University of Toronto
Faculty of Applied Science and Engineering
APS111 & APS113 Engineering Strategies and Practice
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Midterm Examination
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This is a 70 minute midterm. There are **35** questions on the test. It is a multiple choice midterm and is closed book. No aids are permitted. Read each question thoroughly and provide the answer on the answer sheet. Be sure to fill out the answer sheet clearly with no overlaps. Fill out the answer sheet using a pencil. Erase any errors completely. One answer per question and each question is worth 1 mark. There is no deduction for wrong answers. Select the answer that best satisfies the question. You are not required to hand in the exam question booklet. You may tear off the appendix to ease answering of questions.

1. Which of the following would be considered doing due diligence?
   A. Developing at least one good design alternative
   B. Researching standards that pertain to a design project
   C. Chairing a team meeting
   D. Delivering a presentation to the client

2. Which of the following is a synonym for a design brief?
   A. Scoping document
   B. Conceptual design specification
   C. Problem statement
   D. Client statement

3. Which of the following is a synonym for project requirements?
   A. Scoping document
   B. Conceptual design specification
   C. Problem statement
   D. Client statement

4. The design process is iterative because:
   A. Design requires repeating phases in the process as more information is added
   B. It is **not** recommended that you revisit the problem definition stage once it is finished
   C. Idea generation requires creativity
   D. The design process, like close-ended problem solving, requires checking the solution

5. Scoping a problem is the process of:
   A. Expanding the design space
   B. Narrowing the design space
   C. Defining the design space
   D. Organizing the design space

6. A problem statement should be a:
   A. Complete set of requirements
   B. Succinct statement of the client's need
   C. Clear definition of the service environment
   D. Broad description of the problem the client wants solved

7. Free brainstorming is sometimes preferred over structured brainstorming because:
   A. It produces fewer ideas, but they tend to be higher quality
   B. It gives everyone a chance to participate
   C. It tends to produce more ideas if done well
   D. It produces a better organized list of ideas to be investigated

8. The goal of decision making in the design process is to identify the idea:
   A. the team thinks is the best fit for the client's need
   B. that will be the most marketable
   C. that will best fit the needs of the stakeholders
   D. that best fits the requirements

9. Weighted decision matrix method works best for:
   A. Weighing the relative benefits and costs of the design ideas against each other.
   B. Comparing ideas against the two most important objectives in the requirements.
   C. Scoring a small number of high quality solutions to recommended a design.
   D. Reducing a large number of ideas down to a manageable number.

Questions 10 to 14 pertain to the Team Study – Team Organization located in the appendix of this exam booklet.

10. What stage of the Tuckman model best describes where this team is currently?
    A. Forming
    B. Storming
    C. Norming
    D. Organizing

11. What warning signs should Gina and Finn watch for if they are concerned that Hari is hijacking the team?
    A. Hari becomes disengaged with the team and stops organizing meetings
    B. Hari only does the work he has been assigned to do and nothing more
    C. Hari organizes meetings that only one of them can attend
    D. Hari volunteers to edit all reports before they are submitted

12. What can Hari do to assure Gina and Finn that he is **not** hijacking the project?
    A. Set agendas for every team meeting
    B. Use his best judgment to assign each of the action items to the person he thinks will best do the job
    C. Send out emails every day to remind the team of the tasks they need to do
    D. Suggest Finn or Gina be responsible for compiling and submitting team reports

13. Which of the following is a well formulated team rule for this team?
    A. Work load should be evenly distributed so everyone shares responsibility
    B. The team leader should always organize team meetings
    C. If a team member breaks a rule they should have to buy snacks for everyone
    D. The team should avoid discussion of topics that cause conflict

14. This team should probably make decisions using which of the following methods?
    A. Finn makes the decisions after consulting with the team because he is the leader
    B. Hari makes the decisions after consulting with the team because he is organized
    C. Consensus because team discussion is very important in this team
    D. Voting because making decisions quickly is important in this team

End of Questions pertaining to the Team Study - Team Organization located in the appendix of this booklet.

Questions 15 to 31 pertain to the Case Study – Rapid Thawing of Frozen Meat and Fish located in the appendix of this booklet.

