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

Energy Pathway

CIP CODE 17.2071

INTRODUCTORY LEVEL

Title	Code	Credit
Environmental Science	41207	.5 credit

Title	Code	Credit
*Introduction to Energy	41100	.5 credit

TECHNICAL LEVEL

Title	Code	Credit
*Energy Industry Fundamentals	41105	1 credit
Principles Of Applied Engineering	41320	1 credit
Fundamentals of Electricity and Electronics	41170	1 credit
AP Environmental Science	03207	1 credit
Energy, Power and Society	41150	1 credit

Title	Code	Credit
Wind Energy Operations	41160	1 credit
Mechanical Power Transmission and Conveyor Systems	13302	.5 credit
Meteorology	03006	1 credit

APPLICATION LEVEL

Title	Code	Credit
Research and Development for Energy	41250	.5 credit
Research and Development for Energy Comprehensive	41260	1 credit
Advanced Electricity and Electronics	41270	.5 credit

Title	Code	Credit
Materials Science in Engineering	41355	.5 credit
Hydraulics and Pneumatics	39302	.5 credit
HVAC Technology	17056	.5 credit

* Course required for pathway approval.

KANSAS STATE CAREER CLUSTER COMPETENCY PROFILE

ENERGY PATHWAY (C.I.P. 17.2071)

ENGINEERING CLUSTER

STUDENT_____
Rating Scale:

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

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

41100 Introduction to Energy

(.5 credit) Required for Pathway approval. An Introductory course designed to teach students about the occupations in the Energy field and the skills required for those occupations.

3 2 1 0 1. Understand the concepts of energy.
   a. forms of energy & how energy can perform work.
   b. differentiate between potential energy and kinetic energy.
   c. how energy can be transformed.

3 2 1 0 2. Understand how humans utilize energy.
   a. what types of energy is used by humans.
   b. how humans have historically used energy.
   c. how energy use has changed over time.

d. how new forms of renewable and alternative energy sources may be used in the future.

3 2 1 0 3. Demonstrate an ability to understand and interpret data as it relates to energy
   a. read graphs and charts to analyze data and to communicate information.
   b. how data can be used to understand and create opportunities around energy.
   c. how computers, data, analytics, and machine learning can be used to optimize energy generation and consumption.

3 2 1 0 4. Understand what careers are available in the energy field.

3 2 1 0 5. Understand how energy is generated and distributed to where it can be used.
   a. types of power generation.
   b. electrical power distribution lines.
   c. natural gas, water and sewer distribution.
   d. how energy is metered and billed.

3 2 1 0 6. Understand how energy is used in a building.
   e. Building envelope.
   f. Lighting systems.
   g. Heating, cooling, and ventilation.
   h. Water consumption.
   i. Other

3 2 1 0 7. Perform an energy audit in a building.
   a. Conduct energy use benchmarking using historical energy consumption.
   b. Identify equipment, systems and processes that use energy in a building.
   c. Identify the factors that impact energy use in a building.

3 2 1 0 8. Identify opportunities to optimize energy use in a building.
   a. use energy audit to identify existing energy use.
   b. utilize building data to identify opportunities for energy optimization.
   c. calculate the cost and other impacts of optimized energy use.

3 2 1 0 9. Present findings and recommendations from energy audit.
   a. create visual aids.
   b. Oral presentation to school district personnel and/or community members.

41207 Intro to Environmental Science

(.5 Credit) An introductory level course designed to teach students about the concepts of our environment.

Foundations of Environmental Science

3 2 1 0 1. Investigate environmental problems facing the world (i.e., Overpopulation, pollution, resource depletion)

3 2 1 0 2. Demonstrate a knowledge of the components of an ecosystem.

