MIZORAM PUBLIC SERVICE COMMISSION

TECHNICAL COMPETITIVE EXAMINATIONS FOR RECRUITMENT TO THE POST OF

INSPECTOR OF LEGAL METROLOGY

UNDER FOOD, CIVIL SUPPLIES & CONSUMER AFFAIRS, GOVT. OF MIZORAM

NOVEMBER, 2023

CIVIL ENGINEERING PAPER-II

Time Allowed : 2 hours | Full Marks : 200

All questions carry equal mark of 2 each.

Attempt all questions.

1. The dimensions of a pressure gradient in a fluid flow are

(a) $ML^{-1}T^{2}$ (b) $ML^{-3}T^{-2}$

(c) $ML^{-2}T^{-2}$ (d) $M^{-1}L^{-3}T^{-2}$

2. Shear stress in the Newtonian fluid is proportional to

(a) Pressure (b) Strain

(c) Strain rate (d) The inverse of the velocity

3. A liquid of density ρ and dynamic viscosity μ flows steadily down an inclined plane in a thin sheet of constant thickness t. Neglecting air friction the shear stress on the bottom surface due to the liquid flow is (where θ is the angle the plane makes with the horizontal)

(a) $\rho g t \sin\theta$ (b) $\rho g t \cos\theta$

(c) $\mu\left(\frac{g}{t}\right)^{0.5}$ (d) ρg

4. The necessary and sufficient condition for a surface to be called as a 'free surface' is

(a) no stress should be acting on it (b) tensile stress acting on it must be zero

(c) shear stress acting on it must be zero (d) no point on it should be under any stress

5. A lake has a maximum depth of 60 m. If the mean atmospheric pressure in the lake region is 91 kPa and the unit weight of the lake water is 9790 N/m^3, the absolute pressure (in kPa, round off to two decimal places) at the maximum depth of the lake is

(a) 690.4 (b) 658.4

(c) 678.4 (d) 688.4

6. A vertical triangular plane area, submerged in water, with one side in the free surface, vertex downward and latitude 'h' has the pressure centre below the free surface by

(a) h/4 (b) h/3

(c) 2h/3 (d) h/2

7. The equation $gz+\frac{V^2}{2}+\frac{P}{\rho}$ = constant along a stream line holds true for

(a) Steady, frictionless, compressible fluid (b) Steady, uniform, incompressible fluid

(c) Steady, frictionless, incompressible fluid (d) unsteady incompressible fluid

8. Two flow patterns are represented by their stream functions Ψ_1 and Ψ_2 as given below

$\Psi_1 = x^2 + y^2$

$\Psi_2 = 2xy$

If these two patterns are superimposed on one another, the resulting streamline pattern can be represented by one of the following

(a) A family of parallel straight lines
(b) A family of circles
(c) A family of parabolas
(d) A family of hyperbolas

9. A body moving through still water at 6 m/sec produces a water velocity of 4 m/sec at a point 1 m ahead. The difference in pressure between the nose and the point 1 m ahead would be

(a) 2000 N/m^2
(b) 10000 N/m^2
(c) 19620 N/m^2
(d) 98100 N/m^2

10. The reading of differential manometer of a venturi meter, placed at 45° to the horizontal is 11 cm. If the venturi meter is turned to horizontal position, the manometer reading will be

(a) Zero cm
(b) $\frac{11}{\sqrt{2}}$ cm
(c) 11 cm
(d) $11\sqrt{2}$ cm

11. A venturi meter having a throat diameter of 0.1 m is used to estimate the flow rate of a horizontal pipe having a diameter of 0.2 m. For an observed pressure difference of 2 m of water head and coefficient of discharge equal to unity, assuming that the energy losses are negligible; the flow rate (in m^3/s) through the pipe is approximately equal to

(a) 0.500
(b) 0.150
(c) 0.050
(d) 0.015

12. Bernoulli's equation is applicable for

(a) Viscous and compressible fluid flow
(b) Inviscid and compressible fluid flow
(c) Inviscid and incompressible fluid flow
(d) viscous and incompressible fluid flow

13. Water flows through a 100 mm diameter pipe with a velocity of 0.015 m/sec. If the kinematic viscosity of water is 1.13×10^{-6} m^2/sec, the friction factor of the pipe material is

