

MIZORAM PUBLIC SERVICE COMMISSION
DEPARTMENTAL EXAMINATION FOR JUNIOR GRADE OF M.E.S. (AE/SDO)
UNDER IRRIGATION & WATER RESOURCES DEPARTMENT,
GOVERNMENT OF MIZORAM.
(JULY-2025)

ENGINEERING PAPER – II
(Agriculture Engineers)

Time Allowed : 3 hours

FM : 100 PM : 40

SECTION - A (Multiple Choice Questions) (50 Marks)

All questions carry equal mark of 1 each. Attempt all questions.

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

1. Recession limb of a hydrograph is controlled primarily by:
(a) Surface runoff (b) Evapotranspiration
(c) Channel slope (d) Groundwater outflow
2. The duration of a unit hydrograph refers to:
(a) Time between two peaks
(b) Duration of effective rainfall producing the hydrograph
(c) Time to peak discharge
(d) Total time of baseflow
3. Which factor most likely causes negative skewness in annual rainfall data?
(a) Extreme floods (b) Frequent droughts
(c) Uniform rainfall distribution (d) Erratic monsoon
4. Hydrologic routing differs from hydraulic routing in that:
(a) It uses energy equations (b) It uses momentum conservation
(c) It applies continuity only (d) It models sediment flow
5. A drop inlet spillway is most efficient when:
(a) There is high sediment load (b) Flow control is at the crest level
(c) Inlet is submerged (d) Outlet is above ground
6. Which factor does not directly influence soil erodibility?
(a) Soil texture (b) Soil structure
(c) Rainfall intensity (d) Organic matter content
7. The inlet pipe of a drop inlet spillway functions like:
(a) Weir (b) Sluice gate
(c) Orifice (d) Free outfall

8. Universal Soil Loss Equation does not account for:
- (a) Soil erodibility
 - (b) Vegetation
 - (c) Channel bed material
 - (d) Slope length
9. Which of the following is a disadvantage of Thiessen polygon method?
- (a) Over-representation of dense stations
 - (b) Underestimation during extreme rainfall
 - (c) Ignores station elevation
 - (d) Requires continuous data
10. The infiltration capacity curve is always:
- (a) Increasing with time
 - (b) Constant with time
 - (c) Decreasing with time
 - (d) Random with time
11. Which of the following methods is used in hydrologic flood routing?
- (a) Hardy Cross
 - (b) Muskingum Method
 - (c) Finite Difference Method
 - (d) Manning's Equation
12. The total volume of direct runoff from a watershed is equal to:
- (a) Area under hydrograph's rising limb
 - (b) Total area under hydrograph above baseflow
 - (c) Peak discharge multiplied by time of concentration
 - (d) Product of rainfall excess and time
13. Compute erosion control efficiency if control plot loss = 8 t/ha, treated plot loss = 2 t/ha
- (a) 60%
 - (b) 65%
 - (c) 70%
 - (d) 75%
14. A catchment area of 150 hectares receives a rainfall of 80 mm. If the runoff coefficient is 0.6, what is the runoff volume in cubic meters?
- (a) 720,000 m³
 - (b) 900,000 m³
 - (c) 120,000 m³
 - (d) 150,000 m³
15. A straight trapezoidal channel of bed width 3 m, side slope 2:1, and depth 1.5 m carries water at velocity of 1.2 m/s. Estimate discharge.
- (a) 10.8 m³/s
 - (b) 12.4 m³/s
 - (c) 13.6 m³/s
 - (d) 14.5 m³/s
16. A contour bund has 0.5 m height, cross-sectional area 0.75 m², length 200 m. Estimate total earthwork.
- (a) 125 m³
 - (b) 100 m³
 - (c) 150 m³
 - (d) 175 m³
17. For a bench terrace with 8% slope and vertical interval of 2 m, find horizontal spacing.
- (a) 22 m
 - (b) 25 m
 - (c) 27 m
 - (d) 30 m
18. For a 10-year flood, the probability that it will occur at least once in 5 years is approximately:
- (a) 41%
 - (b) 50%
 - (c) 65%
 - (d) 90%

