Foundations of Technology
Semester A Exam Review Guide

Guidance on Student Use

Test Description
Length: 2 hours
Questions: 2 design challenge prompts divided into 3 sections each

Upon successful completion of the first semester, students should be able to do the following:

Unit 1 - Inventions & Innovations
- 1.1 Develop an understanding of the nature, characteristics and scope of technology. (ITEA, STL 1)
  - 1.1.a. Refine and extend a conceptual understanding of new words regarding technology. (VSC Reading Processes/ Vocabulary) Analyze various definitions of “technology.”
  - 1.1.b. Explain that technology creates new economic opportunities and social benefits and, at the same time, produces new social problems.
  - 1.1.c. Recognize and explain that technological innovation is often driven by the profit motive.
- 1.3 Develop an understanding of the relationships among technologies and the connections between technology and other fields of study. (ITEA, STL 3)
  - 1.3.a. 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)
  - 1.3.b. 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)
  - 1.3.c Explain that technological ideas are sometimes protected by the process of patenting. (ITEA, STL 3-1)
  - 1.3.e Explain the strong relationship between technology and the study of science including the common interest in natural scientific laws, systems, design, and modeling.
- 2.2 Develop an understanding of the cultural, social, economic, and political effects of technology. (ITEA, STL 4)
  - 2.2.c Cite instances where ethical considerations have impacted the development, selection, and use of technologies. (ITEA, STL 4-J)
  - 2.2.d. Explain how the transfer of technology from one society to another affects culture, society, economics, and politics. (ITEA, STL 4-K)
  - 2.2.f Justify the contention that individual citizens have to make informed decisions about the development and use of technology.
**Unit 2 - Systems**

- **1.2 Develop an understanding of the core concepts of technology. (ITEA, STL 2)**
  - 1.2.a Explain that systems, which are the building blocks of technology, are embedded within larger technological, social, and environmental systems. (ITEA, STL 2-X)
  - 1.2.b 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)
  - 1.2.f Recognize and explain that systems-thinking applies logic and creativity with appropriate compromises in complex real-life problems.

- **3.6 Develop abilities to use and maintain technological products and systems. (ITEA, STL 12)**
  - 3.6.a Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques. (ITEA, STL 6-J)
  - 3.6.b Diagnose a system that is malfunctioning and use tools, materials, and knowledge to repair it. (ITEA, STL 12-M)
  - 3.6.c Operate systems so that they function in a way they were designed. (ITEA, STL 12-O)
  - 3.6.d Troubleshoot, analyze and maintain systems to ensure safe and proper function and precision.
  - 3.6.e Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate. (ITEA, STL 12-P).

- **4.5 Analyze the functioning and applications of electrical systems.**
  - 4.5.a Identify and describe applications of electrical technology in the designed world such as generators, electric motors, alarm systems, and automobile electrical systems.
  - 4.5.b Explain science concepts and mathematical concepts applied in electrical technology such as measure resistance, conduction, semi-conduction, current (alternating and direct), voltage, power, circuits, magnetism, Ohm's law, and ratio.
  - 4.5.c Identify and describe how various types of electric circuits (i.e., se-ries and parallel) provide a means of transferring and using electrical energy to produce heat, light, sound, as well as chemical changes.
  - 4.5.e Solve for the unknown in a linear equation related to electrical technology.

**Unit 3 - Energy**

- **4.5 Analyze the functioning and applications of electrical systems.**
  - 4.5.a Identify and describe applications of electrical technology in the designed world such as generators, electric motors, alarm systems, and automobile electrical systems.
4.5.b Explain science concepts and mathematical concepts applied in electrical technology such as measure resistance, conduction, semi-conduction, current (alternating and direct), voltage, power, circuits, magnetism, Ohm's law, and ratio.

4.5.c 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.

4.5.e Solve for the unknown in a linear equation related to electrical technology.

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

5.4.a Explain that energy cannot be created nor destroyed; however, it can be converted from one form to another. (ITEA, STL 16-J)

5.4.b Explain that energy can be grouped into major forms: thermal, radiant, electrical, mechanical, chemical, nuclear, and others. (ITEA, STL 16-K)

5.4.e Explain that power systems must have a source of energy, a process, and loads. (ITEA, STL 16-N)

5.4.d Explain that energy resources can be renewable or non-renewable. (ITEA, STL 16-M)

5.4.f Explain the production, conversion, transmission, and application of different forms of energy such as mechanical, radiant, chemical, thermal, electrical, and nuclear.

