

## **Computer Science I – Designing Technology Solutions (125 hours)**

### **Unit 1: Introduction to the Design Process**

#### **Indicator Statement:**

Develop an understanding of the attributes of design. (ITEA, STL 8)

#### **Objectives: The student will be able to:**

- Explain that the design process is a systematic, iterative, approach to problem solving that yields design solutions.
- Explain that the design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating a design, using specifications, refining a design, creating or making it, and communicating processes and results. (ITEA, STL 8-H)
- Explain that design problems are seldom presented in a clearly defined form. (ITEA, STL 8-I)
- Analyze the phases of the design process.
- Explain why designs need to be continually checked and critiqued, and the ideas of the design must be redefined and improved. (ITEA, STL 8-J)
- Explain that requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other. (ITEA, STL 8-K)

#### **Indicator Statement:**

Develop an understanding of engineering design. (ITEA, STL 9)

#### **Objectives: The student will be able to:**

- Describe the personal characteristics involved in engineering. At least – creativity, resourcefulness, and the ability to visualize and think abstractly.
- Explain that established design principles are used to evaluate existing designs, to collect data, and to guide the design process. (ITEA, STL 9-I)
- Explain that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. (ITEA, STL 9-J)
- Explain that the process of engineering design takes into account a number of factors. (ITEA, STL 8-L)

#### **Indicator Statement:**

Develop an understanding of troubleshooting, research and development, invention and innovation, and experimentation in problem solving. (ITEA, STL 10)

#### **Objectives: The student will be able to:**

- Explain that research and development is a specific problem-solving approach that is used extensively in business and industry to prepare devices and systems for the marketplace. (ITEA, STL 10-I)

## **Unit 2: Introduction to Sketching and Technical Communication**

### **Indicator Statement:**

Develop and understanding of information and communication technologies. (ITEA, STL 17)

### **Objectives: The student will be able to:**

- Explain that information and communication systems include inputs, processes, and outputs associated with sending and receiving information. (ITEA, STL 17-L)
- Explain that information and communication systems allow information to be transferred from human to human, human to machine, machine to human, and machine to machine. (ITEA, STL 17-M)
- Explain that there are many ways to communicate information, such as graphic and electronic means. (ITEA, STL 17-P)
- Explain that information and communication systems can be used to inform, persuade, entertain, control, manage, and educate. (ITEA, STL 17-N)
- Explain that technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli. (ITEA, STL 17-Q)

## **Unit 3: Relationships Among Technologies**

### **Indicator Statement:**

Develop an understanding of the relationships among technologies and the connections between technology and other fields of study. (ITEA, STL 3)

### **Objectives: The student will be able to:**

- Explain that technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function. (ITEA, STL 3-G)
- Explain that technological innovation often results when ideas, knowledge, or skills are shared within a technology, among technologies, or across fields. (ITEA, STL 3\_H)
- Explain that the process of patenting sometimes protects technological ideas. (ITEA, STL 3-I)
- Explain that technological progress promotes the advancement of science and mathematics. (ITEA, STL 3-J)
- Explain the strong relationship between technology and the study of science including the common interest in natural scientific laws, systems, design, and modeling.
- Express that mathematical concepts such as the use of measurement, symbols, estimation, accuracy, and the idea of scaling and proportion are key to the development of technology.
- Explain how the development of computer databases has revolutionized research in the social sciences.

## **Unit 4: History of Technology**

### **Indicator Statement:**

Develop an understanding of the influence of technology on history. (ITEA, STL 7)

### **Objectives: The student will be able to:**

- Analyze how different cultures develop their own technologies to satisfy their individual and shared needs, wants, and values.
- Explain that most technological development has been evolutionary, the result of a series of refinements to a basic invention. (ITEA, STL 7-G)
- Explain that the evolution of civilization has been directly affected by, and has in turn affected the development of tools and materials. (ITEA, STL 7-H)
- Explain that throughout history, technology has been a powerful force in reshaping the social, cultural, political, and economic landscape. (ITEA, STL 7-I)
- Explain that early in the history of technology, the development of many tools and machines was not based on scientific knowledge but on technological know-how. (ITEA, STL 7-J)
- Explain that the Iron Age was defined by the use of iron and steel as the primary materials for tools. (ITEA, STL 7-K)
- Explain that the Middle Ages saw the development of many technological devices that produced long-lasting effects on technology and society. (ITEA, STL 7-L)
- Explain that the Renaissance, a time of rebirth of the arts and humanities, was also an important period in the history of technology. (ITEA, STL 7-M)
- Explain that the Industrial Revolution saw the development of continuous manufacturing, sophisticated transportation and communication systems, advanced construction practices, and improved education and leisure time. (ITEA, STL 7-N)
- Explain that the Information Age places emphasis on the processing and exchange of information. (ITEA, STL 7-O)

