MIZORAM PUBLIC SERVICE COMMISSION

TECHNICAL COMPETITIVE EXAMINATIONS FOR RECRUITMENT TO JUNIOR GRADE OF MIZORAM ENGINEERING SERVICE UNDER PUBLIC HEALTH ENGINEERING DEPARTMENT, NOVEMBER, 2015

CIVIL ENGINEERING
PAPER - I

Time Allowed : 3 hours

Full Marks : 200

Attempt all questions.

Part A - Objective Type Questions (100 Marks)

All questions carry equal marks of 2 each.

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

1. In a cylindrical shell, the ratio of longitudinal stress to hoop stress is
   (a) 0.5
   (b) 1
   (c) 2
   (d) 4
2. Buckling load for a given column depends upon
   (a) Length of column only
   (b) Least lateral dimension only
   (c) Both length and least lateral dimension
   (d) None of these
3. If a three hinged parabolic arch carries a uniformly distributed load over the entire span, then any section of the arch is subjected to
   (a) Normal thrust only
   (b) Normal thrust and shear force
   (c) Normal thrust and bending moment
   (d) Normal thrust, shear force and bending moment
4. A bar of square section is subjected to a pull of 10,000 kg. If the maximum allowable shear stress on any section is 500 kg/cm^2, then the side of the square section will be
   (a) $\sqrt{5}$ cm
   (b) $\sqrt{10}$ cm
   (c) $\sqrt{15}$ cm
   (d) $\sqrt{20}$ cm
5. Limit of proportionality depends upon
   (a) Area of cross-section
   (b) Type of loading
   (c) Type of material
   (d) All of these
6. If the diameter of a shaft subjected to torque alone is doubled, then the horse power P can be increased to
   (a) 16 P
   (b) 8 P
   (c) 4 P
   (d) 2 P

7. The elongation of a conical bar under its own weight is equal to
   (a) That of a prismatic bar of same length
   (b) One half that of a prismatic bar of same length
   (c) One third that of a prismatic bar of same length
   (d) One fourth that of a prismatic bar of same length

8. A beam of overall length l with equal overhangs on both sides carries a uniformly distributed load over the entire length. To have numerically equal bending moments at centre of the beam and at supports, the distance between the supports should be
   (a) 0.277 l
   (b) 0.403 l
   (c) 0.586 l
   (d) 0.707 l

9. A beam simply supported at both the ends, of length 'L' carries two equal unlike couples M at two ends. If the flexural rigidity, EI = constant, then the central deflection of beam is given by
   (a) $\frac{ML^2}{4EI}$
   (b) $\frac{ML^2}{16EI}$
   (c) $\frac{ML^2}{64EI}$
   (d) $\frac{ML^2}{8EI}$

10. A long column has maximum crippling load when its
   (a) Both ends are hinged
   (b) Both ends are fixed
   (c) One end is fixed and other end is hinged
   (d) One end is fixed and other end is free

11. If the resultant of two forces has the same magnitude as either of the force, then the angle between the two forces is
   (a) 30°
   (b) 45°
   (c) 60°
   (d) 120°

12. A system of coplanar forces is in equilibrium when
   (a) Force polygon closes
   (b) Funicular polygon closes
   (c) Both force polygon and funicular polygon close
   (d) All the forces are concurrent

13. The principle of virtual work can be applied to elastic system by considering the virtual work of
   (a) Internal forces only
   (b) External forces only
   (c) Internal as well as external forces
   (d) None of these

14. If the kinetic energy and potential energy of a simple harmonic oscillator of amplitude A are both equal to half the total energy, then the displacement is equal to
   (a) A
   (b) A/2
   (c) $A/\sqrt{2}$
   (d) $A\sqrt{2}$

15. Two ships A and B leave a port at the same time, the ship A moving north at 30 km/h and the ship B moving eastwards at 40 km/h. The speed of B relative to A is
   (a) 70 km/h
   (b) 35 km/h
   (c) 10 km/h
   (d) 50 km/h

