GATE 2023 Civil Engineering (Evening Shift)

Q1. For the elevation and temp. data given in the table, the existing lapse rate in the environment is _____ °C/100m (round off two)

Elevation from ground level	Temp.
5	14.2
325	16.9

Q2. M20 concrete as per IS 456:2000 refers to the concrete with a design mix having
(a) an average cylinder strength of 20 Mpa
(b) a 5 percentile cylinder strength of 20 Mpa
(c) a 5 percentile cube strength of 20 Mpa
(d) an average-strength of 20 Mpa cube

Q3. Match the column

Column-1
P. Horton equation
Q. Muskingum method
R. Penman method

Column-2
I. Precipitation
II. Flood frequency
III. Evapotranspiration
IV. Infiltration
V. Channel routing

Option
(a) P-III, Q-IV, R-I
(b) P-III, Q-I, R-III
(c) P-IV, Q-V, R-III
(d) P-IV, Q-III, R-II

Q4. The magnetic bearing of the Sun for a location at room is 183°30′. If the Sun exactly on the geographic meridian at noon the magnetic declination of the location is _____
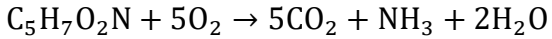(a) 93°30′ W
(b) 3°30′ E
(c) 3°30′ W
(d) 93°30′ E

Q5. SSD equal to the _____
(a) Brake distance
(b) Brake distance + distance travelled during reaction time
(c) Brake distance – distance travelled during reaction time
(d) Distance only during reaction time

Q6. An unconfined compression strength test was conducted on a cohesive soil. The test specimen failed at an axial stress of 76 kPa, the undrained cohesion (in kPa) of the soil is _____
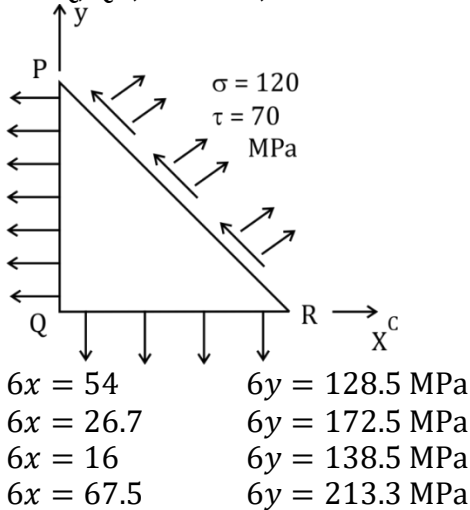
Q7. If the size of the ground area is 6 km × 3 km and the corresponding photo size in the aerial photograph is 3 cm × 15 cm then the scale of photograph is 1 : _____ (in integer)

Q8. The theoretical aerobic oxidation of biomass ($C_5H_7O_2N$) is given below :
$$C_5H_7O_2N + 5O_2 \rightarrow 5CO_2 + NH_3 + 2H_2O$$
The biochemical oxidation of biomass is assumed as first order reaction with a rate constant of 0.23/day at 20°C (base e) neglecting the second stage oxygen demand from its biochemical oxidation. The ratio of BOD_5 at 20°C to Total Organic Carbon (TOC) of biomass is _____. Atomic weight of C, H O as 12g/mol, 1g/mol, 16g/mol and for N = 14g/mol respectively.

Q9. In a two dimensional stress analysis the state of stress at a point is shown in the fig. The value of length of PQ, QR, RP are 4, 3 & 5 units respectively the principal stresses are _____

$6x = 54$	$6y = 128.5$ MPa
$6x = 26.7$	$6y = 172.5$ MPa
$6x = 16$	$6y = 138.5$ MPa
$6x = 67.5$	$6y = 213.3$ MPa

Q10. Match the column

Air Pollutants	**Health effect of human & animal**
P. Aromatic Hydro Carbons	I. Reduce the capacity of the blood to carry oxygen
Q. Carbon Mono Oxide	II. Bronchitis and Pulmonary Emphysema
R. Sulphur Oxides	III. Damages of Chromosomes
S. Ozone	IV. Carcinogenic effect

