ISRO

Previous Year Paper
Scientist ME
2017

	INDIAN SPACE RESEARCH ORGANISATION	SET
इसरो ISRO	MECHANICAL	A

1. The most applicable failure theory for metals like Aluminium is
   - (a) Maximum principal stress theory
   - (b) Maximum principal strain theory
   - (c) Total strain energy theory
   - (d) Maximum distortion energy theory

2. Which one of the following is FALSE?
   - (a) Number of Taps generally used for hand tapping is 3
   - (b) Piispanen's model in machining is used to estimate shear strain
   - (c) Chip hammering during machining is due to improper chip control
   - (d) Cemented carbide tools are generally poor in compression

3. A statistical process control chart which shows the number of defects found in a subgroup of fixed size is
   - (a) C-chart
   - (b) R-chart
   - (c) Control chart
   - (d) Gantt chart

4. Complex irregular three dimensional surfaces can be located using the following method
   - (a) Sighting
   - (b) Nesting
   - (c) Integral locators
   - (d) Buttons

5. The force in member BC of steel truss structure shown in figure below is (Cross section of each member is A, Length of each member is 'l')
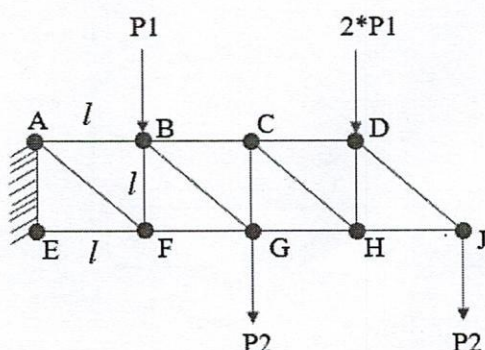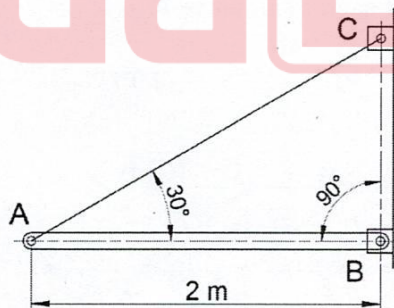

   - (a) $P1 + 2P2$
   - (b) $2P1 + P2$
   - (c) $2*(P1 + P2)$
   - (d) $(P1 + P2)/2$

6. Buckling loads (Pi) of 4 columns of equal length and cross section, but with different end conditions are shown below. Which of the following is TRUE?
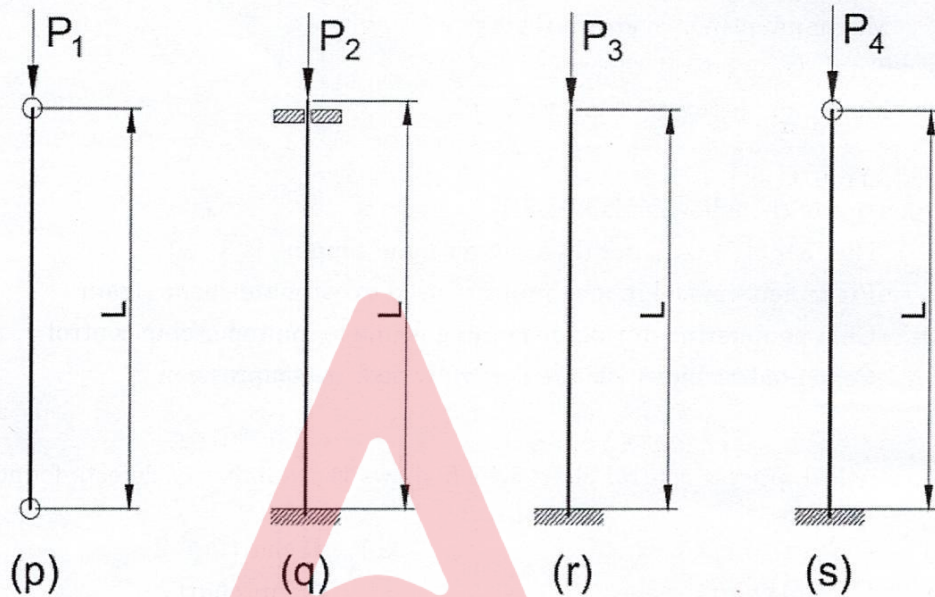
(a) $p_1 < p_2 < p_3 < p_4$

