Students Manual for the Exam

General Engineering and Mechanical Engineering Discipline

- March 2014 -

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1. Aim of Manual

The aim of this Manual is to provide information to the students about the exam objective, structure, timing, and general rules.

2. Overview of Exam

- This engineering exam is planned by the ministry of higher education and administered by Qiyas center.
- It is aimed at examining engineering students in all Saudi Engineering Colleges in their last year of study.
- The exam is Multiple Choice Questions (MCQ) and is divided into two sessions: a morning session devoted to General Skills and General Engineering, and an evening session devoted to disciplines (chemical, civil, computer, electrical, industrial, mechanical and architecture).
- One purpose of the exam is to assess the educational learning outcomes in various programs across the engineering colleges in Saudi Arabia.
- The exam tests the students in the General Skills and also in the four key learning areas:
    - Basic Sciences and Engineering Fundamentals
    - Engineering Analysis and Investigation
    - Engineering Design
    - Engineering Practice
- The results of the students in this exam are kept confidential and are used for statistical analysis.

3. Exam Structure and Organization

3.1 Eligibility for Exam

Bachelor degree holders in Mechanical Engineering and those who are in the final year of such program are eligible to take the exam.

3.2 Exam Structure

The exam consists of two sessions (3-hours each) during one day (one session in the morning and the other in the afternoon) with two hours break between the two sessions, as follows:

Session 1:

The 3-hours morning session consists of 1 hour (44 questions) for General Skills and 2 hours (60 questions) for General Engineering Skills.

The General Skills consist of:

- Communication skills
- Numeracy and calculation skills
- Computer literacy skills
- Interpersonal skills
- Problem solving skills
- Learning and performance improvement skills

The General Engineering Skills cover the following topics:

- Mathematics
- Numerical Techniques
- Probability and Statistics
- Physics
- Statics and Dynamics
- Electricity and Magnetism
- Chemistry
- Thermodynamics
- Fluid mechanics
- Materials Science
- Engineering Drawing
- Process Economics
- Project management
- Codes, Ethics, Environment and Social issues

Each question is a multiple choice question with 4 choices for the answer.

Session 2:

The 3-hours evening session is devoted to subjects of Mechanical Engineering Discipline. The session consists of 50 questions carrying a maximum of 100 marks. Each question is a multiple choice question with 4 choices for the answer. In this session, the following subjects are covered:

- Materials
- Solid Mechanics
- Manufacturing Processes
- Dynamics and Control
- Fluid Mechanics

- Thermodynamics
- Heat Transfer
- Mechanical Design

3.3 Exam Type

The exam is paper based and all questions are multiple choice questions. Each question has 4 choices for the answer. There is no negative marking for wrong answers.

3.4 Exam Rules

- Books, lecture notes, or another type of material are not allowed in the exam
- Approved calculators are allowed to do the necessary calculations
- Admission in the examination center will be only through authorities admit card issued by examination authority
- Necessary reference sheets, monographs, equations and/or relevant data will be provided during the exam.

4. Sample Questions for General Engineering (session 1)

Question #1

Question Statement:

The inverse (if it exists) of the matrix $\begin{pmatrix} \alpha & -\beta \\ \beta & \alpha \end{pmatrix}$ is:

A) $\begin{pmatrix} \boldsymbol{\alpha} & \boldsymbol{-\beta} \\ \boldsymbol{\beta} & \boldsymbol{\alpha} \end{pmatrix}$

B) $\frac{1}{\alpha^2+\beta^2}\begin{pmatrix} \boldsymbol{\alpha} & \boldsymbol{-\beta} \\ \boldsymbol{\beta} & \boldsymbol{\alpha} \end{pmatrix}$

C) $\frac{1}{\alpha^2+\beta^2}\begin{pmatrix} \boldsymbol{\alpha} & \boldsymbol{\beta} \\ \boldsymbol{-\beta} & \boldsymbol{\alpha} \end{pmatrix}$

D) $\frac{1}{\alpha^2-\beta^2}\begin{pmatrix} \boldsymbol{\alpha} & \boldsymbol{-\beta} \\ \boldsymbol{\beta} & \boldsymbol{\alpha} \end{pmatrix}$

Reference Sheet: None

Remarks: The objective of this question is to test the examinee ability to solve a simple linear algebra problem involving a 2x2 matrix inversion.

