Name _____
ASE 379L Mid-term Exam - March 5, 2008
100-point total

Problem 1
Explain the difference between validation and verification of requirements. Provide an example requirement and how it would be validated and verified. (10 points)

Validation: ensuring requirement is correct, complete, well-defined, meets need of customer
→ use SMART test to validate
→ performed early in life cycle, predominantly Phase B

Verification: ensuring that the system as designed and built meets the stated requirements
→ various methods used such as test or analysis
→ performed later in the life cycle, usually in Phase D

Problem 2

For these 4 example requirements:

(1) Rewrite them correctly and explain why the original is incorrect, **OR** (2) explain why it should not be a requirement. (5 points each; 20 points total)

- The rover must be compatible with the lunar communications network, providing data, video, and audio capability.

  must be → shall
  compatible → vague
  multiple Rqmts
  The rover shall use the lunar comm network.
  → children Rqmts for data, video, audio

- The Orbital Maneuvering Vehicle design shall provide adequate design margin in such areas as: dry weight, electrical power, and propulsion system performance.

  Not a rqmt
  This (design margins) is part of sys. eng process & management of design.

- The spacecraft contractor shall precisely land a payload of science instruments on the surface of Mars while taking atmospheric measurements during the descent phase.

  → Rqmt not on contractor
  → precisely is vague
  → separate into 2 requirements
  "The s/c shall deploy a payload of science instruments on the surface of Mars."
  "The s/c shall measure atmospheric conditions during the descent phase."

- The crew shall handle the specimens using a glovebox.

  Not a Rqmts
  Rqmts are not applied to the user
  This is an operational procedure

Problem 3

List the 5 system life-cycle phases (from project inception to launch, not including operations and disposal) in order. Define each phase, describing at least 2 important activities/products during that phase and at least 1 critical control gate that must be achieved before progressing to the next phase. (30 points)

6pts { (1) Phase – Name (1)
(1) →
(1) →
(2) control Gate

[see Project Life Cycle Module for answers]

Problem 4

Match definitions with key systems engineering terms, using the word bank below.
(2 points each; 20 points total)

WORD BANK:

a) functional analysis	b) spacecraft bus	c) margin
d) mission scope	e) heritage	f) objective
g) analytical hierarchy process	h) need	i) figures of merit
j) descope	k) systems engineering	l) payload
m) allocated baseline	n) goal	o) product baseline
p) cost benefit analysis	q) Taguchi method	r) contingency
s) design parameter	t) six sigma	u) concept of operations

r

When added to a resource, results in the *maximum expected value* for that resource. Takes into account expected development threats. Managed by the subsystem lead as part of the lower level design process.

m

Extends the top-level performance requirements of the functional baseline to sufficient detail for initiating manufacturing or coding of a configuration item. Typically established at the Preliminary Design Review (PDR).

a

The systematic process of identifying, describing, and relating the functions a system must perform in order to fulfill its goals and objectives.

i

A metric by which a stakeholder's expectations will be judged in assessing satisfaction with a product or system.

g

Determines "best" through a series of pair-wise comparisons; can be used to determine attribute weightings as well as alternative scores.

u

Describes the system characteristics from an operational perspective and helps facilitate an understanding of the system goals. It stimulates the development of the requirements, and serves as the basis for subsequent definition documents.

j

The management act of removing content from the original baseline of a project. Often equates to reducing mission or system capability, such as the removal of a scientific instrument.

h

Explains why the project is developing this system from the stakeholders' point of view.

k

A robust approach to the design, creation, and operation of systems. This approach is iterative, with several increases in the resolution of the system baselines (which contain requirements, design details, verification plans, cost and performance estimates).

b

A robotic vehicle that provides house-keeping functions in the form of subsystems, such as power and temperature control.

Problem 5
Design margins calculation (10 points)

A payload in the design phase has an estimated mass of 115 kg including a proposed mass contingency of 15 kg. There is no other payload on the Expendable Launch Vehicle (ELV) and the ELV provider plans to allot to you the full capability of the vehicle, if needed. The ELV capability is 200 kg.

- What is the mass contingency (as a percentage, %)?

$$\frac{\text{cont.}}{\text{est mass} - \text{cont}} \times 100$$

$$\frac{15}{115 - 15} \times 100 = 15\%$$

- What is the mass margin (as a percentage, %)?

$$\frac{\text{Margin}}{\text{Max possible value} - \text{margin}} \times 100 =$$

$$\frac{85}{200 - 85} \times 100 = 74\%$$

Problem 6

General questions (First 3 questions are 2 points each; last question worth 4 points):

- How is a work breakdown structure (WBS) different from a system hierarchy?

WBS includes the functions (eg, project mgmt, chief eng etc) as well as the products, broken down by subsystem while a hierarchy deals only with the products to be created.

- How is a performance requirement different from a functional requirement?

Functional Rqt - describes "what" something must do (what its function is)

performance Rqt - describes "how well" something has to be done (often quantitative)

- How is robust design different from optimization?

Optimization deals with the absolute best solution while robust design is the best solution given off nominal conditions.

Robust design reduces sensitivity to variations, while optimization simply seeks to maximize or minimize a parameter without taking into consideration how the variables could vary.

- What does the acronym SMART stand for? (Just the words; no explanation required).

Specific

Measureable

Achievable

Relevant

Traceable