SECTION - A

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

1. (a) Briefly discuss the types of boundary conditions of oil and gas reservoirs and their application to specific reservoir types. (10)

   (b) Derive the formula for calculating fractional recovery of a volumetric Oil reservoir. (10)

   (c) The PVT data of reservoir 'X' is given in Figure Q. No. 1(c). The reservoir so far has produced 1.1 MMSTB of oil at a cumulative produced GOR or 2500 SCF/STB. During that period, the reservoir pressure dropped down to 3200 psi from 4400 psi. Calculate the fractional recovery at 3200 psi. (15)

2. (a) Derive the Havlena-Odeh form for a Dry gas reservoir from General Material Balance Equitation. Also, show how one can identify whether the gas reservoir is dictated by water drive or not using this form. (10)

   (b) Explain the P/Z plot including its application and drawback in gas reservoir engineering. (10)

   (c) Production history of gas 'Y' is shown below:

   Table Q. No. 2(c)

<table>
<thead>
<tr>
<th>Pressure (psia)</th>
<th>Cumulative Production (MM SCF)</th>
<th>Z factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Temperature: 210 F</td>
<td>0</td>
<td>0.910</td>
</tr>
<tr>
<td>2860</td>
<td>1,000</td>
<td>0.81</td>
</tr>
<tr>
<td>600 (abandonment)</td>
<td>??</td>
<td>0.951</td>
</tr>
</tbody>
</table>

   Reservoir Temperature: 210 F
   Base pressure and Temperature: 15.025 psia and 60 F
   Assume negligible water production and volumetric reservoir.

   Estimate

   (i) Gas initially in place (GIIP) (5)

   (ii) Initial gas reserve based on abandonment pressure of 600 psia (5)

   (iii) Recovery factor based on abandonment pressure of 600 psia (5)

   Contd .......... P/2
PMRE 411

3. (a) Name 5 major Drive mechanisms for hydrocarbon extraction. (5)
   (b) Provide a comparative analysis between Diffusivity and Darcy equation. (5)
   (c) What is Skin? Explain the types of skin using sketches. (10)
   (d) A homogenous formation has an average effective Permeability \( k_e \). This has been altered due to damage/stimulation out to a radius of \( r_a \) from the well so that its average value within this region is \( k_a \). Show that the skin factor for this altered area can be expressed as:
   \[
   S = \frac{k_e - k_a}{k_a} \ln \frac{r_a}{r_w}
   \] (15)

4. (a) Compare between the two reserve estimation methods “Volumetric method” and “Decline Curve Analysis”. (5)
   (b) Production history of an oil field is shown in Table-1. Answer the following:
   (i) What type of decline is in effect? (20)
   (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?
   (c) Write short notes on Gravity Drainage drive mechanism. (5)
   (d) Explain why a weak water drive gas reservoir will yield more recovery than a strong water drive gas reservoir. (5)

SECTION – B

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

5. (a) What is petroleum migration? What are the controlling factors of petroleum migration? (2+3)
   (b) Explain the following terms:
   (i) Anticlines,
   (ii) Salt Dome,
   (iii) Basin
   (iv) Strike-slip fault,
   (v) Disconformity.
   (c) Explain Rock Cycle with appropriate diagram. (10)
   (d) Write a short note on carbonate rock reservoir. (5)

6. (a) Write down the classification of porosity. What is effective porosity? (8+2)
   (b) Explain how size, shape and sorting of grains in rock affect porosity? (6)
   (c) Explain the mercury injection method for measuring porosity. (7)
   (d) A clean dry sample weighed 20 gms. This sample was immersed in a pycnometer. The weight of the pycnometer filled with water is 65 gms. After immersing the sample into the pycnometer, the total weight of water, pycnometer measured to be 78.5 gms. The sample was saturated and then reweighed in air, resulting in an increase in weight to 22.5 gms. The saturated sample was immersed in water and subsequently weighted 12.6 gms. What is the porosity of the sample? (water density = 1 gm/cc) (12)

