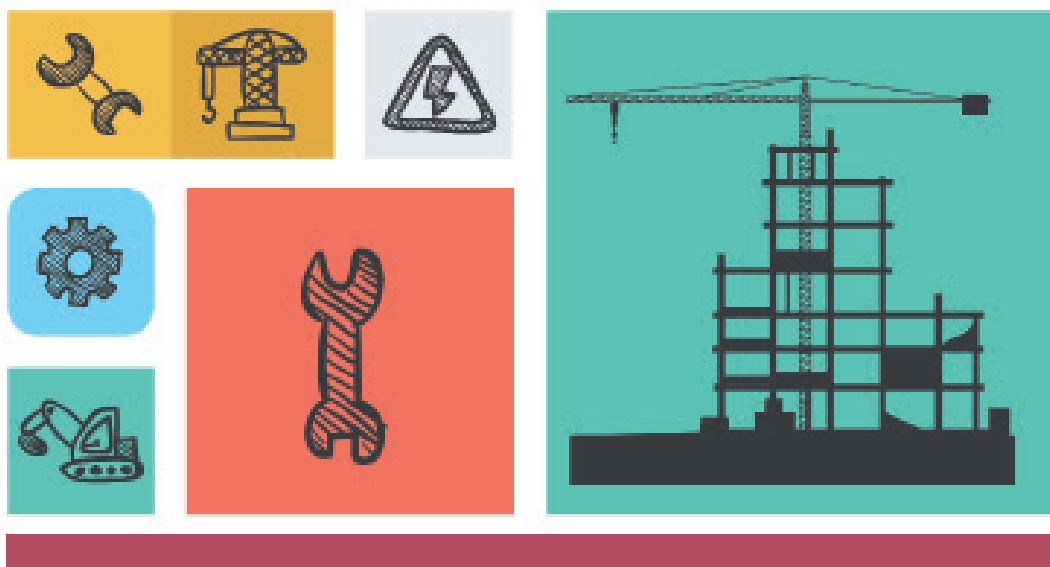


Engineering Fundamentals Exam

Study Guide For General Engineering Exam



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1. Objectives

The aim of this manual is to provide guidelines for the examinees about the exam structure, timing, percentage of question coverage and distribution among various topic areas. In essence, the manual represents the bridge between the developed General Engineering Standards and the actual phrased questions, which constitute the tests to be administered. It is designed to familiarize the examinees with the test questions formats and contents.

2. Contents

This study guide contains essential information for the examinees. Specifically, the following topics are presented in this manual:

- Exam structure, exam schedule and organization, exam type, eligibility for exam, and exam rules
- Organization of the exam framework
- Table of Specifications which includes an overview of the table, its structure and contents
- Sample of questions and solutions for General Engineering

3. Exam Structure

The exam is conducted in two sessions and the duration of each session is 3 hours.

3.1 General Engineering Exam

The first session covers the General Engineering topics. These include the following fourteen topics:

1. Mathematics
2. Probability and Statistics
3. Computer Literacy
4. Statics and Dynamics
5. Chemistry
6. Thermodynamics



7. Fluid Mechanics
8. Materials Science and Engineering
9. Electricity and Magnetism
10. Engineering Drawing
11. Engineering Economics
12. Project Management
13. Ethics
14. General Skills
 - a. Use analytical thinking (logical deductions, statements and assumptions, cause and effect, verbal reasoning, analyzing arguments, statements and conclusions, break a complex problem into smaller problems and solve them)
 - b. Use effective communication in writing, orally, and graphically
 - c. Work cooperatively with other team members to deliver the required outcomes
 - d. Set goals and ways for personal development
 - e. Strive for ways to resolve conflicts while being sensitive to others opinions
 - f. Be able to use time and available resources in an efficient way
 - g. Recognize and interpret environmental, social, cultural, political and safety considerations in engineering solutions.
 - h. Recognize decision making process
 - i. Recognize major engineering concepts outside the discipline.
 - j. Interpret uncertainties in measurements and calculations
 - k. Analyze and interpret data
 - l. Apply evaluation criteria and contemporary knowledge to select the optimum design from alternative solutions



3.2 Engineering Discipline Exam

The second session covers the Engineering Standards and is based on topics associated with one of the following engineering disciplines:

<i>Code</i>	<i>Discipline</i>
CE	Civil Engineering
CHE	Chemical Engineering
EE	Electrical Engineering
IE	Industrial Engineering
ME	Mechanical Engineering
SE	Structural Engineering

4. Exam Implementation

The exam consists of two sessions:

- The first session consists of General Engineering Exam. The total duration of this session is 3 hours with a total number of 90 questions.
- The second session consists of Engineering Discipline Exam. This session consists of 50 questions with a total time of 3 hours.

5. Exam Type

The exam is initially paper-based and will become computer based in a later stage. The exam, in both sessions, is of a multiple choice type where each question has four choices for the answer. There is no negative marking for wrong answers.

6. Eligibility for the Exam

Bachelor degree holders in an Engineering discipline i.e., Chemical Engineering, Civil Engineering, Electrical Engineering, Industrial Engineering, Mechanical Engineering, and Structural Engineering.



7. Exam Rules

- Books, lecture notes, or any type of materials are not allowed in the exam. Necessary reference sheets, monographs, equations, relevant data from codes will be provided in the exam.
- Calculators approved by Exam authorities are allowed.
- Admission in the examination center will be only through authorized admission card
- Examinees are subjected to all the rules and procedures applied by National Center for Assessment in Higher Education (Qiyas)

8. Organization of the Exam Framework

The core topics constitute the basis of this Engineering Exam. Indicators are used to describe the knowledge to be tested in each topic. Each of these indicators is further subdivided into three major levels following the recent Bloom's taxonomy of learning levels (Remembering and Understanding; Applying and Analyzing; and Evaluating and Creating).

