Industrial and Technology Education Subject Matter Requirements

Part I: Content Domains for Subject Matter Understanding and Skill in Industrial and Technology Education

Domain 1.   Nature of Technology

Candidates understand technology as a problem-solving process and know the history and evolution of technology. They understand that technology involves creativity and innovation and are able to use concepts from the core content areas of science, mathematics, social science, and language arts as well as other content areas commonly taught in California public schools to design solutions to problems. Candidates understand the social aspect of technology and analyze the positive and negative effects of technologies on society and the environment. They understand the skills, knowledge, attitudes, and commitment to lifelong learning necessary to develop technological literacy and apply this knowledge in a rapidly changing global environment.

1.1   Innovation and Design
   a. Demonstrate an understanding of the engineering design process (e.g., defining a problem, using research techniques, communicating solutions, analyzing and optimizing solutions).
   b. Understand the product life cycle (e.g., prototypes, transition to production, evaluating product success).
   c. Demonstrate an understanding of how to use technological processes and systems to arrive at solutions to real-world problems.
   d. Demonstrate an understanding of current technological methods and processes to meet the needs of new and emerging fields and technologies (e.g., robotics, artificial intelligence, biotechnology, nanotechnology).
   e. Demonstrate an understanding of factors that influence design form (e.g., color theory, layout, aesthetics, juxtaposition, dimension).
   f. Demonstrate an understanding of factors that influence design function (e.g., purpose, practicality, ergonomics, utility).

1.2   Careers and Employability Skills
   a. Demonstrate an understanding of industrial and technology career opportunities (including postsecondary opportunities) and career paths.
   b. Understand skills, knowledge, responsibilities, attitudes, and aptitudes associated with industrial and technology careers.
   c. Demonstrate an understanding of workplace dynamics and structures (e.g., teaming, development of interpersonal and leadership skills, human resource and human efficiency development, Secretary's Commission on Achieving Necessary Skills [SCANS]).

1.3   Safety and the Environment
   a. Demonstrate an understanding of health and safety procedures needed for laboratory and workplace settings.
   b. Understand the safe and proper use and maintenance of tools and equipment.
   c. Demonstrate an understanding of safety regulations (e.g., OSHA regulations) and procedures (e.g., use of MSDS, handling of hazardous waste), including emergency procedures.

d. Demonstrate an understanding of the safe design and management of laboratory facilities and planning of safe laboratory activities.
e. Demonstrate an understanding of environmental issues (e.g., water pollution, air pollution, noise pollution, health hazards) associated with the development and use of technology and technological systems (i.e., power and energy, communication and information, manufacturing, construction).
f. Understand procedures and techniques for selecting, maintaining, and repairing technological systems to ensure a safe environment.

1.4   Society and Globalization
a. Understand the history and evolution of technology.
b. Identify and analyze the positive and negative influences of technology on communities and society (e.g., air pollution, land use, environmental impact).
c. Analyze factors (e.g., cultural, economic) that influence innovation and the development of technology.
d. Demonstrate an understanding of the relationship between technological literacy and technical skills.
e. Demonstrate an understanding of legal and ethical issues related to technology (e.g., copyright, liability, intellectual property, patents).

1.5   Independent and Integrated System Model
a. Demonstrate an understanding of systems and subsystems in terms of input, process, output, and feedback.
b. Identify and analyze the resources needed to develop and support technological systems.
c. Demonstrate an understanding of control systems and their use in technological systems.
d. Demonstrate an understanding of project and product management.

1.6   Integration with Other Academic Disciplines
a. Use appropriate mathematical concepts (e.g., algebra, trigonometry, statistics, geometry) to analyze data and solve problems.
b. Use a variety of communication skills (e.g., technical writing, schematics, flowcharts, verbal communication) to convey information.
c. Use appropriate scientific concepts (e.g., Newton's laws, ideal gas law, chemical reactions) to analyze and solve problems.
d. Demonstrate an understanding of the interactions between technology and the humanities, culture, and political sciences.

