Q1) In the context of elastic theory of reinforced concrete, the modular ratio is defined as the ratio of

(A) Young's modulus of elasticity of reinforcement material to Young's modulus of elasticity of concrete.

(B) Young's modulus of elasticity of concrete to Young's modulus of elasticity of reinforcement material.

(C) shear modulus of reinforcement material to the shear modulus of concrete.

(D) Young's modulus of elasticity of reinforcement material to the shear modulus of concrete

Q2) Which of the following equations is correct for the Pozzolanic reaction?

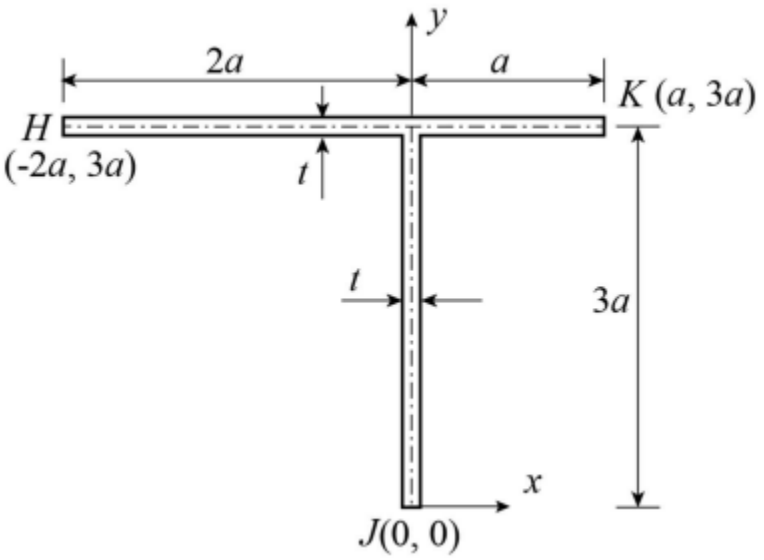
(A) $Ca(OH)_2$ + Reactive Superplasticiser + $H_2O \rightarrow$ C-S-H

(B) $Ca(OH)_2$ + Reactive Silicon dioxide + $H_2O \rightarrow$ C-S-H

(C) $Ca(OH)_2$ + Reactive Sulphates + $H_2O \rightarrow$ C-S-H

(D) $Ca(OH)_2$ + Reactive Sulphur + $H_2O \rightarrow$ C-S-H

Q3) Consider the cross-section of a beam made up of thin uniform elements having thickness t ($t \ll a$) shown in the figure. The (x, y) coordinates of the points along the centre-line of the cross-section are given in the figure



The coordinates of the shear centre of this cross-section are:

(A) $x = 0$, $y = 3a$

(B) $x = 2a$, $y = 2a$

(C) $x = -a$, $y = 2a$

(D) $x = -2a$, $y =$ a

Q4) Four different soils are classified as CH, ML, SP, and SW, as per the Unified Soil Classification System. Which one of the following options correctly represents their arrangement in the decreasing order of hydraulic conductivity?
(A) SW, SP, ML, CH
(B) CH, ML, SP, SW
(C) SP, SW, CH, ML
(D) ML, SP, CH, SW

Q5) With respect to fluid flow, match the following in Column X with Column Y:

Column X	Column Y
(P) Viscosity	(I) Mach number
(Q) Gravity	(II) Reynolds number
(R) Compressibility	(III) Euler number
(S) Pressure	(IV) Froude number

Which one of the following combinations is correct?
(A) (P) – (II), (Q) – (IV), (R) – (I), (S) – (III)
(B) (P) – (III), (Q) – (IV), (R) – (I), (S) – (II)
(C) (P) – (IV), (Q) – (II), (R) – (I), (S) – (III)
(D) (P) – (II), (Q) – (IV), (R) – (III), (S) – (I)

Q6) A rectangular channel with Gradually Varied Flow (GVF) has a changing bed slope. If the change is from a steeper slope to a steep slope, the resulting GVF profile is
(A) S_3
(B) S_1
(C) S_2
(D) either S_1 or S_2, depending on the magnitude of the slopes

Q7) An aerial photograph is taken from a flight at a height of 3.5 km above mean sea level, using a camera of focal length 152 mm. If the average ground elevation is 460 m above mean sea level, then the scale of the photograph is
(A) 1 : 20000
(B) 1 : 20
(C) 1 : 100000
(D) 1 : 2800

Q8) A line between stations P and Q laid on a slope of 1 in 5 was measured as 350 m using a 50 m tape. The tape is known to be short by 0.1 m.