Question #2

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) 8,12
C) 12,14
D) 14,12

Reference Sheet: None

Remarks: The objective of this question is to test the examinee ability to solve an iteration-based problem.

Question #3

Question Statement:

Consider the following data: −1, 1, 2, 3 and 7. The mean and the standard deviation 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

Reference Sheet: None

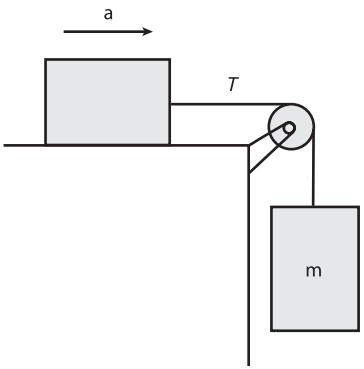
Remarks: The objective of this question is to test the examinee ability to understand the basic concepts of mean and standard deviation.

Question #4

Question Statement:

If the tension, *T*, is 14 N and the magnitude of the acceleration, a, is 3.0 m/s^2, the mass, *m* (kg) of the suspended object is :
(Assume that all surfaces and the pulley are frictionless. Take g = 10 m/s^2)

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



Reference Sheet: None

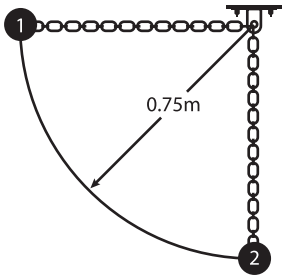
Remarks: This question tests the examinee ability to apply the Newton law and the understanding of the gravity force.

Question #5

Question Statement:

If the pendulum is released from position 1, its velocity (m/s) in position 2 is:

A) 3.8
B) 6.9
C) 14.7
D) 21.0



Reference Sheet: None

Remarks: This question is an illustration of the application of conservation of energy.

Question #6
Question Statement:

The resistance (Ω) of a 2 meter wire having a cross sectional area of 2 mm^2 and a resistivity of 5 x 10^{-8} Ω.m is:

A) 0.001
B) 0.03
C) 0.05
D) 1000

Reference Sheet: None
Remarks: This question is to test the examinee knowledge of basic laws of electricity.

Question #7
Question Statement:

Consider the complete oxidation of C_8H_{18}.

$$C_8H_{18} + O_2 \longrightarrow \ldots\ldots + H_2O$$

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

Reference Sheet: None

Remarks: This question tests the examinee ability to understand the complete oxidation of hydrocarbons and balance it accordingly.

Question #8

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) 42.3
C) 57.7
D) 71.8

Reference Sheet: None

Remarks: This question is to test the examinee ability to recall and use the theoretical efficiency of a Carnot heat engine.

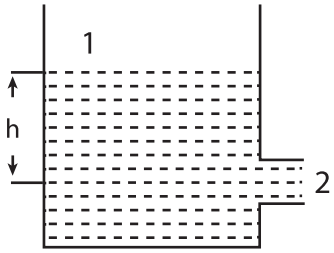
Question #9

Question Statement:

Consider the liquid flowing in the tank shown in the figure. The height (h) of the liquid is 3 m. Assume the tank to be open to the atmosphere. The velocity (m/s) of the liquid at point (2) is:

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

Take g=9.8 m/s^2



Reference Sheet: The Bernoulli equation applied between two points (1) and (2) is:

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

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

Remarks: This question aims to test the examinee ability to apply Bernoulli equation.

Question #10
Question Statement:

What is the group of materials that are hard and brittle, but they are good insulators?:

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

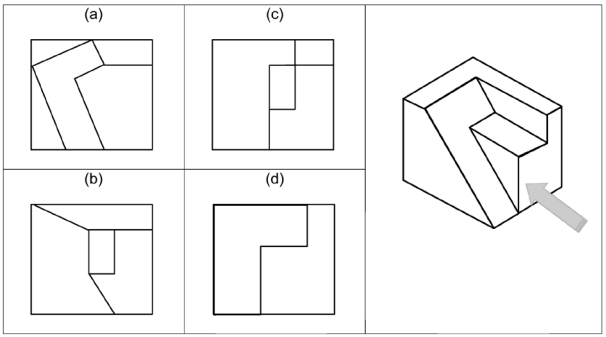
Reference Sheet: None

Remarks: This question is intended to test the examinee ability to recognize the properties of materials.

