Strategies for Taking the FE

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Outline of Presentation

- Format
- Non Traditional Subjects
- DS or General DS?
- Mind
- Body
- Summary of Preparation
- Process
- The Exam
- Summary of Test Day

Format

- **Morning Exam -**
  - General subject areas covered in lower division courses
- **Afternoon Exam --**
  - Choice of 6 Discipline Specific (DS) Exams
  - Concepts covered in upper division courses
- **Discipline Specific (DS) Exams**
  - Chemical
  - Civil
  - Electrical
  - Industrial
  - Mechanical
  - General
- **General DS Exam intended for those engineers who do not fall in any of the 5 specific disciplines**

Non Traditional Subjects

- **Engineering Ethics**
  - Major points of engineering ethics under the categories of the engineer's obligations to society, employers, and fellow engineers.
  - It is difficult to generate problems on ethics for the exam which do not have an obvious answer. There may be some subtleties, requiring care when selecting the correct response to the questions on ethics.

- **Computer Engineering**
  - Digital Systems
  - Flowcharts, Pseudo Code, Spreadsheets

DS or General DS?

- **General Discipline Specific**
  - breadth coverage
  - more complex questions in the general subject areas
  - you will have reviewed the general subjects for the morning exam, so simply continue that preparation for the afternoon session
- **Discipline Specific (DS)**
  - depth coverage
  - will cover more subject areas in the selected discipline
- **May elect to take the General Test for the afternoon session even though your major is one of the 5 DS areas**

Results for General / DS -- 10/96

- Of 17,459 test takers, 52% chose to take the General Exam

- General Exam
  - 83% pass rate for 1st time exam takers
  - 67% for all candidates

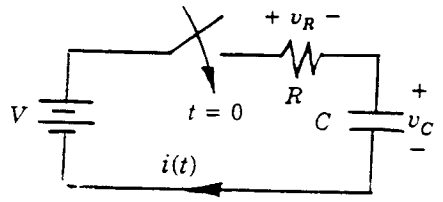
Results for General / DS -- 10/96 (cont'd)

- **Electrical**
  - GEN -- 77% DS -- 82%
- **Chemical**
  - GEN -- 85% DS -- 85%
- **Civil**
  - GEN -- 81% DS -- 84%
- **Industrial**
  - GEN -- 46% DS -- 74%
- **Mechanical**
  - GEN -- 89% DS -- 89%

Mind -- Studying

- **Review**
  - Study Material and Sample Exam Questions and Answers
  - Tapes
- **Reference Handbook**
  - Gives Scope of Material for each section
  - Know it well
  - Page of Conversion Factors
  - General Sections -- pp. 3-79
  - DS Sections -- pp. 82-115
  - Index -- pp. 116-118
- **Prepare a Study Schedule to review as many of the subject areas as possible**
- **Use SI units**

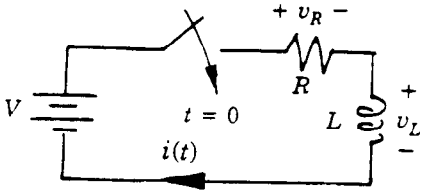
RC AND RL TRANSIENTS



$$t \geq 0;\quad v_C(t) = v_C(0)e^{-t/RC} + V(1 - e^{-t/RC})$$

$$i(t) = \{[V - v_C(0)]/R\}e^{-t/RC}$$

$$v_R(t) = i(t)R = [V - v_C(0)]e^{-t/RC}$$



$$t \geq 0;\quad i(t) = i(0)e^{-Rt/L} + \frac{V}{R}(1 - e^{-Rt/L})$$

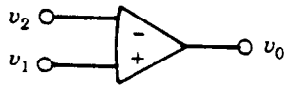
$$v_R(t) = i(t)R = i(0)Re^{-Rt/L} + V(1 - e^{-Rt/L})$$

$$v_L(t) = L(di/dt) = -i(0)Re^{-Rt/L} + Ve^{-Rt/L}$$

$v(0)$ and $i(0)$ denote the initial conditions and the parameters RC and L/R are termed the respective circuit time constants.

