California CTE

Energy, Environment, and Utilities

Adopted 2013

Knowledge and Performance

1 **Academics** 1

2 **Communications** 2

1. Recognize the elements of communication using a sender–receiver model. 2.1
2. Identify barriers to accurate and appropriate communication. 2.2
3. Interpret verbal and nonverbal communications and respond appropriately. 2.3
4. Demonstrate elements of written and electronic communication such as accurate spelling, grammar, and format. 2.4
5. Communicate information and ideas effectively to multiple audiences using a variety of media and formats. 2.5
6. Advocate and practice safe, legal, and responsible use of digital media information and communications technologies. 2.6

3 Career Planning and Management 3

1. Identify personal interests, aptitudes, information, and skills necessary for informed career decision making. 3.1
2. Evaluate personal character traits such as trust, respect, and responsibility and understand the impact they can have on career success. 3.2
3. Explore how information and communication technologies are used in career planning and decision making. 3.3
4. Research the scope of career opportunities available and the requirements for education, training, certification, and licensure. 3.4
5. Integrate changing employment trends, societal needs, and economic conditions into career planning. 3.5
6. Recognize the role and function of professional organizations, industry associations, and organized labor in a productive society. 3.6
7. Recognize the importance of small business in the California and global economies. 3.7
8. Understand how digital media are used by potential employers and postsecondary agencies to evaluate candidates. 3.8
9. Develop a career plan that reflects career interests, pathways, and postsecondary options. 3.9

4 Technology 4

1. Use electronic reference materials to gather information and produce products and services. 4.1
2. Employ Web-based communications responsibly and effectively to explore complex systems and issues. 4.2
3. Use information and communication technologies to synthesize, summarize, compare, and contrast information from multiple sources. 4.3
4. Discern the quality and value of information collected using digital technologies, and recognize bias and intent of the associated sources. 4.4
5. Research past, present, and projected technological advances as they impact a particular pathway. 4.5
6. Assess the value of various information and communication technologies to interact with constituent populations as part of a search of the current literature or in relation to the information task. 4.6

5 Problem Solving and Critical Thinking 5

1. Identify and ask significant questions that clarify various points of view to solve problems. 5.1
2. Solve predictable and unpredictable work-related problems using various types of reasoning (inductive, deductive) as appropriate. 5.2
3. Use systems thinking to analyze how various components interact with each other to produce outcomes in a complex work environment. 5.3
4. Interpret information and draw conclusions, based on the best analysis, to make informed decisions. 5.4

6 Health and Safety 6

1. Locate, and adhere to, Material Safety Data Sheet (MSDS) instructions. 6.1
2. Interpret policies, procedures, and regulations for the workplace environment, including employer and employee responsibilities. 6.2
3. Use health and safety practices for storing, cleaning, and maintaining tools, equipment, and supplies. 6.3
4. Practice personal safety when lifting, bending, or moving equipment and supplies. 6.4
5. Demonstrate how to prevent and respond to work-related accidents or injuries; this includes demonstrating an understanding of ergonomics. 6.5
6. Maintain a safe and healthful working environment. 6.6
7. Review the responsibility of the Occupational Safety and Health Administration (OSHA) to ensure workplace safety. 6.7
8. Identify both potential hazards and accident scenarios in the work environment. 6.8
9. Follow established safety procedures (OSHA regulations and utility company procedures). 6.9
1. Evaluate changes in the environment with respect to their impact on safety of self and others. 6.1
11. Comply with energy industry safety procedures and proper ways to perform work. 6.11
12. Use safety equipment as specified by user manuals and safety training. 6.12
13. Use personal protective equipment (PPE), including safety glasses, hearing protection, gloves, work boots, and hard hats. 6.13
14. Keep personal safety equipment in good working order. 6.14
15. Use tools and equipment in compliance with user manuals and training. 6.15
16. Recognize potential and actual hazardous conditions as they arise. 6.16

