1. Find the volume of voids in a 1-m³ fine aggregate of bulk density equal to 1600 kg/m³. Sieve analysis of a 700-g sample of the aggregate results in the following data. Please find the fineness modulus. (specific gravity of the particles is 2.5) (20)

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>1/2&quot;</th>
<th>No. 4</th>
<th>No. 8</th>
<th>No. 16</th>
<th>No. 50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight Retained (g)</td>
<td>100</td>
<td>200</td>
<td>200</td>
<td>100</td>
<td>90</td>
</tr>
</tbody>
</table>

2. Please describe the definition of the following terms for concrete. (25)
   a. Young’s modulus (3)
   b. creep (3)
   c. shrinkage (3)
   d. compressive strength (3)
   e. splitting tensile strength (3)
   f. curing (3)
   g. \( f'_{c} \) (3)
   h. self compacting concrete (4)

3. Find the cross section of concrete and area of steel required for a simply supported rectangular beam with a span of 6 m that is to carry a dead load of 20 kN/m and a live load of 40 kN/m. Specified concrete strength, \( f'_{c} \), and steel yield strength, \( f_{y} \), are 28 MPa and 414 MPa, respectively. Please use steel ratio equal to 40% of the balanced steel ratio and beam width of 300 mm. (25)

4. A 12x20 in column is reinforced with 3 No. 9 bars at each corner with cover from surface to the center of steel 2.5 in. If \( f'_{c} \)=4000 psi and \( f_{y} \)=60 ksi, determine the following (30):
   a. the uniaxial compressive strength \( \sigma P_{b} \)
   b. the balanced axial load \( P_{b} \), \( M_{b} \) and \( e_{b} \) about the long side (20 in.)
   c. pure moment capacity \( M_{n} \)