- **QUESTION BANK**
- **LEVE: EOOW (UK COC)**
- **SUBJECT: SCIENCE A**
- **OCEANLINK MARITIME COLLEGE, INDIA.**

STUDENT NAME: ……

BATCH: ……

Note: The content included in this file is only for reference purpose. It is not a good idea of writing the same answers in the exam. Instead, ensure you understand the concepts and express the answers in your own words. Also, you should upgrade yourself with the modern technologies used onboard.

About Us:

We, the team of Chief Engineers (with U.K. CoC) and Academic Professionals together formed an Institute, "**Oceanlink MariTime College (OMTC), India,"** situated at Bhubaneswar, Odisha, India. We have been coaching Management level (III/2) and E.O.O.W (III/1) courses for U.K. CoC since 2012 in India. At Oceanlink MariTime College, we are dedicated to delivering an excellent education that enables our students to become responsible leaders and enthusiastic sailors.

OMTC is the unique platform providing these programs for UK CoC. We strive for the best results with an easy, cost-effective pricing structure.

Why Choose Us:

- ✓ We are providing 100% results constantly.
- ✓ We cover exam preparatory courses (tuition) for all 5 subjects, including orals, at a very reasonable price.
- ✓ We are the cheapest and best option all over the world for obtaining EOOW UK COC.
- ✓ Accommodation in India is free for preparatory courses.
- ✓ Mock orals and written exams.
- ✓ Class, till you pass policy*.
- ✓ DLP route, saving in fees and other expenses.
- ✓ 1.5 months in India for tuition. [online/offline]
- ✓ 3 months in the UK for workshops and exams, etc.
- ✓ Learn from Experienced Chief engineers and expert academicians.
- ✓ As this experienced seafarer route is available for rating background students, we start from the basics.
- ✓ OMTC offers complete guidance, from applying for the MNTB record book to getting EOOW UK COC.

PREFACE:

Science A is academic subject. We understand that students from the rating background require special care and proper individual attention to study the academic subject.

As the E.O.O.W. level is the foundation of Class 2 level exams, students need to study these topics carefully and properly understand basic subjects.

Science A contains Mechanical Engineering and Naval Architecture. Both the subjects are essential to be Class 4 engineer. As you come across the many mechanical components onboard, you need deeper skill of implementing problem-solving techniques while dealing with machines. Almost everything you utilize onboard in your everyday routine is the result of mechanical engineering.

Effective marine engineering requires fluency in a variety of subject matters, especially in mathematics and physics. We help you to understand the basic concept behind mechanical components. Our faculties will help the students to understand the concept of Mechanical Engineering right from the beginning of the engineering study.

SCIENCE *A* SYLLABUS

TOPIC NO. 1-Q 1- VELOCITY, ACCELERATION, MOMENTUM

A) Linear Motion

1)	A body is uniformly accelerated from 1·25 m/s to 3.6 m/s in 4 seconds. It then travels at this new velocity for 45 seconds and is then smoothly brought to rest at a deceleration of 0.52 m/s^2. Calculate:	
(a)	The acceleration;	(3)
(b)	The time taken during deceleration;	(3)
(c)	The total distance travelled from the start of acceleration.	(4)

2)	A body initially at rest is uniformly accelerated for 55 seconds during which it travels. 1800 m. It is then brought to rest in 20 seconds. Calculate:	
(a)	The maximum velocity attained;	(3)
(b)	The value of the deceleration;	(3)
(c)	The total distance travelled	(4)

B) Vertical Motion

3)	A Body is projected vertically upwards with initial velocity of 36 m/s. Take the gravitational acceleration as 9.81 m/s2. Calculate:	
(a)	The height on its upward journey when its velocity will have reduced to 24 m/s;	(5)
(b)	The time taken to reach this point.	(5)

C) Angular Motion

4)	A pulley is accelerated uniformly from rest, at 8 rad/s^2 for 20 seconds, it then runs at constant speed for 2 minutes before uniformly decelerating to rest in 40 seconds. Calculate:	
(a)	The angular velocity at the end of the acceleration;	(2)
(b)	The deceleration;	(3)
(c)	The number of revolutions turned.	(5)

5)	A flywheel is accelerated uniformly from 575 rev/min to 925 rev/min in 28 Seconds. Calculate:	
(a)	The acceleration in rad/sec^2	(5)
(b)	The number of revs turned during the acceleration,	(5)
6)	A flywheel accelerates at a rate of 1.5 rad/s^2 from an initial speed of 35 r.p.m. for a time of 25 sec. Calculate:	
(a)	The final speed of the flywheel;	(6)
(b)	The number of revs turned through during this period of time.	(4)

D) Combination of Linear & Angular Motion

7)	A 3 m diameter flywheel increases its speed uniformly from 30 to 60 rpm in 10 sec. Calculate:	
(a)	The angular acceleration;	(4)
(b)	the number of revolutions turned through;	(4)
(c)	the linear acceleration of a point on the rim of the flywheel.	(2)

8)	A thin cord is wrapped around a 75 mm diameter shaft with a mass attached to the end of the cord. The mass is released from rest and falls through 2.1 m in 3 seconds. Calculate:	
(a)	The angular velocity of the shaft after 3 seconds in rad/s;	(5)
(b)	The average angular acceleration in rad/s^2.	(5)

9)	A wheel of diameter of 600 mm has a linear velocity at the rim of 20 m/s accelerates uniformly up to 30 m/s in 8 seconds. Calculate:	
(a)	The linear distance travelled whilst accelerating:	(2)
(b)	The angular acceleration;	(4)
(c)	The number of revolutions turned during acceleration.	(4)
10)	A vehicle is travelling at 36 km/h along a flat straight road, the diameter of the wheels is 500 mm.	
(a)	Calculate:	
	(i) the linear velocity at a point on the rim in m/s;	(2)
	(ii) the rotational speed of a wheel in rev/min.	(4)
(b)	The vehicle now accelerates to 52 km/h in 2.5 seconds, calculate:	
	(i) the linear acceleration of the wheel at the rim;	(1)
	(ii) the angular acceleration of the wheel at the rim.	(3)

11)	A flywheel has a diameter of 1.3 m and is rotating at an angular velocity of 5.6 rad/s. For a point on the rim, calculate:	
(a)	The linear velocity:	(3)
(b)	The rotational speed in revolutions per minute;	(3)
(c)	The number of radians turned when the flywheel rotates through 315°;	(2)
(d)	The equivalent linear distance moved when the flywheel rotates through 315°.	(2)

TOPIC NO. 1-Q 2- VELOCITY, ACCELERATION, MOMENTUM

A) Conservation of Momentum

1)	A bus of mass 80 tons, travelling at 4 m/s, runs into the back of a car of mass 1.8 tons travelling in the same direction at 2.5 m/s. After impact, the velocity of the bus is 3.95 m/s. The duration of impact was 1.05 sec. Determine:	
(a)	The final velocity of the car;	(5)
(b)	The average force on the car during impact.	(5)

2)	A car of mass 1000 kg travelling with a velocity of 2 m/s collides with a stationary bus of mass 7000 kg. After collision, the two vehicles are locked together. The vehicles finally come to rest 2 sec after impact. The friction force Between the vehicles and the ground may be assumed constant. Calculate:	
(a)	The common velocity immediately after impact;	(5)
(b)	The friction force between the vehicles and the ground.	(5)

3)	A railway truck of mass 6000 kg travelling with a velocity of 1.0 m/s collides with a second truck of mass 4000 kg travelling at 0.8m/s in the same direction on level track. During the collision, the two trucks are coupled. The trucks finally come to rest 46 sec after impact. The total frictional resistance to motion may be assumed constant. Determine:	
(a)	The common velocity immediately after coupling;	(5)
(b)	The total friction force acting on the trucks after coupling.	(5)

