MIZORAM PUBLIC SERVICE COMMISSION

TECHNICAL COMPETITIVE EXAMINATIONS FOR JUNIOR GRADE OF MIZORAM ENGINEERING SERVICE (AE/SDO) UNDER PUBLIC HEALTH ENGINEERING DEPARTMENT, GOVERNMENT OF MIZORAM, JANUARY-2024

CIVIL ENGINEERING

PAPER-II

Time Allowed : 3 hours FM : 200

SECTION - A *(Multiple Choice questions) (100 Marks)*

All questions carry equal mark of 2 each. Attempt all questions.

*This Section should be answered only on the **OMR Response Sheet** provided.*

1. Glycerine (specific weight 1260 kg/m^3, dynamic viscosity 8.00×10^{-2} kg-s/m^2) is spread freely to a thickness of 1 mm between a bottom stationary plate and a top movable plate of 10 cm^2 area. The top plate is to be moved at a uniform speed of 1 m/s. The force to be exerted on the top plate is

(a) 1.6 kg (b) 0.8 kg

(c) 0.16 kg (d) 0.08 kg

2. If the flow condition satisfy 'Laplae Equation' Then

(a) flow is rotational

(b) flow is irrotational and does not satisfy continuity equation

(c) flow is rotational and satisfy continuity equation

(d) flow is irrotational and satisfy continuity equation

3. A cylindrical open topped storage reservoir provided to protect the penstock against water hammer pressure is called

(a) intake structure (b) surge tank

(c) forebay (d) trash rack

4. In s hydraulic jump occurring in a rectangular horizontal channel the depth before and after jump are 0.5 m and 1 m respectively then the head loss due to the jump will be

(a) 1/2 m (b) 1/8 m

(c) 1/16 m (d) 1/32 m

5. The type of jump that forms when initial Froude number lies between 2.5 and 4.5 is

(a) weak jump (b) steady jump

(c) undular jump (d) oscillating jump

6. Shear stress in the Newtonian fluid is proportional to

(a) Pressure (b) Strain

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

7. Within a boundary layer for a steady incompressible flow, the Bernoulli equation

(a) holds because the flow is steady (b) holds because the flow is incompressible

(c) holds because the flow is transitional (d) does not hold because the flow is frictional

8. The difference of pressure between the inside and outside of a liquid drop is

(a) $p = T \times r$ (b) $p = \frac{T}{r}$

(c) $p = \frac{T}{2r}$ (d) $p = \frac{2T}{r}$

9. 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 horizontal)

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

(c) $\mu\sqrt{gt}$ (d) ρg

10. Which one of the following is the correct assumption for the derivation of Bernoulli's equation?

(a) The flow is compressible (b) Viscosity is zero

(c) The flow is unsteady (d) The flow is rotational

11. If a water tank partially filled with water is being carried on a truck which is moving with a constant horizontal acceleration. The level of liquid inside tank will

(a) Rise and fall alternately on the front side of the tank

(b) Fall on the rear side of the tank

(c) Remain the same on both sides of the tank

(d) Rise on the rear side and fall on the front side of the tank

12. Mechanical efficiency of a centrifugal pump is the ratio of

(a) Energy available at the impeller to the energy supplied to the pump by the prime mover

(b) Actual work-done by the pump to the energy supplied to the pump by the prime mover

(c) Energy supplied to the pump to the energy available at the impeller

(d) Manometric head to the energy supplied by the impeller per kN of water

13. The stable equilibrium is achieved in the floating body when ?

(a) Center of gravity is below the center of buoyancy.

(b) Metacenter is above the center of gravity.

(c) Metacenter is below the center of gravity.

(d) Metacentric height is zero.

14. Francis Turbine is best suited for

(a) Low head installations up to 30 m (b) Medium head application from 24 to 180 m

(c) High head installations above 180 m (d) High head installations above 1800 m

15. The specific speed (Ns) of a turbine is given by

(a) $Ns = \frac{N\sqrt{P}}{H^{0.75}}$ (b) $Ns = \frac{N\sqrt{P}}{H^{1.25}}$

(c) $Ns = \frac{N\sqrt{P}}{H^{1.5}}$ (d) $Ns = \frac{N\sqrt{P}}{H^{2}}$

16. The change in head across a small turbine is 10 m, the flow rate of water is 1 m^3/s and the efficiency are 80%. The power developed by the turbine is approximately

