MIZORAM PUBLIC SERVICE COMMISSION

TECHNICAL COMPETITIVE EXAMINATIONS FOR JUNIOR GRADE OF MIZORAM ENGINEERING SERVICE (M.E.S.) UNDER PUBLIC HEALTH DEPARTMENT, GOVERNMENT OF MIZORAM, MARCH, 2019.

CIVIL ENGINEERING
PAPER - III

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. The coefficient of compressibility of soil is the ratio of
   - (a) Stress to strain
   - (b) Strain to stress
   - (c) Stress to settlement
   - (d) Rate of loading to that of settlement

2. The ratio of the volume of voids to the volume of soil solids in a given soil mass, is known as
   - (a) Porosity
   - (b) Specific gravity
   - (c) Void ratio
   - (d) Water content

3. The Terzaghi's general bearing capacity equation for a continuous footing is given by
   - (a) $q_f = cNc + \gamma DNq + 0.5\gamma BN\gamma$
   - (b) $q_f = cNc - \gamma DNq + 0.5\gamma BN\gamma$
   - (c) $q_f = cNc + \gamma DNq - 0.5\gamma BN\gamma$
   - (d) None of these

4. The maximum water content at which a reduction in water content does not cause a decrease in volume of a soil mass, is known as
   - (a) Liquid limit
   - (b) Plastic limit
   - (c) Shrinkage limit
   - (d) Permeability limit

5. Surveys which are carried out to provide a national grid of control for preparation of accurate maps of large areas, are known as
   - (a) Cadastral surveying
   - (b) Geodetic surveying
   - (c) Topographical surveying
   - (d) Plane survey

6. The boundary of water of a still lake represents
   - (a) Level surface
   - (b) Horizontal surface
   - (c) Contour line
   - (d) Concave surface

7. The vertical angle between longitudinal axis of a freely suspended magnetic needle and a horizontal line at its pivot is known as
   - (a) Declination
   - (b) Azimuth
   - (c) Dip
   - (d) Bearing

8. If the whole circle bearing (WCB) of a line is 103°, its reduced bearing is
   - (a) N 103° E
   - (b) S 77° E
   - (c) S 77° W
   - (d) N 77° W

9. Which one is a not rural road

    (a) arterial street   (b) national highway

    (c) state highway   (d) village road

10. The strip of land acquired and reserved for construction and future development of road is

    (a) formation width   (b) right of way

    (c) setback   (d) shoulder

11. The rise or fall of elevation along the alignment is

    (a) camber   (b) cross fall

    (c) gradient   (d) none of these

12. CBR is used for

    (a) Shear test   (b) Penetration test

    (c) Bearing test   (d) Flexural test

13. 'One link' means the distance from

    (a) Centre to centre of middle rings

    (b) Centre to centre of inner rings

    (c) Centre to centre of outer rings

    (d) None of the above

14. The minimum water content at which the soil just begins to crumble when rolled into threads 3mm in diameter is known as

    (a) Plastic limit   (b) Liquid limit

    (c) Shrinkage limit   (d) Permeability limit

15. Degree of saturation of a natural soil deposit having water content 15%, specific gravity 2.50 and void ratio 0.5 is

    (a) 60%   (b) 50%

    (c) 75%   (d) 80%

16. If the failure of a finite slope occurs through the toe, it is known as

    (a) Base failure   (b) Face failure

    (c) Slope failure   (d) Toe failure

17. Rankine theory of active earth pressure assumes

    (a) Soil mass is homogeneous, dry and cohesionless

    (b) Ground surface is a plane which may be horizontal or inclined

    (c) Back of the wall is vertical and smooth

    (d) All of these

18. The lateral earth pressure on the retaining wall is

    (a) Equal to the mass of the soil retained

    (b) Proportional to the square of the depth of the soil

    (c) Proportional to the internal friction of the soil

    (d) Proportional to the depth of the soil

19. A pavement designer has arrived at a design traffic of 100 million standard axles for a newly developing national highway as per IRC:37 guidelines using the following data: design life = 15 years, commercial vehicle count before pavement construction = 4500 vehicles/day, annual traffic growth rate = 8%. The vehicle damage factor used in the calculation was

(a) 1.56

(b) 2.24

(c) 3.20

(d) 4.42

20. The following data are related to a horizontal curved of a two lane highway: length of curve = 200 m, radius of curve = 300 m and width of pavement = 7.5 m. Inorder to provide a stopping sight distance (SSD) of 80 m, the set back distance (in m) required from the centre line of the inner lane of the pavement is

(a) 2.64

(b) 4.55

(c) 7.10

(d) 7.96

21. A two-lane urban road with one-way traffic has a maximum capacity of 1800 vehicles/hour. Under jam condition, the average length occupied by the vehicles is 5.0 m. The speed versus density relationship is linear. For a traffic volume of 1000 vehicles/ hour, the density is

