Q.1 – Q.25 Carry ONE mark each.	
Q.1	There are two bags; bag1 contains 3 red, 4 black balls and bag2 contains 4 red and 3 black balls. When a fair die is rolled, if it shows a number on the die as 1 or 3 then a ball is chosen from bag1; otherwise, a ball is chosen from bag2. What is the probability of choosing a red ball if the die is rolled once?
(A)	13/21
(B)	8/21
(C)	11/21
(D)	10/21
Q.2	The order and degree of the differential equation $\frac{d^3y}{dx^3} + 4\sqrt{y^2 + \left(\frac{dy}{dx}\right)^3} = 0$ are, respectively,
(A)	3 and 2
(B)	2 and 3
(C)	3 and 3

(D)	3 and 1

Q.3	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)	$(1-x)e^{x^2}$
Q.4	Evaluate $\int_0^3 e^x dx$ (by Simpson's 3/8th rule if h=1)
(A)	20.28
(B)	21.05
(C)	19.28
(D)	19.72

Q.5	Which of the following pairs are correctly matched? a) Resilience – Resistance to deformation b) Malleability – Shape change c) Creep – Progressive deformation d) Plasticity – Permanent deformation Select the correct answer using the codes given below
(A)	b, c and d
(B)	a, b and c
(C)	a, b and d
(D)	a, c and d
Q.6	A solid uniform metal bar of diameter D and length L is hanging vertically from its upper end. The elongation of the bar due to self weight is:
(A)	Proportional to L and inversely proportional to D^2
(B)	Proportional to L^2 and inversely proportional to D^2

(C)	Proportional to L but inversely proportional to D
(D)	Proportional to U but independent D
Q.7	Which one of the following is correct? When a nut is tightened by placing a washer below it, the bolt will be subjected to
(A)	Compression only
(B)	Tension
(C)	Shear only
(D)	Compression and shear
Q.8	Bernoulli's equation represents
(A)	Momentum balance
(B)	Mechanical energy balance

(C)	Mass balance
(D)	Total energy balance
Q.9	Resultant pressure of the liquid in case of an immersed body acts through which one of the following?
(A)	Centre of gravity
(B)	Centre of pressure
(C)	Metacentre
(D)	Centre of buoyancy
Q.10	The differential form of the mass balance equation, gradient of V = 0 is valid for
(A)	Any flow
(B)	Steady flows only
(C)	Any incompressible flow

(D)	Only incompressible flows that are steady
Q.11	The thickness of laminar boundary layer at a distance ‘x’ from the leading edge over a flat plate varies as
(A)	X
(B)	$X^{1/2}$
(C)	$X^{1/5}$
(D)	$X^{4/5}$
Q.12	When a ship moving on seawater enters a river, it is expected to
(A)	Rise a little
(B)	Sink a little
(C)	Maintain the same level of draft

(D)	Rise or fall depending on whether it is made of wood or steel
Q.13	A large metacentric height in a vessel
(A)	Improves stability and makes periodic time to oscillation longer
(B)	Impairs stability and makes periodic time of oscillation shorter
(C)	Has no effect on stability or the periodic time of oscillation
(D)	Improves stability and makes periodic time to oscillation shorter
Q.14	A 1.0 m long model of a ship is towed at a speed of 81 cm/s in a towing tank. To what speed of the ship, 64 m long, does this correspond to_____ m/s?
(A)	7.20
(B)	6.48
(C)	5.76
(D)	3.60

Q.15	At high frequency, the ship motion is dominated by _____ forces.
(A)	Froude-Krylov
(B)	Restoring
(C)	Diffraction
(D)	Inertia
Q.16	Super long stroke marine diesel engines are working on_____.
(A)	Two stroke diesel cycle
(B)	Four stroke diesel cycle
(C)	Dual cycle
(D)	Combined cycle
Q.17	In an Impulse steam turbine, the relative fluid velocity_____ across the blades.
(A)	remains constant

(B)	is zero
(C)	increases
(D)	decreases
Q.18	In reaction, steam turbine fluid flow is _____ to the turbine wheel.
(A)	radial or axial
(B)	radial
(C)	axial
(D)	tangential
Q.19	Engine room emergency bilge suction is connected to _____ pump.
(A)	main sea water pump
(B)	fire pump
(C)	ballast pump

