Naval Architecture and Marine Engineering

EE25BTECH11026-Harsha

General Aptitude (G.A)

Q.1 - Q.5 Carry ONE mark Each:

1) Despite his initial hesitation, Rehman's _____ to contribute to the success of the project never wavered. Select the most appropriate option to complete the above sentence.

   a) ambivalence   b) satisfaction   c) resolve   d) revolve

2) Bird : Nest :: Bee : _____

   Select the correct option to complete the analogy.

   a) Kennel   b) Hammock   c) Hive   d) Lair

3) If $Pe^x = Qe^{-x}$ for all real values of x, which one of the following statements is true?

   a) $P = Q = 0$ b) $P = Q = 1$ c) $P = 1\,; Q = 1$ d) $\frac{P}{Q} = 0$

4) The paper as shown in the figure is folded to make a cube where each square corresponds to a particular face of the cube. Which one of the following options correctly represents the cube?
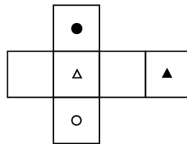
   Note: The figures shown are representative.

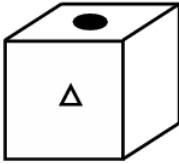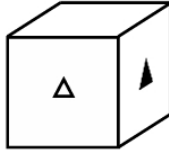
Fig-1
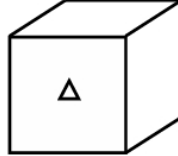
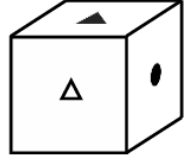a)   b)   c)   d)

5) Let p_1 and p_2 denote two arbitrary prime numbers. Which one of the following statements is correct for all values of p_1 and p_2?

   a) $p_1 + p_2$ is not a prime number.

   b) $p_1 p_2$ is not a prime number.

   c) $p_1 + p_2 + 1$ is a prime number.

   d) $p_1 p_2 + 1$ is a prime number.

Q.6 - Q.10 Carry TWO marks Each:

6) Based only on the conversation below, identify the logically correct inference:

   "Even if I had known that you were in the hospital, I would not have gone there to see you", Ramya told Josephine.

   a) Ramya knew that Josephine was in the hospital.

   b) Ramya did not know that Josephine was in the hospital.

   c) Ramya and Josephine were once close friends; but now, they are not.

   d) Josephine was in the hospital due to an injury to her leg.

7) If IMAGE and FIELD are coded as FHBNJ and EMFJG respectively then, which one among the given options is the most appropriate code for BEACH ?

   a) CEADP   b) IDBFC   c) JGIBC   d) IBCEC

8) Which one of the following options is correct for the given data in the table?

Iteration (i)	0	1	2	3
Input (I)	20	−4	10	15
Output (X)	20	16	26	41
Output (Y)	20	−80	−800	−12000

Fig-6:Data table

a) $X(i) = X(i-1) + I(i);\quad Y(i) = Y(i-1)I(i);\quad i > 0$

b) $X(i) = X(i-1)I(i);\quad Y(i) = Y(i-1) + I(i);\quad i > 0$

c) $X(i) = X(i-1)I(i);\quad Y(i) = Y(i-1)I(i);\quad i > 0$

d) $X(i) = X(i-1) + I(i);\quad Y(i) = Y(i-1)I(i-1);\quad i > 0$

9) In the given figure, PQRS is a square of side 2 cm and PLMN is a rectangle. The corner L of the rectangle is on the side QR. Side MN of the rectangle passes through the corner S of the square. What is the area (in cm^2) of the rectangle PLMN?
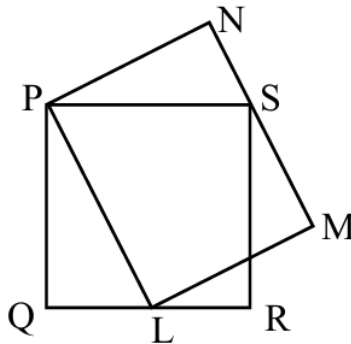
Note: The figure shown is representative.

