1. Choose answer and indicate by writing only the corresponding capital letter (A, B, C, D) as the case may be).

1.1 The value of $\left[\lim_{x\to\infty}\frac{\sin x}{x}\right]$ is:

(a) ∞ (b) 2 (c) 1 (d) 0

1.2 The value of $\left[\lim_{x\to\infty}\left(\frac{1}{\sin x}-\frac{1}{\tan x}\right)\right]$ is:

(a) 0 (b) 1 (c) 2 (d) ∞

1.3 The value of ξ in the mean value theorem of $f(b)-f(a)=(b-a)f'(\xi)$ for $f(x)=Ax^2+Bx+C$ in (a,b) is:

(a) $b+a$ (b) $b-a$ (c) $\frac{(b+a)}{2}$ (d) $\frac{(b-a)}{2}$

1.4 For the differential equation $\frac{dy}{dx}+5y=0$ with $y(0)=1$, the general solution is

(a) e^{5t} (b) e^{-5t} (c) $5e^{-5t}$ (d) $e^{\sqrt{-5t}}$

1.5 The process of hot extrusion is used to produce

(a) curtain rods made of aluminium
(b) steel pipes for domestic water supply
(c) stainless steel tubes used in furniture
(d) large size pipes used in city water mains

1.6 In deep drawing of sheets, the values of limiting draw ratio depends on

(a) percentage elongation of sheet metal (b) yield strength of sheet metal
(c) type of press used (d) thickness of sheet

1.7 The electrodes used in arc welding are coated. This coating is not expected to

(a) provide protective atmosphere to weld (b) stabilize the arc
(c) add alloying elements
(d) prevents electrode from contamination

1.8 Streamlines, path lines and streak lines are virtually identical for

(a) Uniform flow (b) Flow of ideal fluids

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(c) Steady flow (d) Non uniform flow

1.9 In a flow field, the streamlines and equipotential lines

(a) are parallel

(b) cut at any angle

(c) are orthogonal everywhere in the flow field

(d) cut orthogonally except at the stagnation points

1.10 For a fluid element in a two dimensional flow field (x – y plane), if it will undergo

(a) translation only (b) translation and rotation

(c) translation and deformation (d) deformation only

1.11 Net force on a control volume due to uniform normal pressure alone

(a) depends upon the shape of the control volume

(b) translation and rotation (c) translation and deformation

(d) deformation only

1.12 Existence of velocity potential implies that

(a) Fluid is in continuum (b) Fluid is irrotational

(c) Fluid is ideal (d) Fluid is compressible

1.13 Prandtl's mixing length is turbulent flow signifies

(a) the average distance perpendicular to the mean flow covered by the mixing particles.

(b) the ratio of mean free path to characteristic length of the flow field

(c) the wavelength corresponding to the lowest frequency present in the flow field

(d) the magnitude of turbulent kinetic energy

1.14 The definition of 1 K as per the internationally accepted temperature scale is

(a) $\frac{1}{100}th$ the difference between normal boiling point and normal freezing point of water.

(b) $\frac{1}{273.15}th$ the normal freezing point of water

(c) 100 times the difference between the triple point of water and the normal freezing point of water.

(d) $\frac{1}{273.16}th$ of the triple point of water.

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1.15 A gas turbine cycle with infinitely large number of stages during compression and expansion leads to

(a) Stirling cycle
(b) Atkinson cycle
(c) Ericsson cycle
(d) Brayton cycle

1.16 Two insulating materials of thermal conductivity K and 2K are available for lagging a pipe carrying a hot fluid. If the radial thickness of each material is the same.