Example

Topic Area:	T1 Mathematics
Indicator:	GE-T1-06 Apply matrix algebra
Learning Level:	Applying and Analyzing (AA)

9.1 Overview

The Table of Specifications is a map which facilitates the transformation of the Engineering Standards for each Topic Area into balanced and coherent question sheets to be used in the proposed Exam. The Table of Specifications is essentially a tableau structure which distributes, vertically, the exam Questions among various Topic Areas in accordance with the applicable Engineering Standards and, horizontally, over various Learning Levels (Remembering and Understanding, Applying and Analyzing, Evaluating and Creating).



9.2 Structure and Contents

The table below constitutes the Table of Specifications for General Engineering. The Table of Specifications contains the following columns:

9.2.1 Topic Area

These are the widely recognized Topic areas, which are covered in General Engineering, namely:

1. Mathematics
2. Probability and Statistics
3. Computer Literacy
4. Statics and Dynamics
5. Chemistry
6. Thermodynamics
7. Fluid Mechanics
8. Materials Science and Engineering
9. Electricity and Magnetism
10. Engineering Drawing
11. Engineering Economics
12. Project Management
13. Ethics and Professionalism
14. General skills
 - a. Use analytical thinking (logical deductions, statements and assumptions, cause and effect, verbal reasoning, analyzing arguments, statements and conclusions, break a complex problem into smaller problems and solve them)
 - b. Use effective communication in writing, orally, and graphically
 - c. Work cooperatively with other team members to deliver the required outcomes
 - d. Set goals and ways for personal development
 - e. Strive for ways to resolve conflicts while being sensitive to others opinions
 - f. Be able to use time and available resources in an efficient way
 1. Recognize and interpret environmental, social, cultural, political and safety considerations in engineering solutions.
 - g. Recognize decision making process
 - h. Recognize major engineering concepts outside the discipline.
 - i. Interpret uncertainties in measurements and calculations
 - j. Analyze and interpret data
 - k. Apply evaluation criteria and contemporary knowledge to select the optimum design from alternative solutions



9.2.2 % of Test

This column summarizes the total percentage (of the total test) allocated for each Topic Area.

9.2.3 Suggested Number of Questions

This column indicates the number of questions to be allocated for each Engineering Standard. The total number of questions per test conforms to the general guidelines which govern the total duration of the test. In the present case, 90 questions are included for the General Engineering exam.

9.2.4 Engineering Standards

This column lists the Engineering Standards (detailed in the other file about Standards) to be addressed under each Topic Area.

Standards are coded **GE-TJ** (where **GE** denotes the General Engineering, **TJ** denotes the Topic Number **J**), whereas the Indicators (detailed in the other file about Standards) are coded **GE-TJ-K** (where **K** denotes the Indicator number). For example: **GE-T1-3** is the code for the question in General Engineering (GE) that represents Topic 1 (Mathematics) and Indicator #3.

9.2.5 Assigned Allocations among Learning Levels

The three sub-columns (Remembering and Understanding (RU), Applying and Analyzing (AA), and Evaluating and Creating (EC)) under this main column specify the question distribution among the three Learning Levels. It is to be noted that the Learning Levels used in the Table of Specifications represent the so-called cognitive levels/processes (levels of thinking) in the revised Bloom's taxonomy.

It should be noted that the distribution of questions among various learning levels follows a careful question allocation process, which ensures that appropriate relative levels of coverage are maintained. The distribution of questions (for all Topic Areas) among the three Learning Levels is 26 questions (29%) for Remembering and Understanding, 42 questions (47%) for Applying and Analyzing, and 22 questions (24%) for Evaluating and Creating.



Table of Specifications for General Engineering Exam

Topic Area	# Q	Engineering Standard	Assigned Allocations among Learning Levels		
			RU	AA	EC
1. Mathematics	9	GE-T1	3	6	0
2. Probability and Statistics	4	GE-T2	2	2	0
3. Computer Literacy	6	GE-T3	2	4	0
4. Statics and Dynamics	6	GE-T4	0	4	2
5. Chemistry	6	GE-T5	2	3	1
6. Thermodynamics	3	GE-T6	0	2	1
7. Fluid Mechanics	3	GE-T7	0	2	1
8. Materials Science and Engineering	6	GE-T8	2	2	2
9. Electricity and Magnetism	3	GE-T9	0	2	1
10. Engineering Drawing	4	GE-T10	2	2	0
11. Engineering Economics	6	GE-T11	2	2	2
12. Project Management	6	GE-T12	2	2	2
13. Ethics and Professionalism	6	GE-T13	3	3	0
14. General Skills	22	GE-T14	6	6	10
Total	90		26 (29%)	42 (47%)	22 (24%)



10. Sample Questions

A sample of questions is shown in the following tabular format in accordance with the following instructions.

1. For Learning Levels
 - RU for Remembering and Understanding
 - AA for Applying and Analyzing
 - EC for Evaluating and Creating
2. References sheets are denoted in the last column of the Table



Table of Sample Questions

Q. No	Topic Area	Standard Code	Learning Level	Question Statement (Answer's Choices)	Answer	Expected Time (min)	Supplied Reference
1	Mathematics	GE-T1-01	AA	The equation for the tangent of the function $3\sin(x) - \sqrt{x+1}$, at $x=0$ is: A) $y = -5 + \frac{1}{2}x$ B) $y = -3 + 2x$ C) $y = \frac{2}{3}x$ D) $y = -1 + \frac{5}{2}x$	D	3	Reference #1
2	Mathematics	GE-T1-06	AA	Given a 3x3 matrix A with $\det(A)=2$. The value of $\det((3A)^{-1})$ is: A) 1/54 B) 1/27 C) 1/12 D) 1/6	A	2	None
3	Mathematics	GE-T1-08	AA	Starting with the initial guess $x_0=1$ and using Newton-Raphson method, the first iteration in solving the equation $x=e^{-x}$ is: A) 0.538 B) 1.461 C) 1.582 D) 3.164	A	3	Reference #3

