Q.1 – Q.20 Carry One Mark Each.

1. Match the items in columns I and II.

Column I	Column II
(P) Gauss-Seidel method	(1) Interpolation
(Q) Forward Newton-Gauss method	(2) Non-linear differential equations
(R) Runge-Kutta method	(3) Numerical integration
(S) Trapezoidal Rule	(4) Linear algebraic equations

(A) P - 1 Q - 4 R - 3 S - 2
(B) P - 1 Q - 4 R - 2 S - 3
(C) P - 1 Q - 3 R - 2 S - 4
(D) P - 4 Q - 1 R - 2 S - 3

2. The solution of the differential equation

$\frac{dy}{dx} + 2xy = e^{-x^2}$ with $y(0) = 1$ is:

(A) $(1+x)e^{-x^2}$

(B) $(1+x)e^{-x^2}$

(C) $(1-x)e^{+x^2}$

(D) $(1-x)e^{-x^2}$

3. Let x denote a real number. Find out the INCORRECT statement.

(A) $S = \{x : x > 3\}$ represents the set of all real numbers greater than 3

(B) $S = \{x : x^2 < 0\}$ represents the empty set

(C) $S = \{x : x \in A \text{ and } x \in B\}$ represents the union of set A and set B

(D) $S = \{x : a < x < b\}$ represents the set of all real numbers between a and b, where a and b are real numbers.

4. A box contains 20 defective items and 80 non-defective items. If two items are selected at random without replacement, what will be the probability that both items are defective.?

(A) $\frac{1}{5}$

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(B) $\frac{1}{25}$

(C) $\frac{20}{99}$

(D) $\frac{19}{495}$

5. For a circular shaft of diameter d subjected to torque T, the maximum value of the shear stress is:

(A) $\frac{64T}{\pi d^3}$

(B) $\frac{32T}{\pi d^3}$

(C) $\frac{16T}{\pi d^3}$

(D) $\frac{8T}{\pi d^3}$

6. For a four-bar linkage in toggle position, the value of mechanical advantage is:

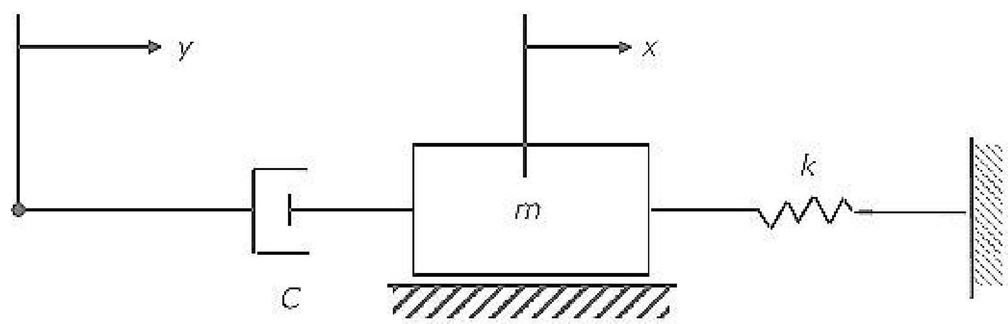
(A) 0.0

(B) 0.5

(C) 1.0

(D) ∞

7. The differential equation governing the vibrating system is:



(A) $m\ddot{x} + c\dot{x} + k(x - y) = 0$

(B) $m(\ddot{x} - \ddot{y}) + c(\dot{x} - \dot{y}) + kx = 0$

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(C) $m\ddot{x} + c(\dot{x} - \dot{y}) + kx = 0$

(D) $m(\ddot{x} - \ddot{y}) + c(\dot{x} - \dot{y}) + k(x - y) = 0$

8. A pin-ended column of length L, modulus of elasticity E and second moment of the cross-sectional area I is loaded centrically by a compressive load P. the critical buckling load (P_{cr}) is given by

(A) $P_{cr} = \frac{EI}{\pi^2 L^2}$

(B) $P_{cr} = \frac{\pi^2 EI}{3L^2}$

(C) $P_{cr} = \frac{\pi EI}{L^2}$

(D) $P_{cr} = \frac{\pi^2 EI}{L^2}$

9. The number of inversions for a slider crank mechanism is:

(A) 6

(B) 5

(C) 4

(D) 3

10. For a Newtonian fluid

(A) shear stress is proportional to shear strain

(B) rate of shear stress is proportional to shear strain

(C) shear stress is proportional to rate of shear strain

(D) rate of shear stress is proportional to rate of shear strain

11. In a two-dimensional velocity field with velocities u and v along the x and y directions respectively, the convective acceleration along the x-direction is given by

(A) $u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y}$

(B) $u\frac{\partial u}{\partial x} + v\frac{\partial v}{\partial y}$

(C) $u\frac{\partial v}{\partial x} + v\frac{\partial u}{\partial y}$

(D) $v\frac{\partial u}{\partial x} + u\frac{\partial u}{\partial y}$

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12. Dew point temperature is the temperature at which condensation begins when the air is cooled at constant.

