2011 – 2012
M.TECH. (I SEMESTER) EXAMINATION
(CIVIL ENGINEERING)
(STRUCTURAL ENGINEERING)
THEORY OF ELASTICITY AND PLASTICITY
(CE – 602)

Maximum Marks : 60
Duration : Three Hours

"Students governed by the old ordinances will be examined out of 75 marks and their obtained marks shall be proportionately raised."

Note:
(i) Answer all the questions.
(ii) Notation used bear their usual meanings.
(iii) Assume the missing data suitably, if any.

1. (a) Explain the state of plane stress and plane strain with examples. [05]
(b) Justify that assumptions of isotropy and homogeneity can be used for structural steel. What is an isotropic material, also give examples. [05]
(c) Obtain all the six strain components for a 3-D elastic body. [05]

2. (a) Derive the relationship
\[ G = \frac{E}{2(1+\nu)} \] [05]
(b) What problem of plane stress are solved using three degree polynomials? Explain. [10]

OR

2'. (a) For a cantilever subjected to point load at the free end, obtain stress components \( \sigma_x, \sigma_y \) and \( \Sigma_{xy} \). [10]
(b) Investigate what problem is solved by
\[ \phi = \frac{3F}{4C} \left( xy - \frac{xy^3}{3C^2} \right) + \frac{P}{2} y^2. \] [05]
Applied to the region included in \( y = 0, y = C, x = 0 \), on the side \( x \) positive.

3. Derive the expressions for stress transformation and the invariants of stress tensor. [15]

OR

3'. The term \( \varepsilon_{ij} \) represents a given strain tensor as shown blow. If another strain tensor is formed by rotating the \( x, y, z \) axes about \( X \) axis through 60° clock wise, find \( \varepsilon_{ns} \) and invariants of both tensors. Show that they are equal. [15]

\[ \varepsilon_0 = \begin{bmatrix} 0.01 & 0 & 0 \\ 0 & 0.02 & 0.02 \\ 0 & 0.02 & 0.02 \end{bmatrix} \]

4. (a) Plot true stress vs true strain curve and derive the expressions to mark the point of instability by two different methods. [10]
(b) Explain maximum shear strain energy theory of yielding in detail and draw the envelop. [05]
1. A square plate of side ‘a’. Simply supported on all four edges is subjected to loading \( q_0 \sin \frac{\pi x}{a} \sin \frac{\pi y}{a} \). Using Navier method, find the central deflexion of the plate, the maximum bending moment per unit length, the distribution of reactive forces along the edges, and the concentrated forces needed at the corners to prevent the corners from rising.

2. (a) Show that for bending of rectangular plates.

\[
M_x = -D \left( \frac{\partial^2 \omega}{\partial x^2} + \nu \frac{\partial^2 \omega}{\partial y^2} \right)
\]

\[
M_y = -D \left( \frac{\partial^2 \omega}{\partial y^2} + \nu \frac{\partial^2 \omega}{\partial x^2} \right)
\]

(b) A rectangular plate \( a \times b \) carries a uniformly varying load \( q_0 \) per unit area (\( q_0 \) is the loading intensity along the edge \( y = b \)). Two opposite edges of the plate are simply supported and two other edges are fixed. Use Levy’s method, calculate maximum deflection at the centre of the plate.

OR
2'. Show that the differential equation for bending of circular plates carrying symmetrical load \( q \) about the vertical axis through centre of the plate is given by

\[
\frac{1}{r} \frac{d}{dr} \left[ r \frac{d}{dr} \left\{ \frac{1}{r} \frac{d}{dr} \left( r \frac{dw}{dr} \right) \right\} \right] = \frac{q}{D}
\]

Where symbols have usual meaning.

3. Using membrane theory for thin cylindrical shells, derive relations for membrane stresses \( N_x, N_{x\phi}, \) and \( N_\phi \) in thin shell of radius ‘\( r \)’, semi-central angle ‘\( \phi_c \)’ and subjected to dead load of ‘\( w \)’ kN/m\(^2\) and show load of ‘\( s \)’ kN/m\(^2\). Also show the stress variation, if any.

OR

3'. Derive equilibrium equations for stresses and moment-curvature relationship for thin cylindrical shells, assuming Bending theory. For simplification, assume \( N_\phi \) and \( M_\phi \) as constant and \( N_x\phi, Q_\phi \) and \( M_x\phi \) as negligible.

4. Using Beam theory for long and thin shells, calculate maximum bending and shear stresses at critical sections of circular cylindrical shell of radius 3 m, span 15 m, thickness 80 mm and semi-central angle of 50°. The shell is to carry a maximum load of 1 kN/m\(^2\) over curved area besides its dead load. Assume density (unit weight) of concrete as 25 kN/m\(^3\).
2011-2012
M.TECH. (I SEMESTER) EXAMINATION
(CIVIL ENGINEERING)
(STRUCTURAL ENGINEERING)
ADVANCED STRUCTURAL ANALYSIS
(CE - 604)

Maximum Marks: 60
Duration: Three Hours

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Note:
(i) Answer all questions.
(ii) Assume any data suitably, if not given.

1. Analyse the portal frame shown in Fig. 1 by stiffness method and plot the bending moment diagram.

   OR

1'. Derive the elements of stiffness matrix for the portal frame with inclined legs.

2. Calculate the forces in the members of the pin jointed plane frame shown in Fig. 2 if the hinge support at D settles vertically downwards by 0.1 cm. The cross sectional area of each member is 20 cm$^2$. Take $E = 20000$ KN/cm$^2$.

3. (a) Derive the relation:

\[
\{V\} = [S]\{P\}
\]

Where the notations used have their usual meanings.

