

Seat No. _____

SUB: MECHANICAL ENGINEERING (ME)

Time: 1 Hour 30 minutes

Instructions:

1. Ensure that all pages are printed.
2. Use Black ball pen only
3. Change in option is not allowed
4. There is no negative marking
5. Use of non -programmable scientific calculator is allowed

1. The resultant of two forces $(P + Q)$ and $(P - Q)$ equals to $(3P^2 + Q^2)^{1/2}$. The forces are then inclined to each other at the angle of
A 30° B 60°
C 90° D 120°
2. Two balls are dropped from the same point with an interval of one second. If $g = 10 \text{ m/s}^2$, their separation three seconds after the release of first ball would be
A 5 m B 15 m
C 25 m D 30 m
3. For a projectile of range R, the kinetic energy is minimum after the projectile covers (from start) a distance equal to
A 0.25 R B 0.5 R
C 0.75 R D R
4. Two bodies of masses m and 2m are dropped from the top of a building. When these bodies reach the ground, their kinetic energy will be in the ratio
A 1 : 2 B $1 : \sqrt{2}$
C 1 : 4 D 1 : 1
5. A pendulum is made of hollow sphere of negligible mass and having a small hole in the bottom. The pendulum is made to vibrate after filling it with water. As the water gradually flows out of the hole, the time period of the pendulum will
A increase B decrease
C may increase or decrease D remain unchanged
6. An attempt to turn a key into a lock manifests in the application of
A coplanar force B moment
C couple D torque
7. The radius of gyration of a circular area of radius r with respect to centroidal axis is
A 0.1 r B 0.2 r
C 0.5 r D 0.7 r
8. A body weighing 400 N is resting on a rough horizontal table. A pull of 120 N applied at an angle of 15° with the horizontal just causes the body to slide over the table. The normal reaction is about
A 280 N B 370 N
C 400 N D 430 N
9. A ball of mass 5 kg, initially at rest, is dropped from the height 1 m. Ball hits the ground and bounces off from it. Upon impact with the ground, the velocity reduces by 20%. The height (in m) to which the ball will rise is
A 0.76 B 0.52
C 0.40 D 0.64

10. The ratio of elongation of a prismatic bar due to its total self-weight W to that of similar bar with an additional weight W attached to its free end is
 A $1/3$ B $2/3$
 C $3/4$ D $1/2$
11. Thermal stress is generally induced in a component when
 1. a temperature gradient exists in the component
 2. the component is free from any restraint
 3. the component is restrained to expand or contract freely
 Which of the statement(s) given above is (are) correct?
 A 1 and 2 B 2 and 3
 C 3 only D 2 only
12. In a strained material one of the principal stress equals twice the other. What will be the ratio of maximum principal stress to maximum shear stress?
 A 1 B 2
 C 4 D 8
13. The strain energy stored in a body due to external loading, within the elastic limit, is known as
 A malleability B ductility
 C toughness D resilience
14. A simply supported beam has equal overhanging lengths and carries equal concentrated load P at ends. Then the bending moment over the length between the supports
 A is zero B is a non-zero constant
 C varies uniformly from one support to the other D is maximum at mid span
15. The ratio of average shear stress to the maximum shear stress in a beam with square cross-section is
 A 1 B $2/3$
 C $3/2$ D 2
16. Two shafts of solid circular cross-section are identical except for their diameter d_1 and d_2 . Under the same torque, the ratio of strain energy stored in each shaft (U_1/U_2) will confirm the relation
 A d_2/d_1 B $(d_2/d_1)^2$
 C $(d_2/d_1)^3$ D $(d_2/d_1)^4$
17. A closed coil helical spring is cut into two equal parts. The stiffness of each resulting spring as compared to the original spring will be
 A one forth B one half
 C same D double
18. When the slider in a four-bar linkage is fixed, it forms the mechanism of
 A hand pump B reciprocating engine
 C quick return D oscillating cylinder
19. In order to draw acceleration diagram, it is necessary to determine the Coriolis component of acceleration in case of
 A crank and slotted lever quick return mechanism B slider crank mechanism
 C pantograph D four bar mechanism
20. The mid-section of flat pulley is slightly raised to
 A reduce tension in belt B increase the angle of contact
 C avoid lateral slip of the belt D save the pulley from any damage from the belt joints

