# Bhubanananda Orissa School of Engineering


## ENGINEERING MECHANICS QUESTION BANK

**YEAR-2019-20**
**SEM-1st and 2nd**

**Prepared by**

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**Lecturer (Mechanical)**

**SET-1**

# ENGG. MECHANICS

## (MET-321)

## Full mark: 80

## Time-3 hrs

## Section-1

## All questions are compulsory <2x10>

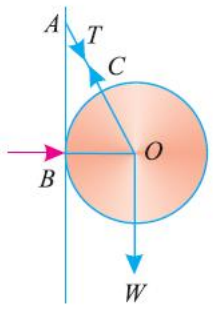
1. **(a) State the principle of transmissibility of force with simple sketch?**
   **(b) Define rigid body.**
   **(c) State triangle laws of forces.**
   **(d) State Newton's second law of motion.**
   **(e) Define the following terms? (a) Coplanar forces (b) concurrent forces**
   **(f) Define coefficient of friction.**
   **(g) Define centre of gravity.**
   **(h) Define Mechanical advantage and velocity ratio.**
   **(i) What is the difference between a resultant force and equilibrant force?**
   **(j) Define coefficient of restitution.**

## Section-2

## Answer any six <6x10>

2. **(a) State and prove Varignon's theorem.** **2x5**

**(b) A smooth sphere of weight *W* is supported by a string fastened to a point *A* on the smooth vertical wall. The other end is in contact with point *B* on the wall as shown in the Fig.**




**If length of the string *AC* is equal to radius of the sphere, find tension (*T*) in the string and reaction of the wall.**

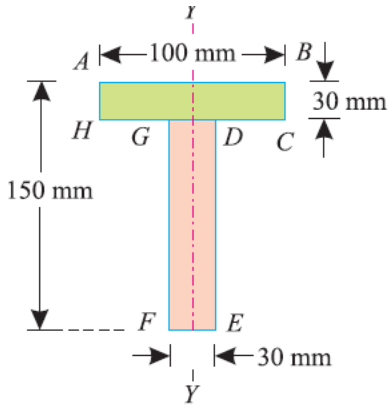
**3. (a) State the necessary and sufficient condition for static equilibrium of a particle in two dimensions** **2**

**(b) State the Coulomb's laws of friction.** **3**

**(c) A body of weight 300 N is lying on a rough horizontal plane having a coefficient of friction as 0.3. Find the magnitude of the force, which can move the body, while acting at an angle of 25° with the horizontal.** **5**

**4. (a) What do you understand by reversibility of a machine? Explain the difference between reversible and self locking machine.** **5**

**(b) Find the centre of gravity of a 100 mm × 150 mm × 30 mm T-section.** **5**




**5. (a) Define momentum.** **2**

**(b) What is recoil of a gun?** **2**

**(c) A ball impinges directly on a similar ball at rest. The first ball is reduced to rest by the impact. Find the coefficient of restitution, if half of the initial kinetic energy lost by the impact.** **6**

**6. (a) A multiple unit electric train has 800 tonnes mass. The resistance to motion is 100 N per tonne of the train mass. If the electric motors can provide 200 KN tractive force, how long does it take to accelerate the train to a speed of 90 km/hr from rest.** **5**

**(b) A scooter starts from rest and moves with a constant acceleration of 1.2 m/s2. Determine its velocity, after it has travelled for 60 meters.** **3**

**(c) State parallel axis theorem.** **2**

**7. (a) A beam 3 m long weighing 400 N is suspended in a horizontal position by two vertical strings, each of which can withstand a maximum tension of 350 N only. How far a body of 200 N weight be placed on the beam, so that one of the strings may just break?** **5**

