Sample Questions from Senior Exam

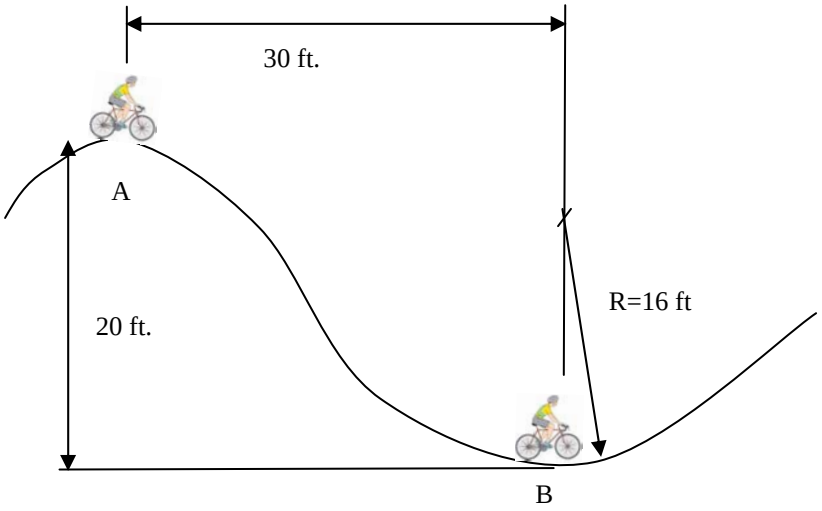
Criterion 3(a)

Skill 1: The student will be able to evaluate basic geometrical quantities and mathematical expressions.

Skill 2: The student will have knowledge of basic sciences and associated analysis techniques.

A 175 lb cyclist starts from rest on his 30 lb bicycle at the top of a hill (Point A). Each wheel of the bicycle weighs 5 lbs and is 27" in diameter and can be modeled as a uniform flat disk ($I_{center} = 1/2mr^2$). Assume that wind resistance and rolling friction of the wheels and bearings is negligible. The rider glides down the hill (without pedaling) until he reaches the bottom (Point B) where the hill has a radius of curvature of 16 ft.

a) What will be his speed when he reaches the bottom of the hill (Point B)?
b) What net force does the bicycle exert on the rider at the bottom of the hill?



Please evaluate the following integrals:

a) Integrate $\int_{y_1}^{y_2} \frac{A}{y^n} dy$ where $n \neq 1$ and A is a constant

b) Integrate $\int_{y_1}^{y_2} \frac{A}{y} dy$ where A is a constant

c) Integrate $2\int_{0}^{\pi/2} \cos\theta d\theta$

d) Integrate $\int \frac{dx}{A - Bx}$ where A and B are constants

e) Integrate $\int e^{-Bx} dx$ where B is a constant

Criterion 3(a)

Skill 3: The student will be proficient with basic analyses associated with other disciplines.

15 lbm of propane are stoichiometrically burned in air. How many cubic feet (ft^3) of dry CO_2 gas are formed after cooling the gas to 70°F and 14.7 psia? You may use the information in the table below to help solve the problem.

Substance	Chemical Formula	Molecular Mass	
Air		28.97	lbm/lbmol
Argon	Ar	39.94	lbm/lbmol
Carbon Dioxide	CO_2	44.01	lbm/lbmol
Carbon Monoxide	CO	28.01	lbm/lbmol
Hydrogen	H_2	2.016	lbm/lbmol
Nitrogen	N_2	28.01	lbm/lbmol
Oxygen	O_2	32	lbm/lbmol
Propane	C_3H_8	44.09	lbm/lbmol
Sulfur Dioxide	SO_2	64.06	lbm/lbmol
Water	H_2O	18.02	lbm/lbmol
Universal Gas Constant	R*	1545.33	ft-lbf/lbmol-R

Criterion 3(b)

Skill 1: The student will be proficient with the selection and basic operation of common instrumentation used in engineering measurement.

Manometers are simple and inexpensive devices for measuring pressure that are widely used by engineers today. Draw and label a schematic of a U-tube manometer and briefly describe how it is used to measure pressure.

