



EMA 3702

Mechanics & Materials Science

(Mechanics of Materials)

Chapter 10 Columns

Homework Solutions



Homework 10.1

Knowing the spring constant at D is of constant k and the column DE is rigid. Please calculate the critical load P_{cr}

Assume initially, under vertical condition, the spring has zero internal force.

If the vertical rod is misaligned from vertical by small angle θ , and reaches equilibrium, draw FBD.

Balance of moment around E gives

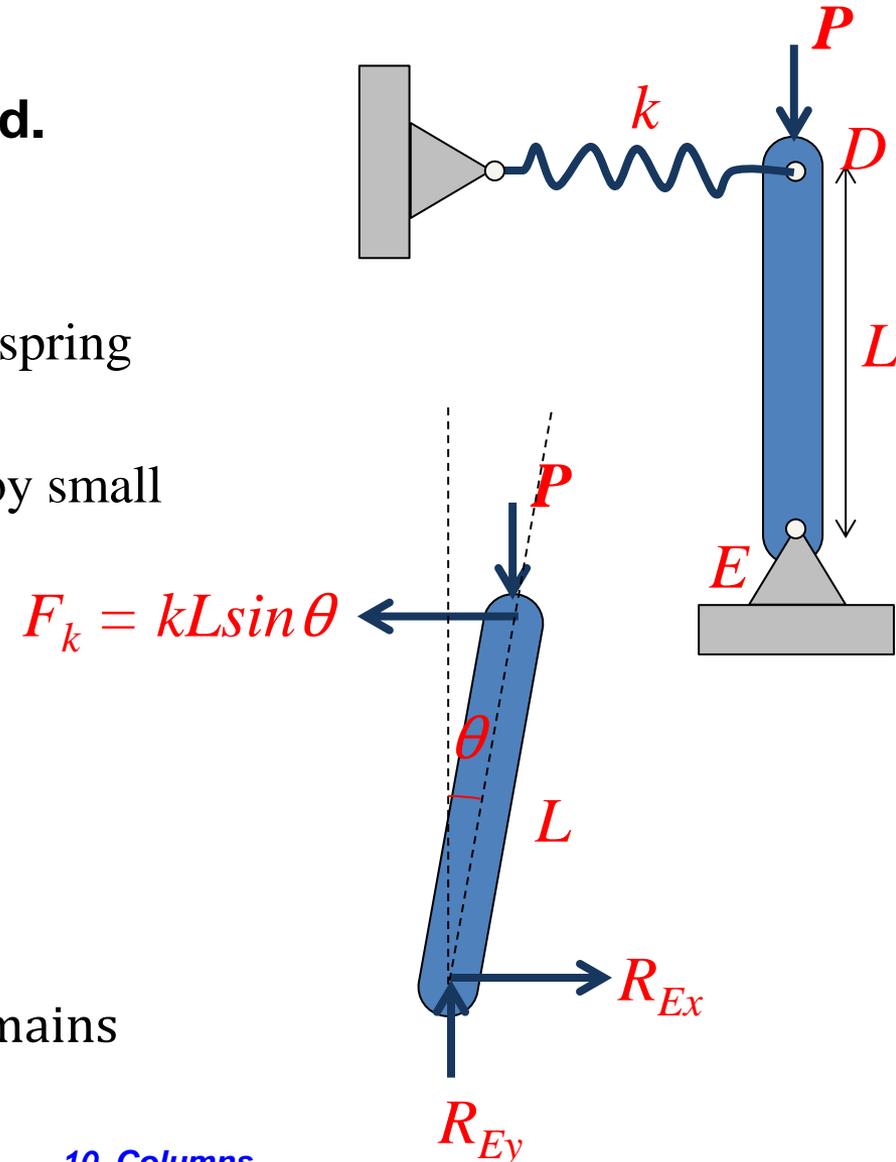
?=?

When θ is very small, $\cos \theta \approx ?$.