(a) 100 kW (b) 78 kW

(c) 20 kW (d) 1 kW

17. A pump running at 1414 rpm delivers 256 lps of water against a head of 16 m. The pump is of the
(a) normal speed radial type
(b) double suction type
(c) mixed flow type
(d) axial flow type

18. A penstock is 2000 m long and the velocity of pressure wave in it is 1000 m/s. Water hammer pressure head for instantaneous closure of value at the downstream end of pipe is 60 m. If the valve is closed in 4 sec, then the peak water hammer pressure head is equal to
(a) 15 m
(b) 30 m
(c) 60 m
(d) 120 m

19. The streamlines of a flow net are concentric circles. If the velocity at a radius of 0.6 m is 2.7 m/sec then the velocity at a radius of 0.9 m will be
(a) 1.8 m/sec
(b) 2.8 m/sec
(c) 3.8 m/sec
(d) 4.8 m/sec

20. A centrifugal pump gives maximum efficiency when its impeller blades are
(a) bent forward
(b) bent backward
(c) straight
(d) wave shaped

21. Water distribution systems are sized to meet the
(a) maximum daily demand and fire demand
(b) average demand and fire demand daily
(c) maximum hourly demand
(d) average hourly demand

22. A straight 100 m long raw water gravity main is to carry water from an intake structure to the jack well of a water treatment plant. The required flow through this water main is 0.21 m^3. Allowable velocity through the main is 0.75 m/s. Assume f = 0.01, g = 9.81 m/s^2. What is the minimum gradient (in cm/100 m length) to be given to this gravity main so that the required amount of water flows without any difficulty.
(a) 2.8
(b) 4.8
(c) 6.8
(d) 8.8

23. The activated sludge process is an
(a) Aerobic attached growth system
(b) Anaerobic attached growth system
(c) Anaerobic suspended growth system
(d) Aerobic suspended system

24. Temporary hardness in water is caused by the presence of
(a) Bicarbonates of Ca and Mg
(b) Sulphates of Ca and Mg
(c) Chlorides of Ca and Mg
(d) Nitrates of Ca and Mg

25. A sewage has a suspended solid content of 250 mg/L. The sedimentation tank removes 55% of the suspended solids and the water content of the sludge is 95%. What is the quantity of sludge produced after treating 6.5×10^6 L of sewage? Assume the specific gravity of sludge as 1.0.
(a) 14.27 m^3
(b) 17.87 m^3
(c) 20.35 m^3
(d) 21.6 m^3

26. The concentration of OH- ion in a water sample is measured as 17 mg/L at 25°C. What is the pH of the water sample
(a) 10
(b) 11
(c) 12
(d) 13

27. The permissible limit of Total arsenic (as As), mg/l in drinking water as per IS 10500 : 2012 is
(a) 0.05 ppm
(b) 0.1 ppm
(c) 0.15 ppm
(d) 0.5 ppm

28. The detention time for an ordinary plain sedimentation tank varies from
(a) 1 to 2 hours
(b) 2 to 4 hours
(c) 6 to 8 hours
(d) 20 to 24 hours

29. The most common cause of acidity in water is
(a) nitrogen
(b) carbon dioxide
(c) oxygen
(d) alkalies

30. A small filter of 0.05 m depth removes 90% of particles present in water. If the particle removal required is 99% what should be the depth of filter?
(a) 0.10 m
(b) 0.50 m
(c) 0.75 m
(d) 1.00 m

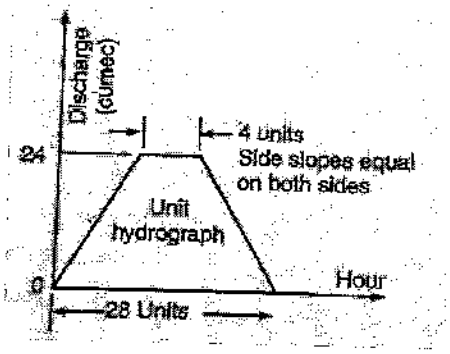
31. The phenomenon of evaporation from water surfaces, from the soil and from plants is generally known as
(a) Vaporisation
(b) Boiling
(c) Transpiration
(d) Hydration

32. Unit–hydrograph method is usually adopted for estimating floods when the catchment area is
(a) 100 sq-km only
(b) less than 5000 sq-km
(c) more than 7500 sq-km
(d) more than 10000 sq-km

