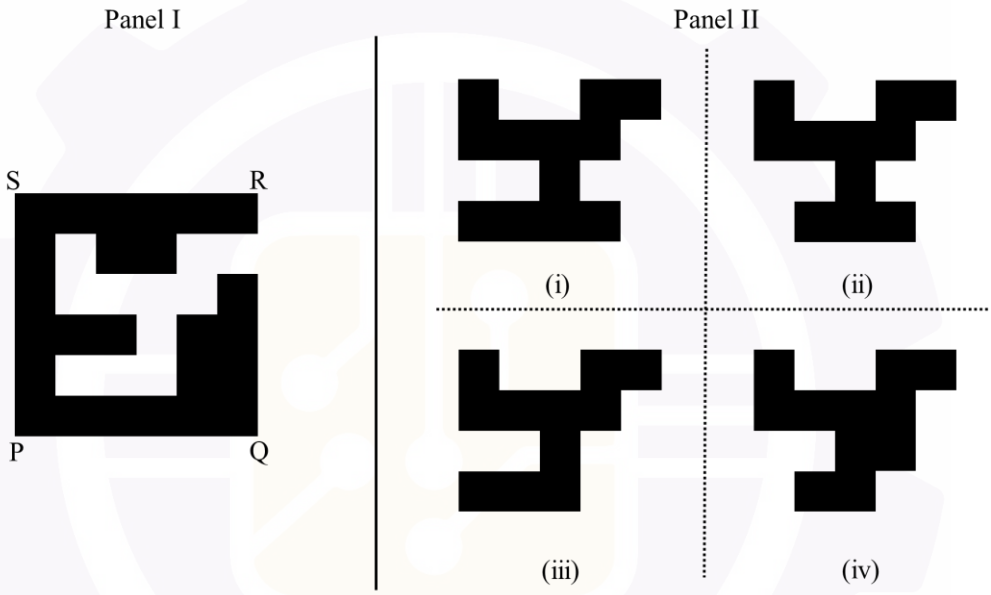
General Aptitude (GA)

Q.1 – Q.5 Carry ONE mark Each

Q.1	Expedite, Hasten, Hurry, _____ Fill the blank by choosing a word with a meaning similar to that of the words given above.
(A)	Accelerate
(B)	Retard
(C)	Provide
(D)	Disable

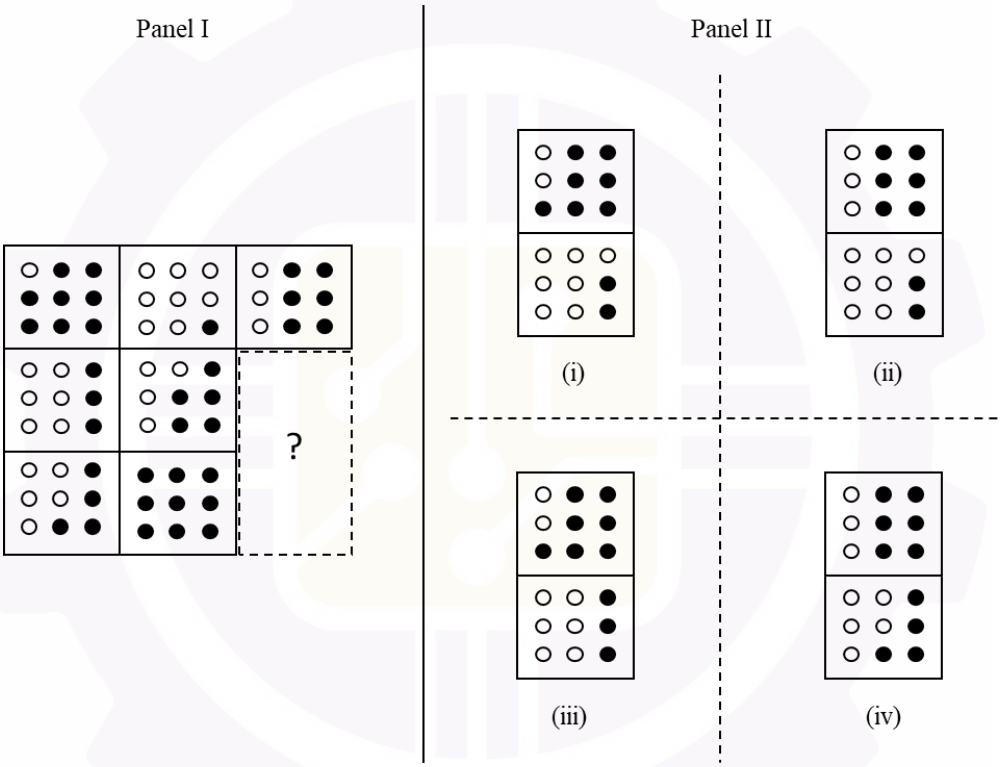
Q.2	A black square PQRS has been cut into two parts. One part of it is shown in Panel I. Which one of the shapes in Panel II is the other part? 
(A)	(i)
(B)	(ii)
(C)	(iii)
(D)	(iv)

