Maximum Marks: 60
Duration: Three Hours

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

Q.No.  

**Question**  

1(a) Obtain all the six strain components for a 3-D elastic body.  
1(b) What is Hooke’s Law? Prove that  
\[
t_{xy} = t_{yx}, t_{yz} = t_{zy} \text{ and } t_{zx} = t_{xz}
\]
1(c) Explain plane stress and plane strain. Prove that plane strain problem, like the plane stress problem, reduces to the determination of \(\sigma_x, \sigma_y\) and \(t_{xy}\).

OR

1'(a) Investigate what problem is solved by \(\phi = \frac{3F}{4c} (xy - \frac{xy^3}{3c^2}) + \frac{F}{2} y^2\), applied to the region included in \(y=0, y=a, x=0\) on the side x positive.

1'(b) A solid cuboid of size 10m\(\times\)5m\(\times\)8m is made up of such a material that the density is uniformly increasing from 1500 kg/m\(^3\) at the bottom face to 3000 kg/m\(^3\) at the top face. Find the intensity of the body force field and total body force under a field of 4.9i+9.8j m/sec\(^2\).

1'(c) A metal specimen is subjected to an axial stress in such a way that no constraint is applied on one pair of sides but on the other; external pressures restrict the lateral strain to one half of what it would be if there were no restraint. Find the modified value of modulus of elasticity if \(\mu\) is the Poisson’s ratio and E is actual modulus of Elasticity.

2 Define stress function. Derive the compatibility equation in terms of stress function for a 2-D element.

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

3'(a) Derive the expression for octahedral shear stress.  
3'(b) The term \(\varepsilon_{ij}\) represents a given strain tensor as shown below. If another strain tensor is formed by rotating \(x, y, z\) through \(50^\circ\) (anti-clockwise) about \(x\) axis, find the new strain tensor \(\varepsilon_{ns}\) and invariants of both the tensors. Show that they remain same.

\[
\varepsilon_{ij} = \begin{bmatrix}
0.01 & 0 & 0 \\
0 & 0.015 & 0.015 \\
0 & 0.015 & 0.015
\end{bmatrix}
\]

4(a) Plot true stress versus true strain curve and derive the expressions to mark the point of instability by two different methods.

4(b) Explain maximum shear-strain energy theory of yielding with the help of neat sketches and predict the failure for a pure shear case.
Q. No. 1  A thin cylindrical shell is simply supported on traverses. Show that the stress resultants are given by:

\[ N_{\theta} = -ZR \]
\[ N_{x\theta} = -Kx \]
\[ N_x = -\frac{1}{2} \left( \frac{I^2}{4} - x^2 \right) \frac{1}{R} \frac{dK}{d\theta} \]

Where \( X, Y \) and \( Z \) are the components of the external loads per unit area in \( x, y \) and \( z \) directions respectively.

\( R \) is the radius of curvature and \( K = \left( \frac{1}{R} \frac{dN_{\theta}}{d\theta} + Y \right) \)

OR

1'(a) A thin circular cylindrical shell of semicircular cross-section cantilevered at \( z = 0 \) with radius \( a \), span \( l \) and uniform thickness \( d \) is loaded with \( X, Y \) and \( Z \) as the components of the external loads per unit area in \( x, y \) and \( z \) directions respectively. Find expressions for membrane stress resultants in this shell under its own weight.

1'(b) Plot the distribution of forces of the above shell over the cross-section and in the longitudinal direction.

2 (a) State boundary conditions for an inner shell with feather edge beams at \( \varphi = 0^\circ \).

2 (b) Using DKJ theory, develop the matrix for stress resultants for a single short cylindrical shell without edge beam with the following data:

1. **Geometry:**
   - Span, \( l = 10.60 \) m
   - Radius of curvature, \( a = 22.40 \) m
   - Thickness, \( d = 80 \) mm
   - Modulus of elasticity of concrete, \( E_{\text{concrete}} = 2.5 \times 10^4 \) N/mm²
   - Modulus of elasticity of concrete, \( E_{\text{st}} = 2.0 \times 10^5 \) N/mm²
   - Semi-central angle, \( \varphi_c = 37^\circ 48' \)

2. **Load**
   - Dead weight 18.0 N/m²

Contd.....2.
Live load 7.50 N/m²

3. Table 1: Multipliers “M” in D-K-J theory

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Odd / Even derivatives</th>
<th>Multiplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>$N_{x\varphi}$</td>
<td>Odd</td>
<td>$(\frac{Dp^2}{a^2})\left(\frac{\rho^2}{\lambda a}\right) \sin \frac{\lambda_n x}{a}$</td>
</tr>
<tr>
<td>$Q_{\varphi}$</td>
<td>Odd</td>
<td>$(\frac{Dp^2}{a^2})\left(-\frac{1}{a\sqrt{2}}\right) \cos \frac{\lambda_n x}{a}$</td>
</tr>
<tr>
<td>$N_{\varphi}$</td>
<td>Even</td>
<td>$(\frac{Dp^2}{a^2})\left(\frac{\rho^2}{\lambda a}\right) \cos \frac{\lambda_n x}{a}$</td>
</tr>
<tr>
<td>$M_{\varphi}$</td>
<td>Even</td>
<td>$(\frac{Dp^2}{a^2})\left(\frac{1}{a\sqrt{2}}\right) \cos \frac{\lambda_n x}{a}$</td>
</tr>
</tbody>
</table>

4. Table 2: Coefficients $B_1$, $B_2$, $B_3$ and $B_4$ in the D-K-J theory

<table>
<thead>
<tr>
<th>Quantity</th>
<th>$B_1$</th>
<th>$B_2$</th>
<th>$B_3$</th>
<th>$B_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$N_{x\varphi}$</td>
<td>$+\beta_1$</td>
<td>$+\alpha_1$</td>
<td>$-\beta_2$</td>
<td>$-\alpha_2$</td>
</tr>
<tr>
<td>$Q_{\varphi}$</td>
<td>$-[\beta_1 + \alpha_1 (\sqrt{2}k - 1)]$</td>
<td>$[\beta_1 (\sqrt{2}k - 1) - \alpha_1]$</td>
<td>$-[(\sqrt{2}k + 1)\alpha_2 + \beta_2]$</td>
<td>$[\beta_2 (\sqrt{2}k + 1) - \alpha_2]$</td>
</tr>
<tr>
<td>$N_{\varphi}$</td>
<td>0</td>
<td>-1</td>
<td>0</td>
<td>+1</td>
</tr>
<tr>
<td>$M_{\varphi}$</td>
<td>$(1 + k\sqrt{2})$</td>
<td>-1</td>
<td>$(1 - k\sqrt{2})$</td>
<td>-1</td>
</tr>
</tbody>
</table>