(a) P-IV, Q-I, R-II, S-III
(b) P-IV, Q-I, R-III, S-II
(c) P-III, Q-I, R-II, S-IV
(d) P-II, Q-I, R-IV, S-III

Q11. A square footing is to be designed to carry a column load of 500 kN. Which is resting on a soil stratum having the following average properties $\sqrt{b}$ = 19 kN/m³ angle of internal friction $\phi = 0°$ & C = 25 kPa. Considering the depth of footing as 1m and adopting Meyerhoj's bearing capacity theory with a FOS = 3, the width of footing in m is _____
Assume – Applicable Shape

Q12. An idealised frame supports a load as shown in fig. The horizontal component of force transferred from the horizontal member PQ to the vertical member RS at P is _____
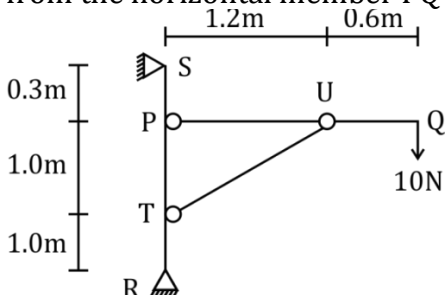
Q13. Which of the following statements is/are true for aerobic composting of sewage sludge?
(a) Bulking agent is added during the composting process to reduce the porosity of the solid mixture
(b) In-vessel composting systems can not be operated in the plug flow mode
(c) Antinoncytes are involved in the process
(d) Leachate can be generated during composting

Q14. The reasons of non uniform elastic settlement profile below a flexible footing resting on a cohensionless soil while subjected to uniform loading is/are
(a) Variation of friction angle along the depth of footing
(b) Variation of soil stiffness along the width of the footing
(c) Variation of soil stiffness along the depth of the footing
(d) Variation of friction angle along the width of the footing

Q15. A compound symmetrical open channel section as shown in the fig. has a maximum of _____ critical depth(s).
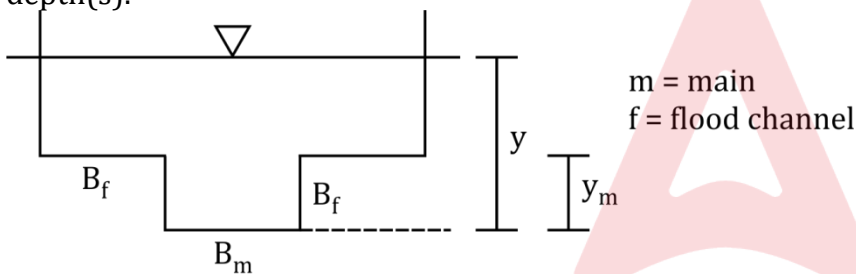
(a) 2
(b) 1
(c) 4
(d) 3

Q16. A beam is subjected to a system of Coplanar forces as shown in the fig. the magnitude of vertical reactions at support P is _____ N
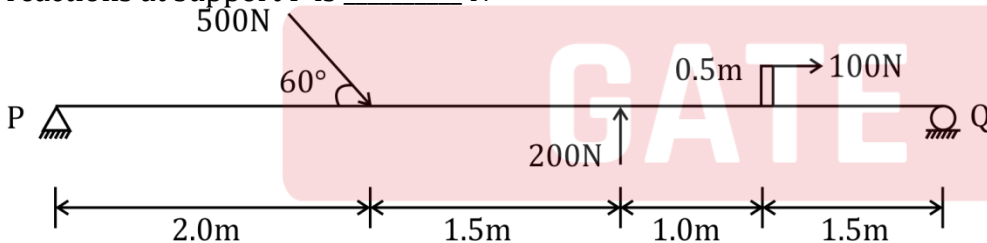
Q17. If x satisfies the equation $4^{8^x} = 256$, then x is equal to
(a) x_3
(b) $\log_{16} 8$
(c) $\frac{1}{2}$
(d) $\log_4 8$

