2015-16
B. Tech Civil Engineering
(VIII Semester Examination)
Construction Management (CE-410)

MaximuMarks:60

Duration: Three Hours

Note: (i) Answer ALL Questions
(ii) All parts of a question should be attempted in one continuation
(iii) Answer to any part of the question should begin from FRESH page
(iv) All questions carry equal marks
(v) Assume any data if not given

Q. 1 (a) Discuss factors of production in detail
(b) Define the following types of cost with example
   (i) Direct Cost
   (ii) Fixed Cost
   (iii) Opportunity Cost
   (iv) Conversion Cost
   (v) Sunk Cost
   (vi) Historical Cost
(c) Discuss the concept of Ceiling Limit with example

Q. 2 (a) What do you understand by the term specification? Explain different types
   specification used in industry with example
(b) What are the different general economic consideration to be kept in mind
   during purchasing

OR

Q.2’ (a) In what ways purchasing of capital equipment is different from routine
   Purchasing
(b) What are the various issues to be examined, during the purchase of,
   construction equipment.

Q.3 (a) Discuss concept of wage and its types in detail
(b) Discuss basic philosophy of various types of rewards offered in lieu of
   achievement of a worker in the industry

OR

Q.3’ (a) Write down detailed account on the evolution of HRM in India
(b) Discuss various elements of HR Planning

Contd.....2.
Q4 (a) The following table shows the job of a project with their duration in days. Draw the network and determine the critical path. Also calculate all the floats.

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>DURATION</th>
<th>PRECEDEOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>13</td>
<td>B</td>
</tr>
<tr>
<td>E</td>
<td>9</td>
<td>C</td>
</tr>
<tr>
<td>F</td>
<td>15</td>
<td>A</td>
</tr>
<tr>
<td>G</td>
<td>17</td>
<td>A</td>
</tr>
<tr>
<td>H</td>
<td>9</td>
<td>F</td>
</tr>
<tr>
<td>I</td>
<td>6</td>
<td>G</td>
</tr>
<tr>
<td>J</td>
<td>12</td>
<td>D, E</td>
</tr>
</tbody>
</table>

(b) Discuss importance and application of dummy activity in a project network.

5 (a) Define Normal Time, Crash Time and Crash Slope in a cost analysis problem.

(b) Solve the following LLP using Simplex Method

\[
\begin{align*}
\text{Max } Z &= 3x_1 + 2x_2 \\
\text{Subject to,} & \\
4x_1 + 3x_2 & \leq 12 \\
4x_1 + x_2 & \leq 8 \\
4x_1 - x_2 & \leq 8 \\
x_1, x_2 & \geq 0
\end{align*}
\]

(b) The following table shows the jobs of a network along with their time estimates. The time estimates are in days.

<table>
<thead>
<tr>
<th>Job</th>
<th>Time estimate in days</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t₀</td>
</tr>
<tr>
<td>1-2</td>
<td>3</td>
</tr>
<tr>
<td>1-6</td>
<td>2</td>
</tr>
<tr>
<td>2-3</td>
<td>6</td>
</tr>
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<td>2-4</td>
<td>2</td>
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<td>3-5</td>
<td>5</td>
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<td>4-5</td>
<td>3</td>
</tr>
<tr>
<td>5-8</td>
<td>1</td>
</tr>
<tr>
<td>6-7</td>
<td>3</td>
</tr>
<tr>
<td>7-8</td>
<td>4</td>
</tr>
</tbody>
</table>

(a) Draw the project network.
(b) Find the critical path.
(c) Find the probability of the project being completed in 31 days.
Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No.  Question                                                                 M.M.

1(a)  Derive continuity equation for unsteady state flow condition in an open channel.  [4]

1(b)  A circular channel is to carry a discharge of 0.558 m$^3$/s. Find the diameter of the conduit such that the flow is critical when the conduit is running quarter full.  [8]

1(c)  Show the variation of $y_1$ and $y_2$ with $B_2/B_1$ in subcritical and supercritical flows with neat sketches.  [3]

1'(a) If $y_1$ and $y_2$ are the alternate depths in a triangular channel show that

$$y_c^2 = \frac{4y_1^4y_2^4}{(y_1 + y_2)(y_1^2 + y_2^2)}$$

Where $y_c$ is the critical depth.  [5]

