a chosen STEM field.

INTRODUCTORY LEVEL COURSES

41310 Introduction to Engineering

(1 credit) Required for pathway approval

- 3 2 1 0 1. Demonstrate use of PPE including safety glasses and ear protection.
- 3 2 1 0 2. Understand the steps in the engineering design process.
- 3 2 1 0 3. Describe the effects of resistance in mechanical, electrical, fluid, and thermal systems.
- 3 2 1 0 4. Recognize various tools, fasteners, and joining systems employed in selected engineering processes.
- 3 2 1 0 5. Identify and use both standard and metric systems of measurement.
- 3 2 1 0 6. Recognize and follow safety rules for using lab tools and machines.
- 3 2 1 0 7. Describe the elements of design and apply this concept to the design process using CAD software.
- 3 2 1 0 8. Use sketches as a communication tool, including thumbnail, perspective, isometric, and orthographic sketches.
- 3 2 1 0 9. Understand Manufacturing and its processes.

- 3 2 1 0 10. Distinguish between concepts of invention and innovation.
- 3 2 1 0 11. Describe engineering and explain how engineers participate in or contribute to the invention and innovation of products
- 3 2 1 0 12. Describe the purpose and importance of working in a team to solve an engineering problem.
- 3 2 1 0 13. List benefits of robot use in today's world and their impact on society.
- 3 2 1 0 14. Experience principles of flight using: kites, whirly gigs, model airplanes, hot air balloons, and/or model rockets.
- 3 2 1 0 15. State the history and development of flight exploration.
- 3 2 1 0 16. Explore how Nano-products are used in society today.
- 3 2 1 0 17. Identify the six simple machines and explain their applications.
- 3 2 1 0 18. Distinguish between the three classes of levers.
- 3 2 1 0 19. Identify the parts of an atom: protons, neutrons, and electrons.
- 3 2 1 0 20. Express how electrons transfer from one atom to another to create electron flow.
- 3 2 1 0 21. Define current, voltage, and resistance.
- 3 2 1 0 22. Clarify the properties of a magnet.
- 3 2 1 0 23. Build an electromagnet to demonstrate its characteristics and functions.

21108 Production Blueprint Reading

(.5 Credit) An introductory level course to provide students with the knowledge and ability to interpret the lines, symbols, and conventions of blueprints from a variety of industrial applications.

- 3 2 1 0 1. Identify symbols associated with blueprints
- 3 2 1 0 2. Interpret work from multiview drawings

- 3 2 1 0 3. Interpret size and location of features
- 3 2 1 0 4. Visualizing shapes and objects in multiple views
- 3 2 1 0 5. Ability to convert fractions and decimals proficiently
- 3 2 1 0 6. Interpret inch and metric drawings
- 3 2 1 0 7. Demonstrate legend and note reading skills
- 3 2 1 0 8. Interpret basic geometric dimensioning and tolerancing terminology
- 3 2 1 0 9. Identify different views utilized in blueprint reading
- 3 2 1 0 10. Identify orthographic projection such as lines and symbols for electrical, piping, mechanical, architectural, welding, and machining prints

03101 Chemistry (1 credit)

- 3 2 1 0 1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms
- 3 2 1 0 2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
- 3 2 1 0 3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
- 3 2 1 0 4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

- 3 2 1 0 5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs.
- 3 2 1 0 6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.
- 3 2 1 0 7. Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction
- 3 2 1 0 8. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.
- 3 2 1 0 9. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
- 3 2 1 0 10. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.
- 3 2 1 0 11. Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).
- 3 2 1 0 12. Evaluate the validity and reliability of claims in published materials of the effects that different frequencies of electromagnetic radiation have when absorbed by matter.