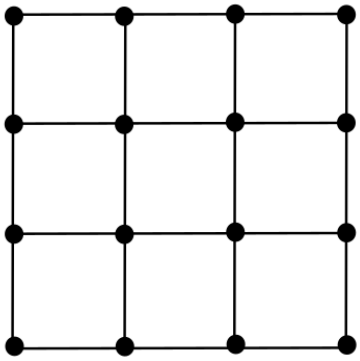
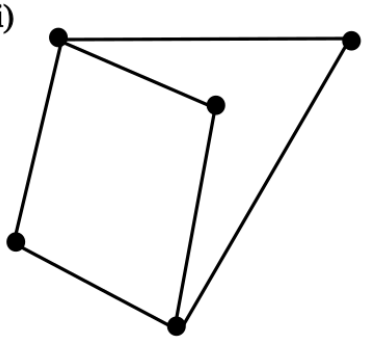
Q.3	A day can only be cloudy or sunny. The probability of a day being cloudy is 0.5, independent of the condition on other days. What is the probability that in any given four days, there will be three cloudy days and one sunny day?
(A)	1/4
(B)	3/4
(C)	2/3
(D)	3/8

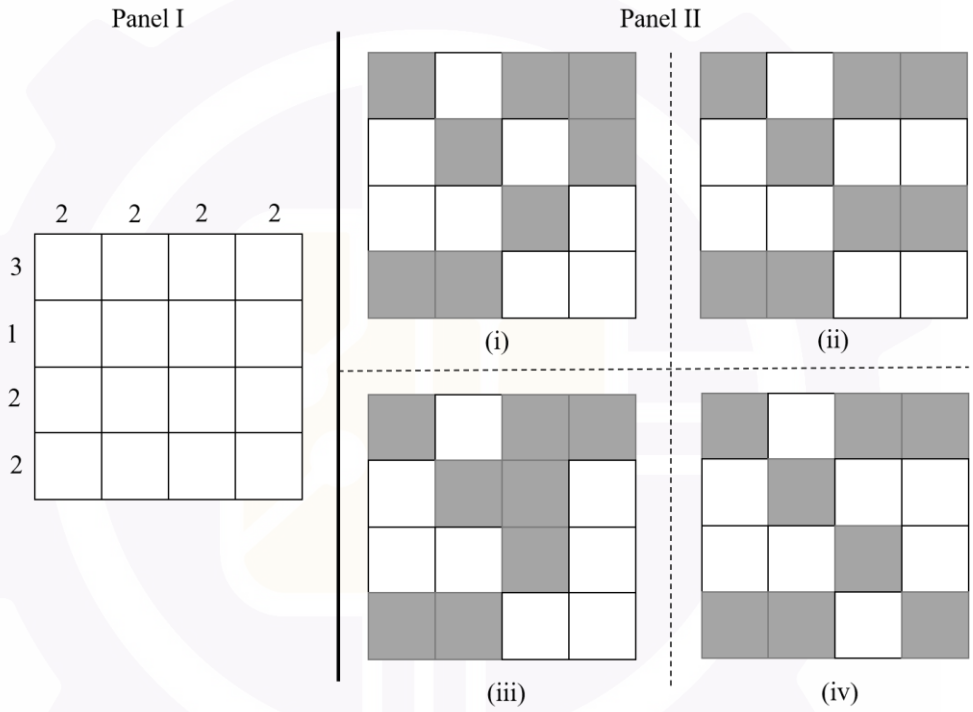
Q. 4	The values of Stock A and Stock B on a particular day are Rs. 50 and Rs. 80, respectively. An investor invests Rs. 100 in Stock A and Rs. 80 in Stock B. He sells all the stocks the next day when the value of Stock A is Rs. 55 and Stock B is Rs. 70. The profit made by the investor is Rs. _____
(A)	0
(B)	5
(C)	10
(D)	20
Q.5	‘When it is raining, peacocks dance.’ Based only on this sentence, which one of the following options is necessarily true?
(A)	Peacocks dance only when it is raining.
(B)	When peacocks dance, it is raining.
(C)	When peacocks are not dancing, it is not raining.
(D)	When it is not raining, peacocks do not dance.

Q.6 – Q.10 Carry TWO marks Each

Q.6	Water : P :: Food : Q Choose the P and Q combination from the options below to form a meaningful analogy.
(A)	P = Thirst; Q = Hunger
(B)	P = Drink; Q = Hunger
(C)	P = Thirst; Q = Satiated
(D)	P = Wet; Q = Critic

Q.7	Two tiles are missing in Panel I. Which one of the options in Panel II is the appropriate choice for the missing tiles? 
(A)	(i)
(B)	(ii)
(C)	(iii)
(D)	(iv)