(a) material with higher thermal conductivity should be used for the inner layer and one with lower thermal conductivity for the outer.
(b) material with lower thermal conductivity should be used for the inner layer and one with higher thermal conductivity for the outer.
(c) it is immaterial in which sequence the insulating materials are used
(d) it is not possible to judge unless numerical values of dimensions are given

1.17 The practice to use steam on the shell side and cooling water on the tube side in condensers of steam power plant is because

(a) to increase overall heat transfer coefficient water side velocity can be increased if water is at the tube side
(b) condenser can act as a storage unit for condensed steam
(c) rate of condensation of steam is invariably smaller than the mass flow rate of cooling water
(d) it is easier to maintain vacuum on the shell side than on the tube side

1.18 For a given set of operating pressure limits of a Rankine cycle, the highest efficiency occurs for

(a) Saturated cycle
(b) Superheated cycle
(c) Reheat cycle
(d) Regenerative cycle

1.19. For a single stage impulse turbine with a rotor diameter of 2 m and a speed of 3000 rpm when the nozzle angle is 20°, the optimum velocity of steam is m/s is?

(a) 334
(b) 356
(c) 668
(d) 711

1.20. A stone of mass m at the end of a string of length l is whirled in a vertical circle at a constant speed. The tension in the string will be maximum when the stone is

(a) at the top of the circle
(b) half-way down from the top
(c) quarter was down from the top
(d) at the bottom of the circle

1.21. A shell is fired from a cannon with a speed v at an angle θ with the horizontal direction. At the highest point in its path it explodes into two pieces of equal mass. One of the pieces retraces its path to the cannon. The speed of other piece immediately after explosion is

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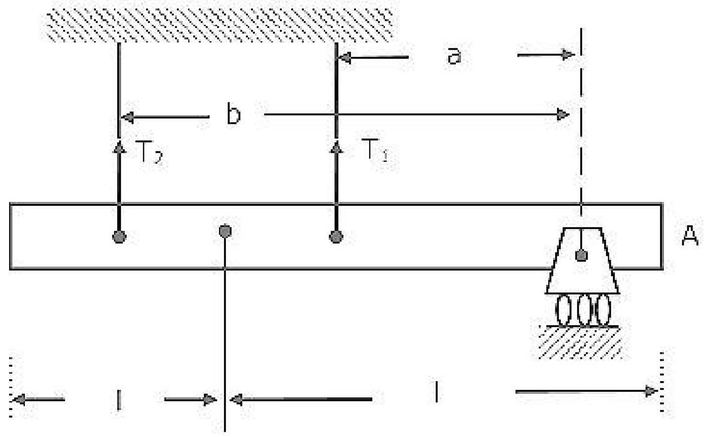
(a) $3v\cos\theta$ (b) $2v\cos\theta$ (c) $\frac{3}{2}v\cos\theta$ (d) $\sqrt{\frac{3}{2}}v\cos\theta$

1.22. Figure below shows a rigid bar hinged at A and supported in a horizontal by two vertical identical steel wires. Neglect the weight of the beam. The tension T_1 and T_2 induced in these wires by a vertical load P applied as shown arc



(a) $T_1 = T_2 = \frac{P}{2}$

(b) $T_1 = T_2 = P$

(c) $T_1 = \frac{Pbl}{(a^2+b^2)}; T_2 = \frac{Pal}{(a^2+b^2)}$

(d) $T_1 = \frac{Pbl}{2(a^2+b^2)}; T_2 = \frac{Pal}{2(a^2+b^2)}$

1.23. For the case of a slender column of length l and flexural rigidity EI built-in at its base and free at the top, the Euler's critical buckling load is

(a) $\frac{4\pi^2 EI}{l^2}$ (b) $\frac{2\pi^2 EI}{l^2}$ (c) $\frac{\pi^2 EI}{l^2}$ (d) $\frac{\pi^2 EI}{4l^2}$

1.24. A mass m attached to a light spring oscillates with a period of 2 seconds. If the mass is increased by 2 kg, the period increases by 1 second. The value of m is:

(a) 1 kg (b) 1.6 kg (c) 2 kg (d) 2.4 kg

1.25 Two shafts A and B are made of the same material. The diameter of shaft B is twice that of shaft A. The ratio of power which can be transmitted by shaft A to that of shaft B is:

(a) $\frac{1}{2}$ (b) $\frac{1}{4}$ (c) $\frac{1}{8}$ (d) $\frac{1}{16}$

2. Each blank(.....) is to be suitably filled in using one of the given options. In the answer book write the question number and the answer only. Also, no explanations for the answer are to be given

2.1 If $f(t)$ is a finite and continuous function for t, the Laplace transformation is given by

$$F = \int_0^\infty e^{-st} f(t)\,dt$$

For $f(t) = \cosh mt$, the Laplace transformation is .....

