



Students Manual for the Exam

*General Engineering
and
Chemical 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 Chemical 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 Chemical 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:

- Foundation Chemistry
- Process Fundamentals
- Physical Transport Processes
- Chemical Processes
- Process synthesis
- Process control
- Process economics

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

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.

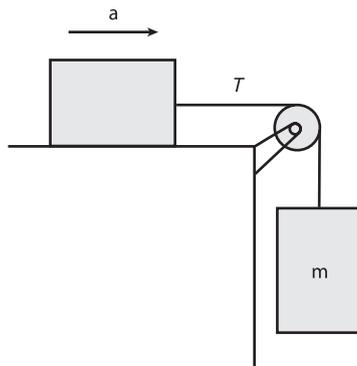
Question #4

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 $g = 10\text{ m/s}^2$)

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



Reference Sheet: None

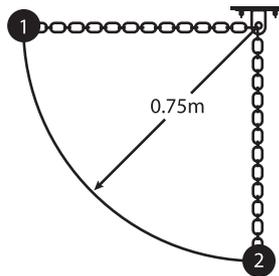
Remarks: This question tests the examinee ability to apply the Newton law and the understanding of the gravity force.

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 $5 \times 10^{-8} \text{ } \Omega \cdot \text{m}$ is:

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

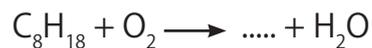
Reference Sheet: None

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} .



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.

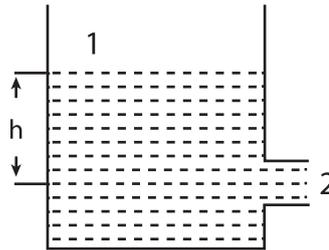
Question #9

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 $g=9.8 \text{ m/s}^2$



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

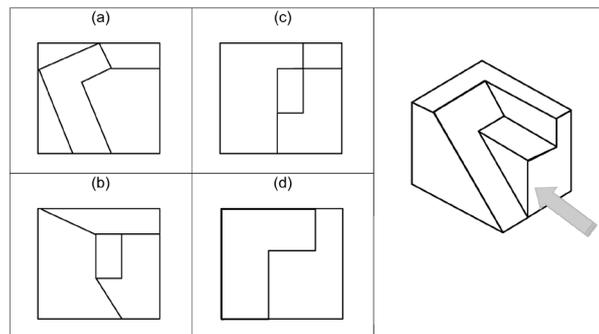
Remarks: This question is intended to test the examinee ability to recognize the properties of materials.

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 Chemical Engineering (session 2)

Question #1

Question Statement:

A 10 g sugar ($C_{12}H_{22}O_{11}$) cube is dissolved in a 450 ml cup of water at $80^{\circ}C$ (density is 0.975 g/ml). The molality of the sugar solution is:

- A) 1.241
- B) 0.232
- C) 0.024
- D) 0.067

Given data: Atomic masses (H:1, C:12, O:16)

Reference Sheet: None

Remarks: The objective of this question is to test the examinee knowledge of various definitions associated with concentration.

Question #2

Question Statement:

The convective mass transport is caused by:

- A) Concentration gradient
- B) Bulk fluid motion
- C) Dispersion
- D) Conduction

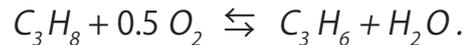
Reference Sheet: None

Remarks: The question evaluates the understanding of the basics of mass transfer.

Question #3

Question Statement:

Find the value of the equilibrium constant for the following gaseous propane oxidative reaction:



The equilibrium concentrations of the various components are: $C_{C_3H_8} = 2 \text{ mol/L}$; $C_{O_2} = 4 \text{ mol/L}$; $C_{C_3H_6} = 3 \text{ mol/L}$ and $C_{H_2O} = 2 \text{ mol/L}$

- A) 2.0
- B) 1.5
- C) 1.25
- D) 0.75

Reference Sheet: None

Remarks: The objective of this question is to test the examinee ability to calculate equilibrium constants.