3 2 1 0 3. Explain the relationship between energy and nutrients (e.g. energy flow, nutrient cycling, Carbon/Oxygen Cycle, Nitrogen Cycle)

3 2 1 0 4. Comprehend population dynamics (e.g., population size (N), population density, population growth, carrying capacity, biotic potential, environmental resistance

Water in the Environment

3 2 1 0 5. Outline the water treatment process (waste and drinking treatments)

3 2 1 0 6. Perform water testing activities (e.g., hardness, turbidity, coliform, pH, minerals)

3 2 1 0 7. Discuss EPA water quality standards

3 2 1 0 8. Explain basic water chemistry

3 2 1 0 9. Identify sources and uses of water

3 2 1 0 10. Diagram the water cycle

3 2 1 0 11. Recognize water pollution, including major types of pollutants (pathogens, inorganic chemicals, organic chemicals, radioactive materials) and pollutants that cause ecosystem disruption (sediments, plant nutrients, oxygen demanding wastes, thermal)

Air in the Environment

3 2 1 0 12. Explain the parts of the atmosphere

3 2 1 0 13. Describe the effects of major air pollutants

3 2 1 0 14. Explain the causes of stratospheric ozone depletion (e.g., UV radiation, CFC's, Montreal Protocol)

3 2 1 0 15. Summarize the Greenhouse effect and global climate change

3 2 1 0 16. Explain the mitigation strategies that reduce or eliminate major air pollutants

Human Impact on the Environment

3 2 1 0 17. Predict the environmental consequences of population change for a country (e.g. food demand and environmental impact, energy demand and environmental impact)

3 2 1 0 18. Understand the concepts of ecological foot print and full life cycle analysis when analyzing human impact on the environment

Energy and the Environment

3 2 1 0 19. Identify energy resources

3 2 1 0 20. Explain forms of energy consumption

3 2 1 0 21. Define energy reserves (e.g., proven vs. Potential, technologically and economically feasible, conventional and nonconventional)

3 2 1 0 22. Describe pollution caused by searches for energy (i.e., strip mining, deep mining, mountaintop removal/valley fills, habitat destruction)

3 2 1 0 23. Predict the impact of future sources of energy on the environment (e.g., Geo-engineering, Alternatives: nuclear, hydropower, solar, wind, hydrogen fuel cells, bio-fuels, thermal conversion, anaerobic digester "cow power")

TECHNICAL LEVEL COURSES

41105 – Energy Industry Fundamentals (1 credit) Required for Pathway approval.

This course is an opportunity to directly link to a nationally recognized industry credential. Links to further information and an Instructor guide can be found at these locations:
http://www.cewd.org/index.php - The Center for Energy Workforce Development (source of this work)
http://www.cewd.org/curriculum/about-the-eif-certificate.php - Information about the EIF Certificate, the curriculum, and the Instructor's guide.
The course also leads to an industry recognized badge.

These competencies are an overview and are not intended to supplant the Instructor's Guide. They are offered as a basic understanding of essential concepts to be covered.

WIND TECHNICIANS (for additional details on required competencies, go to www.centralia.edu/coe)

3 2 1 0 1. Foundational Science and Engineering Concepts

3 2 1 0 2. Is able to describe the power generation delivery grid system from generation to end user including VARS (Vertical and Azimuth Reference System)

3 2 1 0 3. Describes wind energy and the way it is harnessed

3 2 1 0 4. Defines kinetic energy

3 2 1 0 5. Lists and describes the topography and weather patterns of states that effectively harness wind

3 2 1 0 6. Explains hydraulics (brakes and/or blade/tip pitching)

3 2 1 0 7. Comprehends gearing, fasteners, torquing, and lubrication (oils and greases)

3 2 1 0 8. Comprehends how Material Safety Data Sheets (MSDS) are utilized

3 2 1 0 9. Has a basic understanding of aviation terminology and basic aerodynamics (physics)

3 2 1 0 10. Is knowledgeable in instrumentation and controls logic theory

3 2 1 0 11. Has a basic understanding of fiber optics

3 2 1 0 12. Has an understanding of basic rigging

3 2 1 0 13. Is knowledgeable in wind turbine concepts such as: Statics dynamics, Thermodynamics, & Basic Meterology

