Examples

***Example 1***

For a particular aircraft at a flight speed of 100 ms-1, the controls-fixed equations of motion are:

Derive an approximation characteristic equation for the phugoid mode and stating clearly the assumptions that need to be made.

Hence determine the periodic time and time to half amplitude for this mode.

(10 marks)

**Solution**

b. The two longitudinal modes of motion that is likely to result when an aircraft is given a small symmetrical disturbance from straight flight are; phugoid and short period mode.

Phugoid mode:

* Long period
* Lightly damped
* It is characterised by the forward speed u and the pitch angle
* u and are out of phase by .

Short period pitching oscillation:

* short period
* heavily damped
* characterised by pitching angle and incidence angle .
* and are almost in phase.

c. Assumptions,

* The aircraft is moving in trim; hence omit the pitching moment equation.
* No change in incidence w=0 in all the equations

1

2

Substituting:

3

4

Divide equation 3 and 4 by and write it in matrix form:

5

For non zero

Hence the determinant of equation 5 is given by;

6

7

Divide equation 7 through by -100

(Characteristic equation) 8

**Example 2**

The lateral equations of motion for an aircraft in a particular flight condition are:

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If the aircraft is flown in a steady correctly banked turn with a bank angle of, calculate the rate of turn and the aileron and rudder angles required to maintain the turn. (8marks)

(c) Why would it not be appropriate to use the lateral aircraft equations provided in question 4 (b) to estimate the control deflections required for a turn with a large bank angle? (2marks)

**Solution**

1

2

3

Assumptions

In steady turn correctly banked turn, (fixed bank angle)

Also (zero sideslip)

Hence substitute the above assumptions in equations 1-3.

We have,

4

5

6

We know that the bank angle is .1745329rads

From equation 4, we have

From equation 6 and 5

These equations apply to small bank angles, but large bank angles need more complicated equations because the assumptions do not hold.