(b) Calculate the maximum values of the displacements which can occur separately at the coordinates 1, 2, 3 and 4 in a steel bar AB of uniform square cross-section of side 50 mm and a length of 1600 mm, as shown in Fig. 3. The maximum direct stress is limited to 160 MPa. Take $E = 200$ kN/mm$^2$ & $G = 80$ kN/mm$^2$. Shear stress is limited to 80 N/mm$^2$.

4. Four springs A, B, C and D are connected as shown in Fig. 4. Develop the flexibility matrix for the system with reference to the co-ordinates 1, 2, 3 and 4.

   OR

4'. Write the possible types of the displacements in a flexible structural member and discuss their flexibility and stiffness values with respect to different types of loads, moments and torque. Give suitable examples of each of them, giving sketches.

Figures enclosed.
Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.
1. (a) Differentiate between creep of concrete and steel. Also mention factors effecting them. (05)
(b) Design a prestressed concrete beam to support a live load of 16.75 kN/m over a span of 12 m. The allowable stress in steel is 1.35 GPa and allowable compressive stress in concrete is 15MPa. The loss of prestress at working is 18%. (10)

OR

1'. (a) A prestressed concrete beam 200 mm x 400 mm supports a live load of 20kN/m over an effective span of 12 m. The tendons housed in a duct are located at a distance of 150 mm from the saffit of the beam. Calculate increase in the steel stress due to loading when:
(i) Duct is grouted, (ii) Duct is ungrouted
(Take $E_s = 215$ GPa and $E_c = 35$ GPa) (05)
(b) Discuss the advantage of prestressed concrete over the other forms of constructions. (05)
(c) Explain the means by which we can improve shear resistance capacity of a prestressed concrete member. (05)

2. (a) A pretension girder has T-section with flange = 20 cm x 6 cm, web = 6 cm x 60 cm. A horizontal prestress at a point 25 cm from the saffit of the beam is 10 MPa. The shear stress due to transverse loading is 5.50 MPa at the same point. Calculate the increase in the principal tensile stress at this point of T-Section is subjected to a torque of 5kNm. (07)
(b) The support section of a prestress concrete beam 100 mm x 250 mm is required to support a shear force of 50kN. The prestress at the centroidal axis is 5.0 MPa. Design suitable shear reinforcement for the section as per IS : 1343 – 1980. (08)

Contd......
3. (a) Why accurate prediction of deflection in reinforced concrete numbers is difficult? Discuss the assumptions made to simplify the evaluation of deflection in R.C. flexural members.

(b) A singly reinforced one-way slab, simply supported over a span of 4m is 140 mm thick and reinforced with 12 mm dia. bar @ 150 mm c/c. The slab is to carry a live load of 4 kN/m² and a floor finish of 2 kN/m². Calculate short term deflection due to dead and live loads separately, as per the recommendations of British and Indian codes. Assume M₂₀ mix concrete and Fe415 grade steel.

OR

3'. (a) Discuss the factors affecting creep in reinforced concrete structures.

(b) A cantilever beam 4m long, having section 300 mm x 600 mm is reinforced with 28 φ 3 Nos at tension face and 20φ 3 Nos on compression face. It is to carry a u.d.l. over complete span with a maximum service moment of 200 kNm out of which 60% is due to permanent loads. Calculate deflection due to shrinkage & creep separately, assuming εₜₐₚ = 0.0004 and θ = 1.6.

4. Using Yield Line theory, derive relation for ultimate moment of resistance for square slab 4m x 4m, reinforced orthotropically, and fixed on all its four edges.

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M.TECH. (I SEMESTER) EXAMINATION
(CIVIL ENGINEERING)
(HYDRAULIC STRUCTURES)
DESIGN OF IRRIGATION WORKS
(CE-611)

Maximum Marks: 60 Duration: Three Hours

"Students governed by the old ordinances will be examined out of 75 marks and their obtained marks shall be proportionately raised."

Note: (i) Attempt all questions.
(ii) Assume any data suitably, if missing.
(iii) Curves needed are attached

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mention the condition in designing the meter and non-meter straight glacis fall.</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Design a straight glacis flumed meter fall for the data given below:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Full supply discharge of the canal = 80 cumec</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Upstream bed level of canal = 255 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Downstream bed level of canal = 253.5 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>U/s full supply level of canal = 257 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D/s full supply level of canal = 255.5 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bed width of canal u/s and d/s = 45 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Safe exit gradient for canal bed material = 1/6</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>A barrage is to be constructed in an alluvium on a river having a high flood discharge of 10,000 cumec. The relevant data pertaining to the site of barrage are as follows:</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Average bed level of river = 300 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High flood level (before construction of barrage) = 305.5 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Permissible afflux = 1.0 m</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pond level = 303.5 m</td>
<td></td>
</tr>
</tbody>
</table>
Lacey’s silt factor = 1.0
Safe exit gradient for river bed material = 1/6
Concentration = 20.0 %
Bed retrogression = 0.5 m
The stage discharge curve for the river at the barrage site is given as:
Stage (in meter) = 298.5 + 0.8Q - 0.01 Q^2 where Q is high flood discharge in 1000 cumec.

Design Hinds’s expansion transition for the following data collected from the site of a cross drainage work. Assume that the flumed width is half of the normal bed width of canal and consider suitable splay for expansion transition.
High flood discharge = 250 cumec
High flood level = 247.5 m

High flood depth = 2.5 m
Full supply discharge = 30 cumec
Normal bed width of canal = 20 m
Full supply depth = 1.5 m
Full supply level = 251 m

OR

A rectangular channel carries a flow with Froude number of 4. The channel is 6 m wide and depth of flow is 0.9 m. It is required to reduce the channel width to 3 m. Design a contraction and determine the energy loss in the transition. Curves needed for the design are attached.