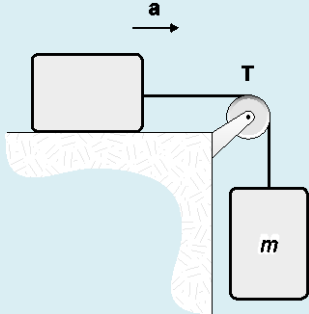


4	Probability and Statistics	GE-T2-01	RU	<p>Consider the following data: -1, 1, 2, 3, 7. The mean and the standard deviations of the data are:</p> <p>A) 2.4 and 2.653 B) 2.4 and 7.040 C) 2.4 and 5.931 D) 12 and 2.653</p>	A	3	None
5	Probability and Statistics	GE-T2-02	AA	<p>A box contains five good bulbs and two damaged ones mixed together. In order to locate the damaged bulbs, they are tested one by one, at random and without replacement. The probability that we find both of the damaged bulbs in the first two tests is:</p> <p>A) 2/7 B) 5/7 C) 1/21 D) 3/21</p>	C	2	Reference #5



6	Computer Literacy	GE-T3-05	AA	<p>Consider the following instructions:</p> <ol style="list-style-type: none"> 1. Start 2. Set $x = 10, y = 5$ 3. If $x > y$ then go to step 4 ; otherwise go to step 6 4. Replace x by $x + 1$ and y by $2(y - 1)$ 5. Go to step 3 6. Print y, x 7. End <p>After executing these instructions, the numbers that are printed are:</p> <ol style="list-style-type: none"> A) 8, 11 B) 11, 8 C) 12,14 D) 14,12 	D	2	None
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7	Statics and Dynamics	GE-T4-04	AA	<p>If the tension, T, is 14 N and the magnitude of the acceleration, a, is 3.0 m/s^2, then the mass, m (kg), of the suspended object is: (Assume that all surfaces and the pulley are frictionless. Take $g = 10 \text{ m/s}^2$)</p>  <p>A) 3.1 B) 2.0 C) 2.8 D) 1.2</p>	B	2	Reference #7
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8	Statics and Dynamics	GE-T4-05	AA	<p>An object (A) of mass (m) and velocity (u_A) hits a stationary object (B) of equal mass. The final velocities of A and B are v_A and v_B. The equation for the conservation of linear momentum leads to:</p> <p>A) $u_A = v_A + v_B$</p> <p>B) $m u_A = m v_A + v_B$</p> <p>C) $u_A^2 = v_A^2 + v_B^2$</p> <p>D) $m u_A^2 = m v_A^2 + v_B^2$</p>	A	2	Reference #8
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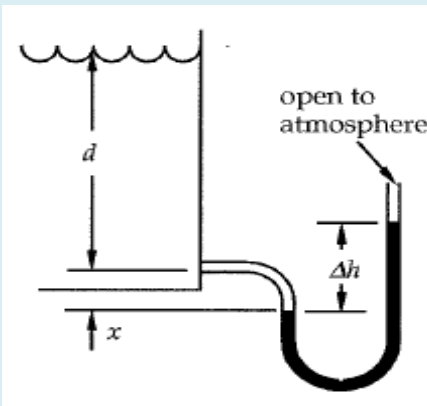
9	Chemistry	GE-T5-03	RU	<p>Consider the complete oxidation of C_8H_{18},</p> $C_8H_{18} + O_2 \rightarrow \dots + H_2O$ <p>The missing product and the coefficients of the balanced reaction are:</p> <p>A) The product is CO and the coefficients are 2, 17, 16, and 18</p> <p>B) The product is CO and the coefficients are 4, 34, 16, and 36</p> <p>C) The product is CO_2 and the coefficients are 4, 4, 32, and 36</p> <p>D) The product is CO_2 and the coefficients are 2, 25, 16, and 18</p>	D	2	None
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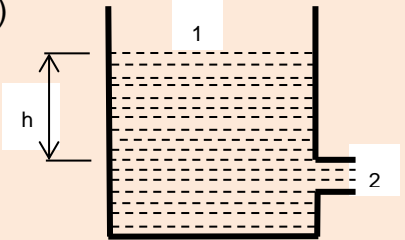


10	Chemistry	GE-T5-05	RU	<p>Consider the following reaction,</p> $\text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g).$ <p>If the nitrogen concentration is increased, this will result in the production of:</p> <p>A) More hydrogen B) Less ammonia C) Less hydrogen D) More ammonia</p>	D	1	Reference #10
11	Thermodynamics	GE-T6-01	AA	<p>One mole of an ideal gas is initially at temperature T_1, pressure P_1 and occupies a volume V_1. The gas goes through an isothermal expansion in which its volume doubles. The final pressure is:</p> <p>A) P_1 B) $\frac{P_1}{2}$ C) $2P_1$ D) $P_1^{\frac{1}{2}}$</p>	B	2	Reference #11

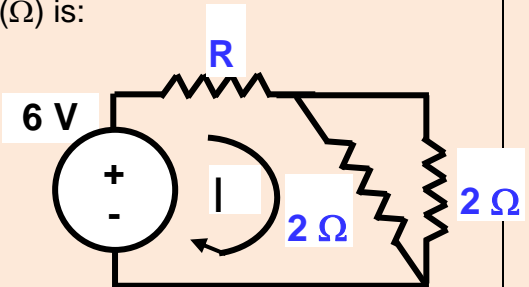


12	Thermodynamics	GE-T6-06	AA	<p>A heat engine operates between 260°C and 110°C. The maximum (Carnot) efficiency (%) of this heat engine is:</p> <p>A) 28.1 B) 57.7 C) 42.3 D) 71.8</p>	A	1	Reference #12
13	Fluid Mechanics	GE-T7-02	AA	<p>A mercury (specific gravity= 13.6) manometer is used to measure pressure at the bottom of a tank (depth d) containing acetone (specific gravity = 0.787) as shown in the figure below. The manometer is to be replaced with a gage. If $\Delta h = 100$ mm and $x = 50$ mm, the expected gage reading (kPa) will be: ($g=9.81$ m/s²)</p> <p>A) 10.76 B) 12.96 C) 17.21 D) 20.32</p>	B	3	NONE



