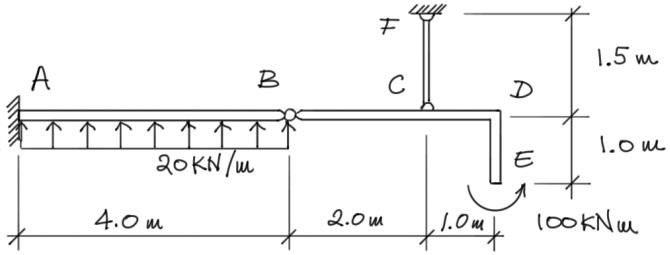
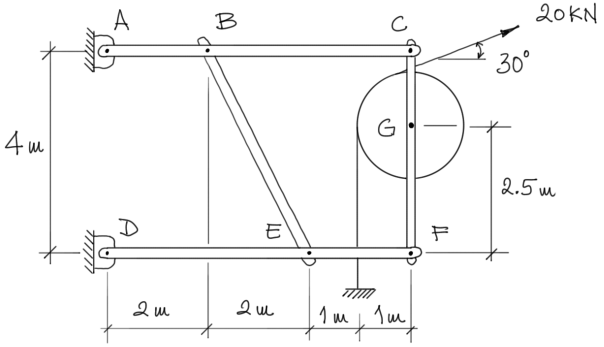
CIV100F/APS160F – Mechanics: Final Exam 2014

Question 1

Draw the shear force and bending moment diagrams in the space reserved below for the beam *ABCD* shown, indicating the values at points *A*, *B*, *C* and *D*, as well as any potential local maxima or minima. The beam is fixed at *A*, has an internal pin at *B* and is supported by a vertical pin-ended hanger at point *C*. The only material available to construct this beam is flat steel plate with a thickness of 100 mm, which can be cut in strips of various widths, in multiples of 10 mm. Determine the cross-sectional dimensions of the beam having the least weight and express your final answer in terms of the 'Width x Height' (i.e. 'Horizontal x Vertical' dimensions) of the cross-section. The yield stress for the steel available is 300 MPa and the load factor for bending is 1.9.



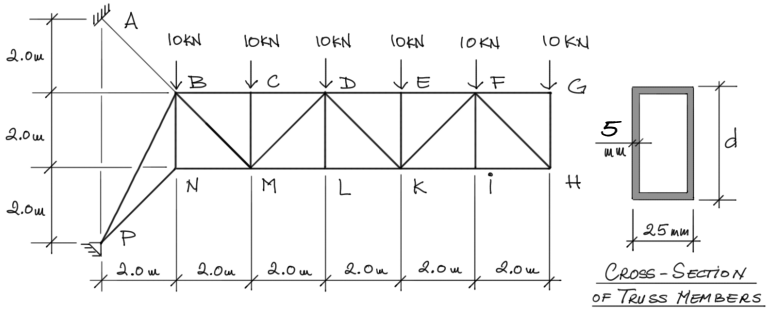
Question 2



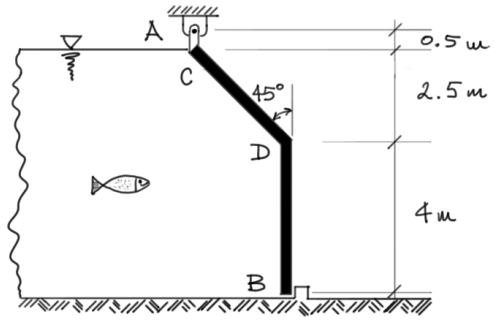
Determine the reaction components at *A* and *D* for this pin-connected frame. The cable passes behind the frame without touching it and the frictionless pulley is pinned to member *CF* at *G*.