Design Bell’s guide bund for the following data
High flood discharge = 6200 cumec
High flood level 103.5 m
River bed level = 99.5 m
Average diameter of river bed material = 0.1 mm.

OR

A sediment excluder is to be provided for a canal head off taking from a river with dominant discharge of 8000 cumec. The other data of canal and excluder are given below:

Canal discharge = 284 cumec
Width of under sluices, where canal regulator is to be provided with an excluder = 15.35 m
River bed slope = 1/4000
Average sediment diameter = 0.37 mm
Head available for design = 0.8 m
Manning's rugosity coefficient = 0.016
Escape discharge = 20% of river discharge
Fix the width of excluder, design the tunnels of excluder and determine head loss in tunnel number 1 (i.e., longest tunnel nearest to the head regulator).
Third parameter = F₁

\[ \tan \theta = \frac{\tan \beta \left( -1 - \sqrt{1 + 8F₁^2 \sin^2 \beta} \right)}{2 \tan^2 \beta - 1 + \sqrt{1 + 8F₁^2 \sin^2 \beta}} \]

Figures for 0.3
2011-2012
M.TECH. (I SEMESTER) EXAMINATION
(CIVIL ENGINEERING)
 HYDRAULIC STRUCTURES)
 RESERVOIR ENGINEERING
(CE - 612)

Maximum Marks: 60 Duration: Three Hours

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Note: (i) Answer any four questions.
(ii) Assume any suitable data, if not given.
(iii) All symbols have their usual meanings.

1. (a) Describe in brief the salient points that are considered while selecting a best reservoir site. (05)

(b) The topographic surveys at a proposed reservoir site yielding the following data:

<table>
<thead>
<tr>
<th>Elevation (m)</th>
<th>100</th>
<th>104</th>
<th>108</th>
<th>112</th>
<th>116</th>
<th>120</th>
<th>124</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (Ha)</td>
<td>0</td>
<td>40</td>
<td>250</td>
<td>930</td>
<td>1810</td>
<td>2780</td>
<td>4040</td>
</tr>
</tbody>
</table>

Prepare area-elevation curve. Compute the storage capacity using Simpson method and draw elevation capacity curve.

2. (a) The average monthly in flow into a reservoir during a dry year is given below. (12)

<table>
<thead>
<tr>
<th>Month</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow (Mm³)</td>
<td>52</td>
<td>160</td>
<td>536</td>
<td>778</td>
<td>535</td>
<td>388</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Month</th>
<th>Dec</th>
<th>Jan</th>
<th>Feb</th>
<th>March</th>
<th>April</th>
<th>May</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow (Mm³)</td>
<td>267</td>
<td>214</td>
<td>150</td>
<td>107</td>
<td>78</td>
<td>67</td>
</tr>
</tbody>
</table>

If a uniform demand of 230 Mm³ per month is to be met by this reservoir, what storage capacity is required? Use sequent Peak Algorithm. (03)

(b) What is a flow mass curve? How is it constructed.

3. (a) A reservoir has the following sediment and discharge data. (15)

<table>
<thead>
<tr>
<th>Year</th>
<th>81</th>
<th>82</th>
<th>83</th>
<th>84</th>
<th>85</th>
<th>86</th>
<th>87</th>
<th>88</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge (Mm³)</td>
<td>1430</td>
<td>3850</td>
<td>2050</td>
<td>6510</td>
<td>2880</td>
<td>1120</td>
<td>6050</td>
<td>2220</td>
</tr>
<tr>
<td>Sediment (M. ton)</td>
<td>2.65</td>
<td>5.82</td>
<td>3.6</td>
<td>7.15</td>
<td>5.22</td>
<td>1.95</td>
<td>6.88</td>
<td>3.94</td>
</tr>
</tbody>
</table>

Contd......2
Calculate the average sediment load/year/100 sq.km at the site.

Develop a regression rotation and predict the sediment yield for the inflow of 3450 Mm$^3$ for the year 1978. Take the catchment area at the site as 3050 sg.km. What is the total sediment yield for 100 years.

4. (a) Explain the terms: (i) Risk (ii) Reliability (iii) Safety factor (iv) Safety margin (v) Return period.

(b) A bridge has an expected life of 25 years and is designed for a flood magnitude of return period 100 years (i) what is the risk of this hydraulic design? (ii) If a 10% risk is acceptable, what return period will have to be adopted?

(c) A factory is proposed to be located on the edge of the 50 year flood plain of a river. If the design life of the factory is 25 years, what is the reliability that it will not be flooded during its design life?

5. (a) List various methods of flood estimation.

(b) The annual peak discharges of a river follows the Gumbel’s extreme value distribution with a mean of 9000 cumec and a standard deviation of 2800 cumec. What is the probability that the annual peak discharge is more than 15000 m$^3$/s? What is the magnitude of the peak discharge with an exceedence probability of 0.10?

6. (a) Write short notes on:

(i) Deterministic and probabilistic processes

(ii) Reservoir routing.