14	Fluid mechanics	GE-T7-03	AA	<p>Consider the liquid flowing in the tank shown in the figure below. The height of the liquid between points (1) and (2) is 3 m. Assume the tank is open to the atmosphere. The velocity (m/s) of the liquid at point (2) is: (use $g=9.8 \text{ m/s}^2$)</p> <p>A) 0 B) 5.42 C) 58.8 D) 7.67</p> 	D	2	Reference #14
15	Materials Science and Engineering	GE-T8-01	RU	<p>What is the group of materials that is hard and brittle, and a good insulator?</p> <p>A) metals B) polymers C) ceramics D) composites</p>	C	1	None
16	Materials Science and Engineering	GE-T8-06	AA	<p>A steel column (4 m long, 0.5 m diameter, modulus of elasticity 200 GPa) carries a load of 40 MN. The column will be compressed (mm) by:</p> <p>A) 1.03 B) 2.15 C) 4.08 D) 5.15</p>	C	3	Reference #16



17	Electricity and Magnetism	GE-T9-01	AA	<p>The resistance (Ω) of a 2 meter wire having a cross sectional area of 2 mm^2 and a resistivity of $2 \times 10^{-8} \Omega \cdot \text{m}$ is:</p> <p>A) 0.001 B) 0.02 C) 0.1 D) 10.0</p>	B	2	None
18	Electricity and Magnetism	GE-T9-03	AA	<p>The power loss in resistor R of the shown electrical circuit is 8 W. Then one possible value of R (Ω) is:</p>  <p>A) 0.5 B) 1 C) 1.5 D) 3</p>	A	2	Reference #18
19	Engineering Drawing	GE-T10-01	RU	<p>These drawings are given to contractors to perform work or manufacture individual parts.</p> <p>A) Assembly details B) 3D drawings C) Working drawings D) Skeleton assemblies</p>	C	1	None



20	Engineering Economics	GE-T11-04	RU	<p>A shop is considering the purchase of a new machine. The machine price is \$4,000 and has a useful life of 10 years. The estimated value of the machine at the end of its useful life is zero. The annual depreciation amount (\$), using the straight line method is:</p> <p>A) 400 B) 512 C) 640 D) 800</p>	A	2	None
21	Engineering Economics	GE-T11-05	AA	<p>A small plant is reported to have the following economic data: Fixed capital investment = \$1,000,000 Working capital = \$200,000 Annual production rate = 500 ton/year Product selling price = \$600/ton Fixed operating costs = \$50/ton Variable operating cost = \$150/ton The pay-back period (years) is about:</p> <p>A) 4 B) 6 C) 12 D) 15</p>	B	3	Reference #21



22	Project Management	GE-T12-01	RU	<p>In project management, the project critical path can be defined as:</p> <p>A) the path that has a chain of activities with a high risk factor.</p> <p>B) the path that has a chain of activities with total float equal zero.</p> <p>C) the path that has a chain of activities with lowest values of total float.</p> <p>D) the path that has a chain of activities with free float equal zero.</p>	C	1	None
23	Ethics and Professionalism	GE-T13-03	AA	<p>You work as an engineer on the construction of a building that is behind schedule and urgently needed by the client. The plumbing system does not work to specifications. Your boss asks you to certify the building as properly completed. Should you:</p> <p>A) Certify it because it serves the interests of the company.</p> <p>B) Explain the problem to the client, and ask him to take a decision about certification.</p> <p>C) Certify it, but keep an eye on the building, in case any problems arise in the future.</p> <p>D) Decline to certify it.</p>	D	1	None



24	General Skills	GE-T14-03	RU	<p>What feature can make teamwork more productive?</p> <p>A) Complete independence within the team B) Conflicts within the team C) Strong competition within the team D) Having clear objectives</p>	D	1	None
25	General Skills	GE-T14-07	RU	<p>A new facility with high energy need is being designed. The engineer has to consider sustainable designs such as using:</p> <p>A) Creative design ideas B) Advanced building material C) Renewable energy as supplement D) Personal taste</p>	C	1	None
26	General Skills	GE-T14-09	RU	<p>Ergonomics is the study of:</p> <p>A) Interactions between products and humans who use them B) Interactions between economy and the society C) Climate activities D) Economic activities</p>	A	1	None
27	General Skills	GE-T14-10	AA	<p>The voltage across a resistance is 10.875 ± 0.001 Volts. Given that the current (I) is 3.15 ± 0.01 Ampere, then the resistance $R=V/I$ is 3.452 (Ohm) with an error of:</p> <p>A) 0.002 B) 0.011 C) 0.015 D) 0.020</p>	B	2	Reference#27



Reference #1

The equation of the tangent line at $x=0$ is:

$$y = f(0) + (x - 0)f'(0)$$

$$\frac{d}{dx}(\sqrt{f(x)}) = \frac{f'(x)}{2\sqrt{f(x)}}$$

$$\frac{d}{dx}(\sin(ax)) = a \cos(ax)$$

Reference #3

If x_n is the current estimate, then the next estimate x_{n+1} is given by:

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$

Reference #5

Let $P(A,B)$ be the probability that events A and B occur simultaneously. We can write:

$$P(A,B) = P(A)P(B|A) = P(B)P(A|B)$$

Where

$P(A|B)$ is the probability that A occurs given that B has occurred

$P(B|A)$ is the probability that B occurs given that A has occurred

Reference #7

Newton's Second Law: $\sum \vec{F} = m \vec{a}$

Reference #8

The linear momentum (\mathbf{M}) of a body of mass (m) at velocity (\mathbf{v}) is defined as,

$$\mathbf{M} = m \times \mathbf{v}$$

Reference #10

Le Chatelier's Principle for Chemical Equilibrium: If a chemical system at equilibrium experiences a change in concentration, temperature, or total pressure, the equilibrium will shift in order to minimize that change and a new equilibrium is established.



Reference #11

An Ideal gas law with n moles at pressure P , volume V , and temperature T satisfies:

$$P V = n R T \quad \text{where } R \text{ is the ideal gas constant}$$

Reference #12

The cycle takes in heat Q_H at a high temperature T_H , produces a net amount of work W , and rejects heat Q_L at a low temperature T_L . The efficiency η of a heat engine is given by:

$$\eta = W/Q_H = (Q_H - Q_L)/Q_H$$

Reference #14

The Bernoulli equation can be applied between two points (1) and (2) of a flow along a streamline:

$$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + z_2$$

(P) denotes the pressure, (V) the velocity, and (z) the height.

