INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MECHANICAL ENGINEERING

TUTORIAL QUESTION BANK

Course Title	**ENGINEERING MECHANICS**				
Course Code	AMEB03				
Program	B.Tech				
Semester	III	ME			
Course Type	Foundation				
Regulation	IARE - R18				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	1	4	-	-
Chief Coordinator	Dr. Ch. Sandeep, Associate Professor				
Course Faculty	Dr. Ch. Sandeep, Associate Professor Mrs. V. Prasanna, Assistant Professor				

COURSE OBJECTIVES:

I	Students should develop the ability to work comfortably with basic engineering mechanics concepts required for analyzing static structures.
II	Identify an appropriate structural system to studying a given problem and isolate it from its environment, model the problem using good free-body diagrams and accurate equilibrium equations.
III	Understand the meaning of centre of gravity (mass)/centroid and moment of Inertia using integration methods and method of moments.
IV	To solve the problem of equilibrium by using the principle of work and energy, impulse momentum and vibrations for preparing the students for higher level courses such as Mechanics of Solids, Mechanics of Fluids, Mechanical Design and Structural Analysis etc.

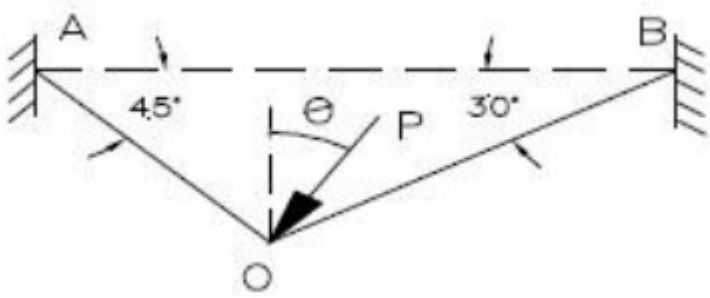
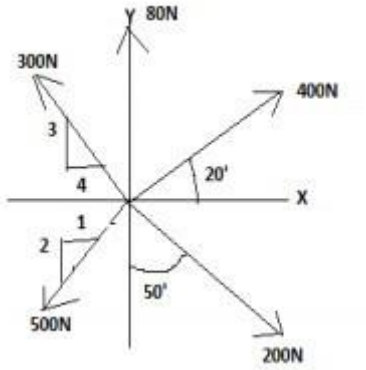
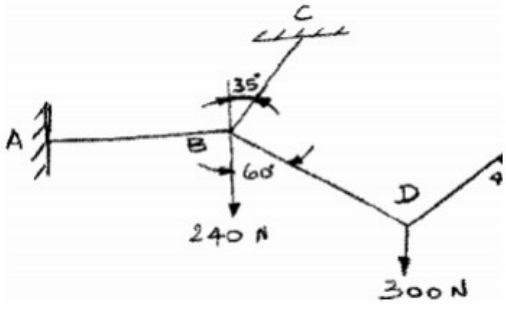
COURSE OUTCOMES (COs):

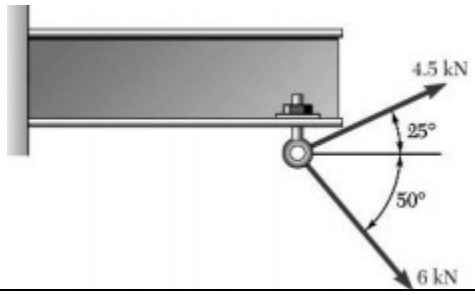
CO 1	Understand the concepts of laws of mechanics, force systems and friction forces.
CO 2	Analyze the spatial systems, forces in frames and the concepts of centroids and centre of gravity.
CO 3	Understand the concepts of kinetics and kinematics to solve the problems related to motion of the body.
CO 4	Understand the concept of impulse forces, work energy relations for connected systems.
CO 5	Explore the knowledge on vibrations and simple harmonic motion.

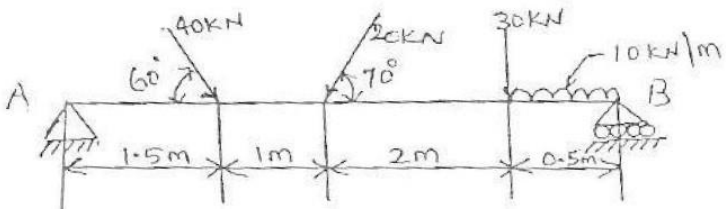
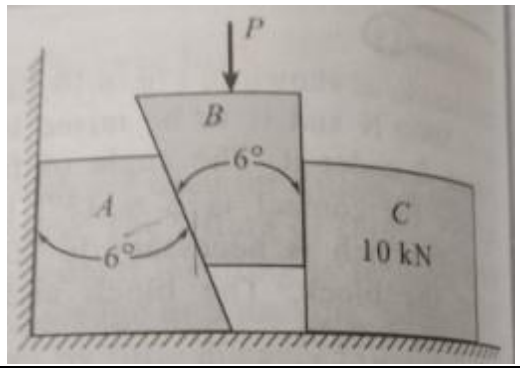
COURSE LEARNING OUTCOMES (CLOs)