16. Coefficient of friction depends on
   (a) Nature of surfaces only
   (b) Area of contact only
   (c) Both (a) and (b)
   (d) None of these

17. The velocity in m/s of a particle moving in a straight line is given by $V = t^3 - t^2$. Its acceleration after three seconds is

(a) 10.25 m/s^2 (b) 25 m/s^2

(c) 18 m/s^2 (d) 21 m/s^2

18. The centre of gravity of a semicircle of radius r from the diameter is

(a) $\frac{3r}{2\pi}$ (b) $\frac{4r}{3\pi}$

(c) $\frac{2r}{3\pi}$ (d) $\frac{3r}{4\pi}$

19. A ladder of weight 'w' rests against a smooth vertical wall, and rests on rough horizontal ground, the coefficient of friction between the ladder and the ground being ¼. The maximum angle of inclination of the ladder to the vertical, if a man of weight 'w' is to walk to the top of it safely, is $\tan^{-1} x$, where x is

(a) ¼ (b) 1/3

(c) 3 (d) 4

20. A disc of mass 4 kg, radius 0.5m and moment of inertia 3 kg-m^2 rolls on a horizontal surface so that its centre moves with speed 5 m/sec. Kinetic energy of the disc is

(a) 50 J (b) 150 J

(c) 200 J (d) 400 J

21. While using three moments equations, a fixed end of a continuous beam is replaced by an additional span of

(a) Zero length (b) Infinite length

(c) Zero moment of inertia (d) None of these

22. For a symmetrical two hinged parabolic arch, if one of the supports settles horizontally, then the horizontal thrust

(a) Is increased (b) Is decreased

(c) Remains unchanged (d) Becomes zero

23. Influence line for horizontal thrust in a two hinged parabolic arch is

(a) Parabolic (b) Cubic

(c) Triangular (d) Rectangle

24. The moment required to rotate the near end of a prismatic beam through unit angle without translation (the far end being fixed) is given by

(a) $\frac{EI}{L}$ (b) $\frac{2EI}{L}$

(c) $\frac{3EI}{L}$ (d) $\frac{4EI}{L}$

25. The maximum bending moment due to a train of wheel loads on a simply supported girder

(a) Always occurs at centre of span (b) Always occurs under a wheel load

(c) Never occurs under a wheel load (d) None of these

26. The strain energy of a structure due to bending is given by

(a) $\int \frac{M^2 dx}{EI}$ (b) $\frac{1}{2}\int \frac{M^2 dx}{EI}$

(c) $\frac{1}{2}\int \frac{2M^2 dx}{EI}$ (d) $\frac{1}{3}\int \frac{M^2 dx}{EI}$

27. Effects of shear force and axial force on plastic moment capacity of a structure are respectively to

(a) Increase and decrease (b) Increase and increase

(c) Decrease and increase (d) Decrease and decrease

28. A fixed beam AB of span L is subjected to a clockwise moment M at a distance 'a' from end A. Fixed end moment at end A will be

(a) $\frac{M}{L^2}(L-a)(L-3a)$ (b) $\frac{M}{L^2}a(2L-3a)$

(c) $\frac{Ma}{L^2}(L-a)$ (d) $\frac{M}{L^2}a(L-a)(2L-a)$

29. Select the correct statement

(a) Flexibility matrix is a square symmetrical matrix

(b) Stiffness matrix is a square symmetrical matrix

(c) Both (a) and (b)

(d) None of these

30. A two span continuous beam ABC is simply supported at A and C and is continuous over support B. Span AB=6m, BC= 6m. The beam carries a udl of 2 t/m over both the spans. EI is constant for the entire beam. The fixed end moment at B in span BA or BC would be

(a) 12 t.m (b) 9 t.m

(c) 8 t.m (d) 6 t.m

31. The property of fresh concrete, in which the water in the mix tends to rise to the surface while placing and compacting, is called