The corrected horizontal length (in m) of the line PQ will be
(A) 342.52
(B) 349.30
(C) 356.20
(D) 350.70

Q9) For wastewater coming from a wood pulping industry, Chemical Oxygen Demand (COD) and 5-day Biochemical Oxygen Demand (BOD_5) were determined. For this wastewater, which of the following statement(s) is/are correct?
(A) COD > BOD_5
(B) COD ≠ BOD_5
(C) COD < BOD_5
(D) COD = BOD_5

Q10) Which of the following process(es) can be used for conversion of salt water into fresh water?
(A) Microfiltration
(B) Electrodialysis
(C) Ultrafiltration
(D) Reverse osmosis

Q11) A horizontal curve is to be designed in a region with limited space. Which of the following measure(s) can be used to decrease the radius of curvature?
(A) Decrease the design speed.
(B) Increase the superelevation.
(C) Increase the design speed.
(D) Restrict vehicles with higher weight from using the facility.

Q12) An uncompacted heap of soil has a volume of 10000 m^3 and void ratio of 1. If the soil is compacted to a volume of 7500 m^3 then the corresponding void ratio of the compacted soil is _____. (round off to one decimal place)

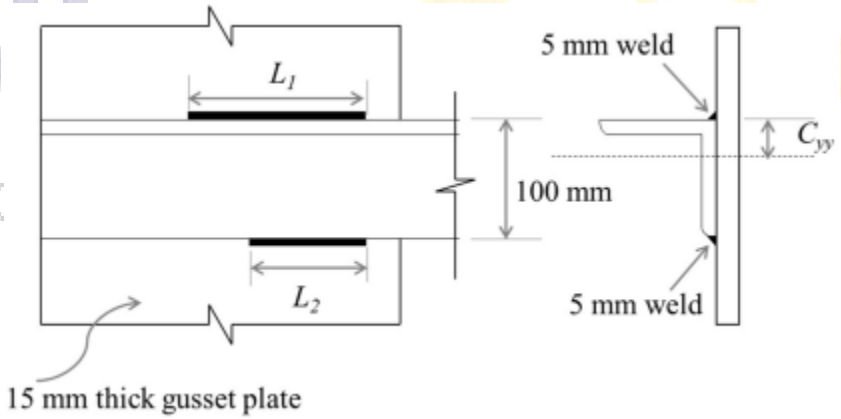
Q13) A concentrated vertical load of 3000 kN is applied on a horizontal ground surface. Points P and Q are at depths 1 m and 2 m below the ground, respectively, along the line of application of the load. Considering the ground to be a linearly elastic, isotropic, semi-infinite medium, the ratio of the increase in vertical stress at P to the increase in vertical stress at Q is _____. (in integer)

Q14) At a site, Static Cone Penetration Test was carried out. The measured point (tip) resistance q_c was 1000 kPa at a certain depth. The friction ratio (f_r) was estimated as 1 % at the same depth.