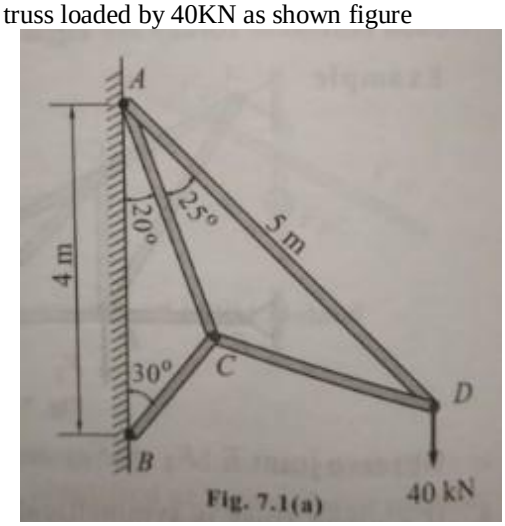
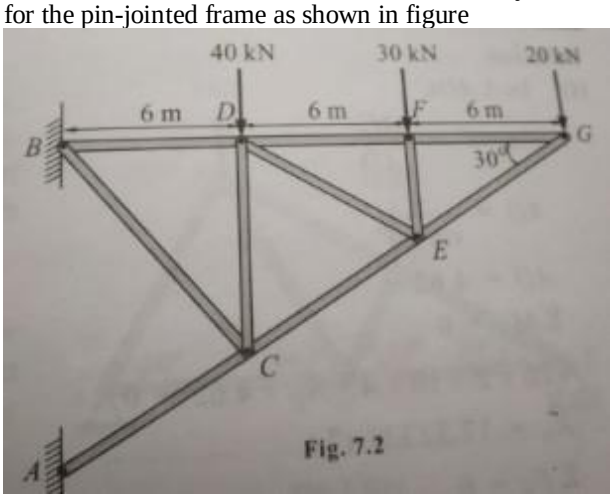
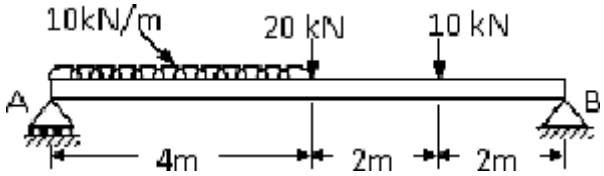
AMEB03.01	A basic understanding of the laws and principle of mechanics
AMEB03.02	The ability to solve simple force system problems in mechanics
AMEB03.03	Determine the resultant and apply conditions of static equilibrium to a plane force system
AMEB03.04	Solve the problems of simple systems with the friction, calculate the linear moving bodies in general plane motion and applications of friction
AMEB03.05	Analyze planer and spatial systems to determine the force in the members of truss and frames
AMEB03.06	Solve the problems on different types of beams
AMEB03.07	Obtain the centroid, center of gravity, first moment and second moment of area
AMEB03.08	Understand the concept of virtual work and an ability to solve practical problems
AMEB03.09	Understand the concepts of kinematics of the particles and rectilinear motion
AMEB03.10	Explore knowledge & ability to solve various particle motion problems.
AMEB03.11	Derive the D' Alembert's principle and apply it to various field problems of kinetic motion.
AMEB03.12	Determine the impact, impulse and impulsive forces occurring in the system and able to solve the problems
AMEB03.13	Develop the work energy relations and apply to connected systems.
AMEB03.14	Understand the fixed axis rotation theory and solving the field problems by application of work energy method.
AMEB03.15	Introduction to concepts of vibration and explain the relation between simple harmonic motion and the equilibrium systems.
AMEB03.16	Derive the expressions for the concepts of simple, compound and torsional pendulums.
AMEB03.17	Explore the use of modern engineering tools, software and equipment to prepare for competitive exams, higher studies etc.

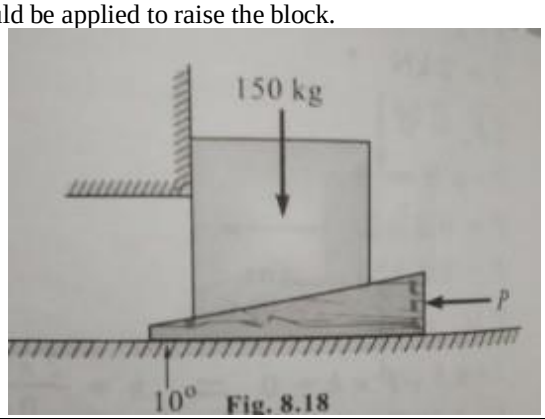
MODULE – I			
INTRODUCTION TO ENGINEERING MECHANICS			
PART - A (SHORT ANSWER QUESTIONS)			
S No	**QUESTIONS**	**Blooms Taxonomy Level**	**Course Learning Outcomes (CLOs)**
1	State Varignon's theorem	Remember	AMEB03:01
2	What is a couple?	Understand	AMEB03:01
3	Define principle of transmissibility.	Remember	AMEB03:02
4	State the triangular law of forces?	Understand	AMEB03:01
5	What is a moment of a couple?	Understand	AMEB03:01
6	Explain free body diagram with one example.	Understand	AMEB03:02
7	State and explain Newton's law of gravitation	Understand	AMEB03:01
8	Define the term resultant and equilibrant	Understand	AMEB03:01
9	What is a rigid body?	Understand	AMEB03:01
10	What is a couple? State its characteristics	Remember	AMEB03:02
11	Define concurrent force?	Remember	AMEB03:01
12	What is a force system?	Understand	AMEB03:01
13	Explain about resolution for forces?	Remember	AMEB03:02
14	State the laws of mechanics?	Understand	AMEB03:01
15	Define parallelogram law of forces	Understand	AMEB03:01
16	Explain about trigonometric method?	Understand	AMEB03:02
17	Define equilibrium and equilibrant forces	Understand	AMEB03:01
18	What is a non parallel non concurrent force?	Understand	AMEB03:01
19	Explain the concept of Varignon's theorem?	Understand	AMEB03:01
20	State the law of transmissibility?	Remember	AMEB03:02
PART - B (LONG ANSWER QUESTIONS)			
1	State Lami's theorem with a neat sketch?	Remember	AMEB03:01
2	State the Parallelogram law of forces?	Understand	AMEB03:01
3	State Newton's three laws of motion?	Remember	AMEB03:01
4	What differences exist between Kinetics and Kinematics	Remember	AMEB03:01
5	Compare 'Resultant' and 'Equilibrant'	Remember	AMEB03:01
6	Distinguish between couple and moment.	Understand	AMEB03:01
7	Explain the procedure to find the resultant of several forces acting at a point	Remember	AMEB03:02
8	Determine the magnitude and the direction of the resultant of two forces 7 N and 8 N acting at a point with an included angle of 60o with between them. The force of 7 N being horizontal	Understand	AMEB03:02
9	Two coplanar forces act towards a point with an angle of 450 between them. If their resultant is 100kN and one of the forces is 20kN calculate the other force	Understand	AMEB03:03
10	Two forces act at an angle of 120^0. The bigger forces is 60N and the resultant is perpendicular to the smaller one. Find the smaller force.	Understand	AMEB03:02
11	Determine the magnitude and the direction of the resultant of two forces 15 N and 12 N acting at a point with an included angle of 45^o with between them. The force of 7 N being horizontal	Remember	AMEB03:01

12	Two coplanar forces act towards a point with an angle of 25^0 between them. If their resultant is 100kN and one of the forces is 20kN calculate the other force	Understand	AMEB03:01
13	Two forces act at an angle of 120^0. The bigger forces is 60N and the resultant is perpendicular to the smaller one. Find the smaller force.	Remember	AMEB03:01
14	What differences exist between Kinetics and Kinematics	Remember	AMEB03:01
15	Compare 'Equilibrium' and 'Equilibrant'	Remember	AMEB03:01
16	Distinguish between force and force system.	Understand	AMEB03:01
17	What differences exist between Rigid body and deformable body?	Remember	AMEB03:02
18	Explain about parallel force systems?	Understand	AMEB03:02
19	Explain the procedure for resolution of forces?	Understand	AMEB03:03
20	What is the difference between force diagram and space diagram?	Understand	AMEB03:02
PART - C (PROBLEM SOLVING AND CRITICAL THINKING QUESTIONS)			
1	A force P is applied at 'O' to the string AOB as shown in fig. If the tension in each part of string is 50 N, Find the direction and magnitude of force P for equilibrium conditions. 	Remember	AMEB03:02
2	Determine the resultant of system of forces acting as shown in fig. 	Remember	AMEB03:02
3	A system of connected flexible cables as shown in figure is supporting two vertical forces 240 N and 300 N at points B and D. Determine the forces in various segments of the cable. 	Remember	AMEB03:03