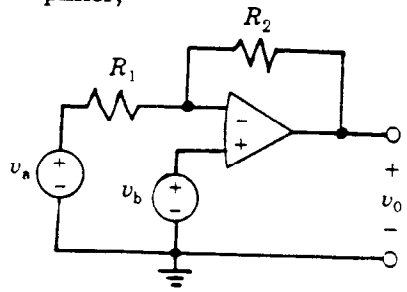
OPERATIONAL AMPLIFIERS

$v_o = A(v_1 - v_2)$, where A is large ($>10^4$) and $v_1 - v_2$ is small enough so as not to saturate the amplifier.



For the ideal operational amplifier, assume that the input currents are zero and that the gain A is infinite so when operating linearly, $v_2 - v_1 = 0$.

For the two-source configuration with an ideal operational amplifier,



$$v_o = -\frac{R_2}{R_1}v_a + \left(1 + \frac{R_2}{R_1}\right)v_b$$

If $v_a = 0$, the non-inverting amplifier output is

$$v_o = \left(1 + \frac{R_2}{R_1}\right)v_b$$

If $v_b = 0$, the inverting amplifier output is

$$v_o = -\frac{R_2}{R_1}v_a$$

AC CIRCUITS

For a sinusoidal voltage or current of frequency f (Hz) and period T (seconds),

$$f = 1/T = \omega/(2\pi), \text{ where}$$

ω = the angular frequency in radians/s.

Average Value

For a periodic waveform (either voltage or current) with period T,

$$X_{ave} = (1/T)\int_0^T x(t)\,dt$$

The average value of a full-wave rectified sine wave is

$$X_{ave} = (2X_{max})/\pi$$

and half this for a half-wave rectification, where X_{max} = the amplitude of the waveform.

Effective or RMS Values

For a periodic waveform with period T, the rms or effective value is

$$X_{rms} = [(1/T)\int_0^T x^2(t)\,dt]^{1/2}$$

For a sinusoidal waveform and full-wave rectified sine wave,

$$X_{rms} = X_{max}/\sqrt{2}$$

For a half-wave rectified sine wave,

$$X_{rms} = X_{max}/2$$

Sine-Cosine Relations

$$\cos(\omega t) = \sin(\omega t + \pi/2) = -\sin(\omega t - \pi/2)$$

$$\sin(\omega t) = \cos(\omega t - \pi/2) = -\cos(\omega t + \pi/2)$$

Phasor Transforms of Sinusoids

$$\mathcal{P}[V_{max}\cos(\omega t + \phi)] = V_{rms}\angle\phi = \boldsymbol{V}$$

$$\mathcal{P}[I_{max}\cos(\omega t + \theta)] = I_{rms}\angle\theta = \boldsymbol{I}$$

For a circuit element, the impedance is defined as the ratio of phasor voltage to phasor current.

$$Z = \frac{\boldsymbol{V}}{\boldsymbol{I}}$$

For a Resistor,

$$Z_R = R$$

For a Capacitor,

$$Z_C = \frac{1}{j\omega C} = jX_C$$

For an Inductor,

$$Z_L = j\omega L = jX_L, \text{ where}$$

X_C and X_L are the capacitive and inductive reactances respectively defined as

Reference Manual

TABLE OF CONTENTS

INDEX

Body

- **Training to Gain Stamina**
  - Test will begin at 8:00 am
  - Will last all day
  - Practice exam questions under exam conditions
- **Just Before**
  - No Exotic Meals the Night Before
  - Hearty Breakfast
- **Layered Clothing**
- **Studying the night before**

