Study Guide 01: Exam 01 — 08 February 2023

Design Concepts for Engineers, Horenstein, 5th edition

Chapter 01: What Is Engineering? — 23–25 Jan 2023

Chapter Objectives

- The numerous fields of engineering
- Engineering as a career
- The relationship between engineers and other professionals
- Engineering professional organizations
- The foundations of engineering design: knowledge, experience, and intuition

Acronyms, Vocabulary, and Concepts

ACM: Association for Computing Machinery

AIAA: American Institute of Aeronautics and Astronautics

AIChE: American Institute of Chemical Engineers

ASABE: American Society of Agricultural and Biological Engineers

ASCE: American Society of Civil Engineers

ASNE: American Society of Naval Engineers

ASME: American Society of Mechanical Engineers

BMES: Biomedical Engineering Society

CAD: Computer-aided design

CAM: Computer-aided manufacturing

IEEE: Institute of Electrical and Electronic Engineers

IIE: Institute of Industrial Engineers

LAN: Local area network

MEMS: Micro-electromechanical systems

MRS: Materials Research Society

NAE: National Academy of Engineering

NASA: National Aeronautics and Space Administration

NCEES: National Council of Examiners for Engineering and Surveying

NEMS: Nano-mechanical systems

PE: (or LPE) Licensed Professional Engineer

SPE: Society of Petroleum Engineers

SWE: Society of Women Engineers

Knowledge: Describes the body of facts, scientific principles, and mathematical tools that an engineer uses to form strategies, analyze systems, and predict results

Experience: Refers to the body of methods, procedures, techniques, and rules of thumb that an engineer uses to solve problems

Intuition: Refers to a basic instinct about what will or will not work as a problem solution

FE Exam: The Fundamentals of Engineering (FE) exam is generally your first step in the process to becoming a professional licensed engineer (P.E.). It is designed for recent graduates and students who are close to finishing an undergraduate engineering degree from an EAC/ABET-accredited program

PE Exam: The Principles and Practice of Engineering (PE) exam tests for a minimum level of competency in a particular engineering discipline. It is designed for engineers who have gained a minimum of four years' post-college work experience in their chosen engineering discipline

Questions

Can you answer these questions? If so, you should have a good grasp of the Chapter 01 concepts.

- Do you know which engineering discipline you want to study? Pick one field of engineering and summarize very briefly. What specialized area within this discipline interests you the most? Explain why.
- Research and discover one moderately well-known engineer (past or present) working or educated in this discipline, and summarize briefly (two or three sentences) who he or she is/was, and what they have accomplished.
- What professional societies should you be thinking about joining? Visit their website and determine whether you can join with a student membership. What is the cost for a student membership? A professional membership?
- To become a licensed PE, you must pass an exam. What is this exam called? When do you become eligible to take it? Who actually gives you this exam?
- Distinguish between knowledge, experience, and intuition. Discuss briefly why taking courses *outside* of math/science/engineering is important to your education. Give an example of a non-technical course you have already taken, or one you plan to take, that you think will be especially relevant and useful to you as an engineer.

Chapter 02: What Is Design? 30 Jan – 06 Feb 2023

Chapter Objectives

- The engineering design process
- The difference between design, analysis, and replication
- The difference between good and bad design
- The elements of the design cycle
- How to generate ideas through brainstorming

Vocabulary and Concepts

Design An open-ended process where more than one feasible solution may exist. The goal of design is to converge on the best possible solution

Analysis To collect and evaluate data and then report the results. Can also be applied whenever mathematics is used to predict or confirm the results of an experiment

Replication The process of re-creating something that has already been designed. May involve an exact reproduction, or minor revisions whose consequences have already been determined

Elements of Good Design

- Meets all technical requirements
- Works all the time
- Meets cost requirements
- Requires little or no maintenance
- Is safe
- Creates no ethical dilemma

Elements of Bad Design

- Meets only some technical requirements
- Works initially, but stops working after a short time
- Costs more than it should
- Requires frequent maintenance
- Poses a hazard to users
- Raises ethical questions

Design Criteria Quantifiable objectives which must be met in order to satisfy a challenge/need (Criteria are what you must do)

Design Constraints Factors that limit how you can solve a problem (Constraints are what you cannot do)

Needs Hierarchy Organize the design criteria and constraints by ranking their importance. Top-level needs are most important, secondary and tertiary have decreasing importance

Ground Rules for Brainstorming

- No holding back.
  Any idea may be brought to the floor at any time.
- No boundaries.
  An idea is never too outrageous to mention.
- No limit.
  Another idea is never one too many.
- No criticizing.
  An idea may not be criticized until the final discussion phase.
- No dismissing.
  An idea may not be discounted until after group discussion.
- No restrictions.
  Participants may generate ideas from any field of expertise.
- No shame.
  A team participant should never be made to feel embarrassed for contributing an idea.

Questions

Can you answer these questions? If so, you should have a good grasp of the Chapter 02 concepts.

- Briefly, using your own words, distinguish between analysis, design, and replication in the context of engineering.
- The textbook uses the example of a Lyle gun to help make the distinction. Briefly, what is a Lyle gun? Without copying the textbook, summarize how this example distinguishes between design and analysis.

At the end of Section 2.2 (pages 34–36), there is a Practice! box which includes a list of tasks with the instruction of determining if the specific item involves analysis, design, or replication.

- Read through this list and find an example of a task which is clearly analysis. Use a sentence or two to justify your choice.
- Read through this list and find an example of a task which is clearly design. Use a sentence or two to justify your choice.
- Read through this list and find an example of a task which is clearly replication. Use a sentence or two to justify your choice.
- Section 2.3 of the textbook discusses good vs. bad design in depth. Identify some physical object for which the design has remained essentially unchanged for a long period of time (decades to centuries, not weeks or months). Use the

table of Characteristics of Good Design Versus Bad Design in your text (page 36) to identify whether the object you have selected is, in fact, the product of good design (and not every object that remains unmodified is an example of good design!)

Recently, the BBC's Science Focus Magazine published an article (https://www.sciencefocus.com/future-technology/cool-gadgets/) identifying some really cool new gadgets. Choose only one of them to think about in detail.

- Figure 2.7 on page 39 of your textbook shows an example flow chart of the Design Cycle. The first step is to Define the Overall Objectives. Identify clearly which product you have selected, and list at least three over-arching design objectives (design criteria).
- Revisit the Needs Hierarchy in the Chapter 02 slides. Construct a Needs Hierarchy for your chosen device. You must:
  - Identify at least three Top-Level Needs.
  - For each Top-Level need, identify two secondary needs.
  - Choose only two of your Secondary Needs, and identify two Tertiary Needs for each.
- Apply the Characteristics of Good Design Versus Bad Design in your text (page 36) to your chosen object. Overall, does the device meet the criteria for good design? Are there any glaring elements of bad design?