1. (30%) In Fig. 1, link 2 rotates about a fixed axis O_2. The link rotates at a speed (ω_2) 5 rad/sec clockwise with an angular acceleration (α_2) 200 rad/sec^2 counter-clockwise. The link has a weight 5 kg and mass moment of inertia about the center of gravity I_{g2} = 0.0212 kg·m^2.

   (a) (7%) Determine the inertia force, magnitude and direction.

   (b) (7%) What is the magnitude of the inertia torque?

   (c) (8%) Consider the gravity effect (**g** =9.81 m/s^2 and is vertically downward), then determine the external force vector $\mathbf{F}_A$ which is acting at point A with a direction shown in the figure to produce the given angular motion. (Hint: write the force/moment balance equations)

   (d) (8%) Continue (c), what is the reaction force on link 2 at O_2?

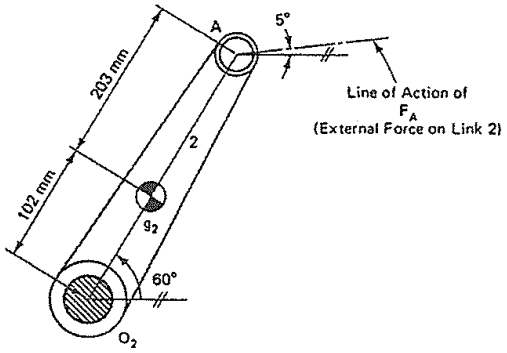

Fig. 1

2. (35%) A scotch yoke mechanism is shown in Fig. 2. The spring is unstretched when link 2 lies horizontally ($\theta_2 = 0$). The spring stiffness is 50 N/m. The length of Link 2 is 1 m. Link 2 is assumed to be massless. Link 3 and Link 4 weigh 1 kg and 3 kg, respectively. There is no friction in the sliding pairs.

   (a) (10%) The mechanism is freely released when link 2 lies horizontally ($\theta_2 = 0$) and starts to oscillate. Determine the maximum and minimum angle of link 2.

   (b) (25%) A motor is installed at the joint between the ground and link 2 to drive link 2 at a constant speed of 10 rad/s in the counter-clockwise direction. Draw the free body diagrams of link 2 and 3 when $\theta_2 = 30°$ and determine the torque applied on link 2 by the motor.

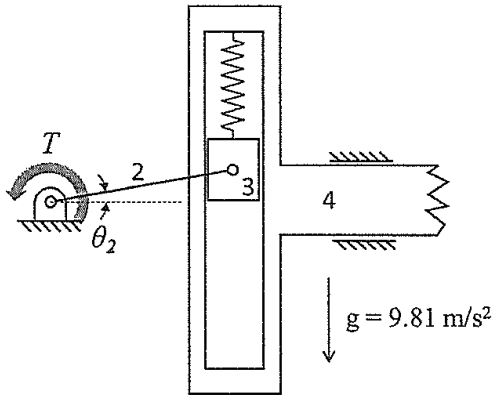

Fig. 2

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3. (25%) A passenger car weighs 2000 kg, and its wheelbase L is 2.5 m, and the position of the center of gravity G is shown in Fig. 3. The friction coefficient between the tire and the road surface is 0.85. Ignore the rolling resistance coefficient and air drag resistance. and the friction in the driveline. (g = 9.81 m/s2.)

(a) (7%) Find the normal forces, in N, of the front and rear wheels acting on a horizontal surface, while the car is not moving.

(b) (18%) Determine the maximum acceleration of this vehicle, in m/s2, if the available power of the vehicle is unlimited.

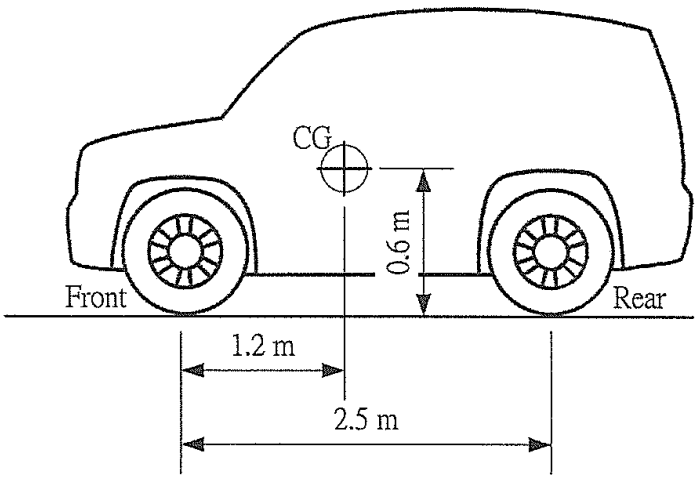

Fig. 3

4. (10%) In the mechanism, shown in Fig. 4, link 2 rotates with a constant angular velocity, 10 rad/s CCW. Use this mechanism as an example to explain the Coriolis' acceleration, and show its direction in this case.

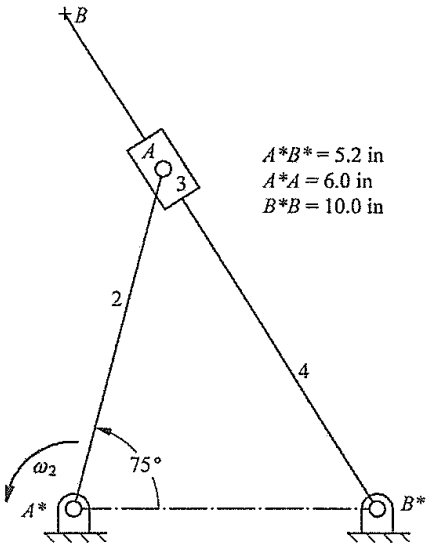

Fig. 4

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