

Mechanical Engineering

ACADEMIC SKILLS

AA SPEAKING AND LISTENING

AA1 Utilize effective verbal and non-verbal communication skills

AA2 Participate in conversation, discussion and group presentations

AA3 Communicate and follow directions/procedures

AA4 Utilize speaking and listening skills to communicate effectively with customers and co-workers

AB READING AND WRITING

AB1 Locate and interpret written information

AB2 Read and interpret workplace documents, e.g., reports, manuals, schematics, flowcharts, tables, graphs

AB3 Identify relevant details, facts and specifications

AB4 Record information accurately and completely

AB5 Demonstrate competence in organizing, writing and editing using correct vocabulary, spelling, grammar and punctuation

AB6 Demonstrate the ability to write clearly and concisely using industry-specific terminology

AC CRITICAL THINKING AND PROBLEM SOLVING

AC1 Utilize critical-thinking skills to determine best options/outcomes, e.g., analyze reliable/unreliable sources of information, use previous experiences, implement crisis management, develop contingency planning

AC2 Utilize innovation and problem-solving skills to arrive at the best solution for the current situation

AC3 Implement effective decision-making skills

AD MATHEMATICS

AD1 Perform basic and higher-level math operations, e.g., addition, subtraction, multiplication, division, decimals, fractions, units of conversion, averaging, percentage, proportion, ratios, numbering systems

AD2 Solve problems using measurement skills, e.g., distance, weight, area, volume

AD3 Make reasonable estimates

AD4 Use tables, graphs, diagrams and charts to obtain or convey information

AD5 Use reasoning and problem-solving skills in mathematics

AE FINANCIAL LITERACY

AE1 Locate, evaluate and apply personal financial information

AE2 Identify the components of a budget and how one is created

AE3 Set personal financial goals and develop a plan for achieving them

AE4 Describe types of financial service providers and considerations in selecting a provider

AE5 Demonstrate ability to meet financial obligations

AF INTERNET USE AND SECURITY

AF1 Recognize the potential risks associated with internet and social media use

AF2 Identify and apply internet security practices, e.g., password security, login, logout, log off, lock computer

AF3 Practice safe, legal and responsible use of technology in the workplace

AG INFORMATION TECHNOLOGY

AG1 Use technology appropriately to enhance professional presentations

AG2 Demonstrate effective, appropriate and ethical use of social media

AG3 Identify ways social media can be used as marketing, advertising and data gathering tools

AH TELECOMMUNICATIONS

AH1 Select and utilize the appropriate environment, devices, services and applications to complete workplace tasks

AH2 Demonstrate appropriate etiquette when using telecommunications, e.g., cell phone, e-mail, messaging services, online meetings, conference calls

EMPLOYABILITY SKILLS

EA POSITIVE WORK ETHIC

EA1 Explain the importance of pride and confidence about work and learning new tasks

EA2 Demonstrate consistent and punctual attendance

EA3 Demonstrate initiative in assuming tasks

EA4 Exhibit dependability in the workplace

EA5 Take and provide direction in the workplace

EA6 Accept responsibility for personal decisions and actions

EB INTEGRITY

EB1 Abide by workplace policies and procedures, e.g., safety, internet and cell phone use, code of conduct

EB2 Demonstrate honesty and reliability

EB3 Demonstrate ethical characteristics and behaviors

EB4 Maintain confidentiality and integrity of company information

EB5 Support the mission and vision of the company

EC SELF-REPRESENTATION

EC1 Demonstrate appropriate dress and hygiene in the workplace

EC2 Use language and manners suitable for the workplace

EC3 Demonstrate polite and respectful behavior toward others

ED TIME, TASK AND RESOURCE MANAGEMENT

ED1 Plan and follow a work schedule

ED2 Complete work tasks successfully with minimal supervision

ED3 Work successfully within budgetary constraints

ED4 Demonstrate ability to stay on task to produce high-quality deliverables on time

EE DIVERSITY AWARENESS

EE1 Define and differentiate diversity, equity, inclusion, discrimination and harassment