(b) The observed annual flood peaks of a stream for a period of 40 years from 1951 to 1990 are given below:

$\begin{align*}
395, 619, 750, 422, 280, 990, 705, 528, 520, 436, \\
697, 624, 496, 589, 598, 400, 650, 726, 527, 310, \\
405, 720, 810, 459, 440, 632, 340, 634, 464, 373, \\
280, 370, 520, 342, 446, 366, 699, 560, 451, 610
\end{align*}$

Determine 200 yr flood using log-pearson type III distribution

Table enclose
<table>
<thead>
<tr>
<th>Co-efficient of skew g</th>
<th>Recurrence interval in years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>50</td>
</tr>
<tr>
<td>3.0</td>
<td>-0.396</td>
</tr>
<tr>
<td>2.5</td>
<td>-0.360</td>
</tr>
<tr>
<td>2.2</td>
<td>-0.330</td>
</tr>
<tr>
<td>2.0</td>
<td>-0.307</td>
</tr>
<tr>
<td>1.8</td>
<td>-0.282</td>
</tr>
<tr>
<td>1.6</td>
<td>-0.254</td>
</tr>
<tr>
<td>1.4</td>
<td>-0.225</td>
</tr>
<tr>
<td>1.2</td>
<td>-0.195</td>
</tr>
<tr>
<td>1.0</td>
<td>-0.164</td>
</tr>
<tr>
<td>0.9</td>
<td>-0.148</td>
</tr>
<tr>
<td>0.8</td>
<td>-0.132</td>
</tr>
<tr>
<td>0.7</td>
<td>-0.116</td>
</tr>
<tr>
<td>0.6</td>
<td>-0.099</td>
</tr>
<tr>
<td>0.5</td>
<td>-0.083</td>
</tr>
<tr>
<td>0.4</td>
<td>-0.066</td>
</tr>
<tr>
<td>0.3</td>
<td>-0.050</td>
</tr>
<tr>
<td>0.2</td>
<td>-0.033</td>
</tr>
<tr>
<td>0.1</td>
<td>-0.017</td>
</tr>
<tr>
<td>0.0</td>
<td>0.000</td>
</tr>
<tr>
<td>-0.1</td>
<td>0.017</td>
</tr>
<tr>
<td>-0.2</td>
<td>0.033</td>
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<tr>
<td>-0.4</td>
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<td>0.083</td>
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<td>-0.6</td>
<td>0.099</td>
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<td>-0.7</td>
<td>0.116</td>
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<tr>
<td>-0.8</td>
<td>0.132</td>
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<td>-0.9</td>
<td>0.148</td>
</tr>
<tr>
<td>-1.0</td>
<td>0.164</td>
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<tr>
<td>-1.2</td>
<td>0.195</td>
</tr>
<tr>
<td>-1.4</td>
<td>0.225</td>
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<tr>
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<tr>
<td>-1.8</td>
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<tr>
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<td>-2.5</td>
<td>0.360</td>
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<tr>
<td>-3.0</td>
<td>0.396</td>
</tr>
</tbody>
</table>
2011 – 2012
M.TECH. (I SEMESTER) EXAMINATION
(CIVIL ENGINEERING)
(HYDRAULIC STRUCTURES)
FLUVIAL HYDRAULICS
(CE-613)

Maximum Marks : 60
Duration : Three Hours

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Note: (i) Answer all the questions.
(ii) Assume any data suitably, if missing.
(iii) Shields curve is attached.

<table>
<thead>
<tr>
<th>Q.No</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>2(a)</td>
<td>7</td>
</tr>
<tr>
<td>2(b)</td>
<td>8</td>
</tr>
<tr>
<td>2(c)</td>
<td>7</td>
</tr>
</tbody>
</table>

Q.1 Write short notes on:

(a) Fundamental properties of individual sedimentary particle.
(b) Sediment samplers.
(c) Aggradation and degradation.

OR

1(a) What is Stokes' law? A sediment particle has a diameter of 1.4 mm and specific gravity 2.65. Find the terminal fall velocity of sediment particle in water at 20° C.

1(b) Comment on the practical significance of incipient motion condition in sediment transport in alluvial channels.

A wide stream has a sediment bed of median size 0.33 mm. the slope of the channel is 1.5x10^-4. If the depth of flow in the channel is 0.25 mm, examine whether the bed particles will be in motion or not? Shields curve is attached.

Q.2 (a) Discuss regimes of flow in alluvial channels. Comment on the influence of bed forms on channel resistance.
2 (b) A trapezoidal unlined irrigation channel carries a discharge of 2.0 cumec. Bed width of channel is 3.25 m, depth of flow is 0.8 m, longitudinal slope is 0.0035, side slopes are 1½ (H) : 1(V), median size of sediment is 0.30 mm. Predict the nature of bed form in the channel and determine the length of the bed undulations.

3 (a) Explain Einstein and Bar Barossa’s method of division of resistance in alluvial channels.

3 (b) The cumulative size distribution of bed material in the river Ganga is given below:

<table>
<thead>
<tr>
<th>Particle diameter in mm</th>
<th>0.01</th>
<th>0.025</th>
<th>0.05</th>
<th>0.10</th>
<th>0.25</th>
<th>0.50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative % finer</td>
<td>6</td>
<td>12</td>
<td>20</td>
<td>60</td>
<td>80</td>
<td>100</td>
</tr>
</tbody>
</table>

Determine standard deviation, geometric mean size, geometric standard deviation and sorting coefficient of the bed material.

3’(a) Determine the bed load transport in an alluvial stream for the following conditions:

Depth of flow = 2.5 m
Velocity of flow = 1.5 m/s
Average slope of water surface = 8x10^-4
Mean size of sediment = 5.0 mm
Specific gravity of sediment = 2.65

3 (b) An alluvial channel has a median size of 0.30 mm, velocity of flow of 1.3 m/s, longitudinal slope of 1.7x10^-4, depth of flow 0.60 m. Compute the total bed material load using Engelund and Hansen method.

4 (a) What is meant by stable alluvial channel?