1'(b) A 3m wide rectangular channel carries a discharge of 9 m$^3$/s at a depth of 0.75m. At a certain section it is proposed to build a hump. Calculate the water surface elevations at upstream of the hump and over the hump if the hump height is (i) 0.08m and (ii) 0.16m. Assume no energy loss at the hump.  [10]

2(a)  Show that maximum discharge in a circular channel occurs when $\frac{y}{D} = 0.938$ where $y =$ depth of flow and $D =$ diameter of the circular channel.  [07]

2(b)  Derive an expression for composite roughness in open channel flow. A rectangular channel 3.6 m wide has badly damaged surfaces and has a value of Manning's $n$ as 0.035. As a first phase of repair, its bed was lined with concrete ($n = 0.018$). If the depth of flow remains same at 1.2 m before and after the repair, what will be the new discharge?  [08]

Contd.....2.
3(a) Show that the GVF profile for a horizontal channel can be expressed by

\[ x = \left[ -\frac{c_1}{Q^2(N+1)} y^{N+1} + \frac{c_2 y^{N-M+1}}{g c_1 (N-M+1)} \right] + \text{Constant} \]

Where \( c_1 \) and \( c_2 \) are coefficients associated with the hydraulic exponents \( M \) and \( N \) respectively.

3(b) A river 105 m wide and 3.0 m deep has an average bed slope of 0.0006. Estimate the length of GVF profile produced by a low dam which raises the water surface just upstream of it by 1.55m. Assume \( n = 0.035 \).

OR

3'(a) Classify the hydraulic jump on the basis of Froude number.

3'(b) If in a hydraulic jump occurring in a horizontal rectangular channel, the Froude number before the jump is 10.0 and the energy loss is 3.20 m, estimate (i) sequent depths (ii) the discharge intensity and (iii) the Froude number after the jump.

3'(c) Derive the basic differential equation of gradually varied flow. Write its other forms. Also mention the assumptions made.

4(a) Classify waves on the basis of motivating force and mass transport.

4(b) What is meant by complete similitude in model studies? Is it possible to obtain complete similitude in modelling a stretch of a river? Support your answer with reasons.

4(c) The speed of travel of a tidal bore up an estuary is 6 m/s. The depth and velocity prior to the arrival of bore were 1.2 m/s and 3.5 m respectively. Estimate the height of the bore.

OR

4'(c) 200 m long and 6 m high spillway without piers discharges 560 m³/s water under a head of 1.2 m. The necessary tail water to form the hydraulic jump on the apron is to be determined by model test. The laboratory channel is 0.4 m wide and 0.5 m deep with a water supply of 0.060 m³/s. Design a suitable model for the spillway.
2015-2016
B.TECH. (IV YEAR) WINTER SEMESTER EXAMINATION
(CIVIL)
IRRIGATION ENGINEERING
(CE-415)

Maximum Marks: 60

Duration: Three Hours

(i) Attempt All questions. All questions carry equal marks.
(ii) Assume suitable data if required.
(iii) All symbols have their usual meanings.

1(a) What are the major challenges faced by Indian agriculture? Discuss any three of them. 07

1(b) List out various types of modules. Draw the neat sketch of Orifice module and explain its working. 08

OR

1’(a) Differentiate between:
   (a) Duty and delta
   (b) Basin flooding and check flooding
   (c) Sprinkler irrigation and drip irrigation 06

1’(b) Why silt exclusion in canals as well as at the head regulators is essential? Describe the tunnel type silt excluder. Give the merits of vortex chamber type silt extractor. 09

2(a) (i) How canals are classified based on alignment?
   (ii) Draw the X-section of an earthen canal in full cutting.
   (iii) Differentiate between contour canal and ridge canal. 06

Contd.....2.
2(b) Why lining of canals is essential? Design lined canal using following data:
Discharge \( Q = 35 \text{ m}^3/\text{s} \)
Mean diameter of average silt particles = 0.464 mm
Assume canal side slope \( = 1.25 \text{ H} : 1.0 \text{ V} \) and bed width zero.

OR

2'(b) Design a channel section by Kennedy’s method using following data:
Discharge \( Q = 25 \text{ m}^3/\text{s} \)
Kutter’s \( N = 0.0225 \)
Critical velocity ratio = 1.05
Side slope of the channel = 0.5 \( \text{ H} : 1.0 \text{ V} \)
B/D ratio = 7
Also find the longitudinal slope of the channel.