7 Responsibility and Flexibility 7

1. Recognize how financial management impacts the economy, workforce, and community. 7.1
2. Explain the importance of accountability and responsibility in fulfilling personal, community, and workplace roles. 7.2
3. Understand the need to adapt to changing and varied roles and responsibilities. 7.3
4. Practice time management and efficiency to fulfill responsibilities. 7.4
5. Apply high-quality techniques to product or presentation design and development. 7.5
6. Demonstrate knowledge and practice of responsible financial management. 7.6
7. Demonstrate the qualities and behaviors that constitute a positive and professional work demeanor, including appropriate attire for the profession. 7.7
8. Explore issues of global significance and document the impact on the Energy, Environment, and Utilities sector. 7.8

8 Ethics and Legal Responsibilities 8

1. Access, analyze, and implement quality assurance standards of practice. 8.1
2. Identify local, district, state, and federal regulatory agencies, entities, laws, and regulations related to the Energy, Environment, and Utilities industry sector. 8.2
3. Demonstrate ethical and legal practices consistent with Energy, Environment, and Utilities sector workplace standards. 8.3
4. Explain the importance of personal integrity, confidentiality, and ethical behavior in the workplace. 8.4
5. Analyze organizational culture and practices within the workplace environment. 8.5
6. Adhere to copyright and intellectual property laws and regulations, and use and appropriately cite proprietary information. 8.6
7. Conform to rules and regulations regarding sharing of confidential information, as determined by Energy, Environment, and Utilities sector laws and practices. 8.7

9 Leadership and Teamwork 9

1. Define leadership and identify the responsibilities, competencies, and behaviors of successful leaders. 9.1
2. Identify the characteristics of successful teams, including leadership, cooperation, collaboration, and effective decision-making skills as applied in groups, teams, and career technical student organization activities. 9.2
3. Understand the characteristics and benefits of teamwork, leadership, and citizenship in the school, community, and workplace setting. 9.3
4. Explain how professional associations and organizations and associated leadership development and competitive career development activities enhance academic preparation, promote career choices, and contribute to employment opportunities. 9.4
5. Understand that the modern world is an international community and requires an expanded global view. 9.5
6. Respect individual and cultural differences and recognize the importance of diversity in the workplace. 9.6
7. Participate in interactive teamwork to solve real Energy, Environment, and Utilities sector issues and problems. 9.7

10 Technical Knowledge and Skills 10

1. Interpret and explain terminology and practices specific to the Energy, Environment, and Utilities sector. 10.1
2. Comply with the rules, regulations, and expectations of all aspects of the Energy, Environment, and Utilities sector. 10.2
3. Construct projects and products specific to the Energy, Environment, and Utilities sector requirements and expectations. 10.3
4. Coordinate with industry experts for specific technical knowledge and skills. 10.4
5. Maintain and troubleshoot equipment used in the energy, environment, and utilities industry. 10.5
6. Identify and evaluate questions that require skilled investigation to solve current problems cited in literature or media, or observed through personal observations. 10.6

11 Demonstration and Application 11

1. Utilize work-based/workplace learning experiences to demonstrate and expand upon knowledge and skills gained during classroom instruction and laboratory practices specific to the Energy, Environment, and Utilities sector program of study. 11.1
2. Demonstrate proficiency in a career technical pathway that leads to certification, licensure, and/or continued learning at the postsecondary level. 11.2
3. Demonstrate entrepreneurship skills and knowledge of self-employment options and innovative ventures. 11.3
4. Employ entrepreneurial practices and behaviors appropriate to Energy, Environment, and Utilities sector opportunities. 11.4
5. Create a portfolio, or similar collection of work, that offers evidence through assessment and evaluation of skills and knowledge competency as contained in the anchor standards, pathway standards, and performance indicators. 11.5

Pathway Standards

. Environmental Resources A.