3 (a) Show that the differential equation for bending of rectangular plate carrying uniformly distributed load $q$ about the vertical axis is $\nabla^4 w = q/D$. [10]

3 (b) How you will apply the boundary conditions to the Simply Supported Edges and the Clamped Edges. Provide reasoning. [05]

OR

3"(a) A rectangular plate $a \times b$ is simply supported at $x = 0$ and $x = a$, and firmly built at $y = 0$ and $y = b$. The intensity of load increases linearly from zero as $y$ increases. Whereas, along $x$ direction, load remains non-varying. Using Levy's method, find the general equation and its solution. [10]

3"(b) How the solution (derived in 3"(a)) will be effected if the loading is broken down into Symmetric and Skew Symmetric parts. [05]

4 (a) Derive the Governing equation in Polar Coordinates from the Cartesian case. [General form of equation is $\nabla^4 w = q/D$] [08]

4 (b) Modify the equation (derived in 4 (a)) for radially symmetric case (use reasoning). [02]

4 (c) If the solution of equation (derived in 4 (b)) for uniform load $q$ is given by:

$$w = qr^4/64D + C_1(\log r - 1)r^2/4 + C_2 r^2/4 + C_3 \log r + C_4$$

Determine $w$ for a plate continuous at $r = 0$ and simply supported round the rim. [05]
2015-16
M.TECH. AUTUMN (I SEMESTER) EXAMINATION
CIVIL ENGINEERING
(STRUCTURAL ENGINEERING)
ADVANCED STRUCTURAL ANALYSIS
(CE-604)

Maximum Marks: 60

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

Q.No. Question M.M.

1 Using force method, analyse the continuous beam ABCD shown in Fig. 1. The beam has an internal hinge at B. [15]

OR

1' Analyse the pin jointed plane truss shown in Fig. 2 using force method. The number in parentheses are the cross-sectional areas of the members in cm². Take \( E = 2 \times 10^5 \text{ N/mm}^2 \). [15]

2 Analyse the portal frame shown in Fig. 3 using flexibility method. [15]

3 Analyse the portal frame shown in Fig. 4 by stiffness method and plot the bending moment diagram. [15]

OR

3' Derive the elements of the stiffness matrix for the portal frame with inclined legs and from them deduce the elements of stiffness matrix for a rectangular frame. [15]

4 Calculate the forces in the members of the pin jointed plane truss shown in Fig. 5 by stiffness method if the hinge supports B and D settle vertically downward by 0.40mm and 0.50mm respectively. The cross-sectional area of each member is 20cm². Take \( E = 200\text{kN/mm}^2 \). [15]

Contd.……2.
M.TECH. (CIVIL) EXAMINATION
STRUCTURAL ENGINEERING
ADVANCED CONCRETE DESIGN
CE-605

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 'Probalistic' and 'Semi-probalistic' approaches of analysis and design? Discuss in brief.  [04]

1(b)  A doubly reinforced concrete beam of cross section 250mm x 450mm is simply supported over a span of 7 m and reinforced with 20\(\phi\) 5Nos. in tension 16\(\phi\) 3 Nos. in compression faces. The beam is subjected to a DL of 25 kN/m and LL of 30 kN/m over its complete span. Calculate short term deflection at midspan due to DL and LL separately using IS code method. Assume M25 mix concrete and Fe415 steel.  [11]

OR

1'(a)  Discuss in brief the Indian code method of predicting crack width in R.C. flexural members.  [04]

1'(b)  A singly reinforced one way slab, simply supported over a span of 4.5 m is 150 mm thick and reinforced with 12mm dia. bars @125 c/c. The slab is subjected to DL of 3 kN/m\(^2\) and a LL of 6 kN/m\(^2\) out which 2 kN/m\(^2\) is a permanent LL. Calculate deflection due to creep and shrinkage separately. Assume \(\varepsilon_{cs} = 0.003\), \(\theta = 1.6\), M25 mix concrete and Fe415 steel.  [11]

2  Using Yield Line theory, determine correct yield line pattern and collapse load for a rectangular slab of size 4m x 6m, anisotropically reinforced and simply supported along its two short and one long edges. The slab is subjected to a uniformly distributed load over its complete area. Assume the ratio of moment of resistances in short to longer direction as 1.3.  [15]
3(a) Explain the need of high strength steel and concrete in the construction of pre-stressed concrete structures.

3(b) Design a pre-stressed concrete beam to support a live load 18kN/m over a span of 10m. The stress in concrete must not exceed 20 MPa in compression at any time and allowable stress in steel is 1.5 GPa. The loss of pre-stress at working is 18%.

3'(a) What do you mean by a pre-stressed concrete? Give historical background behind the development of pre-stressed concrete construction.

3'(b) Differentiate between elastic deformation and creep of concrete. Prove that increase in stress in a bonded tendon due to u.d.l. is approximately two times the increase in stress in an un-bonded tendon if tendon's profile is parabolic.

4(a) Discuss modes of shear cracks and obtain corresponding shear resistance capacities of a pre-stressed concrete member.

4(b) A pre-stressed concrete beam 150mmX300mm is required to support a live load of 20kN/m over a span of 10m. The compressive pre-stress at the centroidal axis is 6.5MPa. Design suitable reinforcement for the beam.
Question

M.M.

1(a) Explain various zones in reservoir with a neat sketch. Discuss the criteria for fixation of these zones briefly. Data for the area-elevation at a proposed reservoir is given below. Compute storage capacity and draw its Area-Elevation and Capacity-Elevation curves.