(b) $p_3 < p_1 < p_4 < p_2$

(c) $p_1 < p_4 < p_2 < p_3$

(d) $p_3 < p_4 < p_1 < p_2$

7. The bar AB weighs 10 kg per meter and is supported by cable AC and a pin at B. Reaction at B is (take g = 10 m/s²)

(a) 200 N, vertical

(b) 200 N, at 30⁰ to horizontal

(c) 100 N vertical

(d) 100 N at 60⁰ to horizontal

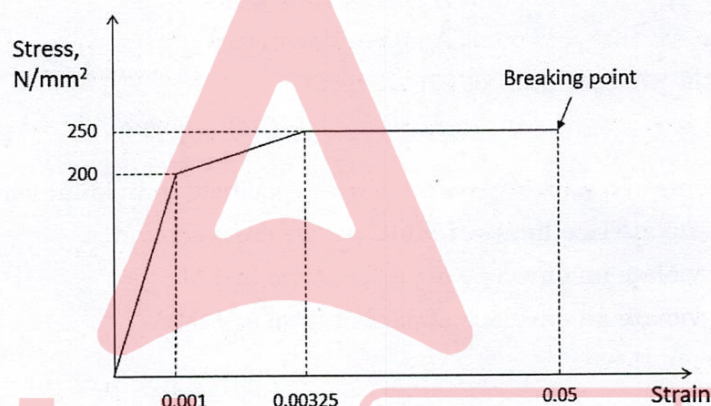8. Arrange the metals Aluminium, Copper, Iron & Silver in increasing order of thermal conductivity

    (a) Iron, Aluminium, Copper, Silver

    (b) Aluminium, Iron, Copper, Silver

    (c) Copper, Iron, Silver, Aluminium

    (d) Iron, Copper, Aluminium, Silver

9. Modulus of resilience for the below material is

    (a) 200 kN/m²

    (b) 100 kN/m²

    (c) 606.25 kN/m²

    (d) 12.29 MN/m²

10. Which of the following is FALSE?

    (a) Heat flow by conduction is directly proportional to the area and temperature gradient

    (b) Heat flow by convection is directly proportional to the area and temperature difference

    (c) Heat flow by radiation is directly proportional to the cube of absolute temperature of the radiating body

    (d) Emissivity of perfect black body is unity

11. Two dimensionally equal blocks made of material M1 and M2 are placed on a flat horizontal surface as shown in figure below. Young's modulus of the materials are E1 & E2 resp. A uniform pressure 'p' is applied over the blocks through a thick plate (AB) symmetrically placed over the blocks. For E1 > E2, consider the statements below.
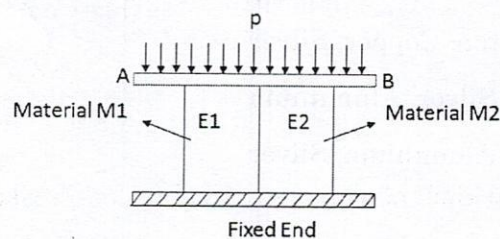

(p)   Stress in both blocks are same
(q)   Strain in both blocks are same
(r)   Plate AB tilts and point B moves downward
(s)   Plate AB tilts and point A moves downward

Which of the above sentences are correct?

(a)   p, q & r   (b)   q & r   (c)   p & s   (d)   p & r

12. In tolerancing of a part, unless otherwise specified, individual features of size must
    (a)   not violate size limits of MMC at any cross section
    (b)   not violate an envelope of perfect form at LMC
    (c)   not violate an envelope of perfect form at MMC
    (d)   none of these