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2.2. The value of $\int_0^{\infty} y^2 e^{y^3} dx$ is .....

2.3. To get good surface finish on a turned job, one should used a sharp tool with a ..... feed and ..... speed of rotation of the job.

2.4. The ratio of acetylene to oxygen is approximately ..... for a neutral flames used in gas welding.

2.5. Generally cylindrical parts produced by powder metallurgy should not have non uniform cross section and a length to diameter ratio exceeding .....

2.6. Bodies in flotation to be in stable equilibrium, the necessary an sufficient condition is that the centre of gravity is located below the .....

2.7. Circulation is defined as line integral of tangential component of velocity about a .....

2.8. For a fully developed flow through a pipe, the ratio of the maximum velocity to the average velocity is .....

2.9. Fluid is flowing with an average velocity of V through a pipe of diameter d. over a length of L, the "head" loss is given by $\frac{fLV^2}{2D}$. the friction factor, f, for laminar flow in terms of Reynolds number (Re) is .....

2.10. The ratio of inertia forces to gravity forces may be expressed as square of non-dimensional group known as .....

2.11. In terms of speed of rotation of the impeller (N), discharge (Q) and change in total head (ΔH) through the machine, the specific speed for a pump is .....

2.12. The slopes of constant volume and constant pressure lines in the T - s diagram are ..... and ..... respectively.

2.13. A 1500 W electrical heater is used to heat 20 kg of water $(C_p = 4186 \text{ J/kg K})$ in an insulated bucket, from a temperature of 30°C to 80°C. If the heater temperature is only infinitesimally larger than the water temperature during the process, the change in entropy for heater is ..... J/K and for water ..... J/K.

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2.14. The shape factors with themselves of two infinitely long black body concentric cylinders with a diameter ratio of 3 are ..... for the inner and ..... for the outer.

2.15. A block of mass 5 kg is thrust up a 30° inclined plane with an initial velocity of 4m/sec. it travels a distance of 1.0 m before it comes to rest. The force of friction acting on it would be .....

2.16. A solid cylinder of mass m and radius r starts rolling from rest along an inclined plane. If it rolls without slipping from a vertical height h, the velocity of its centre of mass when it reaches the bottom is .....

2.17. The ratio of maximum shear stress developed in beam of rectangular section to that of the average shear stress is .....

2.18. For a self-locking screw, the efficiency of the screw must be .....

2.19. In spur gears having involute teeth, the product of circular pitch and diametral pitch is .....

2.20. For a disk of moment of inertia I in the spin and precession angular velocities are ω and ω_p respectively. The magnitude of gyroscopic couple is .....

3. State TRUE or FALSE without copying the questions. Give no reason(s) for your answer.

3.1 $\iint_A = \rho \bar{u}\bar{n} dA = \iiint_{\forall} \Delta\left(\rho \bar{u}\right) d\forall$ where P is a scalar, $\bar{u}$ is a vector, A is surface area, $\bar{n}$ is unit normal vector to the surface and $\forall$ is the volume.

3.2 If $H(x, y)$ is a homogeneous function of degree n, then $x\frac{\partial N}{\partial x} + y\frac{\partial N}{\partial y} = nH$.

(a)

(b)

(c)

(d)

3.3 Rank of the matrix $\begin{bmatrix} 0 & 2 & 2 \\ 7 & 4 & 8 \\ -7 & 0 & -4 \end{bmatrix}$ is 3.

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3.4 The following is a correct FORTRAN 77 statement

$II(DABS((X - XI)/XD - 0.4$ D-0.5),10,10,15

3.5 Electric discharge machining imposes larger forces on tool that Electrochemical machining.

3.6 Electric discharge machining is more efficient process than Electrochemical machining for producing large non-circular holes.

3.7 Ultrasonic machining is about the best process for making holes in glass which are comparable in size with the thickness of the sheet.