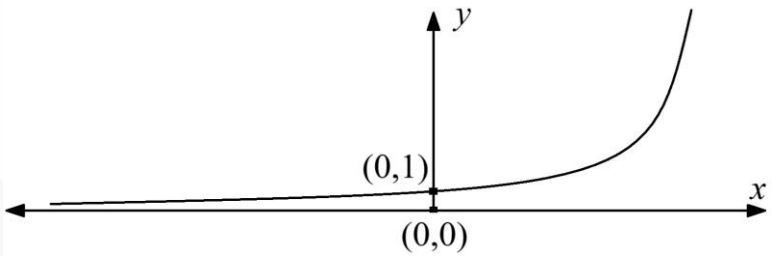
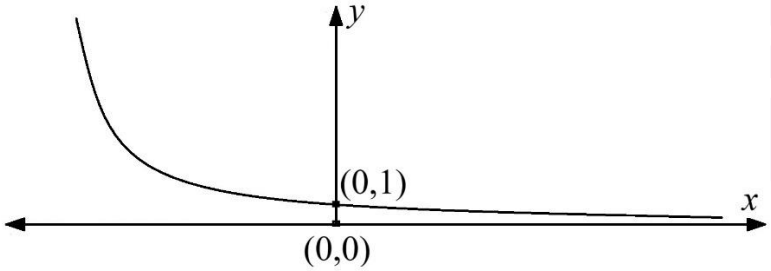
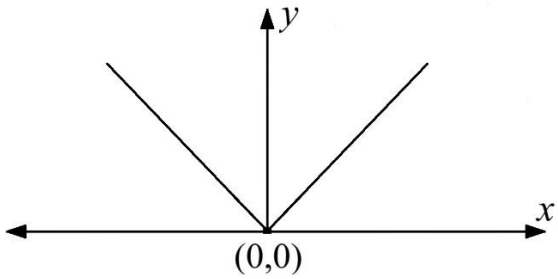
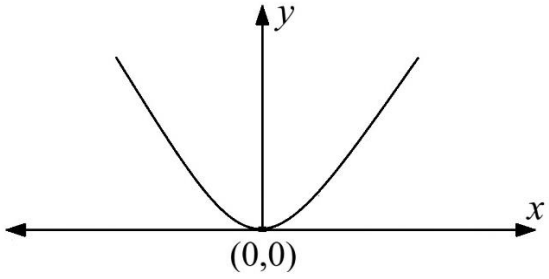
Q.8	Figures (i) and (ii) represent intercity highway systems. The black dots represent cities and the line segments between them represent intercity highways. A salesperson needs to make a trip. She needs to start from a city, visit each of the remaining cities exactly once, and finally return to the same city from which she started. Which one of the following options is then true? (i)  (ii) 
(A)	Such a trip is possible for (i), but not for (ii).
(B)	Such a trip is possible for (ii), but not for (i).
(C)	Such a trip is possible for both (i) and (ii).
(D)	Such a trip is possible neither for (i) nor for (ii).

Q. 9	The figure in Panel I below is a grid of cells with four rows and four columns. The numbers on the top and on the left represent the number of cells that are to be shaded in that column and row, respectively. Which one of the options shown in Panel II below represents the grid shaded correctly? 
(A)	(i)
(B)	(ii)
(C)	(iii)
(D)	(iv)

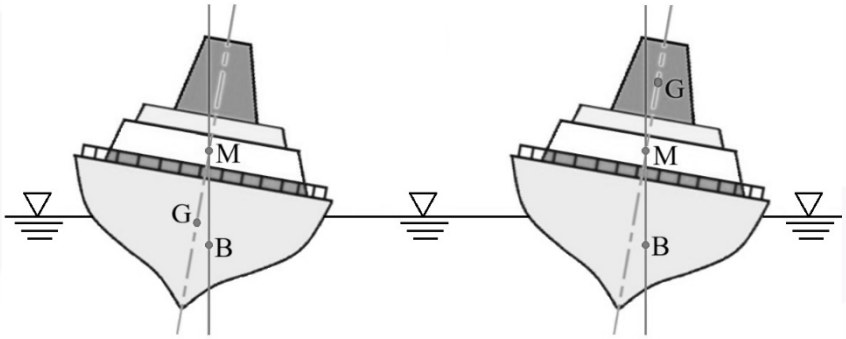
Q.10	An unbiased six-faced dice whose faces are marked with numbers 1, 2, 3, 4, 5, and 6 is rolled twice in succession and the number on the top face is recorded each time. The probability that the sum of the two recorded numbers is a prime number is _____
(A)	$\frac{3}{36}$
(B)	$\frac{13}{36}$
(C)	$\frac{15}{36}$
(D)	$\frac{19}{36}$

Q.11 – Q.35 Carry ONE mark Each

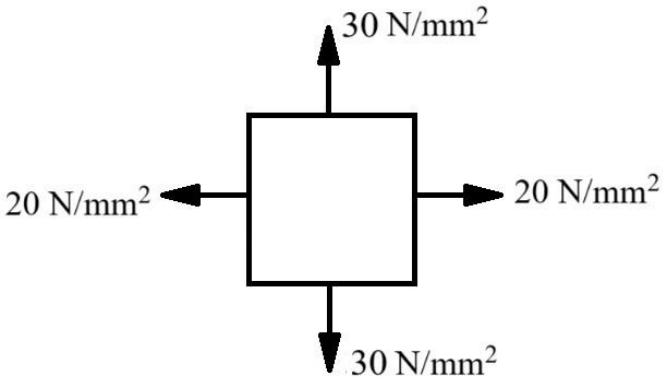
Q.11	The determinant of the matrix $\begin{pmatrix} 1 & p & q+r \\ 1 & q & r+p \\ 1 & r & p+q \end{pmatrix}$ is _____.
(A)	pqr
(B)	$p+q+r$
(C)	$pq+qr+rp$
(D)	0
Q.12	The gradient of a scalar field is _____.
(A)	a vector
(B)	a scalar
(C)	a second order tensor
(D)	always zero

Q.13	Which ONE of the following curves represents the equation $y = e^{-x}$? *Figures not to scale*
(A)	
(B)	
(C)	
(D)	