## **Unit 5: Concepts of Technology**

### **Indicator Statement:**

Develop an understanding of the core concepts of technology. (ITEA, STL 2)

### **Objectives: The student will be able to:**

- Explain that systems, which are the building blocks of technology, are embedded within larger technological, social, and environmental systems. (ITEA, STL 2-X)
- Explain that the stability of a technological system is influenced by all of the components of the system, especially those in the feedback loop. (ITEA, STL 2-Y)
- Explain that selecting resources involves trade-offs between competing values, such as availability, cost, durability, and waste. (ITEA, STL 2-Z)
- Explain that new technologies create new processes. (ITEA, STL 2-CC)
- Explain that management is the process of planning, organizing, and controlling work. (ITEA, STL 2-EE)
- Recognize and explain that systems thinking applies logic and creativity with appropriate compromises in complex real-life problems.
- Explain that requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development. (ITEA, STL 2-AA)
- Define optimization as an ongoing process of designing or making a product and is dependent on criteria and constraint.

## **Unit 6: Technology and Society**

### **Indicator Statement:**

Develop an understanding of the role of society in the development and use of technology. (ITEA, STL 6)

### **Objectives: The student will be able to:**

- Analyze how different cultures develop their own technologies to satisfy their individual and shared needs, wants, and values.
- Defend the proposition that the evolution of civilization has been directly affected by, and has been in turn affected, the development and use of tools and materials.
- Explain that early in the history of technology, the development of many tools and machines was based not on scientific knowledge but on technological know-how.
- Analyze the development and use of technology in the pre-agricultural, agricultural, industrial, and information ages.
- Identify and describe instances where societal opinions and demands or corporate interests have influenced the decision to develop a technology.
- Explain that a number of different factors, such as advertising, the strength of the economy, the goals of the company, and the latest fads contribute to shaping the design of and demand for various technologies. (ITEA, STL 6-J)

## **Unit 7: Technology and the Environment**

**Indicator Statement:** Develop an understanding of the effects of technology on the environment. (ITEA, STL 5)

**Objectives: The student will be able to:**

- Explain that humans devise technologies to reduce the negative consequences of other technologies. (ITEA, STL 5-K)
- Analyze the relationship between technological processes and natural processes.
- Investigate technologies designed to reduce the negative consequences of other technologies.
- Research and report on processes (reusing, reducing, and recycling) that conserve water, soil, and energy.
- Assess the effectiveness of the use of technology to monitor environmental conditions.

## **Unit 8: The Design Process**

**Indicator Statement:**

Develop an understanding of the attributes of design. (ITEA, STL 8)

**Objectives: The student will be able to:**

- Explain that the design process is a systematic, iterative approach to problem solving that yields design solutions.
- Explain that the design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating a design, using specifications, refining a design, creating or making it, and communicating processes and results. (ITEA, STL 8-H)
- Explain that design problems are seldom presented in a clearly defined form. (ITEA, STL 8-I)
- Analyze the phases of the design process.
- Explain why designs need to be continually checked and critiqued, and the ideas of the design must be redefined and improved. (ITEA, STL 8-J)
- Explain that requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other. (ITEA, STL 8-K)

## Unit 9: Computer Hardware and Software

### Indicator Statement:

Create an object-oriented program using the high-level programming language, Java, to solve a problem.

### Objectives: The student will be able to:

- Create a Java program that uses variables and constants in the software code to solve a problem.
- Create a Java program that uses conditional control structures in the software code to solve a problem.
- Create a Java program that uses loop structures in the software code to solve a problem.

### Indicator Statement:

Select and use tools and equipment correctly and safely.

### Objective: The student will be able to:

Select and use tools and instruments in the testing and evaluation of design solutions.

