

航空太空工程研究所

Fundamental Dynamics

Problem A:

Answer the following question:

- What is an equilibrium point of a dynamics system described by the equation of motion $\dot{X} = f(X, t)$? (5%)
- How many different kinds of equilibrium points a dynamic system may possibly have? State their difference. (15%)

Problem B:

A space station circulating the earth orbit is constructed with two donut-shaped ring structures connected by four radial channels. An astronaut is trying to move from the inner ring area to the outer ring through one of the radial channel as shown in Fig. 1. Assume the station is spinning with an angular velocity ω . Show in your answer what is the force the astronaut feels on his way of movement? (Make whatever assumptions you would need for your answer.) (20%)

Problem C:

A pendulum with a metal bob hangs between two magnets, is shown in Fig. 2. The force one magnet exerts on the bob is given by $f = c/x^2$. Write the exact equation of motion. Then linearize for small motions ($\theta \ll h - x$) about the position $\theta = 0$. Obtain the characteristic equation and discuss the effect of c and h upon stability. (30%)

Flight Mechanics

Problem D:

- Write down the generalized drag polar of an airplane at subsonic flight. Determine the maximum aerodynamic efficiency, induced drag to zero-lift drag ratio and the corresponding lift coefficient. (5%)
- What is a Static Margin (S.M.) of an aircraft? How does the center of gravity affect the S.M. as an aircraft is of concern? (5%)

Problem E:

For the vector diagram shown in Fig. 3, X and Z are airplane fixed coordinates with the thrust acts along the X axis.

- If α is the angle of attack and Θ is the angle between X and the horizontal. Write down a relation for the rate of climb dh/dt in terms of V , α and Θ . (5%)
- Completed the equations about L & D coordinates. Simplify these equations by assuming $\alpha \ll 1$ and $\Theta \ll 1$. (5%)
- For a level flight with $\alpha = 0.1$ radian, $L/D = 10$ and $W = 10^4$ pounds, what value would T and L have? (5%)
- Assume the above conditions with $\rho = 0.00238$ slugs/ft³, $C_{L_{\alpha}} = 0$, $C_{L_{\alpha\alpha}} = 5/\text{radian}$ and the wing area $S = 1000$ ft². What is the flight velocity of the aircraft? (5%)

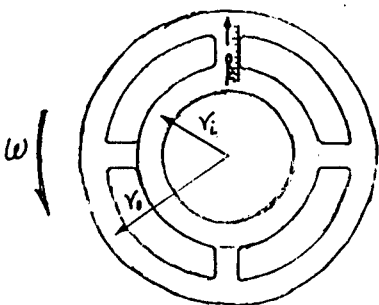


Fig. 1

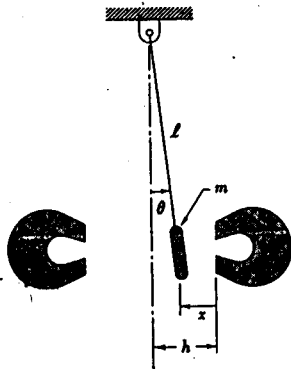


Fig. 2

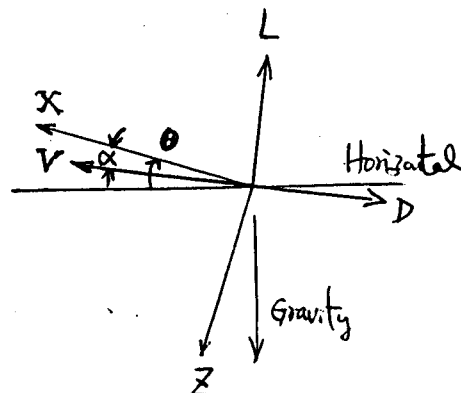


Fig. 3