1 Identify energy resources and the effects of these resources on the environment. A1.0

1 Classify energy resources by type: depletable, nondepletable, renewable, and nonrenewable. A1.1

2 Discover new and emerging energy resources. A1.2

3 Compare the advantages and disadvantages of energy resources in terms of the effects on the environment. A1.3

4 List jobs in the community that result from, or are influenced by, processing and using energy resources. A1.4

2 Identify and describe the global interactive systems and elements that create and sustain climate. A2.0

1 Describe the natural elements that interact to create climate. A2.1

2 Identify world climate patterns and summarize factors that affect climate. A2.2

3 Analyze the impact of climate upon human activities and needs. A2.3

4 Identify the greenhouse effect and climate change. A2.4

5 Explain how greenhouse gases are generated. A2.5

6 Assess impacts of greenhouse gases on the environment. A2.6

3 Evaluate regional interactive systems and elements that create harmful environmental effects. A3.0

1 Describe the sources of, and impacts attributable to, pollution and contamination. A3.1

2 Recognize the actions that cause resource depletion. A3.2

3 Define the causes of erosion and soil depletion. A3.3

4 Describe the attributes and proliferation of hardscape. A3.4

5 Identify the sources of, and impacts attributable to, habitat alteration. A3.5

4 Research the environmental implications of energy conversion processes and energy transmission systems. A4.0

1 Define the basic terms, characteristics, and concepts of physical and chemical processes related to energy conversion. A4.1

2 Identify the basic principles of energy systems, including chemical, hydraulic, pneumatic, electrical, nuclear, solar, wind, and geothermal. A4.2

3 Analyze the impacts of energy conversion processes as they relate to activities across the environment. A4.3

5 Identify the role and impact of waste management systems and their operations on the environment. A5.0

1 Understand the role of waste and storm water management systems, their operation, and their impact on the environment. A5.1

2 Explore the causes and effects of pollution linked to wastewater treatment facilities. A5.2

3 Identify wastewater treatment processes that lessen environmental impacts and improve water reuse. A5.3

4 Explain the types and sources of hazardous waste and associated safety practices and legal requirements for handling and disposing of such waste. A5.4

5 Design solid waste disposal processes that lessen environmental impacts and improve recycling. A5.5

6 Understand the field of land use management and its potential for environmental impact. A6.0

1 Describe the need for, and role of, habitat preservation. A6.1

2 Describe the composition, role, and function of ecosystems, including trends affecting viability. A6.2

3 Demonstrate the need for, and methods of, land use planning. A6.3

4 Identify the aspects of land use planning and describe current trends. A6.4

5 Summarize the relationship between land use planning and energy use and distribution. A6.5

6 Explain the laws and regulations pertaining to land use planning. A6.6

7 Develop strategies to maximize the effectiveness of land use planning. A6.7

7 Research the role of air quality management and systems, their operations, and their impact on the environment. A7.0

1 Understand the elements that create outdoor air quality. A7.1

2 Summarize the causes of air pollutants and their chemical composition. A7.2

3 Research air pollutants and their threat to human health. A7.3

4 Understand U.S. and California laws and regulations related to air pollution control programs and health effects of air pollution. A7.4

5 Describe the basic U.S. Environmental Protection Agency (EPA) and California Air Resources Board (ARB) roles and regulations. A7.5

8 Implement processes to support energy efficiency. A8.0

1 Understand the relationship between power and energy efficiency. A8.1

2 Outline how domestic and industrial appliances and systems affect the environment, such as water units and heating and cooling systems. A8.2

3 Compare costs of alternate/renewable energy sources, systems, and appliances and traditional energy sources, systems, and appliances. A8.3

4 Conduct an energy audit. A8.4

9 Research drinking-water sources, systems, treatment, and conservation. A9.0

1 Understand water reuse: issues, strategies, technologies, and applications. A9.1

2 Analyze strategies for improving energy efficiencies in water collection and distribution. A9.2

4 Describe the role of environmental engineering and green energy in water systems. A9.4

4 Understand the functions and operations of water storage, reservoirs, aqueducts, and dams. A9.4

10 Evaluate the impact and flow management of storm water, rivers, and groundwater. A10.0

1 Understand the designs and tools used in water flow management. A10.1

2 Describe watershed modeling. A10.2

3 Understand the principles and applications of drainage engineering. A10.3

4 Use the Hydrologic Engineering Centers River Analysis System (HEC-RAS). A10.4

5 Analyze and interpret contaminated harbor and river sediment. A10.5

6 Describe the concerns and strategies for catastrophic storm water events and management. A10.6

11 Prepare an efficient solar heated water design and installation plan. A11.0

1 Identify the characteristics of solar heated water design and installation. A11.1

2 Describe the requirements of solar water heaters that meet regulations. A11.2

3 Describe solar hot water financial support programs and regulations. A11.3

4 Analyze efficient solar water heating systems. A11.4

12 Identify and analyze issues, legislation, and regulations related to energy and the environment. A12.0

1 Identify and discuss major environmental laws and policies, including the regulatory and legislative processes used to create such laws. A12.1