### Indicator Statement:

Develop abilities to use and maintain technological products and systems (ITEA, STL 12)

### Objectives: The student will be able to:

- Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques. (ITEA, STL 12-L)
- Diagnose a system that is malfunctioning and use tools, materials, and knowledge to repair it. (ITEA, STL 2-M)
- Operate systems so that they function in the way they were designed. (ITEA, STL 12-O)
- Troubleshoot, analyze and maintain systems to ensure safe and proper function and precision.
- Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate. (ITEA, STL 12-P)

### Indicator Statement:

Develop an understanding of troubleshooting, research and development, invention and innovation, and experimentation in problem solving. (ITEA, STL 10)

### Objectives: The student will be able to:

- Explain that research and development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace. (ITEA, STL 10-I)
- Explain that not all problems are technological, and not every problem can be solved using technology. (ITEA, STL 10-K)
- Explain that technological problems require a multidisciplinary approach. (ITEA, STL 10-L)

- Apply the research and development problem-solving approach to prepare devices and systems for the marketplace.
- Explain why technological problems must be researched before they can be solved.
- Identify and describe problems that cannot be solved through the use of technology.

**Indicator Statement:**

Develop an understanding of information and communication technologies. (ITEA, STL 17)

**Objectives: The student will be able to:**

- Identify and describe the parts of a communication system including source, encoder, transmitter, receiver, decoder, and destination.
- Analyze the functioning and applications of information processing machines including printing, telephone, radio and television, and computer.

**Unit 10: Overview of Core Technologies**

**Indicator Statement:**

Discuss the functioning and applications of core technologies applied in common technology systems.

**Objectives: The student will be able to:**

- Describe the core technologies (mechanical, structural, electrical, electronic, thermal, fluid, optical, bio, and material) as they are applied in the designed world.
- Analyze the functioning of the core technologies in the designed world. In terms of:
  - o common components
  - o basic system design
  - o safety
  - o simple controls
  - o system performance evaluation.

## **Unit 11: Overview of Robot Control System**

### **Indicator Statement:**

Develop an understanding of engineering design. (ITEA, STL 9)

### **Objectives: The student will be able to:**

- Describe the personal characteristics involved in engineering. At least:
  - o creativity
  - o resourcefulness
  - o ability to visualize and think abstractly.
- Explain that established design principles are used to evaluate existing designs, to collect data, and to guide the design process. (ITEA, STL 9-I)
- Explain that engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly. (ITEA, STL 9-J)
- Explain that a prototype is a working model used to test a design concept by making actual observations and necessary adjustments. (ITEA, STL 8-K)
- Explain that the process of engineering design takes into account a number of factors. (ITEA, STL 8-L)
- Explain constraints on the engineering design process. At least:
  - o safety
  - o reliability
  - o economic considerations
  - o quality control
  - o environmental concerns
  - o manufacturability
  - o maintenance
  - o human factors engineering (ergonomics)

### **Indicator Statement:**

Develop abilities to apply and analyze the design process. (ITEA, STL 11)

### **Objectives: The student will be able to:**

- Identify the design problem to solve and to decide whether to address it. (ITEA, STL 11-M)
- Identify criteria and constraints and determine how these will affect the design process. (ITEA, STL 11-N)
- Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product. (ITEA, STL 11-O)
- Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process in order to check for proper design and to note areas where improvements are needed. (ITEA, STL 11-P)
- Develop and produce a product or system using a design process. (ITEA, STL 11-Q)
- Evaluate final solutions and communicate observations, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models. (ITEA, STL 11-R)

- Define the problem. Brainstorm.
- Research and generate ideas.
- Identify criteria and specify constraints. Explore possibilities.
- Select an approach.
- Develop a design proposal. Make a model or prototype. Test and evaluate the design. Redesign.
- Create or make it.
- Communicate processes or results.

**Indicator Statement:**

Assemble a LEGO® MINDSTORMS® NXT robot and program the autonomous robot to perform tasks.

**Objectives: The student will be able to:**

- Using the programming language, Java, program the robot to move around a stationary object.
- Using the programming language, Java, program the robot to use the touch sensor to perform a task.
- Using the programming language, Java, program the robot to use the light sensor to perform a task.
- Using the programming language, Java, program the robot to use the sound sensor to perform a task.
- Using the programming language, Java, program the robot to use the ultrasonic sensor to perform a task.