The value of sleeve (side) friction (in kPa) at that depth was _____ . (in integer)

Q15) During a particular stage of the growth of a crop, the consumptive use of water is 2.8 mm/day. The amount of water available in the soil is 50 % of the maximum depth of available water in the root zone. Consider the maximum root zone depth of the crop as 80 mm and the irrigation efficiency as 70%. The interval between irrigation (in days) will be _____. (round off to the nearest integer)

Q16) A weld is used for joining an angle section ISA 100 mm × 100 mm × 10 mm to a gusset plate of thickness 15 mm to transmit a tensile load. The permissible stress in the angle is 150 MPa and the permissible shear stress on the section through the throat of the fillet weld is 108 MPa. The location of the centroid of the angle is represented by C_{yy} in the figure, where C_{yy} = 28.4 mm. The area of cross-section of the angle is 1903 mm2. Assuming the effective throat thickness of the weld to be 0.7 times the given weld size, the lengths L_1 and L_2 (rounded off to the nearest integer) of the weld required to transmit a load equal to the full strength of the tension member are, respectively.



(A) 541 mm and 214 mm
(B) 214 mm and 541 mm
(C) 380 mm and 151 mm
(D) 151 mm and 380 mm

Q17) The project activities are given in the following table along with the duration and dependency.

Activities	Duration (in days)	Depends On
P	10	-
Q	12	-
R	2	P
S	5	Q
T	10	P , Q

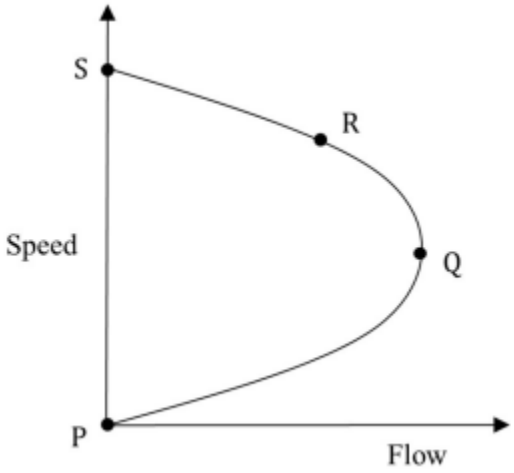
Which one of the following combinations is correct?
(A) Total duration of the project = 22 days, Critical path is Q → S
(B) Total duration of the project = 20 days, Critical path is Q → T
(C) Total duration of the project = 22 days, Critical path is P → T
(D) Total duration of the project = 20 days, Critical path is P → R

Q18) The correct match between the physical states of the soils given in Group I and the governing conditions given in Group II is

Group I	Group II
1. normally consolidated soil	P. sensitivity > 16
2. quick clay	Q. dilation angle = 0
3. sand in critical state	R. liquid limit > 50
4. clay of high plasticity	S. over consolidation ratio = 1

(A) 1-S, 2-P, 3-Q, 4-R
(B) 1-Q, 2-S, 3-P, 4-R
(C) 1-Q, 2-P, 3-R, 4-S
(D) 1-S, 2-Q, 3-P, 4-R

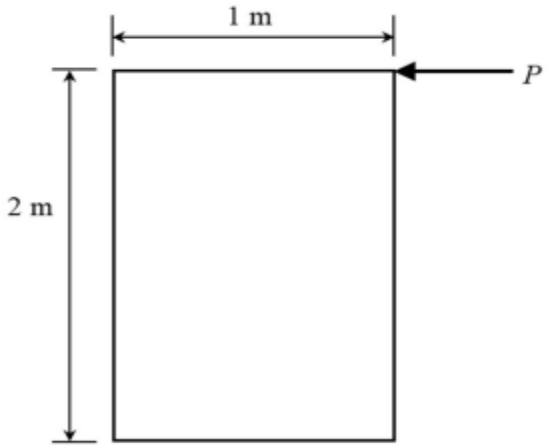
Q19) Consider the four points P, Q, R, and S shown in the Greenshields fundamental speed-flow diagram. Denote their corresponding traffic densities by k_P, k_Q, k_R, and k_S respectively. The correct order of these densities is



(A) $k_P > k_Q > k_R > k_S$
(B) $k_S > k_R > k_Q > k_P$
(C) $k_Q > k_R > k_S > k_P$
(D) $k_Q > k_R > k_P > k_S$

Q20) Let max $\{a, b\}$ denote the maximum of two real numbers a and b. Which of the following statement(s) is/are TRUE about the function $f(x) = \max\{3 - x, x - 1\}$?
(A) It is continuous on its domain.
(B) It has a local minimum at $x = 2$.
(C) It has a local maximum at $x = 2$.
(D) It is differentiable on its domain

Q21) A horizontal force of P kN is applied to a homogeneous body of weight 25 kN, as shown in the figure. The coefficient of friction between the body and the floor is 0.3. Which of the following statement(s) is/are correct?