Question 3

The truss shown is supported by a pin at *P* and a diagonal cable *AB*, at *B*. Determine the force in members *BM*, *MN*, *CM* and *CD*, and indicate whether they are in tension or compression. Members *CD* and *BM* are to be constructed from the same-size rectangular box cross section (shown), which is fabricated from 10 mm thick welded steel plate that can be cut in 5 mm increments. Knowing that the yield stress for steel is 350 MPa, the load factor for axially loaded bars is 2.25 and the modulus of elasticity for steel is 200,000 MPa, determine dimension *d* for the required section. Also, what is the elongation of member BM?

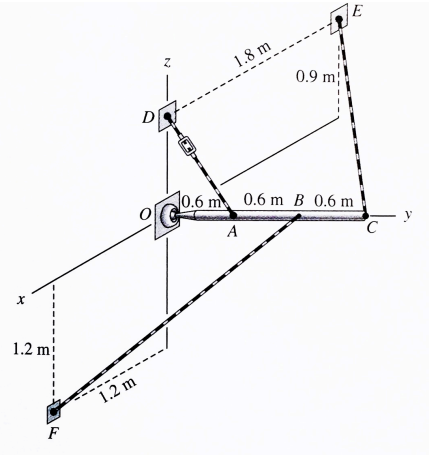


Question 4



A long, continuous steel gate, *BC*, restrains fresh water as shown and is supported by hinges at *A*, which are spaced at 8 metre equal intervals in the longitudinal direction of the gate, and a continuous stop at *B*. Determine the reaction components for a typical hinge at *A*, and at *B*.

Question 5



The turnbuckle on cable *AD* is tightened until the magnitude of the *y*-component of the ball-and-socket reaction at *O* is 2,700 N. Determine the resulting force in cable *AD*. The mass of bar OAC is small and can be neglected.

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Question 1

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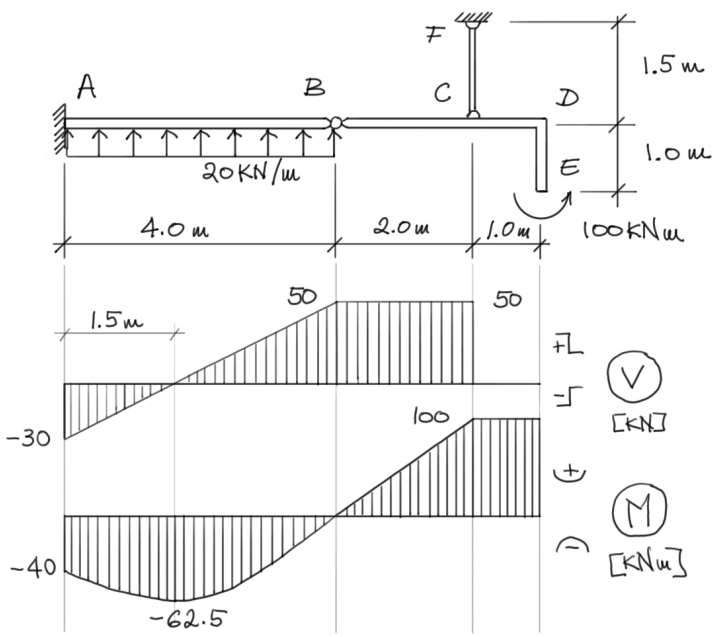
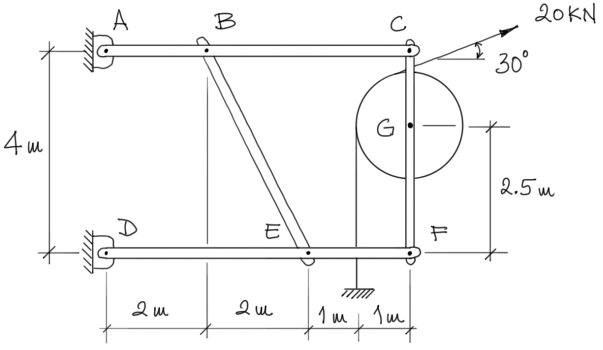


Answer:

The required beam size is W x H = 100.0 x 200 mm

Question 2



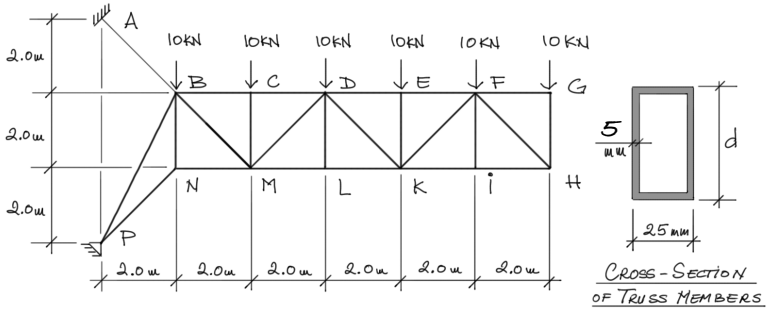
Determine the reaction components at *A* and *D* for this pin-connected frame. The cable passes behind the frame without touching it and the frictionless pulley is pinned to member *CF* at *G*.

Answers:

A_x = 25.8 kN ←
A_y = 20.0 kN ↑
D_x = 8.50 kN →
D_y = 10.00 kN ↓

Question 3

The truss shown is supported by a pin at *P* and a diagonal cable *AB*, at *B*. Determine the force in members *BM*, *MN*, *CM* and *CD*, and indicate whether they are in tension or compression. Members *CD* and *BM* are to be constructed from the same-size rectangular box cross section (shown), which is fabricated from 10 mm thick welded steel plate that can be cut in 5 mm increments. Knowing that the yield stress for steel is 350 MPa, the load factor for axially loaded bars is 2.25 and the modulus of elasticity for steel is 200,000 MPa, determine dimension *d* for the required section. Also, what is the elongation of member BM?

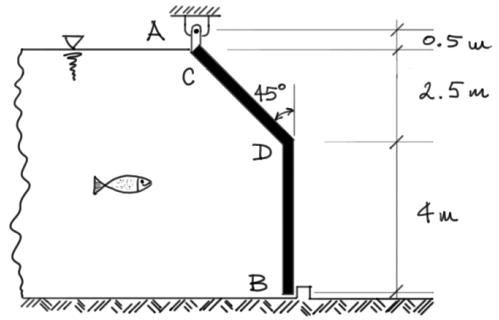


Answers:

F_{BM} = 70.7 kN (T)
F_{MN} = 150.0 kN (C)
F_{CM} = 10.00 kN (C)
F_{CD} = 100.0 kN (T)

d = 50.0 mm
Δ_{BM} = +1.538 mm

Question 4

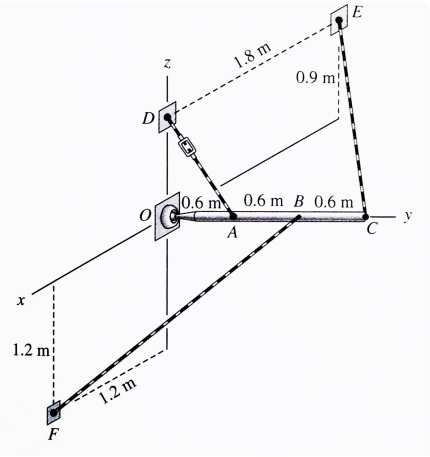


A long, continuous steel gate, *BC*, restrains fresh water as shown and is supported by hinges at *A*, which are spaced at 8 metre equal intervals in the longitudinal direction of the gate, and a continuous stop at *B*. Determine the reaction components for a typical hinge at *A*, and at *B*.

Answers:

A_x = 455 kN ←
A_y = 245 kN ↓
B_x = 150.4 kN/m ←

Question 5



The turnbuckle on cable *AD* is tightened until the magnitude of the *y*-component of the ball-and-socket reaction at *O* is 2,700 N. Determine the resulting force in cable *AD*. The mass of bar OAC is small and can be neglected.

Answer:

T_{AD} = 1,391 N (Tension)