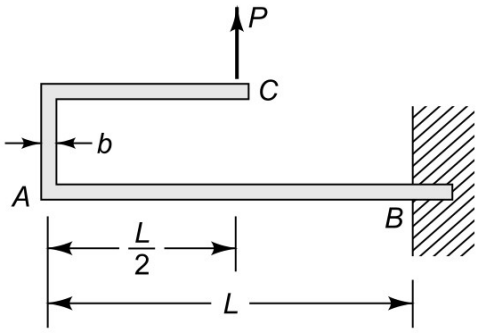
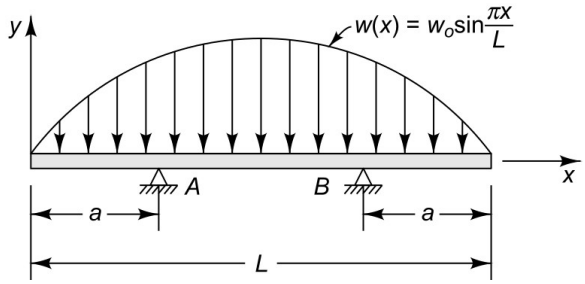
ME231: Tutorial – III

August 21, 2020

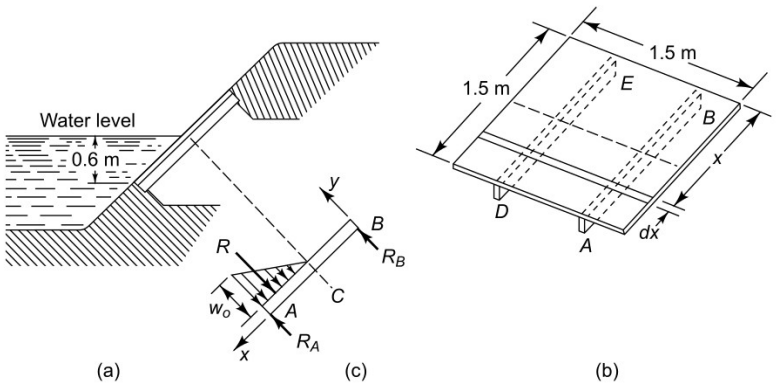
Q.1: The frame BAC is built-in at B and subjected to a load P at C. It is desired to obtain shear-force and bending-moment diagrams for the segment AB.



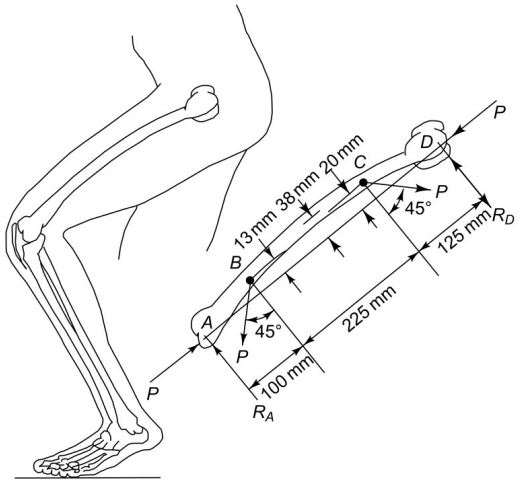
Q.2: The loading on a beam is assumed to have the shape shown in figure. It is required to find the location of the supports A and B such that the bending moment at the midpoint is zero.



Q:3: A 1.5-m-square gate which is retaining the water at half the length of the gate as shown. If it is assumed that the total pressure load on the gate is transmitted to the supports at A, B, D, and E by means of symmetrically located simply supported beams AB and DE, find the maximum bending moment in the beams. The bottom edge DA of the gate is 0.6 m below the water line, and $g = 9.8$ kN/m^3.



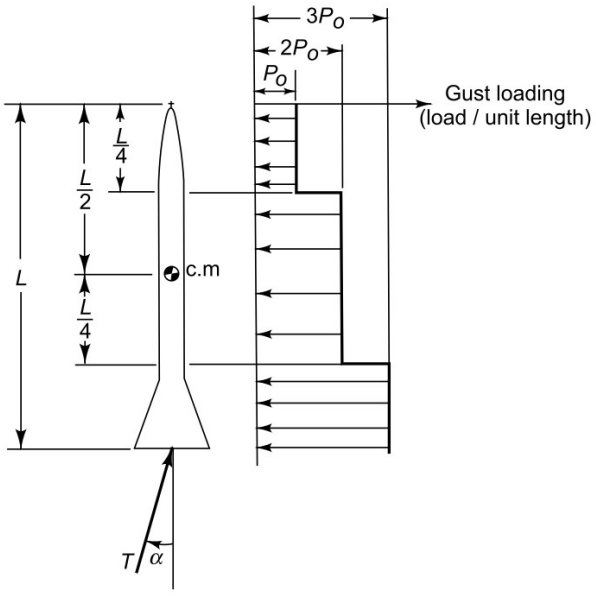
Q.4: The sketch shows a possible set of muscle forces acting on the femur of a man who is running upstairs. Find the unknown reactions R_A and R_D in terms of P and show how the transverse force varies along the femoral shaft. Show how the bending moment varies along the shaft, and comment on the compensating effect of the muscles attached at B and C in terms of reducing the bending moments in the shaft.