4)	A shell of mass 6 kg is fired from a gun barrel of mass 1200 kg. During firing, the average force exerted on the shell is 200 kN. and this force acts for a time of 0.015 sec. Calculate:	
(a)	The momentum of the shell as it leaves the gun;	(4)
(b)	The muzzle velocity of the shell;	(4)
(c)	The initial recoil velocity of the gun.	(2)

B) Work and Power

5)	The engine of a single screw ship has an output power of 3 MW, and the propeller shaft rotates at 100 rpm. The ship is traveling at a velocity of 8 m/s, and the propeller thrust required to maintain this speed is 320 kN. Calculate:	
(a)	The torque in the propeller shaft;	(4)
(b)	The output power of the propeller;	(4)
(c)	The efficiency of the propulsion gear.	(2)

6)	The specification of a deck windlass contains the following data: Input power: 20 kW Chain pull: 80 kN Chain speed: 10 m/min Effective diameter of gypsy wheel: 0.68 m Assuming that the windlass is operating under the specified conditions, Calculate:	
(a)	The torque on the gypsy wheel;	(3)
(b)	Power transferred to the chain;	(2)
(c)	The overall efficiency of the windlass.	(5)

7)	Winding gear is used to lift a load of 800 kg through a height of 2 m in a time of 4.2 sec. The torque applied to the winding drum is 590 Nm, and the drum makes five revolutions. Calculate:	
(a)	The work done on the load;	(2)
(b)	The work done by the torque;	(3)
(c)	The efficiency of the winding gear;	(2)
(d)	The power input to the winding gear.	(3)

TOPIC NO. 1-Q 3- VELOCITY, ACCELERATION, MOMENTUM

A) Force & Conservation of Momentum

1)	A railway carriage of 40-ton mass travelling at 6 m/s collides with a 2nd carriage of 20 ton mass travelling at 3 m/s in the same direction as the first carriage. After impact the carriages are coupled together and come to rest in 40 seconds. Calculate:	
(a)	The velocity of the carriages immediately after impact;	(6)
(b)	The retardation force.	(4)

2)	A space vehicle of mass 1000 kg is travelling at 1100 m/s towards a space station of mass 9000 kg which is traveling in the same direction at 800 m/s. The retro rockets of the space vehicle exert a retardation force of 1200 N. Calculate:	
(a)	How long the retro rockets should be fired to bring the vehicle to the same speed as the station for docking.	(6)
(b)	The common velocity of the vehicle and the station after impact if due to late firing of the rockets, the vehicle is travelling at 804 m/s when it docks.	(4)

3)	A space vehicle of mass 1000 kg is travelling at 800 m/s towards a space station of mass 12000 kg which is travelling in the opposite direction at 200 m/s. The retro rockets of the space vehicle exert a force of 1250 N.	
(a)	Calculate the time during which the retro rockets need to be fired to bring the vehicle to the same speed as the station for docking.	(5)
(b)	Owing to late firing of the rockets, the vehicle is travelling at 196 m/s (in the same direction as the station) when it docks.	(5)

4)	A tennis ball of mass 0.056 kg hits a wall horizontally at 25.00 m/s and rebounds horizontally at 18.50 m/s. The ball is in contact with the wall for 0.1 sec. After leaving the wall, the ball continues to travel almost horizontally, and the force of air friction is 0.02 N.	
(a)	Determine:	(3)
(i)	The change in momentum of the ball during impact;	(2)
(ii)	The average force exerted on the wall;	(5)
(b)	Estimate the velocity of the bail 0.14 s after it leaves the wall.	

B) Force, Velocity, Acceleration, Time

5)	While a tennis ball is in contact with the racquet (during a high-speed serve), it is accelerated from rest to a velocity of 69 m/s in a time of 0.006 sec. The mass of the ball is 57 g. Calculate:	
(a)	The average acceleration of the ball during contact with the racquet;	(2)
(b)	the average force on the ball during contact with the racquet.	(2)
(c)	If the friction force on the ball during flight is 5 N. Calculate:	
(i)	The deceleration;	(3)
(ii)	The velocity after a time of 0.03 s.	(3)

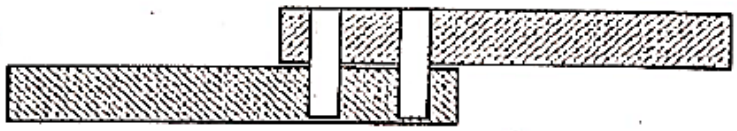
6)	The tractive force exerted on a railway locomotive of mass 400 ton is 100 kN, and there is a frictional resistance of 18 kN at a certain moment, the locomotive is travelling at 3 m/s along level track. Calculate:	
(a)	The net force on the locomotive;	(1)
(b)	The acceleration of the locomotive;	(2)
(c)	The velocity after 10 s;	(3)
(d)	The time taken to reach a velocity of 10 m/s.	(4)

7)		
(a)	A ship of mass 250 000 tons is travelling at a speed of 6 m/s when the engines are stopped. After 10 sec, the speed has dropped to 5.7 m/s. Calculate:	
(i)	The average deceleration;	(2)
(ii)	The average resistive force on the ship.	(2)
(b)	With the ship's speed at 5.7 m/s, the engines are re-started, giving a propulsive force of 10 MN. Assuming that the average resistive force is the same as in Q 3 (a), calculate:	
(i)	The average acceleration;	(3)
(ii)	the time taken to regain a speed of 6 m/s.	(3)

TOPIC NO. 2- Q 4-

AREA, VOLUME, DENSITY

1)		
(a)	A hollow steel shaft 3 m long has outside diameter 108 mm and inside diameter 72 mm. Calculate the mass of the shaft, given that the density of steel is 7600 kg/m^3	(6)
(b)	A 3 m length of solid steel shaft made of the same material has a mass of 108.5 kg. Calculate the diameter of the shaft.	(4)

2)	Two rectangular pieces of pine each have dimensions 200 mm long with section 25mm x 50mm. A lap joint is formed between them, and the joint is secured using FOUR oak pegs 10 mm in diameter and 50 mm long as shown in Fig. Q4. (The density of pine is 500 kg/m^3 and that of oak is 800 kg/m^3) Calculate the total mass of the assembly.  Fig. Q4	10

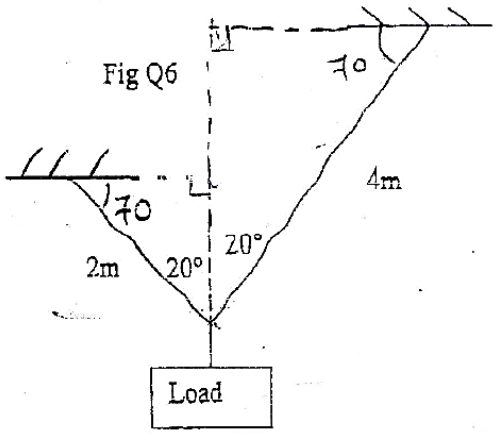
3)		
(a)	A pine plank with dimensions 4 m x 300 mm x 40 mm has a mass of 26.4 kg. Calculate the density of the pine.	(4)
(b)	Two planks similar to the one in Q 4 (a) are bolted together using 8 steel bolts each of mass 0.3 kg. The eight holes drilled in each plank are 25 mm in diameter. Calculate the total mass of the assembly.	(6)

