MIZORAM PUBLIC SERVICE COMMISSION

TECHNICAL COMPETITIVE EXAMINATIONS FOR RECRUITMENT TO
JUNIOR GRADE OF MIZORAM ENGINEERING SERVICE
UNDER POWER & ELECTRICITY DEPARTMENT, NOVEMBER, 2015

MECHANICAL ENGINEERING
PAPER - II

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. When the relative motion between two elements is completely or successfully constrained, then these two elements form a
(a) mechanism (b) machine
(c) kinematic pair (d) none of these

2. Piston and cylinder of a reciprocating steam engine forms a
(a) rolling pair (b) turning pair
(c) sliding pair (d) spherical pair

3. Which of the following is a lower pair?
(a) automobile steering gear (b) ball and roller bearing
(c) cam and follower (d) belt and chain drives

4. Whitworth quick return mechanism is an inversion of
(a) four bar chain (b) single slider crank mechanism
(c) five bar chain (d) double slider crank mechanism

5. Which of the following is a spring loaded type governor?
(a) Watt governor (b) Porter governor
(c) Proell governor (d) Hartnell governor

6. If there are L number of links in a mechanism then number of possible inversion is equal to
(a) L + 1 (b) L
(c) L – 1 (d) L + 2

7. Corioli's component is encountered in
(a) quick return mechanism of shaper (b) four bar chain mechanism
(c) slider crank mechanism (d) all of these

8. Critical damping is a function of
(a) mass and stiffness (b) mass and damping coefficient
(c) stiffness and natural frequency (d) stiffness and damping coefficient

9. The primary unbalance force in reciprocating masses is
(a) directly proportional to crank radius
(b) directly proportional to square of crank radius
(c) inversely proportional to crank radius
(d) independent of crank radius

10. In a spur gear the involute profile is generated from
(a) base circle (b) pitch circle
(c) addendum circle (d) dedendum circle

11. The radius of gyration of a disc type flywheel of diameter D is
(a) D (b) D/2
(c) D/3 (d) D/4

12. The maximum magnitude of the unbalanced force along the perpendicular to the line of stroke is known as:
(a) hammer blow (b) tractive force
(c) swaying couple (d) none of these

13. The number of instantaneous centres for a four bar chain is
(a) 3 (b) 4
(c) 6 (d) 12

14. The minimum number of teeth on a 20° standard involute pinion to mesh with a rack to avoid interference is given by
(a) 15 (b) 17
(c) 18 (d) 27

15. A cotter joint is used to transmit:
(a) axial tensile load only (b) axial compressive load only
(c) axial tensile and torsional loads (d) axial tensile or compressive loads

16. 100 kW of power is to be transmitted by each of two separate shafts, made of the same material. Shaft A is turning at 250 rpm and shaft B at 300 rpm. Which shaft must have greater diameter?
(a) A (b) B
(c) Both will have the same diameter (d) None of these

17. The sleeve or muff of a sleeve coupling is designed by treating it as a
(a) thin pressure vessel (b) thick pressure vessel
(c) solid shaft (d) hollow shaft

18. The most suitable bearing for resisting heavy loads under slow speed is
(a) hydrodynamic bearing (b) ball bearing
(c) roller bearing (d) hydrostatic bearing

19. Which of the following is a positive drive?
(a) Crossed flat belt drive (b) Crossed V-belt drive
(c) Rope drive (d) Chain drive

20. Zero axial thrust is experienced in
(a) helical gears (b) bevel gears
(c) spiral gears (d) herringbone gears

21. The type of thread preferred for power screw is
(a) ACME threads (b) square threads
(c) buttress threads (d) all of these

22. Eye bolts are used for
(a) locking devices
(b) lifting and transportation of machines and cubicles
(c) absorbing shock and vibration
(d) transmission of power

23. A flexible coupling can be used for
(a) axial misalignment (b) angular misalignment
(c) both (a) and (b) (d) can only be used for aligned shaft

24. A positive action clutch is
(a) jaw clutch (b) a single disk friction clutch
(c) a multi disc friction clutch (d) a cone clutch

25. The power transmission capacity of a belt drive due to centrifugal tension
(a) increases (b) decreases
(c) remains unaffected (d) none of these

26. The bearing characteristic number of a journal bearing depends upon
(a) length, width and load (b) length, width and speed
(c) viscosity, speed and load (d) viscosity, speed and bearing pressure

27. Solid length of a helical spring is the product of
(a) total number of coils and wire diameter (b) active number of coils and wire diameter
(c) pitch and total number of turns (d) maximum deflection and inactive coils

28. The power transmitted by a belt drive is maximum when the ratio of maximum tension in the belt to that of centrifugal tension is
(a) 2 (b) 3
(c) 4 (d) none of these

29. If the particles of a body vibrate parallel to the axis of the body, then the body is said to have
(a) transverse vibration (b) torsional vibration
(c) longitudinal vibration (d) none of these

30. A shaft is designed on the basis of
(a) strength and elasticity (b) rigidity and elasticity
(c) strength and rigidity (d) only strength

31. Hydrostatic bearing is most suitable for carrying very heavy loads with
(a) very high speed (b) very slow speed
(c) high speed (d) slow speed

32. Two springs (each having stiffness K) are in parallel. The overall stiffness of the two springs would be
(a) K/2 (b) K
(c) K/4 (d) 2K

33. Brinell number of a material is a measure of its
(a) hardness (b) ductility
(c) rigidity (d) roughness

34. If Young's modulus of a material is given as 1.2×10^5 N/mm^2 and Bulk modulus is 0.8×10^5 N/mm^2, then Poisson's ratio of the material is

