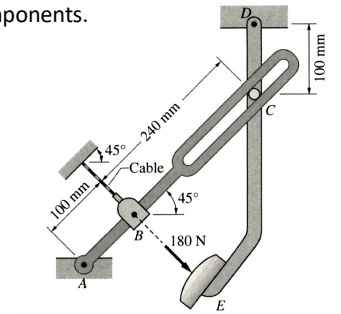
CIV100F/APS160F – Mechanics: Final Exam 2017

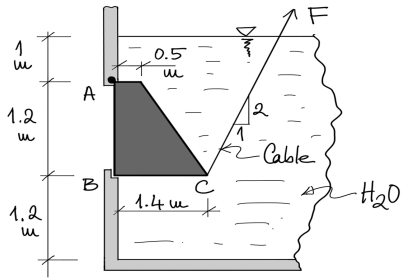
Question 2

Determine the tension in the cable at *B* when the 180 N force is applied to the pedal at *E*. Also, calculate the reaction force components at the pins at *A* and *D*. If the cable at *B* has a diameter of 7.0 mm and the yield stress of the cable material is 70 MPa, determine the actual load (safety) factor for the cable. In your opinion, is this a 'safe' design? In all your calculations, neglect friction and the mass of the components.



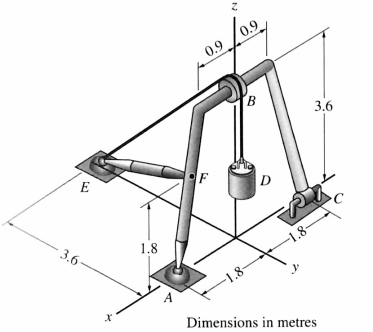
Question 3

The fresh water channel illustrated can be emptied by opening the 6,300 kg solid gate *ABC* (represented in cross-section). The gate is 5 m wide (into the paper), is pinned at *A*, rests against the vertical wall at *B* and can be operated by pulling on the cable attached to it at *C*. Determine the minimum magnitude of the force, F, required to open the gate.



Question 5

The frame shown is supported by a ball-and-socket joint at *A* and a pin at *C*. (The pin is similar to a ball-and-socket joint that was modified to allow translation in the *x*-direction.) The strut *EF* has a ball-and-socket joint at each end. The cable *EBD* runs over a small frictionless pulley at *B* and carries a 2,700 N weight at *D*. Neglecting the weight of the members, determine the force exerted by member *EF* on the frame at *F* and the magnitude of the total reaction at *C*.



Dimensions in metres

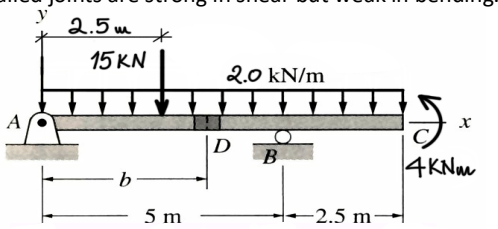
Question 1

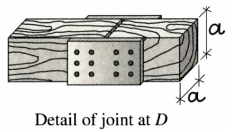
The 7.5 m-long timber floor beam, having a square cross-section, is to be designed to carry the loads shown. Because only 5 m-long timbers are available, the beam is to be fabricated from two pieces connected together by a nailed joint, *D*. You are required to:

(a) In the space provided, draw the shear force and bending moment diagrams for the beam indicating the values at points *A*, *B*, and *C*, and any potential local maxima and minima;

(b) If wood has a strength of 30 MPa, in both tension and compression, determine the required size, *a*, for the beam such that it can safely carry the floor loads. The load factor for timber in bending is 1.67; and

(c) Determine the distance *b* for the most advantageous position of the joint D, knowing that nailed joints are strong in shear but weak in bending.

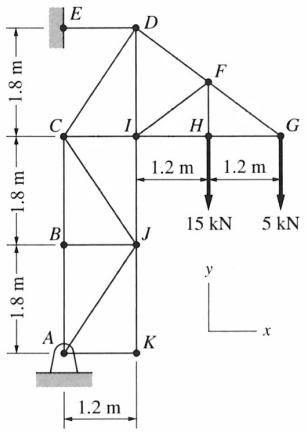


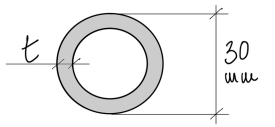


Detail of joint at *D*

Question 4

Determine the force in members *BC*, *CJ*, *DF*, *FH*, *HI* and state if the members are in tension or compression. Members *CJ*, *DF* and *FH* are to be fabricated using the same circular hollow section having an external diameter of 30 mm and a yield stress of 150 MPa. Knowing that the load factor for members in axial tension is 1.5, determine the minimum wall thickness of the cross-section, *t*, such that the three members are safe. The wall thickness can be selected in 0.5 mm increments. Also, what is the elongation of member *DF*? The modulus of elasticity for the material is 69,000 MPa.