(a) 46 vehicles/km

(b) 58 vehicles/km

(c) 67 vehicles/km

(d) 73 vehicles/km

22. Brake is applied on a vehicle which then skids a distance of 16m before coming to stop. If the developed average coefficient of friction between the tyres and the pavement is 0.4, then, the speed of the vehicle before skidding would have been nearly

(a) 50 kmph

(b) 20 kmph

(c) 30 kmph

(d) 40 kmph

23. The minimum water content at which the soil retains its liquid state and also possesses a small shearing strength against flowing is known as

(a) Plastic limit

(b) Liquid limit

(c) Shrinkage limit

(d) Permeability limit

24. The water content of soil is defined as the ratio of

(a) Volume of water to the volume of voids in soil

(b) Weight of water to weight of air in voids

(c) Volume of water to volume of given soil

(d) Weight of water to weight of solids of given mass of soil

25. The effective stress friction angle of a saturated, cohesionless soil is 38°. The ratio of shear stress to normal effective stress on the failure plane is

(a) 0.378

(b) 0.488

(c) 0.616

(d) 0.781

26. When drainage is permitted under initially applied normal stress only and full primarily consolidation is allowed to take place, the test is known as

(a) Consolidated drained test

(b) Drained test

(c) Quick test

(d) None of these

27. Two series of compaction tests were performed in the laboratory on an inorganic clayey soil employing two different levels of compaction energy per unit volume of soil. With regard to the above tests, the following two statements were made.

(i)   The optimum moisture content is expected to be more for the tests with higher energy

(ii) The maximum dry density is expected to be more for the tests with higher energy

(a) Only (i) is true   (b) Only (ii) is true

(c) Both are true   (d) Both are false

28. In the internal molecular attraction of soil, cohesion

(a) Increases as the moisture content decreases (b) Is more in well compacted clays

(c) Decreases as the moisture content increases(d) Depends upon the external applied load

29. The minimum width of the pavement of a National Highway should be

(a) 4.7   (b) 5.7

(c) 6.7   (d) 7.7

30. The advantage of providing super-elevation on road is

(a) Higher speed of vehicle   (b) Reduced maintenance cost of the roads

(c) Draining off rainwater quickly   (d) All of these

31. The distance travelled by a moving vehicle during perception and brake reaction times, is known as

(a) Sight distance   (b) Stopping distance

(c) Lag distance   (d) None of these

32. Stability of hill slope depends on

(a) Angle of slope   (b) Geological condition

(c) Groundwater conditions   (d) All of these

33. Horizontal curves on highways are provided

(a) To break the monotony of driving

(b) To discourage the tendency to increase speed

(c) To decrease the mental strain on drivers

(d) All of these

34. The safe stopping distance may be calculated from the equation

(a) $D = 0.278Vt + \dfrac{V^2}{254f}$ (b) $D = 0.254Vt + \dfrac{V^2}{278f}$

(c) $D = 0.254Vt + \dfrac{V^2}{225f}$ (d) $D = 0.225Vt + \dfrac{V^2}{254f}$

35. Which one of the following statements is true?

(a) Clays are more porous than sands

(b) Pressure of organic matter in a soil decreases the bearing capacity of the soil

(c) Aluminous cement is used for foundations in soils with chemical deposits

(d) All the above

36. In a liquid limit test, the moisture content at 10 blows was 70% and that at 100 blows was 20%. The liquid limit of the soils, is

(a) 35%   (b) 50%

(c) 65%   (d) none of these

37. The correct prismoidal formula for volume is

(a) $D[\text{first area} + \text{last area} + \sum \text{Even area} + 2\sum \text{odd areas}]$

(b) $D/3[\text{first area} + \text{last area} + 4\sum \text{Even area} + 2\sum \text{odd areas}]$

(c) $D/3[\text{first area} + \text{last area} + 2\sum \text{Even area} + 4\sum \text{odd areas}]$

(d) $D/6[\text{first area} + \text{last area} + 2\sum \text{Even area} + 4\sum \text{odd areas}]$

38. The GIVE WAY control
   (a) Requires the driver in the minor road to slow down to a minimum speed and allow the vehicle on the major road to proceed.
   (b) Requires the driver in the major road to slow down to a minimum speed and allow the vehicle on the minor road to proceed.
   (c) Requires the drivers on both minor and major roads to stop.
   (d) Is similar to one way control.