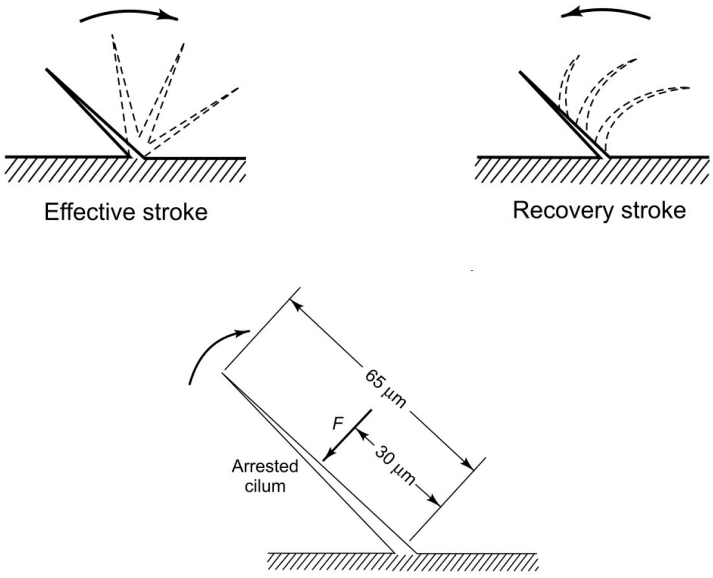
Q.5: The rocket shown experiences a wind gust during its vertical ascent which results in the loading shown. Rotation of the system may be prevented if the resultant moment about the center of mass of the system vanishes. This is to be achieved by varying the orientation of the thrust vector T with respect to the vertical axis.

(a) What relationship must exist among T, a, p_o , and L in order that this requirement be satisfied?

(b) Determine the internal shear force and bending moment at $L/4$ and $3L/4$ in terms of p_o.



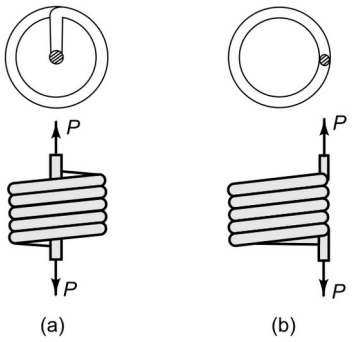
Q.6: (a) Cilia are motile hairlike appendages on the free surfaces of certain cells. They are present in the trachea and in the reproductive tracts of humans as well as in lower animals. Their motion can be considered as made up of an effective stroke which can be thought of as a pendular motion with constant angular velocity through an angle of approximately 140° and a return or recovery stroke as shown in the figure.



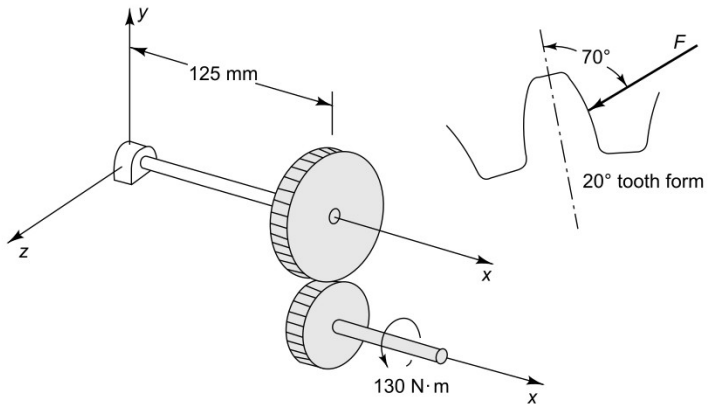
For the configuration shown in the figure in which the cilium is arrested by a force $F = 2.2$ nN, calculate the moment at the cell boundary.

(b) If a cilium moving in a viscous fluid rotates through its effective stroke, estimate the driving moment at the cell boundary. The viscous force on an element of length of the cilium may be taken to be proportional to the length of the element, the angular velocity, the viscosity, and to a function which depends upon the position along the cilium.

Q.7: A closely wound coil spring of coil radius R can have the "ends" in either of the positions shown. Calculate the shear forces, bending moments, and twisting moments at a typical point on the coil for the two cases.



Q.8: A 125-mm-diameter 20° spur gear is attached to the end of a 125-mm-long cantilevered shaft. A smaller gear (ratio 3:1) transmits a 130 N·m torque. Sketch the shear-force, bending-moment, and twisting-moment diagrams for the cantilevered shaft, labeling important values.



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