1(a) Define diffusive flux and convective flux of mass transfer. Show that the molar diffusive and convective fluxes are related as

\[ N_i = x_i \sum N_i + J_i \]

Hence show that \( \sum J_i = 0 \)

1(b) At one point in an absorption column the bulk compositions were found to be \( x_a = 0.0 \) and \( y_a = 0.08 \). The corresponding interfacial compositions estimated to be \( x_{a_l} = 0.025 \) and \( y_{a_l} = 0.04 \). If the overall mass transfer coefficient for the liquid phase is 50 kmol/m²·h·(mole fraction), determine the percentage resistance to mass transfer for gas phase. Assume that the equilibrium relationship for the gas and liquid phases can be described by Henry’s law.

OR

1'(a) Obtain the following relation between the overall gas phase mass transfer coefficient and individual liquid and gas phase mass transfer coefficient

\[ \frac{1}{K_y} = \frac{1}{k_y} + \frac{m'}{k_x} \]

Hence explain the gas phase controlling mass transfer operations.

1'(b) Solute \( A \) is diffusing at unsteady state into a semi-infinite medium of pure \( B \) and undergoes a first-order reaction with \( B \) (reaction rate constant \( k_1 = 1 \times 10^{-5} \text{ s}^{-1} \)). Solute
$A$ is dilute with an interfacial concentration of 1.0 kmol/m$^3$. The diffusivity of $A$ in $B$ is $D_{AB} = 1 \times 10^{-9}$ m$^2$/s. Calculate the concentration of $A$ at the point 5 mm away from the interface and rate of mass transfer at interface after 1 h of contact of $A$ and $B$. The value of error function is given in the following table.

<table>
<thead>
<tr>
<th>$x$</th>
<th>0.1</th>
<th>0.2</th>
<th>1.0</th>
<th>1.1</th>
<th>1.2</th>
<th>1.3</th>
<th>1.4</th>
<th>1.5</th>
<th>1.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{erf}(x)$</td>
<td>0.112</td>
<td>0.222</td>
<td>0.842</td>
<td>0.880</td>
<td>0.910</td>
<td>0.934</td>
<td>0.952</td>
<td>0.966</td>
<td>0.976</td>
</tr>
</tbody>
</table>

2(a) Define the term absorption factor and discuss its physical significance in gas absorption operations.

2(b) Ninety five percent of the acetone vapor in an 85 vol% air stream is to be absorbed by a countercurrent contact with pure water in a valve-tray column with an overall tray efficiency of 50%. The column will operate essentially at 20 °C 101 kPa pressure. Equilibrium data for acetone-water at these conditions are:

<table>
<thead>
<tr>
<th>Mole percent acetone in water</th>
<th>3.30</th>
<th>7.20</th>
<th>11.70</th>
<th>17.10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone partial pressure in air, mm Hg</td>
<td>30.00</td>
<td>62.80</td>
<td>85.40</td>
<td>103.00</td>
</tr>
</tbody>
</table>

Calculate:

(i) Minimum value of $L_s/G_s$

(ii) The number of equilibrium stages required using a water flow rate 1.25 times the minimum

(iii) The concentration of acetone in the exit water

OR

2 (b) Solute $A$ is to be stripped from a liquid stream by contacting with a pure gas. The liquid enters the tower at an $A$-free rate of 2.5 kmol/s and contains 30 mol% $A$. The gas enters the column counter currently at a rate equals to 1.5 times the minimum. Determine the number of theoretical stages required to reduce the concentration of $A$ in the exiting liquid to 1.0 mol%. The distribution of $A$ in the gas and liquid is expressed by $y_A = 0.4x_A$.

3(a) Define the terms absolute humidity, relative humidity, and dew point of an unsaturated vapor-gas mixture used in humidification operation.