Reference #16

Stress on the cross section = loading / (cross-sectional area)

Modulus of Elasticity = stress / strain

Reference #18

The power P absorbed by a resistance R with a current I is:

$$P = RI^2$$

For resistances ($R_1, R_2 \dots R_n$) in series, the equivalent resistance R_E is,

$$R_E = R_1 + R_2 + \dots + R_n$$

For resistances ($R_1, R_2 \dots R_n$) in parallel, the equivalent resistance R_E is,

$$\frac{1}{R_E} = \frac{1}{R_1} + \frac{1}{R_2} + \dots + \frac{1}{R_n}$$

Reference #21

The payback period is the period of time required for the profit of an investment to be equal to the cost of the investment.



Reference #27

Let $z = w/v$

$$\text{Then } \Delta z = |z| \sqrt{\left(\frac{\Delta w}{w}\right)^2 + \left(\frac{\Delta v}{v}\right)^2}$$

11. Solution of Sample Questions

Question # 1

Topic Area: (T1) Mathematics

Learning Level: Applying & Analyzing

Indicator: (GE-T1-01) Recognize and apply principles of differential calculus

Question Statement:

The equation for the tangent of the function $3\sin(x) - \sqrt{x+1}$, at $x=0$ is:

- A) $y = -5 + \frac{1}{2}x$
- B) $y = -3 + 2x$
- C) $y = \frac{2}{3}x$
- D) $y = -1 + \frac{5}{2}x$

Answer: D

Supplied Reference: Reference #1

Estimated Solution Time by Examinee: 2 minutes

Solution:

The equation of tangent at $x=0$ is

$$y = f(0) + (x - 0)f'(0)$$

$$\text{Since } f'(x) = 3 \cos(x) - \frac{1}{2\sqrt{x+1}}$$

The equation of the tangent is

$$y = -1 + \frac{5}{2}x$$



Question # 2

Topic Area: (T1) Mathematics

Learning Level: Applying & Analyzing

Indicator: (GE-T1-06) Apply matrix algebra

Question Statement:

Given a 3x3 matrix A with $\det(A)=2$. The value of $\det((3A)^{-1})$ is:

- A) 1/54
- B) 1/27
- C) 1/12
- D) 1/6

Answer: A

Reference Sheet: None

Estimated Solution Time by Examinee: 2 minutes

Solution:

$$\det((3A)^{-1}) = 1/(\det(3A)) = 1/(3^3 \det(A)) = 1/(27 \times 2) = 1/54$$



Question # 3

Topic Area: (T1) Mathematics

Learning Level: Applying & Analyzing

Indicator: (GE-T1-08) Perform iterations to numerically solve nonlinear algebraic equations

Question Statement:

Starting with the initial guess $x_0=1$ and using Newton-Raphson method, the first iteration in solving the equation $x=e^{-x}$ is:

- A) 0.538
- B) 1.461
- C) 1.582
- D) 3.164

Answer: A

Supplied Reference: Reference #3

Estimated Solution Time by Examinee: 3. minutes

Solution:

Let $f(x)=x-e^{-x}=0$

Newton iteration: $x_1=x_0-f(x_0)/f'(x_0)$

$f(1)=1-e^{-1}=0.632$

$f'(x)=1+e^{-x}$

$f'(1)=1+e^{-1}=1.368$

$x_1=0.538$



Question # 4

Topic Area: (T2) Probability and Statistics

Learning Level: Remembering & Understanding

Indicator: (GE-T2-01) Recognize the concept of mean, mode, standard

Question Statement:

Consider the following data: -1, 1, 2, 3, 7. The mean and the standard deviations of the data are:

- A) 2.4 and 2.653
- B) 2.4 and 7.040
- C) 2.4 and 5.931
- D) 12 and 2.653

Answer: A

Supplied Reference : None

Estimated Solution Time by Examinee: 3. minutes

Solution:

$$\text{Mean} = \frac{-1+1+2+3+7}{5} = 2.4$$

$$\frac{(-1 - 2.4)^2 + (1 - 2.4)^2 + (2 - 2.4)^2 + (3 - 2.4)^2 + (7 - 2.4)^2}{5} = \frac{12}{5} = 7.04$$

$$\text{Standard deviation} = \sqrt{7.04} = 2.653$$



Question # 5

Topic Area: (T2) **Probability and Statistics**

Learning Level: Applying & Analyzing

Indicator: (GE-T2-02) Apply conditional probability

Question Statement:

A box contains five good bulbs and two damaged ones mixed together. In order to locate the damaged bulbs, they are tested one by one, at random and without replacement. The probability that we find both of the damaged bulbs in the first two tests is:

- A) $2/7$
- B) $5/7$
- C) $1/21$
- D) $3/21$

Answer: C

Supplied Reference: Reference #5

Estimated Solution Time by Examinee: 2 minutes

Solution:

Let A be the event: We find a damaged bulb in the first test

Let B the event: We find a damaged bulb in the second test

We want to compute

$$P(A \cap B) = P(A)P(B|A) = (2/7)*(1/6)=1/21$$



Question # 6

Topic Area: (T3) Computer Literacy

Learning Level: Applying & Analyzing

Indicator: (GE-T3-05) Analyze algorithms in flowchart or pseudo code formats.

