Engineering Design

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 Communicate effectively with customers and co-workers

AB READING AND WRITING

AB1 Locate and interpret written information

AB2 Read and interpret workplace documents

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 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)

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 deductive reasoning and problem-solving 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 Use financial services effectively

AE5 Demonstrate ability to meet financial obligations

**AF INTERNET USE AND SECURITY**

AF1 Recognize the potential risks associated with Internet 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 and appropriate use of social media

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

**AH TELECOMMUNICATIONS**

AH1 Select and use appropriate devices, services, and applications to complete workplace tasks

AH2 Demonstrate appropriate etiquette when using e-communications (e.g., cell phone, e-mail, personal digital assistants, online meetings, conference calls)
EMPLOYABILITY SKILLS

EA POSITIVE WORK ETHIC
EA1 Demonstrate enthusiasm 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
EB2 Demonstrate honesty and reliability
EB3 Demonstrate ethical characteristics and behaviors
EB4 Maintain confidentiality and integrity of sensitive company information
EB5 Demonstrate loyalty to 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
EC4 Demonstrate personal accountability in the workplace
EC5 Demonstrate pride in work

ED TIME, TASK, AND RESOURCE MANAGEMENT
ED1 Plan and follow a work schedule
ED2 Work with minimal supervision
ED3 Work within budgetary constraints
ED4 Demonstrate ability to stay on task to produce high quality deliverables on time
EE DIVERSITY AWARENESS

EE1 Recognize diversity, discrimination, harassment, and equity
EE2 Work well with all customers and co-worker
EE3 Explain the benefits of diversity within the workplace
EE4 Explain the importance of respect for feelings, values, and beliefs of others
EE5 Identify strategies to bridge cultural/generational differences and use differing perspectives to increase overall quality of work
EE6 Illustrate techniques for eliminating gender 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 Contribute to the success of the team
EF3 Demonstrate effective team skills and evaluate their importance in the workplace (e.g., setting goals, listening, following directions, questioning, dividing work)

EG CREATIVITY AND RESOURCEFULNESS

EG1 Contribute new ideas
EG2 Stimulate ideas by posing questions
EG3 Value varying ideas and opinions
EG4 Locate and verify information

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 acknowledge customers/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., phone call, face-to-face, e-mail, website)

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

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

**EJ ORGANIZATIONS, SYSTEMS, AND CLIMATES**

EJ1 Define profit and evaluate the cost of conducting business

EJ2 Identify "big picture" issues in conducting business

EJ3 Identify role 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 job opportunities (e.g., volunteerism, internships, co-op, part-time/full-time employment)

EK4 Prepare a resume, letter of application, and job application

EK5 Prepare for a job interview (e.g., research company, highlight personal strengths, prepare questions, set-up a mock interview, dress appropriately)

EK6 Participate in a job interview

EK7 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 Seek and capitalize on self-improvement opportunities

EL4 Discuss the importance of flexible career planning and career self-management
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 life-long learning

EM2 Research and identify emerging technologies for specific careers

EM3 Select appropriate technological resources to accomplish work

**EN HEALTH AND SAFETY**

EN1 Assume responsibility for safety of self and others

EN2 Follow safety guidelines in the workplace

EN3 Manage personal health and wellness
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) (i.e., 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 eye wash 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 effects 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 (i.e., 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 (i.e., 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 (i.e., 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 THE INNOVATION PORTAL

OH1 Present and justify the problem (Element A)
OH2 Document and analyze prior solution(s) attempt (Element B)
OH3 Present and justify a solution design requirements (Element C)
OH4 Design concept generation, analysis and selection (Element D)
OH5 Apply STEM principles and practices (Element E)
OH6 Consider design viability (Element F)
OH7 Construct of a testable prototype (Element G)
OH8 Develop a prototype testing and data collection plan (Element H)
OH9 Test data collection and analysis (Element I)
OH10 Document external evaluations (Element J)
OH11 Reflect on the design process (Element K)
OH12 Present the designer's recommendations (Element L)
OH13 Present the project portfolio (a holistic grade based on elements A-L) (Element M)
OH14 Write like an engineer (a holistic grade based on elements A-L) (Element N)

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 (i.e., 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 (i.e., title block information, dimensions, line types)
OL3 Describe and construct various types of CAD drawings (i.e., part, assembly, drawing files)
OL4 Construct drawings utilizing metric and customary (i.e., SAE and Imperial) measurement systems
OL5 Arrange dimensions and annotations using appropriate standards (i.e., 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 (i.e., 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 (i.e., camera, video) to allow a walkthrough of a project

OM MODELING TECHNIQUES
OM1 Identify the areas of modeling (i.e., 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 Analyze the positive and negative environmental impacts of various design solutions

OO2 Develop architectural models (e.g., balsa structures, balsa residential framing model, foam board models, scale concrete foundations)