(a) 0.25 (b) 0.45

(c) 0.65 (d) 0.85

35. If a rectangular beam is loaded transversely maximum stress develops at

(a) neutral layer (b) bottom layer

(c) middle layer (d) top layer

36. In case of a thin cylinder the ratio of longitudinal stress to hoop stress is

(a) 1/4 (b) 4

(c) 1/2 (d) 2

37. Columns which fail by direct stress only are called

(a) short column (b) medium column

(c) weak column (d) long column

38. Material which absorbs large amount of energy is called

(a) hard (b) tough

(c) brittle (d) malleable

39. The buckling load for a given column depends on

(a) least radius of gyration (b) length of column

(c) modulus of elasticity (d) all of these

40. Maximum shear stress in a Mohr's circle is

(a) equal to diameter of the Mohr's circle (b) equal to radius of the Mohr's circle

(c) less than the radius of the Mohr's circle (d) more than the radius of the Mohr's circle

41. A long column fails by

(a) crushing (b) tearing

(c) shearing (d) buckling

42. The ratio of lateral strain to the linear strain within elastic limit is known as

(a) Young's modulus (b) bulk modulus

(c) Poisson's ratio (d) modulus of rigidity

43. The materials having same elastic properties in all directions are called

(a) ideal materials (b) uniform materials

(c) isotropic materials (d) elastic materials

44. The energy absorbed in a body, when it is strained within the elastic limits, is known as

(a) strain energy (b) resilience

(c) modulus of resilience (d) none of these

45. If a material expands freely due to heating it will develop

(a) thermal stress (b) tensile stress

(c) bending stress (d) no stress

46. In a solid circular shaft subjected to pure torsional moment, the ratio of maximum shear stress to maximum normal stress at any point is:

(a) 2 (b) 1

(c) 2/3 (d) 1/2

47. The strain energy stored in a solid circular shaft of torsional rigidity GJ and length L, subjected to a twisting moment T is given by

(a) TL/GJ (b) T^2L/GJ

(c) $T^2L/2GJ$ (d) GJ/TL

48. The point of contraflexure can exist in a

(a) simply supported beam

(b) cantilever beam

(c) beam fixed at both the ends

(d) beam with overhangs with no loads on the overhanging sections

49. The ratio of the torsional strength of a hollow shaft to that of a solid shaft of equal length and weight and made of same material is

(a) more than one (b) less than one

(c) equal to one (d) none of these

50. Euler's formula is applicable for determining the buckling load for

(a) long columns (b) intermediate columns

(c) medium size columns (d) short columns

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. What is a kinematic pair? Write the classification of kinematic pair according to the nature of relative motion between the elements with suitable sketch and example. **(2+3=5)**

2. Clearly distinguish between the following: **(2×2½=5)**

(i) elasticity and plasticity (ii) ductility and malleability.

3. Discuss in brief any two important theories of failure. Also define the term 'factor of safety'. **(4+1=5)**

4. Define the term 'rating life' of a bearing. Also write the classification of bearings with suitable sketch. **(2+3=5)**

5. Draw shear force and bending moment diagrams of a simply supported beam of span 'L' carrying a concentrated load 'W' at mid span. **(5)**

6. A flywheel absorbs 24 kJ of energy on increasing its speed of 210 rpm to 214 rpm. Determine the kinetic energy of the flywheel at 250 rpm. **(5)**

7. A belt runs over a pulley of 800 mm diameter at a speed of 180 rpm. The angle of lap is 165° and the maximum tension in the belt is 2 kN. Determine the power transmitted if the coefficient of friction between the belt and pulley is 0.3. **(5)**

8. The piston of a steam engine is 60 mm in diameter and operates in a cylinder of diameter 400 mm. The piston rod is 1 m long. What is the maximum pressure that can be allowed in the cylinder if the stress in the rod is limited to 80 N/mm^2 ? What will be the change in the length of the piston at this pressure? Take E=200 GPa. **(5)**

9. What is Coriolis component of acceleration? Explain. When will it exist? **(1+3+1=5)**

10. A pair of spur gear transmitting power at a velocity of 3:1. The teeth are of involute form, module = 6 mm, addendum = 1 module, pressure angle = 20º. The pinion rotates at 90 rpm. Find the number of teeth on pinion to avoid interference on it and also the number of teeth of gear. **(5)**

11. What is slip in belt drive? Is it desirable? How does slip influence power transmission in the drive? **(2+1+2=5)**

12. What do you understand by the term 'Life of a Ball bearing'? How is bearing life is expressed? Explain. **(2+3=5)**

13. The principal stresses at a critical section of a machine component are σ_1 = 420 N/mm^2, = 180 N/mm^2 and = 0. The yield strength of the material is 600 N/mm^2. Compute the factor of safety using **(2½×2=5)**

(i) the maximum shear stress theory (ii) the distortion energy theory.

14. A steel bar of 15 mm in diameter and 250 mm long is pulled axially by a force of 10 kN. Find the total strain energy stored by the bar. Young's modulus of elasticity of the bar material is 2×10^5 N/mm^2.**(5)**

15. A hollow shaft has more strength and stiffness than the solid shaft of the same material and length. Justify. **(5)**

16. What is a gear train? Give the classification of Gear Train. **(2+3=5)**

17. What are the advantages of welding compared to other fastening devices? **(5)**

18. Differentiate between hydrodynamic and hydrostatic lubrication. **(5)**

19. An engine running at 200 rpm drives a line shaft by means of a belt drive. The engine pulley is 750 mm in diameter and the pulley on the shaft is 450 mm in diameter. Determine the speed of the line shaft when there is a slip of 2.5% at each pulley. **(5)**

20. An aluminum shaft (= 330 MPa) of circular cross-section with 20 mm diameter is subjected to an axial load P= 50 kN. Using the octahedral shear stress criterion of failure by yielding, determine the torque T that can be applied to initiate yielding. **(5)**

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