ME597/AAE556 – Fall 2022
Purdue University
West Lafayette, IN

Homework Set No. 5

Assignment date: Wednesday, November 30
Due date: Friday, December 9

Please submit your completed homework assignment by

- Scanning and uploading assignment to ***Gradescope***.

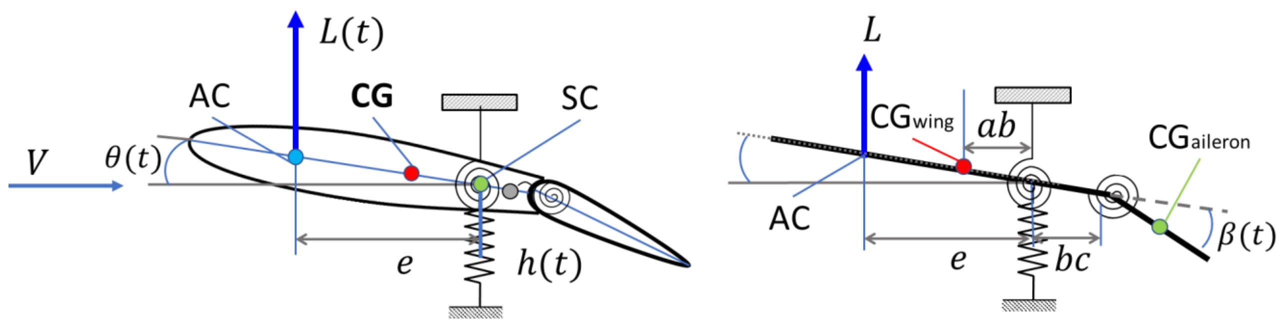
Instructions:

- Please upload your HW with following this name code, where ** is the assignment number (e.g., HW**=HW1): HW**ME597/AAE556_Fall22_NameInitial_Lastname
- This assignment is strictly individual.
- Your work will be evaluated considering the shown procedure to obtain final answers.
- The procedure and results should be **clear** and **ordered**.
- Consider asking questions about the assignment in advance to avoid inconveniences caused by unexpected events close to the submission date.
- **Please ensure your work is submitted via *Gradescope***.

Name____

ME597/AAE556 – Fall 2022
Homework Set No. 5
Problem No. 1 – 50 points

Consider a classical section wing with a trailing edge control surface as shown in the figure below. This is a three degree of freedom systems with the plunge, twist, and control surface angle given by the generalized coordinates $h(t)$, $\theta(t)$, and $\beta(t)$, respectively. The spring associated to each coordinate are given by K_h, K_θ and K_β, respectively. The wing planform has unitary span and chord $2b$. The wing's lift curve slope is 2π.



The purpose of this problem is to develop a code for analyzing the unsteady flutter response of a wing with control surface using Theodorsen's theory. Using the aerodynamic forces given by the T-functions on the Weisshaar's book example 4.8.3 determine the following:

<u>Find:</u>

a) The flutter and divergence speeds for the parameters:
$\omega_h = 50$ rad/s, $\omega_\theta = 100$ rad/s, $\omega_\beta = 300$ rad/s, $a = -0.4$, $c = 0.6$, $b = 1$ m, $\bar{x}_\theta = 0.2$, $\bar{x}_\beta = 0.0125$, $\bar{r}_\theta^{\,2} = 0.25$, $\bar{r}_\beta^{\,2} = 0.00625$, $\mu = 40$. Assume sea level conditions for your calculations in SI units.
Show the $V - \omega$ and $V - g$ graphs obtained from your own code.

b) To increase the flutter speed, a balance weight is to be placed at the 5% chord position. Determine the weight needed to increase the flutter speed by 10 %, 15 %, and 20 % found in part a). Assume the weight to be a point mass. Comment of the relationship between weight and flutter speed.

<u>All results require derivations and accompanying supporting code for grading.</u>

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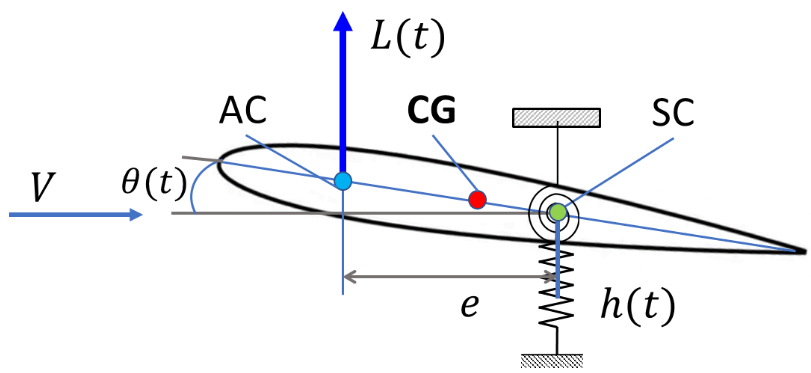
Homework Set No. 5
Problem No. 2 – 50 points

The purpose of this problem is for you to implement your own $p - k$ flutter code for the unsteady analysis of the classical section with unitary wing span. This implies considering the lift using harmonic motion assumption for the lift that leads to the aerodynamic influence coefficient matrix be a function of Theodersen's function and the reduced pressure k.



Find:

a) Determine the flutter speed for the following parameters:
$\omega_h = 10$ rad/s, $\omega_\theta = 25$ rad/s, $a = -0.2$, $\bar{d} = 0.4$, $b = 3$ m, $\bar{x}_\theta = 0.1$, $\bar{r}_\theta{}^2 = 0.5$, $C_{L\_}\alpha = 2\pi$, $\mu = 20$. Assume sea level conditions for your calculations in SI units.
Show the $V - \omega$ and $V - g$ graphs obtained from your own code.

b) Compare your results to the V-g and quasi-steady flutter methods. Show the $V - \omega$ and $V - g$ graphs to illustrate the differences between methods.

<u>All results require derivations and accompanying supporting code for grading.</u>