Summary of Preparation

- Use Review Tapes and Book
- Study at Different Times of the Day
- Focus on Core Concepts
- Take the Sample Tests
- Practice the Test Environment (time of day and duration)
- Use the Reference Manual
- Organize Everything the Night Before
- Relax the Night Before
- No Special Food or Drink

Process

- Exam Day
- Morning Session
- Lunch
- Afternoon Session

Exam Day

- 8 hour exam
- Test Venue
  - Building Location
  - Parking
  - Room Layout
  - Go by ahead of time, if not familiar with venue
- Proper Supplies
  - Calculator
  - Pencils, Erasers
  - Spare Batteries, Spare Calculator
  - DO NOT bring Reference Manual
- Temperature
  - Layered Clothing

Morning Session

- Doors open at 7:30 (arrive early)
- Test Begins
  - As soon as everyone is seated after 8:00
  - No one will be allowed to come in after test begins
- 10-15 minutes of Instructions Required
- A few minutes filling in the answer sheet info
- 120 multiple choice questions (for the most part, unrelated)

Lunch

- Food to Give You a Boost
- Snacks for AM and PM sessions
  - silent

Afternoon Session

- 60 Multiple-Choice Questions
- More Detailed Questions
- Grouped by Subject Areas
- Many questions are related to a common problem, divided into 2-10 sub-problems

The Exam

- Break Down of Questions
- Test Taking Techniques
- Guessing
- Scoring

Break Down of Questions

■ Morning Session

- 120 Multiple Choice Questions
- 1 Point Each
- 4 Hours
- Approx. 2 Minutes per Question
- Do not spend too much time on any one question

■ Afternoon Session

- 60 Multiple Choice Questions
- Questions Grouped into Related Problem Sets
- 2 Points Each
- 4 Hours
- Approx. 4 minutes per Question
- Can maintain a good pace and still spend up to 20-25 minutes solving a problem set that is more difficult for you.

- Different Exam Booklet used for each Session
- Do Not Write in Reference Handbook

Morning FE Exam Subjects

subject	number of questions
chemistry	11
computers	7
dynamics	9
electrical circuits	12
engineering economics	5
ethics	5
fluid mechanics	8
material science and structure of matter	8
mathematics	24
mechanics of materials	8
statics	12
thermodynamics	11
	120

TYPICAL SUBDIVISION OF MAJOR SUBJECTS
MORNING SECTION
ALL REQUIRED SUBJECTS

ELECTRICAL CIRCUITS
- AC Circuits
- Capacitance & Inductance
- Diode Applications
- DC Circuits
- Electric & Magnetic Fields
- Operational Amplifiers (Ideal)
- Transients

DYNAMICS
- Force, Mass, & Acceleration (Kinetics)
- Friction
- Impulse & Momentum
- Kinematics
- Vibrations
- Work & Energy

FLUID MECHANICS
- Flow Measurement
- Fluid Properties
- Fluid Statics
- Impulse & Momentum
- Pipe & Other Internal Flow
- Similitude & Dimensional Analysis

MATERIALS SCIENCE/ STRUCTURE OF MATTER
- Atomic Structure
- Corrosion
- Crystallography
- Diffusion
- Materials
- Phase Diagrams, Binary
- Processing & Testing
- Properties

CHEMISTRY
- Acids & Bases
- Electrochemistry
- Equations
- Equilibrium
- Kinetics
- Nomenclature
- Organic Chemistry
- Oxidation & Reduction
- Periodicity
- Solutions
- States of Matter
- Stoichiometry

ENGINEERING ECONOMICS
- Annual Cost
- Breakeven Analysis
- Benefit-Cost Analysis
- Future Worth or Value
- Present Worth
- Valuation & Depreciation

MATHEMATICS
- Analytic Geometry
- Difference Equations (z-Transforms)
- Differential Calculus
- Differential Equations
- Integral Calculus
- Laplace Transforms
- Linear Algebra
- Probability & Statistics
- Roots of Equations
- Vector Analysis

