Department of Civil Engineering, IIT Bombay
CE 102 Engineering Mechanics – Quiz - I

Date: March 26, 2008 **Max. Marks: 20**

Each question worth 10 marks

Note: State clearly all assumptions you have made, if any. Draw clear Free body Diagram(s) where necessary. If you make multiple attempts, cancel out the one(s) you don't want to be graded. Only the first non-cancelled one encountered will be graded.

Time: 1 hour

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1. The telephone-cable reel has a mass of 250 kg and is mounted on an 80-mm-diameter shaft. If the coefficient of friction between the shaft and its bearing is 0.30, calculated the horizontal tension required to turn the reel.

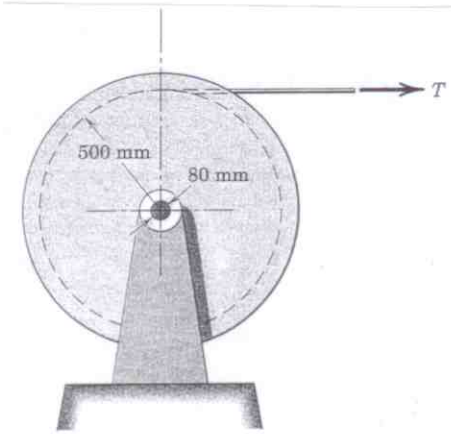

Fig: Problem 1

2. An embossing device imprints an image at D on metal stock. If a force F of 200 N is exerted by the operator, what is the force at D on the stock? The lengths of AB and BC are each 150 mm. (**Note**: you must do this only by Method of Virtual Work, otherwise no marks will be given)

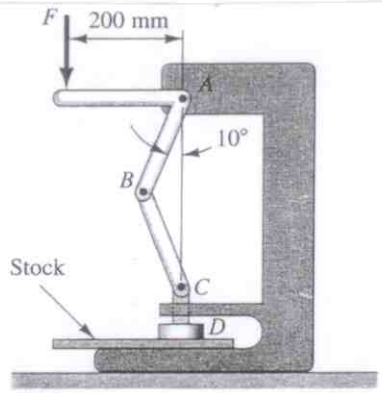

Fig: Problem 2

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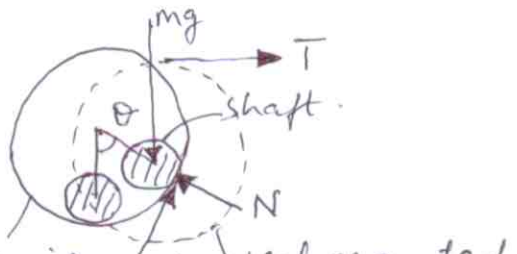
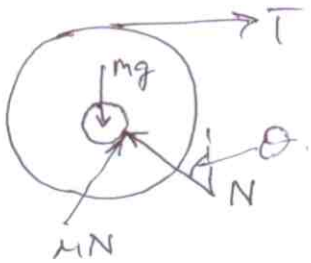


bearing. (size exaggerated). – same as shaft.

reel mounted on shaft.



$\Sigma F_x = 0 = \mu N\cos\theta - N\sin\theta + T \rightarrow (1)$

$\Sigma F_y = 0 = \mu N\sin\theta + N\cos\theta - mg \rightarrow (2)$

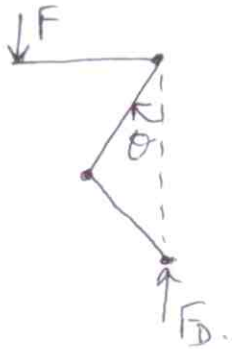
$\Sigma M = 0 = T(500) - \mu N(40) \rightarrow (3)$

$(1)^2 + (2)^2 \Rightarrow T^2 + m^2g^2 = N^2(1+\mu^2)$

Subst (3) in above, $T^2\left[\left(\frac{50}{4}\right)^2 \frac{1}{\mu^2}(1+\mu^2) - 1\right] = m^2g^2$

put $\mu = 0.3$, $m = 258$ kg, get $\boxed{T = 56.39\ N}$

P.2



$\delta W = 0 = (-F)(200\,\delta\theta) - F_D(\delta y)$

$y = 2 \times 150\cos\theta \Rightarrow \delta y = -300\sin\theta\,\delta\theta$

(AB)

$\Rightarrow -200F\,\delta\theta - F_D(-300\sin\theta\,\delta\theta) = 0$

$\boxed{F_D = 767.83}$