3(a) What is piping? Explain with neat sketch how hydraulic structures fail due to piping?

3(b) Using Khosla’s method check the safety of the weir profile shown in following Fig. 1
Assume missing data suitably.

4(a) Draw the line sketches of any three types of Cross Drainage Works.

4(b) Design the crest, and impervious floor of a 1.5 m Sarda type fall for a canal using following data:
Design discharge = 20 \( \text{ m}^3/\text{s} \)
Bed level upstream = 102.00 m
Bed level downstream = 100.5 m
Full supply level upstream = 103.5 m
Full supply level downstream = 102.0 m
Bed width upstream and downstream of the canal = 16 m
Soil = Good Loam
Assume Bligh’s coefficient \( C = 7 \)

Contd…..3.
4(b) Using following data design the waterway of drainage and find the bed levels, full supply levels and total energy line levels at ideal sections of canal trough.

**Data for Canal:**

- Design discharge = 40 m$^3$/s
- R. L. of bed of canal = 160.00 m
- Bed width of the canal = 20 m
- Side slope of the canal = 1 H : 1 V
- Depth of flow in canal = 1.5 m

**Data for Drainage:**

- High flood discharge = 450 m$^3$/s
- High flood level = 160.50 m
- General ground level = 160.0 m
- Bed level of the drainage = 158.0 m

Pond level 204.5

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**Fig. 1**

*Contd.....4.*
PLATE II. Khosla’s Curves
2015-2016
B. TECH. WINTER (VIII SEMESTER) EXAMINATION
(CIVIL ENGINEERING)
GEOENGINEERING OF ROCK AND ROCK MASSES (CE - 427)

MAXIMUM MARKS: 60

Note: Answer all questions. The marks of questions are given in parenthesis.

Q.1- What are the different uses and important physic-mechanical properties of rocks to be used in construction industry. (12)

Q. 2- Define and differentiate amongst joint, shear zone and fault. What are their roles in controlling engineering performance of the rock mass? (12)

OR

Q.2'-Write short account of different parameters of joints, significant in controlling the engineering properties of rock mass. (12)

Q. 3 (a) Describe in detail the Brazilian Test and its importance. (06)

OR

Q. 3(a') Discuss Triaxial Compression Testing of rock and obtaining of shear strength parameters through it with neat diagram. (06)

Q. 3(b) Discuss any three provisions of treatment of rock defects described in IS Code : 13063:1991. (06)

Q. 4 Briefly enumerate important parameters taken into consideration in Rock mass Quality (Q') System and its application in tunnel support system design. (12)

Q. 5- Write short notes on any two of the followings:

a) Residual Stresses in rock mass and measurement techniques. (06)
b) Methods of Rock mass Improvement. (06)
c) Core Recovery and Rock Quality Designation (06)
d) Rock Mass Excavation Techniques (06)
2015-16
B.TECH. (WINTER SEMESTER) EXAMINATION
CIVIL
BRIDGE ENGINEERING
CE 434

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) How the bridges are classified? Discuss in detail. [5]
1(b) Show that for an economical span of a bridge, cost of superstructure of one span should be equal to the cost of substructure of the same span. State the assumptions made in its derivation. [10]

OR

1'. A riveted deck-type plate girder bridge has the following section at the mid-span:
Two cover plates of sizes 500 mm ×12 mm (provided at top and bottom flanges)
Two angles ISA 200 mm × 200 mm × 15 mm (provided at top and bottom flanges)
Web of size: 1800 mm × 10 mm
The bridge is to be used for a single broad gauge main line loading. The effective span of the girder is 20 m. The two girders are located at c/c distance of 2 m. The floor is open deck type. Take wind pressure = 1.5 kN/m² and f_b = 147 N/mm². How the cover plates of plate girder be curtailed? Draw a neat sketch showing the curtailment. [15]

2(a) Explain the behaviour of arch and suspension bridge through diagrams [3]
2(b) Design the cantilever portion of the slab for Class A loading with average thickness of the slab as 200mm. The details are shown in figure 2 and 3 [12]

Contd…..2.
Design the stringer of a through type single lane truss bridge for broad gauge main line (BGML). The effective span of bridge is 30 m. Spacing of the trusses is 5.5 m c/c. The truss is standard Warren type with six panels @5.0 m each.