Q18. Which of the following is/are NOT active disinfectant in heater treatment.
(a) OH
(b) CL^-
(c) O_3
(d) OLL^-

Q19. The MB of sun for a location at noon is 183°30'. If the sun is exactly on the geographic meridian at noon, the magnetic deflection of the location is _____-.
(a) 3°30' W
(b) 93°30' W
(c) 93°30' E
(d) 3°30' E

Q20. For the frame, all members AB, BC, CD, GB & CH. Have the same L & Flexural rigidity, EI. The joints at B & C are rigid joints, and the support A & O are fixed support. Beam GB & CH carry uniform DC of the per unit length. The magnitude of the moment reaction at A, $\frac{WL^2}{K}$. What is the value of K (in integers)? K = ?
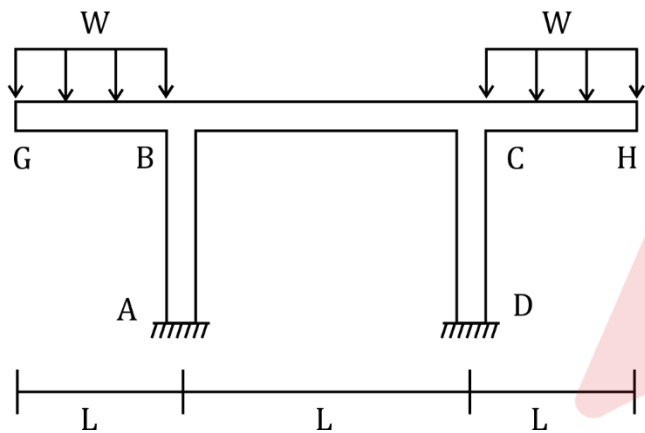
Q21. A unconfined compression strength test was conducted on a cohesive soil. The test specimen failed at an axial stress at 76 KPa. The undrained cohesion (in KPa, in integer) of the soil is _____.

Q22. A beam is subjected to a system of coplanar forces as shown in figure. The magnitude of verticle reaction at support P is _____ N (round off to one decimal place)
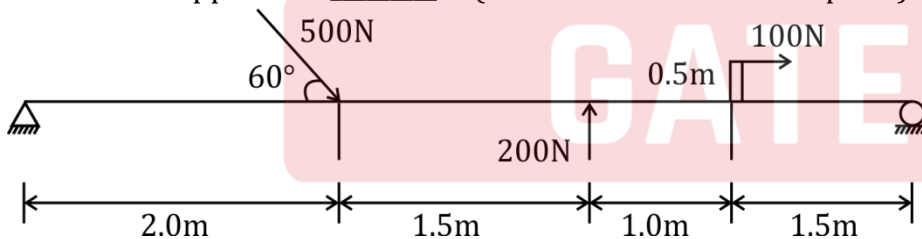
Q23. Kind : _____ : : often : Seldom
(a) Kindred
(b) Type
(c) Cruel
(d) Variety

Q24. The line ran _____ the page, right through the centre, and divided the page into this
(a) between
(b) about
(c) of
(d) across

Q25. Cholesky decomposition is carried out on the following
$$A = \begin{bmatrix} 8 & -5 \\ -5 & a_{22} \end{bmatrix}$$
Let L_{jj} & a_{ij} be the $(i-j)^{th}$ element of matrix $[L] \leftarrow [A]$. If the elements L_{22} of the decomposed lower triangular matrix $[L]$ is 1.968. What is the value of element a_{22}
(a) 11
(b) 7
(c) 5
(d) 9

Q26. If the size of the ground area is 6 km × 3 km and the corresponding photo size in the aerial photograph is 30 cm × 15 cm, the scale of photograph is 1 : _____ in integers.

Q27. A verticle sheet pile hall is installed in an anisotropic soil having co-officient of Horizontal permeability, K_H and cofficient of verticle permeability, k_V. In order to draw the flow net for the isotropic condition, the embedment depth of the initial should be scaled by a factor of _____, without changing the Horizontal scale.