13. A horizontal bar AB assumed to be rigid, is supported by two wires CE & DF, having lengths L and 2L respectively and pinned at A. If each wire has cross sectional area A, the tensile stress $\sigma 1$ and $\sigma 2$ in wires CE and DF are respectively,
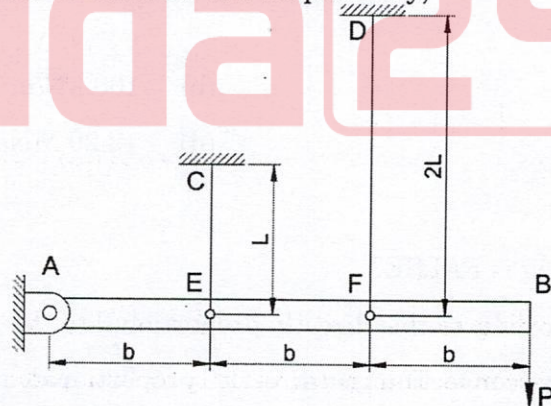
(a) $\dfrac{3P}{5A}$ and $\dfrac{6P}{5A}$ (b) $\dfrac{2P}{5A}$ and $\dfrac{4P}{5A}$

(c) $\dfrac{3P}{A}$ and $\dfrac{6P}{A}$ (d) $\dfrac{P}{A}$ each

14. A 3 m long steel shaft has to transmit 7.5 kW at 3600 rpm. Required shaft diameter is given by (Take allowable shear stress = 100 N/mm², π^2 = 10)?

    (a)   10 mm   (b)   7.5 mm

    (c)   25 mm   (d)   12.5 mm

15. For thin cylindrical shell structures loaded in compression, the design is based on

    (a)   Yield strength of material   (b)   Ultimate strength of material

    (c)   Buckling strength of the structure   (d)   Shear strength of the structure

16. The frictional shear stress (τ) in metal forming is expressed as

    (a) $\dfrac{m\bar{\sigma}}{\sqrt{3}}$ (b) $\dfrac{\bar{\sigma}}{\sqrt{3m}}$

    (c) $\dfrac{\bar{\sigma}}{m\sqrt{3}}$ (d) $\dfrac{\sqrt{3}}{m}\bar{\sigma}$

where 'm' is the friction shear factor and '$\bar{\sigma}$' is the flow stress

17. Governing differential equation for small deflections of elastic beams is given by

    (a) $\dfrac{d^2 y}{dx^2} = \dfrac{M}{EI}$ (b) $EI\dfrac{d^3 y}{dx^3} = V(x)$

    (c) $EI\dfrac{d^4 y}{dx^4} = q(x)$ (d)   All the above

18. A point moves according to the relation $x = 8t^2 \cos(\omega t)$, $y = -4t^3 \sin(\omega t)$, where x and y are in meters, and t in seconds. If angular velocity $\omega = 8\pi$ rad/sec, velocity vector of the point at $t = 0.5$ sec is given by

    (a) $8 + j4\pi$ (b) $6 + j20\pi$

    (c) $8 - j4\pi$ (d) $-20\pi - j6$

19. A 10 mm thick plate-1 is welded to another plate-2 (10 mm thk) using fillet weld of thickness 10 mm, on two sides of plate-1 as shown in figure. Plate-1 projects outside plate-2 by 85 mm. An end load of 1 kN acts on plate-1. The primary shear stress produced in the weld throat is
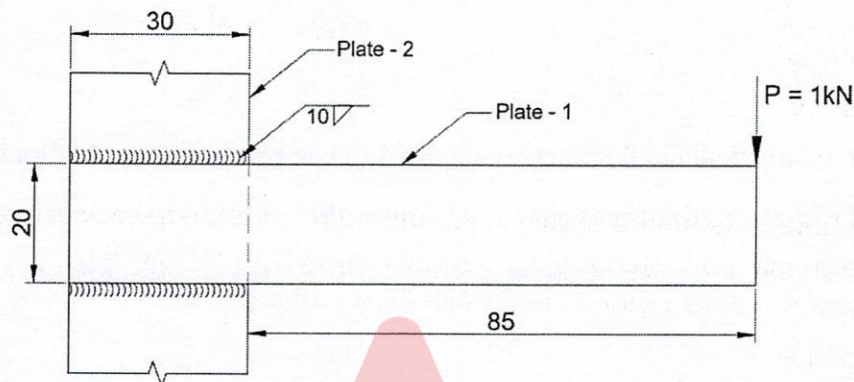
(a)   173 N/mm²