2 Understand current regulations concerning recycling, solid waste, land use management, water quality, and renewable and nonrenewable energy. A12.2

3 Compare and contrast environmental laws and regulations that may have a positive or negative impact on the environment and the economy. A12.3

4 Create an environmental law or regulation and explain how it will impact the environment. A12.4

- **Energy and Power Technology** B.

  1. Explore the basic conventional and emerging principles and concepts of the energy industry, including energy production, energy transmission, and alternative energy technologies B1.0

     1. Describe the past, present, and anticipated demand for, and use of, energy. B1.1
     2. Identify the differences and challenges in energy needs, sources, and uses in developing regions. B1.2
     3. Explain the flow of energy from generation through distribution to the customer. B1.3
     4. Demonstrate an understanding of basic direct current (DC) electrical-circuit skills. B1.4
     5. Identify the role and function of generation, transmission, and distribution organizations. B1.5
     6. Explain the different structures of energy companies, including investor-owned utilities, municipalities (and associated utility practices, such as water/wastewater), electric cooperatives, and independent power producers and the different lines of energy business, including electric and gas. B1.6
     7. Explain the role of regulatory bodies in the energy industry (Federal Energy Regulatory Commission, Public Utilities Commission [PUC]). B1.7
     8. Describe the process of electric metering and billing for energy consumption. B1.8

  2. Identify various conventional electric power generation fuel sources and the cost and efficiency issues associated with each. B2.0

     1. Explain the conventional electric power generation system and process (coal, oil, natural gas, solar, wind, geothermal, and hydroelectric). B2.1
     2. Explain how each source was created and is used to produce electricity. B2.2
     3. Evaluate and list the advantages and disadvantages for each energy source. B2.3
     4. Describe how cost and efficiency rates are determined for each source. B2.4

  3. Investigate emerging and alternative electric power generation technologies and fuel sources. B3.0

     1. Explain biomass conversion, including thermal and chemical processes used to produce electric energy. B3.1
     2. Describe the major sources, scale, and impacts of biomass energy. B3.2
     3. Define biofuels use and production. B3.3
     4. Explain how nuclear power is used to produce electric energy. B3.4
     5. Explain the process of nuclear fission. B3.5
     6. Explain how ocean wave energy is used to produce electric energy. B3.6
     7. Describe how wave power is harnessed in near shore, offshore, and far shore locations. B3.7

8 Explain wave energy technologies (terminator devices, oscillating water column, point absorbers, attenuators, and overtopping devices). B3.8

9 Compare and contrast the advantages and disadvantages of using ocean wave energy technologies for energy. B3.9

4 Understand nonnuclear power generation plant operations (coal, oil, natural gas, solar, wind, geothermal power, hydroelectric, or biofuel). B4.0

1 Explain and use the fundamental laws and principles of electricity and magnetism. B4.1

2 Classify the components of electrical generating systems, including boilers, generators, alternators, turbines, motors, engines, pumps, and switchgear. B4.2

3 Discriminate the differences and similarities of power generation, including use of different fuel types and different power plant uses. B4.3

4 Summarize the basic operating principles of fossil, hydroelectric, and internal combustion systems. B4.4

5 Describe the location of equipment in the plant, how the equipment operates, and normal operating parameters. B4.5

6 Describe the theory, construction, and application of the mechanical components of various types of power generation systems. B4.6

5 Understand and apply basic knowledge and skills necessary for nuclear power generation and nuclear power plant personnel. B5.0

1 Use the fundamental concepts associated with electricity (e.g., electric charge, electric current). B5.1

2 Understand the components of electrical systems, including switchyard construction, transformers, relays, circuit breakers, and motors. B5.2