Domain 2.   Power and Energy
Candidates demonstrate an understanding of the fundamental scientific concepts of power and energy and how these concepts apply to mechanical, fluid, thermal, and electrical systems. Candidates understand the generation, transmission, storage, and control of power and energy and apply this knowledge to design, maintain, and analyze a variety of power and energy technologies, including transportation technologies.

2.1   Processes
a. Demonstrate an understanding of power generation processes (e.g., geothermal, nuclear, solar, fossil fuel, fuel cell).

b. Apply scientific principles of work, power, energy, and efficiency to analyze energy transformations.

c. Demonstrate an understanding of processes for energy storage (e.g., dams, flywheels, batteries).

d. Solve problems using mathematical concepts related to power and energy (e.g., Ohm's law, Pascal's law, moment of inertia, time, distance, velocity).

e. Apply concepts of power and energy to analyze a variety of technological systems (e.g., mechanical, fluid, electrical, thermal).

2.2   Systems

a. Understand safety principles, safety regulations, and safety engineering.

b. Describe and analyze systems that convert energy from one form to another (e.g., engines, generators, actuators).

c. Describe components and analyze characteristics of power control systems (e.g., brakes, valves, switches, circuit breakers).

d. Understand power transmission systems (e.g., gears, cams, parallel and series circuits, pulleys, pumps).

e. Demonstrate knowledge of the architecture and infrastructure associated with land, sea, aerospace, and intermodal transportation systems (e.g., rapid transit, shipping lanes, highways, locks, flight patterns).

2.3   Resources

a. Demonstrate an understanding of renewable (e.g., solar, wind, biomass) and nonrenewable (e.g., fossil, nuclear, chemical) energy sources.

b. Demonstrate an understanding of the uses and properties of materials (e.g., fuels, lubricants, conductors).

c. Demonstrate an understanding of a variety of power and energy tools and equipment (e.g., multimeter, torque wrench, dynamometer).

Domain 3.   Information and Communication

Candidates demonstrate an understanding of the knowledge and skills needed to design, analyze, use, and maintain a variety of communication systems. They demonstrate an understanding of how information systems encode, transmit, receive, decode, and store data. Candidates understand principles of graphic communication and use appropriate graphic tools to communicate visually. They apply knowledge of circuits and their components to electronic communication systems.

3.1   Design Processes

a. Demonstrate an understanding of design documentation (e.g., blueprints, mock-ups, storyboards, schematics).

b. Apply practical design concepts (i.e., form and function) to solve problems in communication.

c. Understand computer design (e.g., hardware, software).

d. Demonstrate an understanding of drawing and drafting principles (e.g., lettering, multiview drawing, dimensioning).

3.2   Systems

a. Apply knowledge of imaging and image production (e.g., photographic, electronic, print).

    b. Analyze characteristics of telecommunication systems.

    c. Analyze characteristics of broadcast communication systems.

    d. Understand processes (e.g., preproduction, production, distribution) for developing multimedia systems.

3.3 Resources

    a. Demonstrate an understanding of the materials (e.g., media, electronic components), tools (e.g., test equipment, software, hand tools), and equipment (e.g., hardware, imaging equipment) used in information and communication systems.

    b. Understand strategies for the effective use of information resources (e.g., data banks, subject matter experts, search engines).

    c. Demonstrate an understanding of communication systems architecture and infrastructure (e.g., analog systems, digital systems, mainframes, client servers, network architecture).

    d. Understand criteria for the selection of appropriate materials, tools, and equipment used in information and communication systems.

3.4 Security and Privacy

    a. Understand physical security systems (e.g., locks, access control, motion detectors, surveillance, intrusion detection).

    b. Understand electronic security systems (e.g., access and permissions, passwords, user IDs, roles of administrators and end users, encryption).

    c. Demonstrate an understanding of principles related to security compliance procedures (e.g., personal responsibility, job function, need-to-know basis, ethical and legal).