(a) $\sqrt{\dfrac{K_H}{k_v}}$

(b) $\dfrac{K_H}{K_v}$

(c) $\sqrt{\dfrac{K_v}{K_H}}$

(d) 1.0

Q28. For the elevation & temperature data given, the existing lapse route in the environment is _____ C/100 m.

Elevation from ground level m	Temperature (°C)
5	14.2
325	16.9

Q29. An Idealised frame supports a load as shown in figure. The horizontal component of the forces transferred from the Horizontal member PQ to the verticle member RS at P is _____ N. (round off one decimal place)
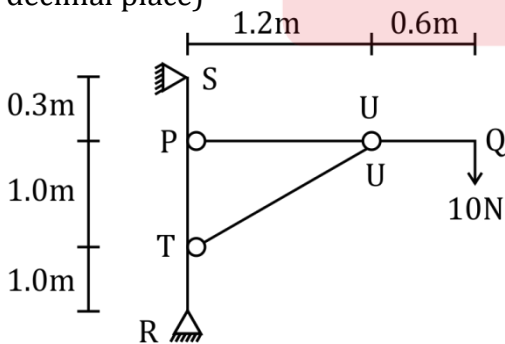
Q30. Two vectors $[2\ 1\ 0\ 3]^T$ & $[1\ 0\ 1\ 2]^T$ belong to the null space of a 4 × 4 inutrix of rank 2. Which one of the following vector also belongs to the null space
(a) $[0 - 2\ 1 - 1]^T$
(b) $[1\ 1 - 1\ 1]^T$
(c) $[2\ 0\ 1\ 2]^T$
(d) $[3\ 1\ 1\ 2]^T$

Q31. A circular shaft of span $L = 5$ m is fixed at one end L free at the other end A torque $T = 100$ kN.m is applied at the free end. The shear modulas & polar MOI of the section are denoted us G & J. The torsional rigidity GJ is 50,000 kN./m²/rad. The following are reported for this shaft
Statement (I) The rotation at the free end is 0.01 rad.
Statement (II) The torsional strain energy is 1.0 kN.m
(a) (I) is correct but (II) is wrong
(b) Both wrong
(c) I is wrong II is correct
(d) Both correct

Q32. Let ϕ be a scalar field, μ be a vector field. Which of the following is true for div (ϕ, μ)
(a) $d(\phi\,\mu) = \phi\,\text{grad}\,(\mu) + \mu.\,\text{Grad}\,(\phi)$
(b) $d(\phi\,\mu) = \phi\,\text{div}\,(\mu) + \mu.\,\text{Grad}\,(\phi)$
(c) $d(\phi\,\mu) = \phi\,\text{grad}\,(\mu) + \mu \times \text{Grad}\,(\phi)$
(d) $d(\phi\,\mu) = \phi\,\text{div}\,(\mu) + \mu \times \text{Grad}\,(\phi)$

Q33. In 20 stress analysis, the state of stress at a point is shown in the figure. The value of length of PQ, QR = RP are 4, 3 & 5 units respectively. The principle stresses are _____.
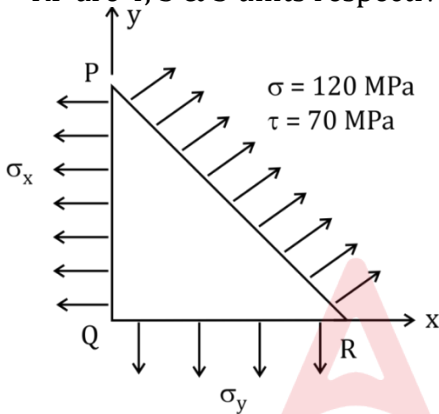
(a) $\sigma_x = 26.7\,MPa \quad \sigma_y = 172.5\,MPa$
(b) $\sigma_x = 67.5\,MPa \quad \sigma_y = 213.3\,MPa$
(c) $\sigma_x = 16.0\,MPa \quad \sigma_y = 138.5\,MPa$
(d) $\sigma_x = 54.0\,MPa \quad \sigma_y = 128.5\,MPa$

