CIV102F Assignment # 1 – September 16, 2020

Due Wednesday September 23, 2020 at 23:59 Toronto time

Important Instructions

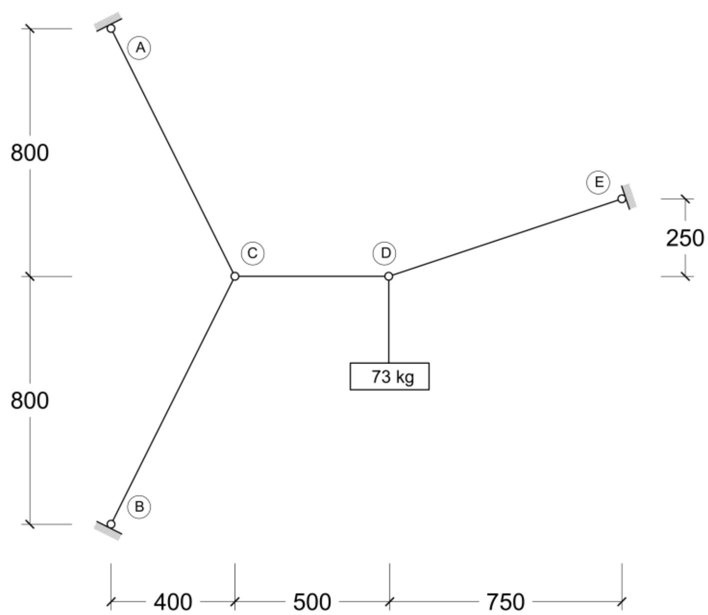
- There are five questions on this assignment. All questions must be attempted; however, only one question will be graded.
- Submissions which are incomplete and do not contain a serious attempt to solve each question will receive a grade of 0.
- Intermediate steps must be provided to explain how you arrived at your final answer. Receiving full marks requires both the correct process and answer.
- All final answers must be reported using slide-rule precision (ie, four significant figures if the first digit is a "1", three otherwise), and engineering notation for very large or very small quantities.
- Submissions must be prepared neatly and be formatted using the requirements discussed in the course syllabus. Marks will be deducted for poor presentation of work.

1. The following equations will be used later in the course. Derive the units of the specified parameters so that the equations remain dimensionally consistent (i.e. the units work out without requiring any conversion parameters). For example, the equation $v_{av} = {}^{\Delta x}/_{\Delta t}$ is dimensionally consistent if the average velocity v_{av} is in [m/s], the distance Δx is in [m] and the change in time Δt is in [s].

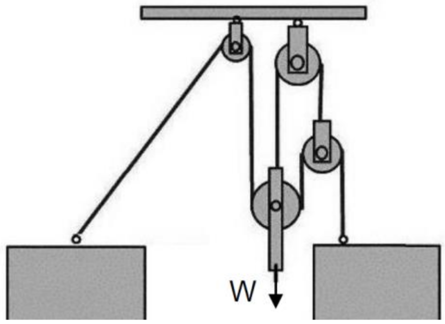
	Equation	Derive the units of the following:	Units of other variables
a)	$\sigma = \frac{P}{A}$	P, a force	σ is in MPa A is in m^2
b)	$\sigma = \frac{My}{I}$	M, a moment with dimensions of [force × distance]	σ is in MPa y is in mm I is in mm^4
c)	$\phi = \frac{M}{EI}$	E, a material stiffness with dimensions of force per unit area	M is in Nmm I is in mm^4 ϕ is in rad/mm
d)	$W = \frac{1}{2}\sigma\varepsilon AL$	L, a length	W is in J σ is in MPa ε is in mm/mm A is in mm^2
e)	$V_s = \phi_s \frac{A_v f_y d_v}{s} \cot\theta$	f_y, a material stress with dimensions of force per unit area	V_s is in N ϕ_s and θ are unitless A_v is in mm^2 d_v and s are in mm

For questions 2-5, a free body diagram showing a sign convention and corresponding equations of equilibrium must be presented for full marks

2. For the system of weights and wires shown below, solve for the forces in each of the cables. All dimensions are in mm.

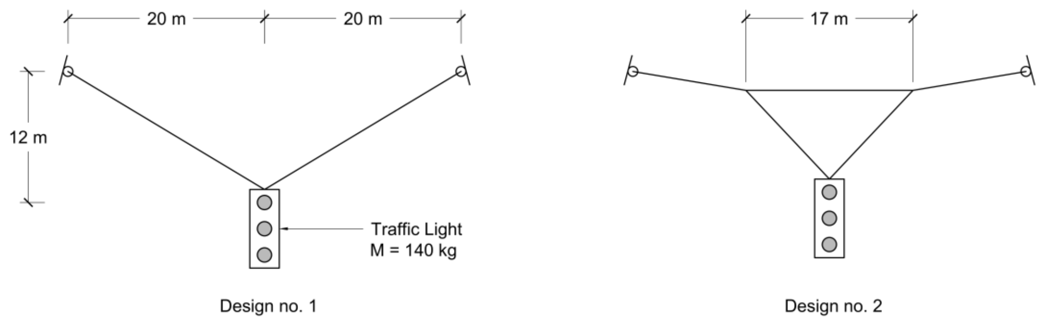


3. For the system of pulleys, weights and wires shown below, solve for the forces in each of the wires.



4. A designer has proposed two designs for a cable system to carry a traffic light which has a mass of 140 kg.

a) Calculate the tension forces in the cables in Design no. 1.
b) Design no. 2 is a modification of Design no. 1 which raises the traffic light by attaching a 17 m cable to connect the midpoints of the original two cables. For safety concerns, however, the maximum tension in any of the wires cannot exceed 4 kN. Is Design no. 2 feasible?



5. Shown below is a heavy box sitting a surface which is inclined at $\theta_1 = 15°$. To pull the box up the slope, a rope is attached to its centre of gravity and a pulling force P is applied.

a) Calculate P which causes the box to move if θ_2 is 45°.
b) Calculate the minimum pulling force P_{min} and the associated $\theta_{2,\ min}$ which makes the box easiest to move.

When solving this question, recall that the static friction force which must be overcome before sliding occurs is:

$$F_{\text{Friction, static}} = \mu_s F_n$$

μ_s is the coefficient of static friction and F_n is the normal force supplied by the surface. For this question, μ_s is 0.75.