Design a stable channel in alluvium to carry a discharge of 30 cumec with sediment load concentration of 60 ppm by weight. The average grain size of the bed material is 0.3mm. Assume the cross section of the channel as trapezoidal with side slopes 1½ (H) : 1(V).
A wide alluvial channel has a slope of 1 in 4500 and a depth of flow 8 m. Suspended load sampling at a height of 0.4 m above the bed revealed a concentration of 800 ppm by weight, consisting of sediment particles having a fall velocity of 0.05 m/s. Estimate and plot the suspended load concentration at levels 0.6 m, 0.8 m, and 2.0 m from the bed.

---

**Shields' Curve**

\[
\frac{U_{cd}}{\sqrt{\gamma_s - f}} = \frac{1}{T}
\]
2011-2012

M.TECH. (I SEMESTER) EXAMINATION
(CIVIL ENGINEERING)
(HYDRAULIC STRUCTURES)
RIGID DAM
(CE-614)

Minimum Marks: 60

Duration: Three Hours

"Students governed by the old ordinances will be examined out of 75 marks and their obtained marks shall be proportionately raised."

Note: (i) Answer any four questions.
    (ii) Assume suitable data if not given.
    (iii) All symbols have their usual meanings.

1. (a) Discuss the criteria for fixing the base width of an elementary profile of a concrete gravity dam and obtain the relation for it. [07]

   (b) Design the first two zones of a non-over flow section of a concrete gravity dam of height 60 m. Fetch of reservoir is 12 km and wind velocity is 85 km/hr. [08]

2. (a) Discuss the effects of horizontal and vertical accelerations due to earthquake in the design of concrete gravity dam. [06]

   (b) Calculate the base width of an elementary profile of a gravity dam considering the earthquake force, hydrostatic pressure of water, uplift pressure and weight of dam. [04]

   (c) How does the top width affect the elementary profile of a gravity dam? [05]

3. (a) Derive the relationship for shear stress distribution at the base of a concrete gravity dam. [07]

   (b) Determine the distribution of shear stress at the base of a dam of top width, \( T = 172.70 \text{ m} \), for the following data.

      (i) Normal vertical stress at heel, \( \sigma_{zu} = 102 \text{ t/m}^2 \).

      (ii) Normal vertical stress at toe, \( \sigma_{zd} = 288.45 \text{ t/m}^2 \).

      (iii) Total water pressure at the U/S face, \( P_u = 205 \text{ t/m}^2 \).

      (iv) No tail water.

      (v) Total horizontal force, \( H = 26,000 \text{ tonnes} \).

      (vi) Slope at U/S, \( \tan \phi_u = 0.1 \) and slope at D/S, \( \tan \phi_D = 0.85 \). [08]

4. (a) Write short notes on the following:

      (i) Elastic theory of design of an arch dam. [04]

      (ii) Thick cylinder theory of design of an arch dam. [04]

      (b) Briefly discuss the advantages and disadvantages of buttress dam as compared to the conventional gravity dam. [07]

Contd......2
5. (a) Determine the stresses in a thin constant angle arch dam at 30 m below maximum water level. The geometrical data are as follows:

(i) Constant angle = 120°.
(ii) Centre line radius = 40.0 m.
(iii) Thickness at crown = 6.0 m.
(iv) Thickness at abutment = 6.25 m

Use Cain’s method for the analysis.
Assume coefficient of thrust at crown = 0.970
Moment coefficient at crown = 0.0106
Coefficient of thrust at abutment = 0.938
Shear coefficient at abutment = 0.0529.
Moment coefficient at abutment = 0.0178.

(b) Write short notes on thin cylinder theory of design of an arch dam.

(c) Site selection of arch and buttress dam.

6. Derive relations for the design of buttresses of a buttress dam by using concept of unit column.

A 100 m high flat deck buttress dam has a buttress spacing of 18 m and inclination of 45°. Assume \( f_c = 450 \text{ t/m}^2 \) and \( w_c = 2.4 \text{ t/m}^3 \). Determine the shape of buttress and required concrete thickness. Minimum thickness of unit column in 2.0 m. Assume water stored upto full height of the dam and frictionless joint of deck and buttresses.
2011-2012
M.TECH. (I SEMESTER) EXAMINATION
(CIVIL ENGINEERING)
(HYDRAULIC STRUCTURES)
EARTH AND ROCK FILL DAM
(CE-615)

Maximum Marks: 60

Answer any four questions.
Assume suitable data if missing.
Symbols have their usual meanings.

1. Derive an expression for the length of discharge face ‘a’ for a homogeneous earth dam in which down stream face \( \alpha < 30^\circ \) acts as the inclined discharge face. 15

2. (a) Determine the optimum length of horizontal filter for the dam section shown in figure-1. Take minimum thickness of dry zone as 2.5m. 08
(b) Discuss the relative advantages and disadvantages of Slanting and Central cores. How the core thickness can be determined? 07

3. For the dam section shown in figure-2 the permeability of foundation material is \( 5 \times 10^{-5} \) m/s. Find (i) head lost upto the end of blanket (ii) percentage reduction in seepage due to provision of blanket. Take \( K_h = 1 \times 10^{-7} \) m/s 15

4. Discuss the influence of various parameters on cracking of embankment dams. Suggest the preventive and remedial measures to control the cracking problems. 15

5. Discuss the following methods of drainage of embankment dams with clear sketches-
   (i) Downstream free draining zone or shell.
   (ii) Rock toe drain
   (iii) A network of longitudinal and transverse drains.
   (iv) Chimney drain 15

6. (i) Discuss various factors which should be considered to determine the best river diversion scheme. 08
(ii) Write a note on criteria for safe design of embankment dams. 07

Encl. figures 2
Q. No. 1
It may be argued that a direct or indirect potable reuse may be the most cost-effective option in large-scale water reuse in the future. It is also argued that water reclamation technologies have advanced to the point where any quality water can be produced reliably by a combination of treatment processes and operations. However, the future of planned direct or indirect potable reuse is uncertain. List pros and cons of direct or indirect potable reuse with respect to decision-making, engineering, public health protection, public perception and acceptance, and cost. Provide a rational basis of how to promote water reclamation and reuse and to what extent, in the context of integrated water resources management.