3(b) A mixture of nitrogen and acetone vapor at 800 mmHg total pressure, 25 °C, has a

Contd....3.
percentage saturation of 80%. Calculate (a) the absolute molal humidity, (b) the absolute humidity, (c) the partial pressure of acetone, (d) the relative humidity, and (e) the dew point. The vapor pressure of acetone in mmHg at any temperature in °C is given by

$$\log p^* = 7.02447 - \frac{1161.0}{t + 224}$$

OR

3(b') A horizontal spray chamber with re-circulated water is used for adiabatic humidification and cooling of air. The active part of the chamber is 2 m long and has cross section of 2 m². With an air flow rate 3.5 m³/s at dry bulb temperature 65 °C and humidity 0.017 kg water/kg dry air, the air is cooled and humidified to a dry bulb temperature 42 °C. If a duplicate spray chamber operates in the same manner were to be added in series with the existing chamber, what outlet conditions could be expected for the air?

4(a) Define the following types of the moistures used in the drying operation and show them on an equilibrium diagram
(a) Equilibrium and free moisture
(b) Bound and unbound moisture

4(b) Describe briefly the nucleation and crystal growth processes in the formation of a crystal.

Contd.....4.
2015-16
B.TECH. (WINTER SEMESTER) EXAMINATION
Chemical Engineering
Chemical Process Industries –I

Maximum Marks: 60
CH-320
Credits: 04
Duration: Three Hours

Answer all the questions.
Notation used have their usual meaning

Q.No. Question M.M.
1 Draw a flow sheet for the production of nitric acid and explain the process. Discuss [15] the major engineering problems associated.

OR

1' (a) Draw the process flow diagram for the production of caustic soda and explain the [10] process of its production.

1' (b) Explain the advantages and disadvantages of membrane cell used in the above [5] process.

2 Draw the flow diagram for the production of urea and explain the process and [15] write the chemical reactions involved. Discuss briefly the major engineering problems that may occur.

OR

2' Draw the flow diagram for the production of ammonia and explain the process. [15] Write the chemical reactions involved. Explain briefly about the major engineering problems.

3 With the help of a neat flow diagram of the production of Portland cement. Write [15] all the chemical reactions. What are the engineering challenges?

4(a) What are the basic requirements of paints for surface coating? [03]

4(b) Explain briefly any three of following about the additives used in paints [4+4+4]
(I) Pigments
(II) Driers
(III) Resins
(IV) Diluents
Maximum Marks: 60 
Credits: 04 
Duration: Three Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No. Question M.M.
1(a) What are the important properties of Ethylene oxide (EO)? What is its specification as per BIS? [03] 
OR
1'(a) List important properties of Aniline. [03]
1 (b) List important applications of Formaldehyde, also mention the specifications of commercially available Formaldehyde. Write down the chemical reaction for production of Formaldehyde from catalytic oxidation and dehydrogenation of Methanol. [04]
OR
1'(b) Mention the important properties and uses of Acetone. List various processes available for the production of Acetone. [04]
1 (c) Explain the manufacturing process of Aniline with the help of process flow diagram along with chemical reactions and process conditions. [08]
OR
1'(c) Compare Air based and Oxygen based processes for the production of Ethylene Oxide with respect to various parameters. [08]
2(a) Explain briefly about the different types of Synthetic rubber [11]
2(b) Differentiate between the following:
   a) Natural and Synthetic Rubber [04]
   b) Thermo Setting and Thermo Plastics
3 (a) List different surfactants and builders used for the production of synthetic detergents. Also discuss the functions performed by builders [08]

Contd.....2.
OR

3'(a) What are the advantages of detergent over soap? What are the steps involved in the continuous hydrolysis of oil to manufacture soap? [08]

3 (b) Explain briefly about the hydrogenation of oil to manufacture vanaspati? [07]

OR

3' (b) What are the requirements of raw material for the production of paper? Explain briefly about pulping of bamboo. [07]

4(a) What are the various methods for the classification of crude oil? Explain them briefly [07]

4(b) Explain briefly about the properties and applications of LPG CNG, Gasoline and Diesel obtained from petroleum refinery. [08]
2015-16
B.TECH. (WINTER SEMESTER) EXAMINATION
Chemical Engineering
Equilibrium Stage Processes
CH322

Maximum Marks: 60  Credits: 04  Duration: Three Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No.  Question  M.M.