39. The length of Summit Curve on a two lane two way highway depends
   (a) upon Allowable rate of change of centrifugal acceleration
   (b) Coefficient of lateral friction
   (c) Required Stopping Sight Distance
   (d) Required Overtaking Sight Distance

40. A well graded sand should have uniformity coefficient 'C_u'
   (a) ≥ 1.00 (b) ≥ 4.00
   (c) ≥ 6.00 (d) ≥ 3.00

41. The ratio of the volume of voids to the total volume of soil in a given soil mass is known as
   (a) Porosity (b) Specific gravity
   (c) Void ratio (d) Water content

42. Root time method is used to determine
   (a) a_v, coefficient of compressibility (b) c_v, coefficient of consolidation
   (c) m_v, coefficient of volume compressibility (d) T, time factor

43. Falling head permeability is used for
   (a) Fine grained soil (b) Coarsed grained soil
   (c) None of the above (d) Both (a) & (b)

44. For battened struts, the effective length is increased by
   (a) 5% (b) 7.5 %
   (c) 10% (d) 12.5%

45. The total neutral and effective vertical stresses (in t/m^2) at a depth of 5m below the surface of a fully saturated soil deposit with a saturated density of $2t/m^2$ would, respectively, be
   (a) 5, 5 and 10 (b) 10, 5 and 5
   (c) 5, 10 and 10 (d) 10, 5 and 10

46. A saturated clay layer with double drainage takes 5 years to attain 90% degree of consolidation under a structure. If the same layer were to be single drained, what would be the time (in years) required to attain the same consolidation under the same loading conditions?

   (a) 10   (b) 15

   (c) 20   (d) 25

47. Two circular footing of diameters D1 and D2 are resting on the surface of a purely cohesive soil. The ratio D1/D2 = 2. If the ultimate load carrying capacity of the footing of diameter D1 is 200 kN/m2, then the ultimate bearing capacity of the footing of diameter D2 will be

   (a) $100 \, kN/m^2$ (b) $200 \, kN/m^2$

   (c) $300 \, kN/m^2$ (d) $314 \, kN/m^2$

48. A saturated soil mass has a total density $22kN/m^3$ and water content of 10%. The bulk density and dry density of this soil are

   (a) $12kN/m^3$ and $20kN/m^3$ respectively   (b) $22kN/m^3$ and $20kN/m^3$ respectively

   (c) $19.8kN/m^3$ and $19.8kN/m^3$ respectively   (d) $23.2kN/m^3$ and $19.8kN/m^3$ respectively

49. The coefficient of permeability K for gravel is

   (a) 0.01 or Lesser than 0.01 cm/s   (b) 0.5 or Lesser than 0.5 cm/s

   (c) 1.0 or Lesser than 1.0 cm/s   (d) 1.0 or More than 1.0 cm/s

50. The coefficient of permeability of the soil sample is found to be 1×10^{-3} cm/s at a void ratio of 0.4. Its permeability at the value of 0.6 is

   (a) 1.26×10^{-3} cm/s   (b) 2.25×10^{-3} cm/s

   (c) 3.62×10^{-3} cm/s   (d) 4.15×10^{-3} cm/s

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. On a two-way traffic road, the speed of overtaking and overtaken vehicles are 70 and 40 kmph respectively. If the average acceleration of overtaking vehicle is 0.92 m/s^2, determine (i) safe overtaking sight distance and (ii) minimum length of overtaking zone. (assume t=2sec)

2. The radius of a horizontal circular curve is 80 km. the design speed is 60kmph and the design co-efficient of lateral friction is 0.15. Determine (i) co-efficient of friction needed if no superelevation is provided (ii) superelevation required if full lateral friction is assumed to develop.

3. Discuss the shear characteristics of cohesion less soils and cohesive soils.

4. State Stoke's law. What is its use in the sedimentation method of analysis? What are its limitation?

5. What is Fenske's chart? Explain its construction and uses.

6. A network is shown in figure, with the expected time of completion of each activity. Determine the earliest expected time and latest occurrence time for each event.
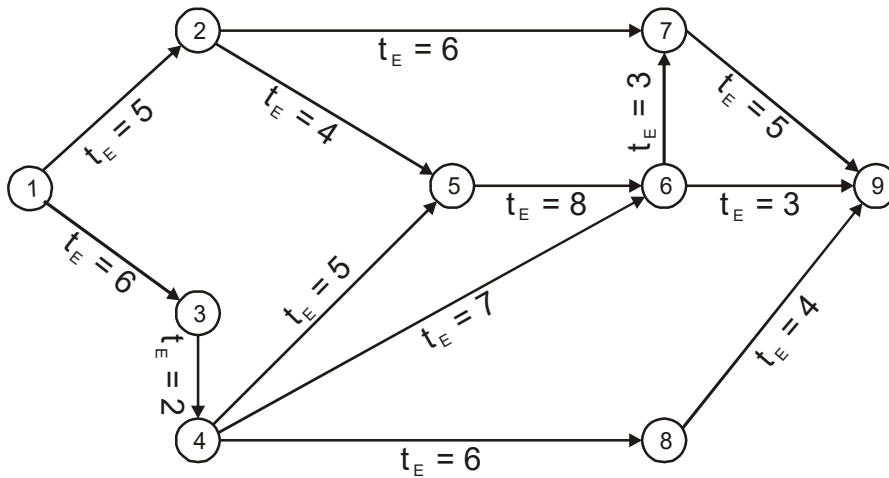