<table>
<thead>
<tr>
<th>Elevation (m)</th>
<th>100</th>
<th>110</th>
<th>120</th>
<th>130</th>
<th>140</th>
<th>150</th>
<th>160</th>
<th>170</th>
<th>180</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (Ha)</td>
<td>150</td>
<td>4150</td>
<td>8150</td>
<td>12150</td>
<td>1615</td>
<td>20150</td>
<td>24150</td>
<td>28150</td>
<td>32150</td>
</tr>
</tbody>
</table>

1(b) The runoff in Mm$^3$ data for a river during a lean year along with the probable demands in Mm$^3$ are given below. Can the demands be met with the available river flow? If so, how? What is the maximum uniform demand that can be met and what is the storage capacity required to meet this demand?

<table>
<thead>
<tr>
<th>Month</th>
<th>J</th>
<th>F</th>
<th>M</th>
<th>A</th>
<th>M</th>
<th>J</th>
<th>A</th>
<th>S</th>
<th>O</th>
<th>N</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Runoff</td>
<td>135</td>
<td>23</td>
<td>27</td>
<td>21</td>
<td>15</td>
<td>40</td>
<td>120</td>
<td>185</td>
<td>112</td>
<td>87</td>
<td>63</td>
</tr>
<tr>
<td>Demand</td>
<td>63</td>
<td>58</td>
<td>83</td>
<td>105</td>
<td>103</td>
<td>124</td>
<td>41</td>
<td>33</td>
<td>28</td>
<td>62</td>
<td>88</td>
</tr>
</tbody>
</table>

2(a) What are the characteristics factors in selection of a site of the reservoir? Describe any one of them in detail.

2(b) The following table gives the average monthly runoff rates at a proposed reservoir site, the pan evaporation and the rainfall recorded at a nearby meteorological observation, and the estimated monthly demands. The downstream riparian rights require the release of natural flow or 20 Mm$^3$ in each month whichever is less. The pan coefficient may be taken as 0.72. The average area of submergence at the reservoir site is 18 km$^2$ for which the runoff coefficient may be taken as 0.55. Determine the storage of the reservoir to meet demands.
<table>
<thead>
<tr>
<th>Month</th>
<th>Average monthly runoff rate (m³/s)</th>
<th>Evaporation (mm)</th>
<th>Precipitation (mm)</th>
<th>Demand (Mm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>22.6</td>
<td>130</td>
<td>20</td>
<td>28.5</td>
</tr>
<tr>
<td>Feb</td>
<td>18.5</td>
<td>135</td>
<td>25</td>
<td>32.0</td>
</tr>
<tr>
<td>Mar</td>
<td>13.2</td>
<td>120</td>
<td>10</td>
<td>34.0</td>
</tr>
<tr>
<td>April</td>
<td>9.0</td>
<td>205</td>
<td>7</td>
<td>39.0</td>
</tr>
<tr>
<td>May</td>
<td>7.2</td>
<td>220</td>
<td>4</td>
<td>35.0</td>
</tr>
<tr>
<td>June</td>
<td>22.8</td>
<td>160</td>
<td>130</td>
<td>37.7</td>
</tr>
<tr>
<td>July</td>
<td>90.0</td>
<td>130</td>
<td>225</td>
<td>29.0</td>
</tr>
<tr>
<td>Aug</td>
<td>97.5</td>
<td>120</td>
<td>190</td>
<td>32.0</td>
</tr>
<tr>
<td>Sept</td>
<td>72.0</td>
<td>110</td>
<td>205</td>
<td>27.0</td>
</tr>
<tr>
<td>Oct</td>
<td>36.0</td>
<td>100</td>
<td>10</td>
<td>25.0</td>
</tr>
<tr>
<td>Nov</td>
<td>31.7</td>
<td>95</td>
<td>40</td>
<td>23.2</td>
</tr>
<tr>
<td>Dec</td>
<td>26.4</td>
<td>95</td>
<td>35</td>
<td>27.0</td>
</tr>
</tbody>
</table>

Accepting the silt load as 9.0 Ha.m/ 100sq.km/year, distribute the pattern of sediment in the reservoir after 50 years by area increment method if the net catchment area at the dam site is 5574 sq. Km. Area –Elevation-Capacity relation at the site is given in the following table.

<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>
<th>128</th>
<th>132</th>
<th>136</th>
<th>140</th>
<th>143</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area (Ha)</td>
<td>0</td>
<td>40</td>
<td>300</td>
<td>1050</td>
<td>1900</td>
<td>3000</td>
<td>4250</td>
<td>5800</td>
<td>7800</td>
<td>9600</td>
<td>11000</td>
<td>14000</td>
</tr>
<tr>
<td>Capacity (Mm³)</td>
<td>0</td>
<td>0.5</td>
<td>7</td>
<td>38</td>
<td>95</td>
<td>189</td>
<td>333</td>
<td>532</td>
<td>736</td>
<td>1135</td>
<td>1561</td>
<td>1875</td>
</tr>
</tbody>
</table>

OR

3’ Define trap efficiency of a reservoir. Explain Brune’s curve for the trap efficiency with a neat sketch.

A reservoir has been planned with a useful life of 100 years. The storage capacity of the reservoir is 1000 Mm³. The average annual yield from the basin is assessed to be 10,000 Mm³ and the average annual sediment flow to be 2 Mm³.

(i) Suggest the dead load approximately that you may like to provide
(ii) In how many years the reservoir capacity will be depleted to 50% of its present capacity due to silting.

The trap efficiency (η) for various capacity and inflow ratio (C/I) are given below for use:
4(a) Enumerate various methods for determining peak flood. The annual flood peak of a stream is estimated to have 50 year and 100 year floods of 2400 m³/s and 2730 m³/s. What is 200 year flood for the same stream? Use Gumbel method.

4(b) The storage and outflow characteristics of a reservoir provided with an uncontrolled spillway with its crest at 100 m are listed below

<table>
<thead>
<tr>
<th>Elevation</th>
<th>100.00</th>
<th>100.50</th>
<th>101.00</th>
<th>101.50</th>
<th>102.00</th>
<th>102.50</th>
<th>102.75</th>
<th>103.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage</td>
<td>0.00</td>
<td>0.96</td>
<td>2.10</td>
<td>3.52</td>
<td>5.10</td>
<td>6.80</td>
<td>8.60</td>
<td>10.50</td>
</tr>
<tr>
<td>Outflow</td>
<td>0.00</td>
<td>6.27</td>
<td>17.75</td>
<td>32.60</td>
<td>50.19</td>
<td>70.15</td>
<td>92.21</td>
<td>116.20</td>
</tr>
</tbody>
</table>

The following flood hydrograph enters into the reservoir when the outflow is zero.