## **Unit 12: Mechanical Technology**

**Indicator Statement:** Analyze the functioning and applications of mechanical systems.

**Objectives: The student will be able to:**

- Identify and describe applications of mechanical technology in the designed world. Such as:
  - o Levers
  - o Inclined planes
  - o Wedges
  - o Wheels and axles
  - o Pulleys
  - o Screws o Gears
  - o Cams
  - o Linkages
- Explain science concepts and mathematic processes applied in mechanical technology. Such as:
  - o Force
  - o Motion
  - o Energy
  - o Work
  - o Power
  - o Efficiency
  - o Gravity
  - o Friction

## **Unit 13: Structural Technology**

**Indicator Statement:**

Analyze the functioning and applications of structural systems.

**Objectives: The student will be able to:**

- Identify and describe applications of structural technology in the designed world. Such as:
  - o Post and beam structures
  - o Frame structures
  - o Suspension structures
  - o Cantilever structures
  - o Mass structures
  - o Pressurized structures
- Explain science concepts and mathematical concepts applied in mechanical technology. Such as:
  - o Compression
  - o Tension
  - o Efficiency
  - o Center of gravity

## **Unit 14: Materials Technology**

### **Indicator Statement:**

Analyze the functioning and applications of materials technology.

### **Objectives: The student will be able to:**

- Identify and describe applications of materials technology in the designed world. Such as:
  - o Metals
  - o Alloys
  - o Nonmetals
  - o Composites
  - o Biomaterials
- Explain science concepts and mathematical concepts applied in materials technology. Such as:
  - o Strength of shapes
  - o Forces
  - o Center of gravity
  - o Moments of inertia
  - o Stress
  - o Strain
  - o Deflection o Efficiency

## **Unit 15: Electronics and Electrical Technology**

### **Indicator Statement:**

Analyze the functioning and applications of electrical systems.

### **Objectives: The student will be able to:**

- Identify and describe applications of electrical technology in the designed world. Such as:
  - o Generators
  - o Electric motors
  - o Alarm systems
  - o Automobile electrical systems
- Explain science concepts and mathematical concepts applied in electrical technology. Such as:
  - o Measure resistance
  - o Conduction
  - o Semi-conduction
  - o Current (alternating and direct)
  - o Voltage
  - o Power
  - o Circuits
  - o Magnetism
  - o Ohm's law
  - o Ratio
- Identify and describe how various types of electric circuits (i.e., series and parallel) provide a means of transferring and using electrical energy to produce heat, light, sound, as well as chemical changes.

**Indicator Statement:**

Analyze the functioning and application of electronic technology systems.

**Objectives: The student will be able to:**

- Identify and describe applications of electronic technology in the designed world. Such as:
  - o Computers
  - o Telephones
  - o Radio and television
- Explain science concepts and mathematical concepts applied in electronic technology. Such as:
  - o Electromagnetic waves
  - o Digital logic
  - o Binary numbers
  - o Frequency
  - o Amplification

**Unit 16: Thermal Technology****Indicator Statement:**

Analyze the functioning and application of thermal technology systems.

**Objectives: The student will be able to:**

- Identify and describe applications of thermal technology in the designed world such as thermometer, refrigerator, furnace, air conditioner, and heat engines.
- Explain science concepts and mathematical concepts applied in thermal technology such as convection, conduction, radiation, insulation, and efficiency.

**Unit 17: Fluid Technology****Indicator Statement:**

Analyze the functioning and applications of fluid technology systems.

**Objectives: The student will be able to:**

- Identify and describe applications of fluid technology in the designed world. Such as:
  - o Air pumps
  - o Water pumps
  - o Automobile brakes
  - o Airfoils
- Explain science concepts and mathematical concepts applied in fluid technology. Such as:
  - o Pressure
  - o Vacuum
  - o Volume
  - o Area
  - o Ratio

## **Unit 18: Optical Technology**

### **Indicator Statement:**

Analyze the functioning and application of optical systems.

### **Objectives: The student will be able to:**

- Identify and describe applications of optical technology in the designed world. Such as:
  - o Microscope and magnifier
  - o Laser
  - o Fiber optics
  - o Optical telescope
  - o Bar code reader
  - o Scanner
- Explain science concepts and mathematical concepts applied in optical technology. Such as:
  - o Light waves
  - o Frequency
  - o Period
  - o Reflection
  - o Refraction
  - o Diffraction
  - o Proportion (direct and indirect)
  - o Superposition
  - o Interference
  - o Doppler effect

## **Unit 19: Biotechnology**

### **Indicator Statement:**

Analyze the functioning and application of biotechnology systems.

