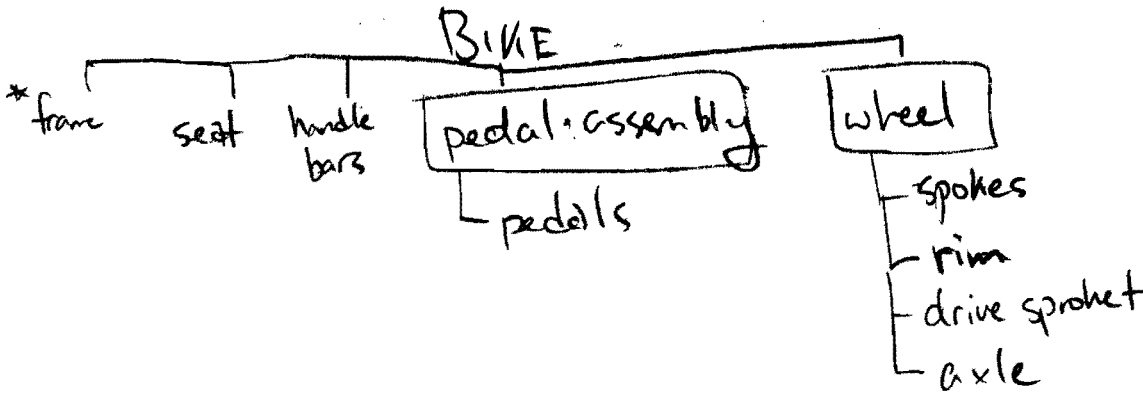


UNIVERSITY OF NOTRE DAME
 Department of Aerospace and Mechanical Engineering

Total Score: 46

This examination is administered under the University's Academic Code of Honor. All work submitted must be your own. This is a **CLOSED BOOK and CLOSED NOTES** examination. Do not take the exam apart and **PRINT** your name at the bottom of each page. Answer all questions in a concise and legible fashion - if it cannot be read, we will always assume the "wrong" answer. On the **TRUE** or **FALSE** and multiple choice questions circle the **most appropriate** response/s.

1. (3 pts) You have been asked to begin the development of a **parts hierarchy** concept map for a bicycle using just the following terms as "nodes." In the space below sketch the beginning of the map using these 11 items: frame, bike, spokes, pedal assembly, rim, pedals, handlebars, drive sprocket, seat, wheels, axle



* I see handle bars + seat attaching to (not being a part of) the frame.

2. (2 pts) The following activities are associated with the analysis or synthesis. Determine which term is most appropriate for each of the activities indicated below. Write the most appropriate term - **ANALYSIS** OR **SYNTHESIS** - on the line in front of each activity: (all correct-2 pts, 3 correct - 1 pt)

- a. Synthesis - focus on many options or opportunities
- b. Synthesis - asking questions
- c. Analysis - finding answers
- d. analysis - convergent thinking
- e. Synthesis - divergent thinking

3. (1 pt) **True** or False - Observing how a person behaves can often be more effective in understanding what they think of a product than asking them to provide an assessment of the product.

4. (1 pt) The acronym CAE stands for Computer Aided Engineering

5. (3 pts) In this class a claim has been made that the design of systems or products always involves an interaction between three FACTORS, these three factors are: (Fill in the blank)

- a. business
- b. technical
- c. human

6. (1 pt) Using the terminology from the House of Quality, the “whats” provided by a customer or stakeholder are usually (circle all responses that apply):

- a. quantitative
- b. focused on their needs not that of others who may use the product
- c. qualitative
- d. influenced by their past experiences
- e. all of the above
- f. none of the above

7. (1 pt) Eggert represents the engineering design process as a linear sequence of 5 phases with iteration. In the blanks following the terms below, indicate the order in which these phases normally occur, 1 to 5.

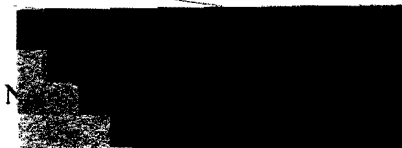
- a. Parametric 4
- b. Configuration 3
- c. Formulation 1
- d. Concept 2
- e. Detail 5

8. (2 pts) The following is a list of characteristics/attributes associated with Left-mode(brain) or Right-mode(brain) thinking. In the table below fill in the boxes and identify the attribute with the appropriate mode. Note there is NOT a corresponding Right-mode characteristic for each Left-mode characteristic, i.e. the two sides of the table are independent and there are not necessarily the same number of attributes for each mode.