Dimensions of cross-section of T-beam bridge and the cantilever portion of the deck are shown in Figure 2 and 3. Clear carriage way width is 7.5m. The cross girders are 250mm thick and spaced at 3.5m c/c. There are three longitudinal-beams spaced at 3.0m intervals. The rib of the beam is 300mm and the depth of slab is 220mm. The footpath is 200mm above the wearing coat. The cantilever slab is 230mm thick at its fixity which reduces to 120 mm at free end. Assume M25 grade concrete mix and Fe415 grade steel. The clear cover to steel is 40mm. The height of railing is 1.2m. Design the interior panel for Class AA tracked vehicle. Use 25% impact factor and 0.8 as continuity factor.

Figure 2 The cross section of deck

**OR**

Determine the DL and LL moments for Class AA wheeled vehicle and design the interior panel of the deck slab. Use data given in Q.No.2 and figures 2 and 3.
Figure 3 Cantilever portion of deck
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.  
1. (a) Briefly describe various losses of prestress.  

1. (b) The cross section of a precast concrete slab unit for a bridge floor is as shown in figure below. Each slab unit is supported at 10 m intervals. The slab unit is subjected to a pre-stressing force of 375 kN applied at 45 mm from the soffit. Determine the extreme stresses in concrete for the mid span section (i) when the beam is subjected to dead load and pre-stressing force, (ii) when the beam is subjected to dead load, live load and pre-stressing force. The live load on the beam is 5.75 kN/m.

![Figure 1](image_url)

2. Design a pre-stressed concrete beam of I-section with the following particulars.

- Span = 6 m
- Superimposed load = 5 kN/m
- Load factor for D.L. = 1.4
- Load factor for L.L. = 1.6
- Concrete cube strength = 50 N/mm$^2$
- Tensile stress in concrete = 1.7 N/mm$^2$
- Loss ratio = 0.8
- Concrete cube strength at transfer = 30 N/mm$^2$

**Permissible Stresses at Transfer**  
Stress in concrete in compression = 15 N/mm$^2$

Contd…..2.
Tensile stress in concrete = 1 N/mm²
Permissible Stresses at Working Load
Safe stress in concrete in compression = 17 N/mm²
Tensile stress in concrete = 0 N/mm²

High tensile steel wires, 7 mm in diameter with an ultimate tensile strength of 1600 N/mm² are used. The safe stress in steel wires is 1200 N/mm². The suggested section with preliminary dimensions is given in Fig. 2.

Fig. 2

2'. (a) A pre-stressed concrete beam of uniform rectangular section and span 18 meters supports a distributed load of 18 kN/m excluding the weight of the beam. Determine the suitable dimensions of the beam section and calculate the area of the tendons and their position. The permissible compressive stress in concrete is 14N/mm² while the permissible tensile stress in the tendon is 1025N/mm².

2'. (b) Design a simply supported pre-stressed concrete slab to the following conditions:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Span of the slab</td>
<td>12 m</td>
</tr>
<tr>
<td>Superimposed load</td>
<td>20 kN/m²</td>
</tr>
<tr>
<td>Safe stress in concrete</td>
<td>14 N/mm²</td>
</tr>
<tr>
<td>Safe stress in steel</td>
<td>900 N/mm²</td>
</tr>
<tr>
<td>Weight of PSC</td>
<td>25 kN/m³</td>
</tr>
</tbody>
</table>

Contd. .... 3.

3. (b) A post-tensioned pre-stressed concrete rectangular beam 200mm wide by 450mm depth is grouted before the application of live loads. The steel consists of two tendons, each made up of 10 numbers of 5mm diameter wires encased in a thin metallic hose of 25mm diameter with an effective cover of 60mm. The \( E_s = 2 \times 10^5 \) MPa; \( E_c = 3.8 \times 10^4 \) MPa. The beam span is 10m simply supported subjected to uniformly distributed load of 25kN/m over entire span. Compute the unit bond stress (a) Between each wire and grout (b) Between the hose and concrete