(b)   2.4 N/mm²

(c)   85 N/mm²

(d)   None of these

20. Isochoric changes in ideal gas are characterized by

(a) $\dfrac{V}{T} = \text{Const}$

(b) $PV = \text{Const}$

(c) $\dfrac{P}{T} = \text{Const}$

(d)   None of these

21. A cantilever beam of cross section area 'A', moment of Inertia 'I' and length 'L' is having natural frequency ω1. If the beam is accidently broken into two halves, the natural frequency of the remaining cantilever beam ω2 will be such that

(a)   ω2 < ω1

(b)   ω2 > ω1

(c)   ω2 = ω1

(d)   Cannot be obtained from the given data

![ISRO logo]	INDIAN SPACE RESEARCH ORGANISATION	SET
इसरो ISRO	MECHANICAL	A

22. In CAD, the geometric transformation is expressed as $P^* = [T]P$ where T is the transformation matrix. If the matrix T is diagonal, then the transformation is called

    (a)   translation

    (b)   reflection

    (c)   rotation

    (d)   scaling

23. A water tank is located 3 m above ground and depth of water in tank is 2 m. Exit pipe is 50 mm in dia and 50 m long. Velocity of water at the exit at the ground level is approximately (Take friction factor f = 0.05, g = 10 m/s²)

    (a)   1.5 m/s   (b)   2 m/s

    (c)   0.7 m/s   (d)   1/4 m/s

24. The work ratio of a gas turbine is a function of

    (a)   temperature ratio and pressure ratio

    (b)   pressure ratio

    (c)   temperature ratio

    (d)   none of these

25. The distribution of temperature T, at a particular instant, across a large concrete wall, 1 m thick, which is heated from one side is given by the equation $T = 150 - 80x + 16x^2$, where the distance x is in meters and T is in degree Celsius. Thermal conductivity of wall is 0.6 W/mK, area of cross section is 10 m². The heat accumulated in unit time at this instant in the concrete wall is

    (a)   768 J/sec   (b)   384 J/sec

    (c)   96 J/sec   (d)   192 J/sec

26. Which one of the following is the permanent mould casting process?

    (a)   Investment casting process

    (b)   Full mould process

    (c)   Vacuum casting process

    (d)   Die casting process

27. Identify the geometric characteristic that describe the feature geometry and the inter-relationship of part features

 (a) form tolerance

 (b) form

 (c) orientation tolerance

 (d) dimension

28. Isothermal compressibility of an ideal gas is

 (a) $\dfrac{nR}{VP}$

 (b) $\dfrac{nRT}{VP^2}$

 (c) $\dfrac{nR}{VP^2}$

 (d) $\dfrac{nRT}{VP}$

29. Datum features on the part are

 (a) permanent

 (b) temporary

 (c) either permanent or temporary

 (d) none of these

30. The eigen values of $A = \begin{bmatrix} 2 & 2 & 4 \\ 2 & -1 & 2 \\ 4 & 2 & 2 \end{bmatrix}$ are,

 (a) $2, 7, 2$

 (b) $-7, -2, -2$

 (c) $-2, -2, 7$

 (d) $2, -1, 2$

31. In process charts, the symbol used for inspection is

 (a) ◯

 (b) ▢

 (c) ⇨

 (d) ▽

32. Efficiency of gas turbines lies between

    (a)   85 to 95%   (b)   50 to 60%

    (c)   30 to 50%   (d)   15 to 18%

33. Which one of the following is impulse turbine?

    (a)   Francis turbine

    (b)   Kaplan turbine

    (c)   Pelton turbine

    (d)   none of these

34. Which of the following is FALSE for bolted joints?

    (a)   Bolted joints are preloaded to avoid vibration loosening

    (b)   Threads made by thread rolling process are preferred over machined threads in bolts

    (c)   When external load is applied to a preloaded bolt joint, a bigger percentage of that load relieves compression of flanges and remaining percentage increases tension in bolts

    (d)   Bolted joints are designed such that bolt stiffness is higher than flange stiffness