**(b) The following forces act at a point:** **5**

**(i) 20 N inclined at 30° towards North of East.**

**(ii) 25 N towards North.**

**(iii) 30 N towards North West and**

**(iv) 35 N inclined at 40° towards South of West.**

**Find the magnitude and direction of the resultant force.**

**SET-2**

# ENGG. MECHANICS

## (MET-321)

## Full mark: 80

## Time-3 hrs

## Section-1

## All questions are compulsory <2x10>

1. **(a) State the principle of superposition of force with simple sketch?**
   **(b) Define couple and moment.**
   **(c) State parallelogram laws of forces.**
   **(d) Define Kinetics and Kinematics.**
   **(e) What is the condition in terms of efficiency for a machine to be self-locking?**
   **(f) Define angle of friction.**
   **(g) State D'Alembert's principle.**
   **(h) Define Newton's first law of motion.**
   **(i) Where the CG of the triangle lies?**
   **(j) Define recoil of a gun.**

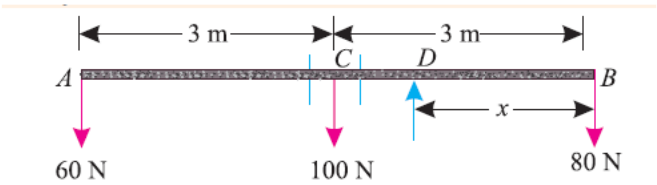
## Section-2

## Answer any six <6x10>

2. **(a) A push of 180 N and pull of 350 N act simultaneously at a point. Find the resultant of the forces, if the angle between them be 135°. 4**

**(b) The forces 20 N, 30 N, 40 N, 50 N and 60 N are acting at one of the angular points of a regular hexagon, towards the other five angular points, taken in order. Find the magnitude and direction of the resultant force. 6**

3. **(a) A uniform beam AB of weight 100 N and 6 m long had two bodies of weights 60 N and 80 N suspended from its two ends as shown in Fig. Find analytically at what point the beam should be supported, so that it may rest horizontally. 5**




**(b) A block of weight 105 N hangs from a point C. AC is inclined at $60^0$ to the horizontal and BC at $45^0$ to the vertical as shown in Fig.(a) shown below. Determine the forces in the strings AC and BC.**

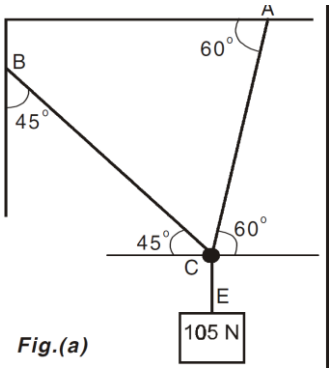


*Fig.(a)*

**4. (a) An I-section has the following dimensions in mm units : 5**

**Bottom flange = 300 × 100**

**Top flange = 150 × 50**

**Web = 300 × 50**

**Determine mathematically the position of centre of gravity of the section.**

**(b) State and prove perpendicular axis theorem. 5**

**5. (a) In a lifting machine, whose velocity ratio is 50, an effort of 100 N is required to lift a load of 4 kN. Is the machine reversible? If so, what effort should be applied, so that the machine is at the point of reversing? 5**

**(b) What load will be lifted by an effort of 12 N, if the VR is 18 and efficiency of the machine at this load is 60 %? If the machine has a constant friction resistance, determine the law of the machine and find the effort required to run this machine at (i) no load, and (ii) a load of 900 N. 5**

**6. (a) Two balls of masses 2kg and 3kg are moving with velocities 2m/s and 3m/s towards each other. If the coefficient of restitution is 0.5, find the velocity of two balls after impact. 6**

**(b) What are the various types of mechanical energy? Discuss in detail with examples. Derive mathematical formulae for them. 4**

**7. (a) A drum weighing 60 N and holding 420N of water is to be raised from a well by means of wheel and axle. The axle is 100 mm diameter and the wheel is 500 mm diameter. If a force of 120 N has to be applied to the wheel, find (i) mechanical advantage, (ii) velocity ratio and (iii) efficiency of the machine. 5**

