There are **FOUR** questions in this section. Answer **Q. No. 1** and any **TWO** from the rest.

1. Q. No. 1 is **COMPULSORY**. Choose the correct answer and provide concise reason for your choice. If you do not defend your choice you will receive only 40% marks. **(10×5=50)**

   (i) Which of these best describes the purpose of planning?
   
   A. To improve communication in the organisation  
   B. To expand the organogram  
   C. To minimize wastage in the future  
   D. To facilitate controlling

   (ii) Which of these is NOT a top level management function?
   
   A. To formulate goals and policies  
   B. To formulate budgets  
   C. To appoint top executives  
   D. To monitor and control the operations performance

   (iii) Which of these is NOT a Decisional role of a Manager?
   
   A. The entrepreneurial role  
   B. The disturbance-handler role  
   C. The liaison role  
   D. The resource allocator role

   (iv) Which of these is NOT an approach in selecting an alternative?
   
   A. Experience  
   B. Intuition  
   C. Experimentation  
   D. Research and Analysis

   (v) The role and responsibilities of process improvement team should be established by which of the following company authorities?
   
   A. The board of directors  
   B. The human resources department  
   C. The team members' supervisors  
   D. The quality steering committee

Contd ........... P/2
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Contd... Q. No. 1

(vi) An operations manager is not likely to be involved in
A. The design of products and services to satisfy customers wants and needs
B. The quality of products and services to satisfy customers wants and needs
C. The identification of customers wants and needs
D. Work scheduling to meet the due dates promised to customers

(vii) Which of the following are the primary functions of all organizations?
A. Operations, marketing and human resources
B. Marketing, Human resource and Finance/Accounting
C. Sales, Quality control, and Operations
D. Marketing, Operations and Finance/Accounting

(viii) The fundamental purpose for the existence of any organization is described by its
A. policies
B. mission
C. plans
D. strategy

(ix) The two general approaches to forecasting are
A. qualitative and quantitative
B. mathematical and statistical
C. judgmental and qualitative
D. historical and associative

(x) A product’s life cycle is divided into four stages, which are
A. introduction, growth, saturation, and maturity
B. introduction, growth, stability, and decline
C. introduction, maturity, saturation, and decline
D. introduction, growth, maturity, and decline

2. (a) Distinguish between - Policy, Rule, Law and Procedure. Write down some of the
characteristics of a good policy and discuss their limitations.  
(b) Three types of organisations are classified by the nature of authority. What are these? Explain your answer with help of diagram(s).  
(c) Choose a suitable technology to illustrate and describe the application of nested S-curves (progression from old technology to new technology)

3. (a) Why is Technology Transfer very difficult to achieve? Explain fully.  
(b) Draw and very briefly explain 4 (four) communication networks.  
(c) The need for planning results from various changes in the environment. What are the aspects of this changing environment? Briefly explain each of these aspects.
4. (a) The following table shows the activities that need to be undertaken to complete an engineering project. Draw the Activity Diagram for the project. Calculate the earliest start, earliest finish, latest start, latest finish and total float for each event, and identify the Critical Path of the given project with the help of an arrow network.

<table>
<thead>
<tr>
<th>Activity Symbol</th>
<th>Estimated time (Weeks)</th>
<th>Post Requisite</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>8</td>
<td>C,D,E</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>H</td>
</tr>
<tr>
<td>C</td>
<td>3</td>
<td>F</td>
</tr>
<tr>
<td>D</td>
<td>5</td>
<td>G</td>
</tr>
<tr>
<td>E</td>
<td>3</td>
<td>H</td>
</tr>
<tr>
<td>F</td>
<td>2</td>
<td>J</td>
</tr>
<tr>
<td>G</td>
<td>3</td>
<td>J</td>
</tr>
<tr>
<td>H</td>
<td>4</td>
<td>I</td>
</tr>
<tr>
<td>I</td>
<td>2</td>
<td>J</td>
</tr>
<tr>
<td>J</td>
<td>3</td>
<td>–</td>
</tr>
</tbody>
</table>

(b) Salesforce is a company specializing in CLOUD COMPUTING. What type of organogram would you suggest, and why? Also, suggest a control scheme for the company.

SECTION – B
There are FOUR questions in this section. Answer any THREE.

5. (a) What is perpetuity in engineering economy? Explain.