<table>
<thead>
<tr>
<th>Time (hour)</th>
<th>0</th>
<th>6</th>
<th>12</th>
<th>18</th>
<th>24</th>
<th>30</th>
<th>36</th>
<th>42</th>
<th>48</th>
<th>54</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge (m³/s)</td>
<td>0</td>
<td>255</td>
<td>184</td>
<td>136</td>
<td>99</td>
<td>74</td>
<td>54</td>
<td>40</td>
<td>28</td>
<td>17</td>
<td>8</td>
</tr>
</tbody>
</table>

Route the flood by I.S.D. method and obtain outflow hydrograph.

OR

4' (a) Explain the concept of risk, reliability and safety factor. Derive a relation of risk in terms of return period and life of the project.

(b) A coffer dam is designed for a 25 year flood. If it takes 5 years to complete the construction of the main dam, what is the risk that the coffer dam may fail before the end of the construction period? What return period in the design of the coffer dam would be reduced the risk to 10%?
M.TECH. (WINTER SEMESTER) EXAMINATION
(CIVIL ENGINEERING)
(HYDRAULIC STRUCTURES)
FLUVIAL HYDRAULICS
(CE-613)

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) Write short notes on: properties of individual sedimentary particle. [07]
1(b) The cumulative size distribution of bed material in the river Ganga is given below: [08]

<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>10</td>
<td>15</td>
<td>20</td>
<td>40</td>
<td>70</td>
<td>100</td>
</tr>
</tbody>
</table>

Determine the Geometric Mean Size, Geometric Standard Deviation, Quartile Geometric Skewness and Sorting Coefficient of the bed material.

OR

1'(a) What are the assumptions made in Stokes’ law? A sediment particle has a diameter of 2.0 mm and specific gravity 2.65. Find the terminal fall velocity of sediment particle in water at 20°C. [07]
1'(b) What is the significance of incipient motion condition of sediment transport in alluvial channels? Enlist the approaches used to establish the condition of incipient motion of sediment particle comprising the bed. [08]

2(a) A wide stream has a sediment bed of median size 0.35 mm and the slope of the channel is 1.5x10⁻⁴. If the depth of flow in the channel is 0.30 m, examine whether the bed particles will be in motion or not? Shields curve is attached. What would be

Contd.....2.
the status of the bed when the depth of flow is 0.1 m

2(b) Explain the importance of regimes of flow in alluvial channels and differentiate between dunes & anti-dunes.
An unlined irrigation channel in an alluvium of median size 0.33 mm is of trapezoidal section with bed width 3.0 m, side slope 1.5 H: 1V, and longitudinal slope 0.0003. If this channel carries a discharge of 2.0 m$^3$/s at a depth of 1.0 m, estimate the (i) nature of the bed form, (ii) shear stress due to the grain roughness, and (iii) shear stress due to the bed forms. Use Garde & Ranga Raju criterion for bed forms.

OR

2'(a) Comment on velocity distribution in alluvial channels. Explain Einstein & Barbarossa's method of division of resistance in alluvial channels.

2'(b) An alluvial stream ($d = 0.60$ mm) has a bed slope of $3 \times 10^{-4}$. Find the mean velocity of flow using Einstein & Barbarossa's method when the hydraulic radius is 1.40 m.

3 (a) Determine the bed load transport in an alluvial stream for the following conditions:
Depth of flow = 2.5 m
Velocity of flow = 1.35 m/s
Average slope of water surface = $4 \times 10^{-4}$
Mean size of sediment = 1.9 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 $1.5 \times 10^{-4}$, depth of flow 0.75 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 40 cumec with sediment load concentration of 50 ppm by weight. The average grain size of the bed material is 0.20 mm. Assume the cross section of the channel as trapezoidal with side slopes 1 (H) : 1(V).

4(b) A wide alluvial channel has a slope of 1 in 4500 and a depth of flow 1.75 m. Suspended load sampling at a height of 0.40 m above the bed revealed a concentration of 1000 ppm by weight. The sediment particles have a fall velocity of 0.05 m/s. Estimate and plot the suspended load concentration at levels 0.75 m, 1.5 m and 1.75 m from the bed.
Fig. 5.7. Einstein-Barbarossa resistance relation based on river data
(1 ft = 0.305 m).

Fig. 5.4. Variation of $K_1$ and $K_2$ with sediment size [52].
2015-2016
M.TECH. AUTUMN (I SEMESTER ) EXAMINATION
(CIVIL ENGINEERING)
(HYDRAULIC STRUCTURES)
RIGID DAM
(CE-614)

Maximum Marks: 60
Duration: Three Hours

"Students governed by the old ordinance 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.

(b) Design the first two zones of a non over flow section of a concrete gravity dam of height 70 m. Fetch of the reservoir is 15 Km and wind velocity is 85 Km/hour.

2.(a) 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.

(b) Design the first strip of a high concrete gravity dam for the following data.
Maximum allowable compressive stress in concrete = 30 kg/cm²
Maximum reservoir level = 200.0 m
R.L. of bottom of dam = 100.0 m
Specific gravity of concrete = 2.4
The portion of dam designed as low gravity dam is shown in Fig.1

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

(b) Determine the distribution of shear stress at the base of a dam of top width, T = 173.0 m, for the following data:
(i) Normal vertical stress at heel, \( \sigma_{zu} = 103 \, \text{t/m}^2 \).
(ii) Normal vertical stress at toe, \( \sigma_{zd} = 289.55 \, \text{t/m}^2 \).
(iii) Total water pressure at the u/s face, \( P_u = 206 \, \text{t/m}^2 \).
(iv) No tail water.
(v) Total horizontal force, \( H = 27000.00 \, \text{tonnes} \).
(vi) Slope at u/s, \( \tan \phi_u = 0.1 \) and slope at d/s, \( \tan \phi_d = 0.85 \).