Characteristics/Attribute: Temporal, Analytic, Holistic, Spatial, Non-verbal, Digital, Intuitive, Linear

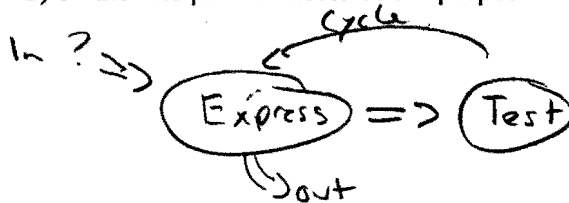
<input checked="" type="checkbox"/> Left-mode (brain)	<input checked="" type="checkbox"/> Right-mode (brain)
temporal	spatial
analytic	non-verbal
digital	intuitive
linear	holistic

9. (1 pt) True or False – To be effective, Engineering Design Requirements should be quantifiable features or measureable characteristics of the design.



10. (1 pt) Sketching or drawing can help you:
- a. bring vague objects/ideas into focus
 - b. identify the optimal solution to a problem
 - c. provide a means of talking to yourself
 - d. enhance talking to others
 - e. all of the above

11. (2 pts) A process for “imagining and thinking” was discussed and referred to as ETC – Express – Test – Cycle and there were five terms associated with the process. 1) Sketch a “schematic” to represent the ETC process and 2) on the line provide describe the purpose of the “Cycle” phase of the process.



Cycle - trial and error approach to return to express w/ better ideas

12. (1 pt) True or ~~False~~ – Engineering Design Requirements are expressed as an organized and prioritized list of customer desires or needs.

13. (1 pt) Briefly describe below what it means for an Engineering Design requirement to be “universal.”
 It should apply to all possible designs (should not limit design options)

14. (2 pts) Engineering design requirements are developed via a process that involves – (circle all the activities that make up this process.

- a. Asking questions
- b. Gathering data
- c. Making decisions prior to the process of developing solutions
- d. Evaluating potential candidate designs
- e. Relating “whats” to “hows”

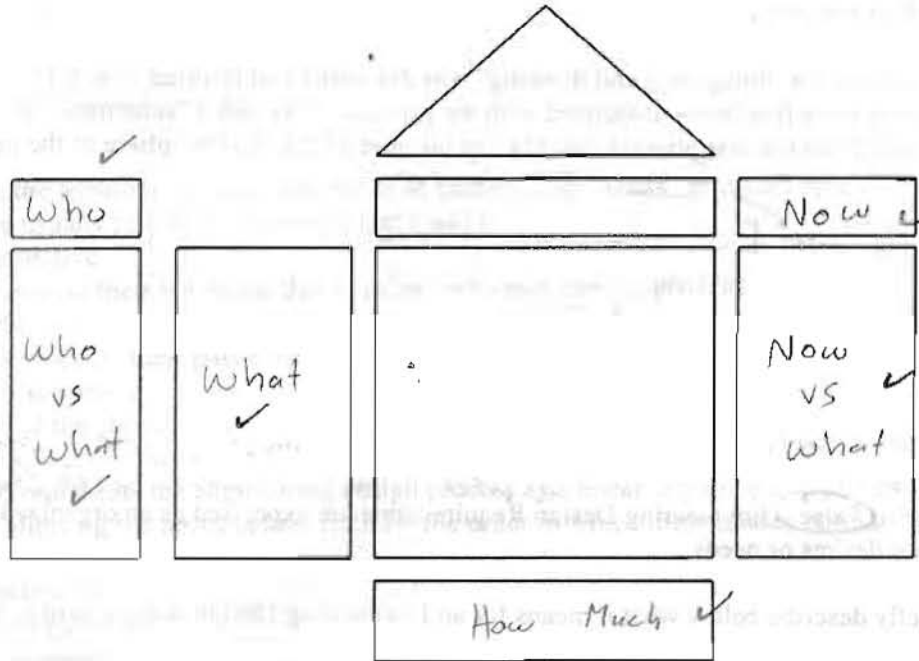
15. (1 pt) True or ~~False~~ – The House of Quality approach is exclusively used to develop engineering characteristics from customer requirements.