(b) In the design of a special-use structure, two mutually exclusive alternatives are under consideration. These design alternatives are as follows:

<table>
<thead>
<tr>
<th>Alternative</th>
<th>( E_1 )</th>
<th>( E_2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Investment</td>
<td>(-14,000)</td>
<td>(-60,000)</td>
</tr>
<tr>
<td>Annual expenses</td>
<td>(-4,000)</td>
<td>(-9,000)</td>
</tr>
<tr>
<td>Useful life (years)</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>Market value (at end of useful life)</td>
<td>8,000</td>
<td>13,000</td>
</tr>
</tbody>
</table>

If perpetual service from the structure is assumed, which design alternative do you recommend? The MARR is 15% per year.
(c) Consider the following cash flow of a proposal (process unit) that can produce 1000 pieces of soap/day. Given MARR is 15% compounded continuously. Find the principal amount that is required to perpetuate the process unit indefinitely.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment</td>
<td>$10,000</td>
</tr>
<tr>
<td>Expected life</td>
<td>5 years</td>
</tr>
<tr>
<td>Salvage value</td>
<td>$1,000</td>
</tr>
<tr>
<td>Annual receipts</td>
<td>$8,000</td>
</tr>
<tr>
<td>Annual expenses</td>
<td>$6,000</td>
</tr>
</tbody>
</table>

6. As a production engineer of an industry you consider mobile cranes to be critical equipment. The purchase of a new medium size crane is being evaluated. The economic estimates for the two MEAs are given below:

<table>
<thead>
<tr>
<th>MEAs</th>
<th>Crane 'A'</th>
<th>Crane 'B'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Investment</td>
<td>−$270,000</td>
<td>−$350,000</td>
</tr>
<tr>
<td>Annual expenses</td>
<td>−28,500</td>
<td>−19,500</td>
</tr>
<tr>
<td>Useful life (years)</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Salvage value</td>
<td>25,000</td>
<td>40,000</td>
</tr>
<tr>
<td>MARR</td>
<td>15%</td>
<td>15%</td>
</tr>
</tbody>
</table>

(a) Which one of the MEAs will you suggest for the task?  
(b) Evaluate the MEAs assuming a study period of 8 years.  
(c) Comment on the results obtained in A and B.

7. A new steam flow monitoring device must be purchased by a local municipality. These most likely (best) estimates have been developed by a group of engineers which are given below:

- Capital Investment, \( I \) = −$11,500
- Annual savings, \( A \) = $3,000
- Market value, \( MV \) = $1,000
- Useful life, \( N \) = 6 years
- MARR = 10%

Because considerable uncertainty surrounds these estimates, it is desired to evaluate the sensitivity of \( pw \) to ± 50% changes in the most likely estimates of (i) capital investment (ii) market value (iii) annual savings and (iv) useful life.
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Contd... Q. No. 7

(a) Construct a spider plot and find two most sensitive factors to which the decision is most sensitive. (26½)

(b) Show the combined impact of these two most sensitive factors on the PW value graphically to conclude your decision whether the estimated cashflow will be considered. (20)

8. (a) A governmental agency is considering four independent projects. The current budget for this investment allows not more than $30,000,000 to be spent in terms of initial investments and the nominal interest rate is 5%. Using modified B/C ratio method, which of the project or combination of projects should be selected? (30)

<table>
<thead>
<tr>
<th>Project</th>
<th>Initial Investment ($)</th>
<th>Annual Costs ($)</th>
<th>Annual Benefits ($)</th>
<th>Useful life (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$12 \times 10^6</td>
<td>1250 \times 10^3</td>
<td>3250 \times 10^3</td>
<td>30</td>
</tr>
<tr>
<td>B</td>
<td>$20 \times 10^6</td>
<td>4500 \times 10^3</td>
<td>8000 \times 10^3</td>
<td>32</td>
</tr>
<tr>
<td>C</td>
<td>$10 \times 10^6</td>
<td>750 \times 10^3</td>
<td>1250 \times 10^3</td>
<td>29</td>
</tr>
<tr>
<td>D</td>
<td>$14 \times 10^6</td>
<td>1850 \times 10^3</td>
<td>4050 \times 10^3</td>
<td>31</td>
</tr>
</tbody>
</table>

(b) What are the major difficulties in evaluating public sector project? (10)

(c) What is self liquidating project? Give three examples of self liquidating projects in context of Bangladesh. (6½)
SECTION – A

There are FOUR questions in this section. Answer any THREE.