Q.14	The Fourier series expansion of the function $f(x) = \lvert\cos(x)\rvert$ in the interval $(-\pi, \pi)$ is $\alpha + \beta\left[\frac{1}{3}\cos(2x) - \frac{1}{15}\cos(4x) + \cdots\right]$. The values of α and β respectively are _____.
(A)	$2/\pi$ and $4/\pi$
(B)	$4/\pi$ and $2/\pi$
(C)	$\pi/2$ and $\pi/4$
(D)	$\pi/4$ and $\pi/2$

Q.15	Consider two configurations P and Q of a stationary ship floating in calm water with transverse sections as shown in the figure, where M is the metacentre, G is the centre of gravity, and B is the centre of buoyancy. Which ONE of the following statements is TRUE regarding the static stability of the ship?  Configuration P Configuration Q
(A)	Configuration P is stable and configuration Q is unstable.
(B)	Both configurations are stable.
(C)	Configuration P is unstable and configuration Q is stable.
(D)	Both configurations are unstable.

Q.16	If the indicated power of an IC engine at NO-LOAD condition is 0.5 kW, then the friction power is _____ kW.
(A)	1
(B)	2
(C)	0.5
(D)	0
Q.17	A ship floating in seawater has a TPC (Tonne Per Centimeter immersion) of 20. If bilge keel of total mass 65.1 tonne and volume 44 m^3 is added to the ship, then the change in the mean draft is _____ cm. Assume that after bilge keel fitment, the TPC remains constant, and the ship undergoes parallel sinkage. Density of seawater is 1025 kg/m^3.
(A)	0.5
(B)	1
(C)	0.55
(D)	1.1

Q.18	The state of plane stress in an element is shown in the figure. The maximum shear stress in the element is _____ N/mm^2. 
(A)	0
(B)	5
(C)	10
(D)	25

Q.19	The virtual work principle states that _____.
(A)	external virtual work is equal to internal virtual work
(B)	there is equilibrium of external and internal forces
(C)	virtual work is inversely proportional to virtual displacement
(D)	the potential energy of the system is equal to its kinetic energy
Q.20	The potential flow theory assumes that the flow is _____.
(A)	irrotational, inviscid and incompressible
(B)	rotational, viscous and incompressible
(C)	rotational, viscous and compressible
(D)	irrotational, inviscid and compressible

Q.21	The RAO (Response Amplitude Operator) of a floating body with no forward speed is denoted by $H(\omega)$. If it encounters a wave spectrum $S(\omega)$, then its response spectrum is _____.
(A)	$H(\omega)S(\omega)$
(B)	$\lvert H(\omega)\rvert^2 S(\omega)$
(C)	$\lvert H(\omega)\rvert^3 S(\omega)$
(D)	$\lvert H(\omega)\rvert S(\omega)$
Q.22	The sway-yaw coupled maneuvering equation of motion for a ship is $$\begin{bmatrix} M - Y_{\dot{v}} & -Y_{\dot{r}} \\ -N_{\dot{v}} & I_z - N_{\dot{r}} \end{bmatrix} \begin{bmatrix} \dot{v} \\ \dot{r} \end{bmatrix} = \begin{bmatrix} Y_v & Y_r \\ N_v & N_r \end{bmatrix} \begin{bmatrix} v \\ r \end{bmatrix} + \begin{bmatrix} Y_\delta \\ N_\delta \end{bmatrix} \delta_R$$ For a control-fixed straight-line stability, the eigenvalues of the function should be _____.
(A)	real and negative
(B)	real and positive
(C)	complex numbers with positive real part and negative imaginary part
(D)	zero

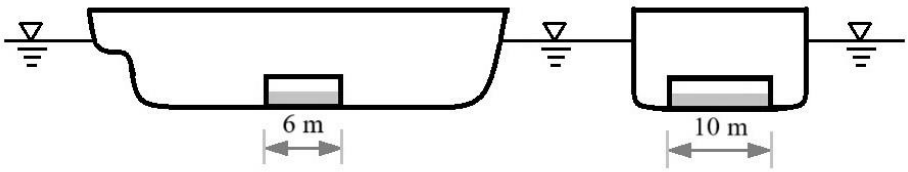
Q.23	Which of the following ordinary differential equations is/are linear?
(A)	$(x+1)\frac{dy}{dx} - y = e^x(x+1)^2$
(B)	$\frac{dy}{dx} - \frac{dx}{dy} = \frac{y}{x} - \frac{x}{y}$
(C)	$\frac{d^2y}{dx^2} + n^2x = 0$, where n is a constant
(D)	$xy\frac{dy}{dx} = 1 + x + y + xy$
Q.24	Which of the following structures is/are mainly used for harbor berthing?
(A)	Dolphins
(B)	Jetty
(C)	Quay
(D)	Jacket

Q.25	Which ONE or MORE of the following welds can be performed through resistance welding method?
(A)	Seam
(B)	Spot
(C)	Fillet
(D)	Groove
Q.26	Which of the following factors affect(s) knocking in a Diesel engine?
(A)	Injection timing
(B)	Cetane number of the fuel
(C)	Spark timing
(D)	Compression ratio