Q. No. 2
Why Indian standards for discharge of treated effluent are not stringent as that of Western standards? Discuss the implications of stringent standards.

Q. No. 3
Present a case discussing ‘Water Reuse Plan’ for any beneficial purpose like agriculture. Your case must include:
- Flow Sheet
- Description of each unit
- Incoming Water Quality
- Standards (effluent)

Q. No. 4
What impact does the development of megacities have on renewable water resources?

Q. No. 5
What is your answer to the opinion that water conservation practices are unnecessary because future generations will be able to work out new solutions for any water shortages, should they develop.

Q. No. 6
Reclaimed water is being considered for landscape irrigation at a large urban park. The park will also contain playgrounds and athletic fields. Sources of reclaimed water being evaluated are effluent from a remote centralized conventional activated sludge plant and a proposed new satellite treatment plant located near the park. For this application, (a) what types of water quality, treatment processes, and infrastructure would be required and (b) what are the advantages and disadvantages of the two types of reclaimed water systems?

Q. No. 7
What is Reverse Osmosis? Discuss its type and classifications on the basis of flow.

Q. No. 8
Three different configurations (schemes) for the same wastewater treatment method are given below. In these schemes, there is only one unit which differentiates the type of
process. Identify that unit and write its correct nomenclature along with some description.
Maximum Marks : 60
Duration : Three Hours

"Students governed by the old ordinances will be examined out of 75 marks and their obtained marks shall be proportionately raised."

Note: (i) Answer all the questions.
(ii) Assume missing data suitably.

1. (a) Briefly explain the different units used for the expression of strength of a solution. [05]
(b) Calculate the equivalent weight of potassium dichromate as used in the following reactions.
   (i) \( \text{Cr}_2\text{O}_7^{2-} + 2\text{Pb}^{2+} + \text{H}_2\text{O} \rightarrow 2\text{PbCrO}_4 + 2\text{H}^+ \)
   (ii) \( \text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightarrow 2\text{Cr}^{3+} + 7\text{H}_2\text{O} \)
(c) Balance the following redox reactions [04]
   (i) Oxidation of \( \text{S}_2\text{O}_5^{2-} \) to \( \text{SO}_4^{2-} \) and reduction of \( \text{Cl}_2 \) to \( \text{Cl}^- \)
   (ii) Oxidation of \( \text{C}_6\text{H}_5\text{O}_6 \) to \( \text{CO}_2 \) and reduction of \( \text{SNO}_3^- \) to \( \text{N}_2 \)

OR

1'. (a) Calculate the hydroxide, carbonate and bicarbonate alkalinity using the following titration results [08]

<table>
<thead>
<tr>
<th>Sample pH</th>
<th>Total mL of titrant to reach end point</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Phenol.</td>
</tr>
<tr>
<td>11.0</td>
<td>10.0</td>
</tr>
</tbody>
</table>

Take sample volume as 100 mL and strength of \( \text{H}_2\text{SO}_4 \) as N/50.

(b) Define proton balance. Illustrate with atleast two examples. [04]

2. (a) Describe in detail the procedure used for the determination of fluoride ion. [08]
(b) How many moles of \( \text{H}_2\text{SO}_4 \) are required to form 65 g of \( \text{CaSO}_4 \) from \( \text{CaCO}_3 \). [04]

3. (a) Briefly describe the significance of concentration diagrams. Draw the logarithmic concentration diagrams for the following solutions.
   (i) 0.1 M \( \text{H}_2\text{CO}_3 \)
   (ii) 0.1 M \( \text{H}_3\text{PO}_4 \)

Draw the diagrams on graph papers.

(b) What are the persistant organic pollutants found in environment? Also describe their properties. [05]
A wastewater contain 50 mg/L of $Z_{u}^{++}$. How high must the pH be raised to precipitate all but 1 mg/L of zinc? What adverse effect might occur if pH were raised too high. Take the values of $K_{sp}$ and formation constants as follows: $K_{sp} = 8 \times 10^{-18}$, $\log K_1 = 4.15$, $\log K_2 = 6.0$, $\log K_3 = 4.11$ and $\log K_4 = 1.26$.

4. (a) A buffer solution has been prepared by adding 0.2 mol/l of acetic acid and 0.1 mole/l of acetate. The pH of the buffer solution has been adjusted to 5.0 by addition of NaOH. How many mol/l of NaOH is required to inverse the pH to 5.5.

(b) What organic compounds are likely to be present in domestic wastewater?

(c) Briefly describe the properties of surfactants.

5. (a) Describe briefly water stabilisation. Derive the equation used for the determination of Lauglier Index.

(b) Calculate the activity coefficient and activity of each ion in a solution containing 75 mg/L Na$^+$, 25 mg/L Ca$^{++}$, 10 mg/L Mg$^{++}$, 125 mg/L Cl$^-$, 50 mg/L HCO$_3^-$ and 48 mg/L SO$_4^{2-}$. 
2011-2012
M.TECH. (I SEMESTER) EXAMINATION
(CIVIL ENGINEERING)
ENVIRONMENTAL ENGINEERING
(ECOLOGY AND ENVIRONMENTAL MICROBIOLOGY)
(CE - 623)

Maximum Marks: 60 Duration: Three Hours

"Students governed by the old ordinances will be examined out of 75 marks and their obtained marks shall be proportionately raised."

Note:
(i) Answer all questions.
(ii) Assume missing data suitably.