Contd.....2.
4.(a) Analyse the cylindrical arch dam under the uniform loading with the following data:
\[ \alpha = 60^\circ, \quad r_c = 36 \text{ m}, \quad t = 6.0 \text{ m}, \quad h = 30.0 \text{ m}. \]
Modulus of elasticity, \( E_m = 2.11 \times 10^9 \text{ Kg/m}^2. \)
Temperature drop = 12 °F.
Coefficient of thermal expansion, \( C_F = 6 \times 10^{-6} \degree \text{F}. \)
Shear factor, \( n = 2.8. \)
Neglect foundation terms and factors.
All symbols have their meanings.

(b) Write the short notes on the following.
   (i) Elastic theory of design of an arch dam.
   (ii) Thick cylinder theory of design of an arch dam.

5.(a) Briefly discuss the advantages and disadvantages of arch and buttress dam as compared to the conventional gravity dam.

(b) Determine the stresses in a thin constant angle arch dam at 35 m below maximum water level. The geometrical data are as follows:
   (i) Constant angle = 120°
   (ii) Centre line radius = 41.0 m
   (iii) Thickness at crown = 6.0 m
   (iv) Thickness at abutment = 6.3 m
Use Cain's method for analysis.
Assume, Coefficient of thrust at crown = 0.9700
Coefficient of moment at crown = 0.0106
Coefficient of thrust at abutment = 0.9380
Shear coefficient at abutment = 0.0529
Coefficient of moment at abutment = 0.0178

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

(b) A 100 m high flat deck type buttress dam has a buttress spacing of 18 m and U/S inclination 30°. Assume \( f_c = 450 \text{ t/m}^2, \quad W_c = 2.4 \text{ t/m}^3, \) determine the shape of buttress and required concrete thickness. Minimum thickness of unit column is 2.0 m. Assume water is stored up to the top of the dam and frictionless joint of deck and buttress.
Maximum Marks: 60                                      Credits: 04                                      Duration: Three Hours

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

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Questions</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.(a)</td>
<td>Write note on criteria for safe design of embankment dams</td>
<td>[05]</td>
</tr>
<tr>
<td>1.(b)</td>
<td>Discuss any two conventional methods to control seepage through the body of an embankment dam as well as its foundation. Write a note also on application of geomembranes in embankment dams.</td>
<td>[10]</td>
</tr>
<tr>
<td>OR</td>
<td></td>
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</tr>
<tr>
<td>1'</td>
<td>Discuss the various causes of transverse as well as longitudinal cracks in embankment dams with clear sketches. Suggest the preventive and remedial measures to control the cracking problems.</td>
<td>[15]</td>
</tr>
<tr>
<td>2(a)</td>
<td>Discuss the procedure to determine (i) suitable length of blanket, (ii) head lost upto the end of blanket, (iii) percentage reduction in seepage due to the provision of blanket and (iv) draw uplift pressure diagram.</td>
<td>[10]</td>
</tr>
<tr>
<td>2(b)</td>
<td>Discuss the design criteria of filters in embankment dams.</td>
<td>[05]</td>
</tr>
<tr>
<td>3</td>
<td>Discuss the methods of slices for stability analysis of embankment dams with a suitable example. Also highlight the advantages of Finite-Element Methods of Stability Analysis over the conventional methods.</td>
<td>[15]</td>
</tr>
<tr>
<td>OR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3'(a)</td>
<td>Describe single-stage and two-stage river diversion works during construction of embankment dams with clear sketches.</td>
<td>[07]</td>
</tr>
</tbody>
</table>

Contd.....2.
### 3'(b)
Discuss the role of moisture in compaction during construction of an embankment dams. Also discuss the lines of optimums for different compaction methods in the field.

### 4(a)
Write a note on ‘Construction of Embankment dams on fault zones’.

### 4(b)
For a homogeneous earth dam as shown in the following Fig.1, estimate the seepage discharge. The length of the horizontal filter is 10 m. Take coefficient of permeability, \( k = 2 \times 10^{-7} \text{ m/s} \).

![Fig.1](image_url)
M. TECH. (1 - SEMESTER) EXAMINATION
CIVIL ENGINEERING
Water Reclamation and Reuse
(CE- 621)

Maximum Marks: 60
Duration: Three Hours

Instructions:
Attempt all questions
Assume suitable data if required

1. Attempt any two parts;

(a) Write down typical values of BOD₅, COD, Chloride, TSS, TKN and TP of weak, medium and strong domestic wastewater.
(b) Give disposal standards of pH, TSS, Oil & grease, BOD₅, COD, TKN, NH₃-N, Ortho-P, NO₃⁻-N, Residual Chlorine for onland surface waters, public sewers, and onland irrigation.
(c) Give BIS drinking water desirable limits conforming to IS: 10500-1991 of Colour, turbidity, pH, total hardness, chloride, iron, TDS, nitrate, fluoride and alkalinity.
(d) What is designated best use classification of rivers as A, B, C, D and E, give water quality criteria of each.

2. (a) Draw an ASP based municipal wastewater treatment scheme including tertiary & sludge treatment showing a neat sketch. Also indicate purpose of each unit.
Work out cumulative detention time of the scheme.

OR

(a') Distinguish between conventional activated sludge process and extended aeration process on the basis of SRT, F/M ratio, organic or volumetric loading rate, MLSS or MLVSS conc. in aeration tank, HRT and Qr/Q ratio.
(b) A textile mill discharging 0.2 mg/l cadmium laden wastewater in a 0.5 m wide and 0.75 m deep rectangular drain to a nearby river. If the avg. depth of flow in the drain is 0.2 m and the avg. velocity of flow is 0.6 m/s. Calculate discharge in m³/s, l/min and m³/d. If the river water background cadmium concentration is 1.5 μg/l at an avg. flow of 12 MLD, calculate downstream cadmium concentration.

Contd…..2.
3. (a) Draw RO module in single array, multiple array and multiple stage. OR

(a') Give design details of RO water membranes for sea water & brackish water with respect to permeate flux, hydrostatic pressure, recovery, pH, and salt rejection.

(b) Design a RO water treatment plant for the following conditions:
- Plant capacity = 20000 m³/d
- TDS in raw water = 1000 mg/L
- Types of RO membranes = BW 8040
- TDS in finished water < 300 mg/L
- TDS in permeate water < 100 mg/L

4. (a) Design an Ion exchange column for the following data:
- Water supply rate = 135 LPCD
- Future design population = 100000
- Influent Hardness = 300 mg/L as CaCO₃
- Finished water hardness = 50 mg/L as CaCO₃
- Purity of NaCl = 98%
- Moisture content of Na Cl = 3%

Calculate:
- No. of columns
- Diameter of columns
- NaCl requirement
- Regeneration wastewater volume
- Regeneration time and total backwash time.

