

1. From Newton's second law of motion, shows that the equation of motion of a rigid body are

$$F = m a_G \quad (10\%)$$

and

$$M_P = r_{GP} \times m a_G + I_G \alpha \quad (20\%)$$

where  $F$  and  $M_P$  are the applied force and applied moment at point  $P$  of the rigid body, respectively.  $a_G$  is the acceleration vector of the mass center,  $I_G$  is the mass moment of inertia related to the mass center,  $\alpha$  is the angular acceleration vector and  $r_{GP}$  is the position vector from point  $P$  to the mass center.

(It is allowed to derive the equation in two dimensional space.)

2. Answer the following questions: (20%)
- What is the relation among the Newton's second law of motion, the principle of work and energy and the principle of impulse and momentum?
  - Which kinds of problem can not be solved by the principle of work and energy? Explain the reason.
3. Two jet planes are flying horizontally at the same elevation, as shown in the Figure 3. Plane A is flying along a straight-line path, and at the same instant shown it has a speed of 700 km/h and an acceleration of 50 km/h<sup>2</sup>. Plane B is flying along a circular path having a radius of  $\rho_B = 400$  km. Its speed is 600 km/h, which is decreasing at the rate of 100 km/h<sup>2</sup>.
- Determine the velocity and acceleration of B as measured by the pilot in A. (5%)
  - Determine the velocity and acceleration of A as measured by the pilot in B. (15%)
4. The uniform beam has a weight  $W$ . If it is originally at rest while being supported at A and B by cables, determine the tension in cable A if cable B suddenly fails. Assume the beam is a slender rod. (12%) (See Fig. 4)
5. Determine the kinetic energy of the 10-kg disk D and 2-kg rod CD when the assembly is rotating about the z axis at  $\omega = 5$  rad/s. (18%) (See Fig. 5)

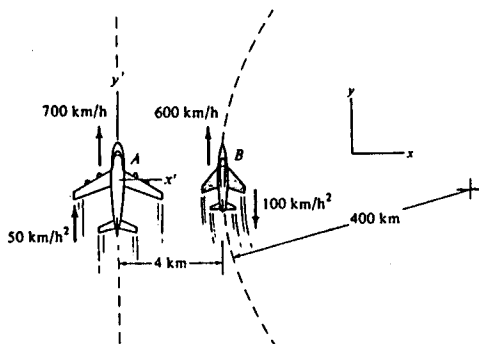


Figure 3

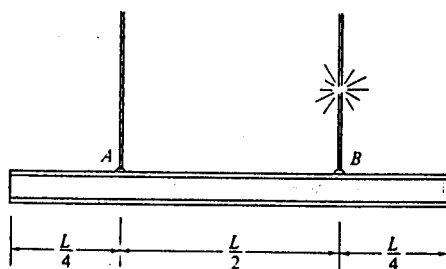


Figure 4

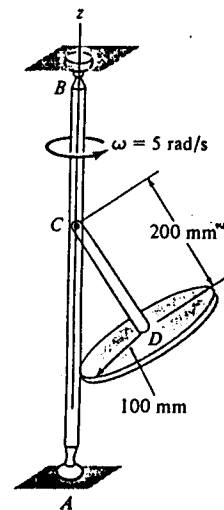


Figure 5

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