EE2 Work effectively with all customers and co-workers

EE3 Explain the benefits of diversity within the workplace

EE4 Explain the importance of respect for the feelings, values and beliefs of others

EE5 Identify strategies to bridge cultural/generational differences and use differing perspectives to increase the overall quality of work

EE6 Illustrate techniques for eliminating bias and stereotyping in the workplace

EE7 Identify ways tasks can be structured to accommodate the diverse needs of workers

EE8 Recognize the challenges and advantages of a global workforce

EF TEAMWORK

EF1 Recognize the characteristics of a team environment and conventional workplace

EF2 Demonstrate effective team skills, e.g., setting goals, listening, following directions, questioning, dividing work, conflict resolution, meeting facilitation, and evaluate their importance in the workplace

EG CREATIVITY AND RESOURCEFULNESS

EG1 Explain the importance of contributing and conveying new ideas in the workplace

EG2 Describe the importance of posing questions when developing ideas

EG3 Explain the value of varying ideas and opinions

EG4 Locate and verify information during the creative process

EH CONFLICT RESOLUTION

EH1 Identify conflict resolution skills to enhance productivity and improve workplace relationships

EH2 Implement conflict resolution strategies and problem-solving skills

EH3 Explain the use of documentation and its role as a component of conflict resolution

EI CUSTOMER/CLIENT SERVICE

EI1 Recognize the importance of and demonstrate how to properly greet/approach customers and clients

EI2 Identify and address needs of customers/clients

EI3 Provide helpful, courteous and knowledgeable service

EI4 Identify appropriate channels of communication with customers/clients, e.g., online, phone call, face-to-face

EI5 Identify techniques to seek and use customer/client feedback to improve company services

EI6 Explain the relationship between customer/client satisfaction and company success

EJ ORGANIZATIONS, SYSTEMS AND CLIMATES

EJ1 Define profit and identify factors affecting the profitability of a business

EJ2 Identify "big picture" issues in conducting business, e.g., forecasting, global market, risk management

EJ3 Identify roles in fulfilling the mission of the workplace

EJ4 Identify the rights of workers, e.g., adult and child labor laws, and other equal employment opportunity laws

EJ5 Recognize the chain of command, organizational flow chart system and hierarchy of management within an organization

EK JOB ACQUISITION AND ADVANCEMENT

EK1 Recognize the importance of maintaining a job and pursuing a career

EK2 Define jobs associated with a specific career path or profession

EK3 Identify and seek various work experience opportunities, e.g., volunteerism, internships, co-op, part-time/full-time employment

EK4 Prepare a resume, cover letter and job application

EK5 Prepare for and participate in a job interview, e.g., research company, highlight personal strengths, prepare questions, conduct a mock interview, dress appropriately

EK6 Explain the components of a successful job interview

EK7 Identify key factors to evaluate employment offers, e.g., salary, benefits packages

EK8 Explain the proper procedure for leaving a job

EL LIFELONG LEARNING

EL1 Acquire current and emerging industry-related information

EL2 Demonstrate commitment to learning as a life-long process and recognize learning opportunities

EL3 Identify various self-improvement opportunities

EL4 Explain the importance of adaptability in career planning and self-management, e.g., diverse portfolio, credentials, professional development

EL5 Employ leadership skills to achieve workplace objectives, e.g., personal vision, adaptability, change, shared vision

EL6 Recognize the importance of job performance evaluation and coaching as it relates to career advancement

EL7 Accept and provide constructive criticism

EL8 Describe the impact of the global economy on jobs and careers

EM JOB SPECIFIC TECHNOLOGIES

EM1 Identify the value of new technologies and their impact on driving continuous change and the need for lifelong learning

