Sikkim Public Service Commission

Written (Main) Examination for the post of
Sub-Jailer

Time Allowed: 3 hours

PAPER – II
CIVIL ENGINEERING

Maximum Marks: 250

INSTRUCTIONS TO CANDIDATES

Read the instructions carefully before answering the questions: -

1. **This Test Booklet consists of 12 (twelve) pages and has 63 (sixty-three) printed questions.**
2. **IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS BOOKLET DOES NOT HAVE ANY UNPRINTED, TORN OR MISSING PAGES OR ITEMS. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET.**
3. **Use only Black Ball Point Pen to fill the OMR Sheet.**
4. Please note that it is the candidate's responsibility to fill in the Roll Number carefully without any omission or discrepancy at the appropriate places in the **OMR ANSWER SHEET** as well as on **SEPARATE ANSWER BOOKLET** for Conventional Type Questions. Any omission/discrepancy will render the Answer Sheet liable for rejection.
5. Do not write anything else on the OMR Answer Sheet except the required information. Before you proceed to mark in the OMR Answer Sheet, please ensure that you have filled in the required particulars as per given instructions.
6. This Test Booklet is divided into 3 (three) parts – **Part-I, Part-II** and **Part-III**.
7. All three parts are **Compulsory**.
8. **Part-I consists of Multiple-Choice Questions**. The answers for these questions have to be marked in the **OMR Answer Sheet** provided to you.
9. **Parts II and III consist of Conventional Type Questions.** The answers for these questions have to be written in the **Separate Answer Booklet** provided to you.
10. After you have completed filling in all your responses on the OMR Answer Sheet and the Answer Booklet(s) and the examination has concluded, you should hand over the OMR Answer Sheet and the Answer Booklet(s) to the Invigilator only. You are permitted to take the Test Booklet with you.
11. **Marking Scheme**
    THERE WIL BE **NEGATIVE MARKING** FOR WRONG ANSWERS MARKED BY A CANDIDATE IN THE OBECTVE TYPE QUESTIONS
    (i) There are four alternatives for the answer to every question. **For each question for which a wrong answer has been given by the candidate, one-third of the marks assigned to the question will be deducted as penalty.**
    (ii) If a candidate gives more than one answer, it will be treated as a wrong answer even if one of the given answers happens to be correct and there will be same penalty as above to the question.
    (iii) If a question is left blank. i.e., no answer is given by the candidate, there will be no penalty for that question.

DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE ASKED TO DO SO

PART – I
(Multiple Choice Questions)

Choose the correct answer for Questions 1 to 50 from the given options. Each question carries 3 marks. *[50 x 3 = 150]*

1. The RL of the point **P** on the floor is 100m and backsight reading on **P** is 2.455 m. If the foresight reading on the point **Q** which is on the ceiling is 2.745m, the RL of point **Q** will be:
   (a) 95.8
   (b) 105.20
   (c) 100.29
   (d) 104.10

2. Buckling of a column fixed at lower end and free on top is given by:
   (a) $\frac{EL\pi^2}{4L^2}$
   (b) $\frac{EL\pi^2}{3L^2}$
   (c) $\frac{EL\pi^2}{L^2}$
   (d) $\frac{EL\pi^2}{2L^2}$

3. Closed coil helical spring has a deflection, δ of:
   (a) $\frac{WR^2\,n}{8Cd^3}$
   (b) $\frac{128\,WR^3\,n}{Cd^2}$
   (c) $\frac{64WR^2\,n}{Cd^2}$
   (d) $\frac{64WR^3\,n}{Cd^4}$

4. A tie bar of dimension 50 mm × 8 mm is carrying a load of 80 kN. The cross-sectional area of the specimen is 250 mm^2 and the maximum load carrying capacity is 125 kN. The factor of safety in the design will be:
   (a) 3.0
   (b) 1.5
   (c) 2.5
   (d) 2.0

5. If for a fluid in motion, pressure at a point is same in all directions, then the fluid is:
   (a) A Non-Newtonian fluid
   (b) A Newtonian fluid
   (c) An ideal fluid
   (d) A real fluid

6. A soil has discharge velocity of 5 x 10^{-7} m/s and a void ratio of 0.50. Its seepage velocity will be:
   (a) 30 x 10^{-7} m/s
   (b) 20 x 10^{-7} m/s
   (c) 15 x 10^{-7} m/s
   (d) 10 x 10^{-7} m/s

