※ 考生請注意：本試題 ☑可 ☐不可 使用計算機

1. Why the centrifugal acceleration of a particle with speed V in a circular motion with radius R can be determined by V^2/R? (15%)
2. How a Coriolis acceleration can occur? Give an example and explain it in detail (15%)
3. For simplification, assume the earth to be a sphere with radius $R = 6{,}378$ km. At a position with longitude $\lambda = 120°$ and latitude $\phi = 23°$ (as you may notice that, it is close to where we are), a rocket is flying at constant altitude $h = 30{,}000$ m with constant speed $V = 2{,}000$ m/s. The heading angle of the flight is $\psi = 30°$, counted clockwise from the north. The revolving speed of the earth is $\Omega = 7.292115856 \times 10^{-5}$ rad/s. At such instant described in the above, determine
   (a) the angular velocity $\boldsymbol{\omega}$ of the rocket relative to the earth surface, (7%)
   (b) the angular acceleration $\boldsymbol{\alpha}$ of the rocket relative to the earth surface, (7%)
   (c) the acceleration $\mathbf{a}$ of the rocket relative to the earth center (which is assumed to be fixed). (6%)

   Express $\boldsymbol{\omega}, \boldsymbol{\alpha}, \mathbf{a}$ in **ENZ**-coordinate system, where **E**, **N**, and **Z** are unit vectors, pointing east, north, and up, respectively.
4. A mass m and a spring of stiffness k are connected in series and lie on a horizontal floor. At t=0, the free end of the initially unstressed spring is moved at a constant speed v_0 in a straight line directly away from the mass. Assuming a friction coefficient μ, solve for the displacement of the mass as a function of time. (15%)
5. A small fixed tube is shaped in the form of a vertical helix of radius R and helix angle γ, that is, the tube always makes an angle γ with the horizontal. A particle of mass m slides down the tube under the action of gravity. If there is a coefficient of friction μ between the tube and the particle, what is the steady-state speed of the particle? Let γ =30° and assume that $\mu < 1/\sqrt{3}$. (15%)
6. A particle of mass m slides along a frictionless horizontal track in the form of a logarithmic spiral

$$r = r_0 e^{-a\theta}$$

   If its initial speed is v_0 when $\theta = 0$, find the speed of the particle and also the magnitude of the track force acting on the particle as functions of θ (20%)