(b) Determine SAR value of Agra and Haridwar water supplies:

<table>
<thead>
<tr>
<th></th>
<th>Haridwar</th>
<th>Agra</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ca²⁺</td>
<td>2.5 mg/L</td>
<td>82 mg/L</td>
</tr>
<tr>
<td>Mg²⁺</td>
<td>1.5 mg/L</td>
<td>24 mg/L</td>
</tr>
<tr>
<td>Na⁺</td>
<td>146 mg/L</td>
<td>98 mg/L</td>
</tr>
</tbody>
</table>

Comment about the relative suitability of water for irrigation purposes.
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)  Calculate the hydroxide, bicarbonate and carbonate alkalinity using the following data.

Initial pH         Total mL of titrant to reach end point

Phenolphthalein  Methyl Orange

11.2             8.2               8.4

1(b)  Briefly explain why principles of environmental chemistry are of importance to environmental engineers. Support your answer with suitable example.

1(c)  Balance the following half reactions and state the application of such reactions in water/wastewater treatment.

(i)  Oxidation of \( \text{NH}_4^+ \) to \( \text{NO}_3^- \) and reduction of \( \text{O}_2 \) to \( \text{H}_2\text{O} \)
(ii) Oxidation of \( \text{CH}_3\text{COO}^- \) to \( \text{CO}_2 \) and reduction of \( \text{SO}_4^{2-} \) to \( \text{H}_2\text{S} \)

OR

1' (a) Describe in detail the procedure used for the determination of Fluorides in water.

1'(b) Draw the structures of different disaccharides amylase and amyllopectin found in wastewaters.

1' (c) Briefly describe the significance of concentration diagrams in water and wastewater treatment.

2 (a) With the help of equations determine the pH of a 0.1M solution of acetic acid.

2 (b) Calculate the activity coefficient and activity of each ion in a solution containing 75

Contd.....2.
mg/L Na\(^+\), 25 mg/L Ca\(^{2+}\), 10 mg/L Mg\(^{2+}\), 125 mg/L Cl\(^-\), 50 mg/L HCO\(_3^-\) and 48 mg/L SO\(_4^{2-}\).

2(c) With the help of concentration diagram and proton balance find the pH of a 0.1 M KH\(_2\)PO\(_4\) solution.

3(a) Derive equations required for the construction of logarithmic concentration diagram for 0.1 M acetic acid solution.

3(b) Calculate the pH of a 200 mL of buffer solution containing 20 mg/L of carbonic acid and 50 mg/L of bicarbonate ion, under the following conditions. Briefly describe the effect of molar concentration on the performance of the buffer.

   (i) Initially
   (ii) After addition of 0.002 M of HCl
   (iii) After addition of 0.002 M of NaOH

OR

3'(b) Discuss the different types of pesticides. Also comment on their biodegradability.

4(a) Chromium ion (Cr\(^{3+}\)) is to be removed from an electroplating wastewater by forming its hydroxides. Find the optimum pH and the minimum possible soluble concentration of chromium (Cr\(^{3+}\)). Take the values of formation constants as follows:

   Log \(K_1\) = 10.0, Log \(K_2\) = 8.3, Log \(K_3\) = 5.70 and Log \(K_4\) = 4.6 and \(K_{sp}\) = \(6 \times 10^{-31}\)

4(b) Describe proton balance and explain its significance in environmental engineering.

4(c) Briefly explain the significance of solubility concepts in water and wastewater treatment. Support your answer with examples.

5(a) Briefly describe the effect of common ion on the solubility of salts. How many milligrams of CaF\(_2\) can be dissolved in 1 L of water that contains 1 mg/L of F\(^-\) at 25\(^\circ\)C? Also find the final amounts (in mg) of Ca\(^{2+}\) and F\(^-\) in water. The water does not contain any calcium. Take \(K_{sp}\) for CaF\(_2\) as \(3 \times 10^{-11}\) at this temperature.

5(b) Describe possible micropollutants found in water and wastewater. Briefly explain their possible methods of treatment.
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 is environmental microbiology and briefly explain its applications in water and soil reclamation and reuse? [06]
1(b) What are protists? How they are classified on the basis of source of energy and source of carbon? Draw the structure of Eucaryotic cell and Prokaryotic cell. [06]
2(a) What are the different types of media used in bacteriological examination of water? How Coliform confirmatory test is performed? What are dilution and staining technique used in MPN test? [06]
2(b) Discuss the deamination of proteins under aerobic and anaerobic conditions? How beta oxidation of fatty acids occurs? [06]

OR

2'(b) What are amino acid, dipeptide and polypeptide? What is the role of Nucleotides in RNA and DNA structure? [06]
3(a) Write down the catabolic energy reactions for aerobic oxidation of acetate, methanogenesis of glucose and methanogenesis of acetate. [06]

OR

3'(a) Explain briefly about aerobic and anaerobic metabolism. What is the role of nitrifying bacteria in environment? [06]
3(b) Discuss the heterotrophic organism growth curve. Derive an expressions when substrate is limited and unlimited based on Monod’s Equation. [06]
4(a) A sample of bacterial culture was placed in an oven overnight at 150°C. The organic portion of residue remaining was then analysed after which the sample was burned in muffle furnace to determine the amount of ash remaining. The composition of cells by weight was found to be 46.9% C, 7.2% H, 24.8 %O, 9.46% N. Remaining 9.2% ash. Prepare empirical formula for the cells taking c=1 and find out the COD per organic weight ratio of the cell.

4(b) Briefly explain about the conversion of glucose to pyruvic acid. How many moles of ATPs are formed during the conversion process and how much energy is captured?

OR

4’(b) Describe TCA cycle. Name the different coenzymes and explain their function in TCA cycle. How many moles of ATPs are formed during the oxidation process of 1 mole of glucose to carbon dioxide and water

5(a) Discuss the concept of flow of energy and matter in ecosystem.

5(b) Write short note any two of the following

   (a) Stratification in Lake and Ocean ecosystem
   (b) Energy and Biomass Pyramid in Ecosystem
   (c) Concept of productivity.
Maximum Marks: 60
Answer all questions.
Assume suitable data where necessary.