1. (a) Describe briefly the applications of microbiology in the solution of environmental engineering problems.
(b) What are coliforms? How they are determined? Briefly explain the protocol of the test.

OR

1'. (a) Explain the staining techniques employed in microbiological examination of wastewater sludge.
(b) Describe briefly serial dilution technique used in MPN test.

2. (a) Differentiate between cellulose and starch. Explain why cellulose is difficult to biodegrade as compared to Amylose. Draw the structures of Amylose and starch molecule.
(b) What are coenzymes? Give examples of different coenzymes that take part in biological treatment.

3. (a) Describe in detail the process of energy capture in biological treatment.
(b) Write down the catabolic reactions for atleast two aerobic processes and two anaerobic processes.

OR

3'. (a) Briefly describe the procedure of total plate count test.
(b) Describe the concept of productivity in ecology.
(c) Describe pond ecosystem and list various biotic and abiotic components.

Contd……2
4. (a) Using Michaelis - Menten equation of enzyme kinetics determine the time required for 95% completion of a reaction when the initial substrate concentration is 50 mg/L, \( V_{\text{max}} = 4.5 \text{ mg/L-h} \) and \( K = 2.0 \text{ mg/L} \).

(b) Describe in detail the compounds formed in the conversion of glucose to PYRUVIC acid in aerobic metabolism of wastewater. Also find the total number of ATPs formed during the process.

5. (a) Briefly describe the metabolism of degradation of lipids in biological treatment of wastewaters.

(b) Draw the microbial growth curve under limited substrate conditions.

(c) What are proteins? Draw their structure and mention peptide linkage.

*****
1. (a) Write in brief about the physical and chemical quality criteria for drinking water. [05]
(b) Sketch and explain two-film theory of gas transfer. [05]

OR

(b') Calculate $K_{La}$ value of an aeration system from the following data assuming $C_S = 10$ mg/L:

<table>
<thead>
<tr>
<th>Time, min</th>
<th>0</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>DO, mg/L</td>
<td>1.1</td>
<td>5.8</td>
</tr>
</tbody>
</table>

(c) Explain destabilization of a negatively charged colloidal suspension by addition of alum. What can be the effect of overdosing of alum? [05]

2. (a) Raw water, alkalinity 40 mg/L is treated with 30 mg/L alum. What should be $Na_2CO_3$ dose if treated water is required to have an alkalinity. [05]
(b) Derive an expression to find out the settling velocity of a discrete particle in water. Also find the settling velocity for sand in water having particle diameters of 100 and 200 $\mu$m and a density of 2650 kg/m$^3$. Assume $\mu = 1.3 \times 10^{-3}$ NS/m$^2$. [08]

OR

(b') A settling column analysis is run on a type-1 suspension. The column is 2m deep and the results of the analysis are as follows:

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>0</th>
<th>58</th>
<th>77</th>
<th>91</th>
<th>114</th>
<th>154</th>
<th>250</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration remaining (mg/L)</td>
<td>650</td>
<td>560</td>
<td>415</td>
<td>325</td>
<td>215</td>
<td>130</td>
<td>52</td>
</tr>
</tbody>
</table>

What is the theoretical efficiency of the settling basin that receive this suspension if the loading rate is $2.4 \times 10^{-2}$ m/min? [02]

(e) What is the role of alkalinity in coagulation of water with alum? [02]

3. (a) Derive the expression for calculating the head loss in a granular media filter. [06]
(b) Sketch the cross-sectional view of a rapid sand filter. Describe the cleaning operation and the advantage of using coal along with sand as filter media. [05]
(b') What should be the backwash rate to achieve 50% expansion of a sand bed consisting of uniform size sand particles of settling velocity 12 cm/s if the porosity of packed bed is 0.45.

(c) A water supply contains 2.5 mg/L Fe$^{++}$ and 1.2 mg/L Mn$^{++}$ at a pH of 7.9, determine the theoretical quantity of oxygen to oxidise iron to Fe(OH)$_3$ and manganese to MnO$_2$.

4. (a) What is the importance of disinfection in water treatment? A disinfectant dose of 2.5 mg/L can cause a kill of 90% in 6 minutes. What is the time required to cause a kill of 99% at 3.5 mg/L dose of the disinfectant? $n = 0.86$.

(b) List design variables in a floatation system. Draw the flow sheets for dissolved air flotation system with and without recycle.

(c) Calculate the does of lime and soda ash required to reduce the hardness of water of given composition to lowest possible level. Ca$^{++} = 126$ mg/L, Mg$^{++} = 43$ mg/L, Na$^+ = 13$ mg/L, K$^+ = 2.1$ mg/L, HCO$_3^-$ = 440 mg/L, SO$_4^{2-} = 139$ mg/L, Cl$^- = 18$ mg/L and CO$_2 = 30$ mg/L.

OR

(c') A wastewater has a flow of 0.95 m$^3$/min and oil concentration of 150 mg/L. For dissolved air flotation process, compute:

(i) recycled flow rate
(ii) surface area of the tank

The surface loading rate is 0.081 m$^3$/m$^2$-min and operating pressure is 4.4 atm. Assume solubility of air, $S_a = 18.6$ mg/L and $f = 0.6$. 
Answer all the questions. Assume any data judiciously, if required.

Q.1(a) Explain why air pollution is a growing problem in India. (7)
Q.1(b) An industry plant stack gas at 440°C contains 2150 ppm of SO₂. If the volume rate of gas emitted is 13565 m³/min. What is the SO₂ emission rate in µg/m³? The stack pressure is 1.0 bar.

OR

Q.1(b)' Discuss the photochemistry of ozone in the upper atmosphere using the pertinent chemical reactions.