STATICS
- 2-Dimensional Equilibrium
- 3-Dimensional Equilibrium
- Centroid of Area
- Concurrent Force Systems
- Friction
- Moment of Inertia
- Vector Forces

THERMODYNAMICS
- 1st Law
- 2nd Law
- Availability-Reversibility
- Cycles
- Energy, Heat, & Work
- Ideal Gases
- Mixture of Gases
- Phase Changes
- Properties: Enthalpy, Entropy & Free Energy
- Thermodynamic Processes
- Heat Transfer

MECHANICS OF MATERIALS
- Beams
- Bending
- Columns
- Combined Stresses
- Shear
- Stress & Strain
- Tension & Compression
- Torsion

Afternoon FE Exam Subjects
(General Exam)

subject	number of questions
chemistry	5
computers	3
dynamics	5
electrical circuits	6
engineering economics	3
ethics	3
fluid mechanics	4
material science and structure of matter	3
mathematics	12
mechanics of materials	4
statics	6
thermodynamics	6
	60

TYPICAL SUBDIVISION OF MAJOR SUBJECTS
AFTERNOON SECTION – GENERAL
ALL REQUIRED SUBJECTS

APPLIED MATHEMATICS
- Analytic Geometry
- Difference Equations (z-Transforms)
- Differential Calculus
- Differential Equations
- Integral Calculus
- Laplace Transforms
- Linear Algebra
- Probability & Statistics
- Vector Analysis

ELECTRIC CIRCUITS
- AC Circuits
- DC Circuits
- Diode Applications
- Capacitance & Inductance
- Operational Amplifiers (Ideal)
- Transients

ENGINEERING MECHANICS
- Dynamics
  - Friction
  - Impulse & Momentum
  - Inertia & Force
  - Kinematics
  - Particles & Rigid Bodies
  - Vibrations
  - Work & Energy
- Mechanics of Materials
  - Beams
  - Bending
  - Columns
  - Combined Stresses
  - Shear
  - Stress & Strain
  - Tension & Compression
  - Torsion
- Statics
  - Equilibrium of Rigid Bodies
  - Frames & Trusses
  - Friction
  - Resultants of Force Systems

THERMODYNAMICS/FLUID MECHANICS
- Fluid Mechanics
  - Flow Measurement
  - Fluid Statics
  - Hydraulics & Fluid Machines
  - Impulse & Momentum
  - Pipe Flow
  - Similitude & Dimensional Analysis
- Thermodynamics
  - Availability-Reversibility
  - Chemical Reactions
  - Cycles
  - Flow Processes
  - Mixture of Gases
  - Heat Transfer

ENGINEERING ECONOMICS
- Annual Cost
- Breakeven Analysis
- Benefit-Cost Analysis
- Future Worth or Value
- Present Worth
- Risk Analysis
- Rate-of-Return Analysis
- Tax Considerations
- Valuation & Depreciation

Afternoon DS Exam

ELECTRICAL ENGINEERING

subject	number of questions
analog electronic circuits	6
communications theory	6
computer and numerical methods	3
computer hardware engineering	3
computer software engineering	3
control systems theory and analysis	6
digital systems	6
electromagnetic theory and applications	6
instrumentation	3
network analysis	6
power systems	3
signal processing	3
solid state electronics and devices	6

Afternoon DS Exams

CHEMICAL ENGINEERING

subject	number of questions
chemical reaction engineering	6
chemical thermodynamics	6
computer and numerical methods	3
heat transfer	6
mass transfer	6
material/energy balances	9
pollution prevention (waste minimization)	3
process control	3
process design and economics evaluation	6
process equipment design	3
process safety	3
transport phenomenon	6

CIVIL ENGINEERING

subject	number of questions
computers and numerical methods	6
construction management	3
environmental engineering	6
hydraulics and hydrologic systems	6
legal and professional aspects	3
soil mechanics and foundations	6
structural analysis (frames, trusses, etc.)	6
structural design (concrete, steel, etc.)	6
surveying	6
transportation facilities	6
water purification and treatment	6