Fig-7:Square PQRS and Rectangle PLMN

a) $2\sqrt{2}$ b) 2   c) 8   d) 4

10) The diagram below shows a river system consisting of 7 segments, marked P, Q, R, S, T, U, and V. It splits the land into 5 zones, marked Z1, Z2, Z3, Z4, and Z5. We need to connect these zones using the least number of bridges. Out of the following options, which one is correct?

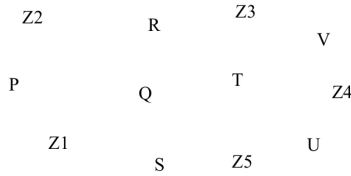Note: The figure shown is representative.

Fig-8:River system

a) Bridges on P, Q, and T

b) Bridges on P, Q, S, and T

c) Bridges on Q, R, T, and V

d) Bridges on P, Q, S, U, and V

Q.11 - Q.35 Carry TWO marks Each:

11) The value of $\lim\limits_{t \to 1} \frac{\ln t}{t^2 - 1}$ is ____.

a) $\frac{1}{2}$ b) 0   c) 1   d) ∞

12) The Fourier series expansion of $f(x) = \sin^2 x$ in the interval $(-\pi, \pi)$ is _____.

     a) $f(x) = \frac{1}{2} - \frac{1}{2} \cos 2x$

     b) $f(x) = \sum_{n=1}^{\infty} (-1)^{n-1} \frac{\cos nx}{n^2}$

     c) $f(x) = 2 \sum_{n=1}^{\infty} \frac{\sin 2nx}{n}$

     d) $f(x) = \frac{1}{2} - \frac{4}{\pi^2} \sum_{n=1}^{\infty} \frac{\cos (2n-1)\pi x}{(2n-1)^2}$

13) For all real values of x and y, the partial differential equation in terms of $\psi(x, y)$ given by $\frac{\partial^2 \psi}{\partial x^2} + 2\frac{\partial^2 \psi}{\partial x \partial y} - 3\frac{\partial^2 \psi}{\partial y^2} = 0$ is _____.

    a) hyperbolic

    b) parabolic

    c) elliptic

    d) elliptic within the region, $x^2 - y < 0$

14) The sum of the static pressure and dynamic pressure at a point in a fluid flow is called the _____.

    a) kinematic pressure

    b) vacuum pressure

    c) stagnation pressure

    d) kinetic pressure

15) Identify the range of Reynolds number (Re) for a creeping flow.

    a) $2000 < Re < 20000$

    b) $1000 < Re < 2000$

    c) $10 < Re < 100$

    d) $Re << 1$

16) The ratio of the magnitudes of vorticity to rate of rotation in a fluid flow is _____.

    a) 2   b) 3   c) $\frac{1}{2}$ d) 1

17) In a laminar boundary layer, the ratio of boundary layer thickness (δ) to the corresponding displacement thickness (δ^*) lies between _____.

    a) 1.5 and 2.4   b) 2.5 and 3.4   c) 3.5 and 4.4   d) 4.5 and 5.4

18) For marine engine shafts subjected to high radial and axial thrust loads, which one of the following types of bearings is the most suitable?

    a) Deep groove ball

    b) Sealed ball

    c) Tapered ball

    d) Needle

19) Which one of the following wave energy spectra is formulated for two peaks?

    a) Pierson-Moskowitz spectrum

    b) JONSWAP spectrum

    c) Ochi-Hubble spectrum

    d) Neumann spectrum

20) According to linear water wave theory, at a point on the free surface of a regular wave, the phase difference between the free surface elevation and the horizontal water particle acceleration is _____.

    a) $0°$ b) $45°$ c) $90°$ d) $135°$

21) The dynamic response amplitude $|H(\omega)|$ of a single degree of freedom system subjected to support motion is given by the following expression.

$$|H(\omega)| = \sqrt{\frac{1 + 4\zeta^2(\frac{\omega}{\omega_n})^2}{[1 - (\frac{\omega}{\omega_n})^2]^2 + 4\zeta^2(\frac{\omega}{\omega_n})^2}}$$

$|H(\omega)|$ increases with an increase in damping ratio (ζ) if the excitation frequency (ω) is _____ the natural frequency (ω_n) of the system.