1. (a) There is a coal fired induced draft Zigzag brick kiln at Amin Bazar near Gabtali. The kiln has 60m high chimney with 2m exit dia at chimney tip. The coal used for firing the kiln contains 3% sulfur on dry basis. It is measured that 90% of sulfur in coal leaves he chimney as SO₂ gas. The kiln requires around 14 tons of wet coal (moisture 8%) to be fired to produce 100,000 fired bricks. The brick kiln can produce 70,000 fired bricks a day. The volumetric flow rate and temperature of the flue gas are measured to be 942 m³/min and 200°C respectively. The ambient wind speed is 2.5 m/s at meteorological centre. Considering the atmospheric stability class as ‘C’ find the following.
   (i) Maximum ground level concentration of SO₂ and corresponding downwind distance (X_{max}) from stack.
   (ii) Plume centerline concentration of SO₂ at X_{max} found in (i).
   (iii) SO₂ concentration at point 20m below the plume centerline at distance X_{max} found in (i).
   (iv) SO₂ concentration at a point 20m to the side and 20m below the centerline at a distance X_{max} found in (i).
   (v) How can you reduce the ground level concentration of SO₂ from this brick kiln?
   [Note: 1. Make necessary assumptions and state them clearly in the answer script.]

2. (a) For fixed-box model, the expression of final concentration of a particular air pollutant is expressed as:
   \[ C = b + (qL/\mu H) \] [Symbols have their usual meaning]
   A rectangular city has the following parameters: W = 3 km; L = 10 km; u = 2 m/s which is parallel to the rectangular arm 'W', and H = 500 m. The back ground concentration of CO is 6 \( \mu g/ m^3 \). The emission rate per unit area is \( 4 \times 10^{-5} \) g/s.m². What is the concentration of CO over the city?
   
   (b) There are several 'pb-Smelters' on the bank of the Buriganga which is located in the South of BUET. The aerial distance from the pb-smelters' and BUET is 3 km. The emission made of 'Pb' is estimated to be \( 2.2 \times 10^{-2} \) g/s-m from the smelters at source.

Contd ............ P/2
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Contd ... Q. No. 2(b)

The affective height of the chimney of smelters is calculated to be 30 ft. If average wind speed (U) is measured as 4 m/s, What will be the ground level concentrations of Pb" at BUET for atmospheric stability type 'A', 'D' and 'F'? Comment on the results obtained for different atmospheric stability. [Note: Figures are given at the end of this question paper].

3. (a) Give an outline of Photochemical smog formation in the atmosphere. Give three characteristic emission parameters and their emission values for a point source. What is your criticism regarding the standard (ECR '97) for crude oil refinery in Bangladesh?

- State briefly. The stack SO₂ concentration of a coal fired brick Kiln was measured to be 120 ppm at 0°C and 1 atm. pressure. What will be the value of this SO₂ in μg/m³ at 25°C and 1 atm. pressure?  

(7+3+3+7)

(b) What are the primary parameters that influence air pollutant dispersion? How can you characterize the different atmospheric stability type? - Write briefly with the help of lapse rate and plum diagram.  

(3+12)

4. (a) Why is isokinetic sampling of stack particulate matter important? - Discuss with diagrams.  

(b) What is cut diameter of a cyclone separator? How can you reduce the cut diameter or increase the separation efficiency of a cyclone separator? - Explain with mathematical relationship.

(c) "It is better to operate the cyclone separator with induced draft fan for particles separation from dust laden gas" - Justify the statement.

(d) 'ESP' it more efficient process to separate very small particles from gases compare of to centrifugal separator: prove the statement using mathematical relationship.

(e) What is breathing loss for volatile liquids? How can you reduce this type of loss? - Explain with diagram.

SECTION – A

There are FOUR questions in this section. Answer any THREE.

5. (a) Briefly discuss the objectives, effects ad benefits of Environmental Impact Assessment (EIA)?

(b) Considering the increasing power demand of the country, the concerned authority has initiated to establish a thermal power project at the hill tract areas. As a part of the feasibility study the government has recruited a local consulting company to assess the environmental impact of the proposed projects. As the project leader of the consulting company, how would you proceed to assess the relevant environmental impact assessment during the operation phase and construction phase of the projects?

(e) Briefly discuss the principle and mechanism of inclined plate clarifier and tube settler.