SOLAR TECHNICIANS

3 2 1 0 14. Describes solar energy and how it is harnessed

3 2 1 0 15. Explains the differences between passive solar and active solar

3 2 1 0 16. Is able to diagram PhotoVoltaic cells (e.g. array, panel, module and boron-enriched silicon)

3 2 1 0 17. Describes a central receiver system

3 2 1 0 18. Identifies parts of a solar plant

BIOMASS AND BIOFUELS TECHNICIANS

3 2 1 0 19. Discusses the major sources of biomass

3 2 1 0 20. Defines biofuels (e.g. ethanol, biodiesel and methanol)

3 2 1 0 21. Outlines the pyramid of energy flow, including the different trophic levels

3 2 1 0 22. Describes the major sources, scale and impacts of biomass energy

3 2 1 0 23. Measures and monitors raw biomass feedstock, including wood, waste or refuse materials

GEOTHERMAL TECHNICIANS

3 2 1 0 24. Defines geothermal

3 2 1 0 25. Identifies how geothermal energy can be used for generation

3 2 1 0 26. Explains the process used for Geothermal Heat Pumps (GHP) and geoexchange

3 2 1 0 27. Identifies and corrects malfunctions of geothermal plant equipment, electrical systems, instrumentation or controls

3 2 1 0 28. Calculates heat loss and heat gain factors for residential properties to determine heating and cooling required by installed geothermal systems

3 2 1 0 29. Designs and lays out geothermal heat systems according to property characteristics, heating and cooling requirements, piping and equipment requirements, applicable regulations or other factors

3 2 1 0 30. Determines the type of geothermal loop system most suitable to a specific property and its heating and

cooling needs.

HYDROPOWER AND MARINE ENERGY TECHNICIANS

3 2 1 0 31. Defines hydropower
3 2 1 0 32. Explains how hydropower works
3 2 1 0 33. Describes ways that hydropower can be utilized without harming fish and wildlife
3 2 1 0 34. Defines marine energy
3 2 1 0 35. Explains how marine energy works

GAS TRANSMISSION AND DISTRIBUTION

3 2 1 0 36. Complies with the procedures necessary to ensure a safe and healthy work environment
3 2 1 0 37. Lays out, assembles, installs and maintains pipe systems and pipe supports for use in the transmission and distribution of natural gas
3 2 1 0 38. Reads, understands and creates basic prints used in the design, operation and maintenance of gas networks including engineering drawings, diagrams and schematics
3 2 1 0 39. Inspects service lines and house lines, investigates leak fume complaints, restores and terminates gas service and performs pressure checks at customer's premises
3 2 1 0 40. Is able to use equipment to detect leaks both in a customer's premises or outdoors such as CGI gas scope leak machine and Gas Ranger

NUCLEAR GENERATION: Technical skills and knowledge necessary for nuclear power plant personnel reactor Theory and Operations:

3 2 1 0 41. Explains the general design overview of the basic reactor types
3 2 1 0 42. Demonstrates understanding of reactor startup and shutdown procedures
3 2 1 0 43. Explains the fission process including the construction of fission product barriers

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.

03207 AP Environmental Science (1 credit)

Earth Systems and Resources

3 2 1 0 1. Explain the concept of geologic time scale.
3 2 1 0 2. Outline the connections between plate tectonics, earthquakes and volcanism.
3 2 1 0 3. Illustrate the layers of the earth's atmosphere.
3 2 1 0 4. Explain the concept of the atmospheric circulation and the Coriolis Effect.
3 2 1 0 5. Explain the concept of ocean circulation.
3 2 1 0 6. Outline surface and groundwater issues.
3 2 1 0 7. Explain the rock cycle.
3 2 1 0 8. Describe the main soil types.
3 2 1 0 9. Recall the rock formation process.