35. Root opening of a Single Vee groove weld joint of plate thickness "t" is

    (a) $\dfrac{t}{3}$ (b) $\dfrac{t}{4}$

    (c) $\dfrac{t}{5}$ (d) $\dfrac{t}{6}$

36. A cubic B-spline curve requires minimum ———— control points.

    (a)   3   (b)   4

    (c)   5   (d)   6

37. Transportation method is concerned with

   (a)   Value analysis

   (b)   Linear programming

   (c)   Queing theory

   (d)   Break-even analysis

38. The reaction in which a liquid phase transform into two different solid phases is called

   (a)   Eutectoid reaction

   (b)   Peritectic reaction

   (c)   Eutectic reaction

   (d)   Peritectoid reaction

39. Margin wear in drill is due to

   (a)   abrasion

   (b)   vibration

   (c)   thermal softening

   (d)   diffusion

40. The specific speed of the Kaplan turbine is

   (a) $2.0 - 5.0$

   (b) < 0.3

   (c) $0.3 - 2.0$

   (d)   none of these

41. If $f(t) = e^{at}$, its Laplace Transform (for $s > a$) is given by

(a) $\dfrac{a}{s^2} + (s-a)$

(b) $\dfrac{\sqrt{\pi}}{2(s-a)}$

(c) $\dfrac{1}{(s-a)}$

(d) Does not exist

42. Smallest thickness which can be measured by a slip gauge is

(a) 1.001 mm

(b) 0.01 mm

(c) 0.001 mm

(d) none of these

43. The deflection of an elastic member at the point of application of a force in the direction of that force is given by the derivative of member's total strain energy taken with respect to applied force. This is known as

(a) Principle of conservation of strain energy

(b) Castigliano's theorem

(c) Conservation of momentum

(d) Saint-Venant's Principle

44. Thumb rule between feed and nose radius in rough turning is

(a) $f = 0.3r$

(b) $f = 0.5r$

(c) $f = 0.7r$

(d) $f = 0.9r$

45. Which of the following is FALSE?

(a) A reverted gear train is one in which the first and last gears are on the same axis.

(b) Train value for a gear is the ratio of product of driven tooth numbers to product of driving tooth numbers.

(c) A planetary gear train is one in which the axes of some of the gears may have a motion.

(d) A compound gear train is one which has two or more gears on each axis.

46. Which of the following is true for ductile materials?

(a) Engineering stress - strain curve cannot have negative slope

(b) Most applicable failure theory is maximum principal stress theory

(c) Ultimate strain is the strain at ultimate stress

(d) Strain hardening is represented by a negative slope in engineering stress strain curve

47. The specific metal cutting energy is expressed as

(a) $\dfrac{\tau \cos(\beta - \alpha)}{\sin \varphi \cos(\varphi + \beta - \alpha)}$

(b) $\dfrac{\tau \sin(\beta - \alpha)}{\sin \varphi \cos(\varphi - \beta + \alpha)}$

(c) $\dfrac{\tau \cos(\alpha - \beta)}{\sin \varphi \cos(\varphi - \beta + \alpha)}$

(d) $\dfrac{\tau \sin(\alpha - \beta)}{\sin \varphi \cos(\varphi + \beta - \alpha)}$

where 'α' is rake angle, 'β' is friction angle, 'φ' is shear angle and 'τ' shear stress

48. For isotropic materials, the modulus of Elasticity in tension and shear (E and G) are related to the Poisson's ratio (ν) as follows

(a) $E = \dfrac{G}{2(1 + \nu)}$

(b) $G = \dfrac{E}{2(1 + \nu)}$

(c) $G = \dfrac{E}{2(1 - \nu)}$

(d) $E = \dfrac{G}{2(1 - \nu)}$

49. Which of the following is NOT true?

(a) For direct impact of two bodies, coefficient of restitution is the ratio of relative velocity of approach of the two bodies to their relative velocity of separation

(b) Conservation of angular momentum implies that total angular momentum of a system remains constant unless acted on by an external torque

(c) Conservation of linear momentum in a given direction implies that the sum of external forces in that direction is zero

(d) The coefficient of friction is independent of area of contact

50. A block (of cross section 4×3 m size) of 20 kg mass rests on a flat horizontal surface as shown in figure below. If the coefficient of friction between the block and the surface is ¼, the force 'F' which will cause block to move is approximately given by
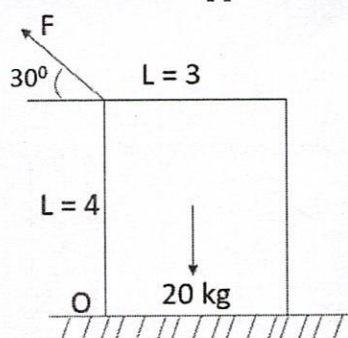

