Florida Department of Education
Curriculum Framework

Program Title: **Chemical Technology**
Career Cluster: **Manufacturing**

AS	
CIP Number	1641030100
Program Type	College Credit
Standard Length	64 credit hours
CTSO	SkillsUSA
SOC Codes (all applicable)	19-4031 – Chemical Technicians
CTE Program Resources	http://www.fldoe.org/academics/career-adult-edu/career-tech-edu/program-resources.stml

Purpose

This program offers a sequence of courses that provides coherent and rigorous content aligned with challenging academic standards and relevant technical knowledge and skills needed to prepare for further education and careers in the manufacturing career cluster; provides technical skill proficiency, and includes competency-based applied learning that contributes to the academic knowledge, higher-order reasoning and problem-solving skills, work attitudes, general employability skills, technical skills, and occupation-specific skills, and knowledge of all aspects of the manufacturing career cluster.

The content includes but is not limited to communication skills, leadership skills, human relations and employability skills, safe and efficient work practices, and a combination of theory and laboratory activities to gain the necessary cognitive and manipulative skills to perform preventive and corrective maintenance, engineering support, and maintain product quality.

Additional Information relevant to this Career and Technical Education (CTE) program is provided at the end of this document.

Program Structure

This program is a planned sequence of instruction consisting of sixty-four credit hours.

Standards

After successfully completing this program, the student will be able to perform the following:

01.0 Demonstrate appropriate written and oral communication skills.
02.0 Demonstrate appropriate mathematical skills to solve basic problems in the sciences.
03.0 Demonstrate appropriate interpersonal skills, decision-making strategies, and awareness of self-worth, ethics and values.
04.0 Demonstrate computer competence.
05.0 Demonstrate basic knowledge of scientific concepts.
06.0 Demonstrate basic knowledge of chemical concepts.
07.0 Demonstrate knowledge of chemical kinetics and thermodynamics.
08.0 Demonstrate skills in the safe handling of chemical materials and equipment.
09.0 Exercise safety in the laboratory and adhere to safety, health and environmental regulations.
10.0 Demonstrate conceptual and laboratory knowledge in the area of organic chemistry and/or physics and/or biology and/or engineering and/or biotechnology and/or chemical instrumentation.

Florida Department of Education
Student Performance Standards

Program Title: **Chemical Technology**
CIP Numbers: **1641030100**
Program Length: **64 credit hours**
SOC Code(s): **19-4031**

Refer to Rule 6A-14.030 (4), F.A.C., for the minimum amount of general education coursework required in the Associate of Science (AS) degree. At the completion of this program, the student will be able to:	
01.0	Demonstrate appropriate communication skills.--The student will be able to:
01.01	Write logical, readable, and understandable sentences and paragraphs.
01.02	Carefully read, accurately follow, and demonstrate an understanding of written instructions, standard operating procedures, and accepted manufacturing practices.
01.03	Read and evaluate ideas recognizing assumptions and implications.
01.04	Carefully follow and deliver oral instructions and other spoken information related to the workplace.
01.05	Prepare, outline, and deliver a short oral presentation.
01.06	Participate in group discussion as a member and as a leader.
01.07	Prepare visual material to support an oral presentation.
01.08	Answer and ask questions coherently and concisely.
01.09	Give clear, concise instructions.
01.10	Read technical manuals, reports and journals.
01.11	Read and prepare diagrams and charts.
01.12	Maintain legibly written logs and notes.
01.13	Keep detailed and accurate records.
01.14	Maintain an accurate and legible notebook.
01.15	Accurately report data.
01.16	Write detailed standard operating procedures.
01.17	Professionally compose memos, letters, and reports.
02.0	Demonstrate appropriate mathematical skills to solve basic problems in the sciences.--The student will be able to:
02.01	Calculate ratios.
02.02	Perform unit conversions.