7. Water flows at a depth of 0.10 m with a velocity of 6 m/s in a rectangular channel, the alternate depth is:
   (a) 0.40 m
   (b) 0.30 m
   (c) 0.86 m
   (d) 0.81 m

8. Which of the following stages of creep are characterized by a high strain rate which slows with increasing time?
   (a) Primary
   (b) Secondary
   (c) Tertiary
   (d) All of the above

9. A settlement of 8mm is observed in square bearing plate of dimension 30 cm in the plate load test on cohesionless soil when the intensity of loading is 180 kN/m2. The settlement of a shallow foundation of 1.5 m square under the same intensity of loading will be nearly:
   (a) 18 mm
   (b) 26 mm
   (c) 22 mm
   (d) 30 mm

10. Water flows at a rate of $10m^3/s$ in a rectangular channel 3m wide. The critical depth of flow is:
    (a) 1.45 m
    (b) 1.04 m
    (c) 2 m
    (d) 1.13 m

11. Which of the following are the general design requirements of retaining wall?
    (1) The factor of safety against sliding should be at least 1.5.
    (2) The factor of safety against over-turning should be at least 2.0.
    (3) The bearing pressure at toe should be less than the bearing capacity of the soil.
    (4) The length of retaining wall to be cast in one go should not exceed 10 m otherwise cracks may develop.

    Codes:
    (a) 1, 2 and 3 only
    (b) 1, 2 and 4 only
    (c) 1, 3 and 4 only
    (d) 2, 3 and 4 only

12. If an element of a stressed body is in a state of pure shear with a magnitude of 80 N/mm^2, the magnitude of maximum principal stress at that location is:
    (a) 113 N/mm^2
    (b) 120 N/mm^2
    (c) 80 N/mm^2
    (d) 57 N/mm^2

13. The coefficient of permeability of a soil in x and y direction are K_X and K_Y respectively. The effective coefficient of permeability of the soil will be:
    (a) $K_X + K_Y$
    (b) $\sqrt{K_X K_Y}$
    (c) $\sqrt{K_X{}^2 + K_Y{}^2}$
    (d) $\frac{K_X}{K_Y}$

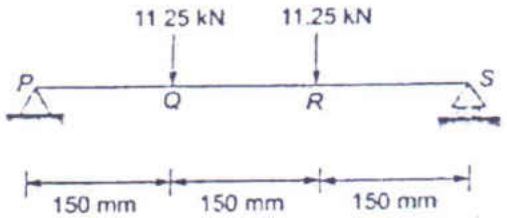
14. Which of the following assumptions are made with respect to Euler's theory applied to columns?
    (1) The section of the column is uniform.
    (2) The length of the column is very large compared to the lateral dimensions.
    (3) The direct stress is large when compared with the bending stress.

    Codes:
    (a) 2 and 3 only
    (b) 1 and 2 only
    (c) 1, 2 and 3 only
    (d) 1 and 3 only

15. A pipe of length 2 km and diameter of 0.2 m is connecting two reservoirs with water level difference in the reservoir as 8 m. The Darcy Weisbatch friction factor of the pipe is 0.04. Accounting for frictional entry and exit losses, the velocity in the pipe in (m/sec) is:
    (a) 1.25
    (b) 2.52
    (c) 0.35
    (d) 0.63

16. Water flows at a depth of 0.10 m with a velocity of 6 m/s in a rectangular channel. The alternate depth is:
    (a) 0.40 m
    (b) 0.30 m
    (c) 0.86 m
    (d) 0.81 m

17. A plain concrete prism of cross section 150 mm x 150 mm is subjected to the concentrated vertical loads as shown in the figure. Length of the prism is given as 450 mm. Considering linear stress distribution across the cross section, the modulus of rapture (in MPa) will be:



(a) 2 MPa
(b) 3 MPa
(c) 5 MPa
(d) 6 MPa

18. Bearing of a given system is shown below:

Line	Fore bearing	Back bearing
AB	126° 45′	308° 00′
BC	45° 15′	227° 30′
CD	340° 30′	161° 45′
DE	258° 30′	78° 30′
EA	216° 30′	31° 45′

Applying correction due to local attraction, the correct bearing of line BC will be:
(a) 48° 45′
(b) 50° 15′
(c) 48° 15′
(d) 49° 15′