3.8 CNC machines are more accurate than conventional machines because they have a high resolution encoder and digital read-outs for positioning.

3.9 CNC machines are more economical to use even for simple turning jobs.

3.10 The contnuity equation in the form $\Delta.\overline{V} = 0$ always represents an incompressible flow regardless of whether the flow is steady or unsteady.

3.11 Bernoulli's equation can be applied between any two points on a streamline for a rotational flow field.

3.12 In a venturimeter, the angle of the diverging section is more than that of converging section.

3.13 As the transition from laminar to turbulent flow is induced a cross flow past a circular cylinder, the value of the drag co-efficient drops.

3.14 The necessary and sufficient condition which brings about separation of boundary layer is $\frac{dp}{dx} > 0$.

3.15 When the fluid velocity is doubled, the thermal time constant of a thermometer used for measuring the fluid temperature reduces by a factor of 2.

3.16 For air near atmospheric conditions flowing over a flat plate, the laminar thermal boundary layer is thicker than the hydrodynamic boundary layer.

3.17 Isentropic compression of saturated vapour of all fluids leads to superhead vapuor.

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3.18 Any thermodynamic cycle operating between two temperature limits is reversible if the product of efficiency when operating as a heat engine and the coefficient of performance when operating as a refrigeration is equal to 1.

3.19 Two balls of mass m and 2m are projected with identical velocities from the same point making angles 30° and 60° with the vertical axis, respectively. The heights attained by the balls will be identical.

3.20 A concentrated load P acts at the middle of a simply supported beam of apan 1 and flexural ridigity EI. Another simply supported beam of identical material, geometry and span is being acted upon by an equivalent distributed load $\left(w = \frac{P}{l}\right)$ spread over the entire span. The central deflections in both the beams are identical.

4. Match 4 correct pairs between List I and List II for question 4.1 through 4.5

4.1

List I	List II
(A) Hooke's law	(1) Planetary motion
(B) St. Venant's law	(2) Conservation Energy
(C) Kepler's laws	(3) Elasticity
(D) Tresca's criterion	(4) Plasticity
(E) Coulomb's law	(5) Fracture
(F) Griffith's law	(6) Inertia

4.2 List I gives a number of processes and List II gives a number of products

List I	List II
(A) Investment casting	(1) Turbine rotors
(B) Die casting	(2) Turbine blades
(C) Centrifugal casting	(3) Connecting rods
(D) Drop forging	(4) Galvanized iron pipe
(E) Extrusion	(5) Cast iron pipes
(F) Shell moulding	(6) Carburetor body

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4.3 For a perfect gas:

List I	List II
(A) Isobaric thermal expansion coefficient	(1) 0
(B) Isothermal compressibility	(2) ∞
(C) Isentropic compressibility	(3) $\frac{1}{v}$
(D) Joule – Thomson coefficient	(4) $\frac{1}{T}$
	(5) $\frac{1}{p}$
	(6) $\frac{1}{\gamma p}$

4.4

List I	List II
(A) Collision of bodies	(1) Kinetics
(B) Minimum potential energy	(2) Reciprocating unbalance
(C) Degree of freedom	(3) dynamics
(D) Prony brake	(4) coefficient of restitution
(E) Hammer blow	(5) stability
(F) Ellipse trammels	(6) Gravity idler

4.5

List I	List II
(A) Strain rosette	(1) Critical speed
(B) Beams	(2) Mohr's circle
(C) Section modulus	(3) Coil springs
(D) Wahl's stress factor	(4) Flexural rigidity
(E) Fatigue	(5) Endurance limit
(F) Somer field number	(6) Core section

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5. (A) Solve for y, *if* $\frac{d^2y}{dt^2} \div 2\frac{dy}{dt} + y = 0$; with $y(0) = 1$ and $y\omega(0) = -2$

(B) Find out eigen values of the matrix $A = \begin{bmatrix} 1 & 0 & 0 \\ 2 & 3 & 1 \\ 0 & 2 & 4 \end{bmatrix}$

For any one of the eigen values, find out the corresponding eigen vector.

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