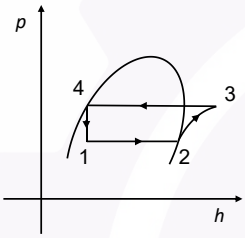
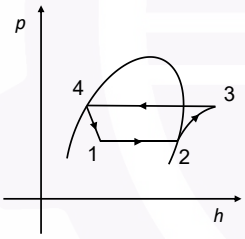
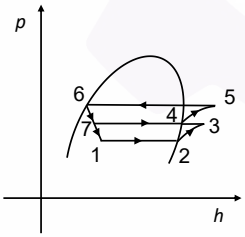
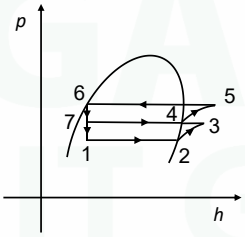
Q.27	During a captive maneuvering model test of a ship with a rudder, which ONE or MORE of the following coefficients can be calculated using an oblique towing test (straight line test with a drift angle)?
(A)	Y_v and Y_{vvv}
(B)	N_v and N_{vvv}
(C)	$Y_{v\delta\delta}$ and $N_{v\delta\delta}$
(D)	$N_{r\delta\delta}$ and $N_{vr\delta}$
Q.28	The weight of a ship is uniformly distributed along its length. Under which ONE or MORE of the following conditions will the ship be subjected to hogging moment? *Note: The weight is equal to buoyancy in all of the following conditions.*
(A)	When buoyancy per unit length is greater than weight per unit length amidships
(B)	When weight per unit length is greater than buoyancy per unit length in the bow and stern region
(C)	When the ship is on a single wave with its crest at midship and troughs at the bow and stern
(D)	When the ship is on a single wave with its crests at the bow, stern and the trough at midship

Q.29	Which of the following processes is/are used for heat addition in an air-standard dual cycle?
(A)	Isochoric
(B)	Isobaric
(C)	Isentropic
(D)	Isothermal
Q.30	Which ONE or MORE of the following methods of shifting weights can be used to improve the transverse stability of a rectangular pontoon? *Note:* CG *denotes the vertical centre of gravity of the pontoon.*
(A)	From below the CG to above the CG
(B)	From above the CG to below the CG
(C)	From port to starboard at the same height from the keel
(D)	From forward to aft at the same height from the keel

Q.31	Which ONE or MORE of the following can be caused by scavenging in a two-stroke Diesel engine?
(A)	Dilution of incoming fuel-air mixture
(B)	Loss of incoming air
(C)	Pushing out exhaust gases by incoming air
(D)	Autoignition

Q.32	A vessel of 5000 m^3 displacement floating in seawater has a rectangular tank of length 6 m and width 10 m. The tank is half-filled with seawater as shown in the figure. The virtual reduction in metacentric height due to free surface effect is _____ m (*answer in one decimal place*).  *Figure not to scale*
Q.33	A solid beam with a rectangular cross-section of breadth 0.5 m and depth 0.12 m, experiences a vertical shear force of 50 kN at a section. The maximum shear stress in that section is _____ MPa (*answer in two decimal places*).
Q.34	Consider two insulated tubes with air flowing steadily through them. The flow rate and temperature of the air are 0.1 kg/s, 20 °C in *tube 1* and 0.2 kg/s, 25 °C in *tube 2*. If the two streams are allowed to mix adiabatically, the steady-state temperature of the mixed stream is _____ °C (*rounded off to one decimal place*). Assume a constant C_p for air.
Q.35	Consider a reversible heat engine with a thermal efficiency of 55%. The engine is reversed and operated as a heat pump between the same temperature reservoirs. If the heat supplied from the low temperature reservoir is 45 kJ/cycle, then the absolute value of heat rejected is _____ kJ/cycle (*answer in integer*).

Q.36 – Q.65 Carry TWO marks Each

Q.36	Identify the *p*-*h* diagram that denotes a vapor compression refrigeration cycle with flash intercooling from the following. The pressure and specific enthalpy of the working fluid are represented by *p* and *h* respectively.
(A)	
(B)	
(C)	
(D)	

Q.37 Which ONE of the following options CORRECTLY matches the efficiencies in **Column 1** with the corresponding definitions in **Column 2**?

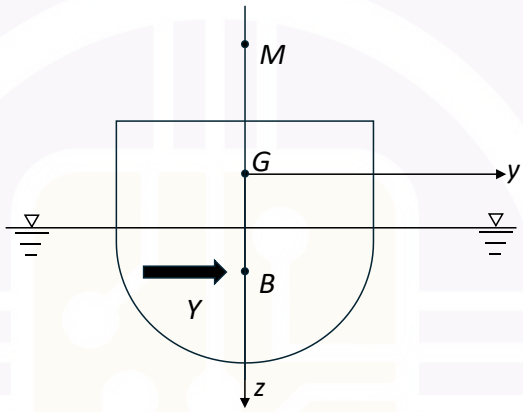
Column 1		**Column 2**	
I	Gear efficiency	P	Ratio of delivered power to shaft power
II	Shaft efficiency	Q	Ratio of shaft power to brake power
III	Hull efficiency	R	Ratio of thrust power to delivered power
IV	Propeller (behind-hull) efficiency	S	Ratio of effective power to thrust power