19. An in plane curved cantilever beam is subjected to lateral loads. It will develop at any section:
(a) Twisting moment and shearing force
(b) Bending moment and shearing force
(c) Bending moment and twisting moment
(d) Bending moment, twisting moment and shearing force

20. The flow rate in a wide rectangular open channel is 2.0 m^3/s per metre width. The channel bed slope is 0.002. The Manning's roughness coefficient is 0.012. The slope of the channel is classified as:
(a) Steep
(b) Horizontal
(c) Mild
(d) Critical

21. In quadrantal bearing system, bearing of a line varies from:
(a) 0°N to 90° S
(b) 0° to 90°
(c) 0° to 180°
(d) 0° to 360°

22. A rectangular open channel of width 5.0 m is carrying a discharge of 100 m^3/s. The Froude number of the flow is 0.8. The depth of flow (in m) in the channel is:
(a) 16
(b) 20
(c) 4
(d) 5

23. The hydraulic jump always occurs from:
(a) Below normal depth to above normal depth.
(b) Below critical depth to above critical depth.
(c) A M_2 curve to a M_1 curve.
(d) A H_3 curve to a H_1 curve.

24. The magnetic needle in a prismatic compass is placed:
(a) Below the needle lifter, but above the bottom inside the compass.
(b) Below the brass box.
(c) At the bottom of the graduated aluminium ring.
(d) Above the graduated aluminium ring.

25. If an element of a stressed body is in a state of pure shear with a magnitude of 80 N/mm², the magnitude of maximum principal stress at that location is:
    (a) 113 N/mm²
    (b) 120 N/mm²
    (c) 80 N/mm²
    (d) 57 N/mm²

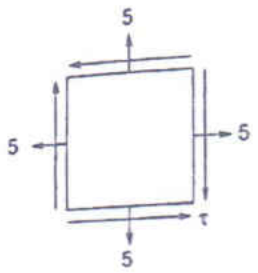
26. On an immersed body in a flowing fluid, the lift force is:
    (a) due to wake phenomenon.
    (b) due to buoyant force
    (c) the dynamic fluid force component normal to approach velocity.
    (d) always in the opposite direction to gravity.

27. A stream function is given by:
$$\Psi = 2x^2y + (x + 1)y^2$$
The flow rate across a line joining points A(3, 0) and B(0, 2) is:
    (a) 0, 4 units
    (b) 4 units
    (c) 1, 1 unit
    (d) 5 units

28. The magnetic bearing of a line AB was N 59° 30′ W in the year 1967, when the declination is 4° 10′ E. If the present declination is 3° W, the whole circle bearing of the line is:
    (a) 293° 20′
    (b) 307° 40′
    (c) 299° 20′
    (d) 301° 40′

29. In a 1/50 model of a spillway, the discharge was measured to be 0.3 m³/sec. The corresponding prototype discharge in m3/sec is:
    (a) 106.0
    (b) 5303.0
    (c) 2.0
    (d) 15.0

30. For the stress state (in MPa) shown in figure, the major principal stress is 10 MPa.



The shear stress τ is:
    (a) 10.0 MPa
    (b) 0.0 MPa
    (c) 5.0 MPa
    (d) 2.5 MPa

31. The depth of tension cracks in a soft clay ($\phi_u = 0°$) is:
    (a) $\frac{C_U}{\gamma}$
    (b) $\frac{4C_U}{\gamma}$
    (c) $\frac{2C_U}{\gamma}$
    (d) $\frac{C_U}{2\gamma}$

32. For the fillet weld of size 's' shown in the adjoining figure, the effective throat thickness is:

    (a) 0.75 s
    (b) 0.70 s
    (c) 0.65 s
    (d) 0.61 s

33. Two straight lines intersect at an angle of 60°. The radius of a curve joining the two straight lines is 600m. The length of long chord and mid-ordinates (in meters) of the curve are:
    (a) 600.0 & 39.89 respectively.
    (b) 600.0 & 80.4 respectively.
    (c) 80.4 & 600.0 respectively.
    (d) 49.89 & 300.0 respectively.