(a) Segregation (b) Bleeding

(c) Bulking (d) Creep

32. Workability of concrete is directly proportional to

(a) Aggregate cement ratio (b) Time of transit

(c) Grading of the aggregate (d) All of these

33. Soundness test of cement by Le-Chatelier's apparatus gives unsoundness due to

(a) Free lime only (b) Magnesia only

(c) Both free lime and magnesia (d) None of these

34. Amount of gypsum required to be added to the clinker depends on the following contents of cement

i. Tricalcium silicate ii. Dicalcium silicate

iii. Tricalcium aluminate iv. Alkali

The correct answer is

(a) (i) and (ii) (b) (ii) and (iii)

(c) (iii) and (iv) (d) (i) and (iv)

35. High carbon content in the steel causes
    (a) Decrease in tensile strength but increase in ductility
    (b) Increase in tensile strength but decrease in ductility
    (c) Decrease in both tensile strength and ductility
    (d) Increase in both tensile strength and ductility

36. When the axis of load lies in the plane of rivet group, then the most heavily loaded rivet will be the one which
    (a) Is at the maximum distance from CG of the rivet group
    (b) Is at the minimum distance from CG of the rivet group
    (c) Gives the maximum angle between the two forces F_a and F_m
    (d) Gives the minimum angle between the two forces F_a and F_m

37. As per IS: 875, for the purpose of specifying basic wind velocity, the country has been divided into
    (a) 4 zones
    (b) 5 zones
    (c) 6 zones
    (d) 7 zones

38. The effective length of a fillet weld should not be less than
    (a) Two times the weld size
    (b) Four times the weld size
    (c) Six times the weld size
    (d) Weld size

39. Economical depth of a plate girder corresponds to
    (a) Minimum weight
    (b) Four times the weld size
    (c) Maximum weight
    (d) Weld size

40. A steel beam of rectangular cross-section is clamped at both ends. Plastic deformation is just observed when the udl on the beam is 10 kN/m. At the instant of collapse, the load on the beam will be
    (a) 10 kN/m
    (b) 15 kN/m
    (c) 20 kN/m
    (d) 30 kN/m

41. The stress at which a material fractures under large number of reversals of stress is called
    (a) Endurance limit
    (b) Creep
    (c) Ultimate strength
    (d) Residual stress

42. According to IS: 456-2000, the maximum reinforcement in a column is
    (a) 2%
    (b) 4%
    (c) 6%
    (d) 8%

43. In counterfort type retaining walls
    i. The vertical slab is designed as a continuous slab
    ii. The heel slab is designed as a continuous slab
    iii. The vertical slab is designed as a cantilever
    iv. The heel slab is designed as a cantilever

    The correct answer is
    (a) (i) and (ii)
    (b) (i) and (iv)
    (c) (ii) and (iii)
    (d) (iii) and (iv)

44. Approximate value of shrinkage strain in concrete, is
    (a) 0.003
    (b) 0.0003
    (c) 0.00003
    (d) 0.03

45. The development length of bars of diameter , as per IS: 456-2000 is given by

(a) $\frac{4\varnothing\sigma_s}{\tau_{bd}}$ (b) $\frac{\varnothing\sigma_s}{4\tau_{bd}}$

(c) $\frac{2\varnothing\sigma_s}{3\tau_{bd}}$ (d) $\frac{\varnothing\sigma_s}{3\tau_{bd}}$

Where, σ_s = stress in bar

τ_{bd} = design bond stress

46. Normally prestressing wires are arranged in the

(a) Upper part of the beam (b) Lower part of the beam

(c) Centre (d) Anywhere

47. According to IS: 456-2000, the maximum compressive stress in concrete for design purpose is taken as

(a) $0.370\ f_{ck}$ (b) $0.416\ f_{ck}$

(c) $0.446\ f_{ck}$ (d) $0.670\ f_{ck}$

48. Increase in the fineness of cement results in

(a) Increase in the rate of heat of hydration without changing the total amount of heat liberated

(b) Decrease in the rate of heat of hydration without changing the total amount of heat liberated