	02.03 Perform calculations using exponents and exponential functions
	02.04 Perform calculations using logarithms and logarithmic functions.
	02.05 Use appropriate significant figures.
	02.06 Recognize patterns in data.
	02.07 Solve single-unknown algebraic equations.
	02.08 Accurately interpret and construct graphs.
	02.09 Plot data, calculate slopes and intercepts of linear graphs.
	02.10 Perform calculations using roots. (square, cube, etc.)
	02.11 Solve simultaneous equations.
	02.12 Solve quadratic equations.
	02.13 Solve word problems using arithmetic and algebra.
03.0	Demonstrate appropriate interpersonal skills, decision-making strategies, and awareness of self-worth, ethics and values.--The student will be able to:
	03.01 Discuss the importance of teamwork and have experience working as a member of a team for planning, performing, analyzing, and reporting.
	03.02 Demonstrate critical thinking skills.
	03.03 Demonstrate high ethical standards in all aspects of work.
	03.04 Apply quality principles to all aspects of work.
	03.05 Recognize sources and symptoms of stress and learn how to manage one's response to it.
	03.06 Determine the importance of initiative and responsibility and examine the possible repercussions of action vs. non-action.
	03.07 Demonstrate the ability to problem solve effectively and resolve typical workplace conflicts.
	03.08 Apply decision-making strategies to workplace situations.
	03.09 Explain the basis for employer expectations: the written and unwritten "rules for success".
	03.10 Recognize the "culture" of an organization or employer and evaluate its impact on the individual.
	03.11 Develop an awareness of diversity and multi-culturalism.
04.0	Demonstrate computer competence.--The student will be able to:
	04.01 Demonstrate use of computer hardware and peripherals.
	04.02 Demonstrate appropriate use of computer software applications and tools.
05.0	Demonstrate basic knowledge of scientific concepts.--The student will be able to:
	05.01 Discuss the scientific method.

	05.02	Understand the need to organize and classify natural phenomena.
	05.03	Discuss relationships between characteristics of natural phenomena.
	05.04	Dissect a natural system into its component parts
	05.05	Model natural phenomena.
	05.06	Understand that nature behaves in predictable ways.
	05.07	Discuss methods of observing natural changes, from extremely slow changes to extremely fast changes.
	05.08	Discuss the variation of naturally occurring phenomena
	05.09	Discuss the diversity found within classes of natural organisms
06.0	Demonstrate basic knowledge of chemical concepts.--The student will be able to:	
	06.01	Write chemical formulas and use correct chemical nomenclature for inorganic compounds.
	06.02	Classify inorganic compounds according to a variety of chemical and physical properties.
	06.03	Name and write the symbols for the elements and describe characteristics of the common groupings of elements.
	06.04	Describe the basic reactions that occur between commonly used chemical substances.
	06.05	Read, write, balance and interpret chemical equations.
	06.06	Solve a variety of basic chemical problems using equations and/or dimensional analysis.
	06.07	Classify chemicals according to reactivity.
	06.08	Demonstrate knowledge of chemical composition and stoichiometry.
	06.09	Demonstrate an understanding of empirical gas laws and theory relating to the behavior of gases.
	06.10	Demonstrate a basic understanding of energy as it relates to chemical and other processes.
	06.11	Demonstrate a basic understanding of the laws and theories relating to the structure of the atom and how this relates to the Periodic Table.
	06.12	Demonstrate a basic understanding of molecular structure and chemical bonding,
	06.13	Describe the structure and properties of liquids and solids.
	06.14	Describe solutions and their properties, and perform calculations involving solution concentrations, composition and colligative properties.
07.0	Demonstrate knowledge of chemical kinetics and thermodynamics.--The student will be able to:	
	07.01	Demonstrate a basic understanding of chemical kinetics
	07.02	Demonstrate a basic understanding of chemical equilibria.
	07.03	Demonstrate a working knowledge of acid/base equilibria.
	07.04	Demonstrate a working knowledge of precipitation equilibria,