TECHNICAL LEVEL COURSES

41320 – Principles of Applied Engineering ((1 credit)

- 3 2 1 0 1. Work with others as an engineering team to solve problems, with each team member having individual and collective responsibility.
- 3 2 1 0 2. Discuss the differences between engineering disciplines and job functions.
- 3 2 1 0 3. Research the educational requirements to become an engineer.
- 3 2 1 0 4. Formulate an organized outline for a technical paper.
- 3 2 1 0 5. Illustrate collected data through the use of tables, charts, and graphs.
- 3 2 1 0 6. Utilize materials from an assigned research topic to design and deliver a presentation.
- 3 2 1 0 7. Explain the functions of the six types of simple machines and use mathematics to distinguish the mechanical advantage gained by each.
- 3 2 1 0 8. Identify practical applications of each material category to engineered products and processes.
- 3 2 1 0 9. Formulate conclusions through analysis of recorded laboratory test data for presentations in the form of charts, graphs, written, verbal, and multimedia formats.
- 3 2 1 0 10. Analyze an engineering failure for the purpose of presenting an oral report which identifies causes, damage done, design failures, and other areas where the failure has impacted the environment or society.
- 3 2 1 0 11. Analyze test data and utilize the results to make decisions.
- 3 2 1 0 12. Locate information and select the materials, tools, equipment, or other

resources to perform the activities needed to accomplish a specific task using a problem solving method.

21006 Engineering Design (1 credit) May offer this course or 21007 Drafting / CAD, but not both)

- 3 2 1 0 1. Identify and demonstrate knowledge in Engineering Design in:
 - Historic influences
 - Architectural styles
 - Form and function
 - Engineering achievements
 - Evolution of technology
 - History-design and its influences on products
- 3 2 1 0 2. Explore careers opportunities in engineering fields to include:
 - Educational requirements
 - Opportunities for employment
 - Job requirements
- 3 2 1 0 3. Gain knowledge of the design process and implement the process during design challenges using:
 - Teamwork
 - Collaboration
- 3 2 1 0 4. Identify and demonstrate knowledge in the use of technology to include:
 - Software
 - Hardware
 - Printing
- 3 2 1 0 5. Demonstrate proper sketching techniques in the creation of Orthographic and isometric drawings
- 3 2 1 0 6. Identify major geometric terms and shapes as well as demonstrate proper drafting techniques in constructing geometric forms to include:
 - Polygons
 - Triangles
 - Circle

- Ellipse
- 3 2 1 0 7. Identify and demonstrate proper use of drafting equipment such as a T-Square, Compass, Divider, Triangles, and Templates
- 3 2 1 0 8. Demonstrate understanding of Orthographic views by constructing:
 - One view drawings
 - Two view drawings
 - Three view drawings
 - Multi-View drawings
- 3 2 1 0 9. Demonstrate proper ANSI dimensioning practices on Orthographic, section, auxiliary, and assembly's drawings and apply size and location dimensions and proper tolerance.
- 3 2 1 0 10. Understand and use proper drafting techniques when constructing pictorial drawings:
 - Axonometric
 - Isometric
 - Diametric
 - Trimetric
 - Perspective
 - Oblique
- 3 2 1 0 11. Apply orthographic knowledge and proper techniques to construct Section drawings to include a:
 - Full Section
 - Half Section
 - Off Set Section
- 3 2 1 0 12. Use proper techniques when creating Auxiliary drawings to include:
 - Cutting Plane
 - Section lining
 - Assembly section
- 3 2 1 0 13. Demonstrate proper techniques used in creating drawings on CAD.
- 3 2 1 0 14. Demonstrate understanding of the terminology and commands:
 - Cartesian Coordinate System
 - 2-D Orthographic
 - 3-D model
 - Working Drawings

- Design Concept
- Parametric models
- Mass Properties
- 3 2 1 0 15. Demonstrate assembly skills to solve a variety of design problems and create:
 - Sub-assemblies
 - Drive constraints
 - Design modifications
- 3 2 1 0 15. Understand manufacturing materials and processes creating solid models and assembly models with:
 - CNC product
 - 3-D Parametric Modeling
 - Laser product
- 3 2 1 0 16. Recognize different machine processes used in manufacturing a product and explain the need for product efficiency throughout the manufacturing processes.
- 3 2 1 0 17. Complete a presentation to include documentation that explains Engineering Design practices and product design.
- 3 2 1 0 18. Demonstrate the use of:
 - Visual aids in presentation
 - Technical Writing skills
 - Communication techniques
- 3 2 1 0 19. Create a Portfolio showing evidence of the skill and understanding of Engineering Design.