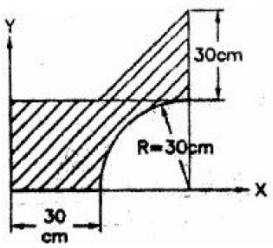
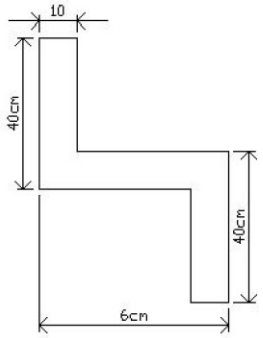
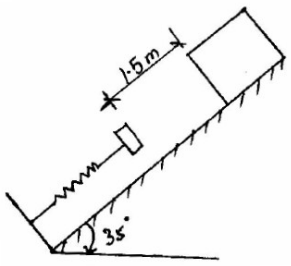
4	Two forces are applied to an eye bolt fastened to a beam. Determine the magnitude and direction of their resultant. 	Remember	AMEB03:02
5	Find the magnitude of two forces such that if they act at right angle, their resultant is $\sqrt{10}$, but they act at 60^0 their resultant is $\sqrt{13}$	Remember	AMEB03:03
6	The five forces 20N, 30N, 40N, 50N and 60N are acting at one of the angular points of a regular hexagon, towards the other five angular points taken in order. Find the direction and magnitude of the resultant force	Understand	AMEB03:02
7	The following forces act at a point a. 30kN inclined at 35^0 towards North to East. b. 22kN towards North c. 30kN inclined at 30^0 towards North to West d. 35kN inclined at 25^0 towards South to West. Find the magnitude and direction of the resultant force.	Understand	AMEB03:02
8	Determine the horizontal force P to be applied to a block of weight of 1800N to hold it in position on a smooth inclined plane, which makes an angle 30^0 with horizontal reference line.	Understand	AMEB03:03
9	A uniform plank ABC of weight of 30N and 2m long is supported one end A and at a point B 1.4m from A. find the maximum weight W that can be placed at C, so that the plank does not topple	Understand	AMEB03:02
10	The force of magnitudes 10KN, 20KN, 25KN & 40KN are concurrent in space and are directed through the points A(3,2,5), B(1,7,4), C(4,-2,4) & D(-2,4,-3) respectively. Determine the resultant of the force system of forces. Given that system of forces are concurrent at the origin.	Understand	AMEB03:03
MODULE – II			
FRICTION AND BASICS STRUCTURAL ANALYSIS			
PART - A (SHORT ANSWER QUESTIONS)			
1	Explain the types of friction with examples?	Understand	AMEB03:04
2	Define the following i) Friction ii) Angle of friction	Understand	AMEB03:04
3	Define the following (i)Angle of Repose (ii)Coefficient of frictions	Understand	AMEB03:04
4	Differentiate between static and dynamic friction?	Understand	AMEB03:01
5	State laws of solid friction	Understand	AMEB03:04
6	What do you understand by the limiting friction? And define angle of repose.	Remember	AMEB03:04
7	What is the principle of a screw jack?	Remember	AMEB03:04
8	Define a beam? And explain different types of beams with neat sketches?	Remember	AMEB03:06
9	Define the term Limiting friction	Understand	AMEB03:04
10	Differentiate between beam and column	Remember	AMEB03:06
11	What do you understand by the limiting friction? And define angle of repose.	Understand	AMEB03:04
12	What is the principle of a differential screw jack?	Understand	AMEB03:04
13	Define a beam? And explain different types of beams with neat sketches?	Understand	AMEB03:04
14	Define the term Limiting friction	Understand	AMEB03:01
15	Differentiate between beam and column	Understand	AMEB03:04
16	What are the wedges and their applications?	Remember	AMEB03:04

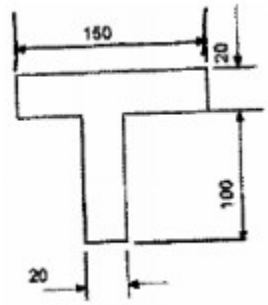
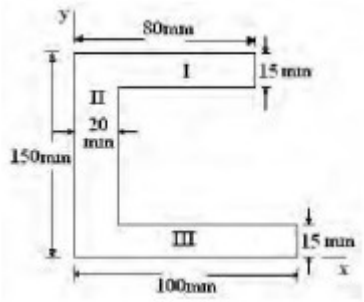
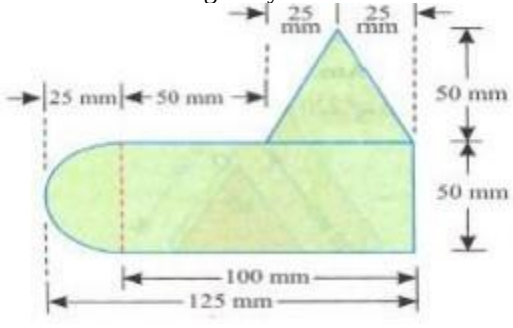
17	What is angle of repose?	Remember	AMEB03:04
18	What is rolling friction?	Remember	AMEB03:06
19	Define the wheel resistance?	Understand	AMEB03:04
20	What is the maximum and minimum force required in friction?	Remember	AMEB03:06
PART - B (LONG ANSWER QUESTIONS)			
1	Derive an expression for the minimum effort required along the inclined plane to keep a body in equilibrium position when it is at point of sliding downwards on a inclined plane.	Remember	AMEB03:06
2	Solve reactions at points A & B 	Understand	AMEB03:06
3	Explain the difference between coefficient of friction and angle of friction	Remember	AMEB03:04
4	Derive an expression for the maximum force required along the horizontal plane to keep a body in equilibrium position when it is at point of sliding downwards on a inclined plane.	Remember	AMEB03:04
5	Two 6^0 of wedges are used to push a block horizontally as shown figure. Calculate the minimum force reqiured to push the block of weight 10KN. Take coefficient of friction as 0.25 for all contact surfaces. 	Remember	AMEB03:04
6	A body of weight 300N is lying on arough horizontal surface having coefficient of friction as 0.3. find the magnitude of force, which can move the body, while acting at an angle $25^0$with the horizontal.	Remember	AMEB03:04
7	A body resting on a rough horizontal plane, required a pull of 180N inclined at 30^0 to the plane just to move it. It is found that a push of 220N inclined at 30^0 to the plane just to move the body. Determine the weight of the body and coefficient of friction.	Remember	AMEB03:04
8	A object of weight 100N is kept in position on a inclined 30^0 to the horizontal by a horizontal applied force. If the coefficient of friction of the surface of the inclined plane is 0.25. determine the minimum magnitude of force.	Remember	AMEB03:04