Contd ............ P/3
6. (a) Categorize and discuss different sludge disposal options. Considering resources, rain and soil patterns, justify the suitable sludge disposal technique(s) for Bangladesh.
(b) Briefly describe the category, mechanisms and regeneration process(s) of different media filtration systems.
(c) Briefly discuss the membrane technologies used in wastewater treatment. Explain the mechanism of Reverse Osmosis (RO) process.

7. An export oriented composite textile industry with knit dyeing capacity of 20 ton fabric, uses 1.50 kg (apprx.) dye for every 100 kg fabric. The key stages of fabric processing are shown in the table below. the liquor ratio for any stage (except rinsing) of pre-dyeing, drying and post-dyeing stages is 1:7 (i.e. 7 liters of liquid for 1 kg fabric). For rinsing, the dyeing machine uses three times more water than a regular dyeing step. Key pollution indicating parameters of different stages for a 700 kg fabric batch are given in the following table. The pollution load of the wastewater varies from stage to stage (see the table below). For simplification, it is assumed that the COD:BOD ratio of wastewater produced from any stage above 3:1 is considered highly polluted, and (COD:BOD ratio of wastewater below 3:1 is considered less polluted.
The industry runs an ETP to treat the wastewater produced from Knit Dyeing plant. The ETP contains Physico-chemical and Biological units. To reduce the operating cost, the industry plans to segregate the less polluted wastewater from the highly polluted wastewater, and treat them separately: only biological treatment for less polluted streams, and physico-chemical followed by biological treatment for highly polluted streams.

<table>
<thead>
<tr>
<th>Stages</th>
<th>TDS (mg/L)</th>
<th>COD (mg/L)</th>
<th>BOD₅ (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scouring</td>
<td>6200</td>
<td>9450</td>
<td>2050</td>
</tr>
<tr>
<td>Hot wash</td>
<td>2950</td>
<td>2750</td>
<td>550</td>
</tr>
<tr>
<td>Neutralization</td>
<td>575</td>
<td>1550</td>
<td>300</td>
</tr>
<tr>
<td>Dyeing</td>
<td>8500</td>
<td>3500</td>
<td>750</td>
</tr>
<tr>
<td>Rinsing</td>
<td>4500</td>
<td>725</td>
<td>275</td>
</tr>
<tr>
<td>Neutralization</td>
<td>275</td>
<td>850</td>
<td>325</td>
</tr>
<tr>
<td>Rinsing</td>
<td>175</td>
<td>450</td>
<td>220</td>
</tr>
<tr>
<td>Hot Wash with Soap Agent</td>
<td>850</td>
<td>700</td>
<td>250</td>
</tr>
<tr>
<td>Rinsing</td>
<td>175</td>
<td>350</td>
<td>175</td>
</tr>
<tr>
<td>Softening</td>
<td>225</td>
<td>175</td>
<td>90</td>
</tr>
</tbody>
</table>
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Contd ... Q. No. 7

On an annual basis.

(a) What would be the yearly effluent volume (m$^3$ per year) and pollution loads (TDS, TSS and BoD$_3$) (in tonnes) discharged in the environment by the effluent produced from the industry?

(b) What would be the composite characteristics (in mg/L) of the highly polluted and less polluted wastewater produced by the above mentioned industry?

8. (a) Discuss the fundamentals of chemical coagulation with the help of surface charge and electrical double layer.

(b) A textile dyeing industry produces 10 m$^3$/hr wastewater, which contains 275 mg/L total suspended solids (TSS), 45mg/L total alkalinity (as CaCO$_3$), 375 mg/L BOD$_3$ and 850 mg/L COD. During the treatment process, in absence of any chemical coagulant, the primary and secondary clarifiers can remove up to 60 percent of TSS. Using of chemical coagulants can improve TSS removal up to 90 percent. Ferric Chloride and Ferric Sulfate are two favorable options as chemical coagulants. Assume that the chemical sludge properties (specific gravity and moisture content) are the same for any of the chemical coagulants. For maximum TSS removal using chemical coagulation, ETP operator uses following dosing rates: 50 kg Ferric Chloride per 1000m$^3$ wastewater, and 55 kg Ferric Sulfate per 1000m$^3$ wastewater. Estimate the mass and volume of sludge produced from wastewater with and without chemical coagulants. Report the amount of lime is required for chemical coagulation. Which chemical coagulant would be more preferred for the given treatment process, and why?

