

Indian Institute of Technology, Guwahati

ME 101 – Engineering Mechanics

Tutorial - 01

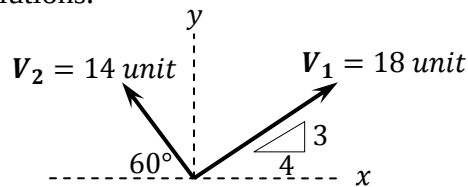
09th January 2014

Duration: 55mins; Total Marks: 80 @ 10 for each question

Problems 1 and 2 will be solved by the tutor at the beginning of the tutorial class. Students are supposed to solve problems 3 to 6 in the tutorial class and submit them before leaving. Problems 7 to 10 have to be solved as assignment and must be submitted in the following tutorial class.

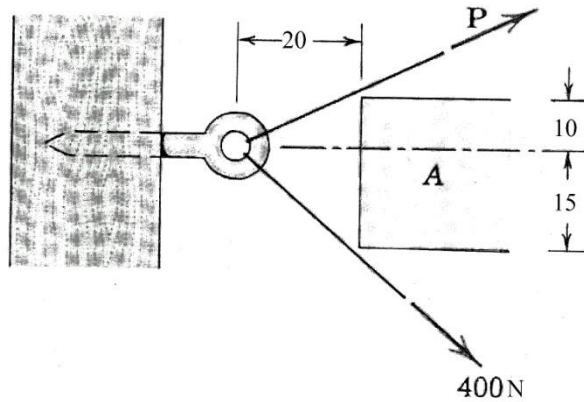


- (1) (i) Determine the magnitude of the vector sum $\mathbf{V} = \mathbf{V}_1 + \mathbf{V}_2$ and the angle θ_x which $\mathbf{V}$ makes with the positive x-axis. Compute both graphical and algebraic solution.
- (ii) For the given vector $\mathbf{V}_1$ and $\mathbf{V}_2$, determine the magnitude of the vector difference $\mathbf{V}' = \mathbf{V}_2 - \mathbf{V}_1$ and the angle θ_x which $\mathbf{V}'$ makes with the positive x-axis. Compute both graphical and algebraic solutions.

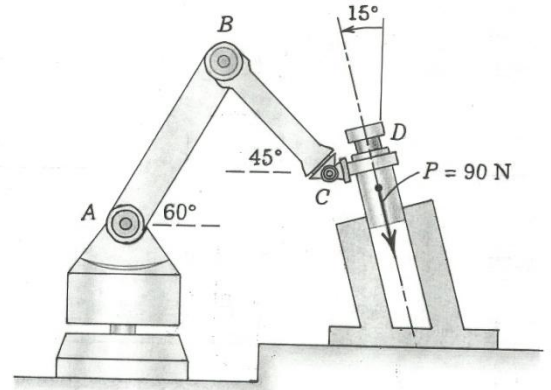


Prob. 1

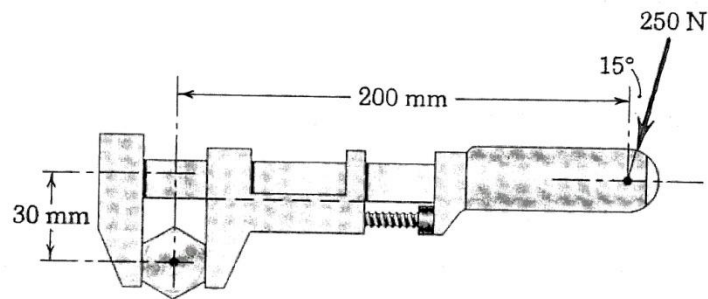
- (2) It is desired to remove the spike from the timber by applying force along its horizontal axis. An obstruction A prevents direct access, so that two forces, one 400 N and the other $\mathbf{P}$, are applied by cables as shown. Compute the magnitude of $\mathbf{P}$ necessary to ensure the resultant tension $\mathbf{T}$ directed along the spike. Also find $\mathbf{T}$.
- (3) In the design of the robot to insert the small cylindrical part into a close fitting circular hole, the robot arm must exert a 90 N force $\mathbf{P}$ on the part parallel to the axis of the hole as shown. Determine the components of the force which the part exerts on the robot along axes (a) parallel and perpendicular to the arm AB, and (b) parallel and perpendicular to the arm BC.
- (4) Calculate the moment of the 250 N force on the handle of the monkey wrench about the center of the bolt by (a) resolving the forces into orthogonal components and (b) vector notations.