1(a)  Discuss the effect of feed conditions on q-line.  [05]

1(b)  Elaborate the role of delta point in Ponchon Savarit method. How can it be used to calculate the heat load on condenser and reboiler.  [04]

1(c)  A liquid mixture of 50 mol % n-heptane, 50 mol % n-octane was subjected to differential distillation at atmospheric pressure, with 60 mol % of the liquid distilled. Calculate the composition of the residue.

\[
\begin{array}{ccccccc}
 x & 0.49 & 0.46 & 0.42 & 0.38 & 0.34 & 0.32 \\
 y & 0.689 & 0.648 & 0.608 & 0.567 & 0.523 & 0.497 \\
\end{array}
\]

OR

1'(a)  What do you understand by relative volatility? With the help of xy diagram explain the effect of temperature and pressure on relative volatility?  [03]

1'(b)  A binary mixture of components A and B is fed to a distillation column to obtain top product 95 mol % and bottom product 0.1 mol % of more volatile component A. Feed to the column is saturated liquid with 30 mol % of A. How many stages are required to achieve the desired separation if the column operates at 1.5 times the minimum reflux ratio? Equilibrium relationship is

\[
y = 2.4 x / (1 + 1.4 x)
\]

2  A solution of hydrocarbons at a total pressure of 405.3 kPa has the analysis: n-
butane (A) = 40, n-pentane (B) = 25, n- hexane(C) = 20, n-pentane(D) = 15 mol%.

Compute the bubble point. K values are given as following:

\[
K_A = 0.0002 T^2 + 0.0066T + 0.318
\]

\[
K_B = 0.0001 T^2 - 0.0014 T + 0.125
\]

\[
K_C = 0.0001 T^2 - 0.0102 T + 0.467
\]

\[
K_D = 0.00009 T^2 - 0.0098 T + 0.3381
\]

Where T is the temperature in °C, first guess can be taken as 65 °C.

3. Pure isopropyl ether of 430kg/h is being used to extract an aqueous solution of 140 kg/h with 28wt% acetic acid by countercurrent multistage extraction. The exit acid concentration in the aqueous phase is 10wt%. Calculate the number of stages required. For acetic acid-water-isopropyl ether system, equilibrium data is given below:

<table>
<thead>
<tr>
<th>Water layer (wt%)</th>
<th>isopropyl ether layer(wt%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.69</td>
<td>98.1</td>
</tr>
<tr>
<td>1.41</td>
<td>97.1</td>
</tr>
<tr>
<td>2.89</td>
<td>95.5</td>
</tr>
<tr>
<td>6.42</td>
<td>91.7</td>
</tr>
<tr>
<td>13.3</td>
<td>84.4</td>
</tr>
<tr>
<td>25.5</td>
<td>71.1</td>
</tr>
<tr>
<td>36.7</td>
<td>58.9</td>
</tr>
<tr>
<td>44.3</td>
<td>45.1</td>
</tr>
<tr>
<td>46.4</td>
<td>37.1</td>
</tr>
</tbody>
</table>

OR

3'. Soybean flakes containing 22 wt% oil are to be leached in a countercurrent multistage process to contain 0.8kg oil/100 kg inert solid using fresh and pure hexane solvent. For every 1000 kg soybeans, 1000kg hexane is used. Experiments give the following retention of solution with the solids in the underflow, where N is kg inert solid/ kg solution retained and \(y_A\) is wt fraction of oil in solution:

Contd.....3.


<table>
<thead>
<tr>
<th>N</th>
<th>yA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.73</td>
<td>0</td>
</tr>
<tr>
<td>1.52</td>
<td>0.20</td>
</tr>
<tr>
<td>1.43</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Calculate the exit flows and compositions and the number of theoretical stages needed.