    a) equal to   b) 0.75 times   c) $\frac{\sqrt{3}}{2}$ times   d) greater than $\sqrt{2}$ times

22) In the stress-strain curve of mild steel, plastic deformation starts at the _____.

    a) proportional limit

    b) elastic limit

    c) upper yield point

    d) lower yield point

23) In ships, a flash evaporator is used to obtain _____.

    a) distilled water

    b) low viscosity lubricating oil

    c) high-temperature heavy oil

    d) air for space heating

24) Which one of the following is the most common type of gear assembly used for coupling steam turbine and propeller shafts?

   a) Spur   b) Single helical   c) Double Helical   d) Worm

25) A ship of 5000 tonne displacement has two empty rectangular double bottom tanks with dimensions:
Tank A: length 12 m, width 16 m, and height 2 m
Tank B: length 16 m, width 12 m, and height 2 m
The length of each tank is oriented along the length of the ship. It is required to ballast the ship with 192 m^3 of seawater of density 1025 kg/m^3. Which one of the following scenarios will minimize the free surface effect?

   a) 100 % of the given ballast water is filled in Tank A.

   b) 100 % of the given ballast water is filled in Tank B.

   c) 50% of the given ballast water is filled in Tank A and the remaining in Tank B.

   d) 40% of the given ballast water is filled in Tank A and the remaining in Tank B.

26) The midship section of a barge of breadth W and depth H is shown in the figure. All plate thicknesses are equal. The barge is subjected to a longitudinal bending moment in the upright condition. Which one of the following statements is correct?
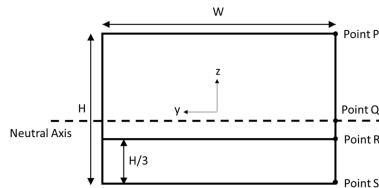

Fig-9:Midship section

   a) Magnitude of longitudinal bending stress is maximum at point P and magnitude of vertical shear stress is maximum at point Q.

   b) Magnitude of longitudinal bending stress is maximum at point S and magnitude of vertical shear stress is maximum at point R.

   c) Magnitude of longitudinal bending stress is maximum at point Q and magnitude of vertical shear stress is maximum at point S.

   d) Magnitude of longitudinal bending stress is maximum at point R and magnitude of vertical shear stress is maximum at point P.

27) Consider a Planar Motion Mechanism (PMM) test of a ship model in a towing tank. The transverse motion of the model from the centerline of the tank is described by $y = a_0 \cos(\omega t)$, where ω is the angular frequency. The carriage speed is 3 m/s, $\omega = \frac{\sqrt{3}}{2}$ rad/s and the maximum drift angle during the test is 30°. The amplitude of oscillation a_0 lies between _____.

    a) 0.2 m and 0.4 m   b) 0.5 m and 0.7 m   c) 1.0 m and 1.2 m   d) 1.9 m and 2.1 m

28) Consider the function $f(x) = |x| - 1$. Which of the following statements is/are true in the interval $[-10,10]$?

    a) The function is differentiable in the domain.

    b) The function is continuous in the domain.

    c) The function is not differentiable in the domain.

    d) The function is not continuous in the domain.

29) For a freely floating body in water, which of the following degrees of freedom has/have inherent restoring force?

    a) Sway   b) Surge   c) Heave   d) Pitch

30) Which of the following boiler arrangements will ensure that there is **NO** contamination of the primary feed system?

    a) Steam-to-steam generator

    b) Double evaporation boiler

    c) Water tube boiler

    d) Fire tube boiler

31) Which of the following components is/are **NOT** found in a two-stroke marine diesel engine?

    a) Crankshaft   b) Piston   c) Spark plug   d) Air-inlet valve

32) Choose the correct statement(s) from the following with respect to a ship generated Kelvin wave pattern in deep water.

a) A system of transverse waves and divergent waves are observed behind the ship.

b) A system of transverse waves and divergent waves are observed in front of the ship.

c) The waves are contained in a sector originating at the bow with a half angle of $9°28'$.

d) The amplitude of wave components decrease as they propagate.