(a) 0.0015
(b) 0.032
(c) 0.037
(d) 0.048

14. On an immersed body in a flowing fluid, the lift force is

(a) due to buoyant force
(b) always in the opposite direction to gravity
(c) due to weak phenomenon
(d) the dynamic fluid force component normal to approach velocity

15. The Prandtl mixing length for turbulent flow through pipes is

(a) dependent on shear stress at the wall
(b) a universal constant
(c) zero at the pipe wall
(d) independent of radial distance from pipe axis

16. A laboratory model of a river is built to geometric scale of 1:100. The fluid used in the model is oil of mass density 900 kg/m^3. The highest flood in the river is 10,000 m^3/s. The corresponding discharge in the model shall be

(a) 0.095 m^3/s
(b) 0.100 m^3/s
(c) 0.105 m^3/s
(d) 10.5 m^3/s

17. The percentage error in the computed discharge over a triangular notch corresponding to an error of 1% in the measurement of the head over the notch would be
    (a) 1.0 (b) 1.5
    (c) 2.0 (d) 2.5

18. In deriving the equation for the hydraulic jump in the rectangular channel in terms of the conjugate depths and the initial Froude number,
    (a) continuity equation and energy equation are used
    (b) continuity equation and momentum equation are used
    (c) equations of continuity, momentum and energy are used
    (d) gradually varied flow equation is used.

19. Water flows in a rectangular channel at a depth of 1.20 m and a velocity of 2.4 m/s. A local rise in the bed of 0.60 m will cause
    (a) the surface to rise (b) the surface to fall
    (c) a stationary jump to form (d) a surge to travel upstream

20. A very wide rectangular channel is designed to carry a discharge of 5 m^3/s per meter width. The design is based on the Manning's equation with the roughness coefficient obtained from the grain size using Strickler's equation and results in a normal depth of 1.0 m. By mistake, however, the engineer used the grain diameter in mm in the Strickler's equation instead of in meter. What should be the correct normal depth?
    (a) 0.32 m (b) 0.50 m
    (c) 2.00 m (d) 3.20 m

21. A tropical cyclone in a northern hemisphere is a wind stream with
    (a) High pressure zone of anti-clockwise rotation (b) High pressure zone of clockwise rotation
    (c) Low pressure zone of anti-clockwise rotation (d) Low pressure zone of clockwise rotation

22. Match List-I with List-II and select the correct answers

List-I	List-II
A. Rainfall intensity	1. Isohyets
B. Rainfall excess	2. Cumulative rainfall
C. Rainfall averaging	3. Hyetograph
D. Mass curve	4. Direct runoff hydrograph

    (a) A B C D 1 3 2 4 (b) A B C D 3 4 1 2
    (c) A B C D 1 2 4 3 (d) A B C D 3 4 2 1

23. The intensity of rainfall and time interval of a typical storm are:

Time interval (minutes)	Intensity of rainfall (mm/minute)
0-10	0.7
10-20	1.1
20-30	2.2
30-40	1.5
40-50	1.2
50-60	1.3
60-70	0.9
70-80	0.4

    The maximum intensity of rainfall for 20 minutes duration of the storm is
    (a) 1.5 mm/minute (b) 1.85 mm/minute
    (c) 2.2 mm/minute (d) 3.7 mm/minute

24. In a catchment, there are four rain-gauge stations, P, Q, R and S. Normal annual precipitation values at these stations are 780 mm, 850 mm, 920 mm and 980 mm, respectively. In the year 2013, stations Q, R and S were operative but P was not. Using the normal ratio method, the precipitation at station P for the year 2013 has been estimated as 860 mm. If the observed precipitation at stations Q and R for the year 2013 were 930 mm and 1010 mm, respectively; what was the observed precipitation (in mm) at station S for that year?

(a) 1023.43 mm
(b) 1093.43 mm
(c) 1043.43 mm
(d) 1103.43 mm

25. A catchment may be idealised as a rectangle. There are three rain gauges located inside the catchment at arbitrary locations. The average precipitation over the catchment is estimated by two methods:

(i) Arithmetic mean (P_A), and
(ii) Thiessen polygon (P_T).

Which one of the following statements is correct?