9	Find the forc and its nature in member AD and BC for given cantilever truss loaded by 40KN as shown figure  Fig. 7.1(a)	Remember	AMEB03:05
10	Find the forces in the members DF, DE, CE, and EF by method of joints for the pin-jointed frame as shown in figure  Fig. 7.2	Understand	AMEB03:05
11	A beam AB is supported and loaded as shown in fig.1. Find the reactions at the supports. 	Understand	AMEB03:06
12	A block of mass M = 10 kg is sitting on a surface inclined at angle θ = 45°. Given that the coefficient of static friction is μ_s = 0.5 between block and surface, what is the minimum force F necessary to prevent slipping? What is the maximum force F that can be exerted without causing the block to slip?	Remember	AMEB03:06
13	A conveyor is dumping sand onto a cone shaped pile. Given that the coefficient of static friction between the sand grains is μ_s, what is the maximum angle θ?	Understand	AMEB03:06
14	A uniform ladder of length L is leaning against the side of a building, as shown. A person of mass m = 75 kg is standing on it. The mass of the ladder is M = 10 kg. The coefficient of static friction between the ground and ladder is μ_{s1} = 0.5, and the coefficient of static friction between the wall and ladder is μ_{s2} = 0.3. What is the minimum angle θ so that the ladder doesn't slip?	Remember	AMEB03:04
15	Two boards are bolted together with two bolts, as shown. The squeeze force between the boards is 500 lbs. If the shear strength of each bolt is 5000 lbs and the coefficient of static friction between the boards is μ_s = 0.5, what is the maximum force F that can be applied to the boards and not pull them apart?	Remember	AMEB03:04

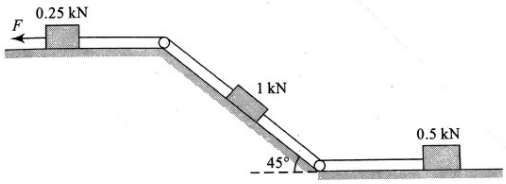
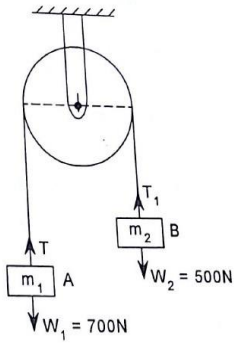
16	A 50 kg crate is being pushed on a horizontal floor at constant velocity. Given that the coefficient of kinetic friction between crate and floor is μ_k= 0.1, what is the push force F?	Remember	AMEB03:04
17	In the previous problem we are given that the coefficient of static friction between crate and floor is μ_s = 0.2. What is the minimum force F to overcome friction with the floor?	Remember	AMEB03:04
18	Two children throw a rope over a tree branch and hang off each end. The children have a mass of 40 kg and 50 kg. What is the minimum coefficient of static friction between rope and tree branch so that the rope doesn't slip? To solve this consider the general equation $T_2 = T_1 e^{\mu\theta}$, where T_1 and T_2 are the rope tensions on the two ends (with $T_2 > T_1$), $\mu$is the coefficient of static friction between rope and tree branch, and θ is the angle of contact between rope and branch, in radians. For example, if the rope wraps completely around the branch then the angle $\theta = 2\pi$.	Remember	AMEB03:04
19	The minimum force required to prevent slipping is the minimum force that will prevent the block from sliding down the incline. It is $F_{min} = 10g\sin(45°) - 10g\cos(45°)\times 0.5$. The maximum force that can be exerted without causing the block to slip is the maximum force that can be exerted without causing the block to slide up the incline. It is $F_{max} = 10g\sin(45°) + 10g\cos(45°)\times 0.5$.	Remember	AMEB03:04
20	To pull the boards apart the friction force between the boards, plus the shear strength of the bolts, must be exceeded. Therefore the maximum pull force must be below the force needed to do this. Hence, $F_{max} = 2\times 5000 + 500\times 0.5$.	Remember	AMEB03:05
	PART – C (PROBLEM SOLVING AND CRITICAL THINKING)		
1	A ladder 6m long and with 300N weight is resting against a wall at an angle of 60^0 to the ground. A man weighing 750N climbs the ladder. At what position along the ladder from bottom does he induce slipping? The coefficient of friction for both wall and the ground with ladder is 0.2.	Understand	AMEB03:04
2	A uniform ladder of length of 3.25m & weight of 250N is placed against a smooth wall with its lower end 1.25M from the wall. Coefficient of friction between the ladder and floor is 0.3. what is the frictional force acting on the ladder at the point of contact between the ladder and the floor? Show that the ladder will remain in equilibrium in this position.	Understand	AMEB03:04
3	A block of mass 150kg is raised by a 10^0wedge weight 50kg under it and by appling a horizontal force at its end. Taking coefficient of friction between all surfaces of contact as 0.3, find minimum force that should be applied to raise the block.  Fig. 8.18	Remember	AMEB03:04
4	A ladder of 7M length rests against a vertical wall with which it makes an angle of 45^0. The coefficient of friction for wall and the flooe are 0.33 and 0.50 respectively. If a man whose weigth is one-half of that of the ladder. How far he will be able to climb the ladder.	Remember	AMEB03:04
5	A screw jack has mean diameter of 50mm and pitch 10mm. if the coefficient of friction between its screw and nut is 0.15, find the effort required at the end of the 700mm long handle to raise a load of 10KN	Remember	AMEB03:04