33. A reservoir is used for
(a) controlling floods
(b) perennial
(c) leaf area
(d) spillway

34. The volume of water that can be released by gravitational effects from a unit volume of an aquifer is its
(a) specific storage
(b) specific yield
(c) specific capacity
(d) specific porosity

35. A–2 hour unit hydrograph can be approximated as trapezoidal as shown in Figure. The unit hydrograph refers to catchment area of



(a) 138.24 km^2
(b) 1382.40 km^2
(c) 384 m^2
(d) 3840 m^2

36. The Muskingum method of flood routing is
(a) from of hydraulic routing of flood
(b) from reservoir routing
(c) from st. venant equation
(d) from hydrological channel routing method

37. The ratio of actual evapo-transpiration to potential evapo-transpiration is in the range of
(a) 0.0 to 0.4
(b) 0.6 to 0.9
(c) 0.0 to 1.0
(d) 1.0 to 2.0

38. The peak of a flood hydrograph due to 2-hour duration isolated storm in a catchment area is 135 m^3/s. The total depth of rainfall is 54 mm. Assume a constant base flow of 10 m^3/s and ϕ - index to be equal to 4 mm/hr, then peak of 2-hr UH for the catchment in m^3/s is —

(a) 23.15 (b) 25.0

(c) 27.17 (d) 29.23

39. The base width of an elementary profile of gravity dam is b and its height is H. 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) $\frac{b}{h}=\frac{1}{G-\sqrt{K}}$

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

40. The inflow (in cumecs) for a stream reach at time $t_1 = 6$ hr and $t_2 = 24$ hr are 15 and 30, respectively. The coefficients C_1 and C_2 in the Muskingum routing equation are 0.4 and 0.5 respectively. If outflow for the stream reach at $t_1 = 6$ hr is 10 cumecs, the outflow rate at $t_2 = 24$ hr will be _____ cumecs.

(a) 12 (b) 14

(c) 16 (d) 18

41. Calculate the permanent wilting point if the depth of water in the root zone at the permanent wilting point per meter depth of soil is 0.4m. The dry density of the soil is 16 KN/m^3.

(a) 0.025 (b) 0.245

(c) 0.45 (d) 0.64

42. The two columns below show some parameters and their possible values.

Parameters	**Value**
P. Gross command area	I. 100 hectares/cumec
Q. Permanent wilting point	II. 6°C
R. Duty of canal water	III. 1000 hectares
S. Delta of wheat	IV. 1000 cm
	V. 40 cm
	VI. 0.12

Which of the following options matches the parameters and the values correctly?

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

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

43. The drainage water intercepting the canal can be disposed of by passing the canal below the drainage in——

(a) Aqueduct and syphon aqueduct (b) Aqueduct and super passage

(c) Super passage and canal syphon (d) Level crossing

44. An outlet irrigates an area of 20 ha. Discharge (L/s) required at this outlet to meet the evapotranspiration requirement of 20 mm occurring uniformly in 20 days neglecting other field losses is

(a) 2.52 (b) 2.31

(c) 2.01 (d) 1.52

45. The consumptive use of water for a crop during a particular stage of growth is 2.0 mm/day. The maximum depth of available water in the root zone is 60 mm. Irrigation is required when the amount of available water is 50% of the maximum available water in the root zone. Frequency of irrigation should be

(a) 10 days
(b) 12 days
(c) 15 days
(d) 20 days

46. A sprinkler irrigation system is suitable when

(a) the land gradient is steep.
(b) the soil is having low permeability.
(c) the water table is low.
(d) the crops to be grown have deep roots.

47. Water table drops by 3 m in an irrigable land of 50 hectare. If porosity and specific retention are 0.30 and 0.10 respectively, the change in storage in hectare-meter is

(a) 15
(b) 30
(c) 45
(d) 60

48. When a small irrigation canal has to cross over a medium drain we construct

(a) pipe aqueduct
(b) box culvert
(c) irrigation culvert
(d) aqueduct

49. Crest of an emergency spillway is fixed at

(a) dead storage level
(b) F.R.L
(c) M.W.L
(d) Top of the dam

50. The base period for a particular crop is 100 days and the duty of the canal is 1000 hectares per cumec, the depth of water will be

