# GATE CE - 2020

AI24BTECH11001 Abhijeet Kumar

40) Consider the system of equations

$$\begin{bmatrix} 1 & 3 & 2 \\ 2 & 2 & -3 \\ 4 & 4 & -6 \\ 2 & 5 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 2 \\ 1 \end{bmatrix}$$

The value of x_3 (round off to the mearest integer), is ...

41) A rigid, uniform, weightless, horizontal bar is connected to three vertical members P, Q and R as shown in the figure (not drawn to the scale). All three members have identical axial stiffness of $10 kN/mm$. The lower ends of bars P and R rest on a rigid horizontal surface. When NO load is applied, a gap of 2 mm exists between the lower end of the bar Q and the rigid horizontal surface. When a vertical load W is placed on the horizontal bar in the downward direction, the bar still remains horizontal and gets displaced by 5 mm in the vertically downward direction.
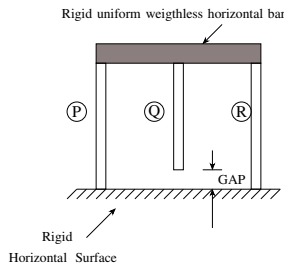

The magnitude of the load W (in KN, round off to the nearest integer), is ...

42) The flange and web plates of the doubly symmetric built-up section are connected by continuous $10 mm$ thick fillet welds as shown in the figure (not drawn to the scale). The moment of inertia of the section about its principal axis X-X is $7.73 x 10^6 mm^2$. The permissible shear stress in the fillet welds is $100 N/mm^2$. The design shear strength of the section is governed by the capacity of the fillet welds.
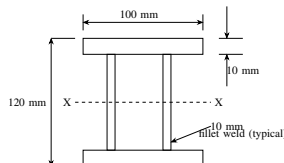
The maximum shear force (in kN, round off to one decimal place) that can be carried by the section, is ...

43) The singly reinforced concrete beam section shown in the figure (not drawn to the scale) is made of $M25$ grade concrete and $Fe500$ grade reinforcing steel. The total cross-sectional area of the tension steel is $942mm^2$.
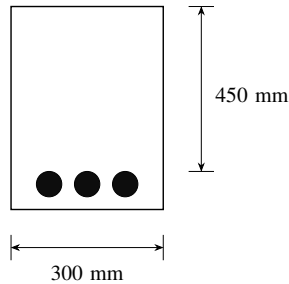

As per Limit State Design of IS 456 : 2000, the design moment capacity (in kN.m, round off to two decimal places) of the beam section, is ...

44) A simply supported prismatic concrete beam of rectangular cross-section, having a span of $8m$, is prestressed with an effective prestressing force of $600kN$. The eccentricity of the prestressing tendon is zero at supports and varies linearly to a value of e at the mid-span. In order to balance an external concentrated load of $12kN$ applied at the mid-span, the required value of e (in mm, round off to the nearest integer) of the tendon, is ...

45) Traffic volume count has been collected on a 2-lane road section which needs upgradation due to severe traffic flow condition. Maximum service flow rate per lane is observed as $1280veh/h$ at level of service 'C'. The Peak Hour Factor is reported as 0.78125. Historical traffic volume count provides Annual Average Daily Traffic as $12270veh/day$. Directional split of the traffic flow is observed to be 60 : 40. Assuming that traffic stream consists of 'All Cars' and all drivers are 'Regular Commuters', the number of extra lane(s) (round off to the next higher integer) to be provided, is ...

46) A vertical retaining wall of $5m$ height has to support soil having unit weight of $18kN/m^3$, effective cohesion of $12kN/m^2$, and effective friction angle of $30°$. As per Rankine's earth pressure theory and assuming that a tension crack has occurred, the lateral active thrust on the wall per meter length (in kN/m, round off to two decimal places), is ...

47) Water flows in the upward direction in a tank through $2.5m$ thick sand layer as shown in the figure. The void ratio and specific gravity of sand are 0.58 and 2.7, respectively. The sand is fully saturated. Unit weight of water is $10kN/m^3$.
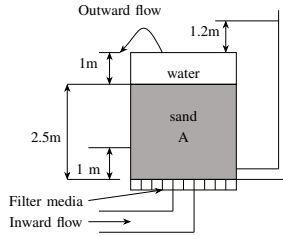
The effective stress (in kPa, round off to two decimal places) at point A, located $1m$ above the base of tank, is ...

48) A $10m$ thick clay layer is resting over a $3m$ thick sand layer and is submerged. A fill of $2m$ thick sand with unit weight of $20kN/m^3$ is placed above the clay layer to accelerate the rate of consolidation of the clay layer. Coefficient of consolidation of clay is $9 \times 10^2 m^2/year$ and coefficient of volume compressibility of clay is $2.2 \times 10 m^2/kN$. Assume Taylor's relation between time factor and average degree of consolidation.
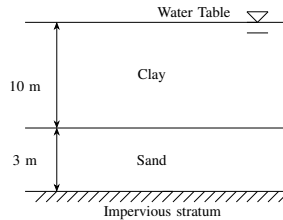
The settlement (in mm, round off to two decimal places) of the clay layer, 10 years after the construction of the fill, is ...

49) Three reservoirs P, Q, and R are interconnected by pipes as shown in the figure (not drawn to the scale). Piezometric head at the junction S of the pipes is 100 m. Assume acceleration due to gravity as $9.81m/s^2$ and density of water as $1000kg/m^3$. The length of the pipe from junction S to the inlet of reservoir R is $180m$.
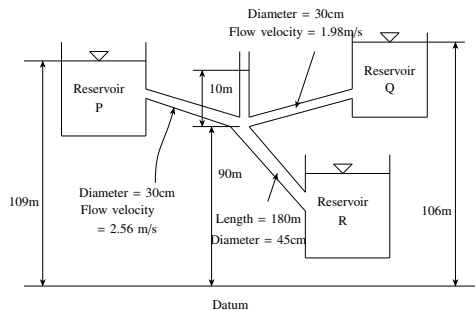
Considering head loss only due to friction (with friction factor of 0.03 for all the

pipes), the height of water level in the lowermost reservoir R (in m. round off to one decimal place) with respect to the datum, is ...

50) In a homogeneous unconfined aquifer of area $3.00km^2$, the water table was at an elevation of $102.00m$. After a natural recharge of volume 0.90 million cubic meter (Mm^3), the water table rose to $103.20m$. After this recharge, ground water pumping took place and the water table dropped down to $101.20m$. The volume of ground water pumped after the natural recharge, expressed (in Mm^3 and round off to decimal places), is ...

51) A circular water tank of $2m$ diameter has a circular orifice of diameter $0.1m$ at the bottom. Water enters the tank steadily at a flow rate of $20litre/s$ and escapes through the orifice. The coefficient of discharge of the orifice is 0.8. Consider the acceleration due to gravity as $9.81m/s^2$ and neglect frictional losses. The height of the water level (in m, round off to two decimal places) in the tank at the steady state, is ...

52) Surface Overflow Rate (SOR) of a primary settling tank (discrete settling) is $20000litre/m^2$ per day. Kinematic viscosity of water in the tank is $1.01 \times 10^3 cm^3/s$. Specific gravity of the settling particles is 2.64. Acceleration due to gravity is $9.81m/s^2$. The minimum diameter (in um, round off one decimal place) of the particles that will be removed with 80%efficiency in the tank, is ...