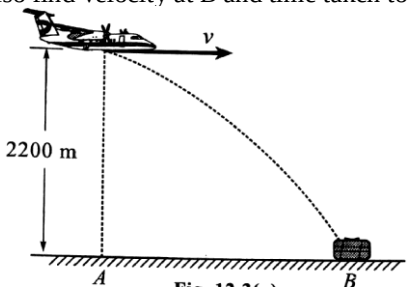
6	A screw press is used to compress books. The thread is adouble thread (square head) with a pitch of 4mm and a mean diameter of 25mm. the coefficient of friction for the contact surface of the thread is 0.3. find the torque for a pressure of 500N.	Understand	AMEB03:04
7	A screw jack with single start square threads has outside and inside diameters of the thread 68mm and 52mm respectively. The coefficeint of friction is 0.1for all the pairs of surfaces in contact. If the length of lever is 0.5M, find the force required to lift the load of 2KN.	Understand	AMEB03:04
8	A mean radius of the screw of a square threaded screw jack is 25mm. the pitch of thread is 7.5mm. if the coefficient of the friction is 0.12, what effort applied at the end of the lever 60cm length is needed to raise a weight of 2KN	Understand	AMEB03:04
9	A differiential screw jack has a pitch of 12mm, 10mm and 300mm arm length. What will be the efficiency of the machine, if it can lift aload of 7.5KN by an effort of 30N.	Understand	AMEB03:04
10	In a differential screw jack has pitch of 10mm and 7mm. if the efficiency of machine is 28%. Find the effort required at the end of the arm 360mm long to lift aload of 5KN.	Understand	AMEB03:04
MODULE-III			
CENTROID AND CENTRE OF GRAVITY AND VIRTUAL WORK AND ENERGY METHOD			
PART - A (SHORT ANSWER QUESTIONS)			
1	Distinguish between centroid and center of gravity.	Understand	AMEB03:07
2	Define polar moment of inertia	Understand	AMEB03:07
3	Define Radius of gyration	Remember	AMEB03:07
4	State the parallel axis theorem	Remember	AMEB03:07
5	State the perpendicular axis theorem	Remember	AMEB03:08
6	State the principle of conservation of energy	Understand	AMEB03:10
7	Explain the term work done by friction force	Understand	AMEB03:08
8	Explain the term work done by spring force	Remember	AMEB03:10
9	Define the term power.	Remember	AMEB03:10
10	Describe the various methods of finding the centre of gravity of a body	Remember	AMEB03:10
11	Explain the pappus-guldinus theorems?	Understand	AMEB03:07
12	What is surface of revolution?	Understand	AMEB03:07
13	What is volume of revolution?	Remember	AMEB03:07
14	Define moment of inertia?	Remember	AMEB03:07
15	What is mass moment of inertia?	Remember	AMEB03:08
16	Explain the theorems of moment of inertia?	Understand	AMEB03:10
17	Define radius of gyration?	Understand	AMEB03:08
18	What is section modulus?	Remember	AMEB03:10
19	What is Polar moment of inertia?	Remember	AMEB03:10
20	Define perpendicular axis theorem?	Remember	AMEB03:10
PART – B (LONG ANSWER QUESTIONS)			
1	State and proof the parallel axis theorem.	Remember	AMEB03:07
2	State and proof the perpendicular axis theorem.	Remember	AMEB03:07
3	State and proof the Pappus guildinus theorem for area and volume.	Remember	AMEB03:07

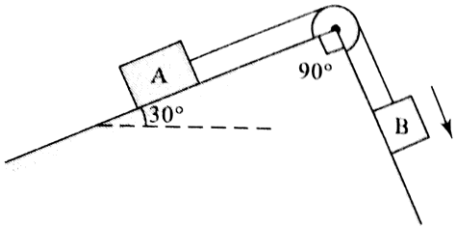
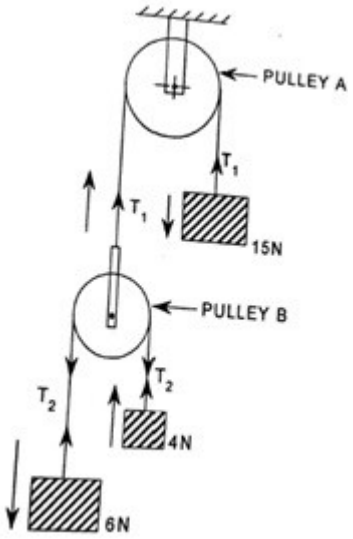
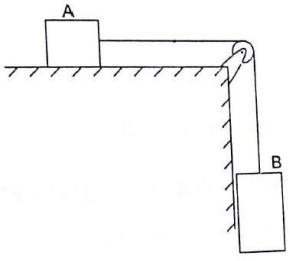
4	Determine the co-ordinates of centroid of the shaded area shown in figure. 	Remember	AMEB03:08
5	Design Moment of Inertia about the co-ordinate axes of plane area shown in fig. Also find Polar Moment of Inertia. 	Remember	AMEB03:07
6	Derive an expression for centroid of semi-circle.	Remember	AMEB03:07
7	Derive an expression for MI for a rectagle section.	Remember	AMEB03:07
8	State and prove work energy principle	Remember	AMEB03:10
9	Explain the following terms 1. Work done by weight force 2. Work done by friction force and 3. Work done by spring force	Remember	AMEB03:12
10	A force of 500N is acting at 30^0 to the horozontal on a block of mass 50kg resting on a horizontal surface.determine the velocity after the block has travelled a distance of 10M. coefficient of kinetic friction is 0.5.	Understand	AMEB03:12
11	A block of mass 50 kg slides down a 35° incline and strikes a spring 1.5 m away from it as shown in Fig. The maximum compression of the spring is 300 mm when the block comes to rest. If the spring constant is 1 kN/m, Solve the coefficient of kinetic friction between the block and the plane. 	Remember	AMEB03:13
12	A pump lifts $40m^3$ of water to aheight of 50m and delivers it with a velocity of 5m/s. what is the amount of energy spent during the process? If the job is done in half an hour, what is the input power of the pump which has an overall efficiency of 70%	Understand	AMEB03:12
13	Find out I_{xx}, I_{yy} and I_{zz} for the homogeneous right circular cylinder of length l and radius r. The mass of the cylinder is M.	Remember	AMEB03:07
14	Find out I_{xx}, I_{yy} and I_{zz} of a hollow sphere of mass M. The radius of the sphere is R and thickness t.	Remember	AMEB03:07
15	Prove that second moment of area of a circle of diameter d about a diametral axis is $\pi/4d^2$	Remember	AMEB03:07