Contd ............ P/3
PMRE 411

7. (a) What is gas solubility? Explain the relationship between gas solubility and pressure with appropriate diagram. (5)
(b) What is total formation volume factor? How does it behave with pressure? (5)
(c) Describe the differential liberation experiment with appropriate diagram. (10)
(d) The results for a volume/pressure investigation of a reservoir fluid at reservoir temperature is shown in Table-7 (b1). In another test on the fluid a sample of oil at its bubble point pressure and reservoir temperature in a PVT cell were passed through a two stage separator at 100 psig and 75°F and 0 psig and 60°F. 34 cc of oil were displaced from the PVT cell and 27.4 cc of oil were collected from the last separator stage. 4976 cc of gas were collected at standard conditions during the test. In a third test the pressure in a PVT cell at reservoir temperature was reduced in stages and the gas produced at each stage removed and the remaining oil volume measured. The total gas produced at standard conditions was recorded and is presented in Table-7b2. (15)
(i) Determine the bubble point pressure of the reservoir fluid at reservoir temperature.
(ii) The oil formation volume factor at 3100 psig
(iii) The solution gas-oil ratio at 3100 psig
(iv) The solution gas-oil ratio at 1000 psig.
(v) The total formation volume factors at 3100 psig and 1000 psig.

8. (a) A reservoir (figure-8(a)) consisting of three parallel beds has height, breadth and width. If the beds have local permeability values of 2, 6 and 9 mD, respectively then what is the average permeability of the reservoir. (8)
(b) What are the factors affecting permeability? Draw a relative permeability and capillary pressure curve for the drainage process of the oil-gas system. (5+5)
(c) Explain the effect of pore openings in fluid distribution of reservoir rocks. (5)
(d) Explain capillary hysteresis. (5)
(e) In an oil reservoir. Water pressure at a depth of 2,500 m is 4,371 psia. Oil pressure at a depth of 2,300 m is 4,102 psia. Consider normal hydrostatic pressure gradient. Calculate the depth of OWC and pressure at OWC. Assume Pressure gradients are (psi/ft):

<table>
<thead>
<tr>
<th></th>
<th>Water</th>
<th>Oil</th>
<th>Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradient</td>
<td>0.45</td>
<td>0.35</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Calculations:

Water = 0.45 psi/ft
Oil = 0.35 psi/ft
Gas = 0.08 psi/ft

---


The General Material Balance Equation

\[ N(B_t - B_i) + \frac{N m B_{ti}}{B_{gi}} (B_g - B_{gi}) + (1 + m) N B_{ti} \left[ \frac{c_w S_{wi} + c_f}{1 - S_{wi}} \right] \Delta \bar{p} + W_e = \]

\[ = N_p[B_t + (R_p - R_{sol})B_g] + B_w W_p \]

Figure Q1(C): PVT data for Reservoir 'X' at 200°F
<table>
<thead>
<tr>
<th>Year</th>
<th>Production Rate, MMSCF/Year</th>
<th>Cumulative Production, MMSCF</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10932</td>
<td>43782</td>
</tr>
<tr>
<td>2</td>
<td>9508</td>
<td>53290</td>
</tr>
<tr>
<td>3</td>
<td>7540</td>
<td>60830</td>
</tr>
<tr>
<td>4</td>
<td>5980</td>
<td>66810</td>
</tr>
<tr>
<td>5</td>
<td>4742</td>
<td>71552</td>
</tr>
<tr>
<td>6</td>
<td>3761</td>
<td>75313</td>
</tr>
<tr>
<td>7</td>
<td>2982</td>
<td>78295</td>
</tr>
<tr>
<td>8</td>
<td>2365</td>
<td>80660</td>
</tr>
<tr>
<td>9</td>
<td>1876</td>
<td>82536</td>
</tr>
<tr>
<td>10</td>
<td>1487</td>
<td>84023</td>
</tr>
<tr>
<td>11</td>
<td>978</td>
<td>85001</td>
</tr>
</tbody>
</table>
Table – 7h1
(System constant)