19. Calculate storage volume for farm pond (trapezoidal shape): top = 18×12 m, bottom = 10×6 m, depth = 2.5 m
- (a) 460 m^3 (b) 325 m^3
(c) 540 m^3 (d) 600 m^3
20. Time of concentration using Kirpich: $L = 200$ m, $S = 0.04$
- (a) 5.0 min (b) 3.9 min
(c) 6.2 min (d) 6.8 min
21. A storm has a recurrence interval of 25 years. What is the probability it will occur in any given year?
- (a) 4% (b) 25%
(c) 0.4% (d) 1%
22. Graded bunds are more appropriate than contour bunds in:
- (a) Very flat lands (b) Sloppy lands with highly permeable soil
(c) Steep, non-arable lands (d) High rainfall areas with impervious soil
23. Assumption of linearity in unit hydrograph means:
- (a) Baseflow is constant
(b) Area is homogeneous
(c) Hydrograph response is directly proportional to excess rainfall
(d) Rainfall occurs at a constant rate
24. A reservoir with 5 MCM storage releases $20 \text{ m}^3/\text{s}$ for 2 days. How much volume remains (ignoring inflow)?
- (a) 1.55 MCM (b) 3.27 MCM
(c) 0.73 MCM (d) 4.65 MCM
25. Which of the following rainfall types is most intense?
- (a) Orographic (b) Convective
(c) Cyclonic (d) Frontal
26. Which spectral bands are most useful in remote sensing applications related to water resource surveys?
- (a) Infrared and Microwave (b) Thermal Infrared and Ultraviolet
(c) Visible and Near-Infrared (d) Ultraviolet and X-rays
27. Which method of levelling is most suitable for long profile surveys such as roads and canals?
- (a) Rise and Fall Method (b) Differential Levelling
(c) Height of Instrument Method (d) Reciprocal Levelling
28. Two GPS points are 0.002° apart in latitude. What is the approximate linear distance?
- (a) 432 m (b) 222 m
(c) 212 m (d) 600 m
29. A line has a fore bearing of $123^\circ 30' 2''$. What is the back bearing?
- (a) $303^\circ 30' 2''$ (b) $243^\circ 30' 2''$
(c) $213^\circ 30' 2''$ (d) $143^\circ 30' 2''$

30. Which of the following methods is used to determine a point's position when its location is unknown, but the coordinates of at least three surrounding control points are known?
- (a) Intersection
 - (b) Radiation
 - (c) Resection
 - (d) Traversing
31. A level has B.S. = 1.5 m, F.S. = 2.3 m, starting RL = 102 m. What is the RL of the new point?
- (a) 101.5 m
 - (b) 102.8 m
 - (c) 101.2 m
 - (d) 112.0 m
32. Given area under contour 105 m = 50,000 m² and under 110 m = 100,000 m², estimate volume between contours using trapezoidal formula for 5 m interval.
- (a) 375,000 m³
 - (b) 312,500 m³
 - (c) 375,500 m³
 - (d) 400,000 m³
33. What is the primary cause of vertical positional error in GPS observations?
- (a) Solar radiation
 - (b) Atomic clock drift
 - (c) Selective availability
 - (d) Satellite geometry (VDOP)
34. A staff reading taken at 200 m distance from level is 2.000 m. What is the angular error in minutes if collimation error is 0.005 m per 100 m?
- (a) 0.86'
 - (b) 0.17'
 - (c) 0.29'
 - (d) 2.58'
35. Which levelling method is used when accurate results are needed across a wide water body?
- (a) Trigonometric levelling
 - (b) Profile levelling
 - (c) Reciprocal levelling
 - (d) Fly levelling
36. What is a typical map scale used for planning reservoir submergence and command area?
- (a) 1:250,000
 - (b) 1:100,000
 - (c) 1:10,000
 - (d) 1:500,000
37. A tractor consumes 5 liters of diesel per hour while operating a rotavator. If the diesel has a density of 0.85 kg/l and a calorific value of 45 MJ/kg, the energy consumed per hour is
- (a) 191.25 MJ
 - (b) 200.00 MJ
 - (c) 180.00 MJ
 - (d) 210.00 MJ
38. A plow requires a draft of 1.2 kN to operate at a depth of 0.3 meters and a width of 1.5 meters. Calculate the draft per unit area.
- (a) 2.67 kN/m²
 - (b) 2.50 kN/m²
 - (c) 2.00 kN/m²
 - (d) 3.00 kN/m²
39. The drawbar horsepower of a tractor is typically:
- (a) Equal to engine horsepower
 - (b) Less than engine horsepower
 - (c) Greater than engine horsepower
 - (d) Not related to engine horsepower
40. Draft is defined as:
- (a) Vertical force during tillage
 - (b) Horizontal force required to pull an implement
 - (c) Rotary force
 - (d) Lateral force