(A) I-Q; II-P; III-S; IV-R

(B) I-P; II-S; III-R; IV-Q

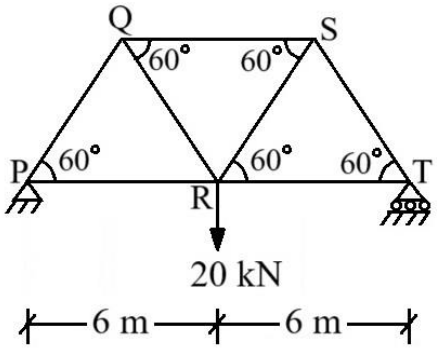
(C) I-P; II-R; III-Q; IV-S

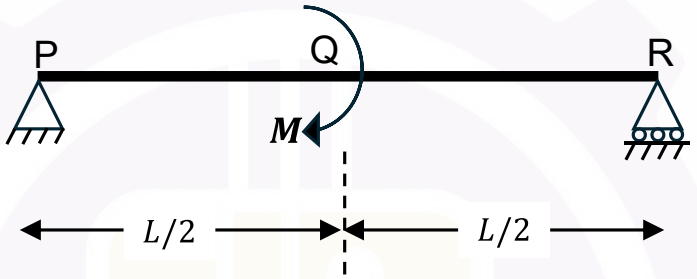
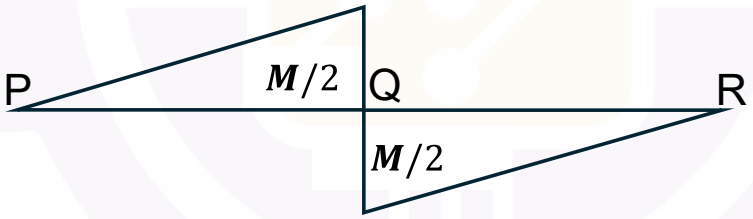
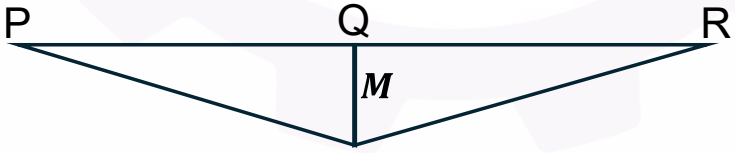
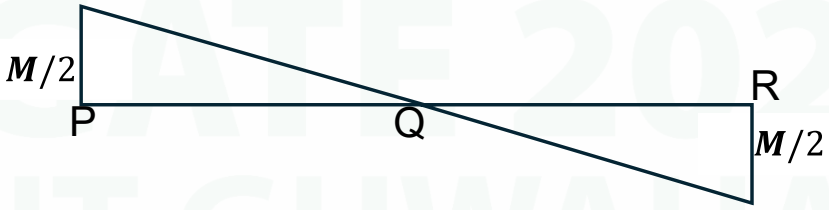
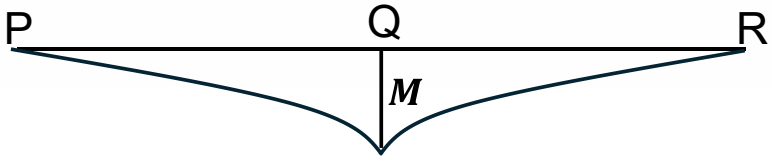
(D) I-S; II-R; III-Q; IV-P

Q.38	A ship is undergoing a steady starboard turn. Assume that the total hydrodynamic forces (Y) including the rudder forces act at the centre of buoyancy (B). If W is the weight of the ship, G is the centre of gravity and M is the transverse metacentre, then the magnitude of the heel angle (ϕ) is given by _____. Assume that ϕ is small. 
(A)	$\left\lvert\frac{Y \times BG}{W \times GM}\right\rvert$
(B)	$\left\lvert\frac{W \times BG}{Y \times GM}\right\rvert$
(C)	$\left\lvert\frac{W \times GM}{Y \times BG}\right\rvert$
(D)	$\left\lvert\frac{Y \times GM}{W \times BG}\right\rvert$

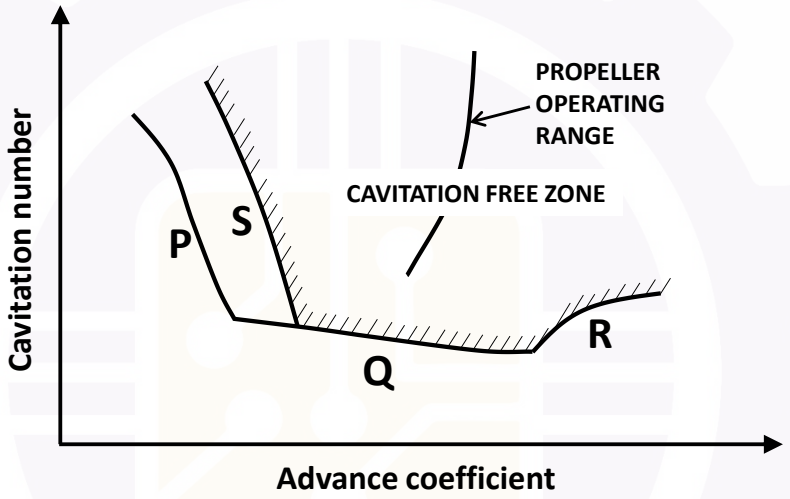
Q.39	A ship undergoing harmonic oscillation has an uncoupled heave motion, $\eta_3(t)$, governed by the following equation $$(M + A_{33})\,\ddot{\eta}_3(t) + B_{33}\,\dot{\eta}_3(t) + K_{33}\eta_3(t) = f_3(t)$$ If $F_3(\omega)$ is the Fourier transform of $f_3(t)$, then the response in the frequency domain can be written as _____.
(A)	$\dfrac{F_3(\omega)}{-\omega^2(M + A_{33}) + i\omega B_{33} + K_{33}}$
(B)	$\dfrac{iF_3(\omega)}{-\omega^2(M + A_{33}) + i\omega B_{33} + K_{33}}$
(C)	$\dfrac{F_3(\omega)}{\omega^2(M + A_{33}) - i\omega B_{33} + K_{33}}$
(D)	$\dfrac{F_3(\omega)}{\omega^2(M + A_{33}) + \omega B_{33} + K_{33}}$