Criterion 3(b)

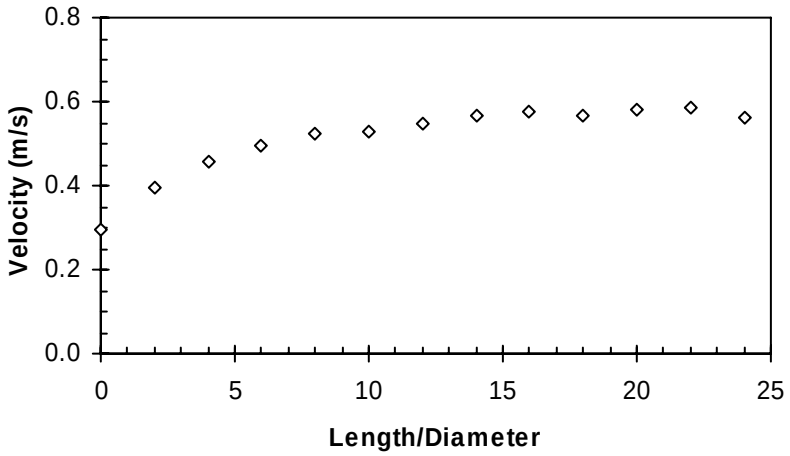
Skill 2: The student will be able to design and conduct an experiment and compare the results to those predicted by an analytical tool.

You are designing a new insulated jacket for a soda can. You have several different designs and you want to compare their thermal performance. Design an experiment to determine the rate of heat loss. In your answer, describe the requirements of a properly designed experimental investigation and the instruments you will need to measure any required physical properties.

Criterion 3(b)

Skill 3: The student will be able to interpret and discuss the results.

The time-averaged velocity of air flowing in a duct is measured at the center of the duct at several locations downstream of the inlet as shown. At what location has the flow become fully developed hydrodynamically? Briefly explain your answer.



Criterion 3(c)

Skill 1: The student will be able to recognize a need and develop appropriate design specifications.

Skill 2: The student will be able to develop component, system, or process concept solutions based on above specifications.

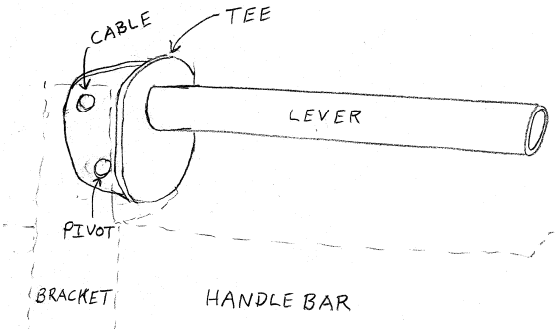
Skill 3: The student will be able to refine the design of a component, a system, or a process.

S-Move, a mobility start-up company, has hired you as a consultant to design the brake system for its new 3-wheel ultralight low-cost commuter vehicle. The S-Move 100, loosely based on the award-winning Cal Poly Human-Powered Vehicle, will carry one person plus luggage at speeds up to 40 mph. Some useful facts:

Max. occupant weight:	300 lb
Target vehicle weight:	100 lb
Target stopping distance:	40 ft
Avg. hand-grip force:	50 lb
Rubber/asphalt friction:	0.8
Rubber/steel friction:	0.7
Wheel diameter:	20 in

a) Develop an appropriate problem statement and <u>complete</u> list of engineering specifications for the brake system.
b) Based on your problem statement, propose <u>at least 5</u> feasible concept solutions. Use appropriate methods to select the best single concept for further development. Draw a clear sketch of this concept, but do not develop it into a detailed design.

c) A simple caliper brake system has been selected and you must now complete the detailed design of the brake lever. The concept, shown below, consists of a hollow steel pipe welded to a 'Tee.' The Tee pivots inside a bracket on the handlebar, and the brake cable is attached at an upper hole in the Tee. Using a safety factor of 2.5 on the grip force, find the minimum tube size (see list on next page) and Tee thickness. The pipe material properties are: S_y = 30 ksi and S_u = 55 ksi. Document any assumptions.