**(b) A bullet of mass 20 g is fired horizontally with a velocity of 300 m/s, from a gun carried in a carriage; which together with the gun has mass of 100 kg. The resistance to sliding of the carriage over the ice on which it rests is 20 N. Find (a) velocity, with which the gun will recoil, (b) distance, in which it comes to rest, and (c) time taken to do so. 5**

**SET-3**

# ENGG. MECHANICS

## (MET-321)

## Full mark: 80

## Time-3 hrs

## Section-1

## All questions are compulsory <2x10>

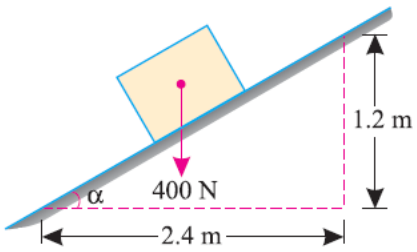
1. **(a) Draw the free body diagram of the ladder resting on a rough floor?**
   **(b) Define characteristics of couple.**
   **(c) State Lami's theorem.**
   **(d) Define force and states its unit.**
   **(e) What is the condition in terms of efficiency for a machine to be overhauling?**
   **(f) Define angle of repose.**
   **(g) State perpendicular axis theorem.**
   **(h) Define Newton's second law of motion.**
   **(i) Write the difference between centroid and centre of gravity?**
   **(j) Define conservation of energy.**

## Section-2

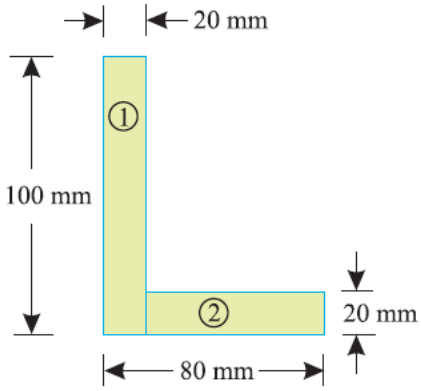
## Answer any six <6x10>

2. **(a) Write the characteristics of force and write about different types of forces. 5**
   **(b) State and prove parallelogram law of forces. 5**

3. **(a) An inclined plane as shown in Fig. below is used to unload slowly a body weighing 400 N from a truck 1.2 m high into the ground. The coefficient of friction between the underside of the body and the plank is 0.3. State whether it is necessary to push the body down the plane or hold it back from sliding down. What minimum force is required parallel to the plane for this purpose? 5**



**(b)** *Find the centroid of an unequal angle section 100 mm × 80 mm × 20 mm.*




4. **(a) The law of a machine is given by the relation: P = 0.04 W + 7.5 where (P) is the effort required to lift a load (W), both expressed in Newton. What is the mechanical advantage and efficiency of the machine, when the load is 2 KN and velocity ratio is 40? What is the maximum efficiency of the machine? If (F) is the effort lost in friction, find the relation between F and W. Also find the value of F, when W is 2 kN. 5**

**(b) A screw jack has a thread of 10 mm pitch. What effort applied at the end of a handle 400 mm long will be required to lift a load of 2 KN, if the efficiency at this load is 45%. 5**

5. **(a) A sphere of mass 1 kg, moving at 3 m/s, overtakes another sphere of mass 5 kg moving in the same line at 60 cm/s. Find the loss of kinetic energy during impact, and show that the direction of motion of the first sphere is reversed. Take coefficient of restitution as 0.75. 5**

**(b) Derive the formula for loss in KE due to collision. 5**

6. **(a) An elevator of gross mass 500 kg starts moving upwards with a constant acceleration, and acquires a velocity of 2 m/s, after travelling a distance of 3 m. Find the pull in the cables during the accelerated motion. If the elevator, when stopping moves with a constant deceleration from a constant velocity of 2 m/s and comes to rest in 2 s, calculate the force transmitted by a man of mass 75 kg the floor during stopping. 7**