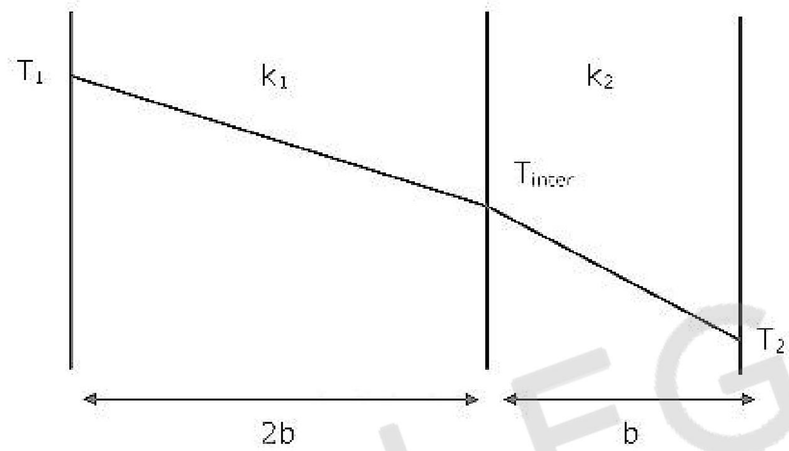
(A) volume

(B) entropy

(C) pressure

(D) enthalpy

13. In a composite slab, the temperature at the interface (T_{inter}) between two materials is equal to the average of the temperatures at the two ends. Assuming steady one-dimensional heat conduction, which of the following statements is true about the respective thermal conductivities?



(A) $2k_1 = k_2$

(B) $k_1 = k_2$

(C) $2k_1 = 3k_2$

(D) $k_1 = 2k_2$

14. In a Pelton wheel, the bucket peripheral speed is 10 m/s, the water jet velocity is 25 m/s and volumetric flow rate of the jet is 0.1 m^3/s. If the jet deflection angle is 120° and the flow is ideal, the owe developed is:

(A) 7.5 kW

(B) 15.0 kW

(C) 22.5 kW

(D) 37.5 kW

15. An expendable pattern is used in

(A) slush casting

(B) squeeze casting

(C) centrifugal casting

(D) investment casting

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16. The main purpose of spheroidising 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

17. NC contouring is an example of
(A) continuous path positioning
(B) point-to-point positioning
(C) absolute positioning
(D) incremental positioning

18. A ring gage is used to measure
(A) outside diameter but not roundness
(B) roundness but not outside diameter
(C) both outside diameter and roundness
(D) only external threads

19. The number of customers arriving at a railway reservation counter is Poisson distributed with an arrival rate of eight customers per hour. The reservation clerk at this counter takes six minutes per customer on an average with an exponentially distributed service time. The average number of the customers in the queue will be
(A) 3
(B) 3.2
(C) 4
(D) 4.2

20. In an MRP system, component demand is:
(A) forecasted
(B) established by the master production schedule
(C) calculated by the MRP system from the master production schedule
(D) ignored

Q.21 to Q.75 Carry Two Marks Each.

21. Eigen values of a matrix

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$S \equiv \begin{bmatrix} 3 & 2 \\ 2 & 3 \end{bmatrix}$ are 5 and 1. What are the eigen values of the matrix $S^2 = SS$?

(A) 1 and 25

(B) 6 and 4

(C) 5 and 1

(D) 2 and 10

22. Equation of the line normal to function

$f(x) = (x-8)^{\frac{2}{3}} + 1$ at $P(0,5)$ is:

(A) $y = 3x - 5$

(B) $y = 3x + 5$

(C) $3y = x + 15$

(D) $3y = x - 15$

23. Assuming $i = \sqrt{-1}$ and t is a real number, $\int_0^{\frac{\pi}{3}} e^{it} dt$ is:

(A) $\frac{\sqrt{3}}{2} + i\frac{1}{2}$

(B) $\frac{\sqrt{3}}{2} - i\frac{1}{2}$

(C) $\frac{1}{2} + i\frac{\sqrt{3}}{2}$

(D) $\frac{1}{2} + i\left(1 - \frac{\sqrt{3}}{2}\right)$

24. If $f(x) = \frac{2x^2 - 7x + 3}{5x^2 - 12x - 9}$, then $\lim_{x \to 3} f(x)$ will be

(A) $\frac{-1}{3}$

(B) $\frac{5}{18}$

(C) 0

(D) $\frac{2}{5}$

25. Match the items in columns I and II.

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columns I	columns II
(P) Singular matrix	(1) Determinant is not defined
(Q) Non-square matrix	(2) Determinant is always one
(R) Real symmetric matrix	(3) Determinant is zero
(S) Orthogonal matrix	(4) Eigen values are always real
	(5) Eigen values are nto defined

(A) P - 3 Q - 1 R - 4 S - 2
(B) P - 2 Q - 3 R - 4 S - 1
(C) P - 3 Q - 2 R - 5 S - 4
(D) P - 3 Q - 4 R - 2 S - 1

26. For $\frac{d^2y}{dx^2} + 4\frac{dy}{dx} + 3y = 3e^{2x}$, the particular integral is:

(A) $\frac{1}{15}e^{2x}$

(B) $\frac{1}{5}e^{2x}$

(C) $3e^{2x}$

(D) $C_1e^{-x} + C_2e^{-3x}$

27. Multiplication of matrices E and F is G. Matrices E and G are

$E \equiv \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$ and $G \equiv \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$. What is the matrix F?