Afternoon DS Exams

INDUSTRIAL ENGINEERING

subject	number of questions
computer computations and modeling	3
design of industrial experiments	3
engineering economics	3
engineering statistics	3
facility design and location	3
industrial cost analysis	3
industrial ergonomics	3
industrial management	3
information system design	3
manufacturing processes	3
manufacturing systems design	3
material handling system design	3
mathematical optimization and modeling	3
production planning and scheduling	3
productivity measurement and management	3
queuing theory and modeling	3
simulation	3
statistical quality control	3
total quality management	3
work performance and methods	3

MECHANICAL ENGINEERING

subject	number of questions
automatic controls	3
computer (numerical methods, automation, etc.)	3
dynamic systems (vibrations, kinematics, etc.)	6
energy conversion and power plants	3
fans, pumps, and compressors	3
fluid mechanics	6
heat transfer	6
material behavior/processing	3
measurement and instrumentation	6
mechanical design	6
refrigeration and HVAC	3
stress analysis	6
thermodynamics	

Test Taking Techniques

- Familiarize Yourself with the Reference Manual
- Develop a Strategy Beforehand
- Work from Most Familiar to Least Familiar Subjects
- Work Easy Ones First
- Decide on type of units (metric or U.S.) to use
  - Some of the Numerical Problems Contain Only Metric Units
  - Remaining Numerical Problems contain both Metric and U.S. Customary Units
  - FE is making a gradual transition to all metric

Afternoon FE Exam Subjects
(General Exam)

subject	number of questions
chemistry	5
computers	3
dynamics	5
electrical circuits	6
engineering economics	3
ethics	3
fluid mechanics	4
material science and structure of matter	3
mathematics	12
mechanics of materials	4
statics	6
thermodynamics	6
	60

Afternoon DS Exam

ELECTRICAL ENGINEERING

subject	number of questions
analog electronic circuits	6
communications theory	6
computer and numerical methods	3
computer hardware engineering	3
computer software engineering	3
control systems theory and analysis	6
digital systems	6
electromagnetic theory and applications	6
instrumentation	3
network analysis	6
power systems	3
signal processing	3
solid state electronics and devices	6

TOTAL ## X 1 = ____
(AM)

Total ## X 2 = ____
(PM)

Summary of P. 80-81 of Reference Handbook

Engineering Ethics

There are sets of rules of conduct that have been established by the engineering community that outline the obligations of professional (registered) engineers to society, to employers and clients, and to fellow engineers. These rules are established in our attempt to safeguard life, health, and property, to promote the public welfare, and to maintain a high standard of integrity. Since the rules are binding on all registered engineers, it is the responsibility of each engineer to be familiar with the rules. In addition to the rules, each registered engineer must meet standards of high moral and ethical conduct when practicing the engineering profession. Each state maintains the right and obligation to enforce such rules of conduct by assessing penalties when such rules are broken.

Engineering registration is a privilege and not a right. It is a privilege to practice engineering in the area or areas of competence in which certification has been granted. This privilege demands that engineers responsibly represent themselves before the public in a truthful and objective manner.

Engineers must compete fairly with others and avoid all conflicts of interest while faithfully serving the legitimate needs and interests of their employers and clients. The following points summarize Engineering Ethics.