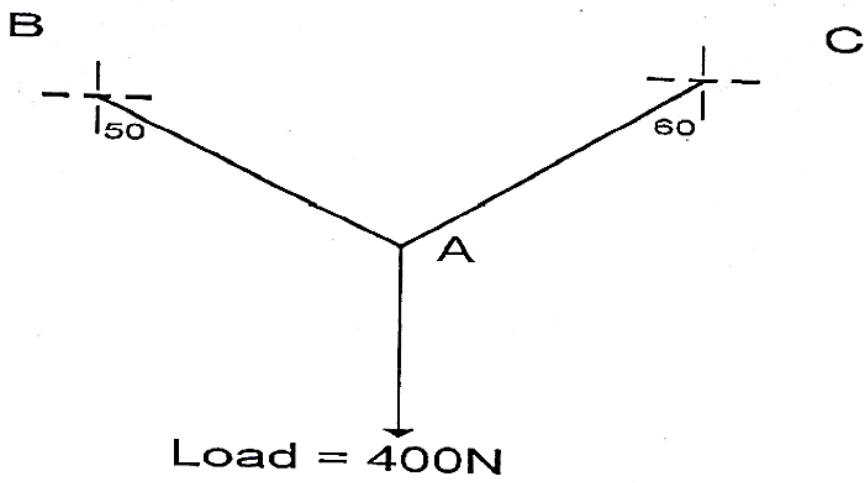
4)	An open topped rectangular tank has dimensions 0.8 m long x 0.4 m wide x 0.5 m deep. It is made of steel sheet 4 mm thick. The tank contains kerosene to a depth of 0.35 m. The density of steel is 7600 kg/m^3. The total mass of the tank and the contents is 138 kg. Calculate:	
(a)	The area of steel sheet required;	(3)
(b)	The mass of steel;	(3)
(c)	The mass of kerosene;	(1)
(d)	The density of the kerosene.	(3)

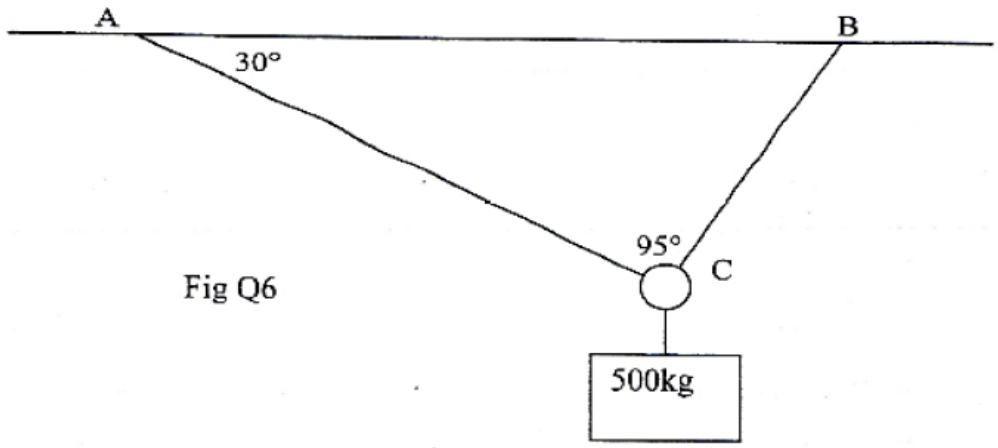
TOPIC NO. 3- Q 5 & 6 - RESULTANT FORCE SYSTEM AND EQUILIBRIUM

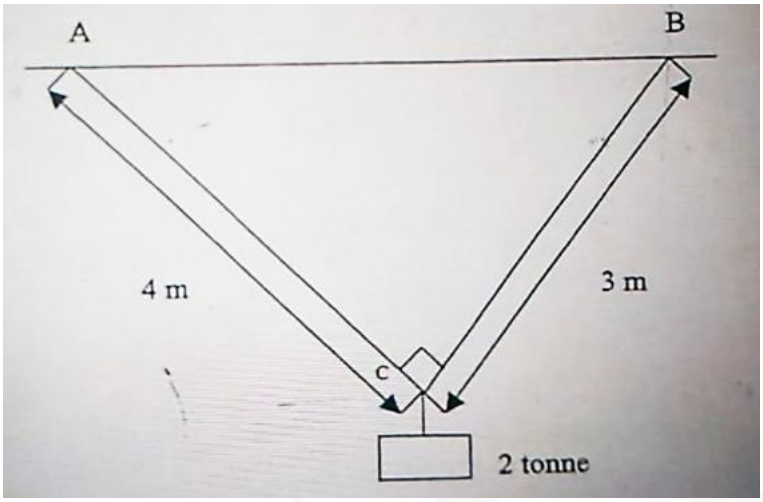
A) Lami's, Sine, Cosine Theorem

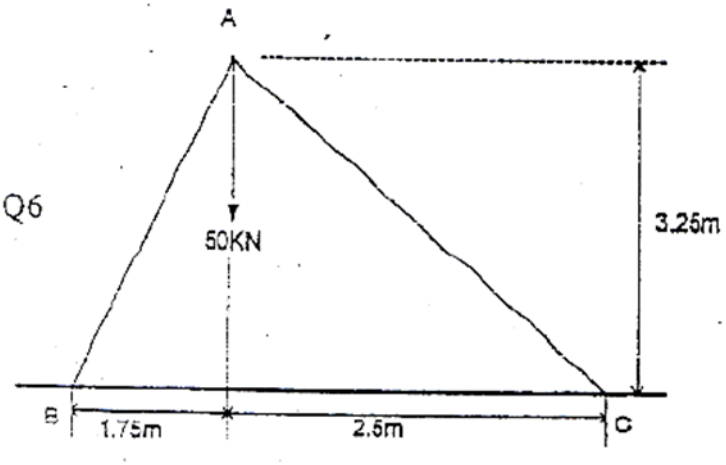
1)		
(a)	With reference to the reaction of a body when a force is momentarily applied explain the terns stable, unstable, and neutral equilibrium.	(3)
(b)	A load of 1 ton is vertically hung from a horizontal beam by two equal length strops of 4 meters, separated by an angle of 40°. Take the gravitational acceleration as 9.81 m/s2.	
(i)	Sketch the arrangement.	(2)
(ii)	Calculate the tensile force in the strops.	(5)

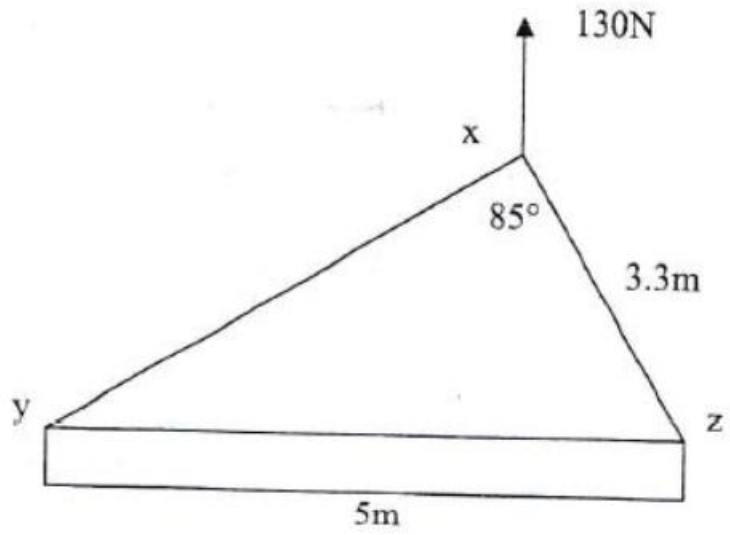
2)	A load of 1 ton is suspended from two wire strops as shown in Figure Q 6. Determine the tensile force in EACH strop.	(10)
		

3)	A weight of 400 N is suspended by strops from points B and C as shown in the figure below.	
	Determine: The tensile force in the strops AB and AC.	(10)
		

4)		
(a)	Describe the meaning of the term equilibrium.	(2)
(b)	Figure Q 6 shows a mass suspended by wire strops from fixed points A and B. Determine by drawing a vector diagram:	
(i)	The force in strop AC;	(4)
(ii)	The force in strop BC.	(4)
	 Fig Q6	