	07.05	Demonstrate a working knowledge of redox chemistry.
	07.06	Use the concepts of heat, work, energy, enthalpy, entropy and Gibbs Free Energy to discuss how energetics and change are interrelated in chemical processes and solve related problems.
	07.07	Demonstrate a basic knowledge of radioactivity.
08.0	Demonstrate skills in the safe handling of chemical materials and equipment.--The student will be able to:	
	08.01	Properly identify and use a variety of common chemistry laboratory glassware.
	08.02	Use common chemistry laboratory equipment to include such items as hot plates, stirrers, laboratory balances and centrifuges.
	08.03	Preparing solutions of specific concentration from pure substances
	08.04	Performing dilutions to prepare solution of specific concentration
	08.05	Purify chemicals using techniques such as filtering, extracting, crystallization, precipitation, distilling, etc.
	08.06	Use basic analytical chemistry procedures and concepts of measurements in volumetric, gravimetric, and electrochemical analyses and correctly perform associated calculations.
	08.07	Prepare samples for analysis, including digesting, ashing, dissolving, grinding, purifying, diluting, and chemically altering as appropriate before analysis.
	08.08	Determine pH using pH paper, indicators, and instrumental methods.
	08.09	Calculate molarity, molality, mole fraction, weight percent, and normality of solutions, given the appropriate information.
	08.10	Conduct analytical tests using acid-base, oxidation-reduction, and complexometric titrations.
	08.11	Perform gravimetric, volumetric, and electrochemical analyses and achieve results within acceptable limits of precision and accuracy.
	08.12	Apply statistical methods for analyzing experimental data.
	08.13	Calibrate instruments per manufacture’s specifications and record in related log book.
09.0	Exercise safety in the laboratory and adhere to safety, health and environmental regulations.--The student will be able to:	
	09.01	Be aware of and follow federal, state, and local legislation pertaining to safety, health, and environmental regulations.
	09.02	Recognize that each company has policies and safety plans that include evacuation procedures, emergency numbers, rules, and practices.
	09.03	Explain the Federal Law as recorded in (29 CFR-1910.1200) and how it applies to chemical laboratory technicians.
	09.04	Recognize, apply, and respond appropriately to the hazard symbols and toxicology sections of Safety Data Sheets (SDS).
	09.05	Choose the proper safety equipment for conducting a variety of laboratory tasks (e.g., proper hoods, shields).
	09.06	Choose and demonstrate the use of personal protective equipment to be used in a variety of situations (e.g., eye wear, special clothing).
	09.07	Demonstrate safe handling procedures (e.g., handling cylinders, glassware, and laboratory instruments).
	09.08	Describe the various categories of hazardous materials.

09.09	Discuss federal, state, and local regulations for the proper storage and disposal of chemicals.
09.10	Make informed and appropriate decisions on how and where to store chemical materials to minimize hazards.
09.11	Given a safety data sheet, explain each section of the sheet.
09.12	Define and give an example of the major physical and health hazards which are likely to be encountered in the industrial laboratory.
09.13	List the information needed on each hazardous material when conducting an inventory.
09.14	Demonstrate the human health effects associated with exposure to hazardous materials.
09.15	Follow federal, state, and local regulations for the proper storage and disposal of sharps and biological materials.
10.0	Demonstrate conceptual and laboratory knowledge in the area of organic chemistry and/or analytical chemistry and/or physics and/or biology and/or engineering and/or biotechnology and/or chemical instrumentation.--Students will be competent in two or more of the following areas of specialization:
Specialty I: Organic Chemistry--The student will be able to:	
10.01	Draw Lewis structures, deduce atomic orbital hybridizations and describe molecular shapes for organic structures.
10.02	Classify organic reactions in common groups, write chemical equations and describe unique features for each type.
10.03	Describe, name, and give common reactions of alkanes, alkenes, and alkynes.
10.04	Describe, name, and give common reactions of alcohols, ethers, and halides.
10.05	Describe, name, and give common reactions of aldehydes and ketones.
10.06	Describe, name, and give common reactions of carboxylic acids and esters.
10.07	Describe, name, and give common reactions of amines and amides.
10.08	Describe and name simple carbohydrates, simple lipids, and amino acids.
10.09	Describe the basic concepts of proteins and their structure.
10.10	Describe the basic concepts of polymerization reactions.
10.11	Apply concepts of chemical reactivity, kinetics, stoichiometry, and equilibrium to chemical syntheses and analyses.
10.12	Crystallize, evaporate, sublime, extract, and use phase separations and/or other purification and separation techniques.
10.13	Perform organic chemical reactions using glassware and techniques typically employed in organic chemistry laboratories (e.g. ‘quick fit glassware, anhydrous conditions etc.)
10.14	Determine reaction yields using chemical stoichiometry.
10.15	Use chemical and instrumental techniques to determine the structure of organic materials.
Specialty II: Physics--The student will be able to:	
10.16	Solve physical problems dealing with mass, distance, area, volume, relative position, motion, velocity, kinetic and potential energy, momentum, force, acceleration, heat, sound and related concepts.