21107 Drafting / CAD (1 credit) (May offer this course or 21006 Engineering Design, but not both)

A comprehensive course designed to instruct students in the use of CAD design and software.

- 4 3 2 1 0 1. Identify and demonstrate the use of CAD commands and system peripherals.
- 4 3 2 1 0 2. Demonstrate the ability to dimension drawings on the CAD system.
- 4 3 2 1 0 3. Demonstrate proficiency in setting limits and scale on the CAD system.

- 4 3 2 1 0 4. Demonstrate proficiency in setting, turning on and turning off layers.
- 4 3 2 1 0 5. Create standard drawings for templates.
- 4 3 2 1 0 6. Demonstrate the ability to create drawings in 3D.
- 4 3 2 1 0 7. Demonstrate the ability to load, store files, and transport files via Internet.
- 4 3 2 1 0 8. Place text on a drawing and be able to change to different font styles, sizes and angles.
- 4 3 2 1 0 9. Be proficient in the use of printer/plotter operations.
- 4 3 2 1 0 10. Demonstrate ability to place text on a drawing and change to different font styles, sizes and angles.
- 4 3 2 1 0 11. Demonstrate ability to dimension drawings on the CAD system.
- 4 3 2 1 0 12. Demonstrate proficiency in setting limits and scale on the CAD system.
- 4 3 2 1 0 13. Construct drawings using straight line, circle, and hidden line statements, etc.
- 4 3 2 1 0 14. Construct isometric and 3D drawings.
- 4 3 2 1 0 15. Set grid and snap specifications.
- 4 3 2 1 0 16. Define and use commands to modify a drawing.
- 4 3 2 1 0 17. Use symbols (from a symbol library) in a drawing.

21109 Robotics (1 credit)

- 3 2 1 0 1. Build, Align, fit, or assemble robotic devices or component parts using hand tools, power tools, fixtures, templates, or microscopes.
- 3 2 1 0 2. Troubleshoot robotic systems using knowledge of microprocessors, programmable controllers, electronics, circuit analysis, mechanics, sensor or feedback systems, hydraulics and or pneumatics.

- 3 2 1 0 3. Train robots using appropriate software (multiple software platforms, if possible) to perform simple or complex tasks such as designing and carrying out a series of tests.
- 3 2 1 0 4. Install, program, and repair programmable controllers, robot controllers, end-of-arm tools, or conveyors.
- 3 2 1 0 5. Read blueprints, schematics, diagrams, or technical orders to determine methods and sequences of assembly
- 3 2 1 0 6. Record numerical and graphical test results and analyze them to prepare for written testing and documentation.
- 3 2 1 0 7. Explain complex mathematical information used in robotic operations.
- 3 2 1 0 8. Demonstrate knowledge of careers in robotics and applications of robotics in research, commercial and industrial settings.
- 3 2 1 0 9. Read and utilize blueprints, production layouts, and technical drawings relating to robotics.
- 3 2 1 0 10. Troubleshoot mechanical failures or unexpected problems including debugging programming.
- 3 2 1 0 11. Integrate robotics with peripherals, sensors or other equipment.
- 3 2 1 0 12. Demonstrate knowledge of how automated robotic systems increase production volume and precision in a variety of high-throughput operations.
- 3 2 1 0 13. Resolve engineering or science problems using robots.
- 3 2 1 0 14. Analyze test results in relation to design or rated specifications and test objectives, and modify or adjust equipment to meet specifications.
- 3 2 1 0 15. Verify dimensions and tolerances of parts in conformance with specifications in conjunction with robotic maintenance including assembly and disassembly of kit parts and or fabricated parts.

21201 Foundations of Electronics (1 credit)

Lab Practices

3210 1. Apply proper OSHA safety standards

3210 2. Demonstrate acceptable soldering and desoldering techniques.

Demonstrate Proficiency in DC Circuits

3210 3. Relate, identify, and apply Ohm's law to voltage, current, resistance, power, and energy.

3210 4. Read and interpret color codes and symbols to identify electrical components and values.

3210 5. Measure properties of a circuit using DMM meters, oscilloscopes, and power supplies.