Question #4

Question Statement:

In order to maintain the process controlled variable at the desired set point, one has to adjust:

- A) Measured variable
- B) Set Point
- C) Manipulated variable
- D) Disturbance

Reference Sheet: None

Remarks: The objective of this question is to test the examinee knowledge in the basics of process control.

Question #5

Question Statement:

How much water (kg) is needed to reduce the concentration of 200 kg of salt solution from 50%wt to 5%wt?.

- A) 2000
- B) 1800
- C) 200
- D) 180

Reference Sheet: None

Remarks: The objective of this question is to test the examinee ability to set up and solve material balance equations

Question #6

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 cost = \$50/ton

Variable operating cost = \$150/ton

The payback period (years) is about:

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

Reference Sheet: None

Remarks: The objective of this question is to test the examinee's ability to solve process economics problems.

Question #7

Question Statement:

100 mol/s of a gas stream is cooled in a double-pipe heat exchanger from 200°C to 100°C by a co-current flow of a water stream. The water enters at 25°C and leaves at 65°C. The overall heat transfer coefficient (U) is 750 W/(m².°C). The heat capacity of the gas stream is 78 J/(mol.K). The required heat transfer area (m²) is:

- A) 13.87
- B) 11.96
- C) 10.19
- D) 7.70

Reference Sheet: None

Remarks: The objective of this question is to test the examinee ability to design heat exchangers.

Question #8

Question Statement:

The first order gas phase reaction $A \xrightarrow{k} B$ takes place in an isothermal continuous stirred tank reactor at 700 K. The activation energy is 10000 J/mol and the frequency (pre-exponential) factor is 3.41 min⁻¹. The initial concentration and molar flow rate of **A** are 3 mol/m³ and 2 mol/min respectively.

The required reactor volume (m³) for 80% conversion of **A** is:

- A) 3.27
- B) 4.36
- C) 5.45
- D) 16.35

Take R=8.314 J/mol.K

Reference Sheet: None

Remarks: The question tests the ability of the examinee to design a CSTR.

Question #9

Question Statement:

A tray in a distillation column receives liquid (L) at a rate of 85 moles per hour and vapor (V) at a rate of 120 moles per hour. The equilibrium relationship is given by:

$$y_n = m x_n \text{ with } m = 1.5$$

The Number of the individual transfer units are: $N_L = 5$ and $N_G = 7$. The Murphree overall tray efficiency, E_{OG} (%) for complete mixing conditions is:

- A) 43.2
- B) 66.7
- C) 82.9
- D) 86.3

Reference Sheet: See reference #1

Remarks: The question evaluates the understanding of mass transfer relationships and the effect of the degree of mixing on tray efficiency.

Reference #1:

The Murphree Local efficiency (E_v) of a distillation tray is given by the relationship:

$$E_v = 1 - e^{-N_{OG}}$$
$$\frac{1}{N_{OG}} = \left(\frac{1}{N_G} + \lambda \frac{1}{N_L} \right)$$

where: $\lambda = \frac{mV}{L}$

Question #10

Question Statement:

As an engineer, you are requested by your company to select a Schedule-40 steel pipe that allows 4.5 ft³/h of liquid to flow at a maximum velocity of 1 ft/s to avoid liquid splash outside from the tank-car. Which nominal pipe size (inches) would you recommend?