Q.40	Adverse pressure gradient implies that _____.
(A)	pressure decreases in the direction of flow
(B)	pressure increases in the direction of flow
(C)	pressure is zero everywhere within the flow field
(D)	pressure is uniform (non-zero) everywhere within the flow field
Q.41	The drag force on a non-lifting smooth body immersed in an incompressible, irrotational, uniform flow is _____.
(A)	zero
(B)	finite and greater than zero
(C)	infinite
(D)	finite and less than zero

Q.42	For the truss shown in the figure, the magnitude of force in the member PR is _____ kN. 
(A)	10
(B)	0
(C)	$\frac{10}{\sqrt{3}}$
(D)	$\frac{20}{\sqrt{3}}$

Q.43	Choose the CORRECT bending moment diagram for the simply supported beam shown in the figure with a concentric moment **M** at mid span. Consider hogging as positive and sagging as negative. *Figures not to scale* 
(A)	
(B)	
(C)	
(D)	

Q.44	The stresses in a shaft are: i. Shear stress due to torsion ii. Normal stress due to bending moments iii. Axial stress Which ONE of the following options lists the stresses that are considered while designing a circular propeller shaft?
(A)	(i) and (ii) only
(B)	(ii) and (iii) only
(C)	(i) and (iii) only
(D)	(i), (ii) and (iii)

Q.45	The figure depicts the cavitation pattern of a propeller. Which ONE of the following options CORRECTLY gives the description for the labels P, Q, R, S, respectively in the figure? 
(A)	Face cavitation, Bubble cavitation, Back cavitation, Tip cavitation
(B)	Back cavitation, Bubble cavitation, Face cavitation, Tip cavitation
(C)	Bubble cavitation, Face cavitation, Tip cavitation, Back cavitation
(D)	Tip cavitation, Face cavitation, Bubble cavitation, Back cavitation

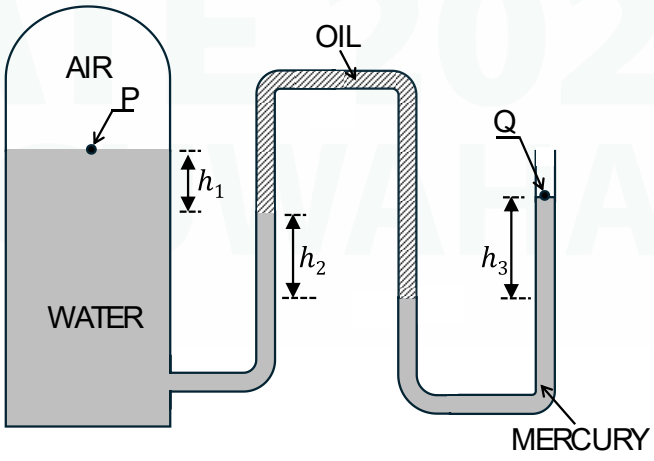
Q.46	The dry bulb temperature (DBT) of atmospheric humid air is 30 °C. The dew point temperature (DPT) is also 30 °C and the humidity ratio is 0.025 $\frac{\text{kg of water vapor}}{\text{kg of dry air}}$. The relative humidity (RH) of the air is _____ %.
(A)	100
(B)	25
(C)	50
(D)	0
Q.47	Which of the following statements is/are TRUE regarding matrices?
(A)	Every square matrix can be expressed as the sum of a symmetric and a skew-symmetric matrix.
(B)	The determinant of a square matrix is same as that of its transpose.
(C)	The product of a square matrix and its inverse results in the identity matrix.
(D)	Eigenvalues of a square matrix are always real and positive.

Q.48	Consider a steady, two-dimensional, laminar, incompressible flow of water over a horizontal flat plate of length L with Reynolds number, $Re_L = 10^4$. The flat plate is aligned with the incoming free-stream flow. The x-axis is along the length of the plate while the y-axis is normal to the plate. The respective velocity components are u and v. Which of the following statements is/are TRUE?
(A)	For the flow within the boundary layer, $u \gg v$.
(B)	For the flow within the boundary layer, $\frac{\partial u}{\partial y} \gg \frac{\partial u}{\partial x}$.
(C)	The flow within the boundary layer is irrotational and inviscid.
(D)	The thickness of the boundary layer is much less than the length of the flat plate.

Q.49	Pick the CORRECT statement(s) corresponding to the following equation $$\frac{\partial \mathbf{u}}{\partial t} + \mathbf{u} \,.\nabla \mathbf{u} = -\frac{1}{\rho}\nabla p + \mathbf{g} + \vartheta \nabla^2 \mathbf{u}$$ where $\mathbf{u}$ is the velocity vector, p is the pressure, ρ is the density, $\mathbf{g}$ is the gravitational acceleration vector, t is time, and ϑ is the kinematic viscosity.
(A)	It represents the conservation of linear momentum.
(B)	It is a nonlinear partial differential equation.
(C)	It is valid for both Newtonian and non-Newtonian fluids.
(D)	It is valid for incompressible flow.