<table>
<thead>
<tr>
<th>Pressure psig</th>
<th>Volume cc</th>
<th>Pressure psig</th>
<th>Volume cc</th>
</tr>
</thead>
<tbody>
<tr>
<td>5000</td>
<td>162.54</td>
<td>1591</td>
<td>168.39</td>
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<tr>
<td>4500</td>
<td>163.21</td>
<td>1573</td>
<td>169.08</td>
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<td>4000</td>
<td>163.90</td>
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<td>169.85</td>
</tr>
<tr>
<td>3500</td>
<td>164.64</td>
<td>1515</td>
<td>171.56</td>
</tr>
<tr>
<td>3000</td>
<td>165.43</td>
<td>1435</td>
<td>174.97</td>
</tr>
<tr>
<td>2500</td>
<td>166.32</td>
<td>1341</td>
<td>180.11</td>
</tr>
<tr>
<td>2000</td>
<td>167.21</td>
<td>1234</td>
<td>186.95</td>
</tr>
<tr>
<td>1900</td>
<td>167.40</td>
<td>1113</td>
<td>197.28</td>
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<td>1800</td>
<td>167.60</td>
<td>989</td>
<td>211.04</td>
</tr>
<tr>
<td>1700</td>
<td>167.80</td>
<td>854</td>
<td>231.71</td>
</tr>
<tr>
<td>1601</td>
<td>168.00</td>
<td>728</td>
<td>259.31</td>
</tr>
</tbody>
</table>

Table – 7h2

<table>
<thead>
<tr>
<th>Pressure in PVT Cell psig</th>
<th>Cumulative Gas Produced cc (standard conditions)</th>
<th>Volume of Oil in Cell cc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bubble Point</td>
<td>0</td>
<td>184.80</td>
</tr>
<tr>
<td>1400</td>
<td>2044</td>
<td>182.35</td>
</tr>
<tr>
<td>1200</td>
<td>4438</td>
<td>179.37</td>
</tr>
<tr>
<td>1000</td>
<td>6732</td>
<td>176.52</td>
</tr>
<tr>
<td>800</td>
<td>9076</td>
<td>173.67</td>
</tr>
<tr>
<td>0</td>
<td>26,928 @ 60°C</td>
<td>140</td>
</tr>
</tbody>
</table>
Figure - 8a
SECTION – A

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

1. (a) Briefly describe major characteristics of ambient air sampling system. (6)

(b) Describe Isokinetic particulate sampler for stack emission monitoring with a simplified diagram. (11)

(c) Explain fabric filter system with the help of a neat sketch. Give its advantages and disadvantages. (9)

(d) Explain the sources, health and welfare effects for the following criteria pollutants: (9)

   (i) Sulfur Dioxide (SO₂)
   (ii) Carbon monoxide (CO)
   (iii) Particulate Matter (PM)

2. (a) Write a short note on Donora smog incident. (10)

(b) Describe a typical Kraft sulfate pulping and recovery process with a block diagram. Show the major sources of emission on the sketch and discuss the remediation measures from the process. (15+10=25)

3. (a) Draw ash system block diagram of a coal based thermal power plant. Explain the fly ash and controlling principles from this diagram. (11)

(b) What is the main source of PM emission in Refinery? How can you control it? (8)

(c) Write short notes on the followings: (4×4=16)

   (i) Fugitive emission
   (ii) Merox sweetening processes
   (iii) Thermal oxidation
   (iv) Catalytic oxidation

Contd .......... P/2
CHE 485

4. (a) Give detail working principle of a Venturi scrubber for particulate control and provide a neat schematic diagram. (15)

(b) Compute the efficiencies for a cyclone separator and a gravity settler for particulate removal from gas stream considering both the block and mixed flow assuming Stokes's law applies. Assume reasonable values for any missing data. (20)

**Given data**

\[ p_{\text{particle}} = 2000 \, \text{kg/m}^3, \quad \mu_{\text{gas}} = 1.8 \times 10^{-5} \, \text{kg/m.s} \]

**Cyclone separator:**

\[ W_i = 0.15 \, \text{m}, \quad V_c = 18.3 \, \text{m/s}, \quad \text{and} \quad N = 5 \]

**Gravity settler:**

\[ H = 2 \, \text{m}, \quad L = 10 \, \text{m}, \quad \text{and} \quad V_{\text{avg}} = 1 \, \text{m/s} \]

