Approved Innovative Course

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Course: Basic Fluid Power
PEIMS Code: N1303683
Abbreviation: BASICFP
Grade Level(s): 11-12
Number of Credits: 1.0

Course description:

Basic Fluid Power is an overview of automated manufacturing principles. It includes coverage of the manufacturing process, control systems, and measurement theory. Students will identify terminology and fundamental concepts of manufacturing; describe the trends of manufacturing careers within the industry cluster; identify safety, health, environmental, and ergonomic issues in manufacturing; discuss quality and continuous improvement methods; describe the importance of maintenance within manufacturing; and identify processes and production steps in manufacturing.

Essential knowledge and skills:

(a) General requirements. This course is recommended for students in Grades 11-12. Recommended prerequisites: Algebra I, Geometry, and Solid-State Electronics. Students shall be awarded one credit for successful completion of this course.

(b) Introduction.

(1) Career and technical education instruction provides content aligned with challenging academic standards and relevant technical knowledge and skills for students to further their education and succeed in current or emerging professions.

(2) The Manufacturing Career Cluster focuses on planning, managing, and performing the processing of materials into intermediate or final products and related professional and technical support activities such as production planning and control, maintenance, and manufacturing/process engineering.

(3) In Basic Fluid Power, students will gain knowledge and skills in automated manufacturing principles. Instruction includes coverage of manufacturing process,

control systems, and measurement theory. Students will identify terminology and fundamental concepts of manufacturing; describe the trends of manufacturing careers within the industry cluster; identify safety, health, environmental, and ergonomic issues in manufacturing; discuss quality and continuous improvement methods; describe the importance of maintenance within manufacturing; and identify processes and production steps in manufacturing.

(4) Students are encouraged to participate in extended learning experiences such as career and technical student organizations and other leadership or extracurricular organizations.

(5) Statements that contain the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(c) Knowledge and skills.

(1) The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:

(A) Discuss and describe the roles, responsibilities, and dynamics of teams as applied in manufacturing careers;
(B) explain employers' work expectations;
(C) demonstrate knowledge of the concepts and skills related to health and safety in the workplace as specified by appropriate governmental regulations such as Occupational Safety and Health Administration (OSHA);
(D) research and describe the trends of manufacturing careers within the industry; and
(E) identify safety, health, environmental and ergonomic issues in manufacturing.

(2) The student identifies terminology and fundamental concepts of pneumatics and hydraulics in manufacturing. The student is expected to:

(A) identify common pneumatic symbols and their physical counterpart;
(B) read and interpret the outputs of pneumatic pressure gages and flow meters;
(C) read and interpret ladder diagrams;
(D) read and interpret pressure meters and determine force applied to pneumatic and hydraulic systems;

(E) read and interpret hydraulic pressure gages, flow meters, and liquid levels in fluid power systems;
(F) analyze and determine the pressure, flow, and liquid temperatures in the system reservoir;
(G) identify and explain the uses and limitations of common pneumatic components such as conditioning units, accumulators, long tubing lines, and safety valves; and
(H) identify the manufacturing processes and pneumatic and hydraulic components needed to complete the production process.

(3) The student demonstrates understanding of the characteristics and applications of hydraulic and pneumatic power. The student is expected to:
(A) identify and describe situations in which hydraulic and pneumatic power is appropriate to use;
(B) investigate applications of hydraulic and pneumatic power systems such as lifts, break systems, and compressors; and
(C) compare and contrast the advantages and disadvantages of hydraulic and pneumatic power systems.

(4) The student applies mathematical calculations to determine the relationship between physics concepts. The student is expected to:
(A) apply knowledge of basic physic concepts including pressure, force and volume;
(B) calculate the Pressure and Force Relationship;
(C) calculate the Pressure and Volume Relationship;
(D) explain the Pressure Drop vs. Flow Relationship;
(E) calculate the extension force of a cylinder given its size and pressure;
(F) calculate the pressure needed to create a known output force on an extending cylinder;
(G) measure the force output of an extending cylinder;
(H) calculate the retraction force of a cylinder given its size and pressure;
(I) solve problems using Boyle's Law;
(J) convert between gage and absolute pressures;
(K) convert air volumes at pressures to free air volumes;
(L) convert between absolute pressure and gage hydraulic pressure;

(M) calculate the extension force of a cylinder given its size and pressure;
(N) measure the force output of an extending cylinder;
(O) calculate the retraction force of a cylinder given its size and pressure;
(P) calculate the extend speed, retract speed, and cylinder stroke time of a hydraulic cylinder given its size and a flow rate; and
(Q) calculate and apply acceptable appropriate volume and pressure ranges in manufacturing.