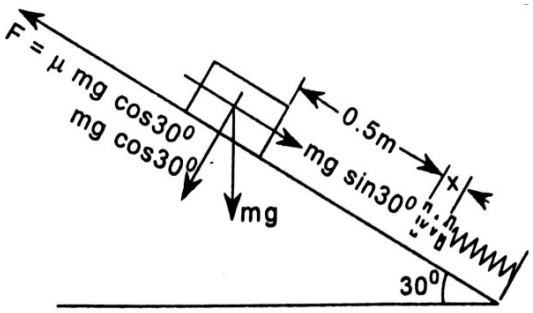
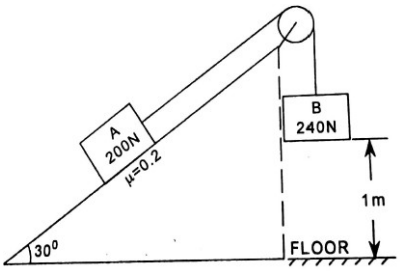
16	The radius of gyration of a plane area is 20 cm and the corresponding second moment of area is 1 cm^4. Find out the area of the plane	Remember	AMEB03:08
17	A uniform rod of mass *M* is pinned at one end and a force *P* is applied at the other end. A spring of spring constant *k* is attached at the mid-point of the rod. Find out the critical load above which the spring will become unstable.	Remember	AMEB03:07
18	A disk of radius *r* is having the angular velocity ω and an angular acceleration of α. A particle P moves in the opposite direction around the circumference with uniform relative velocity v_r. Find the absolute acceleration of P	Remember	AMEB03:07
19	The acceleration of a particle is given by $\vec{a} = 3t\hat{i} - 2t^2\hat{j} + 5t^3\hat{k}$ m/sec^2 Particle starts with zero velocity at the origin. After 5 second find out particle's position, displacement, distance travelled, velocity speed and acceleration.	Remember	AMEB03:07
20	Obtain the velocity and acceleration of a slider crank mechanism as a function of θ.	Remember	AMEB03:07
PART – C (PROBLEM SOLVING AND CRITICAL THINKING)			
1	Find the centre of gravity of the "T "lamina as shown in figure. All dimensions are in mm 	Remember	AMEB03:07
2	Find the centroid of the plane lamina shown in Figure 	Remember	AMEB03:07
3	Uniform lamina shown in fig consists of rectangle, a semi circle and a triangle. Find the centre of gravity. 	Remember	AMEB03:07
4	Derive an expression for centroid of triangular area.	Remember	AMEB03:07
5	Derive an expression for centroid of circle.	Remember	AMEB03:07

6	Derive an expression for centroid of rectangle area.	Understand	AMEB03:13
7	Determine the distance in which a car moving at 90kmph can come to rest after the power switched off if coefficient of friction is 0.8 on road and tyres.	Understand	AMEB03:10
8	Derive the expression for range along an inclined plane. What is the necessary condition for obtaining maximum range along an inclined plane?	Remember	AMEB03:15
9	A body *A* is projected vertically upwards from the top of a tower with a velocity of 40m/s, the tower being 180m high. After *t* seconds, another body *B* is allowed to fall from the same point. Both the bodies reach the ground simultaneously. Calculate *t* and the velocities of *A* and *B* on reaching the ground.	Remember	AMEB03:14
10	A mean radius of the screw of a square threaded screw jack is 25mm. the pitch of thread is 7.5mm. if the coefficient of the friction is 0.12, what effort applied at the end of the lever 60cm length is needed to raise a weight of 2KN	Remember	AMEB03:15
MODULE-IV			
PARTICLE DYNAMICS AND INTRODUCTION TO KINETICS			
PART – A (SHORT ANSWER QUESTIONS)			
1	Define the terms velocity and acceleration	Understand	AMEB03:13
2	Define angular displacement, angular velocity and angular acceleration	Understand	AMEB03:13
3	Define the terms Kinetics and kinematics	Understand	AMEB03:13
4	Define the term rigid body	Remember	AMEB03:13
5	State D'Alembert's principle.	Remember	AMEB03:13
6	Compare Newton's second law with D'Alembert's principle.	Remember	AMEB03:13
7	Define the term momentum of a body with units	Remember	AMEB03:13
8	Distinguish between mass and weight.	Remember	AMEB03:13
9	Write governing equations of velocity and acceleration of fixed axis rotation	Remember	AMEB03:13
10	Define instantaneous centre of velocity	Remember	AMEB03:13
11	Define the terms velocity and acceleration	Understand	AMEB03:13
12	Define angular acceleration	Understand	AMEB03:13
13	Define the terms Kinetics and kinematics	Understand	AMEB03:13
14	Define the term rigid body	Remember	AMEB03:13
15	State D'Alembert's principle.	Remember	AMEB03:13
16	Compare Newton's second law with D'Alembert's principle.	Remember	AMEB03:13
17	Define the term momentum of a body with units	Remember	AMEB03:13
18	Distinguish between mass and weight.	Remember	AMEB03:13
19	Write governing equations of velocity and acceleration of fixed axis rotation	Remember	AMEB03:13
20	Define instantaneous centre of velocity	Remember	AMEB03:13
PART – B (LONG ANSWER QUESTIONS)			
1	Derive an expression F=ma	Understand	AMEB03:13
2	The rectilinear motion of a particle is defined by the displacement-time equation as $x=x_0+v_0t+(1/2)at^2$. Find the displacement and velocity at time t=2s while x_0=250mm, v_0=125mm/s and a=0.5mm/s^2.	Remember	AMEB03:13

3	A particle starts from rest and moves along a straight line with constant acceleration a. If it acquires a velocity v=3 mm/s^2, after having travelled a distance S=7.5m, find the magnitude of the acceleration.	Remember	AMEB03:14
4	A flywheel of diameter 50cm starts from rest with constant angular acceleration of 2 rad/s^2. Determine the tangential and the normal components of acceleration of a point on its rim 3s after the motion began.	Understand	AMEB03:13
5	Derive the expression for range along an inclined plane. What is the necessary condition for obtaining maximum range along an inclined plane?	Understand	AMEB03:14
6	A car of mass 1000kg descends a hill of $\sin^{-1}(1/6)$. The frictional resistance to motion is 200N. Calculate using work energy method, the average braking effort to bring the car to rest from 48kmph in 30m.	Understand	AMEB03:13
7	A hammer of mass 400kg falls through a height of 3m on a pile of negligible mass. If it drives the pile 1m into the ground, find the average resistance of the ground for penetration.	Remember	AMEB03:13
8	A mass of 5kg is dropped from a height of 2 metres upon a spring whose stiffness is 10N/mm. Calculate the speed of the mass when a spring is compressed through a distance of 100mm.	Understand	AMEB03:13
9	For the system of connected bodies as shown in the figure given below, calculate the force F required to make the motion impending to the left. Use the method of virtual work and take coefficient of friction for all contiguous surfaces except pulleys as 0.25. 	Understand	AMEB03:13
10	A pulley whose axis passes through the centre 'O' carries a load as shown in figure given below. Neglect the inertia of pulley and assuming that the cord is inextensible; determine the acceleration of the block A. How much weight should be added to or taken away from the block A if the acceleration of the block A is required to be g/3 downwards? 	Understand	AMEB03:13
11	A particle starts from rest and moves along a straight line with constant acceleration a. If it acquires a velocity v=3 mm/s^2, after having travelled a distance S=7.5m, find the magnitude of the acceleration.	Understand	AMEB03:13
12	A flywheel of diameter 50cm starts from rest with constant angular acceleration of 2 rad/s^2. Determine the tangential and the normal components of acceleration of a point on its rim 3s after the motion began.	Remember	AMEB03:13
13	Derive the expression for range along an inclined plane. What is the necessary condition for obtaining maximum range along an inclined plane?	Remember	AMEB03:14