3210 6. Compute, measure, apply, construct, and verify Ohm's law to operation of series circuits.

3210 7. Compute, measure, apply, construct, and verify Ohm's law to operation of parallel circuits.

3210 8. Compute, measure, apply, construct, and verify Ohm's law to operation of series-parallel circuits.

3210 9. Identify, define, construct, verify, and troubleshoot loaded and unloaded voltage divider circuits.

3210 10. Apply, construct, and verify the operation of DC circuits that demonstrate the maximum power transfer theory.

3210 11. Define magnetic properties of circuits and devices.

3210 12. Determine, define, identify, and troubleshoot RC and RL time constant circuits.

3210 13. Define basic motor theory and operation.

Demonstrate Proficiency in AC Circuits

3210 14. Identify, analyze, and measure AC signals.

3210 15. Define, construct, verify, and troubleshoot AC capacitive circuits.

3210 16. Define, construct, verify, and troubleshoot AC inductive circuits.

3210 17. Construct, verify, and troubleshoot AC circuits utilizing transformers.

3210 18. Define, construct, and verify series and parallel resonant circuits.

3210 19. Define, construct, verify, and troubleshoot filter circuits.

3210 20. Set up and operate DVMs, power supplies, oscilloscopes, and frequency counters for AC circuits.

APPLICATION LEVEL COURSES

21053 Emerging Technologies (1 credit)

3 2 1 0 1. Demonstrate the research skills necessary to identify and evaluate emerging technologies

3 2 1 0 2. Seek and identify sources of information on new technology.

3 2 1 0 3. Identify solutions and problems that go beyond the expected and obvious.

3 2 1 0 4. Identify sciences and technology areas most impacted and with most potential to utilize the new technologies.

3 2 1 0 5. Be able to explain why it is important for STEM professionals to keep abreast of evolving technologies.

3 2 1 0 6. Be able to discuss the advantages, disadvantages, and prospects of current emerging technologies.

3 2 1 0 7. Discuss in depth a chosen emerging technology, based on independent research.

3 2 1 0 8. Explain the change process.

3 2 1 0 9. Develop a plan for anticipating change.

3 2 1 0 10. Address each of the following areas to varying degrees based on available information:

- a. anticipated employment,
- b. drivers and constraints,
- c. size and location of market,
- d. connection(s) to existing technologies,
- e. ability and ease of replication,
- f. physical and capital costs,
- g. industry and education partnerships to be leveraged,
- h. national best practices,
- i. illustrate qualifications, and recommendations, aims and approaches for the Technological innovation
- j. Innovation system modeling
- k. Technology monitoring, forecasting and assessment
- l. Trend analysis methods & scenarios
- m. Impact assessment
- n. Risk analysis
- o. Action (policy) analysis
- p. Technology road mapping
- q. Communication and implementation of innovation forecasts

21008 Digital Electronics (1 credit)

3210 1. Students will identify hazards in the lab and locations of the MSDS, safety equipment, and resources.

3210 2. Students will understand how to prevent dangers from electric shock, including environmental concerns and precautionary measures.

3210 3. Students will define and explain direct and alternating currents along with

- components and schematics used in electronics circuitry.
- 3210 4. Students will correctly calculate and set up lab equipment for safety, design, test, using Ohm's law and circuit measurements.
- 3210 5. Students will identify and differentiate digital and analog waveforms.
- 3210 6. Students will build and test a free running clock and calculate output frequencies from observations on an oscilloscope.
- 3210 7. Students will design and build logic circuits derived from Boolean expressions and truth tables.
- 3210 8. Students will use DE Morgan's Theorem, Karnaugh mapping, NOR, NAND, and combinational logic solutions to reduce and simplify circuits.
- 3210 9. Students will design, code, and build logic circuits to control different kinds of displays.
- 3210 10. Students will control the flow of data by utilizing multiplexers and demultiplexers.
- 3210 11. Students will design and implement logic circuits using programmable logic devices that define combinational circuit designs using logic compiler software.
- 3210 12. Students will compare and contrast operation of RS flip-flops, D flip-flops, and J-K flip-flops.
- 3210 13. Students will understand, design, and implement different circuits using synchronous, asynchronous, triggering, and timing using flip-flops.
- 3210 14. Students will design modification counters using timing from asynchronous flip-flops.
- 3210 15. Students will conduct experiments with shift registers for memory storage and arithmetic circuits.
- 3210 16. Students will design both half and full adders from logic circuits to do simple addition and subtraction using binary numbers.
- 3210 17. Students will appropriately select, size, and implement interface devices to control external devices.
- 3210 18. Students will design and create programming

- to control the position of stepper motors and control speed and torque of servo motors.
- 3210 19. Students will be able to formulate a flow chart to correctly apply basic programming concepts in the planning of a project.