Question #11
Question Statement:

The orthogonal projection according to the arrow's direction would be:

A) a
B) b
C) c
D) d



Reference Sheet: None

Remarks: This question is intended to test the examinee skills in engineering drawing.

Question #12

Question Statement:

Which of the following devices converts chemical energy directly into electrical energy?

A) A battery.
B) An electrical power plant.
C) A solar cell
D) A car engine.

Reference Sheet: None

Remarks: This question is intended to test the examinee recognition of the basics of other engineering disciplines.

Question #13

Question Statement:

Professional engineers are first obliged to:

A) The welfare of the community.
B) The engineering profession.
C) Their employer.
D) Their customer.

Reference Sheet: None

Remarks: This question is intended to test the examinee understanding of the priority they should give, when they become engineers, to the public welfare.

Question #14

Question Statement:

The objective of Project Management is to finish the project

A) within budget, time and required quality.
B) having high safety record.
C) as required by the contract specifications.
D) having profit for the project.

Reference Sheet: None

Remarks: This question is intended to test the examinee understanding of the objective of project management.

Question #15

Question Statement:

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

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

Reference Sheet: None

Remarks: This question is intended to test the examinee ability to perform engineering economics analysis.

5. Sample Questions for Mechanical Engineering (session 2)

Question #1

Question Statement:

If two incremental true strains, namely ε_1 and ε_2 are imposed on a material in the same direction, then the total true strain in the same direction is

A) $\varepsilon_1 \times \varepsilon_2$
B) $\varepsilon_1 - \varepsilon_2$
C) $\varepsilon_1 + \varepsilon_2$
D) $\varepsilon_1 / \varepsilon_2$

Reference Sheet: None

Remarks: The objective of this question is to ensure that the examinee can express the total strain in terms of incremental strains.

Question #2

Question Statement:

Using distortion-energy criterion, yielding will take place when:

A) Distortion energy attains a critical value
B) Second invariant of the stress deviator exceeded some critical value
C) Octahedral shear stress attains a critical value
D) All of the above

Reference Sheet: None

Remarks: The objective of this question is to ensure that the examinee is familiar with theories of failure.

Question #3

Question Statement:

The root locus is a plot of:

A) Closed loop system poles for changing system gains.
B) Closed loop system zeros for constant system gains.
C) Open loop system poles for changing system gains.
D) Open loop system zeros for changing system gains.

Reference Sheet: None

Remarks: The objective of this question is to ensure that the examinee is familiar with the use of root locus.

Question #4

Question Statement:

The system is considered absolutely stable if:

A) All poles have positive real parts.
B) At least one pole has positive real part.
C) At least one pole has negative real part.
D) All poles have negative real parts.

Reference Sheet: None

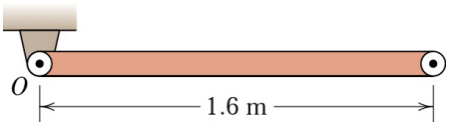
Remarks: The objective of this question is to ensure that the examinee is familiar with basic concepts of automatic control.

Question #5

Question Statement:

If a uniform bar of mass m and length l, pinned at point O, is released from rest at horizontal position, its initial angular acceleration α (rad/s^2) is:
(m = 20 kg, l = 1.6 m, g = 9.81 m/s^2, ($I_G = ml^2/12$, $I_O = ml^2/3$))

A) 1.9
B) 9.2
C) 14.7
D) 36.8



Reference Sheet: None

Remarks: The objective of this question is to ensure that the examinee is familiar with Newton›s second law.

Question #6

Question Statement:

A person holds his hand out of a car window while driving through still air (density ρ) at a speed of V_{car} and at atmospheric pressure P. What is the maximum pressure P_{max} on the person's hand?

A) P
B) $P + \frac{1}{2} (V_{car})^2$
C) $\frac{1}{2} \rho (V_{car})^2$
D) $P + \frac{1}{2} \rho (V_{car})^2$

Reference Sheet: None

Remarks: The objective of this question is to ensure that the examinee is familiar with the basic fluid flow mechanics and that he understands the difference between static and stagnation property values.

Question #7

Question Statement:

Consider a model and a prototype of a physical system, the dynamic similarity between them means the similarity of:

A) Shapes
B) Sizes
C) Motions
D) Forces

Reference Sheet: None

Remarks: The objective of this question is to ensure that the examinee is familiar with the similarity concept.