10.17	Use analytical reasoning in solving problems dealing with a variety of physical quantities and phenomena.
10.18	Use basic concepts and terminology from physics and related applications as found in the industrial workplace.
10.19	Use basic laboratory instruments for determining length, mass, time, temperature and other easily measurable physical quantities.
10.20	Collect and manipulate numerical data in controlled experiments involving physical parameters to discover the mathematical functions by which the variables are related.
10.21	Analyze physical behavior and know how to properly apply principles of physics related to basic mechanics and sound.
10.22	Characterize physical properties of gases, liquids, and solids and describe their reactions to changes of temperature and pressure.
10.23	Choose the appropriate equipment for measuring physical properties based on specified accuracy and precision requirements.
10.24	Solve physical problems dealing with basic concepts in electricity, magnetism, light, optics and thermodynamics.
10.25	Analyze physical behavior and know how to properly apply principles of physics related to basic electricity, magnetism, light, optics and thermodynamics.
Specialty III: Biology--The student will be able to:	
10.26	Name the components of the cell and relate each to basic concepts of life.
10.27	Identify the structural characteristics, components, and functions of cells.
10.28	Given a list of cellular activities or characteristics, relate them to the correct cell structure.
10.29	Explain the consequences of energy in terms of its availability to living organisms, and how it is transferred through food chains.
10.30	Know why energy is limited in amount. Know and be able to explain the consequences of energy in terms of its availability to living organisms, both now and in the future. Know how it is used and transferred through food chains.
10.31	Explain how sunlight is trapped as an energy source and how this trapped energy is used to synthesize simple organic molecules. Describe the basic role or activity of chloroplasts and chlorophyll, cyclic and non-cyclic photophosphorylation, carbon dioxide reduction and fixation.
10.32	Describe the sequential events of mitosis.
10.33	Describe the sequential events of meiosis.
10.34	Solve and interpret various genetics problems involving Mendelian principles.
10.35	List and describe ways and give examples of how man has altered his environment, both positively and negatively, and be able to detail some of the consequences of this action.
10.36	Give the basic characteristics of the carbon, nitrogen, and hydrological cycles.
10.37	Describe the effects of the increasing human population upon natural resources use and depletion, degradation of the environment, social and economic problems both within nations and between nations, etc.
10.38	State the basic morphologic types of Eubacteria.
10.39	Diagram and describe the structural components of bacterial cells using a microscope.
10.40	Describe bacterial cell lifecycle and apoptosis.
10.41	Distinguish gram positive cells and gram negative cells from a description of cell wall chemical components.

10.42	Successfully demonstrate the correct staining procedure for general staining, Gram staining, acid-fast staining, spore staining, capsular staining and flagellar staining.
10.43	Describe the characteristics that identify by form fungi, bacterium, and viruses and show how they are distinguished from other organisms.
10.44	List the factors that affect colonial growth.
Specialty IV: Engineering--The student will be able to:	
10.45	Utilize vectors to solve engineering problems.
10.46	Utilize calculus to solve engineering problems
10.47	Analyze particles and rigid bodies in equilibrium.
10.48	Analyze situations where a force causes a rigid body to rotate.
10.49	Characterize the static and rotational properties of irregular shaped rigid bodies.
10.50	Analyze the distribution of forces and moments within a structural member.
10.51	Analyze the equilibrium of rigid bodies subjected to dry friction.
10.52	Analyze the motion of particles.
10.53	Analyze the kinetics of particles using Newton's Second Law, the methods of work and energy and the methods of impulse and momentum.
10.54	Analyze the kinetics of a system of particles.
10.55	Analyze the motion of rigid bodies.
10.56	Analyze the effect of forces on rigid bodies in two dimensions.
10.57	Analyze the kinetics of rigid bodies using the methods of work, energy, impulse, and momentum in two dimensions.
10.58	Produce accurate diagrams of two and three dimensional objects using a design and drafting software package.
10.59	Solve mathematical problems using software packages such as: Excel, MathCAD and MATLAB.
10.60	Acquire the team building skills typically found in the engineering profession.
Specialty V: Biotechnology--The student will be able to:	
10.61	Demonstrate an understanding of the operating principles, safety features, and use of various equipment found in a biotechnology laboratory.
10.62	Demonstrate an understanding the importance of a sterile working environment and proper aseptic techniques for culturing bacterial.
10.63	Demonstrate an understanding of the operating expression, regulation, and safety features and use of common purification techniques.
10.64	Demonstrate an understanding of the methodologies required for nucleic acid technology.
10.65	Demonstrate an understanding of the science and scientific basis of biotechnology including traditional methodologies, fermentation and industrial microbiology.