Given that the specific gravity of raw sludge is 1.03 with moisture content 94 percent. For Chemical sludge, the specific gravity is 1.06 and moisture content is 92.5 percent

\[
\begin{array}{ccc}
\text{Fe}_2(SO_4)_3 & + & 3\text{Ca(HCO}_3)_2 & \Leftrightarrow & 2\text{Fe(OH)}_3 \Psi & + & 3\text{CaSO}_4 & + & 6\text{CO}_2 \\
(399.9) & & (3\times100 \text{ as CaCO}_3) & & (2\times106.9) \\
2\text{FeCl}_3 & + & 3\text{Ca(HCO}_3)_2 & \Leftrightarrow & 2\text{Fe(OH)}_3 \Psi & + & 3\text{CaCl}_2 & + & 6\text{CO}_2 \\
(2\times162.2) & & (3\times100 \text{ as CaCO}_3) & & (2\times106.9)
\end{array}
\]

With Lime,

\[
\begin{array}{ccc}
\text{Fe}_2(SO_4)_3 & + & 3\text{Ca(OH)}_2 & \Leftrightarrow & 2\text{Fe(OH)}_3 \Psi & + & 3\text{CaSO}_4 \\
(399.9) & & (3\times56 \text{ as CaO}) & & (2\times106.9) \\
2\text{FeCl}_3 & + & 3\text{Ca(HCO}_3)_2 & \Leftrightarrow & 2\text{Fe(OH)}_3 \Psi & + & 3\text{CaCl}_2 \\
(2\times162.2) & & (3\times56 \text{ as CaO}) & & (2\times106.9)
\end{array}
\]
Wind Profile exponent as a function of atmospheric stability class

<table>
<thead>
<tr>
<th>Stability class</th>
<th>rural exponent</th>
<th>urban exponent</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.07</td>
<td>0.15</td>
</tr>
<tr>
<td>B</td>
<td>0.07</td>
<td>0.15</td>
</tr>
<tr>
<td>C</td>
<td>0.10</td>
<td>0.20</td>
</tr>
<tr>
<td>D</td>
<td>0.15</td>
<td>0.30</td>
</tr>
<tr>
<td>E</td>
<td>0.35</td>
<td>0.30</td>
</tr>
<tr>
<td>F</td>
<td>0.55</td>
<td>0.30</td>
</tr>
</tbody>
</table>

![Graph showing lateral diffusion, $\sigma_y$, vs. downwind distance from source for Pasquill's turbulence types.](image-url)

Fig. 3.10 — Lateral diffusion, $\sigma_y$, vs. downwind distance from source for Pasquill's turbulence types.
Fig. 3.11—Vertical diffusion, $\sigma_y$, vs. downwind distance from source for Pasquill's turbulence types.
1. (a) Name different methods to estimate petroleum reserve. Explain the differences between any 3 of these methods. (4+6)
(b) A volumetric oil reservoir has the PVT properties shown in figure 1. The reservoir so far has produced a total of 23 MM ST B of oil while its pressure dropped from its initial pressure to 1500 psia. Cumulative GOR at current condition is 1000 SCF/STB while initial GOR was 2250 SCF/STB at 2500 psi. Both average porosity and connate water saturation for the field was 18% (25)
(i) Calculate the initial oil in place
(ii) Calculate the SCF of evolved gas remaining in the reservoir at 1500 psia
(iii) Calculate the average gas saturation in the reservoir at 1500 psia
(iv) Calculate the total formation volume factor at 1500 psia.

2. (a) The general material balance equation is given in the appendix. For a volumetric dry gas reservoir, reduce this equation to a linear form (stating necessary assumptions) and show how Initial gas in place can be obtained graphically. (15)
(b) Using Havlena-Odeh approach, show how the drive mechanism of a Gas reservoir can be identified. (10)
(c) Write short note on the following:
   (i) Gravity Drainage Drive Mechanism
   (ii) Solution Gas Drive Mechanism (10)

3. (a) Rearrange the Material Balance Equation (see Appendix) in a format of "Drive Index". Explain in what way this format can be utilized in decision making. (10)
(b) For an oil reservoir from production data, how can you identify whether the drive mechanism in a weak water drive or a strong water drive? (5)
(c) Production history of an oil field is shown in Table-1. Find out
   (i) What type of decline is in effect? Explain.
   (ii) What is the remaining life of the well if the abandonment rate is 200 MMSCF/Year?
   (iii) What are the recoverable reserves at abandonment? (20)