Therefore, critical load

$$P_{cr} = kL$$

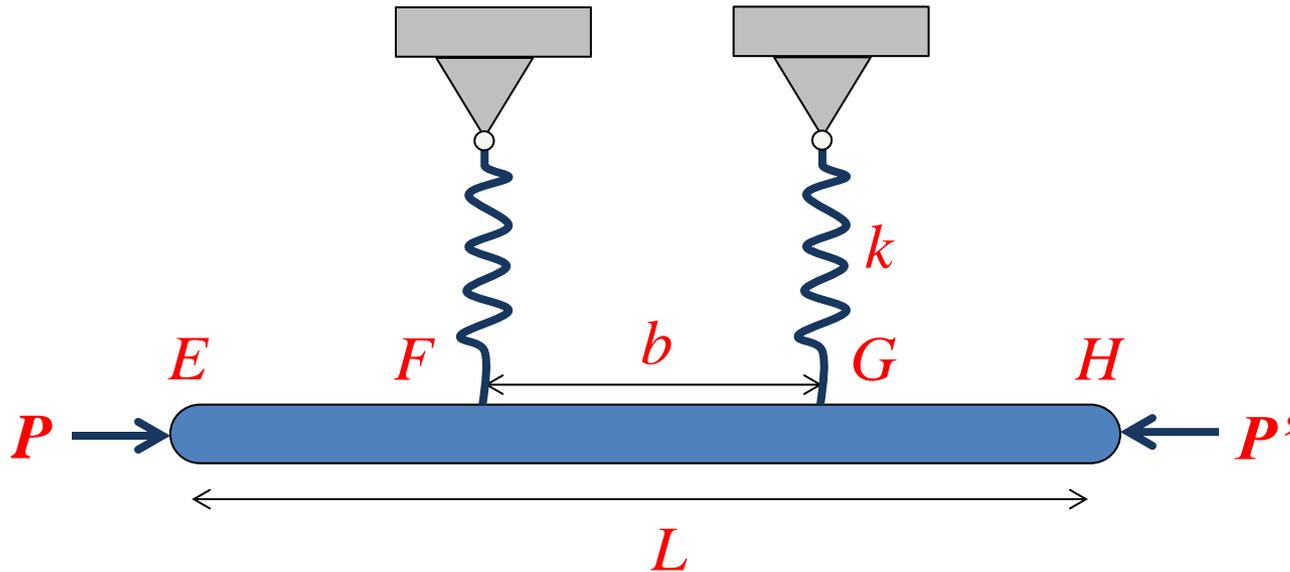
Meaning when $P < P_{cr} = kL$, the system remains stable in the vertical direction





Homework 10.2

A column EH is hang horizontally by two springs with equal length and spring constant k symmetrically at F and G , as illustrated. Please calculate the critical load P_{cr}

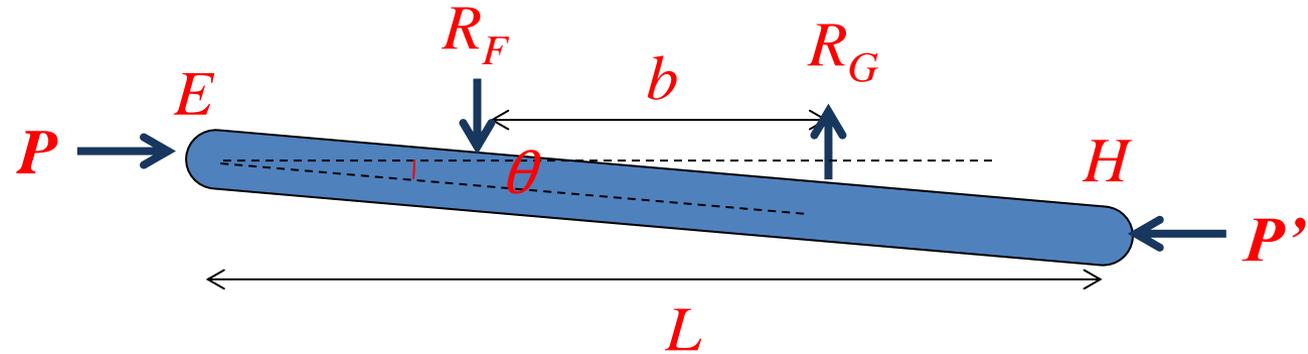




Homework 10.2

Assume initially, under perfect horizontal alignment, the springs have zero internal force.

If the horizontal rod EH become misaligned from horizontal by a small angle θ , and reaches equilibrium, draw FBD.



Balance of moment around E gives

$$?? = ??$$

When θ is very small, $\cos \theta \approx ?$.

Therefore, the critical load

$$P_{cr} = \frac{kb^2}{2L}$$

Meaning when $P < P_{cr} = kb^2/2L$, the system remains stable in the horizontal direction

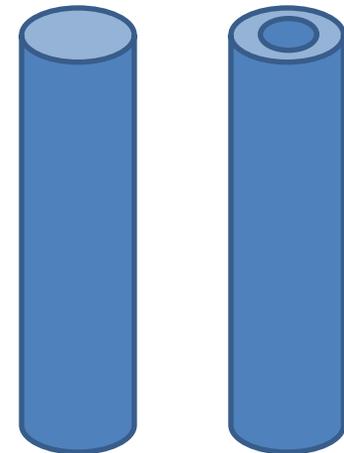


Homework 10.3

A long cylinder shaped solid column has length L and outside diameter (OD) d . It is made of a material with elastic modulus E . If a separate cylinder-shaped **hollow** column is to be made with the **same material** and **same length L and O.D. d** , but has inner diameter of $0.5d$, please calculate (a) the saving in weight for the hollow column versus the original solid column, and (b) the relative reduction in critical load for the hollow column versus the original solid cylinder.

(a) The relative saving in weight is proportional to reduction in cross-section area, which is

(b) In terms of critical load, assume
The relative reduction in critical load will be





Homework 10.4

Members EF and GH are 32 mm diameter and 4 m long steel rod and members of EH and FG are 24 mm diameter and 3 m long steel rod. When rope between EG and FH are tightened, and if the factor of safety is 2, please calculate the largest allowable tension force in EG . Knowing $E = 200$ GPa and consider buckling only in the plane of the structure.