SECTION - B

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

5. (a) Briefly discuss the history and evaluation of Environmental Impact Assessment (EIA)? (10)

(b) Briefly discuss the key items to be considered in Environmental Impact Assessment (EIA) process. (12)

(c) Considering the increasing power demand of the country, a group of non-resident Bangladeshi entrepreneurs has initiated hydro 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 and to prepare environment management plan of the proposed project. As the project leader of the consulting company, what are the factors that you would consider during 'pre-construction', 'construction' and 'post construction operation phase' while preparing environmental management plan (EMP) for the project? (13)

6. (a) Categorize and discuss different sludge disposal options. Considering resources, rain and soil patterns, justify the suitable sludge disposal technique(s) for Bangladesh. (10)

(b) Briefly discuss different aeration techniques used in wastewater treatment process and the key selection criteria. (15)

(c) If one-third of the solid matter in a sludge containing 85 percent water is composed of fixed mineral solids a specific gravity of 2.6, and two-third is composed of volatile solids with a specific gravity of 1.0, then find the specific gravity of the sludge, Ss. (10)

Contd ............ P/3
CHE 485

7. (a) Briefly discuss the objectives and mechanisms of Cleaner Production Options for Textile Industries.

(b) A textile industry with knit dyeing capacity of 15 ton fabric per day dyes medium and light shade fabrics. The key stages of fabric processing are shown in the table below. The liquor ratio for any stage (except rinsing) of pre-dyeing, dyeing and post-dyeing stages is 1:6 (i.e. 6 liters of liquid for 1 kg fabric). The rinsing machine uses three times more water than a regular dyeing step. Key pollution indicating parameters of different stages for a single batch are given in the following table. The pollution load of the wastewater varies from stage to stage (see the table below). On an annual basis.

(i) What would be the composite characteristics (in mg/L) of the wastewater produced by the above-mentioned industry?

(ii) What would be the yearly effluent volume (m$^3$ per year) and pollution loads (TDS, TSS and BOD$_5$) in tones) discharged in the environment by the effluent produced from the industry?

<table>
<thead>
<tr>
<th>Stages</th>
<th>TDS (mg/L)</th>
<th>COD (mg/L)</th>
<th>BOD$_5$ (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>Dyeing</td>
<td>175</td>
<td>450</td>
<td>220</td>
</tr>
<tr>
<td>Rinsing</td>
<td>175</td>
<td>350</td>
<td>175</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>

8. (a) Discuss the fundamentals and mechanisms of the following effluent treatment units: tube settler, moving bed bioreactor (MBBR), and activated carbon filter.

(b) Briefly discuss the key factors you would suggest to the owner of a red category factor to choose an appropriate Effluent Treatment Plant (ETP).

(c) Briefly discuss the types and constituents of waste generated from a typical Pharmaceutical Industry.
BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY, DHAKA
L-4/T-2 B. Sc. Engineering Examinations 2017-2018
Sub: CHE 409 (Corrosion Engineering)
Full Marks: 210 Time: 3 Hours
The figures in the margin indicate full marks.
USE SEPARATE SCRIPTS FOR EACH SECTION

SECTION - A

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

1. (a) [Select the correct statement and provide appropriate reasoning.] Which of the following are the examples of cavitation corrosion?
   (i) cracking of 18-8 steel pipe transporting brackish water.
   (ii) vibration in the blades of turbines
   (iii) failure of ship propellers.
   (b) Explain how corrosion can be considered as extractive metallurgy in reverse.
   (c) Differentiate clearly between pitting and cracking.
   (d) Magnesium corrodes in seawater at a rate of 1.45 g/m²d. Assuming this to be uniform corrosion, how would you rank the performance of magnesium in seawater. Note that metal is considered resistant, satisfactory and not satisfactory when the corrosion rate is less than 0.15 mm/y, between 0.15 and 1.5 mm/y, and more than 1.5 mm/y, respectively. The density of magnesium is 1.738 g/cm³.