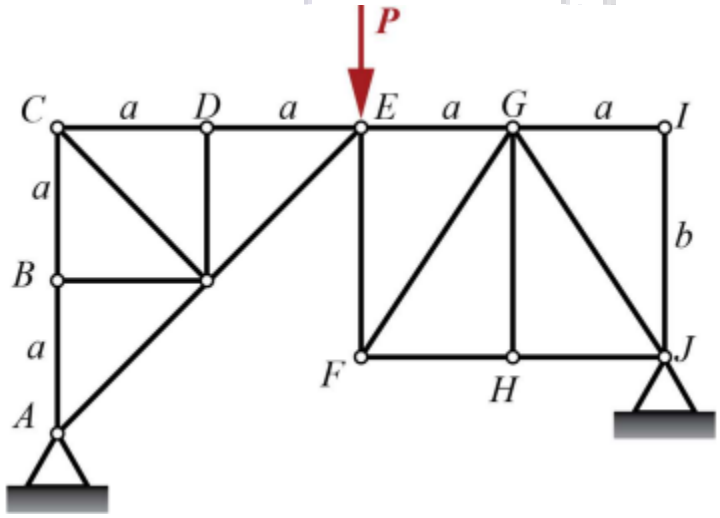


(A) The motion of the body will occur by overturning.
(B) Sliding of the body never occurs.
(C) No motion occurs for P ≤ 6 kN.
(D) The motion of the body will occur by sliding only.

Q22) In the context of cross-drainage structures, the correct statement(s) regarding the relative positions of a natural drain (stream/river) and an irrigation canal, is/are

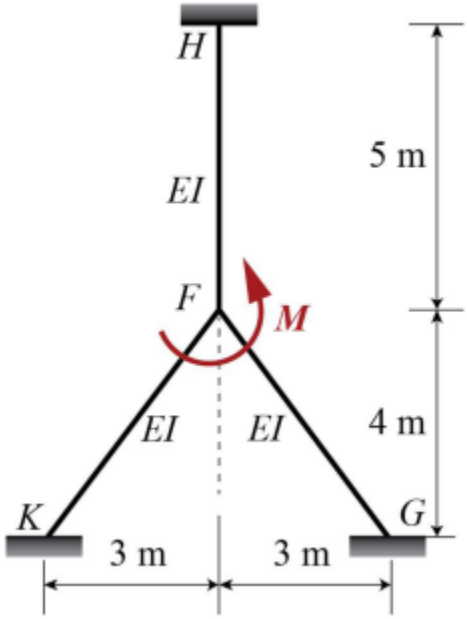
(A) In an aqueduct, natural drain water goes under the irrigation canal, whereas in a super-passage, natural drain water goes over the irrigation canal.
(B) In a level crossing, natural drain water goes through the irrigation canal.
(C) In an aqueduct, natural drain water goes over the irrigation canal, whereas in a super-passage, natural drain water goes under the irrigation canal.
(D) In a canal syphon, natural drain water goes through the irrigation canal.