**(b) State D'Alembert's principle. 3**

7. **(a) Find the moment of Inertia of the rectangular section about its centre of gravity. 7**

**(b) A drum weighing 60 N and holding 420N of water is to be raised from a well by means of wheel and axle. The axle is 100 mm diameter and the wheel is 500 mm diameter. If a force of 120 N has to be applied to the wheel, find (i) mechanical advantage, (ii) velocity ratio and (iii) efficiency of the machine. 3**

**SET-4**

# ENGG. MECHANICS

## (MET-321)

## Full mark: 80

## Time-3 hrs

## Section-1

## All questions are compulsory <2x10>

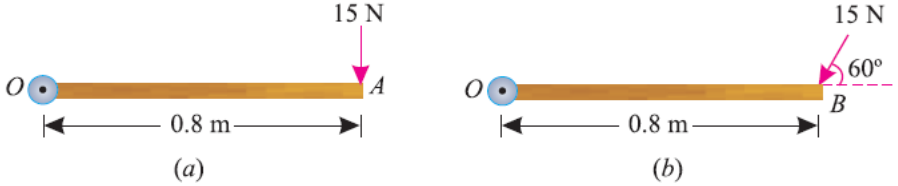
1. **(a) What is free body diagram?**
   **(b) What is momentum and impulse.**
   **(c) State Lami's theorem.**
   **(d) Define coplanar concurrent forces.**
   **(e) What is simple machine?**
   **(f) State the relation between coefficient of friction and angle of friction.**
   **(g) State parallel axis theorem.**
   **(h) Define Newton's second law of motion.**
   **(i) Define dynamic friction with example?**
   **(j) Define kinetic and potential energy.**

## Section-2

## Answer any six <6x10>

2. **(a) State and prove Lami's theorem. 5**
   **(b) Three forces acting on a particle are in equilibrium. The angles between the first and second is 90° and that between the second and third is 120°. Find the ratio of the forces. 5**

3. **(a) A force of 15 N is applied perpendicular to the edge of a door 0.8 m wide as shown in Fig.(a) below. Find the moment of the force about the hinge. If this force is applied at an angle of 60° to the edge of the same door, as shown in Fig. (b), find the moment of this force. 5**




**(b) A load of 500 N is lying on an inclined plane, whose inclination with the horizontal is 30°. If the coefficient of friction between the load and the plane is 0.4, find the minimum and maximum horizontal force, which will keep the load in equilibrium. 5**

4. **(a) An I-section is made up of three rectangles as shown in Fig. below. Find the moment of inertia of the section about the horizontal axis passing through the centre of gravity of the section. 8**
   **(b) What is centre of gravity? 2**

5. **(a) In a simple wheel and axle, the diameter of the wheel is 150 mm and that of the axle is 30 mm. If efficiency of the machine is 60% determine the effort required to lift a load of 500N. 5**
   **(b) On turning a corner, a motorist rushing at 20 m/s, finds a child on the road 50 m ahead. He instantly stops the engine and applies brakes, so as to stop the car within 10 m of the child. Calculate (i) retardation, and (ii) time required to stop the car. 5**

6. **(a) What is Newton's law of collision of elastic bodies? 2**
   **(b) Three perfectly elastic balls A, B and C of masses 2 kg, 4 kg and 8 kg move in the same direction with velocities of 4 m/s, 1m/s and 0.75 m/s respectively. If the ball A impinges with the ball B, which in turn, impinges with the ball C, prove that the balls A and B will be brought to rest by the impacts. 8**

7. **(a) A stone is thrown vertically upwards with a velocity of 29.4 m/s from the top of a tower 34.3 m high. Find the total time taken by the stone to reach the foot of the tower. 4**
   **(b) A body of weight 500 N is lying on a rough plane inclined at an angle of 25° with the horizontal. It is supported by an effort (P) parallel to the plane as shown in Fig. below. Determine the minimum and maximum values of P, for which the equilibrium can exist, if the angle of friction is 20°. 6**