The Engineer's Obligation to Society

1. While performing services, the engineer's foremost responsibility is to the public welfare.
2. Engineers shall approve only those designs that safeguard the life, health, welfare and property of the public while conforming to accepted engineering standards.
3. If an engineer's professional judgment is overruled resulting in danger to the life, health, welfare or property of the public, the engineer shall notify his/her employer or client and any authority that may be appropriate.
4. Engineers shall be objective and truthful in professional reports, statements, or testimonies and provide all pertinent supporting information relating to such reports, statements, or testimonies.
5. Engineers shall not express a professional opinion publicly unless it is based upon knowledge of the facts and a competent evaluation of the subject matter.
6. Engineers shall not express a professional opinion on subject matters for which they are motivated or paid, unless they explicitly identify the parties on whose behalf they are expressing the opinion, and reveal the interest the parties have in the matters.
7. Engineers shall not associate in business ventures with nor permit their names or their firms' names to be used by any person or firm which is engaging in dishonest, fraudulent, or illegal business practice.
8. Engineers who have knowledge of a possible violation of any of the rules listed in this and the following two parts shall provide pertinent information and assist the state board in reaching a final determination of the possible violation.

The Engineer's Obligation to Employers and Clients

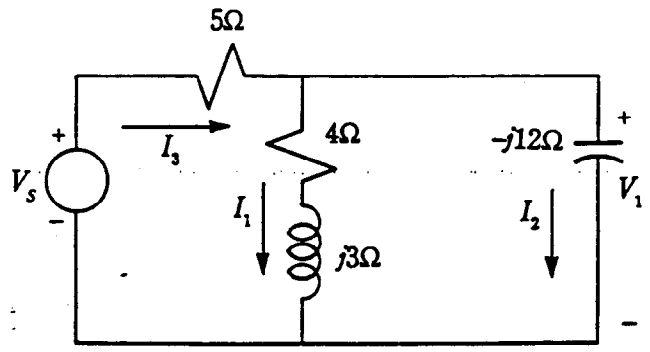
1. Engineers shall not undertake technical assignments for which they are not qualified by education or experience.
2. Engineers shall approve or seal only those plans or designs that deal with subjects in which they are competent and which have been prepared under their direct control and supervision.
3. Engineers may coordinate an entire project provided that each design component is signed or sealed by the engineer responsible for that design component.
4. Engineers shall not reveal professional information without the prior consent of the employer or client except as authorized or required by law.
5. Engineers shall not solicit or accept valuable considerations, financial or otherwise, directly or indirectly, from contractors, their agents, or other parties while performing work for employers or clients.
6. Engineers shall disclose to their employers or clients potential conflicts of interest or any other circumstances that could influence or appear to influence their professional judgment or the quality of their service.
7. An engineer shall not accept financial or other compensation from more than one party for services rendered on one project unless the details are fully disclosed and agreed to by all parties concerned.
8. To avoid conflicts of interest, engineers shall not solicit or accept a professional contract from a governmental body on which a principal or officer of their firm serves as a member. An engineer who is a principal or employee of a private firm and who serves as a member of a governmental body shall not participate in decisions relating to the professional services solicited or provided by the firm to the governmental body.

An Engineer's Obligations to Other Engineers

1. Engineers shall not misrepresent or permit misrepresentation of their or any of their associates' academic or professional qualifications. They shall not misrepresent their level of responsibility nor the complexity of prior assignments. Pertinent facts relating to employers, employees, associates, joint ventures or past accomplishment shall not be misrepresented when soliciting employment or business.
2. Engineers shall not attempt to injure, maliciously or falsely, directly or indirectly, the professional reputations, prospects, practice or employment of other engineers, nor indiscriminately criticize the work of other engineers.
3. Engineers shall not directly or indirectly give, solicit, or receive any gift or commission, or other valuable consideration, in order to obtain work, and shall not make a contribution to any political body with the intent of influencing the award of a contract by a governmental body.

Afternoon Session Type of Question

Questions 47–50 refer to the frequency domain representation of a circuit, as shown below. It is known that $I_1 = 14.4 \angle -36.9°$ and $I_2 = 6 \angle 90°$, expressed in RMS amperes.