(a) P_A is always smaller than P_T
(b) P_A is always equal to P_T
(c) There are no definite relationships between P_A and P_T
(d) P_A is always greater than P_T

26. The number of revolutions of a current meter in 50 seconds were found to be 12 and 30 corresponding to the velocities of 0.25 and 0.46 m/s respectively. What velocity (in m/s) would be indicated by 50 revolutions of that current meter in one minute?

(a) 0.42
(b) 0.50
(c) 0.60
(d) 0.73

27. In a river, discharge is 173 m^3/s; water surface slope is 1 in 6000; and stage at the gauge station is 10.0 m. If during a flood, the stage at the gauge station is same and the water surface slope is 1 in 2000, the flood discharge in m^3/s, is approximately

(a) 371
(b) 100
(c) 519
(d) 300

28. The plan area of a reservoir is 1 km^2. The water level in the reservoir is observed to decline by 20 cm in a certain period. During this period the reservoir receives a surface inflow of 10 hectare-meters, and 20 hectare-meters are abstracted from the reservoir for irrigation and power. The pan evaporation and rainfall recorded during the same period at a nearby meteorological station are 12 cm and 3 cm respectively. The calibrated pan factor is 0.7. The seepage loss from the reservoir during this period in hectare-meters is

(a) 0.0
(b) 1.0
(c) 2.4
(d) 4.6

29. The top width and the depth of flow in a triangular channel were measured as 4 m and 1 m, respectively. The measured velocities on the centre line at the water surface, 0.2 m and 0.8 m below the surface are 0.7 m/s, 0.6 m/s and 0.4 m/s respectively. Using two-point method of velocity measurement, the discharge (in m^3/s) in the channel is

(a) 1.4
(b) 1.2
(c) 1.0
(d) 0.8

30. The average surface area of reservoir in the month of June is 20 km^2. In the same month, the average rate of inflow is 10 m^3/s, outflow rate is 15 m^3/s, monthly rainfall is 10 cm, monthly seepage loss is 1.8 cm and the storage channel is 16 million m^3. The evaporation (in cm) in that month is

(a) 46.8
(b) 136.0
(c) 13.6
(d) 23.4

31. The parameters in Horton's infiltration equation $[f(t) = f_c + (f_0 - f_c)e^{-kt}]$ are given as, $f_0 = 7.62\frac{cm}{hour}$, $f_c = 1.34\frac{cm}{hour}$ and $k = 4.182$/hour. For assumed continuous ponding the cumulative infiltration at the end of 2 hours is

(a) 2.68 cm
(b) 1.50 cm
(c) 1.34 cm
(d) 4.18 cm

32. The direct runoff hydrograph of a storm obtained from a catchment is triangular in shape and has a base period of 80 hours. The peak flow rate is 30 m^3/s and catchment area is 86.4 km^2. The rainfall excess that has resulted the above hydrograph is

(a) 5 cm
(b) 8 cm
(c) 10 cm
(d) 16 cm

33. During a 3-hour storm event, it was observed that all abstractions other than infiltration are negligible. The rainfall was idealized as 3 one-hour storms of intensity 10 mm/hr, 20 mm/hr and 10 mm/hr respectively and the infiltration was idealized as a Horton curve, $f = 6.8 + 8.7e^{-t}$ (f in mm/hr and t in hr). What is the effective rainfall?

(a) 10.00 mm
(b) 11.33 mm
(c) 12.43 mm
(d) 13.63 mm

34. A triangular direct runoff hydrograph due to a storm has a time base of 90 hours. The peak flow of 60m^3/s occurs at 20 hours from the start of the storm. The area of catchment is 300 km^2. The rainfall excess of the storm (in cm), is

(a) 5.40
(b) 2.00
(c) 3.24
(d) 6.48

35. 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 base flow of 10 m^3/s, the peak flow ordinate (in m^3/s) of one-hour unit hydrograph for the watershed is

(a) 12.66 m^3/s
(b) 11.66 m^3/s
(c) 9.66 m^3/s
(d) 10.66 m^3/s

36. Dickens formula predicts maximum flood discharge, Q, in terms of the area, A, and the co-efficient, c, as $Q = cA^n$. The value of n is

(a) 0.25
(b) 0.50
(c) 0.67
(d) 0.75

37. The stage-discharge relation in a river during the passage of flood is measured. If q_f is the discharge at the stage when water surface is falling and q_r is the discharge at the same stage when water surface is rising, then