41. An implement cuts a 1.2 m width and works at 5 km/h. Time to cover 1 hectare?
(a) 3.52 hrs (b) 1.67 hrs
(c) 2.88 hrs (d) 1.25 hrs
42. A disc harrow has 10 discs, each 0.5 m in diameter, spacing = 0.25 m. Working width = ?
(a) 2.51 m (b) 2.25 m
(c) 3.02 m (d) 2.01 m
43. Slip = 12%, travel speed = 5 km/h. Effective speed = ?
(a) 4.4 km/h (b) 4.8 km/h
(c) 5.5 km/h (d) 3.9 km/h
44. In a zero-till seed drill, the key component enabling seeding without tillage is:
(a) Spring-loaded tynes (b) Coulter or disc opener
(c) Vacuum chamber (d) Furrow closer
45. The primary purpose of using a power harrow instead of a rotavator is:
(a) Pulverization of heavy soils
(b) Deep inversion of soil
(c) Fine seedbed preparation with minimal soil structure damage
(d) Enhanced weed control
46. The net traction force is calculated as:
(a) Gross traction minus rolling resistance (b) Rolling resistance plus drawbar pull
(c) Gross traction plus wheel slip (d) Drawbar pull minus slip
47. The coefficient of traction is defined as:
(a) Rolling resistance ÷ load (b) Drawbar pull ÷ gross traction
(c) Net tractive force ÷ normal load (d) Gross traction ÷ slip ratio
48. For a tractor tire, the ideal slip ratio for optimum field operation is:
(a) 0–2% (b) 2–4%
(c) 8–15% (d) >30%
49. What is the main reason for using fluted roller type seed metering devices in seed drills?
(a) Accuracy for large seeds
(b) Variable seed rate for all crops
(c) Ability to handle multiple seed sizes with uniform distribution
(d) High-speed sowing capability
50. Calculate the volume of earthwork using trapezoidal rule:
Areas at 20 m intervals: 20, 24, 28, 22, 18 m²
(a) 1860 m³ (b) 960 m³
(c) 1040 m³ (d) 1000 m³

SECTION- B (Conventional Type) (50 Marks)

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

Marks for each question is indicated against it.

1. A chute channel 1.5 m wide carries $v = 5.2$ m/s and $d = 0.2$ m. Compute Fr and If the flow undergoes a hydraulic jump downstream, estimate the energy loss (in meters) across the jump using hydraulic jump theory. (3)
2. A storm of 12-hour duration delivers 90 mm of rainfall over a 150 km^2 catchment. The average infiltration rate is 3 mm/hr, and losses due to evaporation and depression storage total 10 mm. Calculate the total surface runoff volume in million cubic meters (MCM). (2)
3. A 4-hour storm delivers hourly rainfall depths of [10, 20, 25, 15] mm. If the ϕ -index (constant infiltration rate) is 6 mm/hr, compute the total effective rainfall depth (in mm). (2)
4. A river reach is 600 meters long. The average cross-sectional flow area is 80 m^2 , and the wetted perimeter is 28 m. The water surface drop between upstream and downstream ends is 0.75 m. Manning's roughness coefficient = 0.035. Using the Slope-Area Method, calculate the discharge (in m^3/s). (2)
5. After a 24-hour storm event, a 20-ha watershed records 80 mm of rainfall. The area is predominantly under sparse vegetation with $\text{CN} = 72$. Estimate direct runoff using the SCS-CN method and compute the proportion of rainfall lost to initial abstraction and infiltration. (3)
6. A 5-hectare horticultural field (runoff coefficient $C = 0.55$) is subjected to a 60-minute storm of intensity 100 mm/hr. (a) Estimate the peak runoff using the Rational Method. (b) Check if a trapezoidal channel (base width = 1 m, side slope = 1:1, depth = 0.8 m, bed slope = 0.01, Manning's $n = 0.03$) can safely convey this peak flow. (3)
7. A catchment with an area of 500 km^2 has a mainstream length (L) of 50 km and a distance from the outlet to the centroid of the basin (L_c) of 32 km. Use Snyder's synthetic unit hydrograph method to:
(a) Estimate the peak discharge (Q_p) of a 6-hour unit hydrograph.
(b) Estimate the base time (T_b) of the unit hydrograph. (3)

Assume Snyder's coefficients $C_t = 1.8$, $C_p = 0.45$ unless otherwise specified.