4(a) Which essential properties an adsorbent should possess to be used for adsorption process.

4(b) State Freundlich law for the adsorption of solute from dilute solution. Deduce the relation for the determination of least total amount of adsorbent for two stage cross current operation.

4(c) Write short notes on any two of the following:

   (i) Ion Exchange equilibria
   (ii) Effect of temperature and pressure on adsorption
   (iii) Adsorption hysteresis
Answer all the questions. Assume suitable data if missing. Notations used have their usual meaning.

Q.No.  Question                                                                                     M.M.  
1(a)   Glycerine at 26°C is flowing through a horizontal tube 1 ft long and with 0.1 inch inside diameter. For a pressure drop of 2.76x10^6 dyne/cm², the volumetric flow rate Q is 0.00398 ft³/min. The density of Glycerine at 26°C is 1.261 g/cm³. From the flow data, find the viscosity of Glycerine in centipoise and PaS. Check whether the flow is laminar and also find the entrance length. Derive the expression used. [10]

OR

1'(a)   i. The flow field is given by: \( \mathbf{V} = 2x\mathbf{i} + 3y\mathbf{j} + z\mathbf{k} \); \( \rho = \rho_o x^2 e^{-t} \). What is the rate of density noticed by an observer moving along with the particle at (1,1,1) at time \( t = 2s \). [2]

ii. In a gas absorption experiment a viscous fluid flows upward through a small circular tube and then downward in laminar flow outside the tube (figure on next page). Flow is taking place under the action of gravity only. Obtain the velocity distribution in the falling film. Write down the assumptions made in the derivation and also show the balances pictorially on the elemental volume. [8]

Contd....2.
1(b) Distinguish between the operators $\partial / \partial t$, $d/dt$, $D/Dt$ and write their significance.

There are two parallel plates some distance apart. Between the plates, water is used at $24^\circ$C. The lower plate is pulled at a constant velocity, 0.4 m/s faster relative to the top plate. How far apart should the two plates be placed so that the shear stress, $\tau$ is 0.3 N/m². Also calculate the shear rate.

Given: Viscosity of water, $\mu = 0.9142$ CP

2(a) Liquefied gases are sometimes stored in well insulated spherical containers vented to the atmosphere. Develop an expression for the steady-state heat transfer rate through the walls of such a container, with the radii of the inner and outer walls being $r_0$ and $r_1$, resp. and the temperatures at the inner and outer walls being $T_0$ and $T_1$. Assume that the thermal conductivity of the insulation varies linearly with temperature according to the relation:

$$k = k_0 + (k_1 - k_0) \left( \frac{T - T_0}{T_1 - T_0} \right)$$

OR

Contd.....3.
2(a') A spherical vessel of radius \( R_1 \) meters is insulated from outside such that the outside surface of the insulated vessel has the radius \( R_0 \). The temperature of the inside and outside surface of the insulation are \( T_i \) and \( T_o \) respectively. The ambient temperature is \( T_a \), the convective heat transfer coefficient outside the insulation is \( h_o \) and the thermal conductivity of the insulating material is \( k' \). Determine the outer radius of the insulation for which the rate of heat transfer will be maximum.

Derive the expression used and state the assumptions made.

2(b) A heated sphere of radius 'R' is suspended in a large, motionless body of fluid (figure below). It is desired to study the heat conduction in the fluid surrounding the sphere. It is assumed that free convection effects are negligible

i) Obtain the temperature profile using boundary conditions:

\[
\begin{align*}
\text{BC1: at } r &= R, \quad T = T_R \\
\text{BC2: at } r &= \infty, \quad T = T_\infty
\end{align*}
\]

ii) Develop an expression for the heat flux at the surface. Equate this result to the heat flux given by "Newton's Law of Cooling" and show that dimensionless heat transfer coefficient (known as the Nusselt Number) is given by

\[
Nu = \frac{hD}{k} = 2
\]

Where 'D' is the diameter of the sphere.