Contd .......... P/2
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4. (a) Explain why darcy equation itself is not sufficient and we have to use RDE for solving reservoir engineering problem. Obtain the solution of RDE for PSS flow regime. \(5+20\) (10)
(b) A well has the following data.
Production rate = 100 stb/day
Average reservoir pressure = 2000 psia
Well bore flowing pressure = 1500 psia
Net sand thickness = 10 ft
Borehole radius = 0.25 ft
The well drains an area with drainage radius of 1000 ft
Does this imply that the well is either damaged or stimulated? What is the apparent skin factor?

SECTION – B
There are FOUR questions in this section. Answer any THREE.

5. (a) What are the basic types of rocks? Which type of rock is most interesting to the explorers of hydrocarbon? Explain why. \(3+2+5=10\)
(b) With a near sketch illustrate the rock cycle. \(10\)
(c) What are the essential properties of reservoir rocks? \(5\)
(d) Briefly write the characteristics of sandstone. \(10\)

6. (a) What are the different types of porosity? What are the controlling factors of porosity? \(5+5=10\)
(b) Suppose a sandstone sample has 16% porosity. What will be its weight in air if it is 100% saturated with 0.85 specific gravity oil? Assume that the bulk volume of the sample is 80 cc, while the grain density of rock is 2.65 gm/cc. \(5\)
(c) Find saturation data obtained from different samples from a formation is reported in table Q6c. Determine the average oil saturation of the formation. \(10\)

<table>
<thead>
<tr>
<th>Sample no.</th>
<th>porosity</th>
<th>thickness</th>
<th>Oil Saturation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14</td>
<td>3</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>14</td>
<td>38</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>5</td>
<td>55</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>20</td>
<td>70</td>
</tr>
</tbody>
</table>

(d) Determine the average permeability of the composite block shown in Figure Q6d. \(10\)

Contd .......... P/3
7. (a) Define and explain the following terms:  
   (i) Formation Volume Factor of Oil (Bo)  
   (ii) Solution Gas-Oil Ratio (Rso)  

(b) What is the relation between the Solution Gas Oil Ratio (Rso) and the Producing Gas Oil Ratio (Rp)?

(c) PVT test data are shown in Table Q7C.

---

Table Q7C

<table>
<thead>
<tr>
<th>Pressure, psig</th>
<th>Gas Removed*, cc</th>
<th>Gas Removed**, SCF</th>
<th>Oil Volume, cc</th>
<th>Incremental Gas Gravity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,620</td>
<td>--</td>
<td>--</td>
<td>63.316</td>
<td></td>
</tr>
<tr>
<td>2,350</td>
<td>4.396</td>
<td>0.02265</td>
<td>61.496</td>
<td>0.825</td>
</tr>
<tr>
<td>2,100</td>
<td>4.292</td>
<td>0.01966</td>
<td>59.952</td>
<td>0.818</td>
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<td>--</td>
<td>0.21256</td>
<td>39.572 at 60F</td>
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* at 220°F and cell pressure
** at 60°F and 14.65 psia

R_{so} = \frac{(\text{Cum, gas removed} - \text{gas removed upto pressure p})}{\text{Residual Oil}}

B_{oD} = \text{reservoir oil volume/residual oil volume}

B_{oD} = B_{oD} + B_s (R_{oD} - R_{oD})

z = \frac{V_{RRT_0}}{V_{SCP_{sc}T_R}}

B_s = 0.0282zT/p \text{ ft}^3/\text{SCF}

1 \text{ cc} = 6.29 \times 10^{-6} \text{ bbl} = 35.315 \times 10^{-6} \text{ ft}^3

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Contd .......... P/4
PMRE 411
Contd ... Q. No. 7(c)

(i) Looking at the data, identify the test type.
(ii) Find the solution Gas Oil ratio at 1,850 psia
(iii) Find Bo at 1,850 psia
(iv) Find z factor at 1,850 psia and 220 F
(v) Find Bg at 1,850 psia and 220 F
(vi) Find Bt at 1,850 psia and 220 F