Domain 4. Project and Product Development

Candidates demonstrate an understanding of product development and how to plan, manage, and produce manufacturing and construction systems. Candidates understand the resources and processes needed to safely use a variety of processes to design, produce, maintain, and evaluate products. Candidates demonstrate an understanding of the requirements and constraints in the engineering design process and the systems approach to manufacturing and construction enterprises. Candidates understand issues associated with quality management and quality control, including statistical tools.

4.1 Engineering Principles

    a. Understand the project and product design process (e.g., needs assessment, product analysis, prototyping, production design, design for manufacturing).

    b. Understand safety principles, safety regulations, and safety engineering.

    c. Understand a variety of mathematical concepts and applications (e.g., measurement, tolerance, financial calculations) for product development.

    d. Understand principles of data collection, communication, and analysis (e.g., sampling, graphical representations, statistical measures).

4.2 Manufacturing and Construction Processes

    a. Understand processes involved in manufacturing (e.g., casting, forming, shaping, finishing, assembling, packaging).

    b. Understand project (e.g., building trades, multimedia, transportation) construction processes.

c. Understand manufacturing and construction codes, regulations, and industry guidelines (e.g., OSHA, zoning, building codes, Environmental Impact Reports).

d. Understand the role of research and development in manufacturing and construction enterprises.

e. Understand operations management (e.g., cost estimation, decision making, capacity planning).

4.3   Resources

a. Demonstrate an understanding of the proper identification, selection, use, and maintenance of tools and equipment (e.g., hand tools, power tools, measurement instruments).

b. Demonstrate an understanding of the identification, selection, and use of materials (e.g., wood, metals, plastics, composites, polymers).

c. Demonstrate an understanding of the supply chain and its components (e.g., vendors, just-in-time).

4.4   Quality Assurance

a. Understand principles and procedures of product testing (e.g., source, in-process, final inspection).

b. Demonstrate an understanding of strategies for obtaining and responding to customer feedback.

c. Demonstrate knowledge of the development and purpose of industry standards such as Institute of Electrical and Electronics Engineers (IEEE), International Organization for Standardization (ISO), and American National Standards Institute (ANSI).

d. Understand the principles of total quality management (TQM).

e. Identify principles and strategies of change management (e.g., software version numbers, building codes, change orders).

Part II: Subject Matter Skills and Abilities
Applicable to the Content Domains in Industrial and Technology Education

Candidates demonstrate an understanding of the nature of technology and of the core technological concepts that remain constant as technological progress accelerates. Candidates understand the design process as a problem-solving model and are able to use it to solve problems in industrial and technology education. They apply core academic knowledge of industrial and technology education, including science, mathematics, measurement, economics, and data analysis to investigate and design technological systems and processes. Candidates are able to effectively communicate designed solutions using a variety of technologies and propose strategies for implementing the solutions. They understand how to use the tools, machines, resources, and processes needed to turn ideas into workable solutions. In addition, candidates understand and apply safety rules and practices in the classroom, laboratory, and workplace.

Candidates have knowledge of historical events, current research, and recent developments in technology and industry. Candidates have knowledge of interactions between technology and society (cultural, social, economic, and environmental) in which technologies are used. They demonstrate an understanding of the importance of continued education (e.g., professional organizations, technical publications, industry, research and development) for staying current with technological innovations. They are able to work with industry representatives and community organizations to identify industry trends and job opportunities, employers' expectations, and the personal characteristics (e.g., appropriate work habits, social and communication skills) necessary for obtaining and maintaining employment in industry and technology. They demonstrate an understanding of career planning and development and student leadership opportunities, along with the skills and attitudes needed for developing successful careers in industry and technology. Candidates are aware of the characteristics, functions, and structures of student leadership organizations, clubs, and competitive groups (e.g., SkillsUSA®, Technology Student Association [TSA]) and the candidates' roles and responsibilities as advisors.