(a) 20 kgf

(b) 10 kgf

(c) 5 kgf

(d) 8.7 kgf

51. A point P moves along the path $y = x^2 - 4$. What is the displacement when the point moves from $x = 1$ to $x = 3$

(a) 8.24, @ $\tan^{-1}(4)°$

(b) 2, @ $\tan^{-1}(1)°$

(c) 11.3, @ $\tan^{-1}(4)°$

(d) 11.3, @ $\tan^{-1}(1)°$

52. The pulley system shown in figure has a mass of 1.5 kg and a radius of gyration of 0.2m. The angular acceleration of the pulleys, when the suspended masses are released is
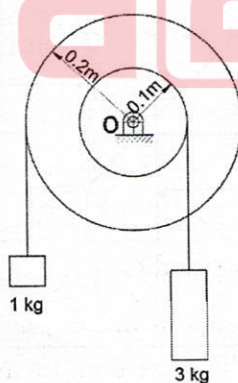
(a) 5 rad/sec²

(b) 10/1.3 rad/sec²

(c) 15/1.3 rad/sec²

(d) 10 rad/sec²

53. A U tube manometer shown in figure is used to measure the gauge pressure of water of density $\rho_1 = 1000$ kg/m³. If the density of manometer liquid ρ_2 is 12000 kg/m³, h1 = 0.5 m & h2 = 1.0 m, gauge pressure at 'A', the centre of tube is (take g = 10 m/s²)
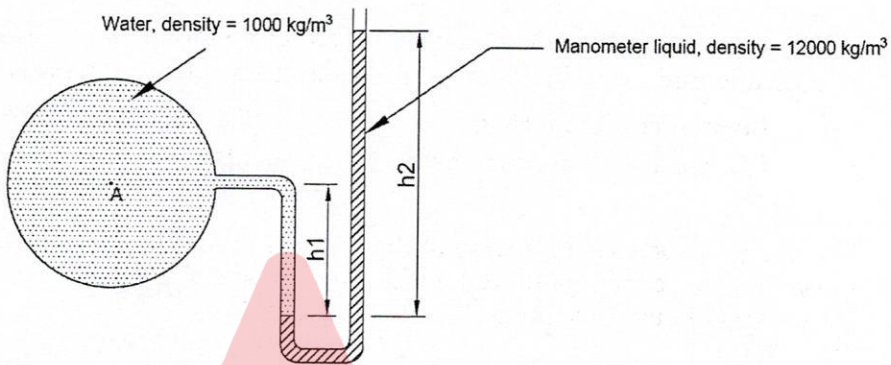
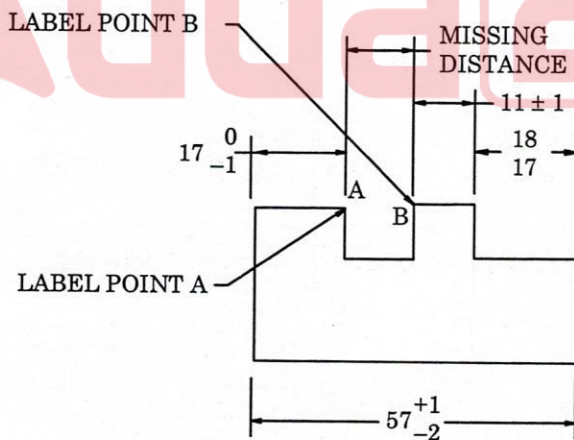

(a) 125 kPa
(b) 115 kPa
(c) 60 kPa
(d) 5 kPa

54. A man draws 3 balls from a jug containing 5 white balls and 7 black balls. He gets Rs. 20 for each white ball and Rs. 10 for each black ball. What is his expectation?