(D)	bilge pump
Q.20	The values of a, b so that rank of the matrix $\begin{pmatrix} 1 & -2 & 3 & 1 \\ 2 & 1 & -1 & 2 \\ 6 & -2 & a & b \end{pmatrix}$ is 2 _____ and _____
Q.21	A steel bar of 40 mm x 40 mm square cross-section is subjected to an axial compressive load of 200 kN. If the length of bar is 2 m and E = 200 GPa, the elongation of the bar will be _____ mm.
Q.22	Find constants a, b, c so that is irrotational, V = (x+2y+az)i + (bx-3y-z)j + (4x+cy+2z)k,

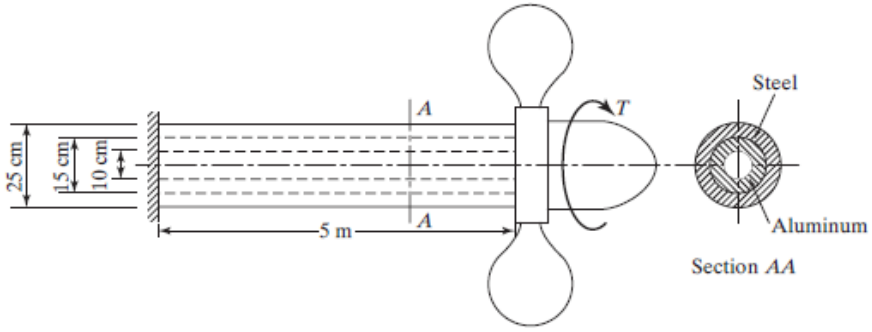
Q.23	The metacentric height for a floating spherical ball of radius R and depth of immersion also equal to R is?
Q.24	A Ship has the following Characteristics: Length= 20 m ; Breadth= 5 m ; Average draught= 2 m ; Block Coefficient= 0.4 ; Transverse Metacentric Height = 0.5m ; Structural radius of Gyration in roll= 2 m. In roll, the damping is 8% of the critical damping. In roll, the added inertia is 20% of the inertia if the ship were in the air. Calculate the roll natural period of the ship in seconds?
Q.25	A frictionless piston cylinder device contains a gas initially at 0.8 MPa and 0.015 m^3. It expands quasi- statically at a constant temperature to a final volume of 0.030 m^3. The work output during this process will be_____ kJ/kg.

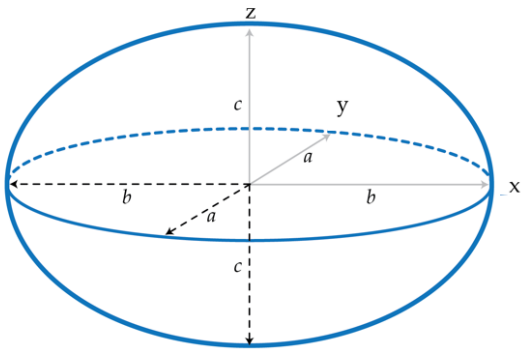
Q.26 – Q.55 Carry TWO marks each.

Q.26	The solution of the differential equation $\frac{dy}{dx} + 2y = 0$, for the boundary condition y = 5 and x =1
(A)	y = e^{-2x}
(B)	y =2 e^{-2x}
(C)	y = $10.95e^{-2x}$
(D)	y = $36.95e^{-2x}$
Q.27	The Extremum (minimum or maximum) point of a function f(x) = x^3-6x is to be determined by using the Newton – Raphson method with an initial guess of x_0 = 1, the value of x after two iterations (x_2) is
(A)	0.0141
(B)	1.4142
(C)	1.4167

(D)	1.5000
Q.28	A concentrated load of P acts on a simply supported beam of span L at a distance L/3 from the left support. The bending moment at the point of application of the load is given by _____.
(A)	PL/3
(B)	2PL/3
(C)	PL/9
(D)	2PL/9
Q.29	The diameter of shaft A is twice the diameter of shaft B, and both are made of the same material. Assuming both the shafts rotate at the same speed, the maximum power transmitted by B is:
(A)	The same as that of A
(B)	Half of A