3(a) A sphere of naphthalene of radius 2 mm is suspended in a large volume of still air at 318 K and 1 atmospheric pressure. The surface temperature of naphthalene can be assumed to be at 318 K. Its vapour pressure at 318 K is 0.555 mmHg. The diffusivity of naphthalene-air system at 318 K is \( 6.92 \times 10^{-6} \) m\(^2\)/s. Calculate the rate of evaporation of the naphthalene from the surface. Also, derive the equation used.

Given: \( R = 8314 \text{ m}^3/\text{Pa} \text{ kg mol K} \)

\[\text{Contd... 4.}\]
3(b) Derive the expressions:

i. \( \frac{\partial \rho_A}{\partial t} = -\nabla \cdot (\rho_A \vec{v}) + \nabla (\rho D_{AB} \vec{v} \cdot w_A) + r_A \)

ii. \( \frac{\partial C_A}{\partial t} = D_{AB} \nabla^2 C_A \)

OR

3'(b) A Polymerization reaction: \( nA \rightarrow A_n \), occurs instantaneously at the catalytic surface as shown in figure below:

\[ z = 0 \quad \text{Catalytic surface, where } r_{x^n} \text{ takes place.} \]

Product \( A_n \) diffuses back out through the gas film to the main turbulent gas stream.

i. Determine the Fick's Law relationship in terms of compound 'A'

ii. Obtain the differential equation describing the concentration profile for component 'A'.

4(a) Write down the significance of macroscopic balance.

4(b) i. A cylindrical tank of radius 'R' and its drainpipe of length 'L' and diameter 'D' are completely filled with heavy oil as shown in figure below. At time \( t=0 \), the valve at the bottom of the drainpipe is opened. How long will it take to drain the tank if the flow in the drainpipe is laminar?

![Figure 4](image)

ii. A cylindrical tank of inside diameter 2 m and with a water level of 4 m is to be emptied by draining through drainpipe of length 4 m and diameter 5 cm. How long it will take to remove one-half of the contents? How long will it take to empty the tank?
Q.No. 1. In a food processing plant there is a requirement to heat 50,000 kg/h of towns water from 10 to 70°C. Steam at 2.7 bar is available for heating the water. An existing heat exchanger is available, with the following specification:
Shell inside diameter 337 mm, E type. Baffles 25 per cent cut, set at a spacing of 106 mm. Tubes 15 mm inside diameter, 19 mm outside diameter, 4094 mm long. Tube pitch 24 mm, triangular. Number of tubes 124, arranged in a single pass.
Would this exchanger be suitable for the specified duty? [15]

OR

1. Design a gasketed plate heat exchanger for the heat duty set out in Question no. 1. [15]
Specify a flow arrangement of one pass: one pass.

2. A condenser is required to condense n-propanol vapour leaving the top of a distillation column. The n-propanol is essentially pure, and is a saturated vapour at a pressure of 2.1 bar(abs). The condensate needs to be sub-cooled to 45°C. Design a horizontal shell and tube condenser capable of handling a vapour rate of 20,000 kg/h. Cooling water is available at 30°C and the temperature rise is to be limited to 30°C. The pressure drop on the vapour stream is to be less than 50 kN/m², and on the water stream less than 70 kN/m². The preferred tube size is 16 mm inside diameter, 19 mm outside diameter, and 2.5 m long. Take the saturation temperature of n-propanol at 2.1 bar as 118°C.

OR

Contd....2.
2'. A 20,000 lb/hr sugar solution at 180°F is to be concentrated from 12 to 30°Brix (degrees Brix is the per cent by weight of sugar in the solution) in a triple-effect, forward-feed, calandria-type evaporator. Assuming that exhaust steam from a steam engine is available at 5 psig and the vacuum in the third effect is held at 23 in. Hg, estimate (a) steam economy; (b) surface of each body, assuming overall heat transfer coefficient $U$ of 500, 300 and 200 Btu/(hr)(ft$^2$)(°F) for first, second and third effects, respectively, and equal surface for each effect; (c) water required for a barometric condenser, assuming that 90°F water is available and a 10°F approach to condensing temperature is permitted.