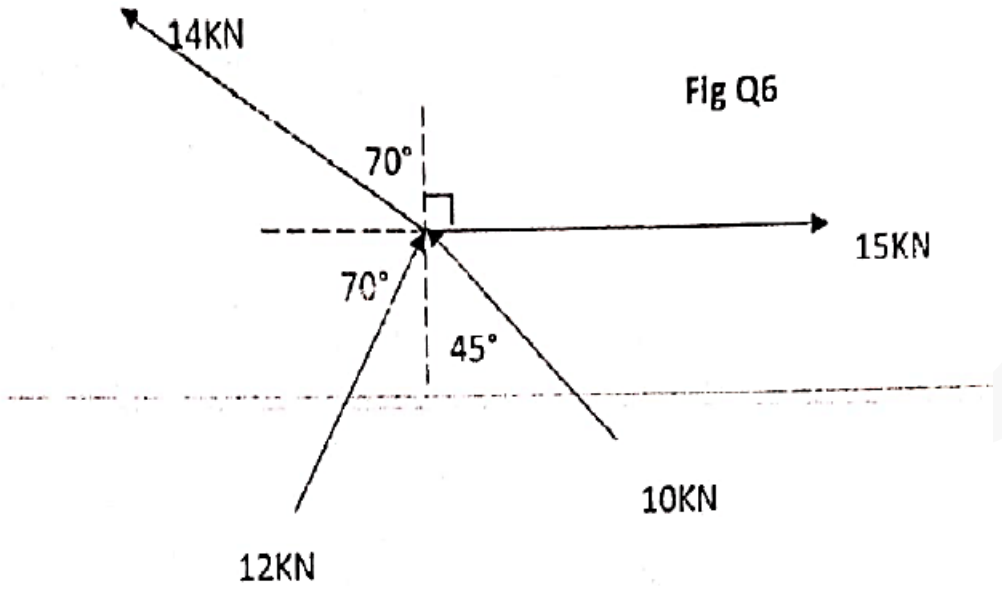
4)	Figure shows the mass suspended by strops from point A and B. Determine: 	
(a)	The force in strops AC & BC.	(8)
(b)	The stress in strop BC given that it has a cross section of 75 mm by 5 mm.	(2)

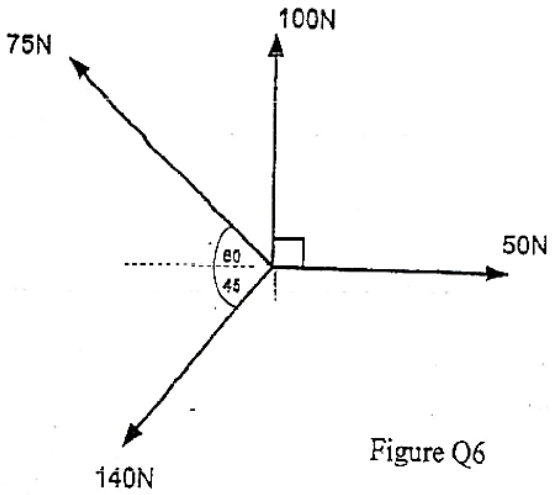
5)	A vertical frame of two legs shown in Figure Q 6 has a weight of 50 KN hanging from point 'A'. Determine the forces in legs 'AB' and 'AC' produced by the 50 KN weight.	(10)
	 Figure Q6	

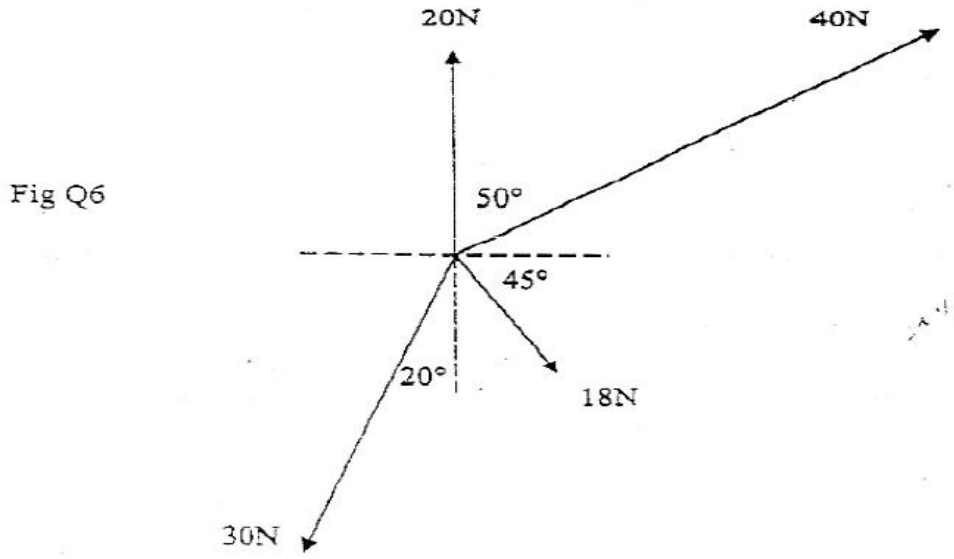
6)		
(a)	Describe the meaning of the term concurrent.	(2)
(b)	A crane lifts a 5 m long beam as shown in Figure Q6. The load on the crane is 130 N. Determine the tension in slings xy and xz.	(8)
	 Fig Q6	

B) Resultant Force Method

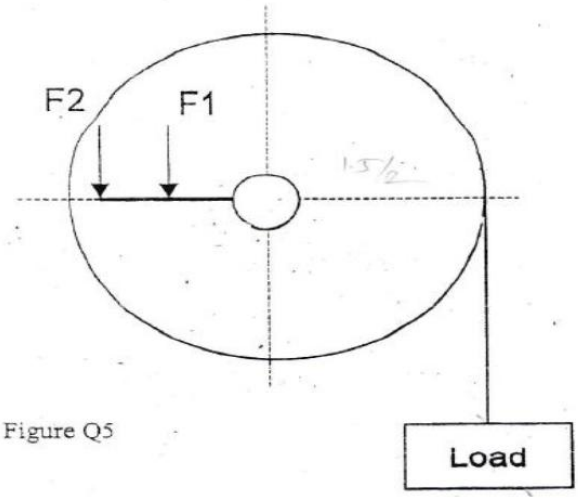
7)	Coplanar forces act outwards from a common point. Three forces have the following magnitudes and directions, the angles being measured clockwise from a horizontal datum: 80 N, 0°; 50 N, 60°; 100 N,150°	
(a)	Draw the force diagram.	(3)
(b)	Determine the magnitude and direction of the resultant force.	(7)

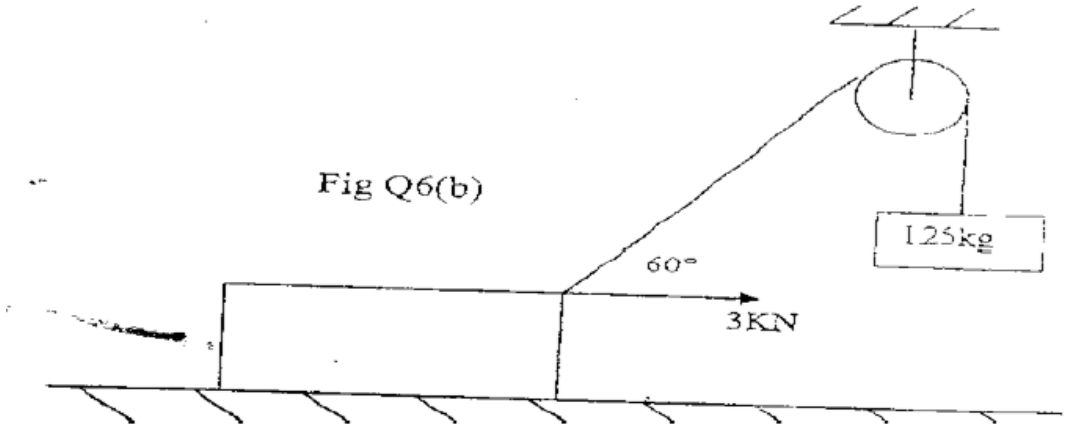
8)	Figure Q 6 shows a system of concurrent, coplanar forces. Calculate, by resolution of forces into vertical and horizontal components, the magnitude of the equilibrium force.	(10)
	 Fig Q6	

