MIZORAM PUBLIC SERVICE COMMISSION

COMPETITIVE EXAMINATIONS FOR JUNIOR GRADE OF M.E.S. UNDER PUBLIC WORKS DEPARTMENT, AUGUST, 2018.

MECHANICAL 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. If two moving elements have surface contact in motion, such pair is known as
(a) sliding pair (b) rolling pair
(c) higher pair

2. The example of a lower pair is
(a) shaft revolving in a bearing (b) straight line motion mechanisms
(c) automobile steering gear (d) all of these

3. Any point on a link connecting double slider crank chain will trace a
(a) straight line (b) circle
(c) ellipse (d) parabola

4. Pitch point on a cam is
(a) any point on pitch curve
(b) the point on cam pitch curve having the maximum pressure angle
(c) the point on cam pitch curve having the minimum pressure angle
(d) none of these

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

6. The number of links in pantograph mechanism is equal to
(a) 2 (b) 3
(c) 4 (d) 5

7. Relationship between the number of links (L) and number of pairs (P) is
(a) P=2L+2 (b) P=2L+4
(c) 2L-2 (d) 2L-4

8. In automobiles the power is transmitted from gear box to differential through
(a) Hooke's joint (b) bevel gear
(c) Knuckle joint (d) universal joint

9. Creep in belt drive is due to
(a) material of the pulley
(b) uneven extensions and contractions due to varying tension
(c) expansion of belt
(d) larger size of the driver pulley

10. Which of the following is false statement in respect of differences between machine and structure
(a) Machine transmit mechanical work, whereas structure transmit forces
(b) Efficiency of machines as well as structure is below 100%
(c) Machine modify movement and work whereas structure modify forces
(d) machines are run by electric motors, but structures are not.

11. If D1 and D2 are the diameters of driver and driven pulleys, then belt speed is proportional to
(a) D1 (b) D2
(c) D1/D2 (d) D2/D1

12. If the opposite links of four bar linkage are equal, the links will always form a
(a) triangle (b) rectangle
(c) parallelogram (d) trapezoid

13. Kinematic pairs are those which have
(a) point or line contact between the two elements when in motion
(b) elements of pairs not held together mechanically
(c) two elements that permit relative motion
(d) surface contact between the two elements when in motion

14. A chain comprises of 5 links having 5 joints. Is it kinematic chain?
(a) yes (b) no
(c) unpredictable (d) it is a marginal case

15. In a four bar chain it is required to give an oscillatory motion to the follower for a continuous rotation of the crank. For the lengths of 50 mm of crank and 70 mm of the follower, determine theoretical length of coupler. The distance between fixed pivots of crank and followers is
(a) 95 mm (b) 45 mm
(c) slightly less than 45 mm (d) slightly less than 95 mm

16. For a simple harmonic motion of the follower, a cosine curve represents
(a) displacement (b) velocity diagram
(c) acceleration diagram (d) all of these

17. The permissible stress for carbon steel under static loading is generally taken as
(a) 2000-3000 kg/cm^2 (b) 3000-3500 kg/cm^2
(c) 4000-4500 kg/cm^2 (d) 5000-5500 kg/cm^2

18. Tensile strength of a mild steel specimen can be roughly predicted from following hardness test
(a) Brinell (b) Rockwell
(c) Vicker (d) Shore's sceleroscope

19. Brittle coating techniques is used for
(a) determining brittleness (b) protecting metal against corrosion
(c) protecting metal against wear and tear (d) experimental stress analysis

20. The fatigue life of a part can be improved by
(a) electroplating
(b) polishing
(c) coating
(d) shot peening

21. Coaxing is the procedure of increasing
(a) metal strength by cycling
(b) fatigue limit by overstressing the metal by successively increasing loadings
(c) metal resistance to corrosion by coating
(d) metal hardness by surface treatment

22. In Vicker's hardness testing, the pyramid indenter apex is
(a) 40°
(b) 122°
(c) 136°
(d) 152°

23. Residual stress in materials
(a) is independent of external load
(b) is always harmful
(c) is always beneficial
(d) acts when external load is applied

24. The ratio of endurance limit in shear to the endurance limit in flexure is
(a) 0.33
(b) 0.5
(c) 0.55
(d) 0.44

25. The deflection of a cantilever beam under load W is 8. If its width is halved, then the deflection under load W will be
(a) 28
(b) 48
(c) 58
(d) 68

26. Rivets are generally specified by
(a) thickness of plates to be riveted
(b) length of rivet
(c) diameter of head
(d) nominal diameter

27. When the length of connecting rod is small, it results in
(a) greater angular swing and greater side thrust on piston
(b) lesser angular swing and lesser side thrust on piston
(c) more chances of buckling failure
(d) no side thrust on piston