Cross-Section of CJ, DF, FH

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Question 2

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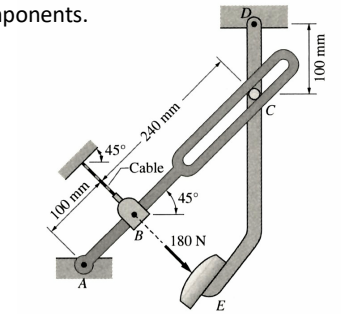

Answers:

T_B = 2,690 N (Tension)
A_x = 1,340 N → A_y = 1,340 N ↑
D_x = 432 N → D_y = 432 N ↓
L.F. = 1.00 – Recommend to redesign

Question 3

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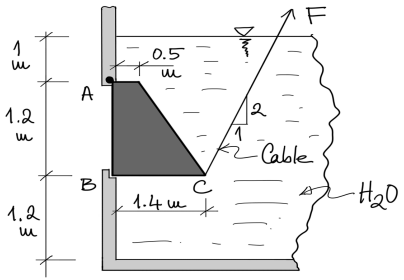
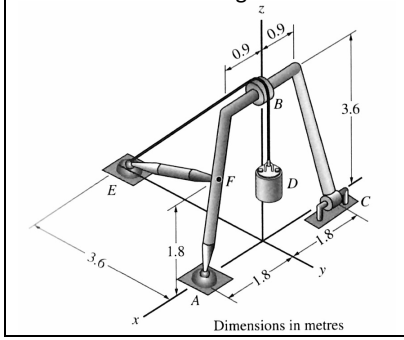


Answer:

F_{MIN} = 37.2 kN (Tension)

Question 5

The frame shown is supported by a ball-and-socket joint at *A* and a pin at *C*. (The pin is similar to a ball-and-socket joint that was modified to allow translation in the *x*-direction.) The strut *EF* has a ball-and-socket joint at each end. The cable *EBD* runs over a small frictionless pulley at *B* and carries a 2,700 N weight at *D*. Neglecting the weight of the members, determine the force exerted by member *EF* on the frame at *F* and the magnitude of the total reaction at *C*.



Answers:

$\overrightarrow{F_{EF}} = 1{,}430\vec{\imath} + 3{,}820\vec{\jmath} + 1{,}910\vec{k}\ N$
R_C = 1,430 N

Question 1

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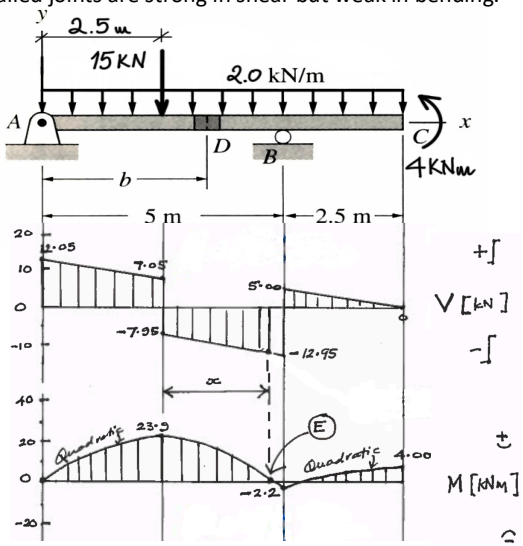

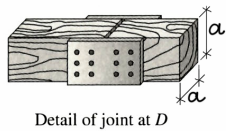

Detail of joint at *D*

Answers:

a = 200 mm

b = 4.82 m
(Place joint D at point E, where M = 0)

Question 4

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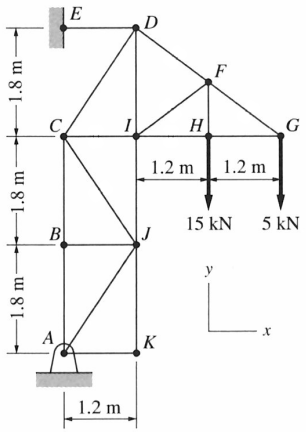

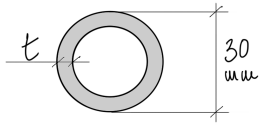

Cross-Section of CJ, DF, FH

Answers:

F_{BC} = 5.00 kN (C)
F_{CJ} = 18.18 kN (T)
F_{DF} = 20.8 kN (T)
F_{FH} = 15.00 kN (T)
F_{HI} = 6.67 kN (C)
(T = Tension; C = Compression)

t = 2.50 mm
Δ_{DF} = +2.10 mm