(a) $q_f = q_r$
(b) $q_f < q_r$
(c) $q_f > q_r$
(d) $\frac{q_f}{q_r} = constant\ for\ all\ stages$

38. The Muskingum model of routing a flood through a stream reach is expressed as $O_2 = K_0 I_2 + K_1 I_1 + K_2 O_1$, where K_0, K_1 and K_2 are the routing coefficients for the concerned reach, I_1 and I_2 are the inflows to the reach, O_1 and O_2 are the outflows from the reach corresponding to time steps 1 and 2 respectively. The sum of K_0, K_1 and K_2 of the model is

(a) -1 (b) -0.5

(c) 0.5 (d) 1

39. An inflow hydrograph is routed through a reservoir to produce an outflow hydrograph. The peak flow of the inflow hydrograph is P_I and the time of occurrence of the peak is t_I. The peak flow of the outflow hydrograph is P_0 and the time of occurrence of the peak is t_0. Which one of the following statements is correct?

(a) $P_I > P_0$ and $t_I > t_0$ (b) $P_I > P_0$ and $t_I < t_0$

(c) $P_I < P_0$ and $t_I < t_0$ (d) $P_I < P_0$ and $t_I > t_0$

40. Match Column X with Column Y:

Column X	Column Y
(P) Horton equation	(I) Design of alluvial channel
(Q) Penman method	(II) Maximum flood discharge
(R) Chezy's formula	(III) Evapotranspiration
(S) Lacey's theory	(IV) Infiltration
(T) Dicken's formula	(V) Flow velocity

Which one of the following combinations is correct?

(a) (P)-(IV), (Q)-(III), (R)-(II), (S)-(I), (T)-(V) (b) (P)-(III), (Q)-(IV), (R)-(I), (S)-(V), (T)-(II)

(c) (P)-(IV), (Q)-(III), (R)-(V), (S)-(I), (T)-(II) (d) (P)-(III), (Q)-(IV), (R)-(V), (S)-(I), (T)-(II)

41. Water distribution systems are sized to meet the

(a) Maximum hourly demand (b) Average hourly demand

(c) Maximum daily demand and fire demand (d) Average daily demand and fire demand

42. The present population of a community is 28000 with an average water consumption of 4200 m^3/d. The existing water treatment plant has a design capacity of 6000 m^3/d. It is expected that the population will increase to 44000 during the next 20 years. The number of years from now when the plant will reach its design capacity, assuming an arithmetic rate of population growth, will be

(a) 5.5 years (b) 8.6 years

(c) 15.0 years (d) 16.5 years

43. The microbial quality of treated piped water supplies is monitored by

(a) Microscopic examination (b) Plate count of heterotrophic bacteria

(c) Coliform MPN test (d) Identification of all pathogens

44. A 50 ml sample of industrial wastewater is taken into a silica crucible. The empty weight of the crucible is 54.352 g. The crucible with the sample is dried in a hot air oven at 104°C till a constant weight of 55.129 g. Thereafter, the crucible with the dried sample is fired at 600°C for 1 h in a muffle furnace, and the weight of the crucible along with residue is determined as 54.783 g. The concentration of total volatile solids is

(a) 15540 mg/l (b) 8620 mg/l

(c) 6920 mg/l (d) 1700 mg/l

45. For a flow of 5.7 MLD (million litres per day) and a detention time of 2 hours, the surface area of a rectangular sedimentation tank to remove all particles having settling velocity of 0.33 mm/s is

(a) 20 m^2 (b) 100 m^2
(c) 200 m^2 (d) 400 m^2

46. The following characteristics pertain to the sand filters used in water industry

I. Filtration rate is 1 to 4 $m^3/m^2/day$
II. Typical duration of operation in one run is 24 to 72 hours
III. Operating cost is lowWhich of the above characteristics pertain to slow sand filters?