Question Statement:

Consider the following instructions:

1. Start
2. Set $x = 10$, $y = 5$
3. If $x > y$ then go to step 4 ; otherwise go to step 6
4. Replace x by $x + 1$ and y by $2(y - 1)$
5. Go to step 3
6. Print y , x
7. End

After executing these instructions, the numbers that are printed are:

- A) 8, 11
- B) 11, 8
- C) 12,14
- D) 14,12

Answer: D

Supplied Reference Sheet: None

Estimated Solution Time by Examinee: 2 minutes

Solution: Start with $x=10$, $y=5$ then Go to Step4: $x=11$ and $y=8$; Go to step 3; $x=12$; $y=14$;



Question # 7

Topic Area: (T4) Statics and Dynamics

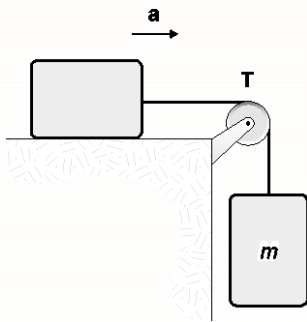
Learning Level: Applying & Analyzing

Indicator: (GE-T4-04) Use Newton's second law of motion

Question Statement:

If the tension, T , is 14 N and the magnitude of the acceleration, a , is 3.0 m/s^2 , then the mass, m (kg), of the suspended object is:

(Assume that all surfaces and the pulley are frictionless. Take $g = 10 \text{ m/s}^2$)



- A) 3.1
- B) 2.0
- C) 2.8
- D) 1.2

Answer: B

Supplied Reference: Reference #7

Estimated Solution Time by Examinee: 2 minutes

Solution:

Applying Newton law on the body of mass (m):

$$\sum F = ma$$

$$mg - T = ma$$

$$mg - ma = T$$

$$m = \frac{T}{g-a} = \frac{14}{10-3} = \frac{14}{7} = 2 \text{ kg}$$



Question # 8

Topic Area: (T4) Statics and Dynamics

Learning Level: Applying & Analyzing

Indicator: (GE-T4-05) Apply Impulse and momentum to problems involving particle and rigid body

Question Statement:

An object (A) of mass (m) and velocity (u_A) hits a stationary object (B) of equal mass. The final velocities of A and B are v_A and v_B . The equation for the conservation of linear momentum leads to:

A) $u_A = v_A + v_B$

B) $m u_A = m v_A + v_B$

C) $u_A^2 = v_A^2 + v_B^2$

D) $m u_A^2 = m v_A^2 + v_B^2$

Answer: A

Supplied Reference: Reference #8

Estimated Solution Time by Examinee: 2 minutes

Solution:

Applying the conservation of momentum:

$$m u_A + 0 = m v_A + m v_B$$

which yields

$$u_A = v_A + v_B$$



Question # 9

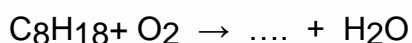
Topic Area: **Chemistry**

Learning Level: (T5) Remembering & Understanding

Indicator: (GE-T5-03) Complete and balance chemical reaction equations

Question Statement:

Consider the **complete** oxidation of C_8H_{18} .



The missing product and the coefficients of the balanced reaction are:

- A) The product is CO and the coefficients are 2, 17, 16, and 18
- B) The product is CO and the coefficients are 4, 34, 16, and 36
- C) The product is CO_2 and the coefficients are 4, 4, 32, and 36
- D) The product is CO_2 and the coefficients are 2, 25, 16, and 18

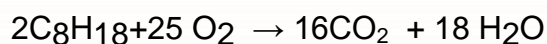
Answer: D

Supplied Reference: None

Estimated Solution Time by Examinee: 2 minutes

Solution:

The complete oxidation will yield CO_2 . After the examinee realizes that he will have to choose between answers (C) and (D). He could test each of one and figure out the right solution.



Question # 10

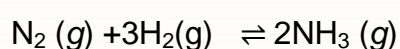
Topic Area: **Chemistry**

Learning Level: (T5) Remembering & Understanding

Indicator: (GE-T5-05) Recognize and apply the principles of chemical equilibrium

Question Statement:

Consider the following reaction



If the nitrogen concentration is increased, this will result in the production of:

- A) More hydrogen
- B) Less ammonia
- C) Less hydrogen
- D) More ammonia

Answer: D

Supplied Reference: Reference #10

Estimated Solution Time by Examinee: 1 minute

Solution: Follows directly from the Chatelier's principle.



Question # 11

Topic Area: (T6) Thermodynamics

Learning Level: Applying & Analyzing

Indicator: (GE-T6-01) Apply the ideal gas law

Question Statement:

One mole of an ideal gas is initially at temperature T_1 , pressure P_1 and occupies a volume V_1 . The gas goes through an isothermal expansion in which its volume doubles. The final pressure is:

- A) P_1
- B) $\frac{P_1}{2}$
- C) $2P_1$
- D) $P_1^{\frac{1}{2}}$

Answer: B

Supplied Reference: Reference #11

Estimated Solution Time by Examinee: 2 minutes

Solution:

Writing the ideal gas law for isothermal expansion from initial state (1) to final state (2) for one mole:

$$P_1V_1 = RT_1 \text{ and } P_2V_2 = RT_2$$

$$T_1 = T_2 \text{ and } V_2 = 2V_1$$

$$\text{Therefore } P_1V_1 = 2P_2V_1 \text{ yields } P_2 = P_1/2$$



Question # 12

Topic Area: (T6) Thermodynamics

Learning Level: Applying & Analyzing

Indicator: (GE-T6-06) Analyze the efficiency of power and refrigeration processes

Question Statement:

A heat engine operates between 260°C and 110°C. The maximum (Carnot) efficiency (%) of this heat engine is:

- A) 28.1
- B) 57.7
- C) 42.3
- D) 71.8

Answer: A

Supplied Reference: Reference # 12

Estimated Solution Time by Examinee: 2 minutes

Solution:

$$\text{Maximum (Carnot) efficiency} = 1 - \frac{110+273}{260+273} = 0.2814$$



Question # 13

Topic Area: (T7) Fluid mechanics

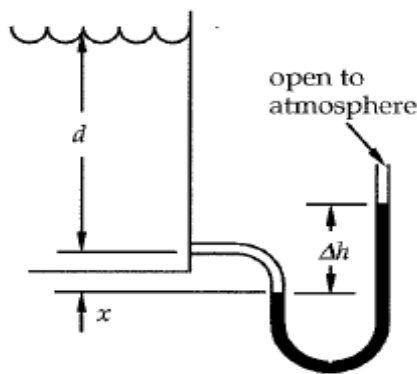
Learning Level: Applying & Analyzing

Indicator: (GE-T7-02) Apply fluid statics

Question Statement:

A mercury (specific gravity= 13.6) manometer is used to measure pressure at the bottom of a tank (depth d) containing acetone (specific gravity = 0.787) as shown in the figure below. The manometer is to be replaced with a gage. If $\Delta h = 100$ mm and $x = 50$ mm, the expected gage reading (kPa) will be: ($g=9.81$ m/s²)

- A) 10.76
- B) 12.96
- C) 17.21
- D) 20.32



Answer: B

Supplied Reference: None

Estimated Solution Time by Examinee: 3 minutes

Solution:

$$\text{Acetone} \quad \rho_a = 787 \text{ Kg/m}^3$$

$$\text{Hg} \quad \rho = 13600 \text{ Kg/m}^3$$

$$p_A + \rho_a x = p_{\text{atm}} + \rho g \Delta h$$

$$p_A + 787(9.81)(0.05) = 1.013 \times 10^5 + 13600(9.81)(0.1)$$

$$p_A + 386 = 1.013 \times 10^5 + 13341.6$$

$$p_A = 1.134 \times 10^5 \text{ pa (abs)} = 12.96 \text{ kPa (gage)}$$



Question # 14

Topic Area: (T7) Fluid Mechanics

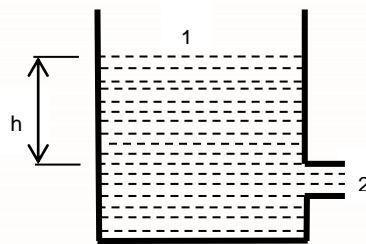
Learning Level: Applying & Analyzing

Indicator: (GE-T7-03) Apply fluid kinematics and dynamics

Question Statement:

Consider the liquid flowing in the tank shown in the figure below. The height of the liquid between points (1) and (2) is 3 m. Assume the tank is open to the atmosphere. The velocity (m/s) of the liquid at point (2) is:
(use $g=9.8 \text{ m/s}^2$)

- A) 0
- B) 5.42
- C) 58.8
- D) 7.67



Answer: D

Supplied Reference: Reference # 14

Estimated Solution Time by Examinee: 3 minutes

Solution:

The Bernoulli equation is applied between point 1 on the surface and point 2. At the surface the velocity is negligible ($u_1 = 0$) and the pressure is atmospheric. Point 2 is open to the air so the pressure is atmospheric ($p_2 = p_1$).

$$u_2 = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 3} = 7.67 \text{ m/s}$$



Question # 15

Topic Area: (T8) **Materials Science and Engineering**

Learning Level: Remembering & Understanding

Indicator: (GE-T8-01) Recognize different material properties

Question Statement:

What is the group of materials that is hard and brittle, and a good insulator?

- A) metals
- B) polymers
- C) ceramics
- D) composites

Answer: C

Supplied Reference: None

Estimated Solution Time by Examinee: 1 minute



Question # 16

Topic Area: (T8) Materials Science and Engineering

Learning Level: Applying & Analyzing

Indicator: (GE-T8-06) Calculate stresses due to normal loads, shear load, bending and torsion.

Question Statement:

A steel column (4 m long, 0.5 m diameter, modulus of elasticity 200 GPa) carries a load of 40 MN. The column will be compressed (mm) by:

- A) 1.03
- B) 2.15
- C) 4.08
- D) 5.15

Answer: C

Supplied reference: Reference #16

Estimated Solution Time by Examinee: 3 minutes

Solution:

$$A = \pi x D^2 / 4 = 0.196 \text{ m}^2$$

$$\sigma = F / A = 40 \times 10^6 / 0.196 = 2.037 \times 10^8 \text{ Pa}$$

$$\varepsilon = \sigma / E = 2.037 \times 10^8 / 200 \times 10^9 = 0.00102$$

$$x = \varepsilon L = 0.00102 \times 48 \times 1000 = 4.08 \text{ mm}$$



Question # 17

Topic Area: (T9) Electricity and Magnetism

Learning Level: Remembering & Understanding

Indicator: (GE-T9-01) Recognize and interpret the basic concepts of electrical and magnetic quantities

Question Statement:

The resistance (Ω) of a 2 meter wire having a cross sectional area of 2 mm^2 and a resistivity of $2 \times 10^{-8} \Omega \cdot \text{m}$ is:

- A) 0.001
- B) 0.02
- C) 0.1
- D) 10.0

Answer: B

Supplied Reference: None

Estimated Solution Time by Examinee: 2 minutes

Solution:

$$R = \text{Resistivity} \times \text{Length} / \text{Area} = 2 \times 10^{-8} \times 2 / (2 \times 10^{-6}) = 0.02 \Omega$$



Question # 18

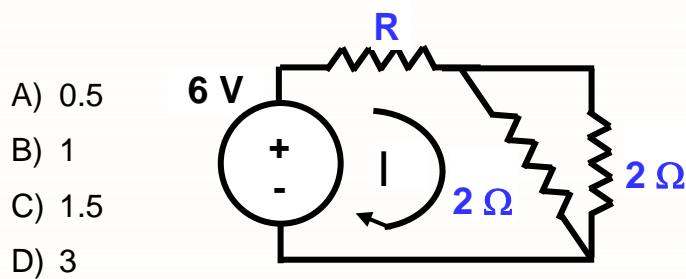
Topic Area: (T9) Electricity and Magnetism

Learning Level: Applying & Analyzing

Indicator: (GE-T9-03) Express and apply current and voltage laws (Kirchhoff, Ohm) for simple electrical circuits

Question Statement:

The power loss in resistor R of the shown electrical circuit is 8 W. Then one possible value of R (Ω) is:



Answer: A

Supplied Reference: Reference #18

Estimated Solution Time by Examinee: 3 minutes

Solution:

$$\text{Power Loss in } R = R \cdot I^2 = R \cdot (6 / (1 + R))^2$$

This gives two possible values of R: 0.5 Ω and 2 Ω .