The Living World

3 2 1 0 10. Explain the concept of ecological niches.
3 2 1 0 11. Label on a map the locations of the major terrestrial and aquatic biomes.
3 2 1 0 12. Define the concept of keystone species.
3 2 1 0 13. Diagram the processes of photosynthesis and cellular respiration.
3 2 1 0 14. Analyze the relationship between food webs and trophic levels.
3 2 1 0 15. Interprets the concepts of Biodiversity, natural selection and evolution.
3 2 1 0 16. Describes climate shifts, species movement and ecological succession.
3 2 1 0 17. Illustrates a natural biogeochemical cycle (e.g. Carbon, nitrogen, phosphorous, sulfur, water)

Population

3 2 1 0 18. Explain the concept of carrying capacity
3 2 1 0 19. Interpret human fertility rates, growth rates and doubling times
3 2 1 0 20. Infers strategies for sustainability

3 2 1 0 21. Predicts the impact of population growth on a region or bio-system

Land and Water Use

3 2 1 0 22. Describes human nutritional requirements

3 2 1 0 23. Predict the impact of genetic engineering on crop production.

3 2 1 0 24. Generate ideas about the future of sustainable agriculture

3 2 1 0 25. Compare old growth forests with new growth.

3 2 1 0 26. Explain forest management.

3 2 1 0 27. Explain the dangers of overgrazing of rangeland

3 2 1 0 28. Outline the concerns with urban land development (e.g., planned development, suburban sprawl, urbanization)

3 2 1 0 29. Describe the problems associated with overfishing

Energy Resources and Consumption

3 2 1 0 30. Explain major concepts associated with Energy (i.e., energy forms, units, conversions, Laws of Thermodynamics)

3 2 1 0 31. Summarizes present global energy use.

3 2 1 0 32. Illustrates the processes involved in the formation of coal, oil and natural gas

3 2 1 0 33. Explain the process of nuclear fission.

3 2 1 0 34. Investigate the environmental advantages/disadvantages of nuclear energy

3 2 1 0 35. Summarizes the process of obtaining hydroelectric power.

3 2 1 0 36. Compares various types of energy conservation strategies.

3 2 1 0 37. Critiques various types of renewable energy (i.e., solar energy, hydrogen fuel cells, wind energy, ocean waves and tidal energy, geothermal)

Pollution

3 2 1 0 38. Identifies the primary and secondary sources of air pollution.

3 2 1 0 39. Lists the primary sources of noise pollution.

3 2 1 0 40. Recalls the major sources of water pollution

3 2 1 0 41. Summarizes major laws addressing water and air pollution (i.e., Clean Water Act, Clean Air Act)

3 2 1 0 42. Explains the process of environmental risk analysis

3 2 1 0 43. Discovers what hazardous chemicals are most common in the environment

3 2 1 0 44. Evaluates the economic impact of pollution on society through a cost-benefit analysis activity

Global Change

3 2 1 0 45. Explain the process of stratospheric ozone formation

3 2 1 0 46. Describe the impacts and consequences of global warming

3 2 1 0 47. Explain the impact of habitat loss on biodiversity

3 2 1 0 48. Summarize the reasons for endangered and threatened species legislation

41170 Fundamentals of Electricity & Electronics (1 credit)

3210 1. Students will apply proper OSHA Safety Standards to their learning in electricity and electronics.

3210 2. Students will relate, identify, and apply Ohm's law to voltage, current, resistance, power, and energy.

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 read and interpret color codes and symbols to identify electrical components and values.

3210 6. Students will measure properties in a circuit using DMM meters, oscilloscopes, and power supplies.

3210 7. Students will compute, measure, apply, construct, and verify Ohm's law as it applies to Series and Parallel circuits.

3210 8. Students will apply, construct, and verify the operation of DC circuits that demonstrate the maximum power of transfer theory.

3210 9. Students will define magnetic properties of circuits and devices.

3210 10. Students will define, identify, verify and troubleshoot RC and RL time constant circuits.

3210 11. Students will define basic motor theory and operation.

3210 12. Students will define, construct, verify, and troubleshoot AC capacitive and inductive circuits.

3210 13. Students will define, construct, verify, and troubleshoot AC circuits utilizing transformer.

3210 14. Students will define, construct, and verify series and parallel resonant circuits.

3210 15. Students will define, construct, verify, and troubleshoot filter circuits.

41150 Energy, Power, and Society (1 credit

3 2 1 0 1. Define and analyze different forms of energy, differentiate between potential and kinetic energy, and give examples of how each form of energy is used.

3 2 1 0 2. Analyze past and present energy conversion systems and conversion efficiencies.

3 2 1 0 3. List major energy resources, their past and present contributions, and projected supplies.

3 2 1 0 4. Describe the energy forms, quantities,

and end uses in the residential, commercial, industrial, and transportation sectors.

3 2 1 0 5. List the factors that could lead to energy crises events, their potential impacts on society, and implications for future energy consumption. Detail what individuals, organizations, and governments can do to prevent or plan for possible energy crises.

3 2 1 9 6. Understand the differences between renewable and nonrenewable energy sources and how each affects the world.

3 2 1 0 7. Differentiate between the positive and negative impacts of renewable and nonrenewable energy sources on global economic, environmental, and societal systems as well as on individuals.

3 2 1 0 8. State how renewable energy sources that utilize solar, wind, earth, oceans, biomass and waste can be used to supply energy and discuss how they were developed.

3 2 1 0 9. Compare and contrast various locations throughout the world which would be best suited for utilization of renewable energies.

Power Generation

3 2 1 0 10. Define work and power. Illustrate an understanding of historic human use of power; demonstrate by making and using simple machines.

3 2 1 0 11. Describe the basic principles of power generation, transmission, distribution and usage with fossil fuels, wind, solar, biomass, hydroelectric, geothermal, and nuclear power sources.

3 2 1 0 12. Compare the benefits and potential harmful effects on the economy, environment, society, and individuals from fossil fuels, wind, solar, biomass, hydroelectric, geothermal, and nuclear power sources.

Transportation Energy & Alternative Transportation Energy

3 2 1 0 13. Analyze the function of reciprocating engine design and construction.

3 2 1 0 14. Analyze the similarities and differences between 2- and 4-stroke cycle engine designs.

3 2 1 0 15. Differentiate between compression ignition engines and other types, and explain why they are currently the most common engines.

3 2 1 0 16. Analyze the similarities and differences in the designs and functions of gas turbine engines, ram powered engines, and rocket engines.

3 2 1 0 17. Describe how the steam turbine functions to transmit energy.

3 2 1 0 18. Describe how external combustion devices produce, transmit, and use power for useful purposes.

3 2 1 0 19. Describe several innovative or uncommon engine designs such as the Stirling engine, how they differ from other engines, and how they may be used in the future.

41160 Wind Energy Operations (1 credit)

3 2 1 0 1. Discuss the history of harnessing wind energy and its future.

3 2 1 0 2. Define and explain wind energy specific terms including different classifications of wind turbines.

3 2 1 0 3. Explain the function of the wind turbine foundation, tower, nacelle, and rotor assembly.

3 2 1 0 4. Discuss the history of the design of wind turbine blades.

3 2 1 0 5. Explain how wind speed, rotor swept area, and air density are used to calculate potential wind energy.

3 2 1 0 6. Describe the performance of wind turbine blades as it relates to their airfoil, lift, drag, pitch, and yaw.

3 2 1 0 7. Explain how wind energy is used to produce electric energy and what are its advantages and disadvantages.

3 2 1 0 8. Explain mechanical, electrical, hydraulic, climbing, and severe weather safety issues in the wind industry.

3 2 1 0 9. Explain the importance of OSHA and the regulations related to the wind industry.

3 2 1 0 10. Explain proper use and inspection of personal protective equipment (PPE) including: safety glasses, hearing protection, work gloves, arc rated gloves, steel or composite boots, and head protection.

3 2 1 0 11. Identify different types of mechanical fasteners and torquing and tensioning requirements, tools, techniques, and safety considerations.

3 2 1 0 12. Explain how anemometers, other sensors, SCADA, and computer networks are used to monitor and control wind farm operations.

03006 Meteorology (1 credit)

3 2 1 0 1. Define the role of meteorology as an academic discipline and identify potential career opportunities.

3 2 1 0 2. Explain how the Earth constitutes a single interconnected system of systems.

3 2 1 0 3. Summarize methods of interpreting and using current environmental data from local and remote sources.

3 2 1 0 4. Summarize the basic laws of physics and thermodynamics.

Atmosphere

3 2 1 0 5. Describe what an atmosphere is and why it is important.

3 2 1 0 6. Describe and explain the origin,

composition, structure, short-term and long-term behaviors of the earth's atmosphere.

3 2 1 0 7. Compare and contrast the Earth's atmosphere with the atmosphere of other planets in our solar system.

3 2 1 0 8. Demonstrate how to take air temperatures.

3 2 1 0 9. Examine forms of condensation.

3 2 1 0 10. Explain the connection between dew point and relative humidity.

3 2 1 0 11. Measure wind chill factor.

3 2 1 0 12. Relate air masses to weather fronts.

3 2 1 0 13. Identify the different types of storms and associated weather.

3 2 1 0 14. Explain the composition of the Earth's atmosphere.

3 2 1 0 15. Identify the troposphere.

3 2 1 0 16. Describe the stratosphere.

3 2 1 0 17. Identify on a diagram where the mesosphere is located.

3 2 1 0 18. Describe the thermosphere.

Solar Radiation

3 2 1 0 19. Describe how sunlight arrives as electromagnetic waves.

3 2 1 0 20. Explain how radiant energy from the sun provides energy and heat to the troposphere.

3 2 1 0 21. Summarize how the earth's atmosphere and solar radiation interact.

3 2 1 0 22. Identify what happens when heat is absorbed by gases, liquids, or solids.

3 2 1 0 23. Summarize what happens to light when it passes through the atmosphere.

Atmospheric Conduction and Convection

3 2 1 0 24. Compare and contrast conduction and convection as ways that heat moves around the planet.

3 2 1 0 25. Explain how heat is transferred to other materials.

Atmospheric Balancing

3 2 1 0 26. Summarize the three kinds of energy transfer- absorption, conduction and convection.

3 2 1 0 27. Describe the ocean system.

3 2 1 0 28. Explain how the atmosphere regulates the Earth's temperature.

3 2 1 0 29. Outline how the atmosphere participates in a number of Bio/Geo/Chemical cycles that involve life itself.

Bio/Geo/Chemical Cycles

3 2 1 0 30. Explain the water cycle.

3 2 1 0 31. Describe the role of solar energy in the water cycle

3 2 1 0 32. Outline the sulfur cycle.

3 2 1 0 33. Describe the nitrogen cycle.

3 2 1 0 34. Explain the carbon cycle.

3 2 1 0 35. Identify the differences in the amount of carbon in the troposphere with the amount of carbon in the atmospheres of other planets.

Atmosphere and Climate Change

3 2 1 0 36. Describe the properties of CO_2 .

3 2 1 0 37. Explain the chemical composition of the Earth's atmosphere.

3 2 1 0 38. States how industrial output can interact with the atmosphere through the various Bio/Geo/Chemical cycles, and as a result, can change the way the atmosphere regulates the heat coming from solar radiation.

13302 Mechanical Power Transmission & Conveyor Systems (.5 credit)

A technical level course designed to provide students with knowledge and skills needed to adjust, maintain, and repair parts of machinery and equipment. Includes hydraulics, pneumatics, gears, belt & chain drives, motors and bearings.