Prob. 2 (all dimension are in cm.)

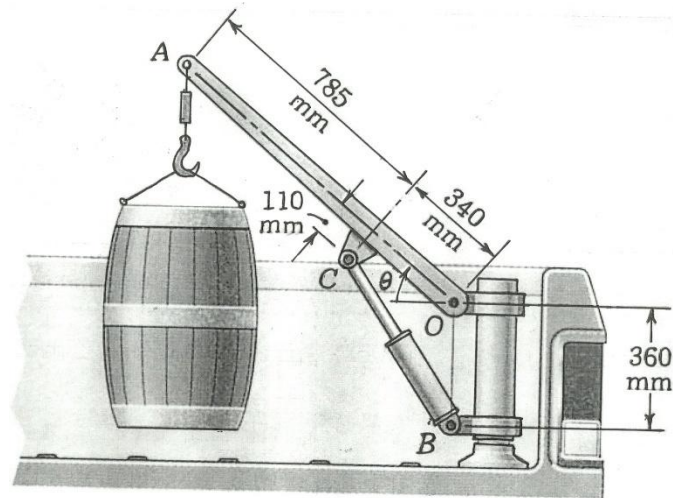


Prob. 3

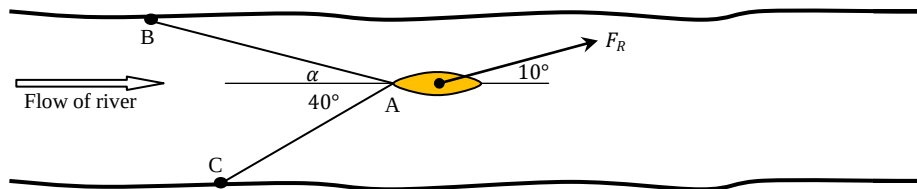


Prob. 4

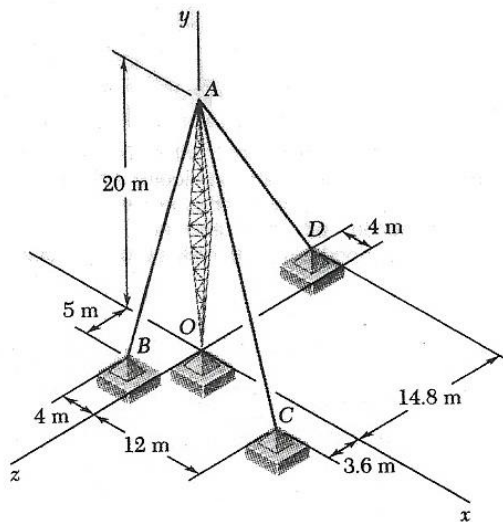
- (5) The small crane is mounted along the side of a pickup bed and facilitates the handling of heavy loads. When the boom elevation angle is $\theta = 40^\circ$, the force in the hydraulic cylinder BC is 4.5 kN , and this force applied at point C is in the direction from B to C (the cylinder is in compression). Determine the moment of this 4.5 kN force about the boom pivot point O.
- (6) Ropes AB and AC are thrown to a boater whose canoe had capsized. Knowing that $\alpha = 25^\circ$ and that the magnitude of force F_R exerted by the river on the boater is 70 N , determine the tension (a) in the rope AB, (b) in rope AC.
- (7) (i) A transmission tower is held by three guy wires anchored by bolts at B, C and D. (a) If the tension in wire AB is 2100 N , determine the components of the force exerted by the wire on the bolt at B. (b) If the tension in wire AD is 1260 N , determine the components of the force exerted by the wire on the bolt at D.
(ii) Two cables BG and BH are attached to the frame ACD as shown. (a) Knowing that the tension in cable BG is 450 N , determine the components of the force exerted by cable BG on the frame at B. (b) Knowing that the tension in cable BH is 600 N , determine the components of the force exerted by cable BH on the frame at B.