(C)	$1/8^{th}$ of A
(D)	$1/4^{th}$ of A
Q.30	The realisation of velocity potential in fluid flow indicates that the
(A)	Flow must be irrotational
(B)	Circulation around any closed curve must have a finite value
(C)	Flow is rotational and satisfies the continuity equation
(D)	Vorticity must be non - zero
Q.31	The velocity components for a two-dimensional incompressible flow of a fluid are $u = x - 4y$ and $v = -y - 4x$. it can be concluded that
(A)	The flow does not satisfy the continuity equation
(B)	The flow is rotational

(C)	The flow is irrotational
(D)	None of the given answers
Q.32	A propeller shaft made of composite material, steel, and aluminum, is shown in the figure below. Determine the torsional spring constant of the shaft in Nm.rad. ($G_{Steel} = 80\times10^9$ N/m^2, $G_{Aluminum} = 26\times10^9$ N/m^2) 
(A)	$5.5\text{x}10^8$
(B)	$4.5\text{x}10^7$
(C)	$5.5\text{x}10^6$
(D)	$6.5\text{x}10^4$

Q.33	An ellipsoid accelerating underwater (completely submerged) will not have which one of the following coupled added mass (A_{ij}). A_{ij} shows the added mass in i^{th} direction due to motion in j^{th} direction. 1-2-3 corresponds to x-y-z axis, and 4-5-6 corresponds to rotation about x-y and z-axis, respectively. 
(A)	A33; A55
(B)	A26; A66
(C)	A55; A66
(D)	A35; A26

Q.34	A man on board of a ship observes that the waves are coming from stern of the ship with zero heading angle. The ship is moving with a velocity of 9.81 m/s. He counts the wave crest for every 31.42 sec. What are the possible wave frequency?
(A)	0.2, 0.6 and 1.2
(B)	0.3, 0.9 and 1.6
(C)	0.3, 0.7 and 1.2
(D)	0.5, 0.9 and 1.6
Q.35	A closed system undergoes a process 1-2 for which the values of Q1-2 and W1-2 are +20 kJ and +50 kJ, respectively. If the system is returned to state, 1, and Q2-1 is -10 kJ, what is the value of the work W2-1 in _____kJ?
(A)	+20
(B)	-40
(C)	-80
(D)	+40

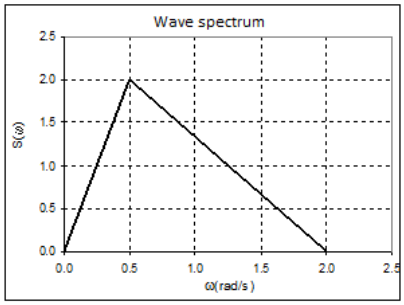
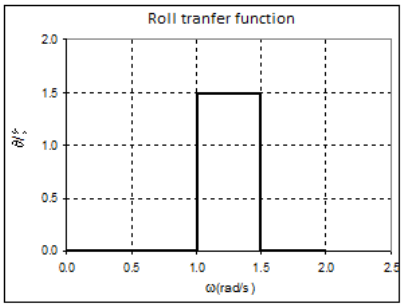
Q.36	At the inlet of the adiabatic steam turbine, h1, 3200 kJ/kg, V1, 160 m/s, Z1, 10 m, P1, 3 MPa and at the outlet h2 = 2600 kJ/kg, V2 = 100 m/s, Z2 = 6 m, P2 = 70 kPa If mass flow rate of steam through the turbine is 20 kg/s the power output of the turbine (in MW) is:
(A)	12.157
(B)	12.941
(C)	168.001
(D)	168.785
Q.37	Efficiency of a Carnot engine can be increased by_____.
(A)	Increasing the sink temperature while keeping the source temperature constant
(B)	Decreasing the sink temperature while keeping the source temperature constant
(C)	Decreasing the source temperature while keeping the sink temperature constant
(D)	Does not depend on source and sink temperatures

Q.38	If the air is maintained at 30^0C and the temperature of a body cools from 80^0C to 60^0C in 12 minutes, what is the temperature of the body after 24 minutes?
Q.39	The Laplace transform of the function $f(t) = \cos^2 2t$ is?
Q.40	One-half length of 50 mm diameter steel rod is solid while the remaining half is hallow having a bore of 25 mm. The rod is subjected to equal and opposite torque at its ends. If the maximum shear stress in the solid portion is τ or, the maximum shear stress in the hollow portion is _____ τ.
Q.41	A Cantilever beam carries a load W uniformly distributed over its entire length. If the same load is placed at the free end of the same Cantilever, then the ratio of maximum deflection in the first case to that in the second case will be_____.