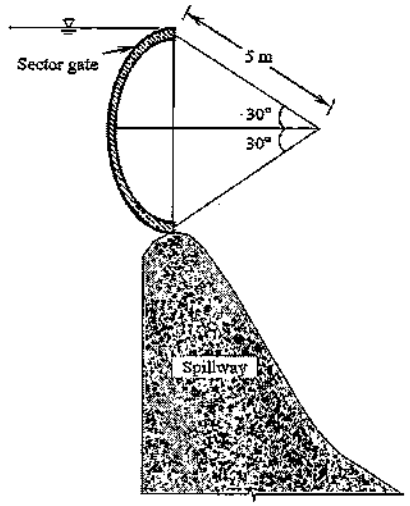
(a) 0.864 cm
(b) 8.64 cm
(c) 86.4 cm
(d) 864 cm

SECTION - B *(Short answer type question) (100 Marks)*

All questions carry equal marks of 5 each.

*This Section should be answered only on the **Answer Sheet** provided.*

1. 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. Calculate the total force on the plate due to the jet.
2. The discharge over a 90° V-notch is given as $Q = 1.37 \times H^{(5/2)}$, where Q is in m^3/s and H is in m. Calculate the coefficient of discharge (Cd) of the notch.
3. A horizontal venturimeter with an inlet diameter of 30 cm and throat diameter of 15 cm was used to measure the flow of water. The reading on a differential manometer connected to the inlet and the throat is 20 cm of mercury. If Cd = 0.98, calculate the rate of flow.
4. The pressure intensity at a point in a fluid is given as 3.895 n/cm^2. Find the corresponding height of fluid when the fluid is (a) water, (b) oil of Sp.Gr 0.8.
5. Write short note on Storage Coefficient and Specific Yield.
6. A 12 hour storm rainfall had the following depth in cm for each hour occurring over the basin: 1.8, 2.6, 7.8, 3.9, 10.6, 5.4, 7.8, 9.2, 6.5, 4.4, 1.8 and 1.6. The surface run-off resulting from the above storm is found to be 24.4 cm depth over the basin. Determine the average infiltration index for the basin.
7. The average surface area of a 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 change is 16 million m^3. Determine the evaporation (in cm) in that month.
8. A 45 cm diameter well penetrates an unconfined aquifer of 30 m thick. Under the steady pumping rate for a long time, the drawdown at two observation wells 10 m and 20 m from the pumping well are 5 m and 3.5 m respectively. What will be the discharge (in m^3/s), if the permeability of the aquifer is given as 20 m/day?
9. Design an irrigation channel in alluvial soil according to Lacey's silt theory for the following data: Full supply discharge is 50 m^3/s, Lacey's silt factor 1.0, Side slope of channel 1/2 (H) : 1 (V).
10. Explain river training in detail. What are the different objectives of river training? Discuss at least five objectives. Explain at least one method of river training with necessary sketches.
11. The transplantation of rice requires 10 days and total depth of water required during transplantation is 48 cm. During transplantation, there is an effective rainfall (useful for irrigation) of 8 cm. Determine the duty of irrigation water (in hectares/cumec).
12. A sector gate is provided on a spillway as shown in the figure. Assuming g = 10 m/s^2, determine the resultant force per meter length (expressed in kN/m) on the gate.



13. 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. Determine the number of years from now when the plant will reach its design capacity. Assume an arithmetic rate of population growth.

14. The analysis of a water sample produces the following results. Calculate the total hardness (in mg/L as $CaCO_3$) of the water sample.

Ion	Concentration (mg/L)	Atomic weight
Ca^{2+}	20	60
Mg^{2+}	12.2	36.6
Na^{+}	23	92
K^{+}	39.1	78.2
SO_4^{2-}	48	72
HCO_3^{-}	61	122

15. Briefly explain the water treatment process with suitable diagram.

16. If a 3 day BOD of sewage at 20°C is 400 mg/l. Find its 5 day BOD at 20° C? Assume value of $K_{20} = 0.1$/day.

17. A pump lifts 93600 litres of water per hours against a total head of 21 m. Pump has an efficiency of 72 percentage. If the direct drive electric motor, having efficiency of 80 percent is used to operate the pump, compute the cost of electric energy in a month. The pump is operated 12 hours daily for 30 days. The cost of electric energy is Rs 3.65 per unit.

18. What do you mean by 'Net positive suction height (NPSH)'?

19. Explain different types of hydraulic turbines. What are the factors affecting the choice of hydraulic turbines? Explain in detail.

20. Write short note on : Reciprocating pump and Centrifugal pump.

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