3. Design a sieve plate type continuous distillation column (Calculate Diameter and Provisional Plate Design only) to recover acetone from a 50-50 mole % acetone-water mixture available at 30°C. The feed stream flow rate is 25,000 kg/h. The top product should contain at least 95 mole% acetone and the bottom product should contain <1 % acetone by mole. Consider reboiler as equivalent to one stage. This column is operated at atmospheric pressure (top tray). Column efficiency of 60% and pressure drop per plate of 1.25 kPa may be assumed. You can take the minimum liquid flow as 70% of the maximum rate both above and below the feed plate. The vapor liquid equilibrium (VLE) data for the acetone-water system at atmospheric pressure is provided in Table 1.

Data given:
Latent heat of water= 41,360 J/mol; latent heat of acetone= 28,410 J/mol; Specific heat of water=75.3 J/mol°C (mean); Specific heat of acetone=128 J/mol°C (mean).
Reflux ratio, $R=2.5 \times R_{min}$ where $R_{min}= 0.67$ for $x_D=0.95$.
(Assuming constant molar overflow)

Molar feed flow rate, $F=657.9$ kmol/h;
Top product, $D=346.2$ kmol/h;
Vapor flow rate above feed plate, $V = 926.2$ kmol/h;
Top section liquid flow rate, $L=580$ kmol/h;
Bottom product: $B=311.7$ kmol/h;
Liquid flow rate below feed plate, $L'=1285.7$ kmol/h;
Vapor flow rate below feed plate, $V'=974$ kmol/h;
Total number of ideal tray= 6 (above feed) +3 (below feed) =9;
$x= $ Mole fraction of acetone in liquid;
$y= $ Mole fraction of acetone in vapor;
BP: Bubble point.

Contd....3.
Table 1: VLE data for the acetone-water system at 1 atm.

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>0.05</th>
<th>0.1</th>
<th>0.15</th>
<th>0.2</th>
<th>0.25</th>
<th>0.3</th>
<th>0.35</th>
</tr>
</thead>
<tbody>
<tr>
<td>$x$</td>
<td>0</td>
<td>0.6381</td>
<td>0.7301</td>
<td>0.7716</td>
<td>0.7916</td>
<td>0.8034</td>
<td>0.8124</td>
<td>0.8201</td>
</tr>
<tr>
<td>$y$</td>
<td>0</td>
<td>74.8</td>
<td>68.53</td>
<td>65.26</td>
<td>63.59</td>
<td>62.6</td>
<td>61.87</td>
<td>61.26</td>
</tr>
<tr>
<td>BP, °C</td>
<td>0.4</td>
<td>0.45</td>
<td>0.5</td>
<td>0.55</td>
<td>0.6</td>
<td>0.65</td>
<td>0.7</td>
<td>0.75</td>
</tr>
<tr>
<td>$y$</td>
<td>0.8269</td>
<td>0.8376</td>
<td>0.8387</td>
<td>0.8455</td>
<td>0.8532</td>
<td>0.8615</td>
<td>0.8712</td>
<td>0.8817</td>
</tr>
<tr>
<td>BP, °C</td>
<td>60.75</td>
<td>60.35</td>
<td>59.95</td>
<td>59.54</td>
<td>59.12</td>
<td>58.71</td>
<td>58.29</td>
<td>57.9</td>
</tr>
</tbody>
</table>

4(a). A continuous cooling crystallizer operating at 30°C is required to produce citric acid monohydrate crystals (density $\rho_C = 1.54$ g/ml, volume shape factor $\alpha = 0.9$, and the solubility is 39.0 wt%) of 833 μm (20 mesh) predominant modal size $L_D$ at the rate $P_C = 1000$ kg/hr. On the basis of pilot plant trials it is expected that the crystallizer will operate with steady state nucleation/growth kinetics expressed (with $j=1$, $i=2$) as $B = 4 \times 10^{18} M_T G^2 m^{-3} s^{-1}$. Assuming MSMPR conditions and a magma density $M_T = 250$ kg/m$^3$, estimate the crystallizer volume and other relevant operating conditions. Calculate the liquor flowrate needed through a fines trap to remove 80% of the crystals smaller than 80 μm.