Q.50	Consider the flow of water over a smooth curved wall surface. It is given that the flow separates at some location R on the surface known as the separation point. Pick the CORRECT option(s).
(A)	At R, the wall shear stress is zero.
(B)	At R, $\frac{\partial u}{\partial y} = 0$, where y is normal to the surface and u is the velocity of the flow tangential to the surface.
(C)	At R, viscosity of the fluid becomes zero.
(D)	Immediately downstream of R, the direction of flow is reversed locally.
Q.51	Which of the following Reynolds numbers do(es) NOT represent creeping flow?
(A)	0.01
(B)	0.001
(C)	5×10^5
(D)	2300

Q.52	Consider two engines operating on Otto and Diesel air-standard cycles with the same compression ratio. Which of the following is/are TRUE about the thermal efficiency (η) and the peak pressure (p_{peak})?
(A)	$\eta_{Otto} < \eta_{Diesel}$
(B)	$\eta_{Otto} > \eta_{Diesel}$
(C)	$(p_{peak})_{Otto} > (p_{peak})_{Diesel}$
(D)	$(p_{peak})_{Otto} = (p_{peak})_{Diesel}$
Q.53	For a dynamic system with single degree of freedom, choose the CORRECT statement(s).
(A)	Damped natural frequency is greater than the undamped natural frequency.
(B)	Dynamic response is always greater than static response at all excitation frequencies.
(C)	Damping ratio can be estimated using logarithmic decrement method.
(D)	A non-zero phase lag is always observed between the excitation and response for a damped system.

Q.54	A differentiable function $f(x)$ is such that $f(-0.1) = 2$, $f(0) = 1$, and $f(0.1) = 2$. Then, $\frac{d^2f}{dx^2}$ at $x = 0$ is _____ (*answer in integer*).
Q.55	Consider the function $f(x, y) = x^3 + y^2$. If $\vec{F} = \nabla f$, then $\int \vec{F}.d\vec{r}$ evaluated from (0, 0) to (1, 2) is _____ (*answer in integer).*
Q.56	Consider a case where two identical six-faced fair dice are rolled simultaneously. The probability of getting even numbers in both AND a sum equal to 5 and above is _____ (*rounded off to two decimal places*).
Q.57	Water of density 1000 kg/m^3 flows at a steady rate in a converging duct of circular cross-section. Let the areas of sections 1 and 2 be 100 cm^2 and 50 cm^2 respectively. The pressure and average velocity at section 1 are 110 kPa and 1 m/s. If the centres of the two sections are at the same elevation, then the pressure at section 2 is _____ kPa (*answer in one decimal place).*
Q.58	A static system consisting of air, water, oil and mercury is shown in the figure. If Q is open to the atmosphere, the gauge pressure at P is _____kPa (*rounded off to one decimal place*). Consider g = 10 m/s^2, h_1 = 0.5 m, h_2 = 0.7 m, h_3 = 0.8 m, density of water = 1000 kg/m^3, $SG_{oil} = 0.9$ and $SG_{mercury} = 13.6$ (where SG is specific gravity). 

Q.59	A ship of 4000 m^3 displacement has a block coefficient of 0.8. If the beam is 0.1 times the length and twice the draught, then the length of the ship is _____ m (*answer in integer*).
Q.60	A ship consumes 250 tonne of fuel when moving from sea to a river. On arrival, draught and trim (measured at rest) are the same as the corresponding values at sea. The displacement of the ship in seawater is _____ tonne (*answer in integer*). The density of seawater and river water are 1025 kg/m^3 and 1000 kg/m^3 respectively.
Q.61	The critical buckling load of a 6 m long, 10 cm diameter axially loaded solid steel column with hinged support at both ends is _____ kN (*rounded off to nearest integer*) Assume Young's modulus of steel as 2×10^5 N/mm^2.
Q.62	A box shaped pontoon of length 100 m, breadth 12 m and draft 10 m is floating in water of density 1 $tonne/m^3$. The roll radius of gyration is 1% of the ship's length and the roll added mass moment of inertia is 20% of the roll mass moment of inertia. The vertical centre of buoyancy is located at half of the draft, and the vertical centre of gravity is at 6 m from the keel. The roll natural frequency of the pontoon is _____ rad/s (*rounded off to two decimal places*). Assume g = 10 m/s^2.
Q.63	A ship is moving at 10 m/s in head sea condition. A person on board counts the time period between two successive wave crests as π seconds. The frequency of the incoming wave is _____ rad/s (*answer in integer*). Assume g = 10 m/s^2.
Q.64	A steel girder of length 10 m has one end rigidly attached to a ship's bulkhead and the other end free. It is subjected to a torsional moment of 30 kNm about its longitudinal axis at the free end. The shear modulus of steel is 80 GPa and the polar moment of inertia of the section is 6×10^{-4} m^4. The total twist at the free end is _____ $\times 10^{-4}$ rad (*rounded off to one decimal place*).

Q.65	A propeller of 4 m pitch is rotating at 120 rpm. It has a behind-hull propeller efficiency of 60% and a real slip of 25%. If the power delivered to the propeller is 2800 kW, then the thrust produced by it is _____ kN (*answer in integer*).