21010 Computer Integrated Manufacturing (1 credit)

- 3 2 1 0 1. Convert English system measurements into metric measurements.
- 3 2 1 0 2. Read and interpret micrometer and caliper reading measurements.
- 3 2 1 0 3. Demonstrate safety practices and proper use of CIM / CNC tools and equipment.
- 3 2 1 0 4. Draw a blueprint/working drawing of an assigned product.
- 3 2 1 0 5. Identify Flow Chart symbols and create a flow chart that illustrates Manufacturing and Non-manufacturing process
- 3 2 1 0 6. Identify a control system and explain its application to manufacturing.
- 3 2 1 0 7. Model and create a program to control an automated system.
- 3 2 1 0 8. Create working drawings and designs using CAD.
- 3 2 1 0 9. Produce a machined tool product using CNC methods and equipment
- 3 2 1 0 10. Transfer drawings made in CAD to a CAM program.
- 3 2 1 0 11. Generate and Interpret G & M code within a CNC program
- 3 2 1 0 12. Calculate feed rate, cutting speed, chip thickness for various materials on a mill or lathe.
- 3 2 1 0 13. Demonstrate proper start-up and shut down of CNC Mill and Computer Systems using recommended procedures and calibration methods appropriately to calibrate and prepare for use.
- 3 2 1 0 14. Utilize CNC software to initialize, verify

- and run CNC tool paths
- 3 2 1 0 15. Create 3D prints from CAD drawings and files
- 3 2 1 0 16. Understanding and determine Mass Properties related to 3D part design.

41350 Project Management (.5 credit)

An application / college level course to teach students the concepts of managing large work-related projects at the contractor level. Must be directly tied to the student's occupational area of interest.

- 3 2 1 0 1. Pathway Project Vision: Clearly identify what is desired to be created. Create a multi-step project (should be multi-student) by defining the opportunity statement. List what is to be the end result of the project; what it is that will be created. (This is not what needs to be done to complete the project or how it is to be done.) Also, list the impact of this project; why it is important and worthwhile to create.
- 3 2 1 0 2. Project Initiation: In alignment with the Pathway Project Vision, Initiate the project by identifying the resources and the details needed for the project: the project deliverables, project budget, project sponsor, project manager, scope, due date and project team members and, if desired, their roles. Document project initiation phase in a project Charter or Project Initiation Document (PID).
- 3 2 1 0 3. Project Planning: The project team should collectively plan the steps to complete the project deliverables within the budget and due date. This project plan should outline the scheduling and utilization of project resources and should be documented through the development of a GANTT chart for the project complete with schedule, tasks, resource assignments and graphical

timeline.

- 3 2 1 0 4. Project Execution: Proceed with accomplishment of project deliverables and utilize methods such as team progress meetings and/or formal status updates to report adherence to the project plan.
- 3 2 1 0 5. Project Control: Check, verify and document adherence to quality standards as defined in the project deliverable specifications.
- 3 2 1 0 6. Project Closure: Prepare a team Closure Report that reconciles budgetary results, provides an overview of the project and analyzes the effectiveness of the project management and resource scheduling processes through use of a tool such as a Plus (what went well that we would want to repeat) / Delta (what could have gone better that we would modify next time) Analysis.
- 3 2 1 0 7. Collaboration: Demonstrate effective teamwork and interaction through team-based accomplishment of all of the above tasks and elements. Teams should learn and practice communication, negotiation and effective teamwork skills in an effort to create a synergistic result.
- 3 2 1 0 8. Ancillary Project Management Concepts: Students should be introduced to and research the following concepts associated with Project Management. If possible, inclusion of these concepts into project management practiced in the classroom is advantageous, but in any case, students should demonstrate understanding of the concepts and their relevance to Project Management:
 - Stakeholder Management
 - Critical Path Method
 - Change Management / Scope Creep
 - Agile Project Management
 - Budgetary Considerations

- Careers in Project Management

41355 Materials Science in

Engineering (.5 credit) An application level course designed to teach students the properties, classes, uses and selection of materials for various applications.