OO3 Define architecture and/or building construction

OO4 Research education and careers related to architecture and/or building construction

OO5 Describe the various residential/architectural styles

OO6 Describe the construction process from site acquisition to occupation

OO7 Investigate various architects throughout history, present their findings

OO8 Develop design presentations which may include: plan sets, cost analysis or estimations, renderings, materials and walkthroughs

OO9 Identify and describe heavy machinery used in various construction processes (i.e., dozers, excavators, graders, scrapers)

OO10 Identify various building, fire, ADA and safety codes

OO11 Apply various building, fire, ADA and safety codes

OO12 Identify specific community planning and zoning regulations

OO13 Apply specific community planning and zoning regulations

OO14 Prepare architectural drawings (e.g., floor plans, site plans, elevations) and prepare roof and demolition plans

OP CIVIL ENGINEERING

OP1 Define civil engineering
OP2 Identify the primary duties and attributes of a civil engineer

OP3 Differentiate the relationships of all stakeholders involved in a civil engineering project

OP4 Discuss various traditional and non-traditional civil engineering career paths

**OQ STRUCTURES**

OQ1 Identify various materials used in engineering structures

OQ2 Identify forces (e.g., tension, compression, torque, shear) that act on structures

OQ3 Construct various structure spans and calculate efficiency

OQ4 Research the different foundation types and uses for a commercial application

OQ5 Describe the different types of loads and how they affect a building design

OQ6 Determine live, dead and secondary loads

OQ7 Design beams to safely carry various loads

OQ8 Calculate beam deflection

OQ9 Utilize building codes to determine structural systems for a given building occupancy

**OR GEOTECHNICAL**

OR1 Apply soil analysis techniques for construction applications

OR2 Identify types of soil and rocks found in certain geographical areas

OR3 Run soil samples with explanation of findings

OR4 Explain the importance of gradation during construction

**OS SURVEYING**

OS1 Be able to identify survey equipment and their uses

OS2 Use survey equipment to plot and draw a topographical map of assigned area

OS3 Recognize emerging technology (i.e. drones, technical equipment/software) associated with surveying

**OT CONCRETE**

OT1 Define concrete and its components

OT2 Calculate material properties (e.g., tensile, modulus of elasticity, compression) of concrete
OT3 Create and test concrete using student created formula
OT4 Create and test homemade concrete
OT5 Identify career opportunities in concrete
OT6 Calculate cost of defined building pad

**OU BUILDING INFORMATION MODELING (BIM) & CITY INFORMATIONAL MODELING (CIM)**

OU1 Explain the purpose of building codes (e.g., IBC, ICC, NEC, ADA) and regulations
OU2 Outline typical components of a framing system
OU3 Identify and explain code requirements for structures
OU4 Utilize building codes to determine structural systems for a given building occupancy
OU5 Interpret HVAC, electrical, plumbing and mechanical systems construction documents
OU6 Create HVAC, electrical plumbing and mechanical systems construction documents
OU7 Identify conventional roof design
OU8 Research building materials that address aesthetics, design loads and environmental challenges
OU9 Model a building using architectural design software
OU10 Estimate cost for a construction project
OU11 Calculate the heat loss for a building
OU12 Research the use and application of different commercial floor systems, wall systems and roofing systems

**OV URBAN PLANNING**

OV1 Explain the purpose of urban planning
OV2 Utilize client requirements and specifications to create a plan set
OV3 Explain how planning projects fits into the community culture
OV4 Create a plan set
OV5 Identify land use and development regulations
OV6 Research energy conservation techniques
OV7 Identify land use and development regulations for commercial parking lots
OV8 Research codes, zoning ordinances and regulations for a commercial design

**OW STATICS**

**OW1** Draw complete free-body diagrams of static systems

**OW2** Write appropriate equilibrium equations including the support reactions on a structure

**OW3** Determine the resultant forces of a truss system

**OW4** Apply the concepts of equilibrium to trusses

**OW5** Calculate compression and tension forces on individual members in a truss system

**OW6** Calculate moments, centers of mass and forces for particular structures

**OW7** Calculate the moment of inertia of a structural member

**OW8** Calculate the deflection of a structural member

**OW9** Design and destructively test a truss to analyze calculated predictions of maximum load and efficiency

**OX MATERIAL PROPERTIES**

**OX1** Describe physical and mechanical properties of different materials (e.g., metals, ceramics, polymers and plastics, semiconductors, wood, composites)

**OX2** Distinguish between stress and strain

**OX3** Distinguish between elastic and plastic deformation

**OX4** Identify different parts of the stress-strain curve for various materials

**OX5** Define modulus of elasticity

**OX6** Identify and calculate parts of a stress-strain curve using material test samples

**OX7** Describe the relationship between the tensile force applied to a material and the deformation of the material

**OX8** Compare and contrast use of a variety of materials for a given application