### **Objectives: The student will be able to:**

- Identify and describe applications of biotechnology in the designed world. Such as:
  - o Genetically modified food
  - o DNA fingerprinting
  - o Oil biodegradation
  - o Insulin production
  - o Bioethics
- Explain science concepts and mathematical concepts applied in biotechnology. Such as:
  - o Genes
  - o Genetic code
  - o DNA structure
  - o Enzymes
  - o Proteins
  - o Cloning
  - o Mutations
  - o Chromosome number
  - o Genetic recombination
  - o Anaerobic conversion

- o Fermentation

## **Unit 20: Energy and Power**

### **Indicator Statement:**

Develop an understanding of energy and power technologies. (ITEA, STL 16)

### **Objectives: The student will be able to:**

- Explain that energy cannot be created nor destroyed; however, it can be converted from one form to another. (ITEA, STL 16-J)
- Explain that energy can be grouped into major forms: thermal, radiant, electrical, mechanical, chemical, nuclear, and others. (ITEA, STL 16-K)
- Explain that it is impossible to build an engine to perform work that does not exhaust thermal energy to the surroundings. (ITEA, STL 16-L)
- Explain that energy resources can be renewable or non-renewable. (ITEA, STL 16-M)
- Explain that power systems must have a source of energy, a process, and loads. (ITEA, STL 16-N)
- Explain the production, conversion, transmission, and application of different forms of energy.  
Such as:
  - o Mechanical
  - o Radiant
  - o Chemical
  - o Thermal
  - o Electrical
  - o Nuclear

## **Unit 21: Transportation Technology**

### **Indicator Statement:**

Develop an understanding of transportation technologies. (ITEA, STL 18)

### **Objectives: The student will be able to:**

- Explain that transportation plays a vital role in the operation of other technologies, such as manufacturing, construction, communication, health and safety, and agriculture. (ITEA, STL 18-J)
- Analyze transportation systems. Such as:
  - o Land
  - o Water
  - o Air
  - o Space
- Analyze the role transportation plays in the operation of other enterprises, such as manufacturing, construction, communication, health and safety, and agriculture.
- Explain that intermodalism is the use of different modes of transportation in an interconnected system that moves people and goods. (ITEA, STL 18-K)

## **Unit 22: Manufacturing Technologies**

**Indicator Statement:**

Develop an understanding of manufacturing technologies. (ITEA, STL 19)

**Objectives: The student will be able to:**

- Analyze manufacturing processes. At least:
  - o Designing
  - o Development
  - o Producing
  - o Servicing
- Explain that materials have different qualities and may be classified as natural, synthetic, or mixed. (ITEA, STL 19-M)
- Explain that durable goods are designed to operate for a long period of time, while non-durable goods are designed to operate for a short period of time. (ITEA, STL 19-N)
- Explain that marketing involves establishing a product's identity, conducting research on its potential, advertising it, distributing it, and selling it. (ITEA, STL 19-R)
- Classify manufacturing systems as being customized production, batch production, or continuous production.
- Describe how the interchangeability of parts increases the effectiveness of a manufacturing process. Research chemical technologies used to modify or alter chemical substances in the manufacturing process. At least:
  - o Synthetic fibers
  - o Pharmaceuticals
  - o Plastics
  - o Fuels

**Unit 23: Construction Technologies****Indicator Statement:**

Develop an understanding of construction technologies. (ITEA, STL 20)

**Objectives: The student will be able to:**

- Explain that infrastructure is the underlying base or basic framework of a system. (ITEA, STL 20-J)
- Explain that structures are constructed using a variety of processes and procedures. (ITEA, STL 20-K)
- Explain that the design of structures includes a number of requirements. (ITEA, STL 20-L)
- Explain that structures require maintenance, alteration, or renovation periodically to improve them or to alter their intended use. (ITEA, STL 20-M)
- Explain that structures can include prefabricated materials. (ITEA, STL 20-N)
- Analyze heavy engineering structures. Such as:
  - o Highways
  - o Rail lines
  - o Bridges
  - o Airports
  - o Canals
  - o Pipelines

- o Power transmission and communication towers
- o Hydroelectric and flood control dams
- Analyze types of buildings. Such as:
  - o Residential
  - o Commercial
  - o Industrial
- Analyze the steps in the construction process. At least - -
  - o Preparing the site
  - o Setting foundations
  - o Building the framework
  - o Enclosing the structure
  - o Installing utilities
  - o Finishing the interior and exterior
  - o Completing the site