OR

3'. (b) A pre-tensioned beam of rectangular section, 200 mm wide by 500 mm deep is pre-stressed by 10 wires of 5 mm diameter located at an effective eccentricity of 150 mm. The maximum shear force at a particular section is 150kN. If the \( E_s = 2 \times 10^5 \) MPa; \( E_c = 3.8 \times 10^4 \) MPa, calculate the flexural bond stress developed assuming, (a) The section as uncracked (b) The section as cracked

4 (a) A pre-stressed concrete column carries axial force \( W \), together with moment \( M \) (smaller than \( W \)). Derive an expression for the area of the column 'Ae' in terms of \( W \), \( M \) and the following parameters: \( p \), \( m \), \( D \), \( \sigma_{cc} \), \( \eta \) and \( \sigma_{sl} \).

4 (b) Design a pre-stressed concrete column of 5.5m long for an axial load of 400 kN and a bending moment of 40 kNm. Determine the factor of safety. Use Concrete mix = M45; Ultimate stress in steel = 1500 MPa; stress in steel at transfer = 0.7\( \sigma_p \); stress in concrete at transfer = 0.1\( \sigma_c \) MPa; stress in concrete at final stage = 0.4 \( \sigma_c \); \( E_s = 2 \times 10^5 \) MPa; \( E_c = 3.8 \times 10^4 \) MPa; \( \eta = 0.8 \).
Answer all questions
Assume suitable data, if necessary
Notations used have their usual meaning

1(a) Explain the characteristics and the construction of Kaolinite, Montmorillonite and Illite mineral groups. Why Montmorillonite clay mineral is considered to be highly expansive as compared to Illite and Kaolinite clay minerals?

1(b) Describe the design considerations of an underreamed pile in terms of stem diameter, length, No. of bulbs, diameter of under ream and their spacing.
Determine the load carrying capacity of underreamed pile in compression and tension from the following data:
Diameter of the pile (Stem) = 750mm
Diameter of under-reamed bulb (Du) = 1500mm
No. of under-reamed bulbs = 3
The cohesion at the ground level is 80 kN/m² and at tip of pile is 100 kN/m²
Length of pile = 7.0m
Adhesion factor (α) = 0.65

2(a) Describe the Vesic’s and Hansen’s general equations for computing ultimate bearing capacity of soils below the footings.

2(b) Briefly explain the standard penetration test for finding the load carrying capacity of soils. A 1.5m wide, 2.5m long, and 0.6m deep spread footing is underlain by a soil with the properties:
γ = 20 kN/m³, c = 5.0 kN/m², φ = 28°. The ground water is at a great depth.
Using Vesic’s method, compute the column load required to cause a bearing capacity failure

OR

2'(a) Briefly describe the plate load test to determine the safe bearing capacity of soil. Under what conditions would you take the test results trust-worthy?

2'(b) Compute the safe load of a foundation 3.0 m square resting at a depth of 2.0 m below the ground level. Use the IS: 6403-1981 method for the soil having γ = 20 kN/m³, c = 16 kN/m² and φ = 30°. The water table is encountered at 1.5m below the base of the footing. Taking S_e=1.30, S_q=1.2, S_r=0.8, d_e=1.23, d_q=d_r=1.11.

Contd.....2.
3(a) In accordance with IS 2911: Part 4: 1985, discuss different types of pile load tests. Explain the guideline to determine the safe load of pile groups.

3(b) A group of 12 concrete piles, each of length 15m is driven in a sandy stratum in $3 \times 4$ arrangement. The diameter of each pile is 250mm and the working load of each pile is 450kN, out of which 150kN is carried by the pile base and rest carried by friction. Determine elastic settlement of the pile group. Use: $E_p = 21 \times 10^6$ kN/m$^2$, $E_s = 25 \times 10^3$ kN/m$^2$, $\mu=0.35$ and $\xi=0.62$.

OR

3'(a) Discuss the effect of pile driving method and pile spacing on group efficiency in case of cohesive as well as cohesionless soil deposits.

3'(b) Derive an expression for group efficiency of frictional piles using simple approach and compare the expression with that of Converse-Labarre formula.

A pile group comprises of 9 piles ($3 \times 3$), each of diameter 60mm and center to center spacing 2D. Compute group efficiency using the following approaches:
   i)  Simplified approach and
   ii) Converse-Labarre Equation

4(a) Discuss the properties of body waves. Derive a relationship to prove that p-wave travels faster through geological materials than s-wave.

