1. Determine the buckling load for a pin-ended column assuming that the deflection is approximated by the function \( y = A \sin \frac{\pi x}{l} \). Work the problem by first using equation 8.41 as given in your notes and then replacing the first part of the equation by \( \int_0^l \frac{M^2}{EI} dx \).

Are your answers different? and in view of the examples covered in class state the reason for your previous reply.

2. The figure below shows two rigid bars that make up a mechanism. The bars are connected by a frictionless hinge at C. The end support of the upper link is a pin at D that can slide in a groove. The end support of the lower link is a fixed pin at A. A vertical load P acts at the midpoint of the upper link and a horizontal spring of stiffness k is fixed at B as shown. Determine the critical value of P that will cause instability of the structure. \( (kL/3) \)

3. A rectangular steel bar of cross section 6mm x 3mm is axially pre-compressed by 100N between two plates that are fixed at a constant distance of 150mm apart. The assembly is performed at 20\(^\circ\)C. What increase in temperature will cause the bar to buckle? Use a value of Young’s modulus of 200,000 N/mm\(^2\) and a value of coefficient of thermal expansion of 15 \( \times \) 10\(^{-6}\) / \( ^\circ\)C.

\( (20.07 \, ^\circ\)C)\)

4. The figure below shows an idea for a simple winch support to be used to haul up L.P.G. tanks on a roof building. One tank weighs 30kg. Calculate the minimum value of the second moment of area required for the boom if it is not to buckle. Apply a factor of safety of 2 on Euler’s buckling law. Steel having a Young’s modulus value of 207GPa is to be used.

\( (4079.7 \, \text{mm}^4) \)
5. Calculate the slenderness ratio for a pin-ended solid circular shaft having a diameter of 50mm and which is 1.5 m long. If the yield stress of the steel shaft is 250 N/mm$^2$ and Young’s modulus is 207000 N/mm$^2$ will Euler’s buckling theory be valid? (120)

6. Re-work problem 4 using the Rankine – Gordon formula given as equation 8.36 in your notes. This time use a factor of safety of 2 on the critical load and an allowable stress of 2/3 the yield stress of 300 N/mm$^2$. If you are not able to come out with a numerical answer describe the further steps necessary to finish designing the cross sectional properties of the boom.

7. A 25mm diameter steel rod 0.75m long has a 12.5mm diameter hole bored centrally from each end for a distance of 0.25m, leaving the central 0.25m solid. Using an energy method estimate the buckling load if used as a strut with pinned ends. Use a value of Young’s modulus of 206000 N/mm$^2$. (65.15kN)