47. The impedence seen by the voltage source V_s is most nearly:
(A) 9.5 $\angle$ 18.4° Ω
(B) 10.0 $\angle$ 36.9° Ω
(C) 10.7 $\angle$ 16.0° Ω
(D) 11.0 $\angle$ 7.1° Ω
(E) 15.0 $\angle$ -53.1° Ω

$(4+j3) \,||\, (-j12) = 6.09 \angle 13.13°$
$5 + 6.09 \angle 13.3° = 11 \angle 7.15°$

48. The RMS phasor expression for the voltage V_1 is most nearly:
(A) 0.5 $\angle$ 0° V
(B) 0.5 $\angle$ 180° V
(C) 72 $\angle$ 0° V
(D) 72 $\angle$ 90° V
(E) 72 $\angle$ 180° V

$V_1 = I_2 Z_{12} = (6 \angle 90°)(12 \angle -90°)$
$= 72 V$

49. The RMS phasor expression for the current I_3 is most nearly:
(A) 10.3 $\angle$ -32.5° A
(B) 11.8 $\angle$ -13.0° A
(C) 18.6 $\angle$ 51.9° A
(D) 18.6 $\angle$ -51.9° A
(E) 20.4 $\angle$ 53.1° A

$I_3 = I_1 + I_2$
$= 14.4 \angle -36.9° + 6 \angle 90°$
$= 11.8 \angle -12.9°$

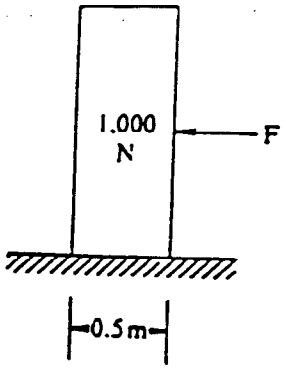
50. The power dissipated by the 4-ohm resistor is most nearly:
(A) 415 W
(B) 829 W
(C) 1300 W
(D) 1660 W
(E) 2590 W

$P_4 = V_4 I_4 = I Z I = I^2 Z$
$= (14.4)^2 (4)$
$= 829 W$

SI and non-SI Question

Select either problem.

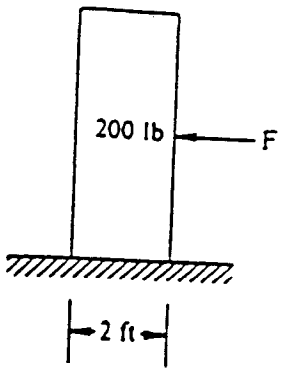
81. (SI)



A rigid box, 0.5 meter wide, weighs 1000 newtons and rests on a rigid floor as shown above. The static coefficient of friction between the box and floor is 0.25. What is the maximum distance from the floor to the point at which the horizontal force F can be applied if motion of the box without tipping is impending?

(A) 0.25 m
(B) 0.5 m
(C) 0.75 m
(D) 1.0 m
(E) 1.25 m

81. (non-SI)



A rigid box, 2 feet wide, weighs 200 pounc on a rigid floor as shown above. The static of friction between the box and floor is 0.2 the maximum distance from the floor to t which the horizontal force F can be applie of the box without tipping is impending?

(A) 1 ft
(B) 2 ft
(C) 3 ft
(D) 4 ft
(E) 5 ft

Guessing

- Guess -- No Penalty for Incorrect Answers
- Problems that You Don't Know in Detail
  - Work from the answer backwards
  - Use the reference manual
  - Eliminate some answers using common sense
- 10 Minutes Before the End of the Session
  - Guess at all of the Remaining Unsolved Problems
  - Make a Consistent Choice

Scoring

- Morning Session -- 1 Pt. each question
- Afternoon Session - 2 Pts. each question
- Raw Score -- 240 Pts.
- From recent history, a passing Score is approx. 50%

Summary of Test Day

- Come Early
- Room will be Hot or Cold (layered clothing)
- Chairs will be Hard
- Administrative Paperwork at beginning of sessions
- Sort the Problems by Section
- Work Easy Ones First
- Guess when Unsure