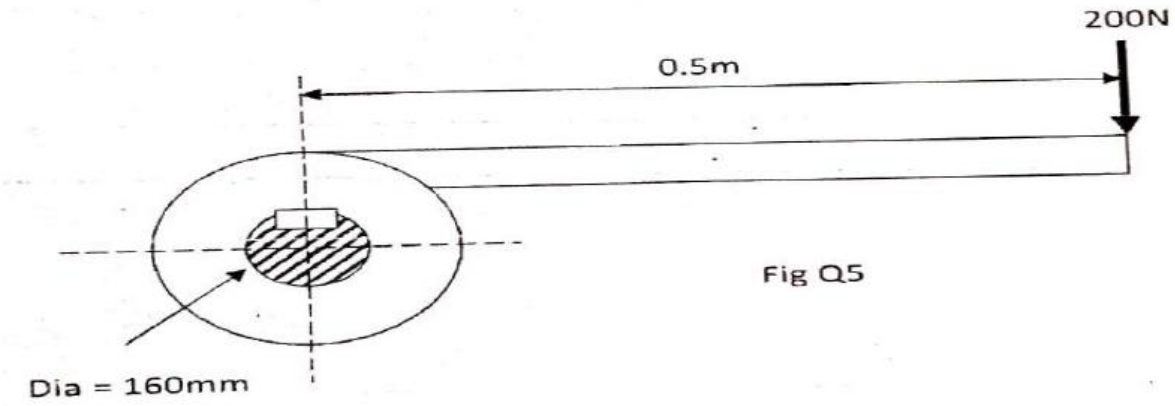
9)		
(a)	Determine the resultant horizontal and vertical components of the system of concurrent coplanar forces shown in Figure Q 6.  Figure Q6	(8)
(b)	State two of the three conditions for equilibrium.	(2)

10)	Figure Q 6 shows a system of concurrent, coplanar forces. Calculate, by resolution into horizontal and vertical components, the magnitude and direction of the resultant force.	(10)
	 Fig Q6	

C) Equilibrium, Moment, Torque

11)	Figure Q 5 shows a 1 ton load hanging by a rope from a wheel 1.5 m diameter. A handle fixed on the same shaft has a length of 600 mm. Two forces are applied to the handle as shown. F_1 is 400 mm from the center, F_2 is at the end and friction forces are negligible. Take the gravitational acceleration as 9.81 m/s^2. If F_1 is 10 KN, calculate the force, F_2, required to stop the load from falling.	(10)
	 Figure Q5	

12)	Figure Q 6 (b) shows an attempt to pull a cylinder head along a workshop floor. The cylinder head has two ropes attached to its top comer, one which passes over a friction-less pulley wheel with a weight attached to the other end, the other has a horizontal force of 3 KN. Calculate the magnitude and direction of the resultant force.	(10)
	 Fig Q6(b)	

13)		
(a)	State the formula for torque, including the units.	(2)
(b)	The handle shown in Figure Q 5 is keyed to a shaft and has a force of 200 N, acting perpendicular to the handle, at its free end preventing rotation. Calculate:	
(i)	The torque on the shaft;	(3)
(ii)	the force on the key.	(5)
	 Fig Q5	

14)	A 1.5 ton load is supported from a drum as shown in figure Q 5 below. The drum is attached to a toothed wheel of the same diameter on the same axis which is driven by a matching toothed pinion. Take the gravitational acceleration as 9.81 m/s^2 & friction forces are Negligible. Calculate:	
(a)	the force required to lift the load at the drum;	(2)
(b)	the torque at the drum center;	(3)
(c)	The force 'F' required at the end of a 100 mm handle to lift the load.	(5)

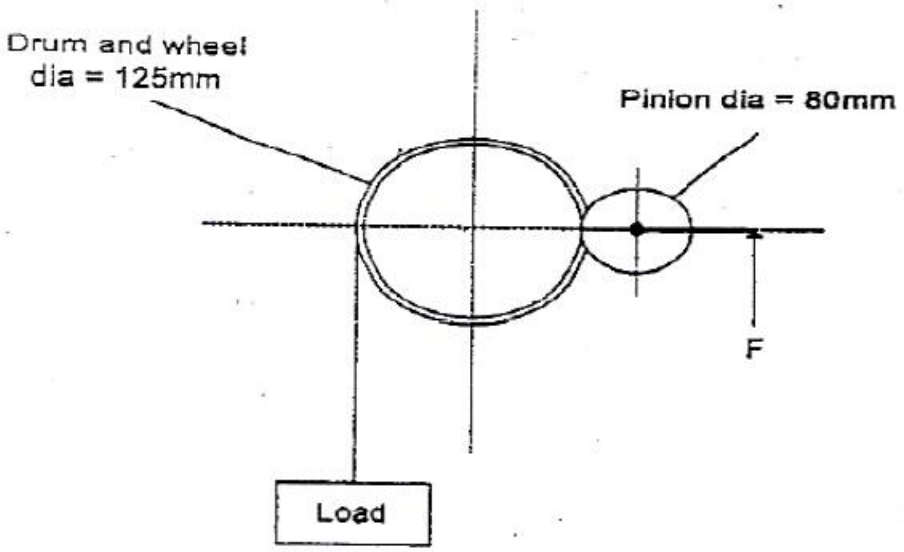


Figure Q5

D) Equilibrium in Beam

15)		
(a)	Stare the principle of moments.	(1)
(b)	Figure Q5 shows a simply supported beam which is in equilibrium. Calculate the reaction forces R1 and R2.	(9)

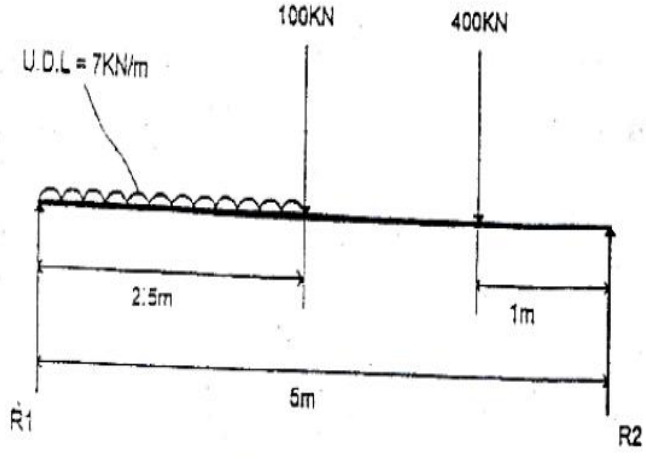
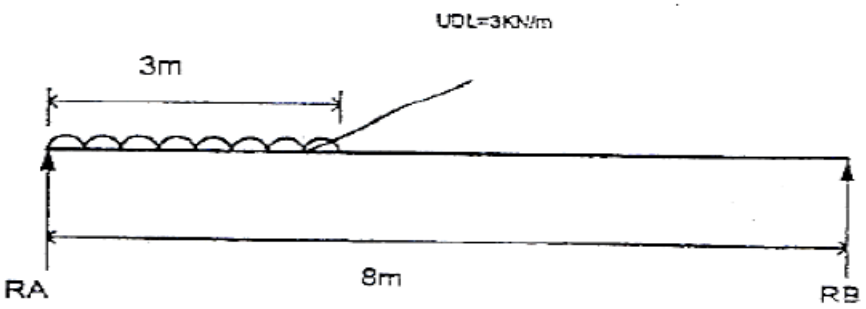
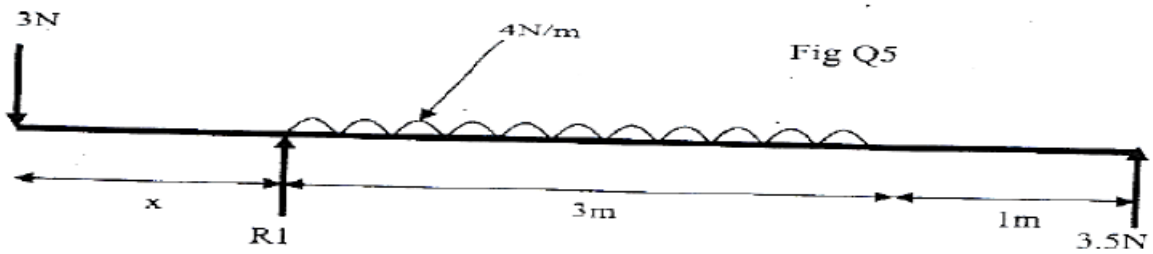
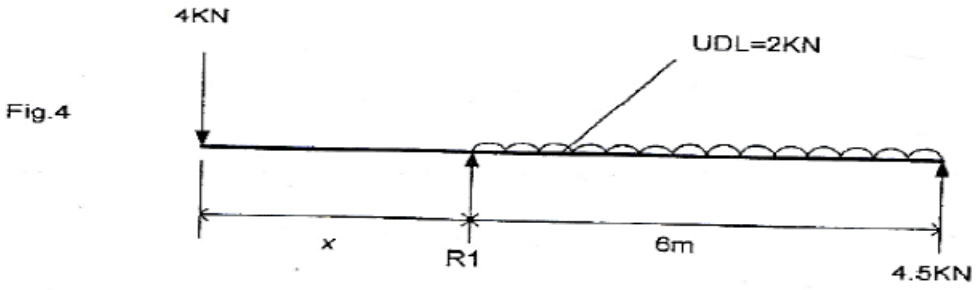