Question #8

Question Statement:

For a solid solution of Cu-7 wt. % Al alloy, what is the atomic percent (%) of Al?
Given data: Atomic weights of Cu and Al are 63.55 and 26.98 amu, respectively.

A) 3.1
B) 10.5
C) 15
D) 17.2

Reference Sheet: None

Remarks: The objective of this question is to ensure that the examinee can express the composition of an alloy in terms of weight percentage or atomic percentage.

Question #9

Question Statement:

Heptane (specific gravity = 0.681, dynamic viscosity = 0.376×10^{-3} Pa.s) flows through a 0.1826 m diameter wrought iron pipe that is 800 m long. The volume flow rate is 0.028 m^3/s. The pressure drop (kPa) in the pipe will be about:

A) 54.6
B) 27.2
C) 25.6
D) 19.1

Reference Sheet: See Reference Sheet # 1

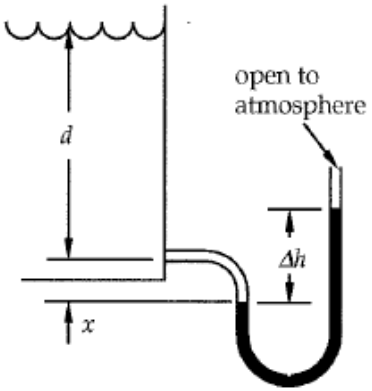
Remarks: The objective of this question is to ensure that the examinee has the ability to calculate the pressure drops in pipes.

Question #10

Question Statement:

A mercury (specific gravity = 13.6) manometer is used to measure pressure at the bottom of a tank containing acetone (specific gravity = 0.787) as shown in the figure below. The manometer is to be replaced with a gage. If Δh = 100 mm and x = 50 mm, the expected gage pressure reading (kPa) will be:

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



Reference Sheet: None

Remarks: The objective of this question is to ensure that the examinee has the ability to obtain the static pressure in a system.

Question #11

Question Statement:

The surface hardness of the gear material is helpful in:

A) Static mode of design
B) Dynamic mode of design
C) Wear mode of design
D) All of the above

Reference Sheet: None

Remarks: The question tests the ability of the student to understand the role of surface hardness of gear materials in designing a gear.

Question #12

Question Statement:

In a thick wall cylinder (yield strength = 400 MPa), the principal stresses are given by $\sigma_1 = 38.82$ MPa, $\sigma_2 = 0$ MPa, $\sigma_3 = 7.00$ MPa. Using distortion energy theory, the safety factor for the wall is

A) 11.16
B) 9.4
C) 6.3
D) 4.4

Reference Sheet: None

Remarks: The question tests the ability of the student in designing a thick wall cylinder.

Question #13

Question Statement:

The quantization error (%) of a 12 bit A/D convertor is:

A) 0.0122
B) 0.122
C) 1.22
D) 12.2

Reference Sheet: None

Remarks: The question tests the ability of the student to determine the bias error in an A/D converter.

Question #14

Question Statement:

The output of a Pitot Static Probe is:

A) Velocity
B) Static pressure
C) Total pressure
D) Dynamic Pressure

Reference Sheet: None

Remarks: The question tests the ability of the examinee to understand the function of flowmeter

Question #15

Question Statement:

Linearly Variable Differential Transformer (LVDT) is basically used to measure:

A) Absolute pressure
B) Electric current
C) Electric power
D) Displacement

Reference Sheet: None

Question #16

Question Statement:

In a system of two identical pumps in series:

A) The head will be the same and the flow rate will be twice that of a single pump
B) The head will be the same and the flow rate will be half that of a single pump
C) The head will be half that of a single pump and the flow rate will be the same
D) The head will be twice that of a single pump and the flow rate will be the same

Reference Sheet: None

Remarks: The objective of this question is to test if the examinee understands the operation and function of pumps.