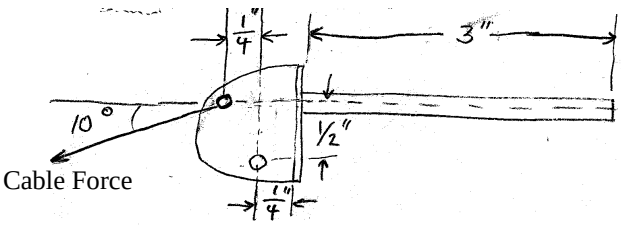


TABLE A16–6 Properties of American National Standard Schedule 40 welded and seamless wrought steel pipe

Diameter (in)					Properties of sections			
Nominal	Actual inside	Actual outside	Wall thickness (in)	Cross-sectional area of metal (in^2)	Moment of inertia, I (in^4)	Radius of gyration (in)	Section modulus, S (in^3)	Polar section modulus, Z_p (in^3)
1/8	0.269	0.405	0.068	0.072	0.001 06	0.122	0.005 25	0.010 50
1/4	0.364	0.540	0.088	0.125	0.003 31	0.163	0.012 27	0.024 54
3/8	0.493	0.675	0.091	0.167	0.007 29	0.209	0.021 60	0.043 20
1/2	0.622	0.840	0.109	0.250	0.017 09	0.261	0.040 70	0.081 40
3/4	0.824	1.050	0.113	0.333	0.037 04	0.334	0.070 55	0.141 1
1	1.049	1.315	0.133	0.494	0.087 34	0.421	0.132 8	0.265 6
$1\frac{1}{4}$	1.380	1.660	0.140	0.669	0.194 7	0.539	0.234 6	0.469 2
$1\frac{1}{2}$	1.610	1.900	0.145	0.799	0.309 9	0.623	0.326 2	0.652 4
2	2.067	2.375	0.154	1.075	0.665 8	0.787	0.560 7	1.121
$2\frac{1}{2}$	2.469	2.875	0.203	1.704	1.530	0.947	1.064	2.128

Criterion 3(d)

Skill 1: The student will recognize the value of a broad skill set resulting from a multidisciplinary team.

An effective product design team should include all the following members **EXCEPT**:

a. Marketing
b. Design Engineer
c. Test Engineer
d. Sales Personnel
e. All should be included

Criterion 3(d)

Skill 2: The student will be able to communicate effectively with colleagues in other disciplines.

The following all improve communication among design team members **EXCEPT**:

a. Use of agendas for meetings
b. Active listening skills
c. Have team members speak only when discussing their area of expertise.
d. Have clearly written design requirements
e. Constructive feedback

Criterion 3(d)

Skill 3: The student will be able to identify when problems occur due to poor interactions among team members and identify ways to improve team dynamics.

Which of the following conflict resolution techniques is most effective at overcoming problems and improving creativity and performance on teams?

a. Avoidance
b. Confrontation
c. Collaboration
d. Accommodation
e. Compromise

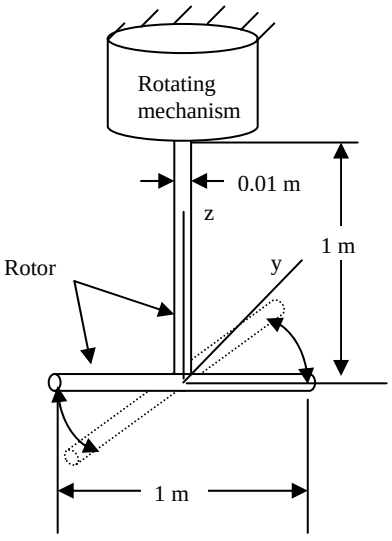
Criterion 3(e)

Skill 1: The student will be able to identify faulty products or processes and develop an engineering solution.

Skill 2: The student will be able to select appropriate models for analyzing a system.

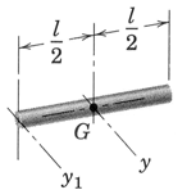
Skill 3: The student will be able to analyze their models and interpret their results.

A rotor mechanism in a manufacturing process consists of two identical slender rods welded together at 90 degrees to form a 'T', as shown below. The rotor is connected to a fixed mechanism that causes the assembly to rotate back and forth about the z axis at a rate of 4 cycles per second. The vertical shaft was found to have fatigued and broken, requiring the device to be replaced. It is suggested that the rotor is being driven near the rotor's first torsion natural frequency aggravating the problem. Data from the material supplier and a vibrations handbook are given below.



$k = \frac{Gd^4}{32L}$ Stiffness for rod in torsion, $k = \frac{EA}{L}$ Stiffness for rod in tension/compression

G = modulus of rigidity (G for steel = 80×10^9 N/m^2), D = rod diameter (0.01 m), L = rod length (1 m), E = modulus of elasticity (E for steel = 200 GPa), Density of steel (7500 kg/m^3)

	Uniform Slender Rod	—	$I_{yy} = \frac{1}{12}ml^2$ $I_{y_1y_1} = \frac{1}{3}ml^2$

a) Determine if the system is currently driven at or near the natural frequency. Neglect damping for your calculations.

b) If the rotating mechanism is modified to increase the speed by 10% will the problem be alleviated or made worse? You must support your conclusions with valid analysis for credit.