2. (a) [Select the correct statement and provide appropriate reasoning.] The most acceptable method of obtaining standard electrode potential is by:
   (i) comparing the electrode potential of a metal immersed in a solution of its ions at any concentration, with the hydrogen half cell.
   (ii) comparing the electrode potential of a metal with any standard electrode, such as Ag-AgCl or calomel electrode
   (iii) comparing the electrode potentials of a metal half cell with a hydrogen half cell.
   (b) State the limitations of the emf series and the advantages of galvanic series.
   (c) Calculate the emf of the following cell at 25°C:
      \[ \text{O}_2(1 \text{ atm}), \text{Pt}; \text{H}_2\text{O}; \text{O}_2(0.1 \text{ atm}), \text{Pt} \]
      Which electrode is the anode?
   (d) Label the different zones in the simplified Pourbaix diagram for iron [Figure 2(d)]. Attach this with your answer script. What does the lines represent in this diagram? What significances do a horizontal/vertical/sloping line have in a Pourbaix diagram?
CHE 409

3. (a) [Select the correct statement and provide appropriate reasoning.] Concentration polarization occurs when:
   (i) the concentration of the electroactive species at the metal/electrode surface and the bulk solution is the same.
   (ii) the solution is continuously agitated.
   (iii) a concentration gradient is built up between the electrode/electrolyte interface and the bulk solution.

(b) If steel rivet are fixed in a copper plate, the rivets are completely corroded after sometime – Explain why?

(c) Briefly discuss oxide-film and absorption theories of passivation. According to some authors these theories are not contradictions, rather they supplement each other. Do you agree with them? Explain your answer.

(d) Write a short note on crystal defects and its influence on corrosion behaviour of metallic materials.

4. (a) [Fill in the blank. Explain your answer] If adding HCl to the corrosion product of a subsoil steel pipe gives out smell of H$_2$S then the corrosion is due to .........................

(b) Briefly discuss the effect of pH on corrosion of iron.

(c) Explain why iron corrodes more rapidly in an aerated solution of acid than in a deaerated solution.

SECTION – B

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

5. (a) Explain briefly the factors which affect soil corrosion.

(b) Demonstrate graphically the typical atmospheric corrosion rate of steels in an industrial environment.

(c) Write down technical notes on-
   (i) Fretting Corrosion
   (ii) Detection of Stray Current
   (iii) Mechanism of Stress Corrosion Cracking (SCC)

(d) How do 'Particulate Matter' and 'Moisture' affect atmospheric corrosion?

6. (a) Make a detailed comparison between cathodic and anodic protections.

(b) Discuss the principle and use of “Coatings by Gas Phase Reaction” and “Coatings by Chemical Reduction”

(c) State the difference between Noble and Sacrificial Coatings.

(d) “Cathodic protection loss made it possible to transport oil and natural gas across thousands of land or ‘sea’ – Explain.

(e) Can you use lead coating in food industries? Justify your answer.
CHE 409

7. (a) List the ways how the corrosive environment can be modified or changed to reduce or control corrosion. (8)

(b) How do inhibitors generally differ from passivators? Explain the effect of using pickling inhibitors. (5+6=11)

(c) Demonstrate the effect of Cu²⁺ and Co²⁺ catalysts on the oxidation of Na-Sulfite for the removal of dissolved O₂ from water. (8)

(d) “Vacuum deaeration would be ideal but expensive for municipal water supplies” – Elaborate. (8)

8. (a) Discuss appropriate remedial measures for ‘Weld Decay’ of stainless steels. (6)

(b) “Initially Si-Fe and Si-Ni alloys show higher corrosion rates, but final rates are much lower” – Explain with appropriate reasoning. (5)

(c) Write short notes on – (6x4=24)

(i) High Temperature Corrosion
(ii) Corrosion Failure Analysis
(iii) Laws of Oxidation
(iv) Pitting Corrosion of Stainless Steels.
Figure 2(d)
1. (a) Do you think you will get the opportunity to design a new plant right away if you get employed as a design engineer? Explain your answer with supporting data. (7½)

(b) "Both design engineer and process engineer deal with process design with different scope of work" – Justify the statement. (8)

(c) List the Stages of Process Plant Implementation and Parties involved in public sector of Bangladesh. (8)