33) A box contains 12 red and 8 blue balls. Two balls are drawn randomly from the box without replacement.

The probability of drawing a pair of balls having the same color is _____ (rounded off to three decimal places).

34) The dynamics of a 90 m long ship are governed by the non-dimensional Nomoto equation. The magnitude of Nomoto gain $|K'| = \frac{72}{35\pi}$ and that of Nomoto time constant $|T'| = \frac{288}{35\pi}$

The steady turning radius of the ship for a $35°$ turning circle maneuver is _____ m (answer in integer).

35) A ship of length 200 m has a beam of 25 m. She floats in seawater with an even keel draught of 5 m. The prismatic coefficient of the ship is 0.9; the mass displacement is 20500 tonne and the density of seawater is 1025 kg/m^3.

The midship section coefficient is _____ (rounded off to two decimal places).

Q.36 - Q.65 Carry TWO marks Each:

36) Consider $f(t) = \cos(at)$, where a is a real constant. The Laplace transform of $f(t)$ is _____.

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

37) A square shaped body is subjected to only direct tensile stresses σ_x and σ_y as shown in the figure. If $\sigma_x > \sigma_y$, then the value of normal stress (σ_θ) and shear stress (τ_θ) respectively are _____.
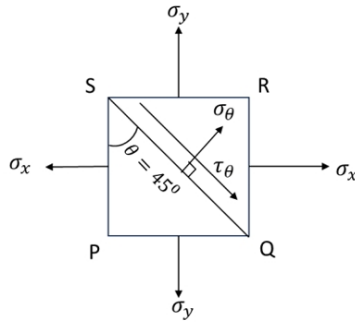
Fig-10:Square shaped body

a) $\frac{\sigma_x-\sigma_y}{2}$ and $\frac{\sigma_x+\sigma_y}{2}$ b) $\frac{\sigma_x+\sigma_y}{2}$ and $\frac{\sigma_x-\sigma_y}{2}$ c) $\frac{\sigma_x+\sigma_y}{2}$ and $\frac{\sigma_x+\sigma_y}{2}$ d) $\frac{\sigma_x-\sigma_y}{2}$ and $\frac{\sigma_x-\sigma_y}{2}$

38) The beam PQRS is subjected to a vertical point load of 10 kN at point S as shown in the figure.
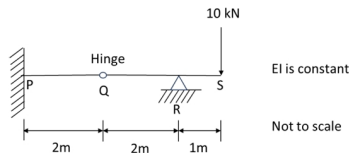
The magnitude of fixed end moment at P is _____ kN-m.

Fig-11:Beam PQRS

a) 50   b) 10   c) 30   d) 40

39) For a butt weld joint of two plates, which one of the following loading scenarios has the least permissible stress?

a) Tensile   b) Bending   c) Bearing   d) Shear

40) Match the non-dimensional numbers in Column 1 with the corresponding definitions in Column 2

	Column 1	**Column 2**
I.	Froude number	P. Ratio of inertial force to surface tension force
II.	Reynolds number	Q. Ratio of inertial force to gravitational force
III.	Euler number	R. Ratio of inertial force to viscous force
IV.	Weber number	S. Ratio of pressure force to inertial force

Column-match

a) I-S;II-R;III-P;IV-Q

b) I-Q;II-R;III-S;IV-P

c) I-Q;II-R;III-P;IV-S

d) I-S;II-Q;III-R;IV-P

41) A closed system is undergoing a reversible process 1-P-2 from state 1 to 2, as shown in the figure, where X and Y are thermodynamic properties. An irreversible process 2-Q-1 brings the system back from 2 to 1.

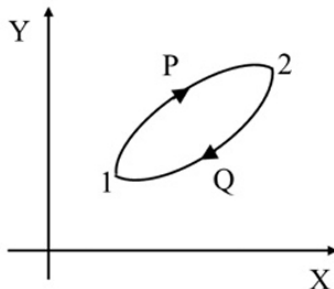The net change in entropy of the system and surroundings during the above mentioned cycle are _____ respectively.