8. (a) An exploration well has drilled which went through both gas and oil zones, but missed the water zone. However, following information were available:
Gas-Oil contact is at 5,200 ft
Oil-Water contact is at 5,500 ft
Oil-pressure gradient = 0.35 psi/ft
Water pressure gradient = 0.45 psi/ft
Gas pressure gradient = 0.08 psi/ft
From pressure test at 5,250 ft, oil pressure is 2,402 psia.
Assume normal pressure condition.
   (i) Develop the pressure equations for oil and gas phases
   (ii) Suppose the top of the structure is at 5,000 ft. What is the pressure difference between water and gas columns at that depth? Do you expect a kick while penetrating the structure? Why? (9)

(b) How does drainage and imbibition processes relate to the life of a hydrocarbon reservoir? (5)

(c) With a neat sketch explain the concept of relative permeability for a oil-water system. (10)

(d) Explain what kind of thermodynamic process is usually considered inside the reservoir, isothermal or isobaric. (5)

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Figure Q6d

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Material Balance Equation: (Question 1-4)

\[ N(B_t - B_u) + \frac{NmB_d}{B_g} (B_g - B_u) + (W_e - B_e W_e) = N_p [B_t + (R_p - R_{soi}) B_d] \]

\[ B_t = B_o + B_g (R_{soi} - R_{so}) \]

Table-1 (Question 3)

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<td>43782</td>
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SECTION - A

There are FOUR questions in this section. Answer any THREE.

1. In an LPG Merx system a carbon steel elbow developed a small leak. The carbon steel piping and the equipment (neat exchanger and splitter) were not originally stress relieved. The failure location was from the weld near a drain point (see the attached figure). While preparing the original elbow for re-welding, plant inspectors noticed that there were transverse cracks within the affected zone of the weld. The inspection personnel began to suspect (incidentally which was correct) that caustic stress corrosion cracking might be the case of elbow failure! The stream temperature downstream of the C3/C4 splitter is 93°C.

   Note that, Merx is a sweetening process, which removes marcaptans by an oxidation process and is performed in a 15 wt% caustic solution.

(a) How could this stress corrosion cracking occur in the elbow? — Explain. (10)
(b) What mechanism would you propose to explain this corrosion? (15)
(c) What preventive measures could have stopped this corrosion? (10)

2. (a) Compare and contrast between cathodic and anodic protections. (10)
(b) 304 stainless steel is exposed to 15 M aerated sulfuric acid. Which of the anodic and/or cathodic protection would you go for this environment? Give reasons for your answer. (10)
(c) What are the requirements of a good paint for corrosion protection? (10)
(d) Can you use lead coating in food industries? Explain your answer. (5)

3. (a) Compare the two methods of removing dissolved oxygen from water. With a simple block diagram show the process you would prefer for removing oxygen from boiler feed water. Mention appropriate reasoning for inclusion of the units and the order of their arrangement. (10+20)
(b) What are the functions of neutralizing and filming amines to prevent return line corrosion? (5)

4. (a) Briefly discuss three laws of oxidation. (10)
(b) "For optimum inhibition, passivation concentration must be more than a critical amount"— Do you agree with this statement? Give reasons for your answer. (10)
(c) Write short notes on (3×5=15)
   (i) Weld decay,
   (ii) Dezincification, and
   (iii) Municipal water treatment.

Contd ………. P/2
SE E 

There are **FOUR** questions in this section. Answer Q. No. 5 and any **TWO** from the rest.

5. (a) A mild steel pipe has been inserted into a concrete base to act as a flag pole. After the rainy season it has been found that the pipe has corroded at its base where it is in contact with concrete. What could have caused this corrosion? What measures can you suggest to avoid this type of corrosion?  
   
(b) Why is “pitting” considered a dangerous form of corrosion? How can cavitation in a pump cause pitting? Where will the pitting take place?  
   
(c) Can you use Hydrogen Electrode in measuring potentials in a Differential Aeration cell? Give reasons for your answer. What can be done to minimize corrosion due to differential aeration?  
   
(d) Can iron resist corrosion in deaerated acid? Give reason for your answer. Will corrosion rate increase if such acid is made to flow in an iron pipe? What will happen when flow rate is increased?  
   
(e) You want to place an order to import a metal from a foreign supplier. What information should you seek to learn about the "Metallurgical History" of the metal to be imported?  

6. (a) Design an experiment to study the effect of temperature on corrosion of iron in aerated water. Can you use this experiment to determine the effect of sodium chloride concentration? What changes can you expect in corrosion rate while carrying out the two experiments?  