7. A construction project consists of 12 activities. The predecessor relationships are identified by their node numbers as indicated below

Activity	Identification	Activity	Identification
A	(1,2)	G	(4,6)
B	(2,4)	H	(5,6)
C	(2,3)	I	(5,7)
D	(2,7)	J	(7,8)
E	(3,4)	K	(6,8)
F	(3,5)	L	(8,9)

Draw the network diagram.

8. The network diagram for a certain project is shown in figure. Determine the expected path for each of the path. Which path is critical.
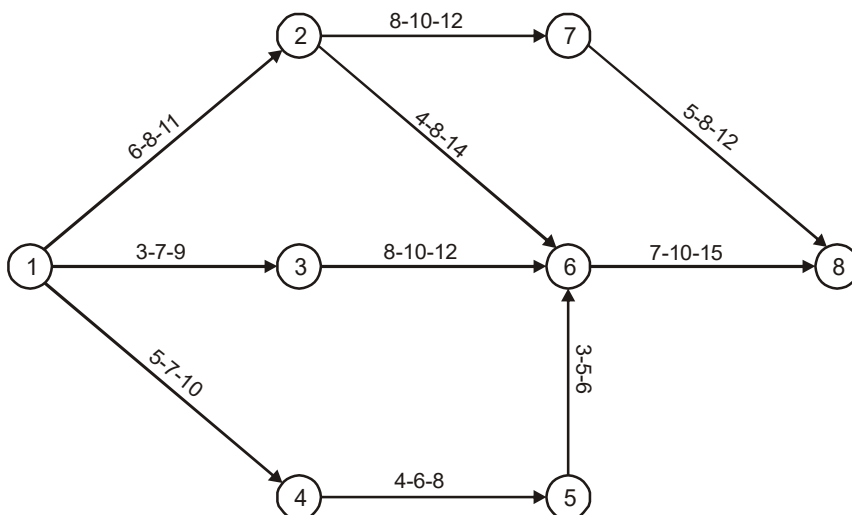
9. What are the assumptions made in Rankine's Analysis of Earth Pressure.

10. A circular area of 7.5 m in diameter on the ground surface carries a uniformly distributed load of 3kN/m2. Find the intensity of vertical pressure below the centre of the loaded area at a depth of 6m below the ground surface.

11. A wall with a smooth vertical backfill 20 m high supports a purely cohesive soil. Determine the Rankine's active pressure against the wall, position of zero pressure and distance of active pressure above the base. ($c = 9.81 \text{kN/m}^2$, $\gamma = 18 \text{ kN/m}^3$).

12. Determine the factor of safety with respect to cohesion for a submerged embankment 40m high and having a slope of 55°. ($c = 40 \text{ kN/m}^2$, $\varphi = 20°$ and $\gamma_{sat} = 19 \text{kN/m}^3$).

13. Explain Laplace equation. What are its assumptions?

14. Explain the California resistance value method of flexible pavement design.

15. Explain grade separated intersections. Mention atleast 3 advantages of grade separation.

16. Design the rate of super elevation for a horizontal highway curve of radius 500m and speed of 100 kmph.

17. A road embankment 40m wide at formation level with side slopes 1 to 1 and with an average height of 15m is constructed with an average gradient of 1 in 40 from contour 150 m to 590 m. The ground has an average slope of 10 to 1 in direction transverse to the centre line. Find (i) the length of the road (ii) volume of embankment in cubic meters.

18. The following consecutive readings were taken with a level and 5metre levelling staff on continuously sloping ground at a common interval of 25 metres 0.450, 1.120, 2.905, 3.685, 0.520, 2.150, 3.205, and 4.485. The reduced level of the change point was 250.000. Calculate reduced levels of the points by rise and fall method and also gradient of the line joining the first and last point in a regular format of the level field book.

19. A smooth backed vertical wall is 6m high and retains a soil with a bulk unit weight of 20kN/m^3 and $\phi = 20°$. the top of the soil is level with the top of the wall and is horizontal. If the soil surface carries a u.d.l. of 50 kN/m^2, find the total thrust on the wall per metre run.

20. At a depth of 6m from the ground level at a site, a shear test gave a torque of 604 kg-cm. the vane was 10 cm high and 7 cm across the blades. Find the cohesive strength of the soil.

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