4(b) Discuss the application and limitations of reflection and refraction methods of survey.

A seismic reflection survey was conducted on a soil layer, which shows the arrival time of 45$\mu$sec and 250$\mu$sec at the geophone located 20m away from the source. Determine the p-wave velocity and thickness of the soil strata.
2015-16
B.TECH. (WINTER SEMESTER) EXAMINATION
CIVIL ENGINEERING
ADVANCED ENVIRONMENTAL ENGINEERING
CE 481 R

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)  Draw a tentative water treatment scheme for a surface water source  [02]
1 (b)  Briefly explain the chemical water quality parameters of concern to human health  [04]
1(c)  Describe how solubility can help in removing heavy metals from water/wastewater?  [06]

It is desired to remove fluoride from water to permissible drinking water limit. Is it possible to remove fluoride by chemical precipitation as CaF$_2$?
Take $K_{sp}$ for CaF$_2$ as $3 \times 10^{-11}$

2 (a)  Differentiate between completely mixed reactor (CSTR) and plug flow reactor (PFTR). Derive the equation of CSTR receiving continuous input of a tracer undergoing decay and operating under non steady state conditions.  [06]

2 (b)  Describe the mechanism involved in anaerobic treatment of wastewater. List various advantages and disadvantages. Derive the relationship between COD removed and methane produced.  [06]

OR

2 ' (a)  Define and briefly explain the significance of kinetic constants $K_s$, $k$, $Y$ and $k_d$ used in biological treatment of wastewater.  [04]

2 ' (b)  Determine the values of the kinetic constants using the following data derived from laboratory experiments carried out on five sets of CSTR without recycle.  [08]
<table>
<thead>
<tr>
<th>Test no.</th>
<th>Influent substrate concentration $S_0$ (mg/L)</th>
<th>Effluent substrate concentration $S$ (mg/L)</th>
<th>Detention time $\Theta$ (days)</th>
<th>Reactor cells concentration $X$ (mg/L)</th>
</tr>
</thead>
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<td>12</td>
<td>3.8</td>
<td>135</td>
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<td>350</td>
<td>70</td>
<td>1.2</td>
<td>122</td>
</tr>
</tbody>
</table>

3(a) Write the equations involved in lime soda process of water treatment. Explain the significance of addition of excess lime.

OR

3 ' (a) Balance the following oxidation reduction reactions involved in water/wastewater treatment.

(a) Oxidation of $\text{NH}_4^+$ to $\text{NO}_2^-$ and reduction of $\text{O}_2$ to $\text{H}_2\text{O}$

(b) Oxidation of $\text{CH}_3\text{COO}^-$ to $\text{CO}_2$ and reduction of $\text{SO}_4^{2-}$ to $\text{H}_2\text{S}$

3 (b) Determine the amount of lime and soda required for the treatment of raw water containing following ions. Draw the bar diagram and list the possible hypothetical combinations of hardness causing salts. Take flow of water as 15,000 m$^3$/d.

$\text{Ca}^{2+} = 40 \text{mg/L}$

$\text{Mg}^{2+} = 14.7 \text{mg/L}$

$\text{Na}^+ = 13.7 \text{mg/L}$

$\text{HCO}_3^- = 135 \text{mg/L as CaCO}_3$

$\text{SO}_4^{2-} = 29 \text{mg/L}$

$\text{Cl}^- = 17.8 \text{mg/L}$

$\text{CO}_2 = 8.8 \text{mg/L}$

4 (a) Briefly describe the working of a UASB reactor. Also draw a rough sketch of the system.

4 (b) Explain the working of gravitational settling chamber for particulate removal. The flow rate of air stream pass through a centrifugal collector is 10m$^3$/s. The diameter of collector is 3 m and viscosity of air 2.04x10$^{-5}$ kg/ms. What are the different dimensions of the centrifugal collector unit. Determine the size of particles that can be removed with 50% efficiency. Using relative size efficiency curve determine the efficiency for removal of 12$\mu$m size particle.

Contd......3.
5 (a) Explain the different steps involved in anaerobic digestion process of solid waste. [04]

5 (b) What are landfills? Show its different components with the help of diagram. Explain the process of generation of different gases during the decomposition in landfills. [08]