28. For maximum torque condition, the crank angle is,
(a) 0° from top dead centre for petrol and diesel engines
(b) 33° before top dead centre for petrol engine and 1° after top dead centre position for diesel engine
(c) 25° to 35° for petrol engine and 30° to 40° for diesel from top dead centre
(d) 90° from top dead centre for petrol and diesel engines

29. The spring index for valve spring is usually
(a) 6
(b) 8
(c) 10
(d) 12

30. Push rod is designed on the basis of,
(a) tensile strength (b) compressive strength
(c) bending strength (d) buckling strength

31. When two springs are in series (having stiffness K), the equivalent stiffness will be
(a) K (b) K/2
(c) 2K (d) 2/K

32. The shock absorbing capacity of a bolt can be increased by
(a) making shank diameter equal to core diameter thread
(b) tightening it properly
(c) grinding the shank
(d) using washer

33. Pick up the incorrect statement from the following:
(a) The C.G. of a circle is at its center
(b) The C.G. of a triangle is at the intersection of its medians
(c) The C.G. of a rectangle is at the intersection of its diagonals
(d) The C.G. of a semicircle is at a distance of r/2 from the center

34. The ratio of limiting friction and normal reaction is known as
(a) coefficient of friction (b) angle of friction
(c) angle of repose (d) sliding friction

35. In the lever of third order, load W, effort P and fulcrum F are oriented as follows
(a) W between P and F (b) F between W and P
(c) P between W and F (d) none of these

36. A cable with a uniformly distributed load per horizontal meter run will take the following shape
(a) straight line (b) parabola
(c) hyperbola (d) elliptical

37. A trolley wire weighs 1.2 kg per meter length. The ends of the wire are attached to two poles 20 meters apart. If the horizontal tension is 1500 kg, find the dip in the middle of the span
(a) 2.5 cm (b) 3.0 cm
(c) 4.0 cm (d) 5.0 cm

38. If a rigid body is in equilibrium under the action of three forces, then
(a) these forces are equal (b) these forces are not equal
(c) the lines of action of these forces are parallel (d) none of these

39. Which of the following is a vector quantity
(a) energy (b) mass
(c) momentum (d) speed

40. When trying to turn a key into a lock, following is applied
(a) coplanar force (b) lever
(c) moment (d) couple

41. Effect of force on a body depends upon
(a) magnitude (b) direction
(c) line of action (d) all of these

42. A beam is said to be of uniform strength, if

(a) Bending moment is same throughout the beam (b) Deflection is same throughout the beam

(c) Bending stress is same throughout the beam (d) shear stress is same throughout the beam

43. In a solid arch, shear force acts

(a) Vertically upwards (b) Along the axis of the arch

(c) Perpendicular to the axis of the arch (d) tangentially to the arch

44. The tensile force required to cause an elongation 0.045 mm in a steel rod of 1000 mm length and 12 mm diameter, is (where $E = 2\times10^6$ kg/cm^2)

(a) 166 kg (b) 102 kg

(c) 204 kg (d) 74 kg

45. The property of a material by which it can be drawn to a smaller section, due to tension, is called

(a) plasticity (b) ductility

(c) elasticity (d) malleability

46. If a circular beam of diameter d experiences a longitudinal strain P/E and a lateral strain 2P/mE, the volumetric strain is

(a) (P/E)+ (2P/mE) (b) (P/E)- (2P/mE)

(c) (P/E)+ (mE/2P) (d) (P/E)- (mE/2P)

47. Forces are called concurrent when their lines of action meet in

(a) one point (b) two point

(c) plane (d) perpendicular plain

48. If a shaft is rotating N revolutions per minute with an applied torque T kg-m, the horse power being transmitted by the shaft is,

(a) 2pNT/550 (b) 2pNT/750

(c) 2pNT/4500 (d) 2pNT/5500

49. A cantilever beam rectangular in cross-section is subjected to an isolated load at its free end. If the width of the beam is doubled, the deflection of the free end will be changed in the ratio of

(a) 8 (b) 1/8

(c) 1/2 (d) 3

50. Dynamic friction as compared to static friction is

(a) same

(b) more

(c) less

(d) may be less or more depending on nature of surfaces and velocity

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

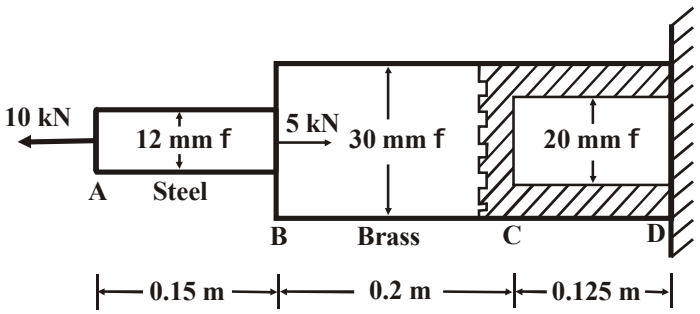
All questions carry equal marks of ***5*** *each.*

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

1. The diameters of the brass and steel segments of the axially loaded bar shown in figure are 30 mm and 12 mm respectively. The diameter of the hollow section of the brass segment is 20 mm. Determine:

(i) The maximum normal stress in the steel and brass

(ii) The displacement of the free end; Take $E_s = 210$ GN/m^2 and $E_b = 105$ GN/m^2.