34. The kern area (core) of a solid circular section column of diameter ***D***, is a concentric circle of diameter ***d*** equal to:
    (a) $D/4$
    (b) $D/8$
    (c) $D/2$
    (d) $D/6$

35. A Theodolite is placed at P and a vertical staff 3 m long is held at Q. The depression angle of 6°10′ is made at a reading of 2.5 m marking on staff. The horizontal distance between P and Q is 2200 m. The height of instrument at P is 1.2 m and reduced level of point P is 880.88 m using curvature correction and refraction correction. Determine the R.L. of point Q (in m)?
    (a) 650 m
    (b) 635 m
    (c) 580 m
    (d) 642 m

36. The necessary and sufficient condition for a surface to be called as a 'free surface' is:
    (a) Shear stress acting on it must be zero.
    (b) No stress should be acting on it.
    (c) Tensile stress action on it must be zero.
    (d) No point on it should be under any stress.

37. The two criteria for the determination of allowable bearing capacity of a foundation are:
    (a) Bond failure and shear failure.
    (b) Shear failure and settlement.
    (c) Tensile failure and compression failure.
    (d) Tensile failure and settlement.

38. Which one of the following surveys employs alidade?
    (a) Archaeological survey.
    (b) Contour survey.
    (c) Reconnaissance survey.
    (d) Plane table survey.

39. An 800 mm diameter pipe has a fluid pressure of 25 N/mm^2. If the safe stress in tension is 100 N/mm^2. Find the minimum thickness of the pipe.
    (a) 6 mm
    (b) 12 mm
    (c) 10 mm
    (d) 8 mm

40. The Prandtl mixing length for turbulent flow through pipes is:
    (a) A universal constant.
    (b) Zero at the pipe wall.
    (c) Dependent on shear stress at the wall.
    (d) Independent of radial distance from pipe axis

41. The number of π parameters needed to express the function $F(A, V, t, \mu, L) = 0$ in dimensional analysis is:
    (a) 2
    (b) 3
    (c) 4
    (d) 5

42. A solid circular shaft of diameter d and length L is fixed at one end and free at the other end. A torque T is applied at the free end. The shear modulus of the material is G. The angle of twist at the free end is:
    (a) $\frac{32TL}{\pi d^4 G}$
    (b) $\frac{128TL}{\pi d^4 G}$
    (c) $\frac{16TL}{\pi d^4 G}$
    (d) $\frac{64TL}{\pi d^4 G}$

43. A clay soil sample is tested in a triaxial apparatus in consolidated drained conditions at a cell pressure of 100 kN/m². What will be the pore water pressure at a deviator stress of 40 kN/m²?
    (a) 60 kN/m²
    (b) 40 kN/m²
    (c) 20 kN/m²
    (d) 0 kN/m²

44. The main purpose of tie lines in surveying is:
    (a) Serves as reference line.
    (b) Check the accuracy of work.
    (c) Take details of nearby objects.
    (d) None of the above.

45. 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

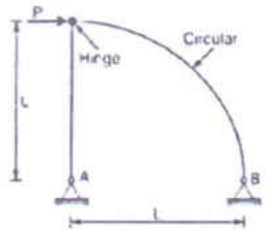
46. The Reduced Levels (RLs) of the points A and B are +49.600 m and +51.870 m respectively. Distance AB is 20 m. The distance (in m from A) at which the +51.000 m contour cuts the line AB is:
    (a) 2.27
    (b) 3.52
    (c) 12.33
    (d) 15.00

47. The distance between two points on the plan, drawn to a scale of 1 cm = 40 m, was 468 m. However, later it was discovered that the scale used was of 1 cm = 20 m. Find the true distance between the points.
    (a) 639 m
    (b) 963 m
    (c) 693 m
    (d) 936 m

48. Flow at critical depth takes place in an open channel when:
    (a) Discharge is minimum for a given specific force.
    (b) Discharge is maximum for a given specific force.
    (c) For a given specific energy, discharge is maximum.
    (d) For a given discharge, specific energy is minimum.

49. A deep cut of 7 m has to be made in a clay with unit weight 16 kN/m³ and a cohesion of 25 kN/m². What will be the factor of safety if one has to have a slope angle of 30°? Stability number is given to be 0.178 (from Taylor's chart) for a depth factor of 3.
    (a) 0.80
    (b) 1.0
    (c) 1.1
    (d) 1.25

50. Vertical reaction at support B of the structure is:



    (a) $\frac{P}{\sqrt{2}}$
    (b) $P\sqrt{2}$
    (c) $\frac{P}{2}$
    (d) P

PART - II
(Conventional Type Questions)

Answer any 2 (two) from Questions 51 to 55. Each question carries 25 marks.