(b) (i) "The lower the Flade Potential the easier it is for passivation to occur" — TRUE or FALSE? Give reasons for your answer.  

(ii) Why one has to be "very careful when using anodic inhibitors"?  

(iii) Austenitic iron-carbon alloy (0.8%C) is quenched while at 2000°F. Can you use the resultant iron-carbon alloy in making an MS pipe? Give reasons for your answer. How can you make "Tempered Steel" from the quenched iron-carbon alloy?  

7. (a) Of the two series mentioned below which one is more useful for industry? Give reasons:  

(i) Galvanic Series  

(ii) Modified EMF series using the Pourbaix’s diagram  

(b) As a Corrosion Engineer you have been asked to reduce corrosion due to concentration polarization in a steel water tank. What will be your recommendation? Explain with the help of diagrams.  

8. Write short notes on:  

(a) Ultra pure metals  

(b) Selective Corrosion  

(c) Corrosion due to Bacterial Activity.
Figure for Question 1
SECTION – A

There are FOUR questions in this section. Answer any THREE.

1. (a) Process design and plant design are often used interchangeably. Do you think this is justified? Explain your answer. (6)
(b) There are different stages of project implementation of a chemical process plant. At which stage is a General Contractor appointed? (Hint: your answer should include the list of different stages of project implementation and scope of work of a General Contractor) (10 ½)
(c) If Bangladesh Chemical Industries Corporation (BCIC) plans to establish a new plant, which ministries and regulatory bodies should it contact for approval? Why? (7)

2. (a) "During economic evaluation of a chemical plant project, tradeoffs between operational savings and incremental investment among several options are considered" – How do you calculate operational savings? (6)
(b) As a developing country our design philosophy dictates us to accept proven processes, which often do not include the latest technology. Suggest suitable ways to address this issue. (6)
(c) A fertilizer factory having capacity of 2800 ton urea per day is to be set-up in Ghorashal at the site of Polash Urea Fertilizer Factory.
   (i) Write down the complete definition of the project (11 ½)
   (ii) What other information do you need to prepare the Technical Definition of the project?

3. (a) "Design basis should be verified before initiating basic engineering" – Justify this statement. (Hint: your answer should include different components of design basis and how a design engineer interprets the data of design basis for basic engineering design) (11 ½)
(b) How does a client evaluate a process licensor? List the key questions a client should ask about the technology offered by the licensor. (12)

4. (a) What is Front End Engineering Design (FEED)? Some projects do not include FEED in this project implementation scheme. How do they complete the task of FEED? (10)

Contd ........... P/2
(b) In our class we have discussed one incident in which a major accident occurred due to unavailability of appropriate codes and standards in NFPA. (i) Discuss the incident. (ii) In our country accidents like Nimtoli fire of 2010 occurred due to improper chemical storage. Do we need any new codes or by-laws to prevent this kind of accident? Explain your answer. (13½)

SECTION – B

There are FOUR questions in this section. Answer Q. No. 5 (Compulsory) and any TWO from the rest.

5. (a) Who selects the Process Licensor: EPC or the client? Which factors are important in selecting the right Process Licensor in Bangladesh? (10)
   (b) Why is it important to Pre-qualify EPC contractors? Which qualifications are most important for Bangladesh? Comment on the evaluation process where the applicants have to meet "minimum requirements". (10)
   (c) During building of a Process Plant where and when "Inspection" is carried out? Who carries out such "Inspection"? Suggest an outline of "Inspection Procedure" for a "running plant". (10)

6. (a) In your Process Design Project (ChE 408) which "Engineering Documents" have you prepared? On the basis of your experience in ChE 408 will you be able to review engineering documents submitted by EPC contractors? Which documents will you be able to review with confidence? Give reasons for your answer. (10)
   (b) "The activities performed by a vendor is generally carried out under turn key type contracting" — Explain and justify. (10)

7. (a) While carrying out Performance Tests on Individual Equipment, Facility or Package Unit which issues are considered most important? Who carries out such tests? Vendor or EPC contractor? Explain. (10)
   (b) When a Performance Test fails how does a foreign EPC contractor usually react in Bangladesh? What should a client do in such circumstances? (10)

8. Write short notes on: (5×4=20)
   (a) Issues to AVOID during negotiation
   (b) Safety features in a plot plan
   (c) Two envelope system for evaluation of bids
   (d) Possibility of a 100% PERFECT Bid by an EPC contractor.