21. Common contact ratio of a pair of spur pinion and gear is
 - A less than 1.0
 - B equal to 1
 - C between 2 and 3
 - D greater than 3
22. The maximum efficiency of a screw jack provided with square threaded screw and angle of friction equals to 30° will be
 - A 27%
 - B 33%
 - C 50%
 - D 61%
23. If the ratio of the length of connecting rod to the crank radius increases, then
 - A primary unbalanced forces will increase
 - B primary unbalanced forces will decrease
 - C secondary unbalanced forces will increase
 - D secondary unbalanced forces will decrease
24. The static deflection of a shaft under a flywheel is 4 mm. What is the critical speed in rad/s if $g = 10 \text{ m/s}^2$
 - A 50
 - B 20
 - C 10
 - D 5
25. For thickness of plates greater than 8 mm, the diameter of the rivet is worked out by using the relation
 - A $d = 2 \sqrt{t}$
 - B $d = 4 \sqrt{t}$
 - C $d = 6 \sqrt{t}$
 - D $d = 8 \sqrt{t}$
26. The size of the weld in case of fillet welded joint is the
 - A smaller side of the triangle of fillet
 - B larger side of the triangle of fillet
 - C hypotenuse of the triangle of fillet
 - D perpendicular distance from root to hypotenuse
27. For a proper design and longer gear life
 - A wear load must be more than dynamic load
 - B wear load must be less than dynamic load
 - C dynamic load must be more than endurance strength
 - D wear load must be less than endurance strength
28. The main purpose of spheroidizing treatment is to improve
 - A hardenability of low carbon steels
 - B machinability of low carbon steels
 - C hardenability of high carbon steels
 - D machinability of high carbon steels
29. Which one of the following defects is 'Schottky defect'?
 - A Vacancy defect
 - B Compositional defect
 - C Interstitial defect
 - D Surface defect
30. Upper and lower yield points are observed in
 - A all pure metals
 - B carbon steels
 - C brittle metals
 - D an α - β brass
31. The decision on the volume of the design riser is based on
 - A Bernoulli's equation
 - B Continuity equation
 - C Newton's law of viscosity
 - D Chvorinov's rule
32. Which of the following materials requires the largest shrinkage allowance, while making a pattern for casting?
 - A Aluminium
 - B Brass
 - C Cast iron
 - D Carbon steel
33. Stretch forming is used for producing bent sheets without any local buckling and wrinkling. This is achieved by keeping the metal strip during the operation under
 - A tension
 - B compression
 - C high temperature
 - D low temperature
34. The punching force required in a blanking operation of mild steel sheet is 500 kN. The diameter of the blank is increased by 20% and thickness is reduced by 4%, then the punching force will be

D 9750

60. A body weighs 30 N and 15 N when weighed under submerged conditions in liquids of relative densities 0.8 and 1.2, respectively. What is the volume (in litre) of the body?

A 12.50

B 3.82

C 18.70

D	75.50
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61. Consider a laminar boundary layer over a heated flat plate. The free stream velocity is U_∞ . At some distance x from the leading edge the velocity boundary layer thickness is δ_v and the thermal boundary layer thickness is δ_T . If the Prandtl number is greater than 1, then

A $\delta_v > \delta_T$

B $\delta_T > \delta_v$
$$\text{C} \quad \delta_v \approx \delta_T \sim (U_\infty x)^{-1/2}$$
D $\delta_v \approx \delta_T \sim x^{-1/2}$

62. The temperature distribution within the thermal boundary layer over a heated isothermal flat plate is given by

$$\frac{T-T_w}{T_\infty-T_w} = \frac{3}{2} \left(\frac{y}{\delta_t} \right) - \frac{1}{2} \left(\frac{y}{\delta_t} \right)^3$$

Where T_w and T_∞ are the temperatures of plate and free stream, respectively, and y is the normal distance measured from the plate. The local Nusselt number based on the thermal boundary layer thickness δ_t is given by

A 1.33

B 1.50

C 2.0

D 4.64

63. In a counter flow heat exchanger, hot fluid enters at 60°C and cold fluid leaves at 30°C . Mass flow rate of the hot fluid is 1 kg/s and that of the cold fluid is 2 kg/s . Specific heat of the hot fluid is 10 kJ/kg K and that of the cold fluid is 5 kJ/kg K . The log mean temperature difference (LMTD) for the heat exchanger in $^{\circ}\text{C}$ is

A 15

B 30

C 25

D 45

64. A hollow enclosure is formed between two infinitely long concentric cylinders of radii 1 m and 2 m, respectively. Radiative heat exchange takes place between the inner surface of the larger cylinder and the outer surface of the smaller cylinder. The radiating surfaces are diffused and the medium in the enclosure is nonparticipating. The fraction of the thermal radiation leaving the larger surface and striking itself is

A 0.25

B	0.50
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C 0.75

D	1.00
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65. Two insulating materials of thermal conductivities ' k ' and ' $2k$ ' are available for lagging a pipe carrying a hot fluid. If the radial thickness of each material is the same, then

A material with higher thermal conductivity should be used for the inner layer and one with lower thermal conductivity for the outer layer

B material with lower thermal conductivity should be used for the inner layer and one with higher thermal conductivity for the outer layer

C it is immaterial in which sequence the insulating materials are used

D it is not possible to judge unless numerical values of the dimensions are given

66. Lumped system analysis is the simplest and most convenient method that can be used to solve transient conduction problems. This analysis can be used only when Biot number (Bi) is

A less than 0.1

B more than 0.1

C less than 1.0

D more than 1.0

67. A furnace is made of a red brick wall of thickness 0.5 m and conductivity 0.7 W/m K. For the same heat loss and temperature drop, this can be replaced by a layer of diatomic earth of conductivity 0.14 W/m K and thickness?

