國立中山大學 101 學年度碩士暨碩士專班招生考試試題

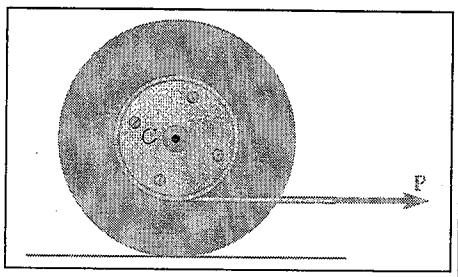
科目：應用力學【機電系碩士班乙組、丙組】

題號：4099

Please choose the correct answers for problem 1 to problem 3
Please be noted that the correct answers for each problem may be more than one

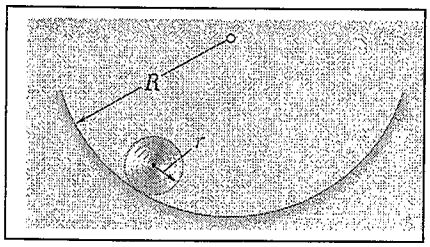
1. Consider a particle P moves along a space curve. The Cartesian coordinates and the cylindrical coordinates of the position of the particle P is (x, y, z) and (r, θ, z), respectively. Let **[i, j, k]**.and [$\mathbf{e}_r$, $\mathbf{e}_\theta$, **k**] be the base unit vectors of the Cartesian coordinate system and the cylindrical coordinate system, respectively. If the velocity of P at an instant is $2\mathbf{i} + 4\mathbf{j} + 6\mathbf{k}$ [unit: m/s], then which of the following statements are correct? (15 %)
   (A) $(d\mathbf{e}_r/d\theta) = -\mathbf{e}_\theta$, . $(d\mathbf{e}_\theta/d\theta) = \mathbf{e}_r$.
   (B) $\mathbf{e}_r = \cos\theta\,\mathbf{i} + \sin\theta\,\mathbf{j}$, $\mathbf{e}_\theta = \sin\theta\,\mathbf{i} - \cos\theta\,\mathbf{j}$.
   (C) $\mathbf{i} = \cos\theta\,\mathbf{e}_r + \sin\theta\,\mathbf{e}_\theta$, $\mathbf{j} = \sin s\theta\,\mathbf{e}_r - \cos\theta\,\mathbf{e}_\theta$.
   (D) At this instant, $(dr/dt) = 2\cos\theta + 4\sin\theta$, where t is the time.
   (E) .At this instant, $(d\theta/dt) = (4\cos\theta - 2\sin\theta)/(x^2 + y^2 + z^2)^{1/2}$, where t is the time.
   (F) None of the previous statements is correct.

2. A drum of radius r is attached to a disk of radius R. The disk and drum have a total mass of M and a combined radius of gyration of k. A cord is attached to the drum as shown and pulled with a force of magnitude P. Knowing that the disk rolls without sliding, then which of the following statements are correct? (15 %)



   (A) The angular acceleration of the disk = $(Pr)/(Mk^2)$.
   (B) The acceleration of G = $(PRr)/(Mk^2)$.
   (C)The friction force existed between the disk and the ground = $P[1 - (Rr)/(k^2 + R^2)]$.
   (D) the minimum value of the coefficient of static friction compatible with this motion = $P(k^2 + r^2 - Rr)/[(k^2 + r^2)(Mg)]$, where g is the acceleration of gravity.
   (E) At any instant, the friction force existed between the disk and the ground is less than or equal to (the coefficient of static friction)(normal force on the contact point).
   (F) None of the previous statements is correct.

3. Consider the small oscillations of a cylinder of radius r with center G which rolls without slipping inside a curved surface of radius R with center O. Let θ be the angle which line OG forms with the vertical, and θ_m is the maximum value of θ. If $\theta_m << 1$, then which of the following statements are correct? (20 %)



   (A) At any instant, the velocity of G = (r)(angular velocity of the cylinder)
   (B) By letting the potential energy at $\theta = 0$ is zero, then at $\theta = \theta_m$, the corresponding potential energy = $W(R - r)(\theta_m)^2/2$.
   (C) At $\theta = 0$, the angular velocity of the cylinder equals to zero.
   (D) The natural frequency of those oscillations = $[(g/3)/(R - r)]^{1/2}$, where g is the acceleration of gravity.
   (E) The corresponding period = $(2\pi)[3(R - r)/g]^{1/2}$, where g is the acceleration of gravity.
   (F) None of the previous statements is correct.

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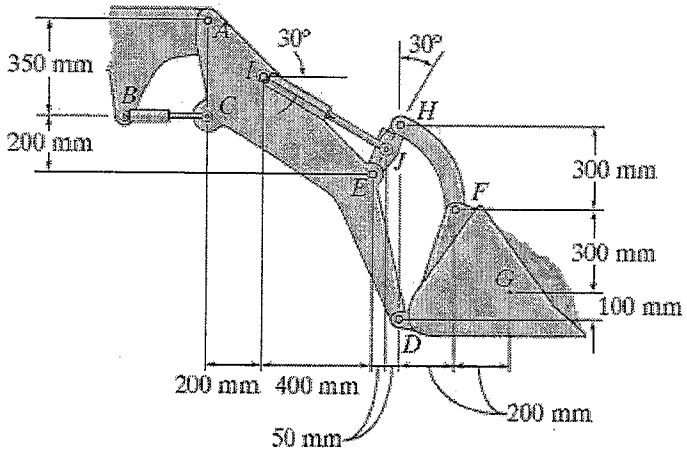
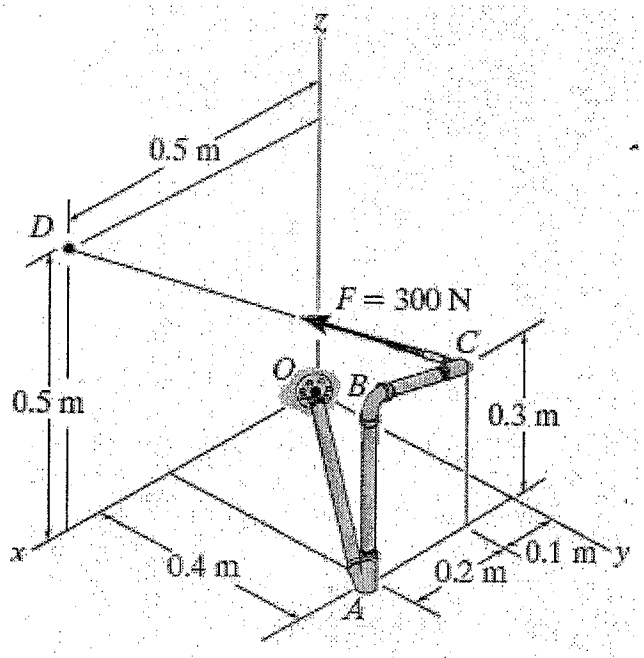
4. The tractor shovel carries a 500-kg load of soil, having a center of mass at G. Compute the forces developed in the hydraulic cylinders IJ and BC due to this loading. (20%)



5. Determine the magnitude of the moment of force F about segment OA of the pipe assembly. (15%)



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6. The crankshaft AB of an engine turns with a clockwise angular acceleration of 20 rad/s^2. Determine the acceleration of the piston C at this instant as shown in the figure. At this instant, ω_{AB} = 10 rad/s and ω_{BC} = 2.43 rad/s. (15 %)