- A) 1 / 4
- B) 3 / 8
- C) 1 / 2
- D) 3 / 4

Given data: (1ft =12 in)

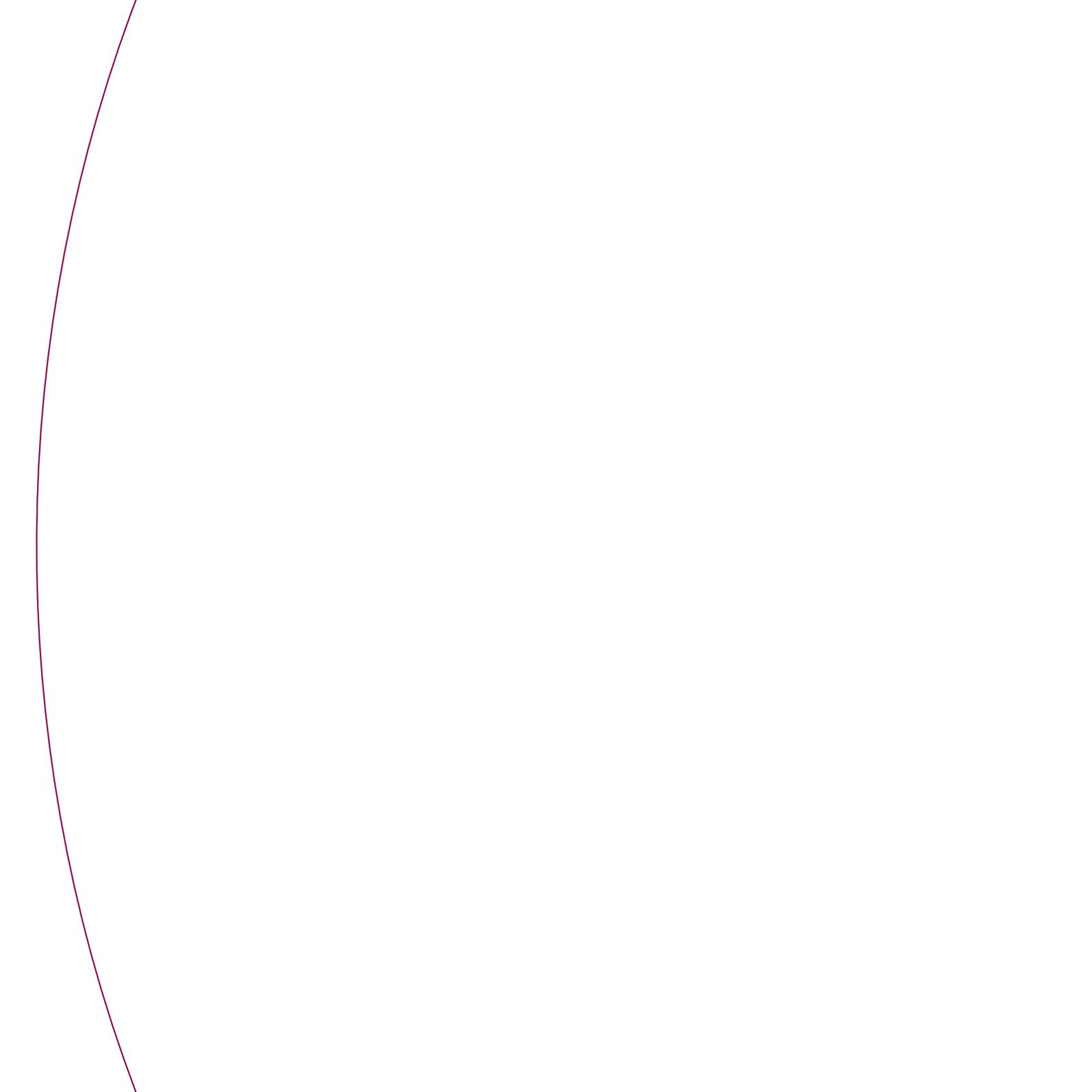
Reference Sheet: Reference #2

Remarks: The question tests the ability of the examinee to design simple flow systems under constraints using codes and standards.

Reference #2:

Supplied Reference: Schedule 40 steel pipe dimensions

Nominal Pipe size, in	Outside diameter, in	Inside diameter, in
1/8	0.405	0.269
1/4	0.540	0.364
3/8	0.675	0.493
1/2	0.840	0.622
3/4	1.050	0.824
1	1.315	1.049
5/4	1.660	1.380
6/4	1.990	1.610



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