2. (a) Write down the definition of the following project: "Eastern Refinery Limited will establish a second refinery to process three million ton of crude oil". (8)

(b) Foster Wheeler Ltd was appointed as the General Contractor for a turnkey project of BCIC. The project was delayed because of the performance of equipment vendor and Customs clearance. Who will take the responsibility of this delay? (8)

(c) What are the main factors regarding maintenance and turnaround to be considered during plant design? (7½)

3. (a) How do the geological data affect plant design? Give examples. (8)

(b) Which parameters of water are to be considered in design basis? Why? (7½)

(c) How do you evaluate a process and process licensor for a specific product? (8)

4. (a) Write down different items of a Basic Engineering Design Report. (8)

(b) At which stage of plant design one should start considering safety and Environmental impact? Why? (7½)

(c) Describe the scope of codes and standards in plant design. (8)

Contd ........... P/2
CHE 407

SECTION – B

There are FOUR questions in this Section. Answer Q. No. 5 and any TWO form the rest. Q. No. 5 is COMPULSORY and carries 30 marks.

5. (a) How can selected vendors influence drawing of PFD & P&ID for final design? (Can they also influence Material and Energy Balance?)  
(b) Which types of contract will you recommend for package unit suppliers? Give reasons for your answer.  
(c) Among the following two types of engineering inspection which one, do you think, was more important for prevention of Bhopal disaster:  
(i) Inspection during fabrication at Vendors facility.  
(ii) Inspection during maintenance. Give reasons for your answer.  
(d) Why is it important to PREQUALIFY bidders in Bangladesh? Is it more important in a technologically advanced country? Give reasons.  
(e) In a TWO envelope system for evaluation of EPC bidders, the client has opened the PRICE envelope by mistake. What should be done now to choose the right EPC?

6. (a) How can Technology Transfer be ensured as a continuous basis while building a chemical process plant? Outline a plan for technology transfer to local personnel in Bangladesh.  
(b) What are the differences between “Mechanical Completion Tests” and “Functional Tests”? How do they influence “Performance Test”? Why “Artificial Upset” conditions are created during “Performance Test”?

7. (a) Rank the following equipment in order of your priority for inspection. Give reasons for such preferences.  
(i) Heat Exchanger  
(ii) Process Heater  
(iii) Piping System  
(iv) Storage Tank  
(v) Pressure Vessel  
(b) Can prior selection of Codes and Standards with EPC firm influence the selection of Vendors? Give reasons for your answer.

8. (a) To ensure process safety which factor/factors will you consider while drawing a “Plot Plan”? Draw a rough “Plot Plan” to show possible “unsafe” or “hazardous area”.  
(b) In your Process Design Project (CHE 408) which “Engineering Documents” have you prepared? How can they help in building a real process plant?
SECTION - A

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

1. (a) A capital investment of $12,000 can be made in a project that will produce a uniform annual revenue of $5,000 for five years and then have a salvage value of $2,000. Annual expenses will be $2,500. The company is willing to accept any project that will earn at least 11% per year, before income taxes, on all invested capital. Determine whether the project is acceptable by using the IRR method, (use linear interpolation).

(b) A heat exchanger has been designed and insulation is being considered for the unit. The insulation can be obtained in thickness of 2, 3, 4, or 5 inch. The following data have been determined for the different insulation thicknesses.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>2 inch insulation</th>
<th>3 inch insulation</th>
<th>4 inch insulation</th>
<th>5 inch insulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Btu/saved</td>
<td>3,50,000</td>
<td>4,00,000</td>
<td>4,20,000</td>
<td>4,30,000</td>
</tr>
<tr>
<td>Cost for installed insulation (Tk.)</td>
<td>1,600</td>
<td>1,800</td>
<td>1,870</td>
<td>1,950</td>
</tr>
<tr>
<td>Annual fixed Charges (Tk.)</td>
<td>10% of</td>
<td>10% of</td>
<td>10% of</td>
<td>10% of</td>
</tr>
<tr>
<td></td>
<td>insulation cost</td>
<td>insulation cost</td>
<td>insulation cost</td>
<td>insulation cost</td>
</tr>
</tbody>
</table>

What thickness of insulation should be used? The value of heat is 45 Tk/1,000,000 Btu. Nominal interest rate is 12% compounded semiannually. The exchanger operates 300 days per year.