4(b). An exothermic reaction with the stoichiometry $A \rightarrow 2B$ takes place in organic solution. It is to be carried out in a cascade of two CSTR’s in series. In order to equalize the heat load on each of the reactors it will be necessary to operate them at different temperatures. The reaction rates in each reactor will be the same, however. In order to minimize solvent losses by evaporation it will be necessary to operate the second reactor at 120°C where the reaction rate constant is equal to 1.5 m$^3$/kmole-ksec. If the effluent from the second reactor corresponds to 90% conversion and if the molal feed rate to the cascade is equal to 28 moles/ksec when the feed concentration is equal to 1.0 kmole/m$^3$, how large must the reactors be? If the activation energy for the reaction is 84 kJ/mole, at what temperature should the first reactor be operated?
### Answer all the questions.

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>Define and discuss with the help of neat diagram, two important phases of a typical batch growth curve of an industrial bio process.</td>
<td>[07]</td>
</tr>
<tr>
<td>1(b)</td>
<td>Explain Deindoerfer’s classification of bio-products with suitable examples and graphs.</td>
<td>[08]</td>
</tr>
<tr>
<td>OR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1'(a)</td>
<td>Discuss the present status and future prospects of Indian bioprocess industries with suitable examples.</td>
<td>[06]</td>
</tr>
<tr>
<td>1'(b)</td>
<td>Discuss the merits and demerits of a biochemical reaction with suitable examples.</td>
<td>[04]</td>
</tr>
<tr>
<td>1'(c)</td>
<td>Show that the lactic acid bacteria can behave like growth associated and non growth associated.</td>
<td>[05]</td>
</tr>
<tr>
<td>2(a)</td>
<td>Derive Michaelis-Menton equation for an enzyme catalysed reaction. Discuss the competitive effect of inhibition on it and compare the rate equation with above equation. How will you calculate experimentally the value of $K_m$ used in the equation?</td>
<td>[10]</td>
</tr>
<tr>
<td>OR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2'(a)</td>
<td>An enzyme has non-competitive effect on substrate. Derive the rate equation of product formation for such reaction. Also explain the effect of temperature and substrate concentration on the rate of enzymatic reactions.</td>
<td>[10]</td>
</tr>
<tr>
<td>2(b)</td>
<td>Explain the mechanism of enzyme catalysed reactions for conversion of starch into fructose syrup.</td>
<td>[05]</td>
</tr>
</tbody>
</table>

*Contd.....2.*
3(a) Define clearly the following with suitable reason:
   i. Air requirement of microorganisms for bioprocess
   ii. Power consumption in bioreactor
   iii. Sterilization of medium by steam/electrical heating

3(b) Explain the basic functions of a bioreactor. Mention clearly the merits and demerits of various bioreactors used in bioprocess industries.

3(c) Write down the Gaden’s equation for a bioprocess. Discuss its significance for industrial production.

4(a) Explain the industrial demand of bio ethanol for various industries.

4(b) Discuss the general scheme of downstream processing.

