

Answer all questions on this exam. For multiple choice questions choose the best answer for each question and circle that answer. Multiple choice questions are 3 points each. Please use the space allotted for short answer questions. This test is two sheets with questions on both sides of each sheet. Good luck.

1. The current engineering design trend, "Engineering without Walls" involves
 - a. engineering departments from several companies working together to create a new product
 - b. the use of an open office concept in engineering office design
 - c. engineers working more closely with other departments rather than just "Throwing a design over the wall" to production
 - d. engineers meeting at locations away from the office to inspire new ways of thinking.
 - e. engineers in Hawaii working in rooms with only a roof because of the tropical weather.

2. The Statement/Restatement process is used to
 - a. improve clarity of a memo.
 - b. develop an improved problem statement.
 - c. facilitate communication in a group to make sure all members understand each other.
 - d. prepare legal documents
 - e. none of the above

3. General Project Goals include
 - a. safety
 - b. ease of operation
 - c. portability
 - d. a. and b. only
 - e. all of the above

4. Iconic models are
 - a. "functionally equivalent but incomplete representation of a physical process or system"
 - b. "visually equivalent but incomplete two-dimensional or three-dimensional representation."
 - c. representations that "include the most important aspects of the process or system in symbolic form, neglecting all (presumably) irrelevant details."
 - d. designs for computer desktop links
 - e. b and d above

5. Any engineering design processes will generally include
 - a. iteration
 - b. investigation of multiple possible solutions
 - c. problem definition
 - d. presentation/Implementation
 - e. all of the above

6. Simple force times distance relationships force distance relationships are
 - a. used to calculate the effect of a lever
 - b. used to calculate the effect of a pulley system
 - c. based on the conservation of energy
 - d. neglect the impact of friction and/or air drag
 - e. all of the above

7. Engineering Specifications
 - a. should be quantitative
 - b. are usually written as equalities
 - c. are independent of the detailed list of goals
 - d. a. and b. only
 - e. all of the above

8. Possible deliverables for a project task include:

- a. memos
- b. drawings
- c. research
- d. a. and b. only
- e. all of the above

9. The units for energy:

- a. are a force times a distance
- b. can be represented by Newton-m
- c. are the same as the units for work
- d. a. and b. only
- e. all of the above

10. (5 pts.) Identify the problems with the following memo header:

"To" should be the first item.

From: Jane
To: George Jungle
cc. Dr. E. Shep
Date: June 23rd
Subject: Progress Report

All names must be the same. With consistent titles and use of first and last name

Date should include year

Subject should be more specific

11. (5 pts.) Complete these metric conversions:

a. How many kOhms is 0.78 MOhms?

780 kOhms

b. Convert 0.18 kg / (m s) to g / (cm s).

0.18 kg	1000 g	m	= 1.8 g / (cm s)
m s	kg	100 cm	

c. Convert 1.28 g/cm³ to kg/m³

1.28 g	kg	(10 ² cm) ³	= 1,280 kg/m ³
cm ³	1000 g	m ³	

12. The group UAΔT represents a rate of heat transfer. U is the heat transfer coefficient with units of kg/(s² Kelvin), A is the area of transfer, and ΔT is a temperature difference in degrees Kelvin.

a. (5 pts.) What are the MKS basic units of this group?

U	A	ΔT	= kg m ² /s ²
kg	m ²	k	
s ² K			

b. (5 pts.) The resulting units are equivalent to the units for (circle one):

- i. force
- ii. energy
- iii. acceleration
- iv. power
- v. none of the above

13. (5 pts.) The period of a pendulum is related to its mass (m), the acceleration of gravity (g), its moment of inertia (I) and its moment arm (L). The basic equation is of the form:

$$T_p = 2\pi f\left(m, g, \frac{I}{L}\right) \quad (\text{i.e., } T_p = 2\pi \text{ times a function of } m, g, \text{ \& } I/L)$$

The units of each of these quantities are:

$$m [=] \text{ kg} \quad g [=] \text{ m/s}^2 \quad I [=] \text{ kg m}^2 \quad L [=] \text{ m} \quad T_p [=] \text{ s}$$

Using the MKS basic units, propose the form of the function $f(m, g, I/L)$ that has proper units.

- Need seconds the only place to get that is from g .
- g will need to be in the denominator and square rooted to yield s
- I/L has units of kg m , it will go in numerator to cancel the meters
- m will go in denominator to cancel kg introduced by I/L

$$T_p = 2\pi \sqrt{\frac{I}{mgL}}$$

14. The flow rate through a circular restriction in a pipe (an orifice) for an incompressible liquid is given by

$$Q = C_f A_o \sqrt{\frac{2\Delta p}{\rho}}$$

where: Q = volumetric flow rate C_f = orifice coefficient A_o = area of the orifice
 Δp = pressure drop ρ = the density of the liquid

- a. (6 pts.) Show two simple proportionalities derived from this equation.

$$Q \propto A_o \quad Q \propto \sqrt{\Delta p} \quad Q \propto \sqrt{\frac{1}{\rho}}$$

- b. (4 pts.) Suppose you can experiment with a given orifice (I.E., the area and coefficient are fixed) and a fixed fluid (i.e. density is fixed). Derive a lumped parameter model that relates the pressure drop to the flow rate using a single parameter that can be determined experimentally.

$$Q = A \sqrt{\Delta p} \quad \text{where } A = C_f A_o \sqrt{\frac{2}{\rho}}$$

15. (10 pts.) Briefly outline the steps in the engineering design process as described in this course and your text. Include the basic steps in the process and key principles of how they are applied.

Steps	Key principles
1. Needs Assessment	Clearly define the problem
2. Problem Definition	Develop Multiple potential Solutions
3. Abstraction & Synthesis	Select "best" solution
4. Analysis	Iterate
5. Implementation	Document

16. (10 pts.) What key items should be included on the first page of a technical report memo.

Purpose of communication or work

Brief Background/problem definition

The bottom line - key recommendations or conclusions

Methodology (briefly)

17. (20 pts.) For each case study mentioned on the left match a characteristic from the list that describes a key aspect of the case study. Place the letter associated with that characteristic in the box by the case study.

Letter	Case Study		Characteristic
H	Single-use camera	A	inadequate information available/ exchanged between companies
E	The Kwik-Loc Closure	B	lowest bid may not be the lowest total cost
J	The Quick-Release Ski Binding	C	an example of the importance of treating customers well
A	Lake Peigneur	D	Shows the importance of ease of use (fail-safe controls)
D	The DC-8 Crash (Ground Spoilers Early Deployment)	E	developed because company needed a new product
B	The Hubble Space Telescope Failure	F	use increased with reduced cost & improved performance
I	The Mianus River Bridge Collapse	G	failed because of inconsistent units
G	Mars Climate Orbiter	H	an example of redesigning for export
C	The Pentium Computer Chip Problems	I	Illustrates the importance of ease of maintenance
F	Fax Machines	J	a design motivated by personal experience