(A) $\begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$

(B) $\begin{bmatrix} \sin\theta & \cos\theta & 0 \\ -\cos\theta & \sin\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$

(C) $\begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$

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(D) $\begin{bmatrix} \sin\theta & -\cos\theta & 0 \\ \cos\theta & \sin\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$

28. Consider a continuous random variable with probability density function

$$f(t) = 1 + t \text{ for } -1 \le t \le 0$$
$$= 1 - t \text{ for } 0 \le t \le 1$$

The standard deviation of the random variable is:

(A) $\frac{1}{\sqrt{3}}$

(B) $\frac{1}{\sqrt{6}}$

(C) $\frac{1}{3}$

(D) $\frac{1}{6}$

29. Match the items in columns I and II.

Column I	Column II
(P) Addendum	(1) Cam
(Q) Instantaneous center of velocity	(2) Beam
(R) Section modulus	(3) Linkage
(S) Prime circle	(4) Gear

(A) P - 4 Q - 2 R - 3 S - 1

(B) P - 4 Q - 3 R - 2 S - 1

(C) P - 3 Q - 2 R - 1 S - 4

(D) P - 3 Q - 4 R - 1 S - 2

30. A disk clutch is required to transmit 5 kW at 2000 rpm. The disk has a friction lining with coefficient of friction equal to 0.25. bore radius of friction lining is equal to 25 mm. assume uniform contact pressure of 1 MPa. The value of outside radius of the friction lining is:

(A) 39.4 mm

(B) 49.5 mm

(C) 97.9 mm

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(D) 142.9 mm

31. Twenty degree full depth involute profiled 19-tooth pinion and 37-tooth gear are in mesh. If the module is 5 mm, the center distance between the gear pair will be

(A) 140 mm

(B) 150 mm

(C) 280 mm

(D) 300 mm

32. A cylindrical shaft is subjected to an alternating stress of 100 MPa. Fatigue strength to sustain 1000 cycle is 490 MPa. If the corrected endurance strength is 70 MPa, estimated shaft life will be

(A) 1071 cycles

(B) 15000 cycles

(C) 281914 cycles

(D) 928643 cycles

33. According to Von-Mises' distortion energy theory, the distortion energy under three dimensional stress state is repreented by

(A) $\frac{1}{2E}\left[\sigma_1^2+\sigma_2^2+\sigma_3^2-2\nu\left(\sigma_1\sigma_2+\sigma_3\sigma_2+\sigma_1\sigma_3\right)\right]$

(B) $\frac{1-2\nu}{6E}\left[\sigma_1^2+\sigma_2^2+\sigma_3^2+2\nu\left(\sigma_1\sigma_2+\sigma_3\sigma_2+\sigma_1\sigma_3\right)\right]$

(C) $\frac{1+\nu}{3E}\left[\sigma_1^2+\sigma_2^2+\sigma_3^2-\left(\sigma_1\sigma_2+\sigma_3\sigma_2+\sigma_1\sigma_3\right)\right]$

(D) $\frac{1}{3E}\left[\sigma_1^2+\sigma_2^2+\sigma_3^2-\nu\left(\sigma_1\sigma_2+\sigma_3\sigma_2+\sigma_1\sigma_3\right)\right]$

34. A steel bar of 40 mm × 40 mm square cross-section is subjected to an axial compressive load of 200 kN. If the length of the bar is 2m and E = 200 GPa, the elongation of the bar will be:

(A) 1.25 mm

(B) 2.70 mm

(C) 4.05 mm

(D) 5.40 mm

35. If C_f is the coefficient of speed fluctuation of a flywheel then the ratio of $\omega_{max}/\omega_{min}$ will be:

(A) $\frac{1-2C_f}{1+2C_f}$

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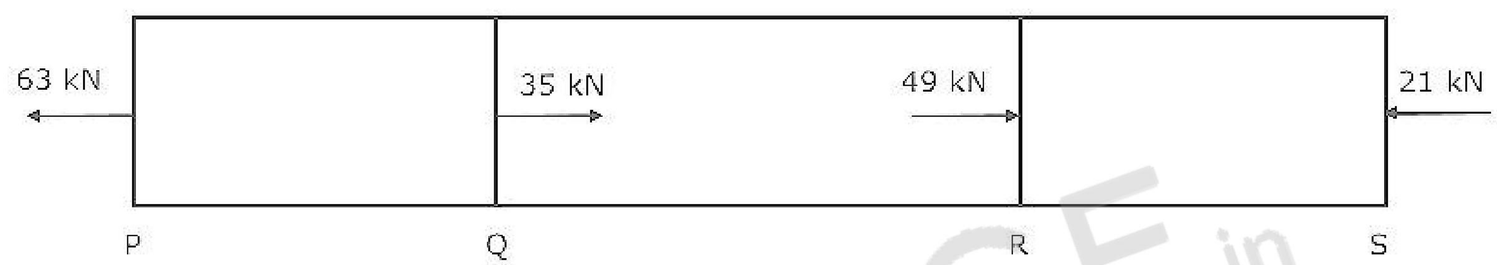
(B) $\frac{2 - C_f}{2 + C_f}$