4(c) What are optimum process conditions of sugar concentration, temperature, and pH to produce ethanol from molasses. Also discuss the mechanism of ethanol formation. What do you anticipate about the future of non-conventional raw material in alcohol industry?
1(a) An old wooden bridge over a bay is in danger of collapse. The highway department is currently considering two alternatives to alleviate the situation and provide for expected increases in future traffic. One plan is a conventional steel bridge, and the other is a tunnel under the bay. The department is familiar with bridge construction and maintenance but has no experience with maintenance costs for tunnels. The following data has been developed for the bridge:

- First Cost: $170000
- Painting every 6 years: $10000
- Deck resurfacing every 8 years: $30000
- Structural overhaul at the end of 12 years: $40000
- Annual maintenance: $3000

The tunnel is expected to cost $240000 and will require repaving every 8 years at a cost of $20000. Both designs are expected to last 20 years with negligible salvage value. Since the tunnel under bay would require less supervision it would be preferred by the highway department. Determine the additional equivalent annual amount, if any, for maintenance that could be permitted for the tunnel if the present worth for both the alternatives is same. (i=8% per annum)

1(b) What are the different types of market segments? Explain the phenomenon of inflation and explain it with the help of supply-demand curve

OR

1'(a) A machine was purchased 5 years ago for Rs.100000. Its annual maintenance expense has been Rs.5000 per year. At the end of three years, Rs.9000 were spent on maintenance. At the end of five years (now), the machine is sold for Rs.120000. During the period of ownership the machine was rented for Rs.10000 per year paid at the beginning of each year. Find the Annual Worth of this investment when the interest rate is 12% per year.

Contd.....2.
1(b) Consider the following cash flow series. What value of C makes the deposit series equivalent to the withdrawal series at an interest rate of 12% compounded annually?

<table>
<thead>
<tr>
<th>EOY</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposits (in $)</td>
<td>1000</td>
<td>800</td>
<td>600</td>
<td>400</td>
<td>200</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Withdrawals (in $)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>C</td>
<td>2C</td>
<td>3C</td>
<td>4C</td>
<td>5C</td>
<td>6C</td>
</tr>
</tbody>
</table>

2(a) A grinder was purchased 3 years ago for $40,000. It has provided adequate service, but an improved version is now available for $35,000 that will reduce operating costs and cut inspection expenses. Costs and salvage values for the two machines are shown below. Costs that are the same for either machine are not included. Also, the operating costs for the challenger are very low due to warranted equipment. Should a replacement be made if the required rate of return is 15% and the service of the grinder will be needed for only 4 more years?

<table>
<thead>
<tr>
<th>Year</th>
<th>Defender D</th>
<th>Challenger C</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Operating Cost ($)</td>
<td>Salvage Value ($)</td>
</tr>
<tr>
<td>0</td>
<td>-</td>
<td>12000</td>
</tr>
<tr>
<td>1</td>
<td>3400</td>
<td>7000</td>
</tr>
<tr>
<td>2</td>
<td>3900</td>
<td>4000</td>
</tr>
<tr>
<td>3</td>
<td>4600</td>
<td>2500</td>
</tr>
<tr>
<td>4</td>
<td>5600</td>
<td>1000</td>
</tr>
<tr>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

2(b) An asset for drilling was purchased and placed in service by a petroleum production company. Its cost Basis is Rs 60000 and it has an estimated Market value of Rs, 12000 at the end of an estimated useful life of 14 years. Compute the depreciation amount in the third year and the Book Value at the end of the Fifth year by using (i) Straight line method (ii) Double Declining Balance Method.

3(a) Differentiate the working of managers by level and area in an organization.

3(b) What are the three basic areas of concern for managerial ethics? Explain.

3(c) Explain the different decision making environments with suitable examples.

4(a) Define “Control” as a function of management and explain its purpose.

4(b) Describe the Managerial Grid and explain the different kind of leadership styles.

4(c) Define Motivation and explain Hertzberg’s theory of motivation.

OR

Contd.....3.
4'(a) Differentiate between the following:
   (i)  Power and authority
   (ii) Hierarchy and chain of commands
4'(b) Differentiate between strategic and operational plans with suitable examples.
4'(c) What is the need for coordination? What are its different forms? Explain any one.

5(a) Derive an expression for economic order quantity. Explain the various costs considered in the model.
5(b) Differentiate between income statement and balance sheet. Define any two financial ratios.
5(c) What is internationalization of an organization? Explain any two alternatives.