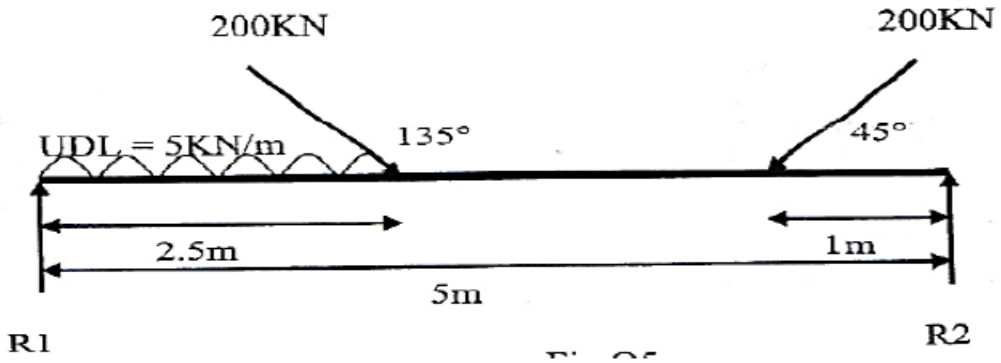
Figure Q5

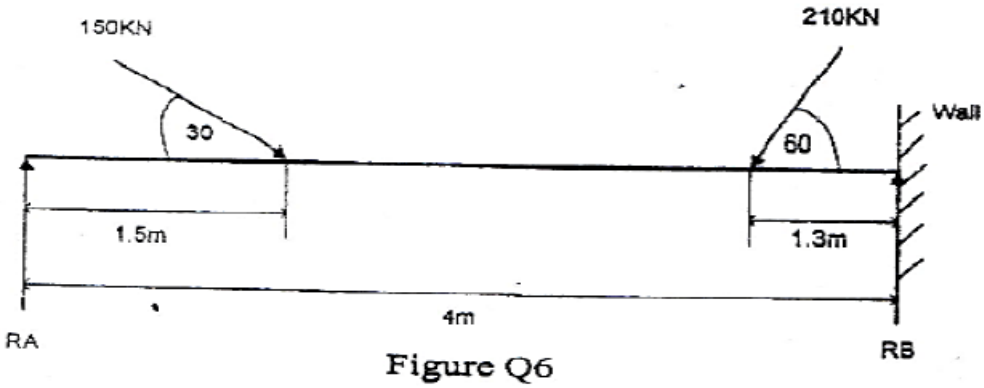
16)	A simply supported beam 10 m long has a mass of 1.5 tons and has a uniformly distributed load of 1.5 KN/m over 3 m from one end.	
(a)	Sketch the arrangement showing all forces.	(2)
(b)	Calculate the reaction forces R_A and R_B at each end of the beam.	(8)

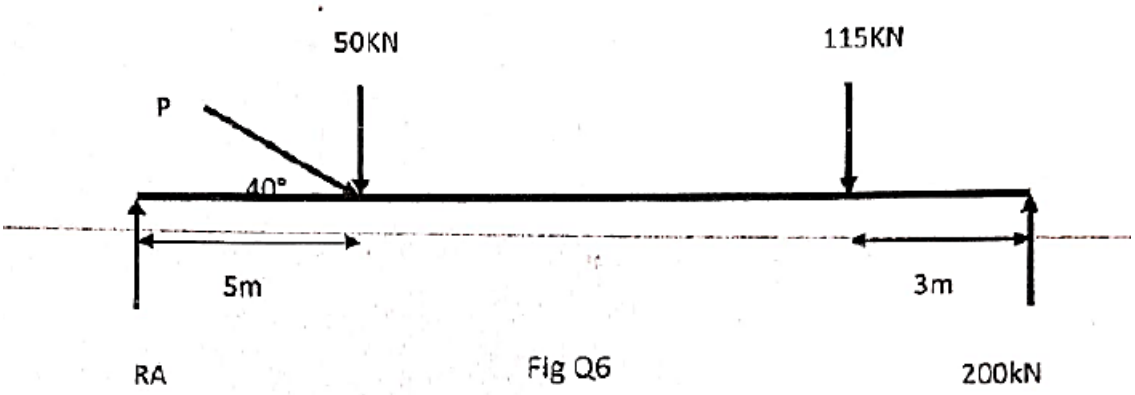
17)	A simply supported beam, shown if Figure Q 5, is in equilibrium, has a mass 1.8 tons, and a uniformly distributed load of 3 KN/m over 3 m. Take the gravitational acceleration as 9.81 m/s^2.	
	Calculate the reaction forces R_A and R_B.	(10)
		

18)		
(a)	State the principles of moments.	
(b)	Figure Q 5 shows a simply supported beam. Calculate: 	
(i)	The total length of the beam:	
(ii)	Reaction force R1.	

19)	A simply supported beam of negligible mass has a uniformly distributed load over 6 m. If the beam is in equilibrium, calculate:	
(a)	the length 'x'	(7)
(b)	Reaction force R1.	(3)
	 Fig.4	

20)	Q 5 shows a simply supported beam. Calculate:	
(a)	The reaction force R1; Figure	
(b)	The reaction force R2;	
(c)	The resultant horizontal component.	
		

