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EGM 6321
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Homework 1- problem 2

Given: $C_0(Y^1,t) = -F^1[(1-\bar{R}\,U_{,SS}(Y^1,t)] - F^2 U^2_{,S} - \frac{T}{R} + M[[1-\bar{R}U^2_{,SS}(Y^1,t)][U^1_{,tt}(Y^1,t) - \bar{R}\,U^2_{,Stt}(Y^1,t)] + U^2_{,S}(Y^1,t)\,U^2_{,tt}(Y^1,t)]$

the subscripts ",s" and ",t " indicate partial differentiation with respect to space and time.

Find: do dimensional analysis of all terms in the above equation and determine physical meaning.

Solution:

Dimensional Analysis of Terms

$[F^1] = \frac{m*L}{t^2} = F = force$

$[F^2] = \frac{m*L}{t^2} = force$

$[\bar{R}] = L = length$

$[U^2_{,S}] = \frac{L}{L} = 1$

$[U^2] = L = length$

$[T] = F*L = torque$

$[U^2_{,SS}] = \frac{\partial^2 U^2}{\partial S^2} = \frac{L}{L^2} = L^{-1}$

$[R] = L = length$

$[\bar{R}U^2_{,SS}] = L*\frac{L}{L^2} = 1$

$[\frac{T}{R}] = F*\frac{L}{L} = F = force$

$[M] = m = mass\ of\ wheel$

$[U^1_{,tt}] = \frac{\partial^2 U^2}{\partial t^2} = \frac{L}{t^2} = acceleration$

$[U^2_{,stt}] = \frac{\partial}{\partial s}(\frac{\partial^2 U^2}{\partial t^2}) = \frac{L}{L*t^2} = t^{-2}$

$[U^2_{,s}] = \frac{\partial U^2}{\partial s} = \frac{L}{L} = 1$

$[U^2_{,tt}] = \frac{\partial^2 U^2}{\partial t^2} = \frac{L}{t^2} = acceleration$

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Physical Meaning

1) C_0 = sum of horizontal forces acting one the wheel

2) Each Term on the right hand side of the equation is a force component acting in the horizontal direction.

3) The terms with "F^1" are reaction forces on the wheel due to "F^1" in the horizontal direction.

4) The terms with "F^2" are reaction forces due to "F^1" in the horizontal direction.

5) The term "$\frac{T}{R}$" is the horizontal force component caused by the torque "T" acting on the wheel.

6) The terms with "M" are the horizontal force components due to the acceleration of the mass of the wheel.