EM2 Research and identify emerging technologies for specific careers

EM3 Select appropriate technological resources to accomplish work

EN HEALTH AND SAFETY

EN1 Identify and assume responsibility for the safety of self and others

EN2 Follow safety guidelines in the workplace, e.g., OSHA, CDC

EN3 Explain the impact of personal health and wellness on job performance

OCCUPATIONAL SKILLS

OA GENERAL LAB SAFETY RULES AND PROCEDURES

- OA1 Describe general shop safety rules and procedures
- OA2 Demonstrate knowledge of OSHA and its role in workplace safety
- OA3 Comply with the required use of personal protection equipment (PPE), e.g., safety glasses, ear protection, gloves, shoes, during lab/shop activities
- OA4 Utilize safe procedures for handling of tools and equipment
- OA5 Operate lab equipment according to safety guidelines
- OA6 Identify and use proper lifting procedures and proper use of support equipment
- OA7 Utilize proper ventilation procedures for working within the lab/shop area
- OA8 Identify marked safety areas and colors
- OA9 Identify the location and the types of fire extinguishers and other fire safety equipment, as well as, demonstrating the procedures for usage
- OA10 Identify the location and use of eyewash stations
- OA11 Identify the location of the posted evacuation routes
- OA12 Identify and wear appropriate clothing for lab/shop activities
- OA13 Secure hair and jewelry for lab/shop activities
- OA14 Demonstrate knowledge of the safety aspects of low and high voltage circuits
- OA15 Locate and interpret material safety data sheets (MSDS)
- OA16 Perform housekeeping duties
- OA17 Follow verbal instructions to complete work assignments
- OA18 Follow written instructions to complete work assignments
- OA19 Demonstrate ergonomically safe use of lab equipment, furniture and materials

OB HAND TOOLS

- OB1 Identify hand tools and their appropriate usage
- OB2 Demonstrate the proper techniques when using hand tools
- OB3 Demonstrate safe handling and use of appropriate tools

OB4 Demonstrate proper cleaning, storage and maintenance of tools

OC POWER TOOLS AND EQUIPMENT

OC1 Identify power tools/equipment, e.g., band saw, drill press, table saw, sanders, portable power tools, and their appropriate usage

OC2 Demonstrate safe and proper techniques when using power tools and equipment

OC3 Demonstrate proper cleaning, storage and maintenance of power tools and equipment

OC4 Choose correct machining processes(s) based on the given/produced design

OD HISTORY OF STEM

OD1 Define Science, Technology, Engineering and Mathematics (STEM) and their relationship to each other

OD2 Identify engineering & technology achievements, e.g., space race, computer technology, aqua ducts, skyscrapers, bridges, subways, airports, throughout history

OD3 Identify famous inventors, e.g., Edison, Tesla, Bell, da Vinci, Washington Carver, Ford, and their achievements throughout history

OD4 Research how historical period and regional style have influenced engineering design

OD5 Investigate the evolution of a product

OD6 Describe the product life cycle

OD7 Describe how your design affects the environment both in a positive and negative way

OE CAREERS IN STEM

OE1 Investigate STEM careers, training, professional organizations and associated opportunities

OE2 Describe the difference between Engineering and Engineering Technology disciplines and job functions

OE3 Explore career opportunities and list the educational requirements for several STEM fields of interest

OE4 Research STEM Fields including non-traditional career paths to understand workload, education, job outlook and salary

OE5 Research STEM education and its role in workforce development

OE6 Identify top KY occupations as they relate to industry sectors

OE7 Utilize KCEWS Future Skills Report to determine future workforce demand in STEM fields

OE8 Research the pros/cons of STEM careers and what their impact is on the Kentucky workforce and on job transitions

OE9 Investigate state and national professional organizations, e.g., KSPE, SAME, NCSEA, SME, NAM, NSPE, ASCE, ABET, SWE, NSBE, LEED, PMP, SHPE, and their importance to fields of engineering

OF ETHICS IN ENGINEERING

OF1 Identify current professional engineering codes of ethics

OF2 Analyze ethical engineering issues

OF3 Analyze and explain ethical and technical issues contributing to an engineering disaster

OF4 Describe how ethics influences the engineering process

OF5 Describe the negative impacts technology can have on the environment

OF6 Connect with Engineering and Engineering Technology professionals in your community to discuss engineering ethics

OF7 Identify various standards organizations, e.g., OSHA, EPA, ACS, and their importance in fields of engineering

OG ENGINEERING DESIGN PROCESS

OG1 Identify several design processes and evaluate pros/cons of each

OG2 Explain how a design process is a systematic, iterative problem-solving method that produces solutions to meet human needs and wants