Unit 4 - Engineering Design Process

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

3.1.a Explain that the design process is a systematic, iterative, approach to problem solving that yields design solutions.

3.1.b 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)

3.1.f Explain that requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other. (ITEA, STL 8-K)

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

3.2.d 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)

3.2.f Explain constraints on the engineering design process.
  ● At least – Safety, Reliability, Economic considerations, Quality control, Environmental concerns, Manufacturability, Maintenance and Human factors engineering (ergonomics)

3.3 Develop abilities to apply and analyze the design process. (ITEA, STL 11)
3.3.b Identify criteria and constraints and determine how these will affect the design process. (ITEA, STL 11-N)
3.3.c Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product. (ITEA, STL 11-O)
3.3.d 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)
3.3.e Develop and produce a product or system using a design process. (ITEA, STL 11-Q)
3.3.f Evaluate final solutions and communicate observations, processes, and results of the entire design process, suing verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models. (ITEA, STL 11-R)
3.3.g Apply the design process including 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.

3.4 Select and use tools and equipment correctly and safely.
3.4.a Select and use the appropriate tools and equipment in making two-dimensional and three-dimensional representations of design solutions, forming and molding processes, machining processes, and assembly processes.

3.5 Develop an understanding of troubleshooting, research and development, invention and innovation, and experimentation in problem solving. (ITEA, STL 10)
3.5.b Explain that not all problems are technological, and not every problem can be solved using technology. (ITEA, STL 10-K)
3.5.d Apply the research and development problem-solving approach to prepare devices and systems for the marketplace.
3.5.f Identify and describe problems that cannot be solved through the use of technology.

Unit 5 - Transportation
5.6 Develop an understanding of transportation technologies. (ITEA, STL 18)
5.6.a 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)
5.6.b Analyze transportation systems such as land, water, air, and space.
5.6.d Explain that intermodalism is the use of different modes of transportation in an interconnected system that moves people and goods. (ITEA, STL 18-K)
5.6.e Research and report on “smart technologies.”
Unit 6-Core Technologies

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

4.2 Analyze the functioning and applications of mechanical systems.
   - 4.2.a Identify and describe applications of mechanical technology in the designed world such as levers, inclined planes, wedges, wheels and axles, pulleys, screws, gears, cams and linkages.
   - 4.2.b Explain science concepts and mathematic processes applied in mechanical technology such as force, motion, energy, work, power, efficiency, gravity and friction.

4.3 Analyze the functioning and applications of structural systems.
   - 4.3.a Identify and describe applications of structural technology in the designed world such as post and beam structures, frame structures, suspension structures, cantilever structures, mass structures, and pressurized structures.
   - 4.3.b Explain science concepts and mathematical concepts applied in mechanical technology such as compression, tension, efficiency, and center of gravity.

4.4 Analyze the functioning and applications of materials technology.
   - 4.4.a Identify and describe applications of materials technology in the designed world such as metals, alloys, nonmetals, composites, and biomaterials.
   - 4.4.b Explain science concepts and mathematical concepts applied in materials technology such as strength of shapes, forces, center of gravity, moments of inertia, stress, strain, deflection, and efficiency.

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

4.8 Analyze the functioning and applications of fluid technology systems.
   - 4.8.a Identify and describe applications of fluid technology in the designed world such as air pumps, water pumps, automobile brakes, and airfoils.
   - 4.8.b Explain science concepts and mathematical concepts applied in fluid technology such as pressure, vacuum, volume, area, and ratio.

4.9 Analyze the functioning and application of optical systems.
   - 4.9.a Identify and describe applications of optical technology in the designed world such as microscope and magnifier, laser, fiber optics, optical telescope, bar code reader, and scanner.
4.9.b Explain science concepts and mathematical concepts applied in optical technology such as light waves, frequency, period, reflection, refraction, diffraction, proportion (direct and indirect), superposition, interference, and Doppler effect.
Prompt 1:

Juanita is buying a house. She is interested in knowing how a basic heating system in a home operates. Using your knowledge about the universal systems model, explain to Juanita the basic operations of a technological system. Use the example of a home heating system to support your description.