10.66	Demonstrate a basic understanding of the concept of bioethics, safety concerns of bioengineered products and the licensing and patenting process for biotechnology products.
10.67	Implement proper aseptic techniques and disposal procedures for potentially biohazardous materials.
Specialty VI: Chemical Instrumentation--The student will be able to:	
10.68	Describe the basic scientific principles behind a variety of instrumental methods used in a modern chemical laboratory.
10.69	Describe the major components of each instrumental method studied and the role that each component plays in making the chemical measurement.
10.70	Choose an instrument appropriate for a given analysis and ~~know~~ identify the limitations of the instrument.
10.71	Properly prepare samples and properly calibrate each instrument.
10.72	Apply proper safety precautions for laboratory instruments and equipment.
10.73	Adjust instrument settings to handle varied chemical samples under a variety of conditions.
10.74	Describe the basic concepts of chemical/physical separation techniques and apply separation techniques to the analysis of materials.
10.75	Choose appropriate sample preparation techniques for physical characterization measurements and/or analysis of structure, concentration, and composition.
10.76	Apply basic knowledge of organic and inorganic chemistry, including nomenclature, classification in chemical groups, chemical and physical characteristics and chemical reactivity to instrumental analysis.

Additional Information

Laboratory Activities

Laboratory investigations that include scientific inquiry, research, measurement, problem solving, emerging technologies, tools and equipment, as well as, experimental, quality, and safety procedures are an integral part of this career and technical program/course. Laboratory investigations benefit all students by developing an understanding of the complexity and ambiguity of empirical work, as well as the skills required to manage, operate, calibrate and troubleshoot equipment/tools used to make observations. Students understand measurement error; and have the skills to aggregate, interpret, and present the resulting data. Equipment and supplies should be provided to enhance hands-on experiences for students.

It is highly recommended that students complete the laboratory portion of this program in person.

Career and Technical Student Organization (CTSO)

SkillsUSA is the intercurricular career and technical student organization for providing leadership training and reinforcing specific career and technical skills. Career and Technical Student Organizations provide activities for students as an integral part of the instruction offered.

Accommodations

Federal and state legislation requires the provision of accommodations for students with disabilities to meet individual needs and ensure equal access. Postsecondary students with disabilities must self-identify, present documentation, request accommodations if needed, and develop a plan with their counselor and/or instructors. Accommodations received in postsecondary education may differ from those received in secondary education. Accommodations change the way the student is instructed. Students with disabilities may need accommodations in such areas as instructional methods and materials, assignments and assessments, time demands and schedules, learning environment, assistive technology and special communication systems. Documentation of the accommodations requested and provided should be maintained in a confidential file.

Certificate Programs

A College Credit Certificate consists of a program of instruction of less than sixty (60) credits of college-level courses, which is part of an AS or AAS degree program and prepares students for entry into employment (Rule 6A-14.030, F.A.C.). This AS degree program includes the following College Credit Certificates:

Chemical Laboratory Specialist (0641030101) – 37 credit hours
Scientific Workplace Preparation (0641030102) – 26 credit hours

Standards for the above certificate programs are contained in separate curriculum frameworks.

Program Length

The AS degree requires the inclusion of a minimum of 15 credits of general education coursework according to SACS, and it must be transferable according to Rule 6A-14.030 (2), F.A.C. The standard length of this program is sixty-four credit hours according to Rule 6A-14.030, F.A.C.

Additional Resources

For additional information regarding Articulation Agreements; Bright Futures Scholarships; Fine Arts/Practical Arts Credit; and Equivalent Mathematics and Equally Rigorous Science Courses please refer to:

http://www.fldoe.org/academics/career-adult-edu/career-tech-edu/program-resources.stml