(a) I, II and III (b) I and II
(c) II and III (d) I and III

47. The potable water is prepared from turbid surface water by adopting the following treatment sequence,

(a) Turbid surface water → Coagulation → Flocculation → Sedimentation → Filtration → Disinfection → Storage & Supply
(b) Turbid surface water → Disinfection → Flocculation → Sedimentation → Filtration → Coagulation → Storage & Supply
(c) Turbid surface water → Filtration → Sedimentation → Disinfection → Flocculation → Coagulation → Storage & Supply
(d) Turbid surface water → Sedimentation → Flocculation → Coagulation → Disinfection → Filtration → Storage & Supply

48. Which of the following process(es) can be used for conversion of salt water into fresh water?

(a) Microfiltration (b) Straining
(c) Ultrafiltration (d) Reverse osmosis

49. Storage coefficient of a compressible confined aquifer is a function of

(a) Specific weight of water, thickness of the aquifer and compressibility of water
(b) Permeability, thickness and compressibility of aquifer and compressibility of water
(c) Transmissibility of the aquifer and compressibility of water
(d) Transmissibility of aquifer and specific yield of aquifer

50. A tracer takes 100 days to travel from Well-1 to Well-2 which are 100 m apart. The elevation of water surface in Well-2 is 3 m below that in Well-1. Assuming porosity equal to 15%, the coefficient of permeability (expressed in m/day) is

(a) 0.30 (b) 0.45
(c) 1.00 (d) 5.00

51. High COD to BOD ratio of an organic pollutant represents

(a) High biodegradability of the pollutant
(b) Low biodegradability of the pollutant
(c) Presence of free oxygen for aerobic decomposition
(d) Presence of toxic material in the pollutant

52. Water samples (X and Y) from two different sources were brought to the laboratory for the measurement of dissolved oxygen (DO) using modified Winkler method. Samples were transferred to 300 mL BOD bottles. 2mL of $MnSO_4$ solution and 2 mL of alkali iodide – azide reagent were added to the bottles and mixed. Sample X developed a brown precipitate, whereas sample Y developed a white precipitate. In reference to these observations, the correct statement is

(a) Both the samples were devoid of DO
(b) Sample X was devoid of DO while sample Y contained DO
(c) Sample X contained DO while sample Y was devoid of DO
(d) Bothe the sampled contained DO

53. Total Kjeldahl nitrogen is a measure of

(a) Total organic nitrogen
(b) Total organic and ammonia nitrogen
(c) Total ammonia nitrogen
(d) Total inorganic and ammonia nitrogen

54. Ultimate BOD of a river water sample is 20 mg/L. BOD rate constant (natural log) is 0.15 day^{-1}. The respective values of BOD (in %) exerted and remaining after 7 days are:

(a) 45 and 55
(b) 55 and 45
(c) 65 and 35
(d) 75 and 25

55. The 'Sag' in the dissolved oxygen curve results because

(a) It is a function of the rate of addition of oxygen to the stream
(b) It is a function of rate of depletion of oxygen from the stream
(c) It is a function of both addition and depletion of oxygen from the stream
(d) The rate of addition is linear but the rate of depletion is non-linear

56. The wastewater from a city, containing high concentration of biodegradable organics, is being steadily discharged into a flowing river at a location S. If the rate of aeration of the river water is lower than the rate of degradation of the organics, then the dissolved oxygen of the river water.

(a) Is the lowest at the location S.
(b) Is lowest at a point upstream of the location S.
(c) Remains constant all along the length of the river.
(d) Is lowest at a point downstream, of the location S.

57. The drop manholes are provided in sewerage system when there is

(a) Change in alignment of the sewer line
(b) Change in size of sewers
(c) Change in the elevation of ground level
(d) Change from gravity system to pressure system

58. An inverted siphon is a

(a) Device for distributing septic tank effluent to a soil absorption system
(b) Device for preventing overflow from elevated water storage tank
(c) Device for preventing crown corrosion of sewer
(d) Section of sewer which is dropped below the hydraulic grade line in order to avoid an obstacle.