Fig-13:Graph of closed system undergoing thermodynamic process

a) positive and negative

b) negative and positive

c) zero and negative

d) zero and positive

42) An ideal Brayton cycle (1-2-3-4) consisting of two isentropic and two isobaric processes is shown in the T-s plot, where T is the temperature and s is the specific entropy of the system. Which one of the following plots represents the corresponding actual cycle 1-2'-3-4' (denoted by dashed lines) between the same two pressures p_1 and p_2 ?
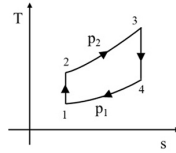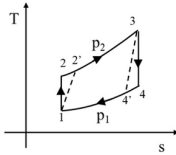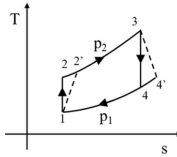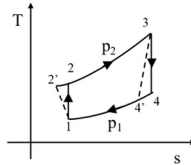

Fig-14:Ideal Brayton cycle

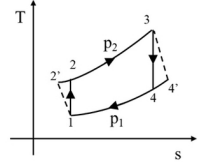a)   b)   c)   d)

43) Consider a rectangular barge of length (L) = 100 m, breadth = 25 m and draught = 10 m. The barge has the following non-dimensional hydrodynamic derivatives with respect to a coordinate system whose origin is at the center of gravity:
$Y'_v = -1000 \times 10^{-5}$, $N'_r = -800 \times 10^{-5}$,

$N'_v = -200 \times 10^{-5}$, $Y'_r = 100 \times 10^{-5}$

The stability criterion C' is given by

$$C' = Y'_v \left(N'_r - m' x'_G \right) - \left(Y'_r - m' \right) N'_v$$

where $m' = \frac{m}{\frac{1}{2}\rho L^3}$, m is the mass of the barge, ρ is the density of seawater, and x_G is the distance of the center of gravity from the origin. Which one of the following is correct regarding the controls-fixed straight-line stability?

a) Unstable with $C' = -1.8 \times 10^{-5}$

b) Stable with $C' = 3.2 \times 10^{-5}$

c) Stable with $C' = -1.8 \times 10^{-5}$

d) Unstable with $C' = 3.2 \times 10^{-5}$

44) A ship has a propeller of 5 m pitch rotating at 120 rpm. The ship travels at 8 m/s and the wake fraction is 0.25. The apparent slip ratio and real slip ratio are _____ respectively.

   a) 0.20 and 0.40   b) 0.40 and 0.20   c) 0.20 and 0.25   d) 0.25 and 0.20

45) A ship of length 100 m and displacement 5000 tonne floats even-keel at 6.5 m in fresh water of density 1000 kg/m^3. The ship's hydrostatic properties are:

   MCT per cm is 10 tonne-m, TPC in seawater is 6.25, LCB is 2 m forward of amidship, LCF is 2 m forward of amidship.

   The ship has moved to seawater of density 1025 kg/m^3 without change in the displacement. The new forward and aft draughts are _____ respectively.

   a) 6.04 m and 6.54 m

   b) 6.30 m and 6.64 m

   c) 6.64 m and 6.30 m

   d) 6.30 m and 6.30 m

46) Consider a case where the load Q for a ship structure has only statistical uncertainties. The probability density function of the load $p_Q(x)$ is shown in the figure. The characteristic limit value of the load (Q_{L_c}) is 1.5 and factor of safety is 1. Which of the following probability of exceedance value(s) of the load will lead to a safe design?
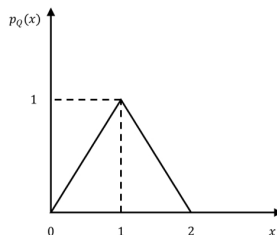

Fig-19

a) 0.05   b) 0.10   c) 0.15   d) 0.20

47) The value of $\int_1^3 dy \int_2^5 x^2 y \, dx$ is _____ (answer in integer).

48) Let $M = \begin{pmatrix} 1 & 0 \\ 0 & 2 \end{pmatrix}$ and $K = \begin{pmatrix} 2 & -1 \\ -1 & 1 \end{pmatrix}$ satisfy the eigenvalue problem given by $[M - \alpha K]\varphi = 0$.
The lowest eigenvalue α is _____ (rounded off to two decimal places).