Question # 19

Topic Area: (T10) **Engineering Drawing**

Learning Level: Remembering & Understanding

Indicator: (GE-T10-01) Recognize the concepts and terminologies used in engineering drawing

Question Statement:

These drawings are given to contractors to perform work or manufacture individual parts:

- A) Assembly details
- B) 3D drawings
- C) Working drawings
- D) Skeleton assemblies

Answer: C

Supplied Reference: None

Estimated Solution Time by Examinee: 1 minute



Question # 20

Topic Area: (T11) Engineering Economics

Learning Level: Remembering & Understanding

Indicator: (GE-T11-04) Recognize the concept of the time value of money and calculate worth (present, annual equivalent and future) of a cash flow time series

Question Statement:

A shop is considering the purchase of a new machine. The machine price is \$4,000 and has a useful life of 10 years. The estimated value of the machine at the end of its useful life is zero. The annual depreciation amounts (\$), using the straight line method is:

- A) 400
- B) 512
- C) 640
- D) 800

Answer: A

Supplied Reference: None

Estimated Solution Time by Examinee: 1 minute

Solution:

Straight line Depreciation method,

$$D = \frac{B - SV}{N}$$

Where:

N: useful life of the machine in years

B: purchase price

D: annual depreciation deduction

SV: estimated salvage value at the end of the useful life

$$= \frac{\$4000 - 0}{10} = \$400$$



Question # 21

Topic Area: (T11) Engineering Economics

Learning Level: Applying & Analyzing

Indicator: (GE-T11-05) Analyze and evaluate alternatives (present-worth, annual equivalent-worth, rate-of-return, payback period and benefit-cost ratio)

Question Statement:

A small plant is reported to have the following economic data:

Fixed capital investment = \$1,000,000

Working capital = \$200,000

Annual production rate = 500 ton/year

Product selling price = \$600/ton

Fixed operating costs = \$50/ton

Variable operating cost = \$150/ton

The pay-back period (years) is about:

- A) 4
- B) 6
- C) 12
- D) 15

Answer: B

Supplied Reference: Reference #21

Estimated Solution Time by Examinee: 3. minutes

Solution:

Pay-back period = Total capital investment/Annual cash flow

Total Capital investment = Fixed capital investment + working capital

Total capital investment = \$1,000,000 + \$200,000 = \$1,200,000

Annual cash flow = Annual sales - Annual operating costs (excluding depreciation)

Annual sales = production rate * selling price = 500*600 = \$300,000 /year

Annual operating costs (excluding depreciation) = variable costs + fixed costs

Total operating costs (excluding depreciation) = 75,000+25,000

Annual Cash flow = 300,000 - 100,000 = \$200,000/year

Pay-back period = 1,200,000/200,000 = 6 years



Question # 22

Topic Area: (T12) Project Management

Learning Level: Remembering & Understanding

Indicator: (GE-T12-01) Recognize the fundamentals of project management

Question Statement:

In project management, the project critical path can be defined as:

- A) the path that has a chain of activities with a high risk factor.
- B) the path that has a chain of activities with total float equal zero.
- C) the path that has a chain of activities with lowest values of total float.
- D) the path that has a chain of activities with free float equal zero.

Answer: C

Supplied Reference: None

Estimated Solution Time by Examinee: 1 minutes



Question # 23

Topic Area: (T13) Ethics and Professionalisms

Learning Level: Applying & Analyzing

Indicator: (GE-T13-03) Make decisions while observing standards, safety and ethical implications

Question Statement:

You work as an engineer on the construction of a building that is behind schedule and urgently needed by the client. The plumbing system does not work to specifications. Your boss asks you to certify the building as properly completed. Should you:

- A) Certify it because it serves the interests of the company.
- B) Explain the problem to the client, and ask him to take a decision about certification.
- C) Certify it, but keep an eye on the building, in case any problems arise in the future.
- D) Decline to certify it.

Answer: D

Reference Sheet: None

Estimated Solution Time by Examinee: 1 minute



Question # 24

Topic Area: (T14) **General Skills**

Learning Level: Applying & Analyzing

Indicator: (GE-T14-03) Work cooperatively with other team members to deliver the required outcomes

Question Statement:

What feature can make teamwork more productive?

- A) Complete independence within the team
- B) Conflicts within the team
- C) Strong competition within the team
- D) Having clear objectives

Answer: D

Supplied Reference: None

Estimated Solution Time by Examinee: 1 minute



Question # 25

Topic Area: (T14) **General Skills**

Learning Level: Remembering and Understanding

Indicator: (GE-T14-07) Recognize and interpret environmental, social, cultural, political and safety considerations in engineering solutions.

Question Statement:

A new facility with high energy need is being designed. The engineer has to consider sustainable designs such as using:

- A) Creative design ideas
- B) Advanced building material
- C) Renewable energy as supplement
- D) Personal taste

Answer: C

Supplied Reference: None

Estimated Solution Time by Examinee: 1 minute



Question # 26

Topic Area: (T14) **General Skills**

Learning Level: Remembering and Understanding

Indicator: (GE-T14-09) Recognize major engineering concepts outside the discipline.

Question Statement:

Ergonomics is the study of:

- A) Interactions between products and humans who use them
- B) Interactions between economy and the society
- C) Climate activities
- D) Economic activities

Answer: A

Supplied Reference: None

Estimated Solution Time by Examinee: 1 minute



Question # 27

Topic Area: (T14) General Skills

Learning Level: Remembering and Understanding

Indicator: (GE-T14-10) Interpret uncertainties in measurements and calculations

Question Statement:

The voltage across a resistance is 10.875 ± 0.001 Volts. Given that the current (I) is 3.15 ± 0.01 Ampere, then the resistance $R=V/I$ is 3.452 (Ohm) with an error of:

- A) 0.002
- B) 0.011
- C) 0.015
- D) 0.020

Answer: B

Supplied Reference: Reference #27

Estimated Solution Time by Examinee: 1 minute

Solution

Using Reference#27

Let $z = w/v$

$$\text{Then } \Delta R = |R| \sqrt{\left(\frac{\Delta V}{V}\right)^2 + \left(\frac{\Delta I}{I}\right)^2} = 3.452 \sqrt{\left(\frac{0.001}{10.875}\right)^2 + \left(\frac{0.01}{3.15}\right)^2} = 0.011$$