Q23) The plane truss shown in the figure is subjected to an external force P. It is given that P = 70 kN, a = 2 m, and b = 3 m



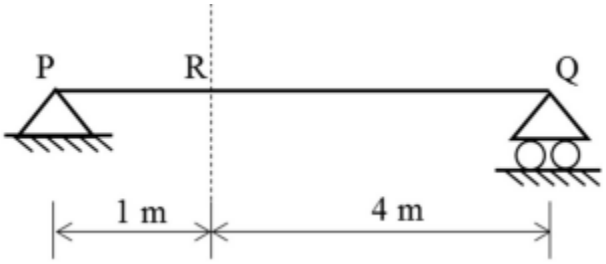
The magnitude (absolute value) of force (in kN) in member EF is _____.
(round off to the nearest integer)

Q24) Consider the linearly elastic plane frame shown in the figure. Members HF, FKand FG are welded together at joint F. Joints K, G and H are fixed supports. A counter-clockwise moment M is applied at joint F. Consider flexural rigidity EI = 10^5kN-m_2 for each member and neglect axial deformations.



If the magnitude (absolute value) of the support moment at H is 10 kN-m, the magnitude (absolute value) of the applied moment M (in kN-m) to maintain static equilibrium is _____. (round off to the nearest integer)

Q25) Consider a simply supported beam PQ as shown in the figure. A truck having 100 kN on the front axle and 200 kN on the rear axle, moves from left to right. The spacing between the axles is 3 m. The maximum bending moment at point R is _____ kNm. (in integer)



Q26) A reinforced concrete beam with rectangular cross section (width = 300 mm, effective depth = 580 mm) is made of M30 grade concrete. It has 1% longitudinal tension reinforcement of Fe 415 grade steel. The design shear strength for this beam is 0.66 N/mm^2. The beam has to resist a factored shear force of 440 kN. The spacing of two-legged, 10 mm diameter vertical stirrups of Fe 415 grade steel is _____mm. (round off to the nearest integer)

Q27) A square concrete pile of 10 m length is driven into a deep layer of uniform homogeneous clay. Average unconfined compressive strength of the clay, determined through laboratory tests on undisturbed samples extracted from the clay layer, is 100 kPa. If the ultimate compressive load capacity of the driven pile is 632 kN, the required width of the pile is _____ mm. (in integer)

(Bearing capacity factor $N_c = 9$; adhesion factor $\alpha = 0.7$)

Q28) A raft foundation of 30 m × 25 m is proposed to be constructed at a depth of 8 m in a sand layer. A 25 m thick saturated clay layer exists 2 m below the base of the raft foundation. Below the clay layer, a dense sand layer exists at the site. A 25 mm thick undisturbed sample was collected from the mid-depth of the clay layer and tested in a laboratory oedometer under double drainage condition. It was found that the soil sample had undergone 50 % consolidation settlement in 10 minutes.

The time (in days) required for 25% consolidation settlement of the raft foundation will be _____. (round off to the nearest integer)

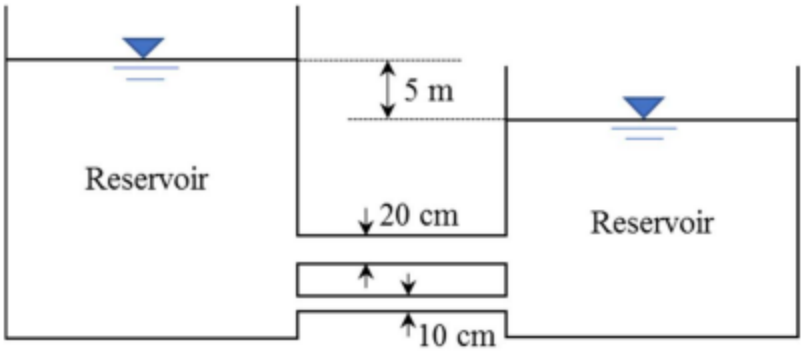
Q29) A two-hour duration storm event with uniform excess rainfall of 3 cm occurred on a watershed. The ordinates of streamflow hydrograph resulting from this event are given in the table.