4 3 2 1 0 1. Demonstrate working knowledge of gears and gear drives

4 3 2 1 0 2. Calculate gear ratios

4 3 2 1 0 3. Apply working knowledge of hydraulic and pneumatic power

4 3 2 1 0 4. Calculate pressures and forces associated with hydraulic and pneumatic power

4 3 2 1 0 5. Incorporate application knowledge of linear motion concepts

4 3 2 1 0 6. Apply working knowledge of belt and belt drives

4 3 2 1 0 7. Utilize knowledge of ratings of motors

4 3 2 1 0 8. Identify and size for replacement various types of bearings and bushings

4 3 2 1 0 9. Apply working knowledge of chain and chain drives

4 3 2 1 0 10. Demonstrate application knowledge of adjustable variable speed drives

4 3 2 1 0 11. Troubleshoot various controls

4 3 2 1 0 12. Demonstrate working knowledge of couplings and U Joints

4 3 2 1 0 13. Demonstrate conceptual knowledge of the following predictive maintenance technologies: vibration analysis, infrared thermography, oil analysis, ultrasonic thickness measurement, passive ultrasonic leak detection

4 3 2 1 0 14. Describe common applications for the following predictive maintenance technologies: vibration analysis, infrared thermography, oil analysis, ultrasonic thickness measurement, passive ultrasonic leak detection

APPLICATION LEVEL COURSES

41250 Research & Design for Energy

(.5 credit) An application level course which may include student research projects and/or workplace/internship experience related to the field of Energy.

Research Element

3 2 1 0 1. Work with peers and instructor to determine an energy-related topic, project, or problem for research or design.

3 2 1 0 2. Identify the stakeholders who will be impacted by a project, and consider multiple points of view in the research/design process.

3 2 1 0 3. Access and utilize industry resources in the completion of the project.

3 2 1 0 4. Research new technologies that could affect the topic/project, and/or help solve the problem.

3 2 1 0 5. Demonstrate ability to manage and set project goals and timelines

3 2 1 0 6. Demonstrate abilities in design/planning, visual communication & problem solving in the energy industry

3 2 1 0 7. Demonstrate an awareness of current energy industry standards

3 2 1 0 8. Use appropriate grammar and word usage in the creation and implementation of a formal graphic presentation using current standards and technology

Workplace Element

3 2 1 0 9. Employ effective communication skills and professionalism when working with peers / clients.

3 2 1 0 10. Employ customer service principles when working with consumers.

3 2 1 0 11. Evaluate and follow-up on customer service provided.

3 2 1 0 12. Employ safety skills and equipment usage in appropriate ways.

3 2 1 0 13. Be aware of MSDS (Material Safety Data Sheets) and other safety resources and employ those resources as required for the workplace.

41260 Research & Design for Energy Comprehensive (1 credit) An application level course which allows for more in-depth student research projects and/or workplace/internship experience related to the field of Energy.

Research Element

3 2 1 0 1. Work with peers and instructor to determine an energy-related topic, project, or problem for research or design.

3 2 1 0 2. Identify the stakeholders who will be impacted by a project, and consider multiple points of view in the research/design process.

3 2 1 0 3. Access and utilize industry resources in the completion of the project.

3 2 1 0 4. Research new technologies that could affect the topic/project, and/or help solve the problem.

3 2 1 0 5. Demonstrate ability to manage and set project goals and timelines

3 2 1 0 6. Demonstrate abilities in design/planning, visual communication & problem solving in the energy industry

3 2 1 0 7. Demonstrate an awareness of current energy industry standards

3 2 1 0 8. Use appropriate grammar and word usage in the creation and implementation of a formal graphic presentation using current standards and technology

Workplace Element

3 2 1 0 9. Employ effective communication skills and professionalism when working with peers / clients.

3 2 1 0 10. Employ customer service principles when working with consumers.

3 2 1 0 11. Evaluate and follow-up on customer service provided.

3 2 1 0 12. Employ safety skills and equipment usage in appropriate ways.