21)	Figure Q 6 shows a simply supported beam of negligible mass which is in equilibrium. Calculate:	
(a)	The value of reactions RA and RB;	
(b)	The value and direction of the horizontal reaction force at the wall.	
	 Figure Q6	

22)	Q 6 shows a 14 m long simply supported beam. Calculate:	
a)	Force P;	(6)
b)	Reaction RA.	(4)
	 Fig Q6	

TOPIC NO. 4- Q 7-

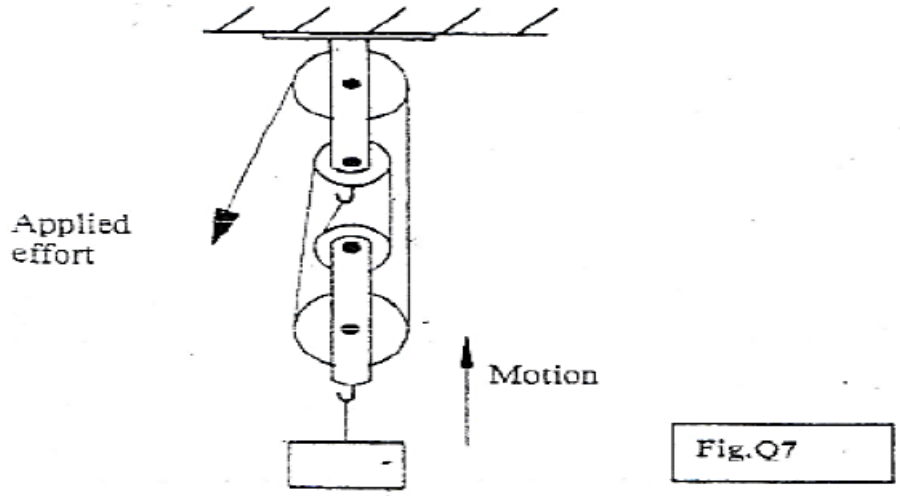
LIFTING MACHINE

A) Pulley

1)	Lifting tackle comprised of a set of pulleys, with three pulleys in the upper block and two pulleys in the lower block, is used to lift a mass of 150 kg. Take the gravitational acceleration as 9.81 m/s^2. If the effort required to make the lift is 0.7 kN, Determine:	
(a)	The efficiency of the lifting tackle;	(4)
(b)	The effort used to overcome friction in the lifting gear;	(3)
(c)	The work expended by the user to lift the load by 2.5 metres.	(3)

2)	Lifting tackle comprised of three pulleys in both the upper and lower blocks, is used to lift a mass of 200 kg. Take the Gravitational acceleration is 9.81 m/s^2. The effort required to make the lift is 0.75kN. Calculate:	
(a)	The efficiency of the lifting tackle;	(4)
(b)	The effort used to overcome fiction in the lifting;	(3)
(c)	The work expended by the user to lift a load by two meters.	(3)

3)	A mass of 45 kg is raised 2.5 m using a pulley system, the upper block having 3 pulleys and the lower block 2 pulleys. The efficiency of the machine is 80%. Calculate:	
(a)	The distance moved by the effort;	(4)
(b)	The mechanical advantage;	(3)
(c)	The effort.	(3)

4)	For the pulley system shown in Fig. Q 7 the effort applied is 200 N and the system is 92% efficient. Calculate:	
(a)	the mass being raised;	(8)
(b)	the distance moved by the effort when the mass is raised a height of 4 m.	(2)
	 Fig.Q7	

B) Screw Jack

5)	A screw jack has a single start screw thread with a pitch of 6 mm and the effective length of the operating bar is 300 mm. The screw jack has an efficiency of 27% when lifting a load using an effort of 50 N. Calculate:	
(a)	The load that is being lifted;	(7)
(b)	The effort required to raise a mass of 600 kg screw after lubrication raises the efficiency to 32 %.	(3)

6)	A screw jack lifts a load of 1·65 ton with an effort of 90 N. The jack has a single start screw thread with a pitch of 6 mm. The effort is applied to the end of a lever having an effective length of 0.83 m. Calculate:	
(a)	The velocity ratio;	(4)
(b)	The mechanical advantage;	(3)
(c)	The percentage efficiency.	(3)

7)	The winding handle of a car jack has a radius of 0.2 m. To lift a load of 500 kg through a height of 0.3 m, the handle must be turned 50 times. The average tangential force on the handle is 70 N, and the operator takes 30 s to Lift the load. Determine:	
(a)	The work done on the load:	(2)
(b)	The work done by the effort;	(3)
(c)	The efficiency of the jack;	(2)
(d)	The power input to the jack.	(3)

8)	Lift machinery is used to lift a load with a mass of 1800 kg. The load is lifted a total distance of 2.5 m. The lift gear winding drum takes six turns to complete the lift with an average torque of 1300 Nm being necessary to complete the lift in six seconds. Calculate:	
(a)	The work output from the winding engine;	(2)
(b)	The work input to the lifting gear;	(2)
(c)	The lift machinery efficiency;	(3)
(d)	The power input to the lift machinery.	(3)

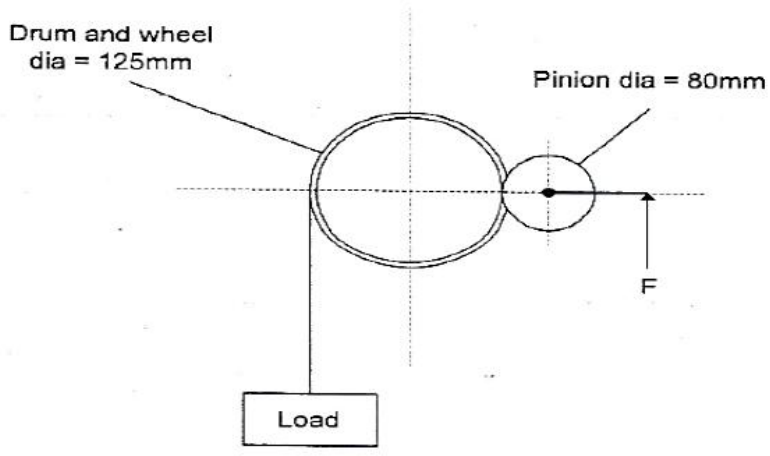
9)	Calculate the power required to pump a mass of liquid of 50 tons to a height of 30 meters every 30 seconds. Take the gravitational acceleration as $9.81 m/s^2$.	(2)

C) Wheel & Axle

10)	A wheel and axle lifting machine has diameters of 240 mm and 40 mm respectively. The machine raises a mass of 60 kg and is assumed to be an "ideal machine", Calculate:	
(a)	The effort required;	(6)
(b)	The power required to lift the load by 3 m in 10 seconds.	(4)

11)	A simple ideal machine consists of a wheel and axle. The wheel has a diameter of 260 mm and a mass of 500 kg is lifted a distance of 3 m. The operation takes 10 seconds and it winds 19.5 m of cable off the wheel. Calculate:	
(a)	The diameter of the axle;	(4)
(b)	The power required.	(6)

D) Torque

12)	A 1.5 ton load is supported from a drum as shown below in Fig. Q 5. The drum is attached to a toothed wheel of the same diameter on the same axis which is driven by a matching toothed pinion. Take the gravitational acceleration as 9.81 m/s^2 & friction forces are negligible. Calculate:	
(a)	The force required to lift the load at the drum;	(2)
(b)	The torque at the drum center;	(3)
(c)	The force 'F' required at the end of a 100 mm handle to lift the load.	(5)
		

TOPIC NO. 5-Q 8- FRICTION

1)	If a block of steel of mass 50 kg requires a horizontal force of 70 N to cause it to slide along a horizontal plane. Calculate:	
(a)	The coefficient of friction between the block and the plane;	(3)
(b)	The acceleration and the distance travelled in 4 seconds from rest if a horizontal force of 80 N is applied.	(7)

2)	A body has a mass of 23 kg and is subject to a force applied parallel to the horizontal plane. Calculate:	
(a)	The least horizontal force required just to cause motion when the coefficient of friction μ is 0.41;	(4)
(b)	The reduction in effort needed to move the body as a percentage of the original force if the coefficient of friction is now reduced by 0.15.	(6)

3)	A block of mass m kg is pulled across a horizontal plane by a rope attached to the block, the pull being inclined at angle θ° to the horizontal. The tension in the rope is F N which is just sufficient to move the block with Constant velocity.	
(a)	Sketch the block on the surface and show all the forces associated with it.	(4)
(b)	If m is 20 kg, θ is 25° and the force in the rope is 40 N, determine the coefficient of friction between the block and the plane.	(6)

TOPIC NO. 6- Q 9,10,11 -

STRESS & STRAIN

A) Tensile Stress:

1)	The extension of a copper alloy wire 3 mm in diameter and 2 m long must not exceed 1 mm under load. Young's modulus is 120 GN/m^2 and the ultimate tensile stress is 200 MN/m^2. Calculate:	
(a)	The stress in the wire:	(5)
(b)	The load in the wire;	(3)
(c)	The factor of safety.	(2)