15. The need, or gap, in this case study can best be described as:
    A. An infra-red or microwave technology for heating meat from -18˚C to -4˚C
    B. A device for heating meat without damaging it
    C. A process for producing fresh fish or meat
    D. A method for thawing the water in a complex multiphase material

16. The primary functional basis of this design problem can best be described as:
    A. Transfer of electrical energy into meat or fish
    B. Transform ice into liquid in the meat or fish
    C. Extraction of ice from the meat or fish
    D. Sensing the temperature of meat or fish

17. A secondary function of this design problem can best be described as:
    A. Transfer of electrical energy into meat or fish
    B. Transform ice into liquid in the meat or fish
    C. Extraction of ice from the meat or fish
    D. Sensing the temperature of meat or fish

18. The best example of a benchmarking activity related to this project would be:
    A. Going to a fish market to observe how they package seafood and interviewing the people working there to get information.
    B. Testing the defrost function on a microwave with a 500g piece of frozen meat to observe the time it takes and the quality of the meat product produced.
    C. Taking samples of frozen meat, fresh meat and cooked meat to observe the qualities of the product under a microscope.
    D. Researching the literature on thawing meat and denaturing of proteins.

19. If you were approaching the analysis of this case using the Black Box Method, the outputs from the “black box” would include:
    A. Information indicating the meat is thawed
    B. Information about the starting temperature of the meat
    C. The user who will be taking the meat out of the device
    D. A refrigerator

20. The client statement lists possible approaches to solve the problem. These can be considered:
    A. Implied solutions
    B. Statements indicating the client's need
    C. A list of all acceptable solutions
    D. Solution independent

21. Suppose we analyze the list of possible approaches shown in the client statement to identify functions of the design. This method is called:
    A. Enumeration
    B. Functional basis analysis
    C. Decomposition
    D. Means analysis

22. An objective for this case study is:
    A. Have operating noise of less than 45dB
    B. Have a working life span of around 10 years
    C. Be easy to use; as few process steps as possible
    D. Increase the core temperature of meat from -18˚C to -4˚C

23. The statement which best expresses an objective goal for this case study is:
    A. Use less than 1000W of power
    B. Be easy to clean
    C. Have a working life span of around 10 years
    D. Increase the core temperature of meat from -18˚C to -4˚C

24. The statement which best expresses a constraint for this case study is:
    A. Have operating noise of less than 45dB
    B. Have little impact on appearance and color of the meat
    C. Be easy to use: as few process steps as possible
    D. Have a working life span of around 10 years

25. The client statement indicates that the client is seeking a solution that will take up relatively little space (i.e. “have dimensions less than 600 mm wide x 400mm high x 500 mm deep”). An appropriate metric for the objective “have a small volume” is:
    A. Measure the size of an existing device used for thawing meat, such as a standard microwave
    B. Measure the inside volume of a standard domestic refrigerator
    C. Measure the size (width, height and depth) of a prototype
    D. Interview users to determine their preference for the size of device they would like to have

26. If you were writing up a description of the service environment for this design, you would most likely include:
    A. A list of the types of meats and seafood likely to be thawed in the device
    B. The power usage of a standard domestic refrigerator
    C. A description of the effect of denatured proteins on meat quality
    D. A description of the lighting in a typical domestic kitchen

27. When brainstorming possible solutions to this design you should:
    A. **Not** include the possible approaches suggested by the client
    B. Include only the possible approaches suggested by the client
    C. Include the possible approaches suggested by the client and add new ideas
    D. Include only original ideas that have **not** been tried before to be innovative

28. If you were using the decomposition method to develop solutions to this problem; your decomposition steps would include:
    A. Substitute one part for another; Adapt existing technologies; Reverse or rearrange the processes
    B. User indicates meat to be thawed; system thaws meat; system indicates completion of process
    C. Meat is put into the device; user starts the process by pushing a button; user takes the meat out of the device
    D. Analyze the functions of the design; develop possible solutions; select an idea that meets the objectives

29. The problem posed in the case study can best be described as:
    A. Determinate
    B. Over-determined
    C. Open-ended
    D. A sizing problem

30. For the Case Study, which of the following is a useful statement of Stakeholder, Interest and Impact on Design:

	Stakeholder	Interest	Impact
A	Restaurants	Serve food and will use this device	• Easy to use • Efficient • Low cost
B	National Health Department	Keeping taxes low	Low cost
C	Refrigerator manufacturers	Profit	Proprietary information must be kept secret
D	City Health Department	Ensuring health of whole population	Easy for city health inspectors to examine in restaurants

31. One student team wants to include the following stakeholder for the case study: International Vegetarian Societies because their interest is to reduce human consumption of meat and fish. The team is trying to decide whether or not to keep this stakeholder. They should remove this stakeholder from their list because:
    A. The interest is not independent of the design
    B. The stakeholder would be a user
    C. Their interest has no impact on design decisions
    D. The PR should only have positive information

End of questions that pertain to the Case Study – Rapid Thawing of Frozen Meat and Fish located in the appendix of this booklet.