Q1 (a) List different types of aerators. Calculate the time required to decrease the concentration of ammonia to 0.5 mg/L in a gas transfer system from an initial concentration of 2 mg/L, if 5 minutes are required for 50% reduction. Assume that the air used for stripping has no ammonia. (5)

Q1 (b) Derive the equation for oxygen transfer in water. (5)

OR

Q1 (b') Explain two film theory of gas transfer. Groundwater is allowed to cascade over four identical steps for removal of CO₂. If the CO₂ concentration decreases from 18 to 9 mg/L in the first step, what will be the effluent concentration? (5)

Q1 (c) What are colloids? What do you understand by colloid destabilization? Distinguish between sweep coagulation and charge neutralization coagulation. (5)

Q2 (a) Alum is used as a coagulant at a dose of 50 mg/L for treating a flow of 20000 m³/d containing 100 mg/L suspended solids,
   (i) If alkalinity in water is 20 mg/L, what is the daily lime dose to maintain the alkalinity of treated water at 40 mg/L?
   (ii) If the clarifier removes 90% solids what is the volume of sludge produced? Assume 2% solids in the sludge. (5)

Contd....2.
Q2 (b) A settling column analysis was run on a discrete suspension. Water samples were withdrawn at different time intervals from a port 2 m below the original water level. The results of the Suspended solids (SS) analysis are provided below. Calculate the theoretical removal efficiency of the suspension in a sedimentation tank having an overflow rate of 30 m/d.

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>0</th>
<th>60</th>
<th>90</th>
<th>120</th>
<th>180</th>
<th>260</th>
<th>400</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS conc. (mg/L)</td>
<td>250</td>
<td>153</td>
<td>148</td>
<td>138</td>
<td>120</td>
<td>70</td>
<td>24</td>
</tr>
</tbody>
</table>

OR

Q2 (b') The local settling velocity \( V_i \) m/h as a function of suspended solid concentration \( C_i \) kg/m\(^3\) is given by:

\[ V_i = 8 \exp(-0.8 \ C_i) + 0.028 \]

Calculate the surface area of a thickener to concentrate a 4 kg/m\(^3\) suspension to 10 kg/m\(^3\) for an influent rate of 145 m\(^3\)/d.

Q2 (c) Compare the surface areas required for a tube settler and a conventional rectangular sedimentation tank for a flow of 25000 m\(^3\)/d to remove particles of 0.6 mm/s settling velocity. The tube settler employs 400 circular tubes of 40 mm size, 800 mm long at an inclination of 60 degree.

Q3 (a) Derive the expression for calculating the head loss in a granular media filter. Why a dual media filter being considered better than a mono media filter?

Q3 (b) A bed of filter sand 0.75 m deep, is composed of uniform 0.5 mm size sand particles \( \psi = 0.9 \). The porosity of the packed bed is 0.40. Determine the head loss using Rose’s formula and Carman-Kozeny formula when filtering at a rate of 140 m\(^3\)/m\(^2\) d. Also, determine the required backwash rate if the filter bed is to be expanded to 1.5 times its original depth during backwash. Assume settling velocity of the sand particles to be 0.1 m/s.

Contd.....3.
Q3 (c) Explain split treatment process. Calculate the quantity of lime and soda ash required to achieve a hardness of 40 mg/L as CaCO₃ for 10 MLD water having the following composition.

\[ \text{Ca}^{++} 126 \text{ mg/L, Mg}^{++} 43 \text{ mg/L, Na}^{+} 13 \text{ mg/L, K}^{+} 2.1 \text{ mg/L, HCO}_3^- 440 \text{ mg/L,} \]
\[ \text{SO}_4^{2-} 139 \text{ mg/L, Cl}^- 8 \text{ mg/L and CO}_2 30 \text{ mg/L} \]

(5)

OR

Q3 (c') Explain or write notes on the following:

(ii) Dissolved air flotation
(iii) Baffled channel flocculator
(iv) Tube settlers

(5)

Q4 (a) A water supply contains 1.5 mg/L of iron and 1.2 mg/L of manganese at a pH of 7.9. Calculate the theoretical dosages of O₂, Cl₂ and KMnO₄ required to oxidise iron to Fe(OH)₃ and manganese to MnO₂.

(5)

Q4 (b) Determine and plot the distribution of HOCl and OCl⁻ as a function of pH for a closed system. \( K_{\text{HOCl}} = 2.5 \times 10^{-8} \)

(5)

Q4 (c) Describe Chick-Watson law of disinfection. Ozone is to be used to obtain 99.9% kill of bacteria in water with a concentration of 0.5 mg/L. Determine the contact time required assuming \( K = 0.058 \text{ s}^{-1} \).

(5)
2015-2016
M. TECH. AUTUMN (I SEMESTER) EXAMINATION
(CIVIL ENGINEERING)
AIR POLLUTION AND CONTROL
(CE-625)

Maximum Marks : 60
Answer all the questions.
Assume any data judiciously, if required

Q.1(a) What are the common type of indoor air pollutants? 5
Discuss their sources in brief.

Q.1(b) Consider oil droplets 0.6μm diameter suspended in air and
exposed to day time radiation. The density of the particle
is 0.9 gm/cm³.
   i) What is the concentration of the particle in μgm/m³
      for a visibility of 1.5 km, if the k value is 4.0.
   ii) What is the concentration of suspended particulates
      in the density of 2.5 gm/cm³ and an effective
diameter of 1.0μ, if k is 2.0 and visibility is
      reduced to 8 km.

OR

Q.1(a)' Explain with neat sketch the mechanism of action of air
pollutants on human being.

Q.1(b)' Gas from a thermal power plant has an SO₂ content of 7
ppm at 760 mm Hg and 50°C. Calculate the SO₂
concentration in micrograms per cubic meter and
milligrams per cubic meter.

Q.1(c)' How the concentration of suspended particulate matter
(SPM) in ambient air is determined. Discuss sampling
location and frequency guidelines in brief.

Q.2(a) An oil pipeline leak results in emission of 100g/h of H₂S. 7
On a very sunny summer day, with a wind speed of 3.0
m/s, what will be the concentration of H₂S 1.5 km directly
downwind from the leak?