59. A trickling filter is primarily a

(a) Straining process to remove suspended solids from sewage
(b) Biological oxidation process to remove BOD from sewage
(c) Straining process to remove turbidity from water
(d) Straining process to remove bacteria from water

60. The most important type of species involved in the degradation of organic matter in the case of activated sludge process is

(a) Autotrophs
(b) Heterotrophs
(c) Prototrophs
(d) Photo-autotrophs

61. An impulse turbine

(a) Always operates submerged
(b) Makes use of a draft tube
(c) Operated by initial complete conversion to kinetic energy
(d) Converts pressure head into velocity head throughout the vanes

62. A hydraulic turbine develops a power of 10^4 metric horse power while running at a speed of 100 revolutions per minute, under a head of 40 m. Its specific speed is nearest to one of the following

(a) 100 (b) 628

(c) 523 (d) 314

63. A nozzle discharging water under head H has an outlet area 'a' and discharge coefficient $C_d = 1.0$. A vertical plate is acted upon by the fluid force F_j when held across the free jet and by the fluid force F_n when held against the nozzle to stop the flow. The ratio $\frac{F_j}{F_n}$ is

(a) $\frac{1}{2}$ (b) 1

(c) $2^{0.5}$ (d) 2

64. A hydraulic turbine has a discharge of 5 m^3/s, when operating under a head of 20 m with a speed of 500 rpm. If it is to operate under a head of 15 m, for the same discharge, the rotational speed in rpm will approximately be

(a) 433 (b) 403

(c) 627 (d) 388

65. A horizontal water jet with a velocity of 10 m/s and cross-sectional area of 10 mm^2 strikes a flat plate held normal to the flow direction. The density of water is 1000 kg/m^3. The total force on the plate due to the jet is

(a) 100 N (b) 10 N

(c) 1 N (d) 0.1 N

66. A horizontal jet of water with its cross-sectional area of 0.0028 m^2 hits a fixed vertical plate with a velocity of 5 m/s. After impact the jet splits symmetrically in a plane parallel to the plane of the plate. The force of impact (in N) of the jet on the plate is

(a) 90 (b) 80

(c) 70 (d) 60

67. A horizontal nozzle of 30 mm diameter discharges a steady jet of water into the atmosphere at a rate of 15 litres per second. The diameter of inlet to the nozzle is 100 mm. The jet impinges normal to ta flat stationary plate held close to the nozzle end. Neglecting air friction and considering the density of water as 1000 kg/m^3, the force exerted by the jet (in N) on the plate is

(a) 318.3 N (b) 218.3 N

(c) 338.3 N (d) 238.3 N

68. A penstock of 1 m diameter and 5 km length is used to supply water from a reservoir to an impulse turbine. A nozzle of 15 cm diameter is fixed at the end of the penstock. The elevation difference between the turbine and water level in the reservoir is 500 m. Consider the head loss due to friction as 5% of the velocity head available at the jet. Assume unit weight of water = 10 kN/m^3 and acceleration due to gravity (g) = 10 m/s^2. If the overall efficiency is 80% power generated (expressed in kW and rounded to nearest integer) is

(a) 6570 kW (b) 6650 kW

(c) 6740 kW (d) 6240 kW

69. Water is to be lifted by a net head of 150 m. Identical pumps each with specific speed of 30 and rotational speed of 1450 rpm with design discharge of 0.2 m^3/s are available. The minimum number of pumps required is

(a) 3 (b) 4

(c) 2 (d) 5

70. The expression for the specific speed of a pump

(a) Does not include the diameter of the impeller

(b) Yield larger values for radial pumps than for axial flow pump

(c) Is necessarily non dimensional

(d) Includes power as one of the variables

71. At a rated capacity of 44 cumecs, a centrifugal pump develops 36 m of head when operating at 1450 rpm. Its specific speed is

(a) 654 (b) 509

(c) 700 (d) 90

72. The comparison between pumps operating in series and in parallel is

(a) Pumps operating in series boost the discharge, whereas pumps operating in parallel boost the head

(b) Pumps operating in parallel boost the discharge, whereas pumps operating in series boost the head

(c) In both cases there would be a boost in discharge only

(d) In both cases there would be a boost in head only

73. The allowable Net Positive Suction Head (NPSH) for a pump provided by the manufacturer for a flow 0.05 m^3/s is 3.3 m. The temperature of water is 30°C (vapour pressure head absolute = 0.44m), atmospheric pressure is 100 kPa absolute and the head loss from the reservoir to pump is 0.3 N-m/N. The maximum height of the pump above the suction reservoir is

(a) 10.19 m (b) 6.89 m

(c) 6.15 m (d) 2.86 m

74. Identify the FALSE statement from the following. The specific speed of the pump increases with

(a) Increase in shaft speed (b) Increase in discharge

(c) Decrease in gravitational acceleration (d) Increase in head

75. If a centrifugal pump has an impeller speed of N (in rpm), discharge Q (in m^3/s) and the total head H (in m), the expression for the specific speed N_s of the pump is given by