(C) $\frac{1 + 2C_f}{1 - 2C_f}$

(D) $\frac{2 + C_f}{2 - C_f}$

36. A bar having a cross-sectional area of 700 mm^2 is subjected to axial loads at the positions indicated. The value of stress in the segment QR is:

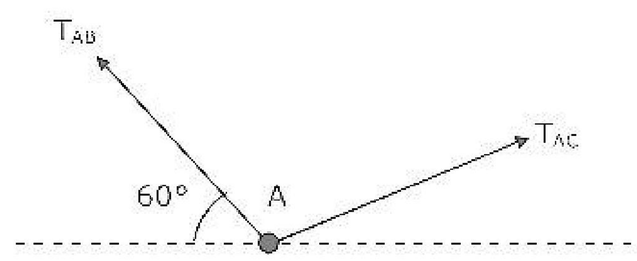


(A) 40 MPa
(B) 50 MPa
(C) 70 MPa
(D) 120 MPa

37. If a system is in equilibrium and the position of the system depends upon many independent variables, the principle of virtual work states that the partial derivatives of its total potential energy with respect to each of the independent variable must be

(A) -1.0
(B) 0
(C) 1.0
(D) ∞

38. If point A is in equilibrium under the action of the applied forces, the values of tensions T_{AB} and T_{AC} are respectively.



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(A) 520 N and 300 N
(B) 300 N and 520 N
(C) 450 N and 150 N
(D) 150 N and 450 N

39. Match the items in columns I and II

Column I	Column II
(P) Higher kinematic pair	(1) Grubler's equation
(Q) Lower kinematic pair	(2) Line contact
(R) Quick return mechanism	(3) Euler's equation
(S) Mobility of a linkage	(4) Planer
	(5) Shaper
	(6) Surface contact

(A) P - 2 Q - 6 R - 4 S - 3
(B) P - 6 Q - 2 R - 4 S - 1
(C) P - 6 Q - 2 R - 5 S - 3
(D) P - 2 Q - 6 R - 5 S - 1

40. A machine of 250 kg mass is supported on springs of total stiffness 100 kN/m. Machine has an unbalanced rotating force of 350 N at speed of 3600 rpm. Assuming a damping factor of 0.15, the value of transmissibility ratio is:

(A) 0.0531
(B) 0.9922
(C) 0.0162
(D) 0.0028

41. In a four-bar linkage, S denotes the shortest link length, L is the longest link length, P and Q are the lengths of other two links. At least one of the three moving links will rotate by 360° if

(A) $S + L \leq P + Q$

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(B) $S + L > P + Q$

(C) $S + P \leq L + Q$

(D) $S + P > L + Q$

42. A 60 mm long and 6 mm thick fillet weld carries a steady load of 15 kN along the weld. The shear strength of the weld material is equal to 200 MPa. The factor of safety is

(A) 2.4

(B) 3.4

(C) 4.8

(D) 6.8

43. A two-dimensional flow field has velocities along the x and y directions given by $u = x^2 t$ and $v = -2xyt$ respectively, where t is time. The equation of streamlines is:

(A) $x^2 y$ = constant

(B) xy^2 = constant

(C) xy = constant

(D) not possible to determine

44. The velocity profile in fully developed laminar flow in a pipe of diameter D is given by $u = u_0 \left(1 - 4r^2/D^2\right)$, where r is the radial distance from the center. If the viscosity of the fluid is μ, the pressure drop across a length L of the pipe is:

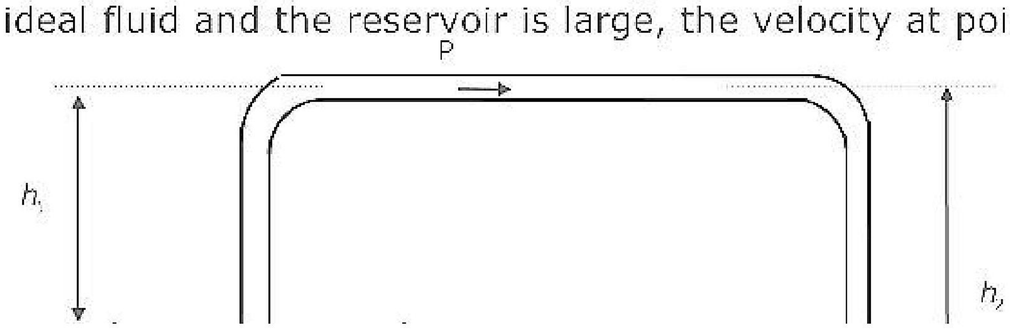
(A) $\frac{\mu u_o L}{D^2}$

(B) $\frac{4\mu u_o L}{D^2}$

(C) $\frac{8\mu u_o L}{D^2}$

(D) $\frac{16\mu u_o L}{D^2}$

45. A siphon draws water from a reservoir and discharges it out at atmospheric pressure. Assuming ideal fluid and the reservoir is large, the velocity at point P in the siphon tube is:



(A) $\sqrt{2gh_1}$

(B) $\sqrt{2gh_2}$

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(C) $\sqrt{2g(h_2 - h_1)}$

(D) $\sqrt{2g(h_2 + h_1)}$

46. A large hydraulic turbine is to generate 300 kW at 1000 rpm under a head of 40 m. for initial testing, a 1:4 scale model of the turbine operates under a head of 10 m. the power generated by the model (in kW) will be

(A) 2.34

(B) 4.68

(C) 9.38

(D) 18.75

47. The statement concern psychrometric chart.

1. Constant relative humidity lines are uphill straight lines to the right
2. Constant wet bulb temperature lines are downhill straight lines to the right.
3. Constant specific volume lines are downhill straight lines to the right.
4. Constant enthalpy lines are coincident with constant wet bulb temperature lines.

Which of the statements are correct?

(A) 2 and 3

(B) 1 and 2

(C) 1 and 3

(D) 2 and 4

48. A 100 W electric bulb was switched on in a 2.5 m × 3 m × 3 m size thermally insulated room having a temperature of 20°C. The room temperature at the end of 24 hours will be

(A) 321 °C

(B) 341 °C

(C) 450 °C

(D) 470 °C

49. A thin layer of water in field is formed after a farmer has watered it. The ambient air conditions are: temperature 20 °C and relative humidity 5%.

An extract of steam tables is given below.

Temperature (°C)	-15	-10	-5	0.01	5	10	15	20

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Neglecting the heat transfer between the water and the ground, the water temperature in the field after phase equilibrium is reached equals

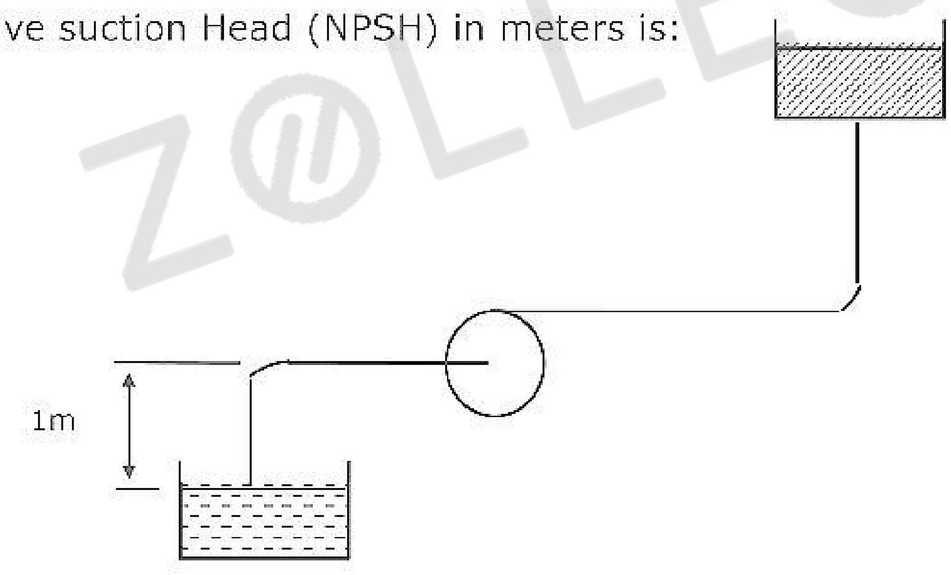
(A) 10.3 °C

(B) -10.3 °C

(C) -14.5 °C

(D) 14.5 °C

50. A horizontal shaft centrifugal pump lifts ware at 65°C. The suction nozzle is one meter below pump centerline. The pressure at this point equal 200 kPa gauge and velocity is 3 m/s. Steam tables show saturation pressure at 65°C is 25 kPa, and specific volume of the saturated liquid is 0.001020 m^3/kg. The pump Net Positive suction Head (NPSH) in meters is:



(A) 24

(B) 26

(C) 28

(D) 30

51. Given below is an extract from steam tables.

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Temperature (°C)	P_{sat} (bar)	Specific volume (m^3/kg)		Enthalpy (kJ/kg)	
		Saturated liquid	Saturated vapour	Saturated liquid	Saturated vapour
45	0.09593	0.001010	15.26	188.45	2394.8
342.24	150	0.001658	0.010337	1610.5	2610.5

Specific enthalpy of water in kJ/kg at 150 bar and 45 °C is

(A) 203.60

(B) 200.53

(C) 196.38

(D) 188.45

52. Determine the correctness or otherwise of the following **Assertion [a]** and the **Reason [r].**

Assertion [a]: In a power plant working on a Ranking cycle, the regenerative feed water heating improves the efficiency of the steam turbine.