Time (Hours)	0	1	2	3	4	5	6	7
Streamflow (m^3/s)	10	16	34	40	31	25	16	10

Considering a constant baseflow of 10 m^3/s, the peak flow ordinate (in m^3/s) of one-hour unit hydrograph for the watershed is _____ . (in integer)

Q30) Two reservoirs are connected by two parallel pipes of equal length and of diameters 20 cm and 10 cm, as shown in the figure (not drawn to scale). When the difference in the water levels of the reservoirs is 5 m, the ratio of discharge in the larger diameter pipe to the discharge in the smaller diameter pipe is _____. (round off to two decimal places)

(Consider only loss due to friction and neglect all other losses. Assume the friction factor to be the same for both the pipes)



Q31) A two-phase signalised intersection is designed with a cycle time of 100 s. The amber and red times for each phase are 4 s and 50 s, respectively. If the total lost time per phase due to start-up and clearance is 2 s, the effective green time of each phase is _____s. (in integer)

Q32) At a traffic intersection, cars and buses arrive randomly according to independent Poisson processes at an average rate of 4 vehicles per hour and 2 vehicles per hour, respectively. The probability of observing at least 2 vehicles in 30 minutes is _____. (round off to two decimal places)

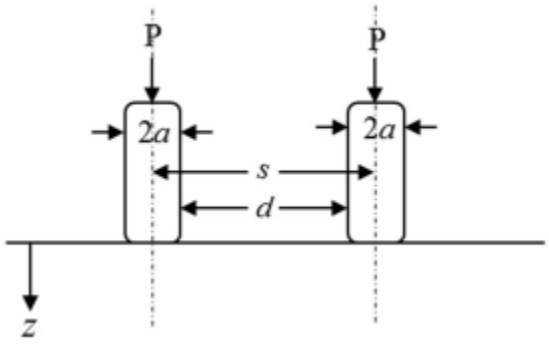
Q33) The vehicle count obtained in every 10 minute interval of a traffic volume survey done in peak one hour is given below.

Time Interval (Minutes)	Vehicle Count
0-10	10
10-20	11
20-30	12
30-40	15
40-50	13
50-60	11

The peak hour factor (PHF) for 10 minute sub-interval is _____. (round off to one decimal place)

Q34) For the dual-wheel carrying assembly shown in the figure, P is the load on each wheel, a is the radius of the contact area of the wheel, s is the spacing between the wheels, and d is the clear distance between the wheels. Assuming that the ground is an elastic, homogeneous, and isotropic half space, the ratio of Equivalent Single Wheel Load (ESWL) at depth z = d/2 to the ESWL at depth z = 2s is _____. (round off to one decimal place)

(Consider the influence angle to be 45° for the linear dispersion of stress with depth)



Q35) The following statements are related to bending of beams:
I The slope of the bending moment diagram is equal to the shear force.
II The slope of the shear force diagram is equal to the load intensity.
III The slope of the curvature is equal to the flexural rotation.
IV The second derivative of the deflection is equal to the curvature.

The only FALSE statement is
(A) I
(B) II
(C) III
(D) IV

Q36) Which one of the following is categorised as a long-term loss of prestress in a prestressed concrete member?
(A) Loss due to elastic shortening
(B) Loss due to friction
(C) Loss due to relaxation of strands
(D) Loss due to anchorage slip

Q37) In a steel plate with bolted connections, the rupture of the net section is a mode of failure under
(A) tension
(B) compression

(C) flexure
(D) shear

Q38) The ratio of the theoretical critical buckling load for a column with fixed ends to that of another column with the same dimensions and material, but with pinned ends, is equal to
(A) 0.5
(B) 1.0
(C) 2.0
(D) 4.0

Q39) Two series of compaction tests were performed in the laboratory on an inorganic clayey soil employing two different levels of compaction energy per unit volume of soil. With regard to the above tests, the following two statements are made

I The optimum moisture content is expected to be more for the tests with higher energy.
II The maximum dry density is expected to be more for the tests with higher energy.

The CORRECT option evaluating the above statements is
(A) Only I is TRUE
(B) Only II is TRUE
(C) Both I and II are TRUE
(D) Neither I nor II is TRUE

Q40) As per the Indian Standard soil classification system, a sample of silty clay with liquid limit of 40% and plasticity index of 28% is classified as
(A) CH
(B) CI
(C) CL
(D) CL-ML