(a) $N_s = \frac{NQ^{0.5}}{H^{0.5}}$ (b) $N_s = \frac{NQ^{0.5}}{H}$

(c) $N_s = \frac{NQ^{0.5}}{H^{0.75}}$ (d) $N_s = \frac{NQ}{H^{0.75}}$

76. The conjugate depths at a location in a horizontal rectangular channel, 4 m wide, are 0.2 m and 1.0 m. The discharge in the channel is

(a) 4.339 m^3/s (b) 5.339 m^3/s

(c) 2.339 m^3/s (d) 6.339 m^3/s

77. The discharge from a spillway on a horizontal floor is 8 cumecs per meter width. If the depth before the jump of 50 cm, the depth after the jump in metres will be

(a) 4.864 m (b) 3.864 m

(c) 5.864 m (d) 6.864 m

78. Direct step method of computation for gradually varied flow is

(a) Applicable to non-prismatic channels

(b) Applicable to prismatic channels

(c) Applicable to both prismatic and non-prismatic channels

(d) Not applicable to both prismatic and non-prismatic channels

79. A spillway discharges flood flow at a rate of 9 m^3/s per metre width. If the depth of flow on the horizontal apron at the toe of the spillway is 46 cm, the tail water depth needed to form a hydraulic jump is approximately given by which of the following options?

(a) 2.54 m (b) 4.90 m

(c) 5.77 m (d) 6.23 m

80. For subcritical flow in an open channel, the control section for gradually varied flow profile is

(a) At the downstream end (b) At the upstream end

(c) At both ends (d) At any intermediate section

81. Delta (Δ) in cm, Duty (D) in hectare/cumec and base period (B) in days are related as

(a) $\Delta = 864\ B/D$ (b) $B = 864\ D/\Delta$

(c) $B = 864\ \Delta/D$ (d) $D = 8.64\ B/\Delta$

82. The moisture content of soil in the root zone of an agricultural crop at certain stage is found to be 0.05. The field capacity of the soil is 0.15. The root zone depth is 1.1 m. The consumptive use of crop at this stage is 2.5 mm/day and there is no precipitation during this period. Irrigation efficiency is 65%. It is intended to raise the moisture content to the field capacity in 8 days through irrigation.

The necessary depth of irrigation is ($\gamma_d = 1.5$)

(a) 115 mm (b) 169 mm

(c) 200 mm (d) 285 mm

83. Wheat crop requires 55 cm of water during 120 days of base period. The total rainfall during this period is 100 mm. Assume the irrigation efficiency to be 60%. The area (in ha) of the land which can be irrigated with a canal flow of 0.01 m^3/s is

(a) 13.82 (b) 18.85

(c) 23.04 (d) 230.40

84. The data for an agricultural field for a specific month are given below:

Pan Evaporation = 100 mm; Effective rainfall = 20 mm (after deducting losses due to runoff and deep percolation); Crop Coefficient = 0.4; Irrigation Efficiency = 0.5; The amount of irrigation water (in mm) to be applied to the field in that month, is

(a) 80 (b) 40

(c) 20 (d) 0

85. In a certain month, the reference crop evapotranspiration at a location is 6 mm/day. If the crop coefficient and soil coefficient are 1.2 and 0.8, respectively, the actual evapotranspiration in mm/day is

(a) 8.00 (b) 7.20

(c) 6.80 (d) 5.76

86. The medium size of the sediment particles in an alluvial channel is 0.4 mm. For a discharge of $3m^3/sec$, the Lacey regime slope would be

(a) $\frac{1}{3371}$ (b) $\frac{1}{4371}$

(c) $\frac{1}{2971}$ (d) $\frac{1}{5371}$

87. A triangular irrigation lined canal carries a discharge of $25 m^3/s$ at bed slope $= \frac{1}{6000}$. If the side slopes of the canal are 1:1 and Manning's coefficient is 0.018, the central depth of flow is equal to