Reason [r]: The regenerative feed water heating raises the average temperature of heat addition in the Rankine cycle.

(A) Both [a] and [r] are true and [r] is the correct reason for [a].

(B) Both [a] and [r] are true but [r] is NOT the correct reason for [a].

(C) Both [a] and [r] are false

(D) [a] is false and [r] is true.

53. Determine the correctness or otherwise of the following **Assertion [a]** and the **Reason [r].**

Assertion [a]: Condenser is an essential equipment in a steam power plant.

Reason [r]: For the same mass flow rate and the same pressure rise, a water pump requires substantially less power than a steam compressor.

(A) Both [a] and [r] are true and [r] is the correct reason for [a].

(B) Both [a] and [r] are true but [r] is NOT the correct reason for [a].

(C) [a] is true but [r] is false

(D) [a] is false and [r] is true.

54. Match items from groups I, II, III, IV and V.

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Group I	Group II	Group III	Group IV	Group V
	When added to the system, is	Differential	Function	Phenomenon
E Heat	G Positive	I Exact	K Path	M Transient
F Work	H Negative	J Inexact	L Point	N Boundary

(A) F – G - J - K – M
E – G - I – K - N
(B) E – G - I - K – M
F – H - I – K - N
(C) F – H - J - L – N
E – H - I – L - M
(D) E – G - J - K – N
F – H - J – K - M

55. Group I shows different heat addition processes in power cycles. Likewise, Group II shows different heat removal processes. Group III lists power cycles. Match items from Groups I, II and III.

Group I	Group II	Group III
P. Pressure constant	S. Pressure constant	1. Rankine cycle
Q. Volume constant	T. Volume constant	2. Otto cycle
R. Temperature constant	U. Temperature constant	3. Carnot cycle
		4. Diesel cycle
		5. Brayton cycle

(A) P – S – 5, R – U – 3, P – S – 1, Q – T - 2
(B) P – S – 1, R – U – 3, P – S – 4, P – T - 2
(C) R – T – 3, P – S – 1, P – T – 4, Q – S - 5
(D) P – T – 4, R – S – 3, P – S – 1, P – S - 5

56. With an increase in thickness of insulation around a circular pipe, heat loss to surroundings due to
(A) convection increases, while that due to conduction decreases
(B) convection decreases, while that due to conduction increases
(C) convection and conduction decreases
(D) convection and conduction increases

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57. The ultimate tensile strength of a material is 400 MPa and the elongation up to maximum load is 35%. If the material obeys power law of hardening, then the true stress-true strain relation (stress in MPa) in the plastic deformation range is:

(A) $\sigma = 540\varepsilon^{0.30}$

(B) $\sigma = 775\varepsilon^{0.30}$

(C) $\sigma = 540\varepsilon^{0.35}$

(D) $\sigma = 775\varepsilon^{0.35}$

58. In a sand casting operation, the total liquid head is maintained constant such that it is equal to the mould height. The time taken to fill the mould with a top gate is t_A. If the same mould is filed with a bottom gate, then the time taken is t_B. Ignore the time required to fill the runner and frictional effects. Assume atmospheric pressure at the top molten metal surfaces. The relation between t_A and t_B is:

(A) $t_B = \sqrt{2}\ t_A$

(B) $t_B = 2\ t_A$

(C) $t_B = \frac{t_A}{\sqrt{2}}$

(D) $t_B = 2\sqrt{2}\ t_A$

59. A 4 mm thick sheet is rolled with 300 mm diameter rolls to reduce thickness without any change in its width. The friction coefficient at the work-roll interface is 0.1. The minimum possible thickness of the sheet that can be produced in a single pass is:

(A) 1.0 mm

(B) 1.5 mm

(C) 2.5 mm

(D) 3.7 mm

60. In a wire drawing operation, diameter of a steel wire is reduced from 10 mm to 8 mm. the mean flow stress of the material is 400 MPa. The ideal force requied for drawing (ignoring friction and redundant work) is:

(A) 4.48 kN

(B) 8.97 kN

(C) 20.11 kN

(D) 31.41 kN

61. Match the items in columns I and II.

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Column I	Column II
(P) Wrinkling	(1) Yield point elongation
(Q) Orange peel	(2) Anisotropy
(R) Stretcher strains	(3) Large grain size
(S) Earing	(4) Insufficient blank holding force
	(5) Fine grain size
	(6) Excessive blank holding force

(A) P - 6 Q - 3 R - 1 S - 2
(B) P - 4 Q - 5 R - 6 S - 1
(C) P - 2 Q - 5 R - 3 S - 4
(D) P - 4 Q - 3 R - 1 S - 2

62. In an arc welding process, the voltage and current are 25 V and 300 A respectively. The arc heat transfer efficiency is 0.85 and welding speed is 8 mm/sec. the net heat input (in J/mm) is:

(A) 64
(B) 797
(C) 1103
(D) 79700

63. If each abrasive grain is viewed as a cutting tool, then which of the following represents the cutting parameters in common grinding operations?