OG3 Identify the activities that occur during each phase of a design process

OG4 Specify criteria and identify constraints when defining a problem and determine the most appropriate solution considering time, material, cost and regulations

OG5 Apply the steps of a design process to solve a variety of design problems

OG6 Describe how social, environmental, legal and financial constraints influence a design process

OG7 Utilize conceptual, mathematical and physical models to evaluate design solutions

OG8 Incorporate computer technology to assist in organizing and analyzing data used during a design process

OG9 Document various design process solutions and communicate to the intended audience

OG10 Utilize a cost analysis tool during the design process

OG11 Identify and implement codes and specifications, e.g., AASHTO, IBC, RBC, AISC, ACI, PCI, AISI, NDS, TMS, ASTM, OSHA, ADA, LEED, ASHRE, based on the intended design solution

OG12 Adapt and change as problems arise in the design process

OG13 Demonstrate best practices when working through the design process on a team

OG14 Incorporate ergonomics within each design solution

OH UTILIZE A DIGITAL PORTFOLIO TO APPLY THE ENGINEERING DESIGN PROCESS

OH1 Present and justify the problem

OH2 Document and analyze prior solution(s) attempt

OH3 Present and justify a solution design requirement

OH4 Design concept generation, analysis and selection

OH5 Apply STEM principles and practices

OH6 Consider design viability

OH7 Construct a testable prototype

OH8 Develop a prototype testing and data collection plan

OH9 Test data collection and analysis

OH10 Document external evaluations

OH11 Reflect on the design process

OH12 Present the designer's recommendations

OH13 Present the project portfolio

OH14 Write like an engineer

OI FREEHAND TECHNICAL SKETCHING TECHNIQUES

OI1 Develop design ideas using freehand sketching

OI2 Identify the six primary orthographic views

OI3 Create pictorial and multi-view sketches

OI4 Create rough, refined and presentation sketches

OI5 Utilize the alphabet of lines, e.g., styles and weights

OI6 Legibly annotate sketches

OI7 Interpret common symbols and terminology

OJ MEASURING AND SCALING TECHNIQUES

OJ1 Identify industry standard units of measure

OJ2 Convert between industry-standard units of measure

OJ3 Determine and apply the appropriate engineering and metric scales

OJ4 Determine and apply the equivalence between fractions and decimals

OJ5 Demonstrate proper use of precision measuring tools

OJ6 Make precision measurements to the degree of accuracy required by the specifications using appropriate instruments

OJ7 Measure effectively and accurately to accomplish engineering-related tasks

OJ8 Utilize geometric dimensioning and tolerancing to solve engineering problems

OK ENGINEERING DOCUMENTATION AND COMMUNICATION PROCEDURES

OK1 Demonstrate record-keeping procedures and communication in engineering utilizing an engineering notebook

OK2 Identify the importance of proprietary documentation in engineering

OK3 Utilize project management timelines in a Gantt chart

OK4 Present design solutions in a clear and concise manner

OK5 Demonstrate the conventions of technical writing to communicate design solutions

OK6 Document object size, area, mass, volume and density

OK7 Utilize appropriate digital file management techniques

OK8 Utilize appropriate presentation techniques

OK9 Identify basic components of a computer system and their function

OK10 Use spreadsheet software to analyze and present data

OK11 Communicate project results through a technical report

OK12 Create a portfolio containing all notes, work and projects documenting the course

OK13 Communicate to a non-technical audience your project solution

OL COMPUTER AIDED DESIGN (CAD) SYSTEM

OL1 Identify various 2D and 3D CAD software

OL2 Interpret basic elements of a technical drawing, e.g., title block information, dimensions, line types

OL3 Describe and construct various types of CAD drawings, e.g., part, assembly, drawing files

OL4 Construct drawings utilizing metric and customary, e.g., SAE and Imperial, measurement systems

OL5 Arrange dimensions and annotations using appropriate standards, e.g., ANSI and ISO

OL6 Read technical drawings identifying and understand the dimensional tolerances and limits