(5) The student demonstrates knowledge in pneumatic and hydraulic operations as they relate to manufacturing. The student is expected to:

(A) identify and apply the principles involved in a hydraulic system operation;
(B) identify components and describe their system function using symbolic representations and placement on a schematic system;
(C) calculate and describe the principles of pressure and flow;
(D) analyze and describe the operating characteristics of single and double acting cylinders;
(E) apply knowledge of directional valve control and the direction of fluid flow in a hydraulic circuit;
(F) calculate the rate of flow in a hydraulic circuit to control the speed of hydraulic cylinders and motors;
(G) apply the principles of general gas law to the compression and expansion of air used in pneumatic systems;
(H) explain the operation of systems used to control the maximum air pressure obtained from compressed air;
(I) explain the use of flow control valves in a pneumatic circuit to control actuator speed;
(J) demonstrate the uses of cylinders in series and in parallel systems that include speed control systems;
(K) measure the force output of a retracting cylinder;
(L) measure the pressure drop (Delta P) across a hydraulic component; and
(M) measure pressure drop (Delta P) across pneumatic components.

(6) The student understands the principles of motor control as applied to hydraulic and pneumatic power systems. The student is expected to:

(A) perform basic pneumatic operations including connecting equipment;

(B) describe lock-out/tag-out procedures and recognize when they are needed;
(C) identify and explain control panel devices and their components;
(D) identify and confirm appropriate control devices for hydraulic and pneumatic systems;
(E) design a multiple actuator pneumatic circuit;
(F) connect pneumatic speed control circuits;
(G) design and construct speed control circuits;
(H) connect and operate pneumatic Directional Control Valve (DCV) applications;
(I) design and construct a rapid traverse-slow feed pneumatic circuit;
(J) design and construct a pneumatic circuit to sequence two cylinders;
(K) design and construct a pneumatic circuit that uses an externally air-piloted DCV;
(L) examine and operate a hydraulic power unit;
(M) connect and operate hydraulic Directional Control Valve (DCV) applications;
(N) design and connect hydraulic speed control circuits; and
(O) design and connect a multiple actuator hydraulic circuit, an independent speed control circuit, and a two-speed actuator circuit.

(7) The student interprets pneumatic and hydraulic schematics. The student is expected to:

(A) construct and test a pneumatic circuit given a schematic;
(B) draw a pneumatic schematic from the actual circuit connections on a machine;
(C) draw a hydraulic circuit given a schematic; and
(D) draw a hydraulic schematic from the actual circuit connections on a pictorial.

(8) The student demonstrates an understanding of vacuum systems. The student is expected to:

(A) convert between units of mercury and units of air pressure;
(B) connect and read a vacuum gage and manometer;
(C) convert between units of water column and units of water pressure;
(D) connect and operate a vacuum generator;
(E) calculate vacuum cup lift force;
(F) connect and operate a vacuum cup; and

(G) design the vacuum cup portion of a handling rack.

(9) The student understands the importance of maintenance within manufacturing. The student is expected to:

(A) document and implement preventive and predictive maintenance methods for manufacturing environments;
(B) demonstrate proficiency in troubleshooting fluid power systems;
(C) test both hydraulic and pneumatic systems;
(D) analyze quality and continuous improvement methods in the manufacturing industry;
(E) predict potential maintenance issues with pneumatic and hydraulic systems and determine when to inform maintenance personnel about issues;
(F) troubleshoot, analyze, and maintain systems to ensure safe and proper function and precision;
(G) develop and implement maintenance schedules; and
(H) identify the most common causes of failure of equipment in order to diagnosis problems quickly.

Description of specific student needs this course is designed to meet:

This course is part of an in-depth coherent sequence of courses in the manufacturing cluster that will allow the students to enter the job market with a work-ready skill upon completion of high school. National and State Workforce data projects high growth for machinists, CNC programmers, electro-mechanical technicians and engineering technicians over the next decade.

Major resources and materials:

Festo Didactic Staff. (2015). *Pneumatics fundamentals.* Quebec, Canada: Lab Volt Ltd.
Festo Didactic Staff. (2015). *Electrical control of pneumatic systems*. Quebec Canada: Lab Volt Ltd.
Breadboards and Circuit Simulators

Recommended course activities:

Design and construct basic electro-pneumatic circuits
Design and construct sequential electro-pneumatic circuits

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Design and construct basic electro-hydraulic circuits
Generate basic pneumatic and electro-pneumatic circuits and schematics

Suggested methods for evaluating student outcomes:

Performance on assigned projects and teacher developed assessments will be used to determine the student's success. Students will be evaluated on skill competency, tests, daily grades and group/individual projects using rubrics.

Teacher qualifications:

Secondary Industrial Arts: Grades 6-12
Secondary Industrial Technology: Grades 6-12
Technology Education: Grades 6-12
Trade and Industrial Education:
Grades 6-12 with appropriate work approval as identified on the certificate
Grades 8-12 with appropriate work approval as identified on the certificate
Vocational Trades and Industry with appropriate work approval as identified on the certificate

Additional information: