

Course Outline

Health Science and Medical Technology

REVISED: August/2022

Job Title

X-Ray Technician

76-45-86

Career Pathway:

Patient Care

X-Ray Technology/2

Industry Sector:

Health Science and Medical
Technology

Credits: 35

Hours: 460

O*NET-SOC CODE:

29-2034.00

Course Description:

This competency-based course is the second in a sequence of three designed for x-ray technology. It provides students with project-based experiences according to the California State certification examination requirements in the limited category of chest. Didactic and clinical instruction includes parts two of anatomy and physiology, radiographic positioning, image critiques, principles of exposure and image quality, and clinical assistant procedures. Emphasis is also placed on radiologic physics, radiobiology, and radiation safety. Students are given more hours for clinical experience in health care facilities supervised by the instructor and staff personnel in order to perform as safe, competent, and professional X-Ray Technicians. The passing of the state examination allows graduates to work as X-Ray Technicians under a supervising licentiate. The competencies in this course are aligned with the California High School Academic Content Standards and the California Career Technical Education Model Curriculum Standards.

CBEDS Title:

Healthcare Occupations

Prerequisites:

Enrollment requires successful completion of the X-Ray Technology/1 (76-45-83) course.

NOTE: For Perkins purposes this course has been designated as a **concentrator** course.

This course **cannot** be repeated once a student receives a Certificate of Completion.

CBEDS No.:

4257



COURSE OUTLINE COMPETENCY-BASED COMPONENTS

A course outline reflects the essential intent and content of the course described. Acceptable course outlines have six components. (Education Code Section 52506). Course outlines for all apportionment classes, including those in jails, state hospitals, and convalescent hospitals, contain the six required elements:

(EC 52504; 5CCR 10508 [b]; Adult Education Handbook for California [1977], Section 100)

COURSE OUTLINE COMPONENTS

LOCATION

GOALS AND PURPOSES

Cover

The educational goals or purposes of every course are clearly stated and the class periods are devoted to instruction. The course should be broad enough in scope and should have sufficient educational worth to justify the expenditure of public funds.

The goals and purpose of a course are stated in the COURSE DESCRIPTION. Course descriptions state the major emphasis and content of a course, and are written to be understandable by a prospective student.

PERFORMANCE OBJECTIVES OR COMPETENCIES

pp. 7-19

Objectives should be delineated and described in terms of measurable results for the student and include the possible ways in which the objectives contribute to the student's acquisition of skills and competencies.

Performance Objectives are sequentially listed in the COMPETENCY-BASED COMPONENTS section of the course outline. Competency Areas are units of instruction based on related competencies. Competency Statements are competency area goals that together define the framework and purpose of a course. Competencies fall on a continuum between goals and performance objectives and denote the outcome of instruction.

Competency-based instruction tells a student before instruction what skills or knowledge they will demonstrate after instruction. Competency-based education provides instruction which enables each student to attain individual goals as measured against pre-stated standards.

Competency-based instruction provides immediate and continual repetition. In competency-based education the curriculum, instruction, and assessment share common characteristics based on clearly stated competencies. Curriculum, instruction and assessment in competency-based education are: explicit, known, agreed upon, integrated, performance oriented, and adaptive.

COURSE OUTLINE COMPETENCY-BASED COMPONENTS
(continued)

COURSE OUTLINE COMPONENTS	LOCATION
INSTRUCTIONAL STRATEGIES	p. 21
<p>Instructional techniques or methods could include laboratory techniques, lecture method, small-group discussion, grouping plans, and other strategies used in the classroom.</p> <p>Instructional strategies for this course are listed in the TEACHING STRATEGIES AND EVALUATION section of the course outline. Instructional strategies and activities for a course should be selected so that the overall teaching approach takes into account the instructional standards of a particular program, i.e., English as a Second Language, Programs for Adults with Disabilities.</p>	
UNITS OF STUDY, WITH APPROXIMATE HOURS ALLOTTED FOR EACH UNIT	Cover
<p>The approximate time devoted to each instructional unit within the course, as well as the total hours for the course, is indicated. The time in class is consistent with the needs of the student, and the length of the class should be that it ensures the student will learn at an optimum level.</p> <p>Units of study, with approximate hours allotted for each unit are listed in the COMPETENCY AREA STATEMENT(S) of the course outline. The total hours of the course, including work-based learning hours (community classroom and cooperative vocational education) is listed on the cover of every CBE course outline. Each Competency Area listed within a CBE outline is assigned hours of instruction per unit.</p>	
EVALUATION PROCEDURES	pp. 21
<p>The evaluation describes measurable evaluation criteria clearly within the reach of the student. The evaluation indicates anticipated improvement in performances as well as anticipated skills and competencies to be achieved.</p> <p>Evaluation procedures are detailed in the TEACHING STRATEGIES AND EVALUATION section of the course outline. Instructors monitor students' progress on a continuing basis, assessing students on attainment of objectives identified in the course outline through a variety of formal and informal tests (applied performance procedures, observations, and simulations), paper and pencil exams, and standardized tests.</p>	
REPETITION POLICY THAT PREVENTS PERPETUATION OF STUDENT ENROLLMENT	Cover
<p>After a student has completed all the objectives of the course, he or she should not be allowed to reenroll in the course. There is, therefore, a need for a statement about the conditions for possible repetition of a course to prevent perpetuation of students in a particular program for an indefinite period of time.</p>	

ACKNOWLEDGMENTS

Thanks to VERONICA AGUILAR, JENNIFER AYONN and LUZ GRANADOS for developing and editing this curriculum. Acknowledgment is also given to ERICA ROSARIO for designing the original artwork for the course covers.

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CALIFORNIA CAREER TECHNICAL EDUCATION MODEL CURRICULUM STANDARDS
Health Science and Medical Technology Industry Sector
Knowledge and Performance Anchor Standards

1.0 Academics

Analyze and apply appropriate academic standards required for successful industry sector pathway completion leading to postsecondary education and employment. Refer to the Health Science and Medical Technology academic alignment matrix for identification of standards.

2.0 Communications

Acquire and accurately use Health Science and Medical Technology sector terminology and protocols at the career and college readiness level for communicating effectively in oral, written, and multimedia formats.

3.0 Career Planning and Management

Integrate multiple sources of career information from diverse formats to make informed career decisions, solve problems, and manage personal career plans.

4.0 Technology

Use existing and emerging technology to investigate, research, and produce products and services, including new information, as required in the Health Science and Medical Technology sector workplace environment.

5.0 Problem Solving and Critical Thinking

Conduct short, as well as more sustained, research to create alternative solutions to answer a question or solve a problem unique to the Health Science and Medical Technology sector using critical and creative thinking, logical reasoning, analysis, inquiry, and problem-solving techniques.

6.0 Health and Safety

Demonstrate health and safety procedures, regulations, and personal health practices and determine the meaning of symbols, key terms, and domain-specific words and phrases as related to the Health Science and Medical Technology sector workplace environment.

7.0 Responsibility and Flexibility

Initiate, and participate in, a range of collaborations demonstrating behaviors that reflect personal and professional responsibility, flexibility, and respect in the Health Science and Medical Technology sector workplace environment and community settings.

8.0 Ethics and Legal Responsibilities

Practice professional, ethical, and legal behavior, responding thoughtfully to diverse perspectives and resolving contradictions when possible, consistent with applicable laws, regulations, and organizational norms.

9.0 Leadership and Teamwork

Work with peers to promote divergent and creative perspectives, effective leadership, group dynamics, team and individual decision making, benefits of workforce diversity, and conflict resolution as practiced in the Cal-HOSA career technical student organization.

10.0 Technical Knowledge and Skills

Apply essential technical knowledge and skills common to all pathways in the Health Science and Medical Technology sector, following procedures when carrying out experiments or performing technical tasks.

11.0 Demonstration and Application

Demonstrate and apply the knowledge and skills contained in the Health Science and Medical Technology anchor standards, pathway standards, and performance indicators in classroom, laboratory, and workplace settings and through the Cal-HOSA career technical student organization.

Health Science and Medical Technology Pathway Standards

B. Patient Care Pathway

The standards for the Patient Care pathway apply to occupations or functions involved in the prevention, treatment, and management of illness and the preservation of mental and physical well-being through the services offered by the medical and allied health professions. The standards specify the knowledge and skills needed by professional and technical personnel pursuing careers in this pathway.

Sample occupations associated with this pathway:

- ◆ Kinesiotherapist
- ◆ Nurse Anesthetist
- ◆ Respiratory Therapist
- ◆ Radiologic Technician
- ◆ Dental Hygienist

- B1.0 Recognize the integrated systems approach to health care delivery services: prevention, diagnosis, pathology, and treatment
- B2.0 Understand the basic structure and function of the human body and relate normal function to common disorders.
- B3.0 Know how to apply mathematical computations used in health care delivery system.
- B4.0 Recognize and practice components of an intake assessment relevant to patient care.
- B5.0 Know the definition, spelling, pronunciation, and use of appropriate terminology in the health care setting.
- B6.0 Communicate procedures and goals to patients using various communication strategies to respond to questions and concerns.
- B7.0 Apply observation techniques to detect changes in the health status of patients.
- B8.0 Demonstrate the principles of body mechanics as they apply to the positioning, transferring, and transporting of patients.
- B9.0 Implement wellness strategies for the prevention of injury and disease behaviors that prevent injury and illness
- B10.0 Comply with protocols and preventative health practices necessary to maintain a safe
- B11.0 Comply with hazardous waste disposal policies and procedures, including documentation, to ensure that regulated waste is handled, packaged, stored, and disposed of in accordance with federal, state, and local regulations.
- B12.0 Adhere to the roles and responsibilities, within the scope of practice, that contribute to the design and implementation of treatment planning
- B13.0 Research factors that define cultural differences between and among different ethnic, racial, and cultural groups and special populations.

CBE
Competency-Based Education

COMPETENCY-BASED COMPONENTS
for the X-Ray Technology/2 Course

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>A. ANATOMY AND PHYSIOLOGY II</p> <p>Understand, apply, and evaluate the organs of the body systems from a radiologic perspective and function.</p>	<ol style="list-style-type: none"> 1. Identify and describe the following: <ol style="list-style-type: none"> a. features of the cervical and thoracic spines that distinguish them from other aspects of the vertebral column b. location, classification, and type of movement for specific joints of the cervical and thoracic spine c. topographical landmarks that can be palpated to locate specific thoracic and cervical vertebra d. structures that best demonstrate each position of the cervical and thoracic spine e. structure and functions of the lumbar spine, sacrum, and coccyx f. anatomy that is seen with the “Scotty Dog” g. classification of the joints found in the lumbar spine h. topographical landmarks that can be palpated to locate specific aspects of the lumbar spine, sacrum, and coccyx i. diseases affecting the vertebral column j. classification of ribs: true, false, or floating k. structures that are best seen with specific projections of the ribs and sternum l. functions of the spinal cord 2. Define and demonstrate the following: <ol style="list-style-type: none"> a. labeling the layers, chambers, valves, and major blood vessels on a diagram of the heart b. flow of blood as it enters the heart and goes to the body cells, naming each chamber and valve in the heart c. pathologies associated with the chest 3. Define and describe the functions and structures within the respiratory system: <ol style="list-style-type: none"> a. bony thorax b. three sections of the pharynx c. trachea d. bronchi/bronchioles e. alveolar sacs f. hilum g. lungs h. mediastinum 4. Describe the following: <ol style="list-style-type: none"> a. exchange of oxygen and carbon dioxide in the alveoli b. path of an oxygen molecule entering the nasal/oral cavity through the respiratory system into a tissue cell c. function of the epiglottis and how it prevents food from entering the trachea 	<p>Career Ready Practice: 1, 2, 5</p> <p>CTE Anchor: Academics: 1.0 Communications: 2.4, 2.7, 2.8 Problem Solving and Critical Thinking: 5.4, 5.6</p> <p>CTE Pathway: B2.1, B2.2, B5.1, B5.2, B5.3, B5.4, B5.5, B5.6, B5.7</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(Theory: 30 hours)	<ul style="list-style-type: none"> d. processes of inspiration and expiration, including muscle action that occurs during each phase e. diseases of the respiratory system f. joint function of the circulatory and respiratory systems 	
<p>B. RADIOLOGIC PHYSICS</p> <p>Understand, apply and evaluate the basics of Radiologic Physics.</p>	<ul style="list-style-type: none"> 1. Identify and describe the following: <ul style="list-style-type: none"> a. differences between matter and energy b. basic structure of matter c. fundamental particles of the atom and the characteristics of each d. model of atomic structures e. chemical symbol f. periodic table of elements g. energy levels of the atom h. various forms of energy i. differences between x-rays with short wavelength and those with long wavelengths j. relationship between electromotive force, current, and resistance in an electric circuit k. units used to measure electromotive force, current, and resistance in an electric circuit l. differences between direct current and alternating current waveforms m. function of solid-state rectification n. process of electromagnetic induction 2. Demonstrate the following: <ul style="list-style-type: none"> a. parts and functions of x-ray equipment b. features of a typical x-ray room c. features of the x-ray machine's control panel d. purposes of the control booth and the transformer cabinet e. general components and function of the primary, secondary and filament circuits f. application of automatic exposure control (AEC) devices g. construction of the glass envelope and the protective tube housing 3. Demonstrate the safe changing of positions of the radiographic table and the x-ray tube. 4. Define the following: <ul style="list-style-type: none"> a. radiation types: <ul style="list-style-type: none"> i. primary radiation ii. scattered radiation iii. remnant radiation iv. leakage radiation v. useful radiation vi. non-useful radiation b. radiation field c. central ray d. thermionic emission e. dual focus tube 	<p>Career Ready Practice: 1, 2, 5, 6, 7, 10</p> <p>CTE Anchor: Academics: 1.0 Communications: 2.4 Problem Solving and Critical Thinking: 5.1, 5.2, 5.3, 5.4, 5.5, 5.6 Health and Safety: 6.3, 6.4, 6.6 Responsibility and Flexibility: 7.4 Technical Knowledge and Skills: 10.1 Demonstration and Application: 11.1</p> <p>CTE Pathway: B2.1, B2.2, B2.3, B3.1, B3.2, B5.2, B8.1, B8.2, B8.3, B8.4, B8.5, B9.1, B12.1</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(Theory: 30 hours)	<ol style="list-style-type: none"> 5. Describe the following: <ol style="list-style-type: none"> a. effects of scattered radiation b. purpose of the collimator c. parts and function of the collimator d. concept of half-value layer and its calculation e. differences between single phase, three phase, high frequency and falling load generators in terms of radiation production and efficiency f. classification and identify properties of x-rays g. requirements for the production of x-rays h. process of thermionic emission i. production of bremsstrahlung and characteristic radiation j. factors that determine the wavelengths of bremsstrahlung k. conversion of electron energy to x-ray energy in the x-ray tube l. x-ray emission spectra m. factors affecting the x-ray emission spectra n. clinical significance of the photoelectric, Compton and modified scattering interactions in diagnostic imaging o. features and function of the basic parts of the x-ray tube p. advantages of a dual focus tube q. effective focal spot and its significance r. rotating anode s. function of a rotating anode t. effect of changes in mA and kVp on the resulting x-ray beam u. production of the anode heel effect and how it can assist radiographers v. differences between an autotransformer, step-up transformer, a step-down transformer, location and equipment circuit system 6. Describe and demonstrate the following: <ol style="list-style-type: none"> a. draw and label an x-ray tube b. labeling the parts of a given unlabeled x-ray circuit diagram c. drawing a simple diagram of a step-up transformer and a step-down transformer 7. Define the following: <ol style="list-style-type: none"> a. unrectified wave b. half-wave rectification c. full-wave rectification 8. Describe and demonstrate: <ol style="list-style-type: none"> a. drawing the current waveform for each of the following: unrectified, half-wave rectification, full-wave rectification, three-phase rectified, and high frequency b. differentiating single phase, three phase, and high generators relative to x-ray production and efficiency c. identifying possible causes of tube failure and describe methods to prevent each d. applying the formula for measurement of heat units e. calculating safe exposures when provided with a tube rating chart and anode cooling chart 	

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>C. RADIOBIOLOGY AND RADIATION SAFETY</p> <p>Understand, apply, and evaluate the rules and regulations affecting radiation exposure and radiation protection.</p>	<ol style="list-style-type: none"> 1. Define the following: <ol style="list-style-type: none"> a. cellular biology b. ionizing biology c. radiation exposure and dose d. maximum permissible dose equivalent e. dose graph f. Compton scattering g. photoelectric effect h. pair production i. coherent scattering j. radiation intensity k. radiosensitivity 2. Identify and describe the following: <ol style="list-style-type: none"> a. general principles of cellular biology b. nature of ionizing radiation c. sources of radiation exposure d. sources of ionizing radiation: <ol style="list-style-type: none"> i. principal sources ii. natural sources iii. man-made sources e. units used to measure radiation in conventional and international system of units: <ol style="list-style-type: none"> i. radiation intensity ii. radiation dose iii. Dose equivalence f. devices used to detect and measure radiation g. events that occur when radiation passes through the human body h. differences between Compton scattering, photoelectric effect, pair production, and coherent scattering i. formula for determining the maximum permissible dose equivalent j. types of interactions between radiation and matter that produce scattered radiation k. factors influencing radiosensitivity l. differences between cells that are highly radiosensitive vs. those that have low radiosensitivity m. differences between direct and indirect effect of radiation 3. Define the following: <ol style="list-style-type: none"> a. radiolysis b. irradiation c. ionizing radiation d. radiation risks <ol style="list-style-type: none"> i. somatic radiation vs. genetic radiation ii. stochastic vs. nonstochastic iii. short term vs. long term e. lethal dose (LD) f. Law of Bergonie and Tribondeau 4. Describe the following: <ol style="list-style-type: none"> a. radiolysis of water b. irradiation of macromolecules 	<p>Career Ready Practice: 1, 2, 5, 6, 7, 8, 9, 10</p> <p>CTE Anchor: Academics: 1.0 Communications: 2.1, 2.2, 2.4, 2.5, 2.7, 2.8 Problem Solving and Critical Thinking: 5.1, 5.2, 5.3, 5.4, 5.5, 5.6 Health and Safety: 6.2, 6.3, 6.4, 6.5, 6.6 Responsibility and Flexibility: 7.2, 7.3, 7.4, 7.7 Ethics and Legal Responsibilities: 8.1, 8.2, 8.3, 8.4 Leadership and Teamwork: 9.6 Technical Knowledge and Skills: 10.1, 10.2, 10.3 Demonstration and Application: 11.1</p> <p>CTE Pathway: B1.2, B2.1, B2.2, B2.3, B3.1, B3.2, B5.2, B5.6, B6.1, B6.2, B6.3, B7.1, B7.4, B8.4, B8.5, B9.1, B9.3, B9.6, B12.1, B12.2, B12.3, B12.4</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
	<ul style="list-style-type: none"> c. characteristics of radiation dose-response relationships and draw diagrams demonstrating them d. effects of limited vs. total body exposure e. short-term effects of exposure to radiation f. long-term effects of ionizing radiation g. relationship between short-term/long-term effects and high/low radiation doses h. differences between somatic and genetic radiation effects i. specific diseases or syndromes associated with somatic and genetic radiation j. life-span shortening k. differences between genetic and biological damage due to irradiation l. radiation effects on an embryo-fetus m. radiation effects on children and adults n. time periods of greatest radiosensitivity o. concept of LD 50/60 p. LD 50/60 for humans q. relationship between x-ray interactions and technical factor selections r. effects of “scatter”, relative to patient and radiographer s. types of potential biological effects of ionizing radiation t. significance of radiation effects on the total body u. risk estimates for radiation-induced malignancies v. risks of exposure of low doses of ionizing radiation as compared to other health risks w. significance of the As Low As Reasonably Achievable (ALARA) concept x. relationship of beam-limiting devices to patient radiation protection y. how beam-limiting apparatus limit patient’s exposure to radiation z. purpose of x-ray filtration in radiography <p>5. Define the following:</p> <ul style="list-style-type: none"> a. dosimetry reports b. filtration: <ul style="list-style-type: none"> i. inherent ii. added iii. total filtration <p>6. Describe the following:</p> <ul style="list-style-type: none"> a. differences between added and inherent filtration in terms of the effect on patient dosage b. varieties of shields employed c. reasons for using gonad shielding during radiographic exams d. need for using correct exposure factors for all radiographic exams e. relationship of exposure factors to patient dosage f. rationale for decreasing the number of repeat radiographs g. differences between high dose techniques and low dose techniques h. possible risks of radiation exposure during pregnancy and ways to reduce them 	

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
	<ul style="list-style-type: none"> i. students own monthly dosimeter reports 7. Demonstrate the following: <ul style="list-style-type: none"> a. placement of the gonadal shield b. effect of high speed combinations on radiographic exposure to patients c. radiation-safety precautions for the radiographers, patients, & others 8. Review the definitions of the following radiation units of measurement: <ul style="list-style-type: none"> a. roentgen b. rad c. rem d. gray e. seivert 9. Define half value layer (HVL). 10. Identify and describe the following: <ul style="list-style-type: none"> a. relationship between HVL and shielding design b. inverse square law c. identification and appropriate use of garments that can be worn to reduce radiation exposure d. people and methods that can help with patient immobilization during an x-ray exposure e. objectives of a radiation protection program f. differences between controlled and non-controlled areas and their acceptable exposure levels g. "Radiation Area" signs and their appropriate placement sites h. procedures used to verify performance standards for equipment i. quality assurance relative to the radiographic equipment j. differences between quality improvement/ management, quality assurance and quality control k. benefits of a quality management program to the patient and to the department l. compliance with the legal and ethical radiation protection guidelines for radiation workers m. California Code of Regulations (CCR) -Title 17 as it applies to the public, radiation workers, and the environment n. current National Council on Radiation Protection and Measurements (NCRP) reports regarding radiation safety 11. Describe and demonstrate the following: <ul style="list-style-type: none"> a. radiation protection methods b. identifying the legal and ethical radiation protection responsibilities of the radiographer c. personnel monitoring methods for radiation workers d. identifying the dose limits for occupational and non-occupational exposure e. using dosimeters for monitoring personnel exposures to radiation f. interpreting dosimetry reports g. determining values for dose equivalent limits for occupational radiation exposures (annual and lifetime) 	

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>(Theory: 50 hours) (Laboratory: 20 hours)</p>	<ul style="list-style-type: none"> h. calculating the dose-limiting recommendations for radiology personnel i. determining dose equivalent limits for the embryo and fetus in occupationally exposed women j. understanding of structural shielding construction and items that influence this construction k. using primary and secondary radiation barriers l. operating various x-ray and ancillary equipment to ensure radiation safety m. manipulating time, distance, and shielding to decrease the radiation exposure n. calculating exposure with varying time, distance and shielding o. Radiologic Health Branch (RHB) required lab techniques to illustrate methods of reducing exposure to patients, personnel, and to the general public <p>12. Pass the safety test with 100% accuracy.</p>	
<p>D. RADIOGRAPHIC POSITIONING II</p> <p>Understand, apply, and evaluate the basic radiographic positioning for exams involving the chest.</p>	<ul style="list-style-type: none"> 1. Review the definitions of the following: <ul style="list-style-type: none"> a. radiologic positioning b. anatomic position c. body planes d. radiographic view 2. Review and describe the following: <ul style="list-style-type: none"> a. general principles of positioning b. patient care considerations relevant to positioning c. primary principles of radiation protection d. methods of reducing patient radiation exposure e. special considerations necessary when performing radiographic procedures on an infant, child and or geriatric patient f. symptoms and precautions taken for a patient with a spinal injury g. examples of topographical landmarks and their corresponding vertebrae h. characteristics of each of the four major body types 3. Describe and demonstrate patient preparation techniques required for every chest radiographic exam. 4. Describe and demonstrate the basic and special positioning used to visualize anatomic structures of the following: <ul style="list-style-type: none"> a. chest and upper airway b. vertebral column 5. List and identify the central ray location with angulation specifics, cassette size and orientation, and the extent of the field necessary for both the basic and special projections of the following: <ul style="list-style-type: none"> a. chest and upper airway b. vertebral column 6. Identify and describe the technical factors required to produce an acceptable radiograph for basic and special projections of the: <ul style="list-style-type: none"> a. chest and upper airway b. vertebral column 	<p>Career Ready Practice: 1, 2, 5, 6, 7, 8, 9, 10</p> <p>CTE Anchor: Academics: 1.0 Communications: 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8 Problem Solving and Critical Thinking: 5.1, 5.4, 5.6 Health and Safety: 6.4 Responsibility and Flexibility: 7.2, 7.3, 7.4, 7.7 Ethics and Legal Responsibilities: 8.2, 8.3, 8.4 Leadership and Teamwork: 9.6 Technical Knowledge and Skills: 10.1, 10.2 Demonstration and Application: 11.1</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(Theory: 10 hours)	<ol style="list-style-type: none"> 7. Identify and describe the patient instructions for basic and special projections of the: <ol style="list-style-type: none"> a. chest and upper airway b. vertebral column 8. Describe and demonstrate the following: <ol style="list-style-type: none"> a. positioning basic and special projections of the chest on a phantom and/or human models b. positioning the basic and special projections of the cervical and thoracic spine on phantom and/or human models c. positioning the basic and special projections of the lumbar spine, sacrum, and coccyx on phantom and/or human models d. identifying the differences in patient dose on alternative frontal (AP) vs. posteroanterior (PA) projections of the vertebral column on a human model e. positioning the basic and special projections of the ribs and sternum on phantom and/or human models f. evaluating positioning and technical factors on given radiographs g. making procedural modifications for atypical or impaired patients to better demonstrate the anatomic area of interest 	<p>CTE Pathway: B2.1, B2.3, B2.4, B3.1, B5.1, B5.7, B6.1, B6.2, B6.3, B6.4, B7.2, B7.3, B7.4, B8.2, B8.3, B8.4, B8.5, B9.6, B12.1, B12.2, B12.3, B12.4</p>
<p>E. IMAGE CRITIQUE II</p> <p>Review, apply, and evaluate the procedures used to produce quality radiographic products.</p>	<ol style="list-style-type: none"> 1. Review the following: <ol style="list-style-type: none"> a. radiographic detail a. image sharpness b. radiographic density c. contrast d. short-scale contrast image e. long-scale contrast image f. radiographic distortion g. collimation 2. Review and describe: <ol style="list-style-type: none"> a. role of the radiographer in image analysis b. elements of a diagnostic image c. conditions that must be present in a radiographic image that would indicate acceptable visibility of image details d. controlling factors for radiographic density and contrast e. image quality factors of a radiograph f. geometric factors that influence image sharpness g. ways of controlling involuntary and voluntary motion h. parameters for evaluating visibility of detail on the image i. controlling factors for radiographic distortions j. criteria for evaluating radiographic distortions 3. Review and demonstrate: <ol style="list-style-type: none"> a. determining that the adequate level of penetration has been applied to produce the desired level of contrast b. techniques for adequate density, contrast, recorded detail and acceptable limits of distortion of a radiographic image c. identifying short scale contrast and long scale contrast images d. evaluating image distortion 	<p>Career Ready Practice: 1, 2, 5, 6, 8, 10</p> <p>CTE Anchor: Academics: 1.0 Communications: 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8 Problem Solving and Critical Thinking: 5.1, 5.2, 5.3, 5.4, 5.5, 5.6 Health and Safety: 6.2 Ethics and Legal Responsibilities: 8.1, 8.2 Technical Knowledge and Skills: 10.1, 10.2 Demonstration and Application: 11.1</p> <p>CTE Pathway: B2.1, B2.2, B2.3, B2.4, B3.1, B3.2,</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(Theory: 10 hours)	<ol style="list-style-type: none"> 4. Review and describe the following: <ol style="list-style-type: none"> a. criteria for evaluating radiographs for positioning accuracy and overall image quality b. importance of collimation, anatomic side markers, and proper radiograph identification c. general criteria for repeating a radiograph d. elements of a diagnostic image as they relate to film critique e. differences between technical factor problems, procedural problems, and equipment malfunctions f. common equipment malfunctions that affect image quality g. impact of patient preparation on the resulting radiographic image h. modifications of procedures for atypical or impaired patients to better demonstrate the anatomic area of interest 5. Describe/ review and demonstrate the following: <ol style="list-style-type: none"> a. analyzing sample radiographs in the following categories: <ol style="list-style-type: none"> i. chest and upper airway ii. upper limb and shoulder girdle iii. lower limb and pelvic girdle iv. vertebral column b. recommending modifications for improvement c. discriminating acceptable radiographs from the unacceptable ones based on the following criteria: <ol style="list-style-type: none"> i. exposure factors ii. motion iii. collimation iv. positioning errors 	B5.1, B5.2, B5.3, B5.4, B5.5, B5.6, B5.7, B12.1, B12.2, B12.3, B12.4
<p>F. PRINCIPLES OF EXPOSURE AND IMAGE QUALITY II</p> <p>Understand, apply, and evaluate the techniques for radiographic calculations and exposure to produce quality radiographs.</p>	<ol style="list-style-type: none"> 1. Review the following: <ol style="list-style-type: none"> a. prime factors of exposure b. reciprocity law c. radiographic effect caused by changes in each of the four prime factors of exposure 2. Review and demonstrate the following: <ol style="list-style-type: none"> a. calculating mAs when given mA and exposure time b. calculating mA when given mAs and exposure time c. calculating exposure time when given mAs and mA d. application of the reciprocity law e. evaluating the relationships between mA, exposure time, mAs and quantity of x-rays produced f. assessing radiographic density on radiographic images g. recognizing changes in radiographic density and determining the exposure factors used to control radiographic density h. identifying high, low, and optimum contrast on a radiograph and determining the exposure factor that primarily controls radiographic contrast i. differentiating between short-scale contrast and long-scale contrast j. distinguishing between acceptable and unacceptable levels of density and contrast based on given radiographs 	<p>Career Ready Practice: 1, 2, 5, 7, 8, 10</p> <p>CTE Anchor: Academics: 1.0 Communications: 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8 Problem Solving and Critical Thinking: 5.1, 5.2, 5.3, 5.4, 5.5, 5.6 Responsibility and Flexibility: 7.2 Ethics and Legal Responsibilities: 8.1, 8.3</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
	<ol style="list-style-type: none"> 3. Review and demonstrate the following: <ol style="list-style-type: none"> a. application of the 15% rule b. calculation of the new kVp needed to maintain density when changes are made in mAs, using the 15% rule c. calculation of an optimum kVp d. application of the inverse square law e. calculation of mR when the SID is changed f. calculation of needed mAs to maintain density when changes are made in SID 4. Review the following: <ol style="list-style-type: none"> a. differences between magnification and shape distortion b. film and screen factors that influence radiographic definition c. geometric factors that affect radiographic definition d. effects of magnification on radiographic definition e. recorded image f. effect of pathology on radiation absorption g. pathologic conditions that result in increased/decrease attenuation of the x-ray beam 5. Review and demonstrate the following: <ol style="list-style-type: none"> a. methods for minimizing motion blur on radiographs b. assessing radiographs for optimum quality c. create and utilize an x-ray technique chart d. determining the value of an optimum kVp e. selecting an appropriate mA, time, and kVp for a given set of circumstances f. taking appropriate steps when technique charts fail to provide an appropriate exposure g. calculating exposure adjustments for changes in patient/part size h. estimating the technique change required when radiographs are too dark or too light i. suggesting appropriate technique changes for lengthening or shortening the scale of contrast j. calculating technique changes for variations in SID k. calculating technique changes required when using a grid or changing grid ratio l. calculating technique changes required for changes in the speed of the image receptor system m. developing a technique chart for personal use during internship n. performing State required experiments to illustrate effects of kVp, mA, SID, heel effect, and scattered radiation on image quality 6. Define the following: <ol style="list-style-type: none"> a. grid b. grid ratio c. grid frequency d. grid cutoff e. bucky f. stationary grid 	<p>Technical Knowledge and Skills: 10.1, 10.2 Demonstration and Application: 11.1</p> <p>CTE Pathway: B2.1, B2.2, B2.3, B2.4, B3.1, B3.2, B5.1, B5.2, B5.3, B5.4, B5.5, B5.6, B5.7, B7.1, B12.3</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>(Theory: 15 hours) (Laboratory: 5 hours)</p>	<ol style="list-style-type: none"> 7. Identify and describe the following: <ol style="list-style-type: none"> a. x-ray interaction with matter b. types of interactions between radiation and matter that produce scattered radiation c. techniques for analyzing the relationships between x-ray interactions and technical factor selections d. problems caused by scattered radiation in radiography e. factors that affect the amount of scattered radiation reaching a radiograph f. techniques for identifying scattered radiation on a radiograph g. measures that can be taken to reduce the quantity of scattered radiation h. purpose of the grid i. differences between a bucky and a stationary grid j. criteria for determining whether a grid is to be used k. common grid ratios and their appropriate applications 8. Define the following: <ol style="list-style-type: none"> a. construction of a grid and its frequency b. techniques for analyzing the relationships between grid selection, patient dose, radiographic density, and absorption of scatter c. calculation of changes in technical factors to compensate in grid selection 	
<p>G. CLINICAL ASSISTANT PROCEDURES II</p> <p>Review, apply, and evaluate the basic clinical procedures necessary to assist in the health care facility and to maintain patient safety.</p>	<ol style="list-style-type: none"> 1. Review the following: <ol style="list-style-type: none"> a. common vital signs and their role in assessing patient condition: <ol style="list-style-type: none"> i. temperature ii. pulse iii. respiration iv. blood pressure b. normal vital signs for adults and children c. taking and recording vital signs techniques d. responding to emergencies e. handling trauma patients 2. Describe and demonstrate the following techniques: <ol style="list-style-type: none"> a. assessing and assisting patients b. collecting patient information prior to examination c. completing a medical history form in an accurate and complete fashion d. administering screening tests for auditory and visual acuity e. administering emergency first aid for nosebleed, shock, and seizure f. managing medical emergencies g. handling and disposal of hazardous materials h. hand washing i. cleaning/sterilizing technique j. applying departmental procedures for infection control k. preventing and controlling infections l. protecting the patient, yourself, and others from contagious diseases 	<p>Career Ready Practice: 1, 2, 5, 6, 8, 9, 10</p> <p>CTE Anchor: Academics: 1.0 Communications: 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8 Problem Solving and Critical Thinking: 5.1, 5.2, 5.3, 5.4, 5.5, 5.6 Health and Safety: 6.1 Ethics and Legal Responsibilities: 8.4, 8.5 Leadership and Teamwork: 9.3 Demonstration and Application: 11.1</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(Theory: 10 hours)	<ul style="list-style-type: none"> m. protecting patient modesty and self-esteem n. applying proper body mechanics in moving and transferring patients o. reassuring and comforting, within the limits of your training, the anxious and fearful patient p. assisting the falling patient q. assisting the patient with a walker and/or cane r. transporting the patient in a wheelchair s. assisting the patient between radiographic table and wheelchair t. preparing the patient for the radiographic exam u. preventing injury to a patient during a radiographic examination v. Identify and respond to an emergency code 	<p>CTE Pathway B2.1, B2.2, B2.3, B2.4, B4.1, B4.2, B4.3, B4.4, B4.5, B5.1, B5.2, B5.3, B5.4, B5.5, B5.6, B5.7, B7.1, B10.1, B10.2, B10.3, B10.4, B10.5, B10.6, B10.7, B11.1, B11.2, B11.3, B11.4, B12.1, B13.1, B13.2</p>
<p>H. CLINICAL EXPERIENCE I</p> <p>Understand, apply, and evaluate clinical and radiographic procedures in a health care facility.</p>	<ul style="list-style-type: none"> 1. Review and demonstrate the following: <ul style="list-style-type: none"> a. knowledge of selected medical and radiological terminology; the effects of and regulations for radiation exposure b. understanding of the parts, appropriate use, and care of the radiographic machine; the principles involved in the function of the radiographic machine c. professional and ethical standards for safe practice as an X-Ray technician d. occupational safety standards, including usage of effective body mechanics and avoidance of physical hazards e. effective hand washing techniques f. effective patient transfer and ambulation techniques g. accurate interpretation of radiographic calculations and exposure conditions affecting the quality of radiographs h. steps necessary to develop radiographs i. knowledge of medical and radiologic terminology when documenting on a patient's chart j. evaluating the diagnostic and radiographic quality of radiographs, making modifications as needed k. combining basic clinical procedures skills and radiographic skills in a health care facility 2. Review and demonstrate effective care for a patient with a musculoskeletal system disorder including the following: <ul style="list-style-type: none"> a. traumatic disorder b. amputation c. scoliosis d. arthritic conditions e. osteoporosis f. in cast g. with orthopedic aids: <ul style="list-style-type: none"> i. crutch/cane ii. walker iii. sling/immobilizer iv. brace 3. Describe and demonstrate effective care for the patient with a cardiovascular disorder including the following: 	<p>Career Ready Practice: 1, 2, 5, 6, 9, 10</p> <p>CTE Anchor: Academics: 1.0 Communications: 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8 Problem Solving and Critical Thinking: 5.1, 5.2, 5.3, 5.4, 5.5, 5.6 Health and Safety: 6.4, 6.5, 6.6, 6.7, 6.8 Leadership and Teamwork: 9.2 Technical Knowledge and Skills: 10.1, 10.2</p> <p>CTE Pathway: B2.1, B2.2, B2.3, B2.4, B2.5, B2.6, B2.7, B2.8, B3.1, B4.3, B5.1, B5.2, B5.3, B5.4, B5.5, B5.6, B5.7, B6.1, B6.2, B6.3, B6.4, B6.5, B6.6, B6.7, B7.1, B8.1, B8.2, B8.3, B8.4, B8.5,</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(280 hours)	<ul style="list-style-type: none"> a. chronic obstructive pulmonary disease (COPD) b. infectious disease c. allergic reactions d. traumatic injuries <p>4. Describe and demonstrate the following radiographic standards for the chest category:</p> <ul style="list-style-type: none"> a. effective and accurate positioning of the patient b. effective and accurate central ray location c. familiarity with the examination, so that it is completed in a timely manner d. optimum radiographic diagnostic quality e. optimum radiation protection for the patient, clinical personnel, and self f. well-organized critique skills g. attentiveness to the factors that affect radiographic quality h. effective interpretation of radiographic calculations and exposure conditions affecting the quality of radiographs i. responding appropriately to patient emergencies, as well as clinical emergencies <p>5. Describe and demonstrate:</p> <ul style="list-style-type: none"> a. proper imaging procedures under the appropriate level of supervision b. perform and record 50 actual patient chest exams required by the State within the mandated time period of 12 consecutive months c. perform and record 200 actual patient torsoskeletal exams required by the State within the mandated time period of 12 consecutive months d. perform and record 100 actual patient extremity exams required by the State within the mandated time period of 12 consecutive months e. complete and record of 40 actual patient cranial exams (plus 60 phantoms) 	B12.1, B12.2, B12.3, B12.4

SUGGESTED INSTRUCTIONAL MATERIALS and OTHER RESOURCES

TEXTBOOKS

Kendrick, Leslie E. and Lampignano, John. Bontrager's Textbook of Radiographic Positioning and Related Anatomy, 10th Edition. Elsevier Health Science, 2021.

Kendrick, Leslie E. and Lampignano, John. Workbook for Bontrager's Textbook of Radiographic Positioning and Related Anatomy, 10th Edition. Elsevier Health Science, 2021.

Mason, Starla. Essentials of Radiologic Science Second Edition. Wolters Kluwer. 2018

Mason, Starla. Essentials of Radiologic Science Work Book Second Edition. Wolters Kluwer. 2018

Coakes, Dawn M. and Ehrlich, Ruth Ann. Patient Care in Radiography: With an Introduction to Medical Imaging 10th Edition. Elsevier Health Science, 2020.

ASRT Scanner. Monthly News Magazine of American Society of Radiologic Technologists.

RESOURCES

Employer Advisory Board members

California Career Technical Education Model Curriculum Standards

<https://www.cde.ca.gov/ci/ct/sf/documents/healthmedical.pdf>

American Registry of Radiologic Technologists (ARRT): <https://www.arrt.org/>

Joint Review Committee on Education in Radiologic Technology (JRCERT): <https://www.jrcert.org/>

Radiologic Health Branch: <https://www.cdph.ca.gov/Programs/CEH/DRSEM/Pages/RHB.aspx>

COMPETENCY CHECKLIST

TEACHING STRATEGIES and EVALUATION

METHODS AND PROCEDURES

- A. Teacher and student guided:
 - 1. Lecture
 - 2. Discussion
 - 3. Role play
 - 4. Problem-solving
 - 5. Demonstration/practice/return demonstration
 - 6. Home assignment, patient case studies
- B. Field trips
- C. Multi-sensory presentations
 - 1. Films, videos
 - 2. PowerPoint presentations
 - 3. Mock-ups
 - 4. Audio-visuals, CD-ROMs
 - 5. Radiographs
- D. Clinical activities

EVALUATION

SECTION A – Anatomy and Physiology II – Pass all assignments and exams with a minimum score of 75% or higher.

SECTION B – Radiologic Physics – Pass all assignments and exams with a minimum score of 75% or higher.

SECTION C – Radiobiology and Radiation Safety – Pass the safety test with 100% accuracy.

SECTION D – Radiographic Positioning II – Pass all assignments and exams with a minimum score of 75% or higher.

SECTION E – Image Critique II – Pass all assignments and exams with a minimum score of 75% or higher.

SECTION F – Principles of Exposure and Image Quality II – Pass all assignments and exams with a minimum score of 75% or higher.

SECTION G – Clinical Assistant Procedures II – Pass all assignments and exams with a minimum score of 75% or higher.

SECTION H – Clinical Experience I – Pass all assignments and exams with a minimum score of 75% or higher

Standards for Career Ready Practice

1. Apply appropriate technical skills and academic knowledge.

Career-ready individuals readily access and use the knowledge and skills acquired through experience and education. They make connections between abstract concepts with real-world applications and recognize the value of academic preparation for solving problems, communicating with others, calculating measures, and performing other work-related practices.

2. Communicate clearly, effectively, and with reason.

Career-ready individuals communicate thoughts, ideas, and action plans with clarity, using written, verbal, electronic, and/or visual methods. They are skilled at interacting with others: they are active listeners who speak clearly and with purpose, and they are comfortable with terminology that is common to workplace environments. Career-ready individuals consider the audience for their communication and prepare accordingly to ensure the desired outcome.

3. Develop an education and career plan aligned with personal goals.

Career-ready individuals take personal ownership of their educational and career goals and manage their individual plan to attain these goals. They recognize the value of each step in the educational and experiential process, and they understand that nearly all career paths require ongoing education and experience to adapt to practices, procedures, and expectations of an ever-changing work environment. They seek counselors, mentors, and other experts to assist in the planning and execution of education and career plans.

4. Apply technology to enhance productivity.

Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring and using new technology. They understand the inherent risks—personal and organizational—of technology applications, and they take actions to prevent or mitigate these risks.

5. Utilize critical thinking to make sense of problems and persevere in solving them

Career-ready individuals recognize problems in the workplace, understand the nature of the problems, and devise effective plans to solve the problems. They thoughtfully investigate the root cause of a problem prior to introducing solutions. They carefully consider options to solve a problem and, once agreed upon, follow through to ensure the problem is resolved.

6. Practice personal health and understand financial literacy.

Career-ready individuals understand the relationship between personal health and workplace performance. They contribute to their personal well-being through a healthy diet, regular exercise, and mental health activities. Career-ready individuals also understand that financial literacy leads to a secure future that enables career success.

7. Act as a responsible citizen in the workplace and the community.

Career-ready individuals understand the obligations and responsibilities of being a member of a community and demonstrate this understanding every day through their interactions with others. They are aware of the impacts of their decisions on others and the environment around them, and they think about the short-term and long-term consequences of their actions. They are reliable and consistent in going beyond minimum expectations and in participating in activities that serve the greater good.

8. Model integrity, ethical leadership, and effective management.

Career-ready individuals consistently act in ways that align with personal and community-held ideals and principles. They employ ethical behaviors and actions that positively influence others. They have a clear understanding of integrity and act on this understanding in every decision. They use a variety of means to positively impact the direction and actions of a team or organization, and they recognize the short-term and long-term effects that management's actions and attitudes can have on productivity, morale, and organizational culture.

9. Work productively in teams while integrating cultural and global competence.

Career-ready individuals contribute positively to every team, as both team leaders and team members. To avoid barriers to productive and positive interaction, they apply an awareness of cultural differences. They interact effectively and sensitively with all members of the team and find ways to increase the engagement and contribution of other members.

10. Demonstrate creativity and innovation.

Career-ready individuals recommend ideas that solve problems in new and different ways and contribute to the improvement of the organization. They consider unconventional ideas and suggestions by others as solutions to issues, tasks, or problems. They discern which ideas and suggestions may have the greatest value. They seek new methods, practices, and ideas from a variety of sources and apply those ideas to their own workplace practices.

11. Employ valid and reliable research strategies.

Career-ready individuals employ research practices to plan and carry out investigations, create solutions, and keep abreast of the most current findings related to workplace environments and practices. They use a reliable research process to search for new information and confirm the validity of sources when considering the use and adoption of external information or practices.

12. Understand the environmental, societal, and economic impacts of decisions.

Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact other people, organizations, the workplace, and the environment. They are aware of and utilize new technologies, understandings, procedures, and materials and adhere to regulations affecting the nature of their work. They are cognizant of impacts on the social condition, environment, workplace, and profitability of the organization.

Statement for Civil Rights

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