A	82.4%	B	59.5%
C	72.3%	D	79.5%

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86. General solution of $y'' - y' - 6y = 0$ is
- A $y = c_1 e^{3x} + c_2 e^{-2x}$ B $y = c_1 e^{3x} + c_2 e^{2x}$
 C $y = c_1 e^{-3x} + c_2 e^{-2x}$ D None of these
87. Determine the particular integral of $y'' - y' = -3$
- A $y_p = 2x$ B $y_p = 3x$
 C $y_p = -3x$ D None of these
88. Find the solution of $(x+1) \frac{dy}{dx} + (x+2)y = 2x e^{-x}$.
- A $(x+1) e^x y = x^3 + c$ B $(x+1) e^x y = x + c$
 C $(x+1) e^x y = x^2 + c$ D None of these
89. The particular integral of $y'' + y = \cos^2 x$
- A $y_p = \frac{1}{2} - \frac{1}{6} \cos 2x$ B $y_p = \frac{1}{2} - \frac{1}{3} \cos 2x$
 C $y_p = \frac{1}{2} - \cos 2x$ D None of these
90. The solution of $xy'' + y' = 0$ is
- A $y = c_1 x + c_2 \ln x$ B $y = c_1 x^{-1} + c_2 \ln x$
 C $y = c_1 + c_2 \ln x$ D None of these
91. Let $A = \begin{bmatrix} 5 & 2 \\ 0 & k \end{bmatrix}$. Find the number k such that A is the root of the polynomial $f(x) = x^2 - 7x + 10$.
- A 1 B 2
 C 0 D None of these
92. Choose appropriate option for eigen values of $A = \begin{bmatrix} 2 & 4 \\ -1 & 6 \end{bmatrix}$.
- A 1, 3 B 2
 C 4 D 1, 2
93. Solve $2x - 4 = 3y$, $5y - x = 5$.
- A (5, 2) B (5, -2)
 C (-5, 2) D None of these
94. Find the derivative of $f(z) = 3z^{-2}$ at $z = 1 + i$.
- A $\frac{3}{2} + \frac{3}{2}i$ B $\frac{5}{2} + \frac{3}{2}i$

C $\frac{1}{2} + \frac{3}{2}i$

D $\frac{3}{2} - \frac{3}{2}i$

95. Choose correct Cauchy Integral formula for $n = 1, 2, 3, \dots$.

A $f^{(n)}(a) = \frac{n!}{\pi i} \oint_C \frac{f(z)}{(z-a)^{n+1}} dz$

B $f^{(n)}(a) = \frac{n!}{\pi i} \oint_C \frac{f(z)}{(z)^{n+1}} dz$

C $f^{(n)}(a) = \frac{(n+1)!}{\pi i} \oint_C \frac{f(z)}{(z-a)^{n+1}} dz$

D $f^{(n)}(a) = \frac{n!}{2\pi i} \oint_C \frac{f(z)}{(z-a)^{n+1}} dz$

96. Choose correct option for the series of $\cot z$.

A $z - \frac{z}{3} - \frac{z^3}{45} + \dots$

B $\frac{1}{z} - \frac{z}{3} - \frac{z^3}{45} + \dots$

C $z - \frac{z}{3} - \frac{z^3}{15} + \dots$

D None of these

97. A card is drawn at random from an ordinary deck of 52 playing cards. Find the probability that it is an ace.

A $\frac{1}{3}$

B $\frac{2}{3}$

C $\frac{1}{13}$

D $\frac{2}{13}$

98. Find the probability that in tossing a fair coin three times, there will appear two tails and one head.

A $\frac{3}{8}$

B $\frac{1}{2}$

C $\frac{3}{4}$

D $\frac{1}{3}$

99. Determine the interval where root lies for the function $f(x) = x^3 - x - 1$.

A $(0, 1)$

B $(-1, 0)$

C $(1, 2)$

D $(2, 3)$

100. Choose appropriate formula of Trapezoidal rule for $\int_{x_0}^{x_1} f(x) dx$ where $x_0 < \xi < x_1$.

A $\frac{h}{3} [f(x_0) + f(x_1)] - \frac{h^3}{12} f''(\xi)$

B $\frac{h}{2} [f(x_0) + f(x_1)] - \frac{h^3}{12} f''(\xi)$

C $\frac{h}{4} [f(x_0) + f(x_1)] - \frac{h^3}{12} f''(\xi)$

D None of these