2. Mention the relationship between three elastic constants i.e. elastic modulus (E), rigidity modulus (G), and bulk modulus (K) for any Elastic material. How is the Poisson's ratio (m) related to these moduli?

3. A steel wire 2 m long and 3 mm in diameter is extended by 0·75 mm when a weight W is suspended from the wire. If the same weight is suspended from a brass wire, 2·5 m long and 2 mm in diameter, it is elongated by 4 .64 mm. Determine the modulus of elasticity of brass if that of steel be 2.0×10^5 N/mm^2.

4. If a rod of brittle material is subjected to pure torsion, show with help of a sketch, the plane along which it will fail and state the reason for its failure.

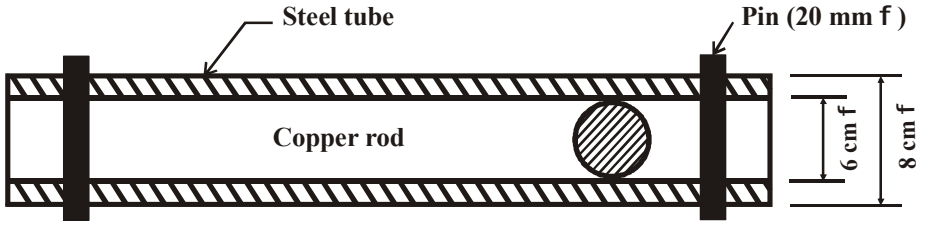
5. A steel bolt of diameter 10 mm passes through a brass tube of internal diameter 15 mm and external diameter 25 mm. The bolt is tightened by a nut so that the length of tube is reduced by 1.5 mm. If the temperature of the assembly is raised by 40 °C, estimate the axial stresses the bolt and the tube before and after heating. Material properties for steel and brass are: $E_s = 2 \times 10^5$ N / mm^2 , $a_s = 1.2 \times 10^{-5}$ /°C and $E_b = 1 \times 10^5$ N/mm^2 , $a_b = 1.9 \times 10^{-15}$/°C.

6. Explain the following in brief:

(i) Effect of size on the tensile strength

(ii) Effect of surface finish on endurance limit.

7. A Copper rod 6 cm in diameter is placed within a steel tube, 8 cm external diameter and 6 cm internal diameter, of exactly the same length. The two pieces are rigidly fixed together by two transverse pins 20 mm in diameter, one at each end passing through both rod and the tube. Calculate the stresses induced in the copper rod, steel tube and the pins if the temperature of the combination is raised by 50°C. [Take E_s=210 GPa, a_s = 0.0000115 /°C; E_c=105 GPa, a_c=0.000017 /°C]



8. What are common modes of failure of rolling element bearings?
9. Write a brief comment on the holding torque acting on epicyclic gear train casings.
10. Explain with the help of neat sketch, how the limitation of Helical gear can overcome Herringbone gear.
11. Explain any one inversion of Double Slider crank chain.
12. Draw a neat sketch of Tchebicheffs mechanism and prove that the link lengths must be in the ratio of 1:2:2·5 for a point on coupler to trace an approximate straight line.
13. Explain rubbing velocity at a Pin joint.
14. What is the significance of contact ratio in gear drives?
15. What is meant by stress concentration? How do you take it into consideration in case of a component subjected to dynamic loading?
16. Write a short note on notch sensitivity and endurance limit.
17. Write a note on the influence of various factors on the endurance limit of a ductile material.
18. A shaft is stepped down from 40mm to 30mm with a fillet radius of 6mm. It is subjected to a torque of 100 Nm. if the form of stress factor for the shaft is K, maximum stress in stepped shaft is?
19. A piston rod made of circular cross section is subjected to a cyclic load fluctuating between 15 KN in compression to 25 KN in tension. The endurance limit for the piston rod material is 360 N/mm^2 while yield strength 400 N/mm^2. The impact factor is 1.25 while factor of safety is 1.5. The surface finish factor and stress concentration factor are 0.88 and 2.25 respectively. Determine the diameter of piston rod.
20. Sketch a bolted connection and indicate the various forces including initial tension. Derive the relationship to estimate the load shared by the bolt in a preloaded joint when an external load acts on the joint.

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