OL7 Construct exploded assembly drawings with part lists and balloons

OL8 Create rendered drawings

OL9 Utilize a CAD modeling system to perform a physical property analysis, e.g., quantities, take offs, area, mass, weight, for a part or assembly

OL10 Calculate costs and physical requirements impacted by product physical properties of a product

OL11 Use appropriate technology, e.g., camera, video, to allow a walkthrough of a project

OM MODELING TECHNIQUES

OM1 Identify the areas of modeling, e.g., physical, conceptual, mathematical

OM2 Create various mock-ups, scale models and working prototypes based on CAD drawings

OM3 Evaluate various mock-ups, scale models and working prototypes using a design process

OM4 Design simulations to model intended design outcomes

OM5 Create virtual walk throughs and fly overs to model intended design outcomes

OM6 Describe the difference between additive and subtractive modeling

ON RAPID PROTOTYPING TECHNOLOGY

ON1 Explain how technology shifts throughout history have made rapid prototyping possible

ON2 Explain current and emerging rapid prototyping applications in a variety of industries

ON3 Describe the advantages and limitations of each rapid prototyping technology

ON4 Evaluate real-life scenarios and recommend the appropriate use of rapid prototyping technology

ON5 Identify opportunities to apply rapid prototyping technology for time and cost savings

ON6 Discuss the economic implications of rapid prototyping including its impact on startup businesses and supply chains

ON7 Determine appropriate rapid prototyping process to solve various design problems

ON8 Determine appropriate rapid prototyping material(s) to solve various engineering-related problems

ON9 Demonstrate an understanding of rapid prototyping using a 3D printer to solve engineering-related problems

ON10 Demonstrate an understanding of rapid prototyping using a laser engraver to solve engineering-related problems

ON11 Demonstrate an understanding of rapid prototyping using a CNC equipment to solve engineering-related problems

ON12 Demonstrate an understanding of rapid prototyping using breadboards and microcontrollers to solve engineering-related problems

OO ARCHITECTURE AND BUILDING CONSTRUCTION

OO1 Identify various building, fire, ADA and safety codes

OO2 Apply various building, fire, ADA and safety codes

OP STRUCTURES

OP1 Design beams to safely carry various loads

OP2 Calculate beam deflection

OQ BUILDING INFORMATION MODELING (BIM) & CITY INFORMATIONAL MODELING (CIM)

OQ1 Interpret HVAC, electrical, plumbing and mechanical systems construction documents

OQ2 Create HVAC, electrical plumbing and mechanical systems construction documents

OR BASIC ELECTRICITY

OR1 Measure circuit values, e.g., voltage, resistance, current, using a digital multimeter

OR2 Construct and calculate voltage, resistance and current of series and parallel circuits using Ohm's law

OR3 Demonstrate breadboarding through various projects

OR4 Interpret basic electrical schematics

OR5 Compare and contrast the behavior of electrical circuits with parallel and series circuit designs

OS INTERMEDIATE CIRCUITS AND LAWS OF ELECTRICITY

OS1 Understand the advantage and disadvantages of AC and DC electrical systems and their applications

OT MANUFACTURING ENGINEERING

OT1 Define manufacturing engineering

OT2 Research fields of engineering related to manufacturing

OT3 Describe the history of manufacturing and why and how it has evolved

OT4 Describe common manufacturing processes, e.g., molding, casting, extruding, machining and joining

OT5 Identify how manufacturing processes can be used to produce a product

OU MANUFACTURING SYSTEMS

OU1 Operate output devices to perform a function

OV MECHANICAL ENGINEERING

OV1 Define mechanical engineering

OV2 Research education and careers related to mechanical engineering

OW SIMPLE AND COMPOUND MACHINES

OW1 Distinguish between the six simple machines, their attributes and components

OW2 Measure forces and distances related to simple machines

OW3 Calculate mechanical advantage of all simple machines

OW4 Design, construct and test various simple machines

OW5 Design, construct and test a compound machine

OW6 Design, construct and calculate various gear ratios

OW7 Define, identify and demonstrate forms of potential and kinetic energy

OX STATICS

OX1 Draw complete free-body diagrams of static systems

OX2 Write appropriate equilibrium equations including the support reactions on a structure