To help explain how a basic heating system works, use the components in the Universal Systems Model shown below.

- **Input**
- **Process**
- **Output**
- **Feedback**

Assessed Indicators:
- **1.2** Develop an understanding of the core concepts of technology.
  - **1.2b** Explain that the stability of a technological system is influenced by all of the components of the system, especially those in the feedback loop.
- **4.7** Analyze the functioning and application of thermal technology systems.
  - **4.7a** Identify and describe applications of thermal technology in the designed world such as thermometer, refrigerator, furnace, air conditioner, and heat engines.

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Prompt 2:

On June 23, 2009, The *Washington Post* covered the news story about a Metro train that slammed into the back of another on the Red Line. The accident occurred at the height of the evening rush hour. Experts from the National Transportation and Safety Board (NTSB) investigated the possible causes of the accident.

Use what you know about engineering design to prepare a written statement for the *Washington Post*. Describe how engineers seek an optimal solution in their design solutions which must take into account a number of requirements known as engineering factors. Clarify how these factors will help investigators determine what may have caused the Metro train accident. After providing factors that will assist in the accident investigation, use the original design constraints listed below to create an innovative redesign for the Metro train. Using the sketch area, provide a technical sketch depicting your design refinements that ensure quality, efficiency, and maximum productivity.

**Engineering Factors list includes:**

1. safety
2. reliability
3. economic considerations
4. quality control
5. environmental concerns
6. manufacturability
7. maintenance and repair
8. human engineering (ergonomics)

**Original Design Constraints:**

- Metro must be made of metal.
- Must be able to maintain speeds of 85 miles per hour.
- Must be human operated.
- Must have seating for the disabled.
- Must have proper safety features. (Ex. brakes, lights)

**Assessed Indicators:**

- 3.2 Develop and understanding of engineering design.
  - 3.2f Explain constraints on the engineering design process
- 3.3 Develop abilities to apply and analyze the design process.
  - 3.3b Identify criteria and constrains and determine how these will affect the design process.
  - 3.3c Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.
Metro Car Redesign Sketch Area:

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Prompt 3:
Discuss why social networks such as Facebook, Twitter, and YouTube were created. Is the creation of these websites positive or negative for society? Defend your answer with examples discussed during the semester.

Assessed Indicators:
- Develop an understanding of the nature, characteristics, and scope of technology
  - 1.1b Explain that technology creates new economic opportunities and social benefits and, at the same time, produces new social problems.
  - 1.1c Recognize and explain that technological innovation is often driven by the profit motive.

Notes:
Prompt 4:
Discuss why car manufacturers don’t make a car that’s indestructible. In other words, why don’t car companies create cars where the likelihood of someone getting hurt in a crash is very small?

Assessed Indicators:
- 3.1 Develop an understanding of the **attributes of design**
  - 3.1f Explain that requirements of a design, such as criteria, **constraints**, and efficiency, sometimes compete with each other

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Prompt 5:
A company approaches you for advice on how they should proceed with **inventing** and distributing a brand new device that will lower heating and cooling bills. What do you say to them?

Assessed Indicators:
- 3.5 Develop and understanding of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
  - 3.5d Apply the research and development problem-solving approach to prepare devices and systems for the marketplace.

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Prompt 6:

Technology can have both negative and/or positive economic, cultural, social, and political impacts.

Reflecting on technological devices discussed in class, select an example of a technological device, artifact, system, or processes and describe the various negative and positive impacts of the technology.

<table>
<thead>
<tr>
<th>Technological Device Examples</th>
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<tbody>
<tr>
<td>Oscillating Fan</td>
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<tr>
<td>Lawn Mower</td>
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Assessed Indicators:

- 1.3 Develop and understanding of the relationship among technologies and the connections between technology and other fields.
- 2.2 Develop an understanding of the cultural, social, economic, and political effects of technology.

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Prompt 7:
This semester you learned how to operate the band saw and drill press. Pretend you are the teacher. A student approaches you and says that the band saw is acting funny and something is wrong. What do you? How do you go about fixing it?