(a) 2.98 m
(b) 3.62 m
(c) 4.91 m
(d) 5.61 m

88. As per the Lacey's method for design of alluvial channels, identify the TRUE statement from the following:

(a) Wetted perimeter increases with an increase in design discharge
(b) Hydraulic radius increases with an increase in silt factor
(c) Wetted perimeter decreases with an increase in design discharge
(d) Wetted perimeter increases with an increase in silt factor

89. The depth of flow in a alluvial channel is 1.5 m. If critical velocity ratio is 1.1 and Manning's n is 0.018, the critical velocity of the channel as per Kennedy's method is

(a) 0.713 m/s
(b) 0.784 m/s
(c) 0.879 m/s
(d) 1.108 m/s

90. An unlined canal under regime conditions along with a silt factor of 1 has a width of flow 71.25 m. Assuming the underlined canal as a wide channel, the corresponding average depth of flow (in m, round off to two decimal places) in the canal will be

(a) 2.94 m
(b) 3.94 m
(c) 1.94 m
(d) 5.94 m

91. The live storage requirement for a reservoir is to be determined by

(a) Topographical survey
(b) Annual demand
(c) Double mass curve analysis
(d) Mass curve analysis

92. The base width of an elementary profile of a gravity dam of height H is b. The specific gravity of the material of the dam is G and uplift pressure coefficient is K. The correct relationship for no tension at the heel is given by

(a) $\frac{b}{H} = \frac{1}{\sqrt{G-K}}$
(b) $\frac{b}{H} = \sqrt{G-K}$
(c) $\frac{b}{H} = \frac{1}{G-K}$
(d) $\frac{b}{H} = \frac{1}{K\sqrt{G-K}}$

93. In a syphon aqueduct, the most severe condition of uplift on the floor occurs when

(a) The canal and drainage run full
(b) The canal runs full; the drainage channel is dry, and the water table is at the stream bed.
(c) The canal is dry, the drainage floor is at HFL and the water table is at the HFL of the drainage flow
(d) The canal runs full; and the drainage is dry

94. For the head regulator, the most severe condition of uplift pressure on the floor occurs when

(a) The flow in the river is at flood level and canal is running at full supply depth
(b) The canal runs empty and the river flow is at high flood level
(c) The canal runs at full supply depth and the river flow is at pond level
(d) The canal runs dry and the river flow is pond level

95. Which one of the following equations represents the downstream profile of Ogee spillway with vertical upstream face? (x,y) are the coordinates of the point on the downstream profile with origin at the crest of the spillway and H_d is the design head.

(a) $\frac{y}{H_d} = -0.5\left(\frac{x}{H_d}\right)^{1.85}$ (b) $\frac{y}{H_d} = -0.5\left(\frac{x}{H_d}\right)^{\frac{1}{1.85}}$

(c) $\frac{y}{H_d} = -2.0\left(\frac{x}{H_d}\right)^{1.85}$ (d) $\frac{y}{H_d} = -2.0\left(\frac{x}{H_d}\right)^{\frac{1}{1.85}}$

96. A launching apron is to be designed at downstream of a weir for discharge intensity of 6.5 $m^3/s/m$. For the design of launching aprons the scour depth is taken two times of Lacey scour depth. The silt factor of the bed material is unity. If the tailwater depth is 4.4 m, the length of launching apron in the launched position is

(a) $\sqrt{5}$m (b) 4.7 m

(c) 5 m (d) $5\sqrt{5}$ m

97. Water emerges from an Ogee spillway with velocity of 13.72 m/s and depth of 0.3 m at its toe. The tail water depth required to form a hydraulic jump at the toe is

(a) 6.48 m (b) 5.24 m

(c) 3.24 m (d) 2.24 m

98. A conventional flow duration curve is a plot between

(a) Flow and percentage time flow is exceeded

(b) Duration of flooding and ground level elevation

(c) Duration of water supply in a city and proportion of area receiving supply exceeding this duration

(d) Flow rate and duration of time taken to empty a reservoir at that flow rate

99. If the path of an irrigation canal is below the bed level of a natural stream, the type of cross-drainage structure provided is

(a) Level crossing (b) Super passage

(c) Aqueduct (d) Sluice gate

100. Super passage is a canal cross-drainage structure in which

(a) Canal water flows under pressure below a natural stream

(b) Natural stream water flows under pressure below a canal

(c) Canal water flows with free surface below a natural stream

(d) Natural stream water flows with free surface below a canal

* * * * * * *