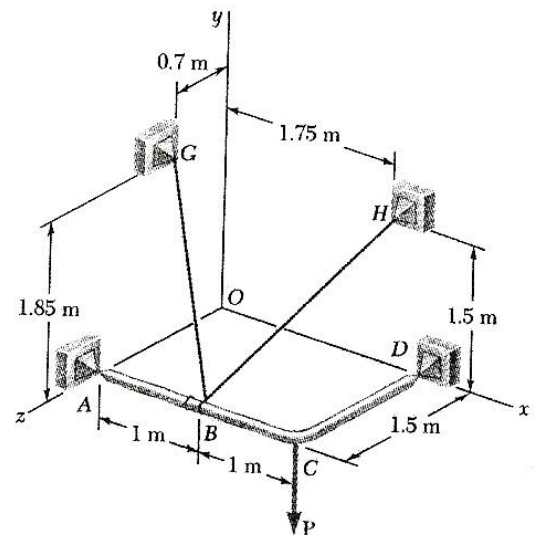
Prob. 5



Prob. 6



Prob. 7.(i)



Prob. 7.(ii)

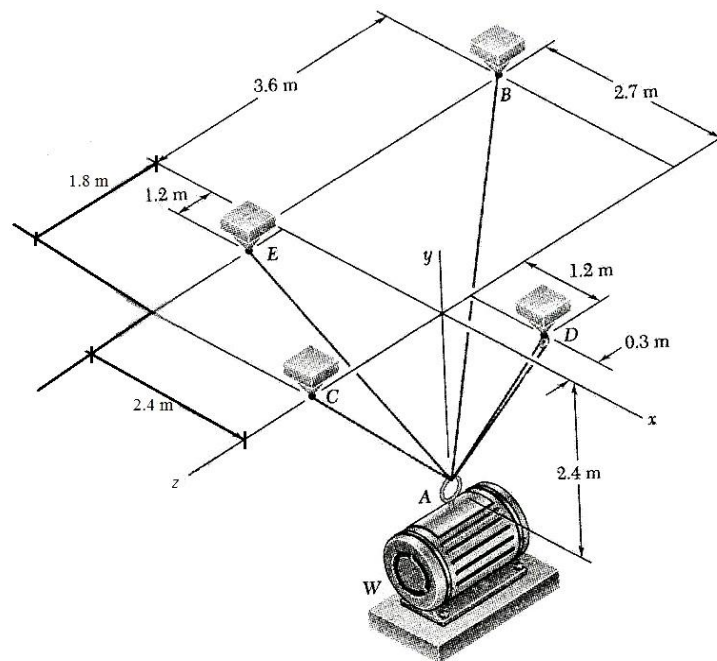
- (8) A derrick boom is guyed by cables AC and AD. A worker is lifting a 20 kg block by pulling on a rope that passes through the pulley at A. Knowing that the boom AB

A 3D diagram of a frame structure. The structure consists of a horizontal base and a vertical member. The base is a rectangular frame with dimensions 8 m (width) and 6 m (depth). A vertical member of height 6 m is attached to the base. A horizontal member of length 4.5 m is attached to the top of the vertical member. A point A is located at the top of the vertical member. A point B is located on the horizontal member. A point C is located at the end of the horizontal member. A point D is located at the bottom of the vertical member. A point E is located on the base. A force of 15 kN is applied at point A, acting vertically downwards. A force of 10 kN is applied at point B, acting horizontally along the member. A force of 20 kN is applied at point C, acting horizontally along the member. A force of 15 kN is applied at point D, acting vertically upwards. A force of 10 kN is applied at point E, acting horizontally along the member. The origin of the coordinate system is at point D. The x-axis is horizontal, the y-axis is vertical, and the z-axis is along the depth of the base.

A diagram of a bent lever arm. The lever is pivoted at point O at its base. It consists of two segments: a lower segment of length 30 units and an upper segment of length 350 units. The lower segment is inclined at an angle of 65° to the horizontal. The upper segment is inclined at an angle of 15° to the horizontal. A force of 60 N is applied at point A at the end of the upper segment, directed at an angle of 15° to the horizontal. The lever is shown in a bent position, with the angle between the two segments being 110° (since $65^\circ + 45^\circ = 110^\circ$, where 45° is the complement of 45° to the horizontal for the upper segment).

(9) A prybar is used to remove a nail as shown. Determine the moment of the 60 N force about the point O of contact between the prybar and the small support block.

(10) A piece of machinery of weight W is temporarily supported by cables AB, AC and ADE. Cable ADE is attached to the ring at A, passes over the pulley at D and back through the ring, and is attached to the support at E. Knowing that $W = 1400\text{ N}$, determine the tension in each cable.



Instructions: All dimensions are in mm unless otherwise mentioned. Books and class-notes may be referred in tutorial class.