14	A car of mass 1000kg descends a hill of $\sin^{-1}(1/6)$. The frictional resistance to motion is 200N. Calculate using work energy method, the average braking effort to bring the car to rest from 48kmph in 30m.	Understand	AMEB03:13
15	A hammer of mass 400kg falls through a height of 3m on a pile of negligible mass. If it drives the pile 1m into the ground, find the average resistance of the ground for penetration.	Understand	AMEB03:14
16	A mass of 5kg is dropped from a height of 2 metres upon a spring whose stiffness is 10N/mm. Calculate the speed of the mass when a spring is compressed through a distance of 100mm.	Understand	AMEB03:13
17	Derive an expression F=ma	Remember	AMEB03:13
18	The rectilinear motion of a particle is defined by the displacement-time equation as $x=x_0+v_0t+(1/2)at^2$. Find the displacement and velocity at time t=2s while x_0=250mm, v_0=125mm/s and $a=0.5mm/s^2$.	Understand	AMEB03:13
19	A particle starts from rest and moves along a straight line with constant acceleration a. If it acquires a velocity $v=3\ mm/s^2$, after having travelled a distance S=7.5m, find the magnitude of the acceleration.	Understand	AMEB03:13
20	A hammer of mass 400kg falls through a height of 3m on a pile of negligible mass. If it drives the pile 1m into the ground, find the average resistance of the ground for penetration.	Understand	AMEB03:13
PART – C (PROBLEM SOLVING AND CRITICAL THINKING)			
1	An aeroplane is flying in horizontal direction of 540 km/hr and at a height of 2200m as shown in figure. When it is vertically above the point *A* on the ground, a body is dropped from it. The body strike the ground at point *B*. Calculate the distance *AB* ignoring air resistance. Also find velocity at *B* and time taken to reach *B*. 	Understand	AMEB03:13
2	A particle starts moving along a straight line with initial velocity of 25m/s, from O under a uniform acceleration of -2.5 m/s2. Deterime (i) Velocity, displacement and the distance travelled at t= 5 sec (ii) How long the particle moves in the same direction? What is its velocity, displacement and the distance covered then? (iii) The instantaneous velocity , displacement and the distance covered at t=15 sec (iv) The time required to come back to O, velocity, displacement and distance covered then (v) Instantaneous velocity, , displacement and distance covered at t=25 sec	Remember	AMEB03:13
3	A stone is dropped from the top of a tower. When it has travelled a distance of 10m, another stone is dropped from a point 38m below the top of the tower. If both the stones reach the ground at the same time, calculate (i) The height of the tower and (ii) The velocity of the stone when they reach the ground	Understand	AMEB03:12

4	Two blocks A and B are connected by an inextensible string moving over a frictionless pulley as shown in the figure given below. If the blocks are released from rest, determine the velocity of the system after the travel of 4s. Take the masses of blocks A and B as 20 and 60 kg respectively and coefficient of friction for all the contiguous surfaces as 0.3 	Understand	AMEB03:13
5	A body *A* is projected vertically upwards from the top of a tower with a velocity of 40m/s, the tower being 180m high. After *t* seconds, another body *B* is allowed to fall from the same point. Both the bodies reach the ground simultaneously. Calculate *t* and the velocities of *A* and *B* on reaching the ground.	Understand	AMEB03:13
6	Two cars *A* and *B* travelling in the same direction get stopped at a traffic signal. When the signal turns green, car *A* accelerates at 0.75 m/s^2. 1.75 seconds later, car *B* starts and accelerates at 1.1 m/s^2. Determine i when and where *B* will overtake *A* and ii The speed of each car at that time.	Understand	AMEB03:14
7	A system of weights connected by string passing over pulleys A and B is shown in figure given below. Find the acceleration of three weights assuming weightless strings and ideal conditions for pulleys 	Remember	AMEB03:13
8	Two blocks A and B are connected with inextensible string as shown in figure given below. If the system is released from rest, determine the velocity of block A after if has moved 1.5m. Assume the coefficient of friction between block A and the plane is 0.25. Masses of block A and B are 200kg and 300kg respectively. 	Understand	AMEB03:13

9	A block of mass 5kg resting a 30º inclined plane is released. The block after travelling a distance of 0.5m along inclined plane hits a spring of stiffness 15N/cm as shown in figure given below. Find the maximum compression of spring. Assume coefficient of friction between block and the inclined plane as 0.2. 	Understand	AMEB03:13
10	Two blocks of A (200N) and B (240N) are connected as shown in figure given below. When the motion begins, the block B is 1m above the floor. Assuming the pulley to be frictionless and weightless, determine (i) The velocity of block A when the block B touches the floor (ii) How far the block A will move up the plane? 	Understand	AMEB03:13

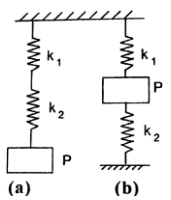
MODULE-V

MECHANICAL VIBRATIONS

PART - A (SHORT ANSWER QUESTIONS)

1	Define simple harmonic motion. Give examples	Remember	AMEB03:15
2	Define the terms amplitude and Oscillations.	Understand	AMEB03:15
3	Define the terms periodic time and frequency and give their units.	Remember	AMEB03:16
4	Write the equation of simple harmonic motion with notations	Understand	AMEB03:15
5	Draw the graphical representation for displacement, velocity and acceleration equations of SHM	Remember	AMEB03:15
6	Discuss the different types of vibrations?	Understand	AMEB03:16
7	Write the expression for time period of a simple pendulum	Understand	AMEB03:16
8	Write the expression for time period of a compound pendulum	Understand	AMEB03:15
9	Write the expression for time period of a torsional pendulum	Understand	AMEB03:16
10	Define the term free vibration.	Understand	AMEB03:15
11	Define simple harmonic motion. Give examples	Remember	AMEB03:15
12	Define the terms amplitude and Oscillations.	Understand	AMEB03:15