[2 x 25 = 50]

51.

(a) What are the assumptions and limitations of Euler's theory for long columns?

(b) A slender pin ended aluminium column 2.0 m long and of circular cross-section is to have an outside diameter of 50 mm. Calculate the necessary internal diameter to prevent failure by buckling if the actual load applied is 12 kN and the critical load applied is twice the actual load. Take E for aluminium as 70 GN/m^2.

52. Two sets of tacheometric reading were taken from an instrument station A (R.L. = 100.50 m) to a staff station B as given below:

Instrument	P	Q
Multiplying constant	95	90
Additive constant	0.25	0.35
Height of instrument	1.35 m	1.40 m
Staff held	Vertical	Normal

Instrument	Instrument station	Staff station	Vertical angle	Stadia readings (m)		
P	A	B	8°12′	0.905	1.305	1.555
Q	A	B	8°12′	?	?	?

Determine:

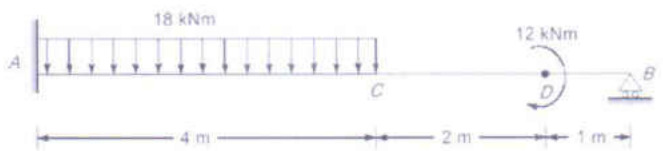
(a) The distance between instrument station and staff station.

(b) The reduced level of staff station B.

(c) The stadia readings with instrument Q.

53. Soft saturated clay has a thickness of 6 m. After one year, when the clay consolidated by 50%, the observed settlement was 10 cm. For an identical clay and loading condition, what will be the magnitude of settlement at the end of one year and five years if the thickness of the clay layer was 25 m?

54. Analyse the propped cantilever beam shown in the figure. During loading the top B sinks by 6 mm. $E = 2 \times 10^5\ MPa$, $I = 86.04 \times 10^6\ mm^4$. Draw shear force and bending moment diagrams. Find the maximum Bending Moment value and its location from either of the supports.



55. What are the different forces acting in a moving fluid? Also, discuss different similarity model laws used to study the dynamic similarity of prototypes?

PART - III
(Conventional Type Questions)

Answer any 5 (five) from Questions 56 to 63. Each question carries 10 marks.

[5 x 10 = 50]

56. Derive the Bernoulli's equation and state its assumptions.

57. Define 'noise' and explain as to why and how it should be regarded as an Environmental pollutant. Also, explain briefly the major factors and actions that may help in noise abatement in a modern society.

58. What do you understand by aerobic digestion? What are its advantages and disadvantages?

59. Two shaft PQ and QR of equal length and diameter d and $2d$ are made of the same material. They are joined at Q through a shaft coupling. A twisting moment (T) is applied at Q. Find the ratio of twisting moments at the end P to twisting moments at the end R.

60. A concrete pile 450 mm in diameter and 20 m long is driven through a system of layered cohesive soil. The following data are available:
    (1) The top layer is 8 m thick and comprises of soft clay with cohesion of 30 kN/m² and adhesion factor of 0.90.
    (2) The middle layer which is medium stiff clay has a thickness of 6 m and undrained cohesion of 50 kN/m² with adhesion factor of 0.75.
    (3) The bottom-most layer which is stiff strata extends to a great depth with undrained cohesion of 105 kN/m² and adhesion of 0.50.

    Compute the ultimate and allowable capacity of the pile if the factor of safety is assumed as 3.0. The water table is observed to be at ground level.

61. Plan of an area has shrunk such that a line originally 10 cm long now measures as 9.5 cm. If the original scale was 1 cm = 10 m, determine the:
    (a) Correct length corresponding to a measured length of 100 m.
    (b) Correct area corresponding to a measured area of 100 m².
    (c) Shrinkage factor.
    (d) Shrunk scale.

62. A beam of rectangular cross-section is subjected to vertical shear force of V. Then find the shear force carried by the upper one-third of the cross section.

63. A rectangular plate of $0.50\ m \times 0.50\ m$ dimensions weighing 500 N slides down an inclined plane making 30° angle with the horizontal, at a velocity of 1.75 m/s. If the 2 mm gap between the plate and the inclined surface is filled with a lubricating oil, find its viscosity and express it in *poise* as well as in Ns/m^2.

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