- 3 2 1 0 1. Research key participants & events in the history of materials science & engineering to include: metallurgy, polymers, ceramics, and composite development.
- 3 2 1 0 2. Identify professional organizations & resources for materials science.
- 3 2 1 0 3. Recognize, locate, & utilize MSDS information in the workplace.
- 3 2 1 0 4. Evaluate physical properties of materials: solid, liquid, gas, and plasma.
- 3 2 1 0 5. Explain materials properties related to:
 - Mechanical
 - Electrical
 - Thermal
 - Chemical
 - Optical
 - Acoustical
 - Environmental
 - Atomic
 - Manufacturing
- 3 2 1 0 6. Summarize key properties of: reactivity, toxicity, flammability, stability
- 3 2 1 0 7. Distinguish various classes of materials: crystals, metals, semiconductors, polymers, composites, and ceramics/vitreous.
- 3 2 1 0 8. Explain the fundamentals of materials in terms of structural properties, behaviors under varying conditions, bonding, conductivity, chemical reaction, and decomposition.
- 3 2 1 0 9. List examples of specialized usage of materials in industry.
- 3 2 1 0 10. Defend choices for using one material

over another in specific applications.

- 3 2 1 0 11. Compare and contrast methods of chemical and physical bonding.
- 3 2 1 0 12. Defend, in various applications, whether it is better to use chemical of physical bonding.
- 3 2 1 0 13. Define tribology and its importance.
- 3 2 1 0 14. Detail the impact of biomaterials on industry.
- 3 2 1 0 15. Research a material that has recently become available or recently adopted for widespread use and how it may impact future design & development.
- 3 2 1 0 16. Explain how availability of new materials has changed manufacturing processes.
- 3 2 1 0 17. Compare and contrast techniques for testing the integrity of a part made from a particular material.
- 3 2 1 0 18. Create 2D or 3D Model(s) that explain understanding of various types of materials related to science and engineering.

21012 Civil Engineering & Architecture (1 credit)

- 3 2 1 0 1. Compare and contrast civil engineering and architecture.
- 3 2 1 0 2. Understand careers related to Civil Engineering and Architecture
- 3 2 1 0 3. Manage a civil engineering and architectural project by documenting proposed changes from review and feedback recommended by client within the project journal.
- 3 2 1 0 4. Identify needed elements (criteria & constraints) for project assessment and decision making
- 3 2 1 0 5. Communicate ideas using various drawing methods including sketches, CAD systems and software
- 3 2 1 0 6. Communicate the current common practices utilized in civil engineering and architecture and apply them to develop a viable

solution for an engineering or architecture project.

- 3 2 1 0 7. Students will communicate understandings of the relationship of structures and land and the responsibility of designers to handle resources in an ethical manner.
- 3 2 1 0 8. Conduct a site survey locating various utilities, roadways, set-backs, and mechanical systems required for building placement
- 3 2 1 0 9. Develop and be able to read a contour map.
- 3 2 1 0 10. Students will examine and assess the pros and cons of local, state, and federal regulations on site development.
- 3 2 1 0 11. Apply knowledge of architectural styles to the design of structures.
- 3 2 1 0 12. Design and create a utility plan to include electrical, plumbing, and sewer
- 3 2 1 0 13. Calculate and determine heat loss and/or gain related to building structures
- 3 2 1 0 14. Compare and contrast various elevation views and communicate their purpose
- 3 2 1 0 15. Students will draw the exterior and interior elevations.
- 3 2 1 0 16. Compare and contrast section and detail views and communicate their purpose
- 3 2 1 0 17. Draw section and detail views complete with appropriate architectural symbols.
- 3 2 1 0 18. Determine the live and dead loads of a structure using load tables and appropriate mathematics.
- 3 2 1 0 19. Identify regions of the United States that are susceptible to seismic loads.
- 3 2 1 0 20. Identify roofing materials, types of roof systems, rafters and trusses; calculate the load for roof members; and determine the architectural styles that will support the roof system design chosen for their project.
- 3 2 1 0 21. Determine the strength of columns and beams required for a structure.
- 3 2 1 0 22. Research various foundation types, draw sketches of each one, and describe their use.
- 3 2 1 0 23. Prepare a foundation detail.