Q.2(b) Discuss the various factors affecting dispersion of 8
pollutants. Describe the advantages and disadvantages of
Gaussian models.

OR
Q.2(b) Sulfur dioxide is emitted at a rate of 155 g/s from a stack with an effective height of 65 m. The wind speed at stack height is 5.2 m/s, and the atmospheric stability class is D for the overcast day. Determine the concentration crosswind at 50 m from the center line for the downwind distance of 0.50 km.

Q.3(a) A bag house is to design to handle 1000 m³/min of air. The filtration takes place at constant pressure so that the air velocity through each bag decreases during the time between clearing according to the relation

\[ U = \frac{1}{0.267 + 0.08t} \]

where \( U \) is in m³/m² of the cloth and \( t \) is time in sec. The bags are shaken in sequence row by row on a 30 min cycle. Each bag is 25 cm in diameter and 2.5 m height. The bag house is to be square in x-section with 25 cm spacing between bags and 30 cm clearance from walls. Calculate the number of bags require.

OR

Q.3(a) A plate type ESP use in a cement plant for removing dust particles consist of 12 equal channels. The spacing between the plates is 20 cm and the plates are 3 m high and 3 m long. The unit handles 20,000 m³/h of gas.

I) What is the efficiency of collection plates?

II) What is the collection rate of particles having density 9.2 gm/m³?

III) What should be the length of the plate for achieving efficiency of 99% keeping other parameter same?

Q.3(b) What is the principle of wet scrubber? Discuss the advantages and disadvantages of wet scrubbers.

Q.4(a) What are the principal gases of concern in air pollution control? Discuss the types of treatment process available for control of gases.

Q.4(b) List the causes of ozone depletion? And its potential health effects.

Q.4(c) Describe the harmful effects of NO₂ on living things and the environment.
Figure 4.6  Standard deviation, \( s_y \), in the crosswind direction as a function of distance downwind. (source: D. B. Turner, Workbook of Atmospheric Dispersion Estimates. Washington, D.C.: HEW, 1989.)

Figure 4.7  Standard deviation, \( s_z \), in the vertical direction as a function of distance downwind. (source: D. B. Turner, Workbook of Atmospheric Dispersion Estimates. Washington, D.C.: HEW, 1989.)

Table 4.1  KEY TO STABILITY CATEGORIES

<table>
<thead>
<tr>
<th>SURFACE WIND</th>
<th>INCOMING SOLAR RADIATION</th>
<th>CLOUD COVER</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPEED AT 10 M (m/s)</td>
<td>STRONG</td>
<td>MODERATE</td>
</tr>
<tr>
<td>&lt; 2</td>
<td>A</td>
<td>A-B</td>
</tr>
<tr>
<td>2-3</td>
<td>A-B</td>
<td>B</td>
</tr>
<tr>
<td>3-5</td>
<td>B</td>
<td>B-C</td>
</tr>
<tr>
<td>5-6</td>
<td>C</td>
<td>C-D</td>
</tr>
<tr>
<td>&gt; 6</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>


*The neutral class, D, should be assumed for overcast conditions during day or night. Class A is the most unstable and class F is the most stable, with class B moderately unstable and class E slightly unstable.*
M. TECH. (AUTUMN SEMESTER) EXAMINATION
(CIVIL ENGINEERING)
ADVANCED SOIL MECHANICS AND FOUNDATION ENGINEERING
(CE-641)

Maximum Marks: 60
Duration: Three Hours

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

Q.No. Questions M.M.

1(a) Discuss the advantages of deep foundation over shallow foundation. Also discuss the classification of pile foundation. 6

1(b) Design a pile group to be installed in deep cohesive soil by using following information:

Working load = 3000 kN
Unconfined compressive strength of soil = 200 kN/m²
FOS against shear = 2.5
(OR)

1'(a) What do you understand by settlement of pile group in clays? Discuss in detail. 6

1'(b) Determine the load carrying capacity of an under reamed pile foundation in uplift and compression to be installed in deep cohesionless soil, using following data:

Stem diameter = 35 cm
Angle of internal friction of soil = 36°
Value of $N_T$ = 44.5
Value of $N_q$ = 37.8
Unit weight of soil = 17.0 kN/m³
No. of bulbs = 03

2(a) Discuss in detail about negative skin friction. How the negative skin friction affects the load carrying capacity of pile group. 6

2(b) Compute the settlement of pile group (nine piles arranged in square pattern) carrying a load of 6000 kN. The diameter and length of each pile is 400 mm and 12 m respectively. The subsoil consists of uniform clay 30 m deep having undrained cohesion of 90 kN/m². The clay may be assumed to be of normal sensitivity and normally loaded, with liquid limit 60% and unit weight = 17.2 kN/m³.

3(a) Enumerate various geotechnical site exploration methods. Discuss in detail about electrical resistivity method for exploration of soil at site.

Contd.-2.
3(b) What do you understand by raft foundation? Briefly explain the design procedure of a mat foundation by conventional method.

4 What are the various conditions when a combined footing is considered suitable than isolated footings? Design a combined footing for four columns each having a size of 400 mm × 400 mm. The centre to centre spacing between the columns is 4000 mm. The allowable bearing capacity of the soil is 145 kN/m². Due to site condition, the width of the footing is to be restricted to 2000 mm. The load carried by each column is shown in Fig. 1. Use M 20 grade of concrete and Fe 415 grade of steel.

5(a) What are the various types of earth retaining structures? Explain how the stability of the gravity wall is checked against sliding, overturning, bearing capacity failure and tension.

5(b) Determine the fraction of theoretical maximum pressure on the embedded length of anchored sheet pile wall which must be mobilized for equilibrium. Use the free-earth support method. Also find out the tensile force (T) in anchor rod (Fig. 2).

(OR)

5'(a) Discuss the degree of freedom of machine foundation and dynamic magnification factor.

5'(b) Design a machine foundation block for a machine which develops sinusoidal force having amplitudes of Q₀ = 40 kN at 500 rpm. The 60 kN machine is to be supported by the block resting directly upon the soil having physical properties:

- Unit weight of soil = 18 kN/m³
- Shear wave velocity, Vₛ = 250 m/s
- Poison's ratio = 0.33

The acceptable value of amplitude of motion as prescribed by manufacturer of the machine is 0.0004 mm.