16. (1 pt) True or ~~False~~ – The purpose of a brainstorming session is to solve a specific design problem and at the conclusion of a successful session a group should be able to state the problem’s solution.

17. (1 pt) If you are only using one criterion to select between alternative concepts using the weighted-sum method, the importance weight of that criterion is 100 %.

18. (1 pt) The purpose of a staged-gate or toll-gate design process in many organizations is to provide a step-by-step validation of the process in order to reduce risk.

19. (6 pts) The following figure represents the framework for the House of Quality, a method used to develop engineering design requirements. Also listed below are SOME of the "names" of the "rooms" in the house. a.) Label each room on the figure with its appropriate title from the list below and then briefly describe the content of each of the rooms you labeled. NOTE: YOU ONLY NEED TO LABEL AND DESCRIBE THE "ROOMS" LISTED BELOW - NOT ALL OF THEM.



a. What - qualitative reasons why a customer chooses a products (ex rides smooth, goes fast, stores lots of gear) no units involved.

b. Now Competitors products

c. Now vs. What How your competitors products satisfy the customers wants (what). ranked 1 (not good) - 5 (very good)

d. How Much How products (yours and competitors) meets How's. Each product has quantitative (number) result and customers goal (delighted/disgusted)

e. Who vs. What How the customers (who) prioritize each what, gives a weighted importance of each what

f. Who Any potential customers (consumers, repairmen, manufacturers)

20. (1 pts) Two basic characteristics of a designed artifact are often referred to as: 1) FUNCTION and

2) Form.

21. (3 pts) List three of the "rules" recommended for a brainstorming session.

- encourage wild ideas.
- build on ideas
- one person speaking at a time

22. (1 pt) True or False: Design is NOT an exact science.

23. (1 pt) True or False Engineering is an exact science.

↳ probabilistic

24. (2 pts) List two potentially useful outcomes from a brainstorming session:

- quantity of ideas (100 per hour for group of 8)
- better understanding of the problem and creative ideas

25. (4 pts) During the concept selection process a designer may consider the function, physical principle and abstract embodiment associated with a specific component. Indicate for the items listed below if they are: 1) function, 2) physical principle, or 3) abstract embodiment.

- Bolt abstract embodiment
- Reduce speed function
- I-beam abstract embodiment
- Amplify function
- Hooke's law physical principle
- Thermal conduction physical principle
- Change direction function
- Polymer adhesive abstract embodiment (adhesion is physical principle)

26. (1 pt) Briefly describe the ways in which a cultural anthropologist might contribute to a consumer product design project.

They better understand the end user and can provide ideas of how a design might better account for human factors. They also provide a different perception which might provide ideas that would otherwise not have been thought of

27. (5 pts) This question allows you to demonstrate a basic understanding of the Pahl-Beitz (Weighted Sum Method) as discussed in class. Complete the following form for the information provided below and determine which of the three concepts appears most appropriate at this point in the design process.

You have three concepts you are considering: Concept A, Concept B and Concept C.

You are evaluating the concepts against three criteria: Criteria I, Criteria II and Criteria III.

You decided the importance of Criteria I was 20% and Criteria III was 50%.

The your assessment of each concept against each criteria is:

Concept A [Criteria I – Adequate, Criteria II – Very good, Criteria III – Just tolerable]

Concept B [Criteria I – Good, Criteria II – Good, Criteria III – Unsatisfactory]

Concept C [Criteria I – Just tolerable, Criteria II – Adequate, Criteria III – Very good]

		Concept Alternatives					
		Concept A		Concept B		Concept C	
Criteria	%						
Criteria 1	20	2	.40	3	.60	1	.20
II	30 ✓	4	1.20	3	.90	2	.60
III	50	1	.50	0	0	4	2.00
			2.10		1.50		2.80

Rating	Value
Unsatisfactory	0
Just tolerable	1
Adequate	2
Good	3
Very Good	4

Briefly explain which concept you would recommend for further consideration and why.

I recommend Concept C. Because of its great success with Criteria III, it is the concept with the highest score of 2.80. ✓ Concept A had a score of 2.10, and Concept B of only 1.50. If criteria III is that important, ~~g~~ consider Concept C further.