21013 Aerospace Engineering (1 credit)

History of Flight

- 3 2 1 0 1. Students will construct a PowerPoint that shows knowledge of the history of flight.
- 3 2 1 0 2. Students will demonstrate an understanding of aerospace history in a Presentation Format or PowerPoint that provides insight to future challenges involving travel through the atmosphere and space.
- 3 2 1 0 3. Students shall identify the major components of airplanes which has a specific function in the design and operation of the airplane.
- 3 2 1 0 4. Students will list the various forces that act on an aircraft which enable it to fly.

Aerodynamics

- 3 2 1 0 1. Students will identify the forces applied to an airplane in-flight: lift, weight, drag and thrust.
- 3 2 1 0 2. Students will explain aircraft theory related to wing design and its impact on the lifting forces needed to overcome the weight of an airplane.
- 3 2 1 0 3. Student will demonstrate their understanding of power to weight ratio.
- 3 2 1 0 4. Students will demonstrate basic knowledge of aerodynamics and physics.

Airfoil Construction

- 3 2 1 0 1. Students will design, create, and test prototypes/models of airfoils.
- 3 2 1 0 2. Students will create sub-scale models used to represent a full-size system.
- 3 2 1 0 3. Students will apply coordinate geometry to create varied shapes used to design an airfoil.

Wind Tunnel Testing

- 3 2 1 0 1. Students will use scale models to evaluate, to test, and to determine the performance of aircraft designs.
- 3 2 1 0 2. Students will use the wind tunnel to graph, display, evaluate and analyze test data.

Glider Design & Construction

- 3 2 1 0 1. The students will use flight theory to design a glider.
- 3 2 1 0 2. Students predict the flight performance of an aircraft utilizing flight theory.
- 3 2 1 0 3. Students will construct a multi-component device by the use of assembly and alignment jigs.
- 3 2 1 0 4. The student will collect and use flight testing data to evaluate an aircraft design.

Measuring Rocket Engine Thrust

- 3 2 1 0 1. Rocket thrust is measured using a simple device.
- 3 2 1 0 2. Students calibrate thrust measurements
- 3 2 1 0 3. Thrust vs. time data is acquired using a data taking device.

Model Rocket Trajectory

- 3 2 1 0 1. Students will identify Parts of a model rocket.
- 3 2 1 0 2. Students will understand and explain how the forces of weight, thrust, drag, and lift interact differently on a rocket in flight.
- 3 2 1 0 3. Students will state how Newton's three laws of motions (inertia, F= ma, and action-reaction) can be used to describe and predict events during each phase of a rocket launch.
- 3 2 1 0 4. The student will calculate a rocket's maximum altitude by using indirect measurement.

Orbital Mechanics

- 3 2 1 0 1. Students will create drawings to show that ellipses are conic sections, and circles are special cases of ellipses.
- 3 2 1 0 2. Students will create diagrams to show that orbits involve the steady procession of a small mass object around a large mass object.
- 3 2 1 0 3. Students will calculate to show that an object in orbit is continuously "falling" toward the body about around which they orbit.
- 3 2 1 0 4. Students will show how orbital elements can be used to fully define a satellite's orbit, allowing the accurate prediction of the precise location of the satellite at a given time.

Life Support & Environmental Systems

- 3 2 1 0 1. Students will describe basic physiological needs of the human body when living safely within and outside of Earth's atmosphere.
- 3 2 1 0 2. Students will construct a model to show how the environment on earth and in space must be considered when designing solutions to problem in aerospace engineering.