49) The gradient of $y = 3x^2 \sin(2x)$ at (0.2, 1) is _____(rounded off to three decimal places).

50) A simply supported solid beam is subjected to a vertical point load of 10 N at the middle. The length of the beam is 4 m, and the cross section is $0.5\,m \times 0.5\,m$.
The magnitude of maximum tensile stress in the beam is _____ N/m^2 (answer in integer).

51) The displacement field of a body is given by $\mathbf{u} = yx\,\hat{i} + yz\,\hat{j} + (z + x^2)\,\hat{k}$. The shear strain γ_{xy} at (2, 1, 5) is _____(answer in integer).

52) A freely-floating rectangular barge of length 200 m is divided into five equal compartments. In light-weight condition, the weight and buoyancy are uniformly distributed along the length of the barge. Assume $g = 9.81\ m/s^2$.
If 500 tonne of liquid cargo is added to each of the two end compartments as shown in the figure, then the maximum bending moment is _____ MN-m (rounded off to two decimal places).
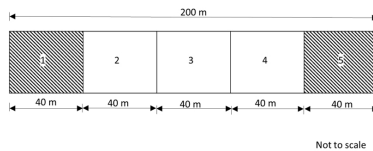

Fig-20:Free-floating rectangular barge

53) The stream function of a two-dimensional flow field is given as $\psi = 2xy + 2y + 2x$. The coordinates of two points P and Q in the flow field are (1, 2) and (2, 5) respectively. The magnitude of flow discharge between the streamlines passing through P and Q is _____(answer in integer).

54) A tank with a constant water level of 4 m above the centreline of an opening of diameter 100 mm is shown in the figure. Neglect all losses and assume $g = 9.81 m/s^2$.
The discharge through the opening is _____ litre/s (answer in integer).
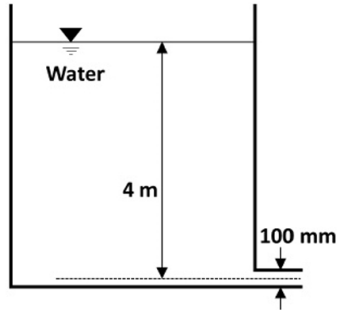
Not to scale

Fig-21:water tank

55) Air flows with a velocity of 2 m/s over a flat stationary surface parallel to its length of 0.5 m. Kinematic viscosity of air v is $1.5 \times 10^{-5}\, m^2/s$.
Using Blasius solution, the boundary layer thickness at the trailing edge of the surface is _____ mm (rounded off to two decimal places).

56) A negligibly thin horizontal plate PQ has a length 3 m and width 1 m. It is being pulled along its length at a speed of 1 m/s in between two static parallel plates as shown in the figure. The gap of 6 cm between the plates is filled with a Newtonian fluid of dynamic viscosity $\mu = 0.2\, N - s/m^2$. The thin plate is located at 3 cm from the top surface. The velocity distribution between the thin plate and the static plates is linear. The steady force required to pull the plate is _____N (answer in integer).
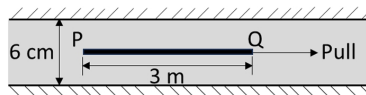
Not to scale

Fig-22

57) Water of density $\rho = 1000\, kg/m^3$ flows with a velocity $V = 50$ m/s through a $180°$ curved tube of uniform cross-section as shown in the figure. If the flow rate is $0.06\, m^3/s$, the magnitude of reaction force F_x required to keep it stationary is _____ kN (rounded off to one decimal place).
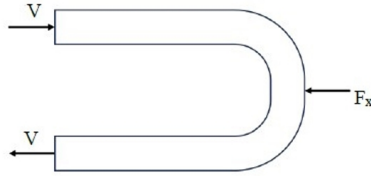
Fig-23:Curved tube of uniform cross section

58) An ocean wave is propagating from deep to shallow water. The wave is approaching the coast at 45° counterclockwise from the shore normal with an initial phase speed of 12.5 m/s. After entering the shallow water, the wave direction becomes 30° counterclockwise from the shore normal.
The phase speed of the wave at the shallow water is _____ m/s (rounded off to one decimal place).