OX3 Determine the resultant forces of a truss system

OX4 Apply the concepts of equilibrium to trusses

OX5 Calculate compression and tension forces on individual members in a truss system

OX6 Calculate moments, centers of mass and forces for particular structures

OX7 Calculate the moment of inertia of a structural member

OX8 Calculate the deflection of a structural member

OX9 Design and destructively test a truss to analyze calculated predictions of maximum load and efficiency

OY MATERIAL PROPERTIES

OY1 Describe physical and mechanical properties of different materials, e.g., metals, ceramics, polymers and plastics, semiconductors, wood and composites

OY2 Distinguish between stress and strain

OY3 Distinguish between elastic and plastic deformation

OY4 Identify different parts of the stress-strain curve for various materials

OY5 Define modulus of elasticity

OY6 Identify and calculate parts of a stress-strain curve using material test samples

OY7 Describe the relationship between the tensile force applied to a material and the deformation of the material

OY8 Compare and contrast use of a variety of materials for a given application

OZ THERMODYNAMICS

OZ1 Describe convection, conduction and radiation as they apply to thermal energy transfer

OZ2 Describe the four laws of thermodynamics

OZ3 Calculate heat transfer using Newton's Law of cooling

OZ4 Calculate the rate at which energy is transferred through materials by applying different R-values

OZ5 Design, construct and test insulation materials for reducing thermal energy transfer

OAA DYNAMICS

OAA1 Describe Newton's three laws of motion

OAA2 Calculate velocity and acceleration for a body in motion in one and two dimensions using kinematic equations

OAA3 Translate linear motion variables, relationships and equations to rotational motion

OAA4 Describe the impact of torque on a rotating system

OAA5 Calculate torque given a force and a point of application

OAA6 Identify and explain basic components of linkage systems, e.g., links, joints, slots, degrees of freedom

OAA7 Design a linkage system that completes a specified task by converting rotational motion to linear motion or vice versa

OAB FLUID MECHANICS

OAB1 Identify the advantages of hydraulic and pneumatic systems

OAB2 Understand the differences between hydrodynamic and hydrostatic systems

OAB3 Identify and explain basic components and functions of fluid power devices including hydraulic and pneumatic power systems

OAB4 Understand how pressure and temperature affect fluid systems

OAB5 Calculate design parameters in a fluid power system utilizing Pascal's Law and ideal gas laws

OAB6 Design, create and test a hydraulic device and a pneumatic device

OAB7 Calculate flow rate, flow velocity, power, and mechanical advantage in a fluid power system

OAB8 Utilize a flow meter to acquire and analyze flow rate and pressure data for a fluid power system

OAB9 Identify and explain basic components and functions of water pumps and hydroelectric systems

OAC MACHINE DESIGN

OAC1 Identify and explain the advantages and disadvantages of different types of gears

OAC2 Calculate gear ratios and mechanical advantage for gear trains

OAC3 Calculate mechanical advantage of screws and bolts using thread, pitch and diameter

OAC4 Identify different machine elements, e.g., cam mechanisms, linkages, belt drives, in motion and their components

OAC5 Identify machine elements, e.g., springs, flywheels, clutches, brakes, that absorb and store energy

OAC6 Understand and utilize ISO Drawing standards for machine components and assembly

OAC7 Design, build and test a machine utilizing multiple machine elements and components that also meets safety requirements

OAC8 Calculate work and power

OAD ROBOTICS ENGINEERING

OAD1 Define robotic engineering

OAD2 Define common types of robots

OAD3 Identify various inputs and outputs used in robotic systems

OAD4 Apply basic physics concepts, e.g., velocity, speed, force, distance, torque, fluid power, to solve various design problems

OAD5 Demonstrate an understanding of robotics, its history, applications, evolution and future

OAD6 Demonstrate an understanding of the impact of robotics on the manufacturing process

OAE ROBOTIC PROGRAMMING

OAE1 Apply basic programming to robotic systems to solve various engineering-related problems