Assessed Indicators:
- 3.6b Diagnose a system that is malfunctioning and use tools, materials, and knowledge to repair it.
- 3.6c Operate systems so that they function in a way they were designed.
- 3.6d Troubleshoot, analyze, and maintain systems to ensure safe and proper function and precision.

Notes:
Prompt 8:
In what aspects of your daily life are you affected by or encounter any of the core technologies? (Mechanical, structural, electrical, electronic, thermal, fluid, optical, and bio and material) Explain your answer.

Assessed Indicators:
- 4.1 Discuss the functioning and applications of core technologies applied in common technology systems.
  - 4.1a Describe the core technologies (mechanical, structural, electrical, electronic, thermal, fluid, optical, bio and material) as they are applied in the designed world.
  - 4.1b Analyze the functioning of the core technologies in the designed work in terms of common components, basic system design, safety, simple controls and system performance evaluation.

Notes:
**Prompt 9:**

Mark is at the kitchen sink washing dishes. While wiping the counter, he accidentally knocked the plugged in electric coffee maker into the sink which is filled with water. He quickly unplugs the coffee maker and then removes it from the sink.

Once he safely removes the coffee maker from the sink, he tries to plug it back in, but it doesn’t work. Use what you know about *electricity* and *electrical systems* to explain the steps Mark may want to take to determine if the machine can function again, otherwise he will have to spend money to purchase another machine.

**Assessed Indicators:**
- 4.5 Analyze the functioning and applications of electrical systems.
- 3.4 Select and use tools and equipment correctly and safely.
- 3.5 Develop an understanding of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

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Prompt 10:

Many people view transportation as a basic need. The more complex life and work become, it seems the more essential the elements of transportation systems are.

From what you learned in your technology education class, explain how transportation directly and indirectly impacts your life. In your description, include examples of how the system is intermodal and why some vehicles are used more than others.

Assessed Indicators:

- 5.6 Develop an understanding of transportation technologies.
  - 5.6a Explain that transportation plays a vital role in the operation of other technologies, such as manufacturing, construction, communication, health and safety, and agriculture.
  - 5.6b Analyze transportation systems such as land, water, air, and space.
  - 5.6d Explain that intermodalism is the use of different modes of transportation in an interconnected system that moves people.
  - 5.6e Research and report on “smart technologies.”

Notes:
Prompt 11:

Explain why you think bridges are built the way that they are. In other words, why do they incorporate the shapes and formations that they use. Explain the importance of selecting the appropriate materials to use in bridges?

Assessed Indicators:
- 4.3 Analyze the functioning and applications of structural systems.
  - 4.3a Identify and describe applications of structural technology in the designed world such as post and beam structures, frame structures, suspension structures, cantilever structures, mass structures, and pressurized structures.

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**Prompt 12:**

In a car, brakes operate using brake **fluid**. Brake fluid is basically a semi-oily substance that is contained in lines that reach from the end of the gas pedal to the brakes.

When you press the brake pedal, the brake fluid is compressed in the lines, this compression in turn, “pushes” the brake pads on your car wheel, slowing your car down using friction. What other systems use fluids in manner that create work?

**Assessed Indicators:**

- 4.8 Analyze the functioning and applications of fluid technology systems.
  - 4.8a identify and describe applications of fluid technology in the designed world such as air pumps, water pumps, automobile brakes, and airfoils.

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**Prompt 13:**
A Quick Response (QR) code is a square made up of different size objects within the square. It is like a bar code but with a QR code you use your phone’s camera to scan the QR code and it redirects you to somewhere else on the web. Explain how you think the technology behind QR codes works.

**Assessed Indicators:**
- 4.9 Analyze the functioning and application of optical systems.
  - 4.9a Identify and describe applications of optical technology in the designed world such as microscope and magnifier, laser, fiber optics, optical telescope, bar code reader, and scanner.

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[QR Code]
Prompt 14:
A student places a number two pencil in a glass of water and it appears to be larger. Using what you know about optical systems, explain why when an object is immersed in a glass of water it appears bigger than it is in real life.

Assessed Indicators:

- 4.9 Analyze the functioning and application of optical systems.
  - 4.9b Explain science concepts and mathematical concepts applied in optical technology such as light waves, frequency, period, reflection, refraction, diffraction, proportion (direct and indirect), superposition, interference, and Doppler Effect.

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