32. Which of the following is a **True** statement:
    A. Critical thinking is a good substitute for research.
    B. Critical thinking takes bias and validity into account.
    C. Critical thinking is the same as common sense.
    D. Critical thinking is a talent, not a learned skill.

33. A **claim** is a statement
    A. Based on facts
    B. Based on neither opinion nor fact
    C. Based on opinion
    D. Based on skeptical questions

34. Which of the following is a TRUE statement about evidence that supports a claim?
    A. You can support a claim with data that you generate scientifically.
    B. You can only support a claim with research from professional journals.
    C. You cannot support a claim with information from a personal blog or email.
    D. If you use a scientific principle to support a claim, it must have a reference.

35. A **fallacy** is a statement that
    A. Takes bias into account
    B. May be true but is not valid
    C. May be valid but is not true
    D. May not meet requirements

There are no questions beyond this point.

Appendix A: Written Sources

There are no questions in this appendix. You may detach this appendix for ease of answering the questions that pertain to the Team Study and Case Study.

A.1 - Team Study – Team Organization

The team of Finn, Gina, and Hari has been working together on a design project. Finn was chosen to be the team leader. However, after a few weeks it became clear that Hari was more organized so he has taken over arranging team meetings and keeping the project on track. At first this caused some difficulty and conflict in the team, but now it seems to be working out well. Gina and Finn still have some concerns that Hari was trying to hijack the team. However, they appreciate the quality of organization he has brought to their project.

A.2 - Case Study – Rapid Thawing of Frozen Meat and Fish

(Taken from a NineSigma project with minor modifications)

BACKGROUND

NineSigma's client is a global market leader in household appliances with research, development, manufacturing and sales operations in many countries. The client develops and manufactures domestic and industrial refrigerators and freezers.

Customers use freezers as a means to preserve foods and provide convenience in food storage. Meat and fish stored in a freezer is typically thawed or defrosted prior to use in cooking. A common method of thawing is leaving the product at room temperature or within the refrigerator for long periods (e.g. 2-24 hours). Customers have indicated that they wish to reduce the time taken to thaw frozen products.

Many red meat proteins begin to denature and change colour/structure at temperatures above approximately 38˚C, whilst fish proteins can denature at temperatures above 20˚C. This results in faster methods, such as the use of a microwave oven or a warm water bath, negatively affecting the appearance, texture or taste of the thawed meat and fish.

NineSigma's client seeks technologies or approaches to enable the rapid thawing of frozen meat/fish without compromising product appearance, taste, texture or nutrition.

REQUEST FOR PROPOSAL DESCRIPTION

NineSigma, representing a **global developer and manufacturer of refrigerators and freezers**, invites proposals for new technologies or approaches to enable the rapid thawing of frozen food products without compromising product appearance, taste, texture or nutrition.

A typical domestic refrigerator has an interior temperature of approximately 4˚C.

The successful technology will:

- Increase the core temperature of a 500g portion of meat or fish from -18˚C to -4˚C within 30 minutes maximum.
- Be suitable for integration within a domestic refrigerator or freezer
- Have little or no impact on appearance, taste, texture, nutrition, and color of the meat
- Be easy to use with few process steps
- Be easy to clean
- have a working life span of around 10 years
- have dimensions less than 600 mm wide x 400mm high x 500 mm deep
- use less than 1000W of power (absolute maximum)
- Have operating noise of less than 45dB (absolute maximum)
- Have a unit cost of less than US$50 at volumes of 3 million units per year
- Meet all relevant regulations and standards for marketing in North America

POSSIBLE APPROACHES

Possible approaches might include, but are not limited to:

- Pressure assisted thawing
- Far-infrared
- Air blast thawing
- Vacuum thawing
- Electrical resistance heating
- Microwave technology

APPROACHES NOT OF INTEREST

The following approaches are not of interest:

- Technologies that are harmful to humans
- Technologies that generate harmful substances
- Technologies not suitable for use in domestic appliances