13	Define the terms periodic time and frequency and give their units.	Remember	AMEB03:16
14	Write the equation of simple harmonic motion with notations	Understand	AMEB03:15
15	Draw the graphical representation for displacement, velocity and acceleration equations of SHM	Remember	AMEB03:15
16	Discuss the different types of vibrations?	Understand	AMEB03:16
17	Write the expression for time period of a simple pendulum	Understand	AMEB03:16
18	Write the expression for time period of a compound pendulum	Understand	AMEB03:15
19	Write the expression for time period of a torsional pendulum	Understand	AMEB03:16
20	Define the term free vibration.	Understand	AMEB03:15
PART - B (LONG ANSWER QUESTIONS)			
1	Derive an expression for the time period of a simple pendulum.	Remember	AMEB03:15
2	Derive an expression for the time period of a compound pendulum.	Remember	AMEB03:16
3	Derive an expression for the time period of a torsional pendulum.	Remember	AMEB03:16
4	A body performing simple harmonic motion has a velocity 12m/s when the displacement is 50mm and 3m/s when the displacement is 100mm, the displacement measured from the midpoint. Calculate the frequency and amplitude of the motion. What is the acceleration when the displacement is 75mm.	Remember	AMEB03:16
5	A body moving with SHM has amplitude of 1m and period of oscillation of 2 seconds. What will be its velocity and acceleration at 0.4s after passing an extreme position?	Remember	AMEB03:16
6	A body moving with SHM has amplitude of 30cm and the period of one complete oscillation is 2s. What will be the speed and acceleration of the body 2/5 of a second after passing the mid position	Remember	AMEB03:15
7	A vertical shaft 5mm in diameter and 1.2m in length has its upper end fixed to the ceiling. At the lower end it carries a rotor of diameter 180mm and weight 30N. The modulus of rigidity for the material of the rotor is $0.85x10^5$ N/mm^2. Calculate the frequency of torsional vibrations for the system.	Remember	AMEB03:16
8	Derive an expression for the time period for a spring mass system subjected to free vibration.	Understand	AMEB03:15
9	A weight of 10N attached to a spring oscillates at a frequency of 60 oscillations per minute. If the maximum amplitude is 30mm, find the tension induced in the spring. Also find the spring constant and the maximum velocity in the spring.	Understand	AMEB03:15
10	A pendulum having a time period of 1s is installed in a lift. Determine its time period when a The lift is moving upwards with an acceleration of $g/10m/s^2$ b The lift is moving downwards with an acceleration of $g/10m/s^2$	Remember	AMEB03:15
11	A body performing simple harmonic motion has a velocity 12m/s when the displacement is 50mm and 3m/s when the displacement is 100mm, the displacement measured from the midpoint. Calculate the frequency and amplitude of the motion. What is the acceleration when the displacement is 75mm.	Remember	AMEB03:15

12	A body moving with SHM has amplitude of 1m and period of oscillation of 2 seconds. What will be its velocity and acceleration at 0.4s after passing an extreme position?	Remember	AMEB03:16
13	A body moving with SHM has amplitude of 30cm and the period of one complete oscillation is 2s. What will be the speed and acceleration of the body 2/5 of a second after passing the mid position.	Remember	AMEB03:16
14	A vertical shaft 5mm in diameter and 1.2m in length has its upper end fixed to the ceiling. At the lower end it carries a rotor of diameter 180mm and weight 30N. The modulus of rigidity for the material of the rotor is $0.85x10^5$ N/mm^2. Calculate the frequency of torsional vibrations for the system.	Remember	AMEB03:16
15	Derive an expression for the time period of a simple pendulum.	Remember	AMEB03:16
16	Derive an expression for the time period of a compound pendulum.	Remember	AMEB03:15
17	Derive an expression for the time period for a spring mass system subjected to free vibration	Remember	AMEB03:16
18	Derive an expression for the time period of a torsional pendulum.	Understand	AMEB03:15
19	A vertical shaft 5mm in diameter and 1.2m in length has its upper end fixed to the ceiling. At the lower end it carries a rotor of diameter 180mm and weight 30N. The modulus of rigidity for the material of the rotor is $0.85x10^5$ N/mm^2. Calculate the frequency of torsional vibrations for the system.	Understand	AMEB03:15
20	Derive an expression for the time period for a spring mass system subjected to free vibration.	Remember	AMEB03:15
PART – C (PROBLEM SOLVING AND CRITICAL THINKING)			
1	In a mechanism, a cross head moves in straight guide with simple harmonic motion. At distance of 125mm and 200mm from its mean position, it has velocities of 6m/s 3m/s respectively. Find the amplitude, maximum velocity and period of vibration. If the cross head weighs 2N, calculate the maximum force on it in the direction of motion.	Remember	AMEB03:15
2	A clock with compound pendulum is running correct time at a place where the acceleration due to gravity is 9.81 m/s2. Find the length of the pendulum. This clock is taken at a place where the acceleration due to gravity is 9.8m/s2. Find how much the clock will lose or gain in a day at this place?	Remember	AMEB03:16
3	A load is suspended from a vertical spring. At rest it deflects the spring 12mm. Calculate the time period. Ifit is displaced further 25mm below the ret position and then released.	Understand	AMEB03:15
4	The frequency of free vibrations of a weight W with spring constant k is 12 cycles/s. When the extra weight of 20N is coupled with weight W, the frequency reduced to 10 cycles/s. Find the weight W and stiffness k of the spring.	Remember	AMEB03:17
5	Determine the period of vibration of a weight P attached to springs of stiffness k1 and k2 in two different cases as shown in figure given below.  	Remember	AMEB03:16

6	A particle is moving with its acceleration directed to and proportional to its distance from a fixed point. When the distance of the particle from equilibrium position has values of 1.3m and 1.8m, the corresponding velocities are 5m/s and 2 m/s. Determine a Amplitude and time period of oscillations b Maximum velocity and maximum acceleration	Understand	AMEB03:15
7	A vertical shaft 5mm in diameter and 1m in length has its upper end fixed to the ceiling. At the lower end it carries a rotor of diameter 200mm and weight 20N. The modulus of rigidity for the rotor is $0.85x10^5$ N/mm^2. Calculate the frequency of torsional vibration for the system.	Remember	AMEB03:15
8	A vertical shaft 7mm in diameter and 1.7m in length has its upper end fixed to the ceiling. At the lower end it carries a rotor of diameter 180mm and weight 50N. The modulus of rigidity for the material of the rotor is $0.95x10^5$ N/mm^2. Calculate the frequency of torsional vibrations for the system.	Understand	AMEB03:15
9	A body moving with SHM has amplitude of 50cm and the period of one complete oscillation is 3s. What will be the speed and acceleration of the body 1/5 of a second after passing the mid position	Understand	AMEB03:15
10	A body performing simple harmonic motion has a velocity 20m/s when the displacement is 40mm and 3m/s when the displacement is 120mm, the displacement measured from the midpoint. Calculate the frequency and amplitude of the motion. What is the acceleration when the displacement is 85mm.	Understand	AMEB03:16

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