(a) Rs. 21.25
(b) Rs. 42.50
(c) Rs. 31.25
(d) Rs. 45.21

55. The missing dimension in the following simple part is

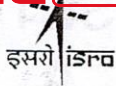(a) 11.5 ± 1.5
(b) 11.5 ± 2.5
(c) 11.5 ± 3.5
(d) 11.5 ± 4.5

56. Which one of the following is FALSE about Boronizing process?
    (a)   it is a pack cementation process
    (b)   it can be done only on high carbon steels
    (c)   it is used to obtain extremely high wear resistant surfaces on steels
    (d)   it leads to high distortion

57. In dynamic balancing of machines, which of the following is NOT a method of measuring the magnitude and location of correction weight for a two plane correction?
    (a)   Pivoted cradle method   (b)   Mechanical compensation method
    (c)   Pivoted compensation method   (d)   Nodal point method

58. The stress produced in a wire of diameter 6 mm, when it is bend around a large cylinder of diameter 2 m can be obtained as (Young's modulus of both wire and cylinder = 200 GPa, the stress strain curve of the material is given below)

   (a)   600 MPa   (b)   300 MPa   (c)   100 MPa   (d)   200 MPa

59. The critical pressure ratio for maximum discharge in steam nozzle is

    (a) $\dfrac{2}{\gamma+1}$

    (b) $\left(\dfrac{2}{\gamma+1}\right)^{\gamma}$

    (c) $\left(\dfrac{2}{\gamma+1}\right)^{\gamma-1}$

    (d) $\left(\dfrac{2}{\gamma+1}\right)^{\frac{\gamma}{\gamma-1}}$

    where 'γ' is the isentropic index

60. The type of locator used to prevent jamming during locating of a work piece is

    (a) concentric locator

    (b) integral locator

    (c) equilateral locator

    (d) spherical locator

61. A carton carrying vessel of mass 10 tons (width = length = 5 m, height = 6 m), floats on water. The mass of contents of the vessel are symmetrically placed. If the vessel tilts by 0.01 radians by moving a 50 kg carton from the centre by a distance of 2 m towards side in horizontal direction, the metacentric height of the vessel is (g = 10m/s²)

    (a) 1 m   (b) 3 m

    (c) 1.5 m   (d) 2 m

62. The maximum value of reduction in rolling process is

    (a) $\dfrac{D}{2}\left[1-\dfrac{\cos\alpha}{2}\right]$ (b) $\dfrac{D}{2}[1-\cos\alpha]$

    (c) $D(1-\sin\alpha)$ (d) $\dfrac{D}{2}[1-\sin\alpha]$

    Where 'D' is roll diameter and 'α' is the angle of bite

63. Which of the following is TRUE for vibration of a mechanical system

    (a) Damping ratio (ξ) is the ratio of the critical damping to the actual damping

    (b) The damping can be obtained from the response of the system under forced vibration using logarithmic decrement method

    (c) For damped mechanical systems, the amplitude of vibration tends to become infinity when excitation frequency (ω) reaches the system's natural frequency (ω_n)

    (d) Amplitude ratio and transmissibility of a vibration isolator is unity when the frequency of exciting force is $\sqrt{2}$ times the natural frequency
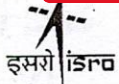
64. What is the maximum rate that a heat pump which uses 1 kW of electric power can supply heat to a house at 27°C when the outside temperature is 12°C

   (a)   50 J/s   (b)   25 kJ/s

   (c)   20 kJ/s   (d)   30 J/s

65. Evaluate $\int\limits_0^1 \int\limits_0^1 \dfrac{1}{\sqrt{(1-x^2)(1-y^2)}}\, dx\, dy$

   (a) $\dfrac{\pi}{2}$ (b) $\dfrac{\pi}{4}$

   (c) $\dfrac{\pi^2}{2}$ (d) $\dfrac{\pi^2}{4}$

66. White iron structure consists of

   (a)   Pearlite

   (b)   Cementite

   (c)   Ferrite

   (d)   Pearlite and Cementite

67. A cantilever beam of rectangular cross section (depth 'd', width 'b' & length 'L') is subjected to a shear force 'F' at its free end as shown in figure. The beam is made of material which follows maximum shear stress theory. Which of the following is TRUE?
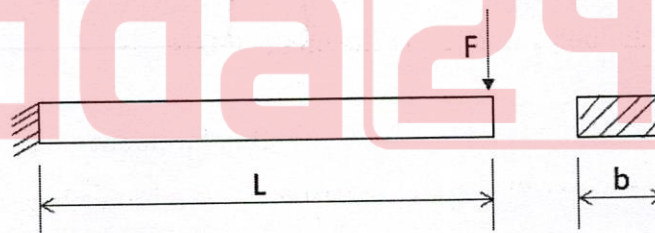
   (a)   The beam section has a uniform shear stress, $\dfrac{F}{bd}$

   (b)   Maximum shear stress in section and maximum bending stress in beam is equal when $L = d/2$

   (c)   For $L > d/2$, bending stress decides the failure stress.

   (d)   Bending stress developed in the beam is independent of 'b'

68. A jet engine consumes 1 kg of fuel for each 40 kg of air intake. Fuel consumption is 1 kg/sec. When aircraft travels in still air at 200 m/sec, velocity of discharge gases with respect to engine is 700 m/sec. The power developed by engine is

(a) 7200 kW

(b) 5600 kW

(c) 2070 kW

(d) 4140 kW

69. Which of the following is most appropriate for vapour power cycles?

(a) In Carnot cycle, expansion of vapour occurs without change in entropy

(b) In Rankine cycle, transformation of liquid water in steam generator occurs at constant temperature

(c) In Carnot cycle, heating of vapor occurs at constant volume

(d) In Rankine cycle, entropy of vapor increases during its expansion in steam turbine

70. Load Vs Displacement curve shown in the following figure pertains to
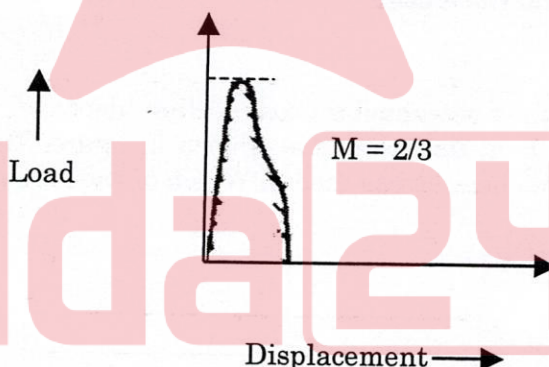
(a) Extrusion

(b) Bending

(c) Blanking

(d) Coining

71. The reheat factor R_f for a steam turbine is usually in the range of

(a) 0 to 1

(b) 1 to 1.065

(c) 2 to 2.065

(d) 5 to 10

72. Adaptive response rate forecasting is related to

   (a)   Production Planning

   (b)   Production Scheduling

   (c)   Value analysis

   (d)   Inventory control

73. Process in which lowest tolerances in cast products of ferrous and non ferrous metals can be achieved is

   (a)   Die casting

   (b)   Shell casting

   (c)   Investment casting

   (d)   Sand casting

74. Pickling treatment is cleaning the casting with

   (a)   Soda ash

   (b)   Dilute acid

   (c)   Compressed air and sand particles

   (d)   Iron shots

75. Element which makes steel stainless

   (a)   Mg   (b)   Ni

   (c)   C   (d)   Cr

76. Isentropic process is related to

   (a)   Adiabatic Expansion

   (b)   Reversible Adiabatic Expansion

   (c)   Isothermal Expansion

   (d)   Reversible Isothermal Expansion

77. Tolerances generally followed for tooling design are

    (a)   5 - 10% of work piece tolerance

    (b)   11 - 30% of work piece tolerance

    (c)   31 - 50% of work piece tolerance

    (d)   none of these

78. Which of the following is FALSE about Normal distribution?

    (a)   Normal Distribution is applied for discrete Random Distribution

    (b)   The shape of the Normal Curve is Bell Shaped

    (c)   The area under a standard normal curve is 1

    (d)   The standard normal curve is symmetric about the value 0

79. The temperature of the products of combustion when the maximum amount of chemical energy is converted to thermal energy is

    (a)   Higher than adiabatic flame temperature

    (b)   Lower than adiabatic flame temperature

    (c)   Equal to adiabatic flame temperature

    (d)   Independent of adiabatic flame temperature

80. Fredric W Taylor introduced a system of working known as

    (a)   line organisation

    (b)   effective organisation

    (c)   functional organisation

    (d)   none of the above