2)	The extension of a steel wire 2 mm in diameter and 4 m long must not exceed 2 mm under load. Young's modulus is 210 GN/m^2 and the ultimate tensile Stress is 320 MN/m^2. Calculate:	
(a)	The stress in the wire;	(4)
(b)	The load in the wire;	(3)
(c)	The factor of safety.	(3)

3)	A brass tie rod 8 mm in diameter and 1 m long extends 0.5 mm under load. Young's modulus is $80x10^9$ N/m^2 Calculate:	
(a)	The strain;	(3)
(b)	The stress;	(3)
(c)	The load (force) on the bar.	(4)

4)	A steel wire 10 m long and 3 mm diameter stretches 2 mm when loaded. For the wire, E = 210 GN/m^2, Calculate:	
(a)	The strain in the wire;	(1)
(b)	The stress in the wire;	(2)
(c)	The tensile force in the wire;	(3)
(d)	The extension if the wire were changed for one 6mm diameter.	(4)

5)	A steel wire 5 mm in diameter and 2 m long carries a tensile load of 1 kN. The Modulus of elasticity is 200 GN/m^2. Calculate:	
(a)	The stress in the wire;	(5)
(b)	The extension of the wire.	(5)

6)	The safe working load on a steel tie rod 25 mm in diameter is 25 kN. Given that for steel "Young's Modulus" E = 200 GN/m² and the tensile Strength is 350 MN/m². Calculate:	
(a)	The working stress;	(4)
(b)	The working strain;	(3)
(c)	The factor of safety.	(3)

7)	The safe working load on a steel strut of rectangular cross-section 20 mm x 25 mm is 28 kN. For steel, E=210 GN/m^{2,} and the tensile strength is 380 MN/m^2. Calculate:	
(a)	The working stress;	(4)
(b)	The working strain;	(3)
(c)	The factor of safety.	(3)

8)	The tensile stress in a brass rod 12 mm in diameter and 1.5 m long is 10 MN/m^2. Young's modulus for brass is $80x10^9$ N/m^2. Calculate:	
(a)	The strain;	(2)
(b)	The extension;	(3)
(c)	The load (force) on the bar;	(3)
(d)	The safety coefficient if the UTS is 25 MN/m^2	(2)

B) Compressive Stress:

9)	A steel column has a hollow circular section of 200 mm outside diameter and 120 mm inside diameter. It is 2 m high and carries a compressive load of 800 kN. The modulus of elasticity is 200 GN/m^2. Calculate:	
(a)	The stress in the column;	(4)
(b)	The change in height.	(6)

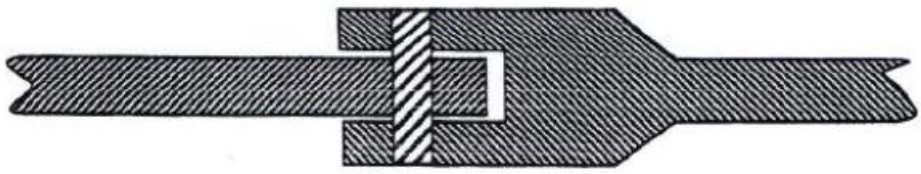
10)	A steel column 3 m high is of hollow square section, 200 mm outside dimension, and 20 mm wall thickness. (Young's modulus E= $210x10^9$ N/m^2) Calculate:	
(a)	The compressive load, which will give a stress of 60 MN/m^2 in the column;	(6)
(b)	The compression of the column under the load in Q 9 (a).	(5)

11)	The crushing stress of concrete is 100 MN/m^2. A short concrete column of a square section is to carry a load of 1 MN with a safety factor of 4. Calculate:	
(a)	The working stress;	(4)
(b)	The section area;	(4)
(c)	The section dimension,	(2)

C) Shear Stress:

12)	A single lap joint is fastened with 6 rivets, each of diameter 15mm. Calculate:	
(a)	Tensile load which the joint will withstand if the working shear stress is limited to 30 MN/m^2;	(5)
(b)	How many 15 mm diameter rivets would be needed if the design load were 50 kN.	(5)

13)		
(a)	Calculate the force needed to punch a hole 20 mm in diameter in 5 mm thick plate if the ultimate shear stress is 200 MN/m^2.	(5)
(b)	Determine the dimension of a square hole that could be punched in the same plate with the same force.	(5)

14)	Two tie rods are joined using a “fork and pin’” connection, as shown in Fig Q 11. The shear stress in the pin is 30 MN/m^2 and the diameter of the pin is 5 mm.	
(a)	The tension in the ties:	(6)
(b)	The tension that would give the same shear stress in a 6 mm diameter pin.	(4)
		

15)	Two tie rods are joined using a “fork and pin” connection. The tension in the rods is 1.50 kN and the shear stress in the pin is 40 MN/m^2. Calculate:	
(a)	The diameter of the pin;	(6)
(b)	The tension which would give the same shear stress in a 6 mm diameter pin.	(4)

TOPIC NO. 7- Q 12-

NAVAL ARCHITECTURE

1)	A box barge 50 m long, 8 m wide is floating in seawater at the draft of 4 m, with its center of gravity 4.2 m above the keel. Take the seawater density as 1025 kg/m^3. Calculate the new position of the center of gravity above the keel when a deck cargo of 500 tons on the centerline at 6.3 m above the keel is discharged.	(10)

2)	A box barge 50 m long, 8 m wide is floating in seawater at a mean draft of 4 m with its center of gravity.4.2 m forward of midships. Calculate the new position of the center of gravity from midships when a deck cargo of 500 ton on the center line 10 m forward of midships is discharged. Take the seawater density as 1025 kg/m^3.	(10)

3)	A vessel floating in a river has an underwater volume of 8540 m^3. The ship's center of gravity is 4 m from the keel. The center of buoyancy is 2 m from the keel. The second moment of the waterplane area about the ship's centerline is 29890 m^4. A mass of 8.5 ton on the port side of the deck is now moved transversely 11.5 m across the deck to the starboard side. Given the formula: mxd= Δx GM x tanθ and the density of the river water is 1010 kg/m^3. Calculate the angle of heel due to the movement of the mass.	(10)

4)	A ship of displacement 5000 ton has its center of gravity G positioned 5.0 metre above the keel. A rectangular centerline double bottom tank, 15.0 mx 6.0 m x 2.0 m deep, is now filled with water of density 1020 kg/m^3. Calculate:	
(a)	The mass of water in the tank:	(3)
(b)	The Kg (length from keel to the center of gravity) of the water in the tank;	(1)
(c)	The new position of the ship's center of gravity above the keel (=KG).	(6)

5)	A ship has a displacement of 17550 ton and when a mass of 16.5 ton is moved transversely 20 meters across the deck, an angle of heel of 2° is produced. Given mxd= Δ x GM x tanθ and KM=7.4 m; Calculate the position of the center of gravity above the keel (KG)	(10)

6)	A ship is floating in seawater of density 1.025 tons/m^3 has a displacement of 17550 ton. The center of buoyancy is 3 m from the keel and the second moment of waterplane area about the ship's centerline 75336.6 m^4. A mass of 16.5 ton is moved transversely 20 m across the deck producing an angle of heel of 2 degrees. Given the formula: mxd= Δx GMx tanθ Calculate the position of the center of gravity above the keel.	(10)

7)	A ship in a loaded condition is lying at even keel. A mass of 100 tons is moved longitudinally from 50 m aft of midships to 30 m aft of midships. Describe:	
(a)	How this shift of mass would affect the Center of Gravity relative to the center of Buoyancy;	(7)
(b)	The final condition of the ship.	(3)

8)		
(a)	Describe what needs to occur for a ship lying at even keel to be trimmed by the stern.	(4)
(b)	Give three examples of how trimming by the stem can be achieved.	(6)

9)	State the THREE Conditions required for a ship floating calmly in water to be in stable static equilibrium.	(10)

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