Q34. Two plates are connected by fillet welds of size 10 mm and subjected to tension, as shown in figure the thickness of each plate is 12 mm. The yield stress and ultimate stress of steel under tension are 250 MPa and 410 MPa respectively. The welding is done in the workshop $\gamma_{mw} = 1.25$. As per limit state method of IS 800 : 2007. What is the minimum length required of each weld to transmit a factored force P 275 kN?
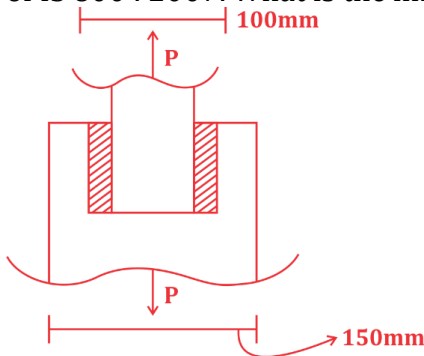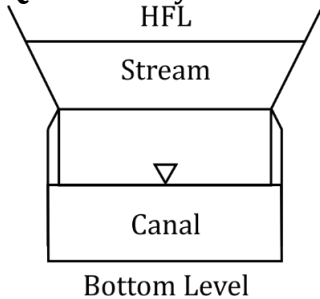
(a) 115
(b) 100
(c) 105
(d) 110

Q35. A SPT was carried out at a location by using manually operated hammer dropping system with 50% efficiency, the recorded SPT values at a particular depth is 28. If an automatic hammer dropping system with 70% efficiency is used at the same location, the recorded SPT value will be _____.
(a) 25
(b) 40
(c) 28
(d) 20

Q36. Identity the CD works in the fig.

(a) Level crossing
(b) Siphon aqueduct
(c) Super passage
(d) Aqueduct

Q37. As per IRC guidelines (IRC 86 : 2018) extra widening depends on which of the following parameters?
(a) No. of lanes
(b) Longitudinal gradient
(c) Super elevation
(d) horizontal curve radius

Q38. Muller-Breslau principle is used in analysis of structure for
(a) drawing an ILD for any force response in the structure
(b) Writing the virtual work expression to get the equilibrium equation
(c) Superposing the load effects to get the total force response in the structure
(d) relating the deflection between two points in a member with the curvature diagram in between.

Q39. Which of the following is/are not active disinfectants in water treatment plant
(a) Cl^-
(b) O_3
(c) OCl^-
(d) OH

Q40. A vertical sheet pile was installed in an anisotropic soil having coefficient of horizontal permeability, K_H & K_V. In order to draw the flow net for the isotropic condition, the embedment depth of the wall should be scaled by factor of _____ without changing the horizontal scale
(a) 1.0
(b) $\sqrt{\dfrac{K_H}{K_V}}$
(c) $\sqrt{\dfrac{K_V}{K_H}}$
(d) $\dfrac{K_H}{K_V}$

Q41. For the frame shown in the figure all members AB, BC, CD, GB and CH have the same length L and flexure rigidity. EI the B & C are rigid joints and A & D are fix supports Beam CHB & CH carry UD2 & the moment of reaction at A is WL^2/K. K is _____.
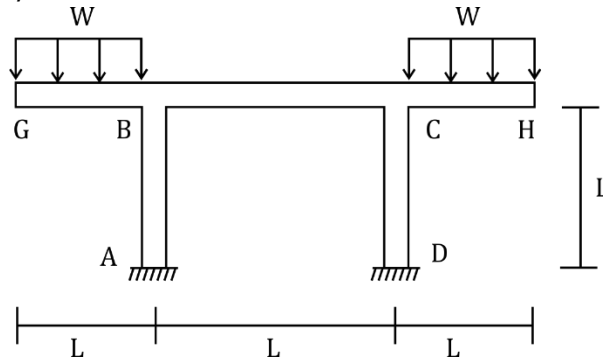
**Q42.** The critical flow condition in a channel is given by a = kinetic energy correction factor