Q.42	A simply supported beam of span length 6 m and 75 mm diameter carries a uniformly distributed load of 1.5 kN/m. The maximum value of bending moment will be _____ kNm?

Q.43	A horizontal beam under bending has maximum bending stress of 100 MPa and maximum shear stress of 20 MPa. What is the maximum principal stress in the beam?
Q.44	A stream function is given by $\Psi = 2x^2y + (x+1)y^2$. The flow rate across a line joining points A (3,0) and B(0,2) is _____ Units.
Q.45	An open tank contains water to a depth of 2 m and oil over it to a depth of 1 m. if the specific gravity of oil is 0.8, then the pressure intensity at the interface of the two fluid layers will be _____ N/m^2.
Q.46	Pressures have been observed at four different points in different units of measurement as follows a) 150 KPa

	b) 1800 millibar c) 20 m of water d) 1240 mm of mercury Then the points arranged in descending order of pressure are?
Q.47	Air (kinematic viscosity = 15 x 10^{-6} m^2/s) with a free stream velocity of 10 m/s flows over a smooth two–dimensional flat plate. If the critical Reynolds number is 5 x 10^5, what is the maximum distance (in cm) from the leading edge up to which laminar boundary layer exists?
Q.48	Ship response is denoted by the equation $\eta(t) = \eta^A \cos(\omega t - \phi)$. Where η^A is the magnitude of response amplitude, and ϕ is the phase angle relative to the excitation force. A model sails in regular waves with a heave motion of 0.2 m amplitude and 45 deg delay relative to the excitation force. The pitch motion has a 6 deg amplitude and 120 deg delay relative to the excitation moment. The surge motion is 0.2 m amplitude with a 30 deg delay relative to the excitation force. The model is moored in head waves (180 deg heading) of 4 m wavelength. What will be the absolute value of the vertical acceleration in m/s^2 at a point located at 2 m forward of the centre of gravity at time t = 0 sec? (Follow a right handed coordinate system with x-y-z axis pointing toward bow, port, and up and clockwise rotation about these axes are positive).

Q.49	The following figures show the irregular wave spectrum and the RAO of roll motion. Calculate the significant amplitude of the roll motion.  
Q.50	A ship of 5000 tonne displacement has a rectangular tank 6 m long and 10 m wide. Calculate the virtual reduction in metacentric height if this tank is partly full of oil (relative density 0.8).
Q.51	A ship of 7200 tonne displacement has KG 5.20 m, KB 3.17 m and KM 5.35 m. 300 tonne of fuel at Kg 0.6 m are now used. Ignoring free surface effect and

	assuming that KM remains constant, calculate the angle to which the vessel will loll in degrees (round off to the nearest integer).

Q.52	In an experimental set-up, air flows between two stations P and Q, adiabatically. The direction of flow depends on the pressure and temperature conditions maintained at P and Q. The conditions at station P are 150 kPa and 350 K. The temperature at station Q is 300 K. The following are the properties and relations performing to air: Specific heat at constant pressure, c_p = 1.005 kJ/kgK, Specific heat at constant volume, c_v = 0.718 kJ/kgK, Characteristic gas constant, R = 0.287 kJ/kgK, Enthalpy, h = c_p T, Internal Energy, u = c_v T, If the pressure at station Q is 50 kPa, the change in entropy (sQ – sP) is _____ kJ/kg.
Q.53	Two compartments of an insulated vessel, each of 3 m^3, contain air at 0.7 MPa, 95 ^oC and 0.35 MPa, 205 ^oC. If the wall between the two compartments is

	removed and the air is mixed adiabatically, the change in entropy will be ____ J/K.
Q.54	A series combination of two Cornot's engines operates between the temperatures of 180 ^{o}C and 20 ^{o}C. If the engines produce an equal amount of work, then the intermediate temperature is _____ ^{o}C?
Q.55	Assume the above turbine to be a part of the simple Rankine cycle. The density of the water at the inlet to the pump is 1000 kg/m^3. Ignoring the kinetic energy and potential energy effects, the specific work supplied to the pump is_____ kJ/kg.

END OF THE QUESTION PAPER