3 Explain the basic atomic and nuclear physics terms, unit, definitions, and basic concepts, including atomic structure, nuclear interactions and reactions, sources of residual heat/decay heat, and reactor operation. B5.3

4 Understand reactor theory and operations. B5.4

5 Explain the general design overview of the basic reactor types. B5.5

6 Demonstrate understanding of reactor startup and shutdown procedures. B5.6

7 Explain the fission process, including the construction of fission product barriers. B5.7

8 Operate, repair, and test machines, devices, and equipment based on electrical or mechanical principles in order to diagnose machine malfunctions, using basic hand and small electric tools and equipment. B5.8

9 Conduct tests and inspections of products, services, or processes to evaluate quality or performance. B5.9

6 Research methods of energy procurement, transmission, distribution, and storage. B6.0

1 Describe the electric power transmission principles and processes. B6.1

2. Explain the need for electric distribution systems and how they are designed to operate. B6.2
3. Understand the emerging technologies in electric power transmission. B6.3
4. Identify electric power transmission equipment and systems. B6.4

7. Understand the interrelationships among components of systems. B7.0
    1. Understand the components and workings of the electric transmission and distribution network. B7.1
    2. Understand the components and workings of the gas transmission and distribution network. B7.2
    3. Define and explain voltage, current, resistance, power, and energy. B7.3
    4. Measure voltage, amperage, and resistance using a volt-ohm meter (VOM) and a digital volt-ohm meter (DVM). B7.4
    5. Explain and apply Ohm's Law. B7.5
    6. Design and construct an electrical circuit with a power generation source. B7.6

- **Telecommunications** C.
  1. Understand the basic principles and concepts that impact the telecommunications industry, including systems, concepts, and regulations. C1.0
     1. Understand the relationship between telecommunications and society. C1.1
     2. Evaluate the effects of telecommunications media and networks (telephone, television, cellular, social networking, etc.). C1.2
     3. Understand the fundamentals of voice telephony and voice characteristics. C1.3
     4. Compare analog transmission concepts (bandwidth, voiceband, modulation), analog circuits and sounds, and plain ordinary telephone service (POTS). C1.4
     5. Understand digital transmission concepts (capacity, bits-per-second), converting sound to digital signals (PCM, CODECS), and compensating for transmission impairments (attenuation, noise, delay, jitter). C1.5
     6. Define voice over IP (VoIP). C1.6
     7. Describe public switched telephone network (PSTN) and signaling system 7 (SS7). C1.7
     8. Understand signaling: pulse dialing and dual tone multiple frequency (DTMF). C1.8
  2. Demonstrate understanding and use of the basic and emerging technologies that impact the telecommunications industry. C2.0
     1. Describe the differences between analog and digital transmission and the migration to a converged digital/optical network for voice, data, and video. C2.1
     2. Compare and contrast the components of voice networks, such as carrier switches, routing, PBXs, T1 trunks, switched versus dedicated circuits, and packet and wireless networks. C2.2
     3. Define the components of data networks, such as modems, virtual circuits, hubs, switches, and routers. C2.3
     4. Evaluate the differences between the various access methods, including DSL, cable modems, wireless (cellular, WiMax, Wi-Fi), T1, and carrier Ethernet. C2.4
     5. Compare private voice network design alternatives using tie-lines, Centrex, virtual private networks (VPN), and hosted services. C2.5
     6. Understand the basics of local, metropolitan, and wide area networks (LANs, MANs, and WANs), including the differences between network bridging/switching and routing. C2.6
     7. Recognize technologies such as frame relay, ATM, MLPS, Ethernet, and TCP/IP and determine each technology's impact on network design, communication capabilities, and quality of service (QOS). C2.7
     8. Compare the benefits, drawbacks, and technology behind voice over IP (VoIP) using IP PBXs, IP phones and Internet telephony service providers (ITSP), and IPTV. C2.8
     9. Obtain a working knowledge of communications protocols and standards with an emphasis on their importance in network engineering and network

operation. C2.9

10 Understand the uses and effects of new technologies, such as social networking and cloud computing, on the network. C2.10

