國立臺灣大學 104 學年度碩士班招生考試試題

1. (15%)A uniform rectangle steel plate has a mass of 10 kg and is rest on a smooth frictionless horizontal surface. If a horizontal force F (80 N) is applied to one corner, as shown in Fig. 1, find the angular acceleration α_2 rad/sec^2 of the plate, and the magnitude and direction of the acceleration of the point A at the corner of the plate, in mm/sec^2. (Hint: For a (b x h) plate, $I_{z\,of\,CG} = bh(b^2+h^2)/12$)

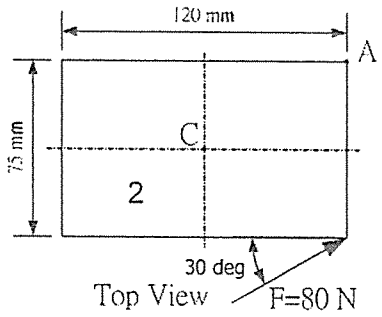

Fig. 1

2. (20%) Blocks A and B, has a mass 12 kg and 4 kg respectively, and are connected by a weightless string rapped around and passing over a pulley as shown in Fig. 2. The pulley has a mass of 6 kg and a radius of gyration of 0.05 m. The bearing of the pulley can be treated as frictionless.

(a) Find the minimum static friction coefficient, μ_s, between the blocks and the surface, such that the system will stay unmoved. (10%)

(b) If the static friction coefficient, μ_s, is small enough for the blocks to move, and the kinetic friction coefficients, μ_k, is 0.1, please determine the angular velocity of the pulley, 3 seconds after starting from rest, in rad/sec, and turning CCW direction as positive. (10%)

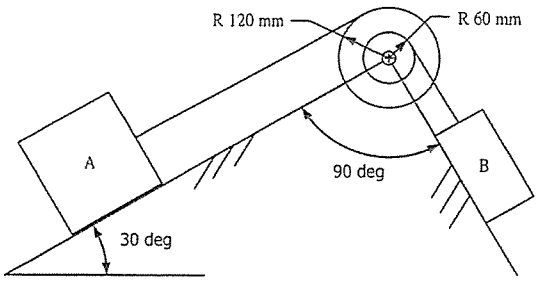

Fig. 2

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3. (35%) Shown in Fig. 3 is the mechanism that drives the windshield wiper of an automobile. The mechanism consists of six links, links 1, 2, …, and 6, where link 1 (MN) is the car body and acts as a fixed frame, links 2 (BN) and 4(AM) are the wiper blades, links 3 (AB) and 5 (CB) are connecting rod, and link 6 (PC) serves as the input of the driving motor. These links are respectively connected by hinges (revolute joints) at the locations, P, C, B, A, M, and N. Assume the wiper must be able to work in the worst weather condition as when the maximum force caused by wind and rain on the wiper blade is F Nt during the stormy day and the friction coefficient between rubber blades and the windshield window is 0.9. This friction force acts as the external force on the wiper. Assume the link length of each link is known and the input motor rotates at a constant speed ω.

If you are a design engineer who is required to write a research report to analyze the strength of the mechanism. Following are the key issues that must be contained in the report.

(a) What else design parameters are needed to know in order to obtain the action and/or reaction force in the joints as at P, C, B, A, M, and N? (5%)

(b) Once the parameters in (a) are known, how can you find the magnitude and direction of the inertia force and inertia torque acting on link 3? What equations do you need in solving the problem? Explain your procedure in details. (15%)

(c) How can you find the magnitude and direction of torque for the input motor? Explain your procedure in detail. (15%)

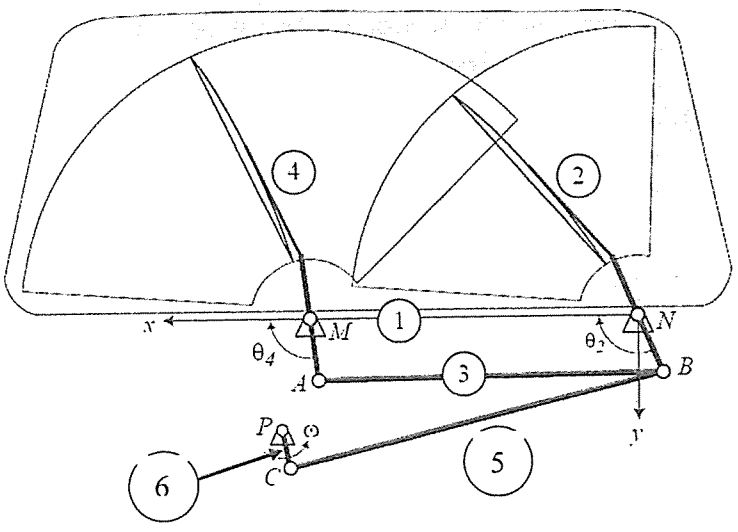

Fig. 3

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4. (30%) Explain the following:
   (a) Parallel-axis theorem for mass moment of inertia (5%)
   (b) Coriolis acceleration (5%)
   (c) Radius of gyration (5%)
   (d) Kinetic Energy (5%)
   (e) Law of conservation of energy (5%)
   (f) Center of percussion (5%)

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