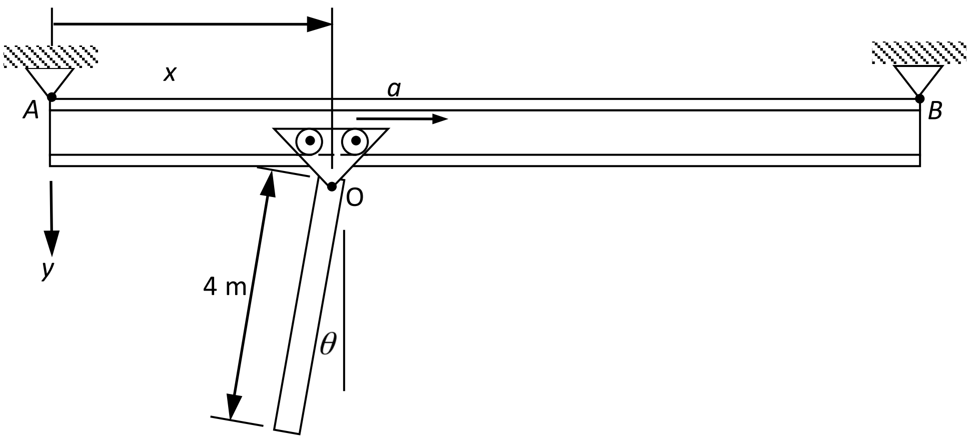
Coursework #S1

1. Mechanical engineer Sontipee needs to design a structure in order to carry and transport 4-m long columns in a factory. The structure is made from a steel I-beam that has a span length *AB* of 20 m and is simply supported at both ends. If the overhead trolley is mounted on the structure and hinged to a 500-kg column at O. During transportation the trolley starts from rest with $\theta = \dot{\theta} = 0$ at end *A* and is given a constant horizontal acceleration $a = 2$ m/s^2 until it reaches the midpoint of the beam structure and is decelerated with $a = -2$ m/s^2 until it is completely stopped at end *B*. As the top 5% of students in Thailand, you must assist engineer Sontipee solving this design by:
   (1) Plot the values of θ and $\dot{\theta}$ VS. x , where *x* is the distance of the trolley motion from *A* to *B*. Also find the maximum values of θ and $\dot{\theta}$ and their corresponding locations. This is important information because the maximum swing should constitute a factory safety consideration.
   (2) Plot the reaction forces at *O* and *A* in the *y* direction VS. *x*. The reaction forces are the necessary information to design the beam structure.
   (3) Design the beam structure by select an I-beam form the table of your strength of material book. The chosen I-beam should be sufficiently stiff such that the maximum deflection of the beam should be less than 50 mm at any point during the motion of trolley and the beam must have minimum weight as possible.



Coursework #S2

2. Mechanical engineering Sontipee is designing a drawbridge. The drawbridge is controlled by a hanging weight m_2. The drawbridge has mass m_1 = 200 kg, and length L = 4 m. Assume that the drawbridge pivots freely at O and that the rope connecting m_2 to the bridge is massless. As the top 5% of students in Thailand, you must assist engineer Sontipee solving this design by:

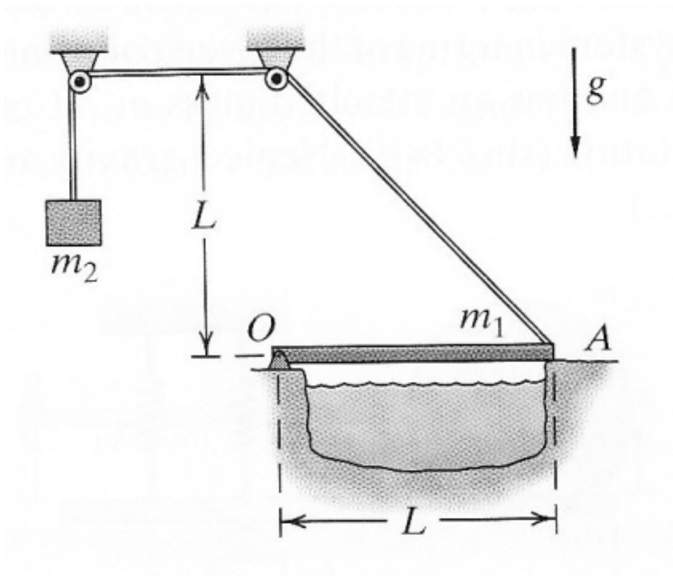
   (1) Plot θ (the inclination angle of the bridge) versus time when m_2 = 150 kg, 175 kg, and 200 kg.

   (2) Plot $\dot{\theta}$ versus θ when m_2 = 150 kg, 175 kg, and 200 kg.

   (3) Repeat the above instructions (1) and (2) by using equivalent constant pulling force F = 150g N, 175g N, and 200g N on the left end of the rope instead of mass m_2. Are the results obtained the same? Discuss physics of the drawbridge's motion thoroughly.

   (4) If a motor is used to apply the pulling force F on the rope, determine the maximum power of the motor that is required to lift the drawbridge for the three cases of pulling force.

   (5) Select the appropriate nylon rope with sufficient strength (safe load) and less weight for the six cases of pulling. Go to website http://www.engineeringtoolbox.com/nylon-rope-strength-d_1513.html for rope selection. Compare the selected rope in each case.



Coursework #S3

3. The crank rotate clockwise at the constant rate $\dot{\theta}$ = 3 rad/s. The uniform circular cross-section connecting link *AB* passes through the pivoted collar at C. Mass of crank *AO* and link *AB* are 0.05 kg and 0.15 kg, respectively. Link *AB* is 320 mm long.
   (1) Plot angular velocity of link *AB* vs. θ for $0 \le \theta \le 180^o$
   (2) Plot reaction forces at *C* (assume the collar surface is smooth so that only normal component of *C* is considered) and A (both normal and tangential components to link *AB* are considered separately) vs. θ for $0 \le \theta \le 180^o$
   (3) Calculate the maximum internal bending moment, internal longitudinal force, and internal transverse shear force in link *AB*, their occurring position in link AB and the corresponding value of θ during the motion interval $0 \le \theta \le 180^o$. Note that dynamic loads must be taken into account as external loads by applying inertia force and inertia moment (inertia force is $-m\vec{\bar{a}}$ and inertia moment is $-\bar{I}\vec{\alpha}$) on the center of mass of link *AB*.