Effect of Gravity on the Human Body

- 3 2 1 0 1. Students will simulate the action of spinning and how it can fool the senses and stimulate the vestibular system in the inner ear.
- 3 2 1 0 3. Students will work in cooperative and supportive teams to simulate how these behaviors result in increased safety and higher quality data.
- 3 2 1 0 4. Students will investigate and give examples of how a stress-filled environment is physically unique and can affect the ability to perform mental functions.

Microgravity Drop Tower

- 3 2 1 0 1. Students will describe gravity and its effects on other masses.
- 3 2 1 0 2. Students will state the value of "g" on earth.
- 3 2 1 0 3. Students will demonstrate microgravity.

Composites Fabrication & Testing

- 3 2 1 0 1. Students will describe the composition of composite materials that are fabricated by molding together layers of reinforced fabric (often glass or carbon fiber) with a plastic matrix, such as epoxy.
- 3 2 1 0 2. Students will describe how composite materials are used in the aerospace industry
- 3 2 1 0 3. The student will assess material performances by comparing strength to weight ratios.
- 3 2 1 0 4. Students will use a deflection test to evaluate the stiffness of various composite samples.

Thermal Protection Systems for Vehicles

- 3 2 1 0 1. Students will gain an understanding of the physics of space vehicle re-entry into the

atmosphere through thermal protection systems (TPS)

- 3 2 1 0 2. Students will describe the heat transfer process that creates high temperatures in a space vehicle.

Intelligent Vehicles

- 3 2 1 0 1. Students will evaluate incentives for building robots.
- 3 2 1 0 2. Students will describe uses for robotic devices.
- 3 2 1 0 3. Students will list robotic devices that are composed of mechanical, electrical, and computer based systems that can be programmed to make decisions and control actions based upon sensor readings.

21015 Particular Topics in Engineering (1 credit

Coursework should represent specific objectives and topics not covered in other pathway courses, or build upon essential skills learned in previous pathway courses through research and/or projects. Evaluation should be through the following measures:

- 3 2 1 0 1. Define the scope of work (or topic to be researched) and appropriately document the process as it progresses.
- 3 2 1 0 2. Create and deliver a final presentation or portfolio of the results of the research or project.

21007 Engineering Design & Development (1 credit

- 3 2 1 0 1. Develop a problem statement from research.
- 3 2 1 0 2. Justify a problem through academic research.
- 3 2 1 0 3. Justify a problem through market research.

- 3 2 1 0 4. Research and document prior solution attempts.

- 3 2 1 0 5. Analyze prior solution attempts with a matrix.
- 3 2 1 0 6. Develop and document design requirements based on research.
- 3 2 1 0 7. Brainstorm and document concepts that solve a problem.
- 3 2 1 0 8. Build a mock-up that communicates a solution.
- 3 2 1 0 9. Use a matrix to justify the best solution.
- 3 2 1 0 10. Create a set of technical drawings that fully explain a design.
- 3 2 1 0 11. Identify and apply STEM Principles to a design.
- 3 2 1 0 12. Document the Viability of a Design.
- 3 2 1 0 13. Document a prototype build procedure.
- 3 2 1 0 14. Build a testable prototype.

- 3 2 1 0 15. Develop and document ways to test design requirements.
- 3 2 1 0 16. Test a prototype and document an analysis of the results.
- 3 2 1 0 17. Document an external evaluation of a prototype.

41048 Workplace Experience in Engineering (.5 credit)

Application level workplace experience /internship completed by students at a business location or within the school that is an engineering occupational experience.

- 3 2 1 0 1. Employ effective listening skills when working with client.
- 3 2 1 0 2. Employ customer service principles when working with consumers.
- 3 2 1 0 3. Evaluate and follow-up on customer service provided.
- 3 2 1 0 4. Employ safety skills and equipment usage in appropriate ways.
- 3 2 1 0 5. Be aware of MSDS (Material Safety Data Sheets) and other safety resources and

employ those resources as required for the workplace.

21048 Workplace Experience (1 credit)

Application level workplace experience /internship completed by students at a business location or within the school that is an engineering occupational experience.

- 3 2 1 0 1. Employ effective listening skills when working with client.
- 3 2 1 0 2. Employ customer service principles when working with consumers.
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