The solutions and answers may be in either Chinese or English.

1. Explain the D'Alembert's principle in a dynamic system of rigid bodies. Give one example to explain your answer. (15%)

2. Blocks A and B, weighting 2 kg and 6 kg respectively, are connected by a weightless rope passing over a frictionless pulley as shown in Fig. 1. Assuming a coefficient of friction of 0.3, please determine the velocity of the system 5 seconds after starting from rest. (20%)

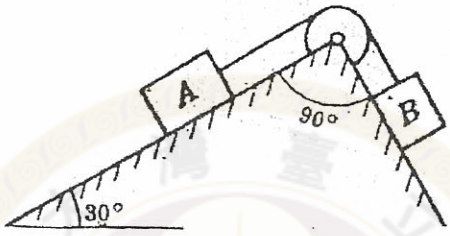

Fig. 1

3. As shown in Fig. 2, the collar at O and attached shaft OC rotate about the fixed x_0-axis at the constant rate $\Omega = 4$ rad/s. Simultaneously, the circular disk rotates about OC at the constant rate $p = 10$ rad/s. Determine the magnitude of the total angular velocity ω of the disk and find its angular acceleration α. (20%)

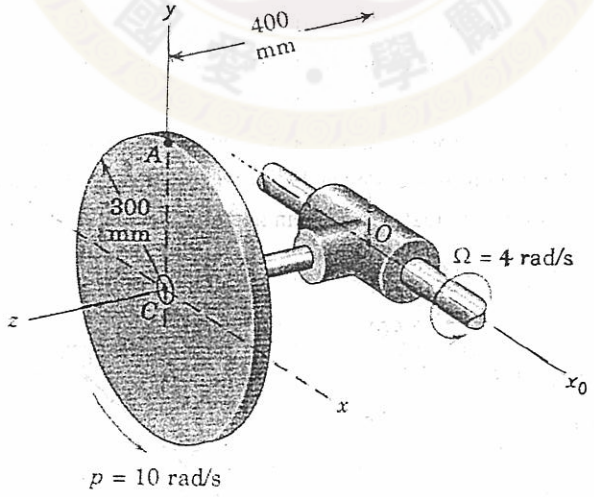

Fig. 2

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4. The center O of the 2-kg wheel, with radius of gyration of 60 mm about O, has a velocity v_o = 0.3 m/s down the 15 incline when a force P = 10 N is applied to the cord wrapped around its inner hub, as shown in Fig. 3. If the wheel rolls without slipping, calculate the velocity v of the center O when P has been applied for 5 seconds. (20%)

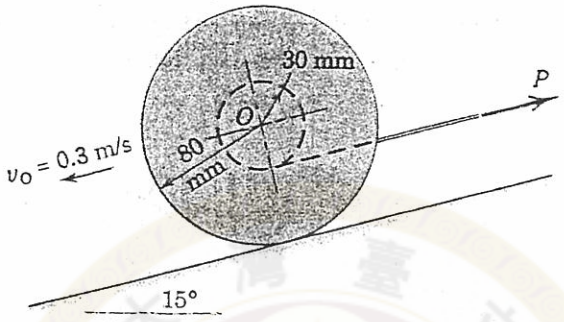

Fig. 3

5. In the four-bar mechanism shown in Fig. 4, the center of mass of link 3 is at G_3, which is located at the center of link 3. The mass of link 3 is 0.5 kg. Its moment of inertia about G_3 is 0.0012 kg·m². The weights and moments of inertia of members 2 and 4 can be neglected. Link 2 is driven at a constant angular velocity of 50 rad/s clockwise (CW) by a torque T_{12} applied to link 2. The mechanism moves in the horizontal plane, and friction is also neglected.
(a) How can you find the magnitudes and directions of the inertia force and inertia torque acting on link 3? Explain your procedure in details. (10%)
(b) How can you find the magnitude and directions of forces exerted on link 3 by link 2 at A and by link 4 at B. Explain your procedure in detail. (15%)
For both questions, you just need to write down the procedures to solve and equations necessary to solve them. Numerical calculations are not needed in both questions. Note that link lengths are given as O_AA=20, AB=70, O_BB=60, O_AO_B=80, all in millimeter.

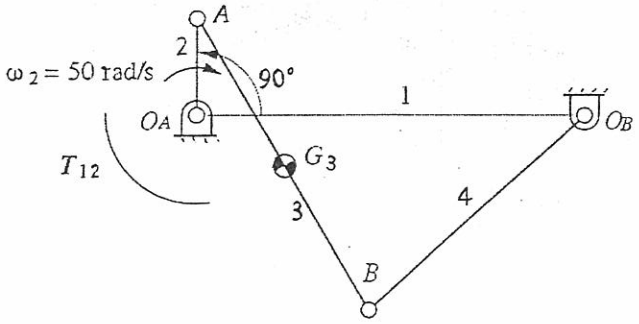

Fig. 4

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