American University of Beirut
Department of Civil and Environmental Engineering

Spring 2008-2009 **Instructor: Professor Fouad Kasti**

NAME: Mr. Solution_____ **ID: CIVE210 Exam I_____**

CIVE 210 Statics	Exam I 1 ½ Hour Exam	Sat Apr 4, 09 Closed Books	1/1

Problem #1: (50%)

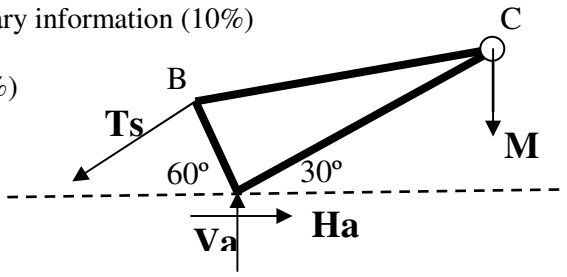
The crane ABC consists of 3 rigid, weightless and straight bars AB, BC and AC. The crane is lifting a mass M with a weightless cable connected to C. A spring having K = 30Kg/cm tie point B back to a rigid support at point D.

Assume:

1- Bar AC and AB make angles 30° and 60° respectively with the horizontal
2- BD is perpendicular to AB
3- Hinge support at A
4- Length AB = 2m, BC = 4m
5- Drawing is not to scale.

Answer the following:

a- Draw the Free Body Diagram and indicate clearly all necessary information (10%)



b- Determine the tension force in spring DB in terms of M (15%)
∑M@A = 0 → Ts*AB = M*AC*cos(30) → Ts = 1.5*M

c- Assuming the tension force capacity in the cable holding M at C is 10Kg and the tension force capacity of the spring BD is 12Kg, determine the maximum mass M that can be carried (10%)
M = T cable = 10Kg → Ts = 15Kg > 12Kg capacity → Ts = 12Kg & M= 8Kg

d- In part C, determine the corresponding spring force and corresponding deformation. Indicate magnitudes, tension or compression, shortening or elongation (5%)
Ts = 12Kg (Tension) → Δ = 12/30 = 0.4cm (Elongation)

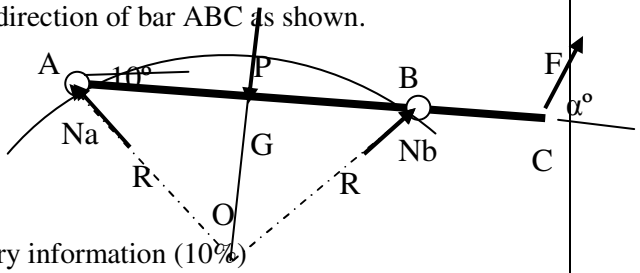
e- In part C, determine the corresponding reactions at A. Indicate magnitudes and directions. (15%)
∑Fx = 0 → Ha = Ts*cos(30) = 10.4Kg → = Ha, ∑Fy = 0 → Ha = Ts*sin(30)+8 = 14Kg ↑ = Va

Problem #2: (50%)

The rigid, weightless and straight bar ABC is roller supported at A and B over a circular path of radius R = 24m and subjected to a pair of forces P and F. P is acting at a point G located in the middle of segment AB oriented perpendicular to AB, F is acting at tip C oriented at an angle α to the direction of bar ABC as shown.

Assume:

1- The magnitude of P = 60N
2- Frictionless and dimensionless roller supports A and B
3- Length AB = 12m, BC = 6m
4- Drawing is not to scale.



Answer the following:

a- Draw the Free Body Diagram and indicate clearly all necessary information (10%)
OP = sqrt (24^2 – 6^2) = 23.24, angle OAP = $\cos^{-1}$(6/24) = 75.52°

b- Determine the minimum force F required for equilibrium and the corresponding angle α and reactions at A and B. Indicate magnitudes and directions (25%)
Na, Nb and P passes through center of circle. ∑M@O = 0 → F*dF = 0 → Minimum F = 0, α = any
Na = Nb = 60/(2*sin 75.52) = 30.98 = Na = Nb

c- Determine the minimum force F required to cause roller at B to barely touch the ground (reaction at B = 0) and the corresponding reaction at A. Indicate magnitudes and directions (15%)
∑M@O = 0 → F passes thru O → α = $\tan^{-1}$(OP/PC) = $\tan^{-1}$(23.24/12) = 62.69° = α
∑Fx = 0 → F*cos α = Na * cos 75.52 → Na = 1.84*F
∑Fy = 0 → F*sin α + Na * sin 75.52 = 60 → F = 22.5N, Na = 41.4N