3 Examine the role and functions of satellites in telecommunications. C3.0

1 Understand the evolution of satellite communications. C3.1

2 Analyze the limitations of terrestrial communications and the advantages and disadvantages of satellites. C3.2

3 Illustrate and describe the basic elements of satellite communications. C3.3

4 Describe common types of satellites and their respective functions. C3.4

5 Learn the vocabulary and acronyms associated with satellite communications. C3.5

6 Understand satellite orbits, including launch vehicles and the launching of satellites. C3.6

7 Understand satellite systems, including geo-synchronous earth orbiting (GEO), low-earth orbiting (LEO), medium-earth orbiting (MEO), high-earth orbiting (HEO), and mobile satellite systems. C3.7

8 Analyze satellite system architecture, including the network configuration, remotes, satellite subsystems, ground stations, and network management. C3.8

9 Understand frequency bands and those used in satellite communications. C3.9

10 Understand the importance of modulation, multiplexing, and multiple access. C3.10

11 Explain propagation and interference, including radio noise, ionosphere effects, troposphere effects, interference between satellite networks, and interference with terrestrial networks. C3.11

12 Research applications and trends in satellite communications, including personal, commercial, military and government, and global applications. C3.12

4 Research the components, interaction, and operations of wireless telecommunications systems. C4.0

1 Understand mobile wireless services and applications. C4.1

2 Demonstrate device management. C4.2

3 Describe access technologies, including wireline and wireless end-to-end switching and signaling. C4.3

4 Identify switching, routing, and security systems and technologies for wireless and Internet networking. C4.4

5 Understand radio frequency (RF), air interface, and radio access network (RAN). C4.5

6 Explain code division multiple access (CDMA), wireless technologies, services, and applications. C4.6

7 Research the different functions and uses of wireless and cable networks. C4.7

8. Describe mobile network components and basic operation, including cellular principles and AMPS (1G), 2G; digital radio voice communications and digital cellular; data communications and spectrum-sharing technologies; frequency division multiple access (FDMA), time division multiple access (TDMA), CDMA, orthogonal frequency division multiplexing (OFDM) and 3G cellular; CDMA and 4G mobile cellular; LTE, wireless local area networks (LANs) and WiFi. C4.8
9. Understand the function and basic operations of communications satellites. C4.9

5. Research the components, interaction, and operations of fixed-wire telecommunications systems. C5.0
    1. Demonstrate and apply safety procedures and practices for traffic control, pole climbing, roadside safety, electrical hazards, and data line safety checks. C5.1
    2. Demonstrate proficiency in making electrical connections, splices, and basic field repair. C5.2
    3. Understand the differences between function and uses of wireless and cable networks. C5.3
    4. Understand access technologies, including wireline and wireless end-to-end switching and signaling. C5.4
    5. Practice troubleshooting and repairing telecommunication system wiring. C5.5
    6. Demonstrate proficiency in basic AC and DC circuits. C5.6
    7. Inspect and demonstrate proficiency in the use of tools, equipment, and test equipment used in the voice and data communications industry. C5.7
    8. Install, repair, terminate, and test network cabling. C5.8
    9. Demonstrate cable repair techniques. C5.9
    10. Prepare work site plans to demonstrate proficiency in site requirements and considerations. C5.10
    11. Understand the theory of twisted pair design and shielding. C5.11
6. Consider privacy and security issues of the telecommunications systems. C6.0
    1. Understand switching, routing, and security systems and technologies for wireless and Internet networking C6.1
    2. Explain the need and strategies for network security and integrity. C6.2
    3. Demonstrate the appropriate applications of network and user data mining and behavior profiling. C6.3
    4. Explain industry code of conduct. C6.4
7. Demonstrate proficiency in customer relations. C7.0
    1. Demonstrate appropriate personal hygiene and professional attire. C7.1
    2. Apply techniques for instilling customer confidence and satisfaction. C7.2
    3. Apply techniques for keeping the customer informed. C7.3
    4. Describe and demonstrate effective follow-up techniques. C7.4

5 Demonstrate discretion in interacting with customers in field and retail environments. C7.5

6 Illustrate basic conflict-resolution practices. C7.6