Criterion 3(f)

Skill 1: The student will have knowledge of ASME code of ethics.

The Professional Obligations section of the Code of Ethics for Engineers lists numerous expectations for engineers. Which one of the following is **not** among those obligations?

a. Engineers shall acknowledge their errors and shall not distort or alter the facts.
b. Engineers shall advise their clients or employers when they believe a project will not be successful.
c. Engineers may accept outside employment regardless of its effect on their other obligations if it generates additional revenues. Based on privacy laws, they do not have to notify their current employers.
d. Engineers shall not attempt to attract an engineer from another employer by false or misleading pretenses.
e. Engineers shall not promote their own interest at the expense of the dignity and integrity of the profession.

Criterion 3(f)

Skill 2: The student will be able to identify health and safety concerns associated with their design.

You have been asked to design an industrial ventilation system for a wood shop that generates a significant amount of wood dust. What are the types of hazards that you should recognize in this type of application? What types of safety requirements are you required to follow?

Criterion 3(f)

Skill 3: The student will be able to identify situations with ethical concerns.

A professional engineer is about to retire. Since the fees for his license were paid by his former employer, his P.E. designation will no longer be active unless he pays himself. However, he would like to continue to use his P.E. designation after his name when he works with the local

government agencies and when he expresses his opinions on matters related to engineering, although he will no longer practice engineering.

a. He may no longer use his P.E. designation.

b. He may use his P.E. designation if he indicates that he is retired.

c. He may freely use his P.E. designation.

Criterion 3(h)

Skill 1: The student will be aware of society's need for engineering solutions.

Climate change due to rising atmospheric concentrations of carbon dioxide is receiving significant global attention. What is one way we, as engineers, could contribute to alleviating this problem? Please disregard changes in personal behavior when answering this question.

Criterion 3(h)

Skill 2: The student will be aware of the environmental and economic impact of their engineering solutions.

What are two reasons that inflation occurs?

Criterion 3(h)

Skill 3: The student will be able to identify possible unintended negative global or societal consequences of proposed engineering solutions.

In addition to the typical internal combustion engine, hybrid-electric cars have large battery systems and an electric motor. Please identify a possible unintended negative consequence of the use of hybrid-electric cars compared to typical motor vehicles.

Criterion 3(i)

Skill 1: The student will be able to understand the limitations of their knowledge.

You have been hired by a leading automobile manufacturer to work in their crash safety division. Your first project is to lead a project aimed at improving the design of the closed cell polypropylene foam used in the front bumper. In particular, you will study the complex deformation patterns that occur throughout the front bumper and relate them to the total energy absorbed during 8, 15, 30, and 41 mph front-end collisions. The mechanics of this foam material is known to include very large strains and to depend on the rate of applied loading. One of your colleagues has proposed using a Young's modulus E of 1.2 GPa in the four analyses. What are the first steps you will take in helping your colleague evaluate his analysis technique? Comment on the expected limitations of his approach.

Criterion 3(i)

Skill 2: The student will be able to find and use appropriate technical resources.

What specific types of internet sources would you rely on to obtain temperature- and rate-dependent mechanical properties for a specific material?

Criterion 3(i)

Skill 3: The student will be able to identify their need for additional education.

What are your plans to keep yourself current in your chosen engineering profession?

Criterion 3(j)

Skill 1: The student will be able to identify important contemporary regional, national, or global issues.

The Gaza Strip is located:

a) Between Israel and Jordan
b) Between Israel and Lebanon
c) Between Israel and Egypt
d) Between Israel and Syria

Criterion 3(j)

Skill 2: The student will be able to discuss the historical roots of important contemporary regional, national, or local issues.

Recent news reports seem to indicate a tension between India and Pakistan as a result of the bombing in Mumbai, India. Prior to their independence as sovereign nations in 1947, both countries were part of a single territory. Who controlled this territory?

Criterion 3(j)

Skill 3: The student will be able to discuss ways engineers are contributing or might contribute to the solution of regional, national, or global problems.

List three ways in which mechanical engineers can help combat global warming. Please disregard changes in personal behavior when answering this question.