Q.2(a) What is mathematical modeling? Describe the concept of mathematical modeling applied to air pollution.
Q.2(b) Sulfur dioxide is emitted at the rate of 178 g/s from a stack with an effective height of 60 m. The wind speed at stack height is 6.8 m/s, and the atmospheric stability class is D for the overcast day. Determine the ground level concentration along the center line at a distance of 500 m from the stack, in micrograms per cubic meter. The standard deviation δy and δz are 36 m and 18.5 m respectively.

OR

Q.2(a)' For the given data in the above question determine the concentration crosswind at 48 m from the center line for the downwind distance of 500 m.
Q.2(b)' Discuss the various factors affecting dispersion of pollutants in the atmosphere. Describe the advantages and disadvantages of Gaussian models.
Q.3(a) What is adiabatic lapse rate? Drive mathematical relation showing change in temperature with altitude.
Q.3(b) Define the term Meteorology and discuss high and low pressure systems with the help of diagram.

Q.4(a) What is the principle of wet scrubber? Discuss the advantages and disadvantages of wet scrubbers.

Q.4(b) An ESP is designed to treat 46,000 m$^3$/min with 95% efficiency. Assuming an effective drift velocity of 2.5 m/min, calculate the required plate area and the number of plates. The plate size is 8 m by 3.5 m (height by length).

OR control

Q.4(b) Describe the various air pollution methods for gases. Write the principle, construction & operation of any one method.
2011-2012
M.TECH. (I SEMESTER) EXAMINATION
(CIVIL ENGINEERING)
(STRUCTURAL ENGINEERING)
ADVANCED SOIL MECHANICS AND FOUNDATION ENGG.
(CE - 641)

Maximum Marks: 60
Duration: Three Hours

“Students governed by the old ordinances will be examined out of 75 marks and their obtained marks shall be proportionately raised.”

Note:  
(i) Answer any five questions.  
(ii) Assume suitable data, if not given.

1. (a) Discuss $\alpha$ and $\lambda$ approaches for determining load carrying capacity of piles. (06)

(b) Design the pile group for a column load of 3000 kN to be installed in deep cohesive soil having $Cu = 120 \text{kN/m}^2$, $\gamma = 18 \text{kN/m}^3$ and $\alpha = 0.5$ and FOS may be assumed as 3. (06)

2. (a) With the help of neat sketch, discuss pile loading test as per the recommendation of IS: 2911 (Part IV). (04)

(b) The results of pile loading test on a 45 cm diameter pile are shown below. Draw load settlement curve and determine ultimate and allowable load carrying capacity of pile.

<table>
<thead>
<tr>
<th>Settlement (mm)</th>
<th>0.0</th>
<th>1.3</th>
<th>2.5</th>
<th>5.1</th>
<th>7.6</th>
<th>10.2</th>
<th>12.7</th>
<th>15.2</th>
<th>17.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load (kN)</td>
<td>0</td>
<td>200</td>
<td>350</td>
<td>670</td>
<td>870</td>
<td>1070</td>
<td>1250</td>
<td>1400</td>
<td>1500</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Settlement (mm)</th>
<th>20.8</th>
<th>22.9</th>
<th>25.4</th>
<th>27.9</th>
<th>30.5</th>
<th>33.0</th>
<th>35.6</th>
<th>38.1</th>
<th>45.7</th>
<th>47.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load (kN)</td>
<td>1600</td>
<td>1700</td>
<td>1750</td>
<td>1780</td>
<td>1810</td>
<td>1830</td>
<td>1860</td>
<td>1870</td>
<td>1900</td>
<td>1905</td>
</tr>
</tbody>
</table>

3. (a) Discuss in detail about settlement of pile group in clay and sand. (06)

(b) A pile group consisting of 9 piles, each 0.4 m in diameter, is arranged in a 3x3 matrix at a spacing of 1.2m. The piles penetrate in a medium clay ($Cu = 40 \text{kN/m}^2$, $\gamma_{sat} = 18 \text{kN/m}^3$) of thickness 8m and are embedded 2m in a stiff clay ($Cu = 90 \text{kN/m}^2$, $\gamma_{sat} = 18.5 \text{kN/m}^3$). Calculate the allowable group capacity for a FOS of 3. (06)

Contd......2
4. (a) With the help of neat sketch discuss about the foundation for expansive soils. (06)

(b) Describe the standard penetration test on soil to determine its safe and allowable bearing capacity. (06)

5. (a) What are the various procedures for the design of combined footing? (04)

(b) Design a rectangular combined footing for the two columns. Allowable soil pressure is 150kN/m$^2$. (fig. 1) (08)

6. (a) Briefly explain the design considerations involving principles of soil mechanics for rigid and flexible retaining walls. (04)

(b) Determine the depth of embedment and force in tie rod. The properties of soil both behind and infront of wall are: $\gamma = 20 \text{ kN/m}^3$, $c = 0$ and $\phi = 30^0$. Also find the tension in tie rods, if the rods are spaced 2.0 m centre to centre. (Fig. 2) (08)

7. (a) Why is vibration isolation required? Describe the method of vibration control. (04)

(b) The foundation for a machine has the following data:

(i) Weight of machine = 100 kN
(ii) Weight of RCC block = 200 kN
(iii) Weight of Stressed Soil = 200 kN
(iv) Spring stiffness = $6 \times 10^5 \text{ kN/m}$
(v) Damping factor = 0.12
(vi) Speed of rotation = 300 rpm
(vii) unbalanced force = 10kN

Determine the value of amplitude and dynamic magnification factor.

Figures enclosed

****
(Fig. 1)

(Fig. 2)

\[ \gamma = 20 \text{ KN/m}^3 \]
\[ c = 0 \]
\[ \phi = 30^\circ \]