Question #17

Question Statement:

Cavitations in centrifugal pumps cannot be prevented using one of the following methods by:

A) Cooling the liquid at inlet
B) Installing pumps in series
C) Increasing the suction pressure
D) Decreasing the suction pressure

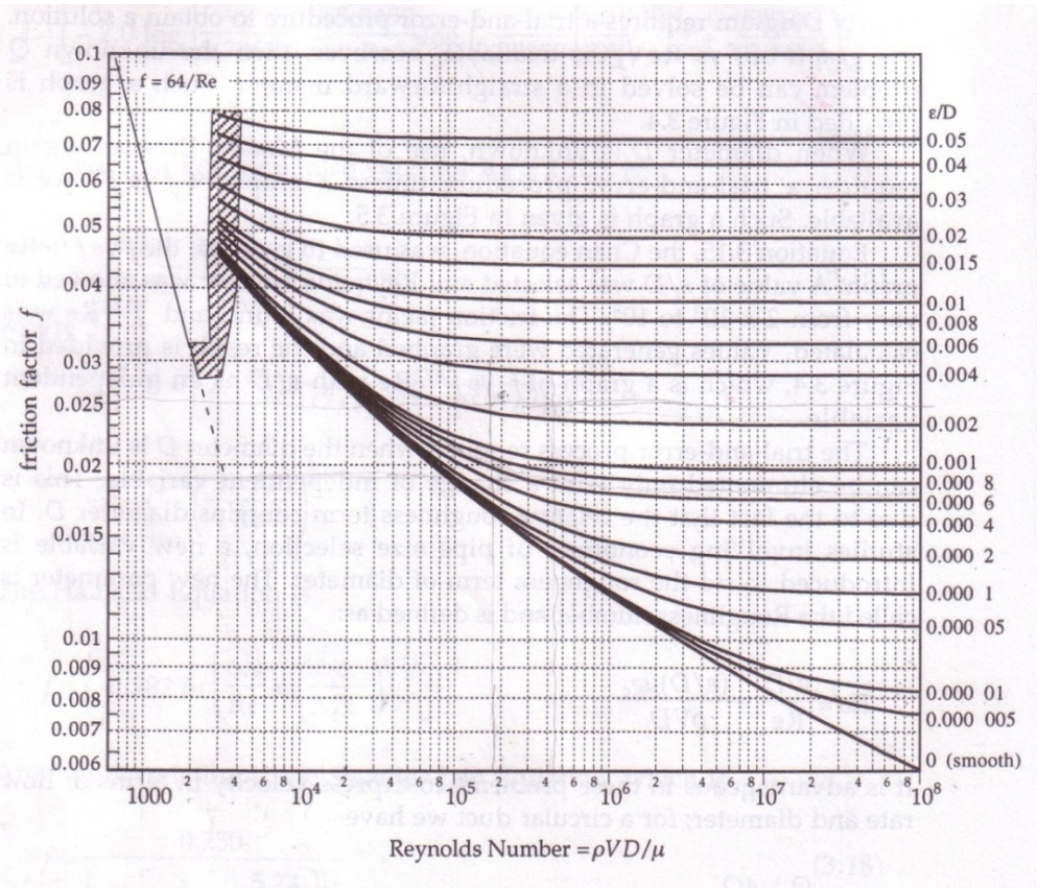
Reference Sheet: None

Remarks: The purpose of the questions is to test the examinee understanding the cause of cavitation in pumps

Reference sheet # 1

Take the average value

Pipe Material	ε, ft	ε, cm
Steel		
Commercial	0.00015	0.004 6
Corrugated	0.003–0.03	0.09–0.9
Riveted	0.003–0.03	0.09–0.9
Galvanized	0.0002–0.0008	0.006–0.025
Mineral		
Brick sewer, Cement–asbestos, Clays, Concrete	0.001–0.01	0.03–0.3
Wood stave	0.0006–0.003	0.018–0.09
Cast iron	0.00085	0.025
Asphalt coated	0.0004	0.012
Bituminous lined	0.000008	0.000 25
Cement lined	0.000008	0.000 25
Centrifugally spun	0.00001	0.000 31
Drawn tubing	0.000005	0.000 15
Miscellaneous		
Brass, Copper, Glass, Lead, Plastic, Tin	0.000005	0.000 15
Galvanized	0.0002–0.0008	0.006–0.025
Wrought iron	0.00015	0.004 6
PVC	Smooth	Smooth


f = 64/Re
friction factor f
Reynolds Number = ρVD/μ
ε/D
0.05
0.04
0.03
0.02
0.015
0.01
0.008
0.006
0.004
0.002
0.001
0.000 8
0.000 6
0.000 4
0.000 2
0.000 1
0.000 05
0.000 01
0.000 005
0 (smooth)
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.025
0.02
0.015
0.01
0.009
0.008
0.007
0.006
1000
10^4
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10^6
10^7
10^8

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