59) Consider the psychrometric process denoted by the straight line from state 1 to 2 in the figure. The specific humidity, Dry Bulb Temperature (DBT) and Wet Bulb Temperature (WBT) at the two states are shown in the table. The latent heat of vaporization of water (hfg) is 2440 kJ/kg.
If the flow rate of air is 1 kg/s, the rate of heat transfer from the air is _____ kW (rounded off to two decimal places).

Property	State 1	State 2
Specific humidity (kg of water vapour/kg of dry air)	0.020	0.015
DBT (°C)	25	25
WBT (°C)	25	22

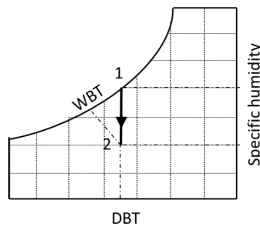Fig-24:Psychometric process

60) Consider a weightless, frictionless piston with a 2 kg mass placed on it as shown in the figure. At equilibrium in position 1, the cylinder contains 0.1 kg of air. The piston cross-sectional area is 0.01 m^2. The ambient pressure in the surroundings outside the piston-cylinder arrangement is 0 bar (absolute). When the mass above the piston is removed instantaneously, it moves up and hits the stop at position 2 which is 0.1 m above the initial position. Assuming g = 9.81 m/s^2,the thermodynamic work done by the system during this process is _____ J (answer in integer).

p_{amb} = 0 bar (abs)

2

0.1 m

2 kg

1

m_{air}=0.1 kg
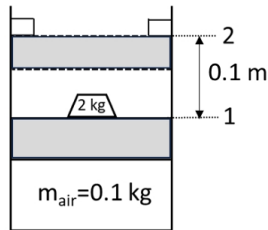
Not to scale

Fig-25:Weightless, frictionless piston

61) A two-stroke four-cylinder large marine diesel engine has a cylinder bore of 600 mm and stroke length of 2400 mm. The brake thermal efficiency (η_{bth}) is 45% and fuel consumption rate ($\dot{m}_f$) is 0.265 kg/s at an engine speed (N) of 100 rpm.Assuming the calorific value of fuel is 42 MJ/kg, the brake mean effective pressure (bmep) is _____ bar (rounded off to one decimal place).

62) A multi-cell midship section of a ship with B = 40 m and D = 20 m is shown in the figure. The shear-flows are given as q_1 = q_2 = q_3 = 0.9376 MN/m. he applied twisting moment on the midship section is _____ MN-m (rounded off to two decimal places).
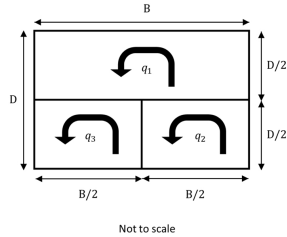
Fig-26:Multi-cell midship section

63) A ship of 3300 tonne displacement is undergoing an inclining experiment in seawater of density 1025 kg/m^3. A mass of 6 tonne is displaced transversely by 12 m as shown in the figure. This results in 0.12 m deflection of a 11 m long pendulum suspended from the centerline. The transverse metacenter of the ship is located at 7.25 m above the keel.The distance of the center of gravity from the keel is _____ m (rounded off to two decimal places).
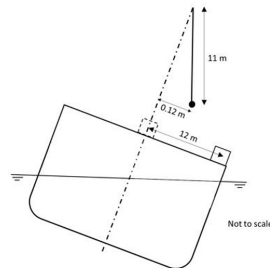

Fig-27:Figure of inclined ship

64) A ship moving at a steady forward speed of 10 m/s experiences a total resistance of 140 kN. The Quasi Propulsive Coefficient (QPC) is 0.70; the propeller shaft losses are 5% and the mechanical efficiency of the main engine is 80%. The indicated power of the main engine is _____ kW (rounded off to two decimal places).

65) A single degree of freedom system is undergoing free oscillation. The natural frequency and damping ratio of the system are 1 rad/sec and 0.01 respectively. The reduction in peak amplitude over three cycles is _____ % (rounded off to one decimal place).