3 2 1 0 13. Be aware of MSDS (Material Safety Data Sheets) and other safety resources and employ those resources as required for the workplace.

41270 Advanced Electricity & Electronics (.5 credit)

3210 1. Apply proper OSHA Safety Standards to their learning in electricity and electronics

3210 2. Identify and explain operation of basic electronic components, and series & parallel circuit functions.

3210 3. Define and explain direct and alternating currents along with components and schematics used in electronic circuitry.

3210 4. Correctly calculate and set up lab equipment for safety, design, test, using Ohm's law, and circuit measurements.

3210 5. Identify and explain use of circuit breaker, fuses, construction of conductors and insulator functions.

3210 6. Understand and explain electron theory.

3210 7. Demonstrate an understanding of instrumentation schematics, control circuitry, ground protection, protective relaying, magnetism, relays, series & parallel, and combination circuits.

3210 8. Explain theory of plant operations including motors, generators, transformers, and auxiliary systems.

3210 9. Diagnose problems and perform

maintenance on electrical supply systems, electrical controls, resistive components, and rotating equipment.

3210 10. Identify and explain use of battery systems, electrical distribution, emergency power, and transformer and auxiliary systems.

3210 11. Identify and explain use of advanced electronic theory (including operational amplifiers and integrated circuits), digital electronics, circuit timing, and process measurements.

3210 12. Maintain, troubleshoot, and repair electronic equipment, signal converters, electrical components, sensors and detectors, instrumentation, actuators, and auxiliary equipment.

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.

39302 Hydraulics & Pneumatics (.5 credit)

An application level course designed to provide students with advanced knowledge and skills in operating, maintaining and troubleshooting hydraulic & pneumatic systems.

4 3 2 1 0 1. Compare & contrast the principles of hydraulics & pneumatics.

4 3 2 1 0 2. Demonstrate a working knowledge of hydraulics & pneumatics terminology.

4 3 2 1 0 3. Identify basic hydraulic and pneumatic symbols.

4 3 2 1 0 4. Read and understand Schematic Diagrams

4 3 2 1 0 5. Design and construct basic hydraulic and pneumatic circuits

4 3 2 1 0 6. Demonstrate proper use of pneumatic and hydraulic-operated Tools

4 3 2 1 0 7. Explain the operation of air compressors and vacuum pumps

4 3 2 1 0 8. Perform diagnostic procedures on hydraulic and pneumatic systems

4 3 2 1 0 9. Compare & contrast the use of synthetic and petroleum-based lubricants in hydraulic systems

4 3 2 1 0 10. Create a comprehensive maintenance schedule for hydraulic & pneumatic systems

4 3 2 1 0 11. Identify components in a fluid power/pneumatic circuit

17056 HVAC Technology (.5 credit)

An application level course designed to provide students with exposure to and training in the theories, equipment and skills needed to install and maintain HVAC systems.

4 3 2 1 0 1. Safely utilize and maintain tools common to the mechanical trades industry.

4 3 2 1 0 2. Describe the heating and cooling process.

4 3 2 1 0 3. Demonstrate the use of a duct calculator and the formulas used to calculate heat loads.
4 3 2 1 0 4. Apply layout to HVAC projects.
4 3 2 1 0 5. Describe various types of heating and cooling systems, including the pros, cons and applications of each.
4 3 2 1 0 6. Demonstrate basic electrical knowledge of how electrical circuits work and how they are used within the industry.
4 3 2 1 0 7. Install basic and programmable heat/cool thermostats.
4 3 2 1 0 8. Describe thermostat wire and identify what each color should be used for.
4 3 2 1 0 9. Research future trends in “green technology” for the HVAC industry.
4 3 2 1 0 10. Troubleshoot and repair problems with HVAC systems.
4 3 2 1 0 11. Correctly measure, cut and join piping/tubing.
4 3 2 1 0 12. Demonstrate proper soldering techniques.
4 3 2 1 0 13. Demonstrate ability to maintain appropriate maintenance documentation.