2. (a) You are an engineer of Dhaka North City Corporation (DNCC). You have been given responsibility to manage medical waste of DNCC. Management has given you the option to choose the better alternative (truck) to carry the waste to the dumping site. Cash flow of two alternatives (trucks) are given below:

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Tata Truck</th>
<th>Isuzu Truck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital Investment</td>
<td>-$408,000</td>
<td>-$519,000</td>
</tr>
<tr>
<td>Annual expenses</td>
<td>-$43,200</td>
<td>-$29,000</td>
</tr>
<tr>
<td>Useful life (years)</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Market value</td>
<td>$35,000</td>
<td>$55,000</td>
</tr>
</tbody>
</table>

Steady period is 15 years. MARR is 12%, by using incremental analysis with PW method, show which alternative will be favourable for this project.

(b) Suppose the study period of QS. 02 (a) is 10 years. In this case, which of the alternatives will be chosen? Show your work using ERR method.

(c) Comment on the result obtained in QS. 01(a) and (b)
CHE 411

3. (a) Two 80-horsepower motors are being considered for use. Necessary particulars of the motors are given below:

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Brand 'A' motor</th>
<th>Brand 'X' motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase price</td>
<td>$ 1,800</td>
<td>$ 6,000</td>
</tr>
<tr>
<td>Useful life (years)</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Annual maintenance</td>
<td>$150</td>
<td>$300</td>
</tr>
<tr>
<td>Efficiency</td>
<td>80%</td>
<td>90%</td>
</tr>
</tbody>
</table>

If the power cost is $0.15 per kW-h and the MARR is 10%, how many hours of operation per year are required to justify the purchase of Brand ‘X’ motor? (1 hp = 0.746 kW).

(b) Three mutually exclusive alternative public works projects are currently under consideration. Their respective costs and benefits and useful lifes are included in the table below:

<table>
<thead>
<tr>
<th>Projects</th>
<th>Initial Investment</th>
<th>Annual costs</th>
<th>Annual Benefits</th>
<th>Useful life</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$12\times10^6</td>
<td>$1.25\times10^6</td>
<td>$3.25\times10^6</td>
<td>40 years</td>
</tr>
<tr>
<td>B</td>
<td>$20\times10^6</td>
<td>$4.5\times10^6</td>
<td>$8.0\times10^6</td>
<td>45 years</td>
</tr>
<tr>
<td>C</td>
<td>$10\times10^6</td>
<td>$0.75\times10^6</td>
<td>$1.25\times10^6</td>
<td>50 years</td>
</tr>
</tbody>
</table>

Nominal interest rate is 10% per year. Which, if any, of these projects should be selected using conventional B/C method considering repeatability assumption?

4. Answer the following:

(a) What is Bond? A bond has a matured value of USD 1000 at an interest rate of 10% for a period of 5 years. What is the discount?

(b) What are the added advantages of ERR method over IRR method in Project evaluation? Write briefly.

(c) Write short notes on the following:

(i) Excise tax  
(ii) Surtax  
(iii) Carry-back and Carry-forward of losses  
(iv) Bailee’s liability  
(v) The Risk-free rate plus Risk premium model of cost of equity capital.

(d) Each year, sector ‘A’ purchases $ 5 million of goods from sector ‘B’ and $ 10 million from sector ‘C’. Sector ‘B’ makes annual purchases of $ 2 million from sector ‘A’ and $8 million from sector ‘C’. Annual purchases of sector ‘C’ are $3 million from sector ‘A’ and $6 million from sector ‘B’. Within-sector purchases are $1 million for sector ‘A’, $4 million for sector ‘B’, and $5 million for sector ‘C’. Total sales in the sectors are $20 million, $20 million, and $30 million, respectively. Write the transactions matrix for the three sectors showing value addition and final demand for each sector.
CH411

SECTION – B

There are FOUR questions in this Section. Q. No. 5 is compulsory. Answer any TWO form the rest.