(A) Large negative rake angle, low shear angle and high cutting speed
(B) Large positive rake angle, low shear angle and high cutting speed
(C) Large negative rake angle, high shear angle and low cutting speed
(D) Zero rake angle, high shear angle and high cutting speed

64. Arrange the processes in the increasing order of their maximum material removal rate.

Electrochemical Machining (ECM)
Ultrasonic Machining (USM)
Electron Beam Machining (EBM)
Laser Beam Machining (LBM) and
Electric Discharge Machining (EDM)

(A) USM, LBM, EBM, EDM, ECM
(B) EBM, LBM, USM, ECM, EDM
(C) LBM, EBM, USM, ECM, EDM

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(D) LBM, EBM, USM, EDM, ECM

65. Match the items in columns I and II.

Column I	Column II
(P) Charpy test	(1) Fluidity
(Q) Knoop test	(2) Microhardness
(R) Spiral test	(3) Formability
(S) Cupping test	(4) Toughness
	(5) Permeability

(A) P - 4 Q - 5 R - 3 S - 2
(B) P - 3 Q - 5 R - 1 S - 4
(C) P - 2 Q - 4 R - 3 S - 5
(D) P - 4 Q - 2 R - 1 S - 3

66. A manufacturing shop processes sheet metal jobs, wherein each job must pass through two machines (M1 and M2, in that order). The processing time (in hours) for these jobs is:

Machine	Jobs					
	P	Q	R	S	T	U
M1	15	32	8	27	11	16
M2	6	19	13	20	14	7

The optimal make-span (in hours) of the shop is:
(A) 120
(B) 115
(C) 109
(D) 79

67. Consider the following data for an item.

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Price quoted by a supplier

Order quantity (units)	Unit price (Rs.)
< 500	10
≥ 500	9

Annual demand: 2500 units per year
Ordering cost: Rs.100 per order
Inventory holding rate: 25% of unit price.
The optimum order quantity (in units) is:
(A) 447
(B) 471
(C) 500
(D) ≥ 600

68. A firm is required to procure three items (P, Q and R). The prices quoted for these items (in Rs.) by suppliers S1, S2 and S3 are given in table. The management policy requires that each item has to be supplied by only one supplier and one supplier supply only one item. The minimum total cost (in Rs.) of procurement to the firm is:

Item	Suppliers		
	S1	S2	S3
P	110	120	130
Q	115	140	140
R	125	145	165

(A) 350
(B) 360
(C) 385
(D) 395

69. A stockist wishes to optimize the number of perishable items he needs to stock in any month in his store. The demand distribution for this perishable item is:

Demand (in units)	2	3	4	5
Probability	0.10	0.35	0.35	0.20

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The stockist pays Rs.70 for each item and he sells each at Rs.90. if the stock is left unsold in any month, he can sell the item at Rs.50 each. There is no penalty for unfulfilled demand. To maximize the expected profit, the optimal stock level is:

(A) 5 units

(B) 4 units

(C) 3 units

(D) 2 units

70. The table gives details of an assembly line.

Work station	I	II	III	IV	V	VI
Total task time at the workstation (in minutes)	7	9	7	10	9	6

What is the line efficiency of the assembly line?

(A) 70%

(B) 75%

(C) 80%

(D) 85%

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Common Data Questions

Common Data for Questions 71, 72, 73:

In an orthogonal machining operation:

Uncut thickness = 0.5 mm

Width of cut = 5 mm

Thrust force = 200 N

Rake angle = 15°

Cutting speed = 20 m/min

Chip thickness = 0.7 mm

Cutting force = 1200 N

Assume Merchant's theory.

71. The values of shear angle and shear strain, respectively, are

(A) 30.3° and 1.98

(B) 30.3° and 4.23

(C) 40.2° and 2.97

(D) 40.2° and 1.65

72. The coefficient of friction at the tool-chip interface is:

(A) 0.23

(B) 0.46

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(C) 0.85

(D) 0.95

73. The percentage of total energy dissipated due to friction at the tool-chip interface is:

(A) 30%

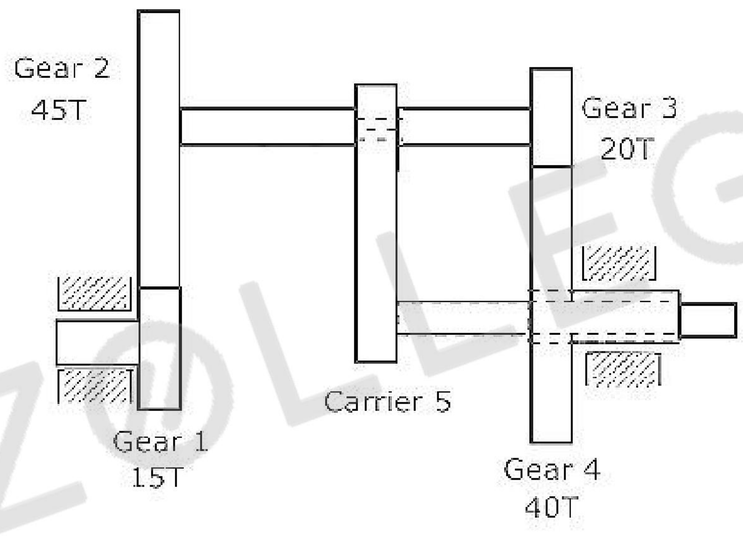
(B) 42%

(C) 58%

(D) 70%

Common Data for Questions 74, 75:

A planetary gear train has four gears and one carrier. Angular velocities of the gears are $\omega_1, \omega_2, \omega_3$ and ω_4 respectively. The carrier rotates with angular velocity ω_5.



74. What is the relation between the angular velocities of Gear 1 and Gear 4?

(A) $\frac{\omega_1 - \omega_5}{\omega_4 - \omega_5} = 6$

(B) $\frac{\omega_4 - \omega_5}{\omega_1 - \omega_5} = 6$

(C) $\frac{\omega_1 - \omega_2}{\omega_4 - \omega_3} = -\left(\frac{2}{3}\right)$

(D) $\frac{\omega_2 - \omega_5}{\omega_1 - \omega_5} = \frac{8}{9}$

75. For $\omega_1 = 60$ rpm clockwise (cw) when looked from the left, what is the angular velocity of the carrier and its direction so that Gear 4 rotates in counterclockwise (ccw) direction at twice the angular velocity of Gear 1 when looked from the left

(A) 130 rpm, cw

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(B) 223 prm, ccw
(C) 256 rpm, cw
(D) 156 rpm, ccw

Linked Answer Questions: Q.76 to Q85 Carry Two Marks Each

Statement for Linked Answer Questions 76 & 77:

A simply supported beam of span length 6 m and 75 mm diameter carries a uniformly distributed load of 1.5 kN/m.

76. What is the maximum value of bending moment?
(A) 9 kNm
(B) 13.5 kNm
(C) 81 kNm
(D) 125 kNm

77. What is the maximum value of bending stress?
(A) 162.98 MPa
(B) 325.95 MPa
(C) 625.95 MPa
(D) 651.90 MPa

Statement for Linked Answer Questions 78 & 79:

A vibratory system consists of a mass 12.5 kg, a spring of stiffness 1000 N/m, and a dashpot with damping coefficient of 15 Ns/m.

78. The value of critical damping of the system is:
(A) 0.223 Ns/m
(B) 17.88 Ns/m
(C) 71.4 Ns/m
(D) 223.6 Ns/m

79. The value of logarithmic decrement is:
(A) 1.35
(B) 1.32
(C) 0.68
(D) 0.66

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Statement for Linked Answer Questions 80 & 81:

A football was inflated to a gauge pressure of 1 bar when the ambient temperature was 15°C. When the game started next day, the air temperature at the stadium was 5°C. Assume that the volume of the football remains constant at 2500 cm^3.

80. The amount of heat lost by the air in the football and the gauge pressure of air in the football at the stadium respectively equal
    (A) 30.6 J, 1.94 bar
    (B) 21.8 J, 0.93 bar
    (C) 61.1 J, 1.94 bar
    (D) 43.7 J, 0.93 bar

81. Gauge pressure of air to which the ball must have been originally inflated so that it would equal 1 bar gauge at the stadium is:
    (A) 2.23 bar
    (B) 1.94 bar
    (C) 1.07 bar
    (D) 1.00 bar

Statement for Linked Answer Questions 82 & 83:

A smooth flat plate with a sharp leading edge is placed along a gas stream flowing at U = 10 m/s. The thickness of the boundary layer at section $r-s$ is 10 mm, the breadth of the plate is 1 m (into the paper) and the density of the gas $\rho = 1.0$ kg/m^3. Assume that the boundary layer is thin, two-dimensional, and follows a linear velocity distribution, $u = U(y/\delta)$, at the section $r-s$, where y is the height from plate.

82. The mass flow rate (in kg/s) across the section $q-r$ is:
    (A) zero
    (B) 0.05
    (C) 0.10
    (D) 0.15

83. The integrated drag force (in N) on the plate, between $p-s$, is:
    (A) 0.67
    (B) 0.33
    (C) 0.17
    (D) zero

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Statement for Linked Answer Questions 84 & 85:

Consider a PERT network for a project involving six tasks (a to f).

Task	Predecessor	Expected task time (in days)	Variance of the task time (in days^2)
a	-	30	25
b	a	40	64
c	a	60	81
d	b	25	9
e	b, c	45	36
f	d, e	20	9

84. The expected completion time of the project is:

(A) 238 days

(B) 224 days

(C) 171 days

(D) 155 days

85. The standard deviation of the critical path of the project is:

(A) $\sqrt{151}$ days

(B) $\sqrt{155}$ days

(C) $\sqrt{200}$ days

(D) $\sqrt{238}$ days

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