Student # _____

Ph.D. Qualifiers Examination in

ENGINEERING DESIGN

Fall 2009

Instructions

The study guide states that to be successful on this exam, you must demonstrate that you know:

- How to formulate a problem,
- How to sketch and understand engineering drawings (projections),
- How to obtain order of magnitude results (approximate analysis),
- What next steps you would take to get to a more in-depth solution,
- How to identify failure criteria and assess failure,
- How and when to perform optimization, and
- How to implement component design.

You should show analytical insight through design solutions that exhibit the level of maturity and understanding expected of Master's level students. Remember that there is not a single correct solution, but we are interested in seeing your thought process.

This design examination is open-ended to some extent, allowing you to demonstrate your creativity, resourcefulness, and mastery of various aspects of design. The design problem statement may lack certain details, much as problems in industry or academe. As such, you may need to make some reasonable assumptions and suggestions in order to develop potential designs. Be certain to clearly identify any assumptions you feel you need to make in order for a certain design feature or concept to be a reasonable solution. You are expected to address what is known about the design problem, but also what is not known and make suitable design decisions and conclusions.

The exam evaluators have no preconceived notion/ideas of the best solutions. Thus, you will be graded on your process of thinking and approach to open design problems.

Be sure to pace yourself to finish in the time allotted. Consider spending about 15 minutes maximum on Part 1, 50 minutes on part 2, and 55 minutes on part 3.

Good luck!

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Problem Statement

With today's health conscious citizens, people are coupling cycling and canoeing! However it is difficult to transport canoes from a home to a body of water (river, lake, etc) using a bicycle.

To meet this need you are to design a system for transporting a canoe from a home in downtown Clemson to Lake Hartwell.

Some key information:

- the typical round trip distance is limited to about 5 miles, staying within the city limits.
- customers can sustain around 0.5 hp (~370 W) for about 50 minutes with a resulting speed of 25 mph.

You are expected to consider the design of your mechanism(s) and structures to fulfill this need.

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Canoe specifications

Length	16' 3”/ 496 cm
Width @ 4" waterline	34" / 86 cm
Maximum	36" / 91 cm
Center Depth	15" / 38 cm
Bow Depth	22" / 56 cm
Stern Depth	21" / 53 cm
Bow Rocker	2.25" / 6 cm
Stern Rocker	2.125" / 5.5 cm
Average Weight	82 lbs / 38 kg
Max Capacity 6" Freeboard	1100 lbs / 499 kg

The cost of the canoe is $600.00

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Trailer Bemchmarks

Sample benchmark concepts that may be included in your evaluation process.

Concept A: Trailer

Concept B: Side Car

Concept C: Trailing Bike

Concept D: Basket

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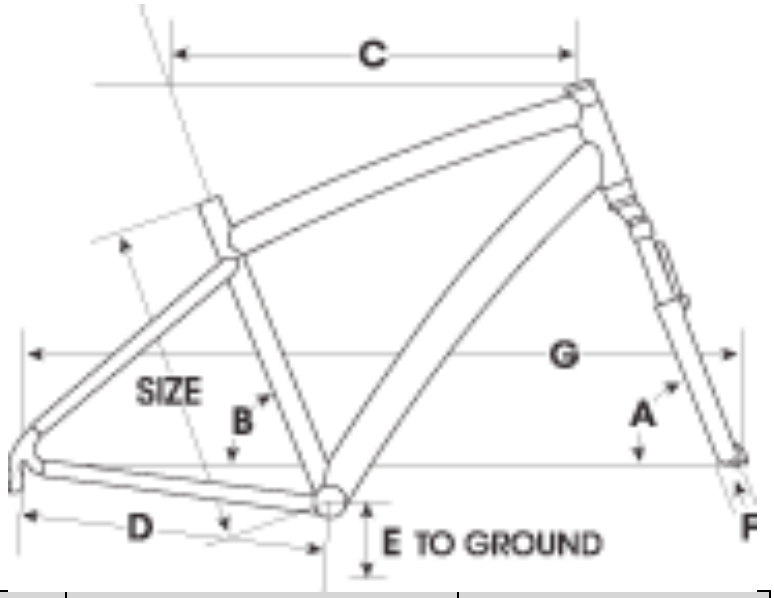
Bike specifications



	Frame Size	M (18 in)
A	Head Angle	69.0°
B	Seat Angle	68.0°
C	EFF Top Tube	23.1
D	Chain Stay	17.1
E	Bottom Bracket	11.1
G	Wheel Base	41.0
	Tire size	26.0 diameter

The cost of the bicycle is approximately $400.

Stage 1: Problem Formulation and Concept Development

Part 1.1: In lieu of spending time formulating the problem, we ask you to consider the following requirements (note – you may expand on these requirements):

1. *The system must interface with the bike*
2. *The system must be able to be removed for normal commuting*
3. *The system must be secure*
4. *The system must fulfill the functionality for different types of bicycles*
5. *The system must not require permanent modification to canoe or bicycle*
6. *The system must not damage the bicycle or canoe*
7. *The system must be stable*
8. *The system must be esthetically pleasing*
9. *The cost of the trailer should not exceed the canoe or the bicycle*

Part 1.2: *Determine* the functions of the system.

Part 1.3: Develop a set of conceptual solutions that address the requirements and functions

Stage 2: Analysis, Evaluation, and Failure Mode Identification

Part 2.1: *Identify* critical failure modes of the proposed solution. Examine the effects of these failure modes and discuss approaches for addressing these.

Part 2.2: *Formulate* an analysis plan for the conceptual design solutions. Determine what analysis (e.g., computational, experimental, physical prototyping) is required to improve upon the design and generate a viable solution. Specifically identify what analysis must be performed and to which component / assembly.

Stage 3: Critical Component Design and Generalization

Part 3.1: *Select* the most critical component or interface in the existing solution. Explain why you feel this is the most critical element.

Part 3.2: *Implement* a detailed solution for the selected component. Provide specific details to progress from conceptual design to detailed design specifications, including analysis steps, manufacturing plan, critical interfaces, etc.