(a) $\frac{aQ^2}{g} = \frac{A_C^3}{T_C}$

(b)

(c) $\frac{aQ}{g} = \frac{Ac^3}{T_c^2}$

(d) $\frac{aQ^2}{g} = \frac{A_c^3}{T_C^2}$

Q43. In how many ways can cells in a 3×3 grib be shaded, such that each row each column have exactly one shaded cell?
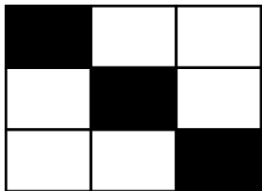

Q44. If x satisfies the equation 4^{8^x}=256, then x is equal to _____.

Q45. In the given figure point O indicates the stress point of soil element at initial non-hydrostatic stress condition. For the stress path (OP) which of the following coadding condition is correct?
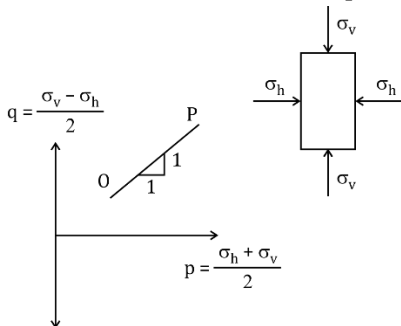
(a) σ v is decreasing & 6 h is increasing
(b) σ v is increasing & 6 h is decreasing
(c) σ v is constant & 6 h is increasing
(d) σ v is increasing & 6 h is constant

Q46. A circle radius 30 km, 5 rain gauges
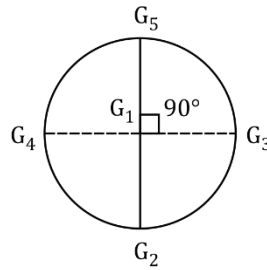
Guage	G_1	G_2	G_3	G_4	G_5
Rainfall (mm)	910	930	925	895	905

Using Thiessen polygon method, what is the average, rainfall over the catchment in that years.

Q47. A delivery agent is at a location R. To deliver the order, she is instructed to travel to location P along the straight line paths of RC, CA, AB & BP of 5 km each. The direction of each path is given in the table below as WCB. Assume latitudes & Departure D of R is (0, 0) km. What is L & D of P in km

Path	RC	CA	AB	BP
Direction	120	0	90	240

(a) L = 0.0, D = 5.0
(b) L = 0.0, D = 0.0
(c) L = 2.5, D = 5.0
(d) L = 5.0, D = 2.5

Q48. A consolidated drained triaxial test was carried out on a sand sample with the known effective shear strength parameters $C' = 0$ and $\phi' = 30°$. In test prior to the failure, when the sample was under going axial compression under constant cell pressure. The drainage value was accidentally closed. At the failure 360 KPa 6_d was recorded along with 70 KPa pore water pressure. If the test is repeated without such error and no back pressure is applied in either of the tests. What is the 6d at the failure.

Q49. Which of the following statements is/are true?
(a) For a curved surface immersed in stationary liquid. The vertical component of the force on the curved surface is equal to the weight of liquid about it.
(b) For flow through circular pipes, the momentum correction factor for laminar flow is larger than that for turbulent flow.
(c) If the streamlines and equipotential lines of a source are interchanged with each other, the resulting flow will be a sink.
(d) The thickness of a turbulent boundary layer on a flat plate kept parallel to the flow direction is proportional to the square root of the distance from the leading edge.

Q50. A circular pile of dia 0.6 m and length 8 m was constructed in a cohesive sail stratum having the following properties. $\gamma_b = 19$ kN/m³, $\phi = 0°$, $c = 25$ KPa. The allowable load the pile can carry with FOS = 3 is in _____ kN ($\gamma = 1.0$ $N_c = 9.0$)

Q51. In the context of water and waste water treatments the correct statements are
(a) ammonia decreases chlorine demand
(b) phosphorous stimulates algal and aquatic growth
(c) Ca & Mg increases hardness and TDS
(d) particulate matter may shield micro-organisms during disinfections.