5. This question is COMULSORY. Choose the correct answer and provide concise reason for your choice. If you do not defend your choice you will only receive 40% marks. (10×5=50)

(i) SWOT analysis is performed during
(a) Strategic intent
(b) Strategic formulation
(c) Strategic implementation
(d) Strategic evaluation

(ii) …………………. can occur at the individual, group, organizational or extra-organizational level.
(a) Planning
(b) Controlling
(c) Organizing
(d) Scheduling

(iii) Plan which is firstly discussed in business plan mostly
(a) Marketing plan
(b) Financial plan
(c) Personnel plan
(d) Production plan

(iv) The architecture of the MIS plan provides:
(a) A way to handle the system or subsystem by way of simplification, coupling and decoupling of subsystems
(b) For preparing the schedule of the system in the overall information requirement
(c) An online information on the stocks markets and the accounts balance
(d) None of these

(v) ……………….. are formal social units devoted to the attainment of specific goals.
(a) Management
(b) Organization
(c) Decision support system
(d) None of those

(vi) Which of the following statements about leadership is false?
(a) Leadership does not necessarily take place within a hierarchical structure of an organization
(b) Not every leader is a manager
(c) When people operate as leaders their role is always clearly established and defined
(d) All the above
ChE 411

(vii) What management functions refers to the process of anticipating problems, analyzing them, estimating their likely impact and determining actions that will lead to the desired outcomes and goals?
   (a) Planning
   (b) Leading
   (c) Controlling
   (d) Organizing

(viii) Legitimate power is based on the subordinate's perception that the leader has a right to exercise influence because of the leader's
   (a) role or position within the organization
   (b) ability to punish or reward
   (c) Personal characteristics and personality
   (d) expertise and knowledge

(ix) ......................... reduces uncertainty
   (a) Negotiating; (b) Planning; (c) Organizing; (d) Leading

(x) In a highly formalized organization, job behaviours are relatively
   (a) Non programmed (b) Non-existent (c) Programmed (d) Discretionary

6. (a) The types of Communication Problems can be treated in three (3) basic groups. Discuss the three types of communication problems.  
   (b) Write an essay on "Technology Management" with respect to Developed and Developing countries.

7. (a) What is the role of SWOT analysis in Strategic Management? Explain your answer using an example of a real company of your choice.
   (b) Why do we do DEPARTMENTATION? With the help of a figure show different types of departmentation.
   (c) List and explain the three (3) roles of a manager.

8. (a) Suppose that you have completed B.Sc. in Engineering from a renowned university a few years back. Recently you have been informed that a convocation ceremony will be arranged soon. But you don't have the necessary documents to be eligible for registration for convocation because you did not apply for them before.
   The following table shows the activities that need to be undertaken to collect the documents.
   (i) Draw the activity diagram for this process.
   (ii) Calculate the early start and finish time, late start and finish time and total float for each event, and identify the Critical Path of the given process with the help of an arrow network. Also determine whether you will be able to register for convocation within due date. The final date for registration is 1 month from now.

Contd ........... P5
### ChE 411

**Contd ... Q. No. 8(a)**

<table>
<thead>
<tr>
<th>Activity Symbol</th>
<th>Estimated time (Days)</th>
<th>Post Requisite</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>8</td>
<td>C,D</td>
</tr>
<tr>
<td>B</td>
<td>6</td>
<td>C</td>
</tr>
<tr>
<td>C</td>
<td>5</td>
<td>H</td>
</tr>
<tr>
<td>D</td>
<td>2</td>
<td>E, F</td>
</tr>
<tr>
<td>E</td>
<td>4</td>
<td>H</td>
</tr>
<tr>
<td>F</td>
<td>5</td>
<td>G, I, J</td>
</tr>
<tr>
<td>G</td>
<td>4</td>
<td>K</td>
</tr>
<tr>
<td>H</td>
<td>3</td>
<td>I, J</td>
</tr>
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<td>I</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>J</td>
<td>3</td>
<td>K</td>
</tr>
<tr>
<td>K</td>
<td>5</td>
<td>-</td>
</tr>
</tbody>
</table>

(b) Draw a technology S-curve and label its different sections.  

(6)