(c) Increase in the rate of heat of hydration with an increase in the total amount of heat liberated

(d) Decrease in the rate of heat of hydration with a reduced amount of total heat liberated

49. In a ring beam subjected to uniformly distributed load

i. Shear force at mid span is zero

ii. Shear force at mid span is maximum

iii. Torsion at mid span is zero

iv. Torsion at mid span is maximum

(a) (i) and (iii) (b) (i) and (iv)

(c) (ii) and (iii) (d) (ii) and (iv)

50. To minimize the effect of differential settlement, the area of a footing should be designed for

(a) Dead load only (b) Dead load+ live load

(c) Dead load+ fraction of live load (d) Live load+ fraction of dead load

Part B - Short Answer Questions (100 Marks)

All questions carry equal marks of 5 each.

*This Part should be answered only on the **Answer Booklet** provided.*

1. Write a note on requirement of good concrete.

2. Explain and define free body diagram (FBD). Draw a free body diagram of a ball of weight W placed on a horizontal surface.

3. Two forces acting at a point have their resultant 10 N when they act at right angle and their least resultant is 2 N. Find their greatest resultant and also the resultant when they act at an angle of $\theta = 60^0$.

4. A uniform steel bar of 2 m long , 8 mm diameter is subjected to a tensile force of 3500 N. Determine the tensile stress and its elongation if Young's modulus E is 1.86×10^5 N/mm^2.
5. The principal tensile stresses at point in a strained bar across two perpendicular planes are 100 N/mm^2 and 50 N/mm^2. Calculate the normal stress, shear stress and resultant stress on a plane inclined at 30° to the axis of the major stress.
6. State and prove the Law of Maxwell's Reciprocal Deflection theorem.
7. Write on (i) Moment Distribution Method and (ii) Slope Deflection Method.
8. A short column of 350 mm × 350 mm in section is reinforced with 6 bars of 25 mm diameter. Find the safe load on the column as per IS code, permissible stress in concrete and steel being 5 N/mm^2 and 190 N/mm^2 respectively.
9. A single reinforced concrete beam 300 mm wide has an effective depth of 500 mm, the effective span being 5m. It is reinforced with 804 mm^2 of steel. If the beam carries a total load of 16 kN/m on the whole span determine the stresses produced in concrete and steel. Take m=13.
10. A prestressed concrete beam 300 mm × 500 mm in section has a span of 5 m and is subjected to a UDL of 12 kN/m including the self weight of the beam. The prestressing tendons are located at the lower third point and provide an effective prestressing force of 900 kN. Determine the extreme fiber stresses in concrete at the mid section.
11. Two plates 10 mm and 18 mm thick are to be jointed by a double cover butt joint. Assuming cover plates of 8 mm thickness, design the joint to transmit a factored load of 500 kN. Assume Fe 410 plate and grade 4.6 bolt.
12. Select a suitable angle section to carry a factored tensile force of 170 kN assuming a single row of M 20 bolts and assuming design strength as f_y=250 N/mm^2.
13. Determine the effective throat dimension of a 10 mm fillet weld made by (1) shielded metal arc welding (SMAW) and (2) Submerged arc welding (SAW).
14. Determine the design axial load on the column section ISMB 400, given that the height of column is 3.6 m and that it is pin-ended. Also assume the following f_y=250 N/mm^2, f_u= 410 N/mm^2, E= 2.2×10^5 N/mm^2.
15. State and Prove the Clapeyron's Theorem of Three Moments.
16. Write advantages and disadvantages of a fixed beam.
17. A cantilever beam of length 4.5 m is subjected to a UDL of 15 kN/m for a length of 3.5 m free end. Analyse the beam and draw SFD and BMD.
18. Write difference between statically determinate structures and statically indeterminate structures.
19. What are the basic assumptions in the analysis of reinforced concrete member?
20. Prove that if four forces acting along the sides of a square are in equilibrium, they must be equal in magnitude.

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