8. During a heavy storm event, rainfall data from five stations (A, B, C, D, and E) in a catchment is recorded as shown below. However, stations A and D failed to record rainfall during the storm due to equipment malfunction. The normal annual rainfall and the storm rainfall (where available) are provided on the table. Use the Normal Ratio Method to estimate the storm rainfall at Stations A and D, assuming that the ratio of normal annual rainfall at each station is an appropriate weighting factor. Show all steps and computations clearly. (3)

Station	Normal Annual Rainfall (mm)	Rainfall During Storm (mm)
A	1600	?
B	1500	105
C	1400	95
D	1550	?
E	1450	90

9. A drop spillway is designed with a vertical drop of 2.5 m and a design discharge of $1.2 \text{ m}^3/\text{s}$. The channel is horizontal and rectangular (width = 1.5 m), and the downstream flow is uncontrolled. (4)

Assume the following:

- Supercritical flow enters the stilling basin as a free jet
- Tailwater depth equals the sequent depth from hydraulic jump theory
- Gravity $g=9.81 \text{ m/s}^2$
- Ignore losses except in the hydraulic jump

Design the stilling basin, determining:

- (a) Pre-jump (initial) depth
- (b) Sequent depth
- (c) Energy loss
- (d) Required basin length

10. A chain line is 100 m long with offsets (in meters) at 10 m intervals as: (2)

[2.0, 2.4, 2.6, 2.8, 2.9, 2.5, 2.0, 1.8, 1.6, 1.5, 1.2]

Calculate the area enclosed using:

- (a) Trapezoidal rule
- (b) Simpson's rule

11. Following is a 5-sided traverse with last length missing: (2)

Line	Length (m)	Bearing
AB	100.0	N 45° E
BC	120.0	E
CD	130.0	S 45° E
DE	100.0	S
EA	???	???

Calculate missing side EA (length and bearing).

12. A 3-bottom moldboard plough, each bottom 30 cm wide, is operated at 5 km/h. Assume field efficiency of 75%. Calculate: (2)

- (a) Theoretical field capacity
- (b) Effective field capacity

13. A dumpy level is tested for collimation error. Two pegs A and B are placed 60 m apart. Staff readings are: (2)

When the instrument is set 10 m from Peg A:

Staff reading at A = 1.210 m; Staff reading at B = 1.325 m

When the instrument is set approximately at the midpoint between A and B (30 m from both):

Staff reading at A = 1.215 m; Staff reading at B = 1.330 m

Calculate the collimation error and determine if the instrument needs adjustment.

14. Discuss the role of mechanization in small and marginal farm holdings in India. Explain the constraints and suggest viable implement and power options with justification. (3)

- 15.** A tractor exerts a drawbar pull of 2000 kgf at 5 km/h. The rear wheel radius is 0.75 m. If the wheel slip is 12%, calculate: **(4)**
- (a) The torque developed at the wheels
 - (b) The power delivered at the drawbar
 - (c) Power loss due to slip
 - (d) Overall traction efficiency
- 16.** A 4-stage gear system connects an engine (1800 RPM) to tractor wheels (desired 4.5 km/h). The wheel radius is 0.6 m. Calculate: **(2)**
- (a) Required final RPM at wheel and Overall gear ratio
 - (b) Gear ratios for each stage assuming equal reduction per stage
- 17.** A simple circular curve of radius 200 m is to connect two tangents with deflection angle of 60° . Calculate: **(3)**
- (a) Length of curve
 - (b) Tangent length
 - (c) Mid-ordinate
- 18.** Describe the traction characteristics of wheeled tractors versus crawler tractors in different soil conditions. Justify when crawler-type would be advantageous. **(3)**
- 19.** Two tangents intersect at chainage 1050 m with a deflection angle of 40° . A circular curve of radius 300 m is to be provided. Find: Chainage of start and end of curve. **(2)**

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