Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

VII SEMESTER B.TECH. (AERONAUTICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2016

SUBJECT: INTRODUCTION TO AEROELASTICITY [AAE 427]

REVISED CREDIT SYSTEM
(30/11/2016)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** questions.
- Missing data may be suitable assumed.

1A. A swept flexible lifting surface is modeled as the two interconnected, uncambered wing sections shown in Figure 1.1 below. This model simulates wing sweep by positioning the outer wing segment at a distance $h \tan \Lambda$ aft of the inner section (here the term h is a dimension, not the plunge displacement). (07)

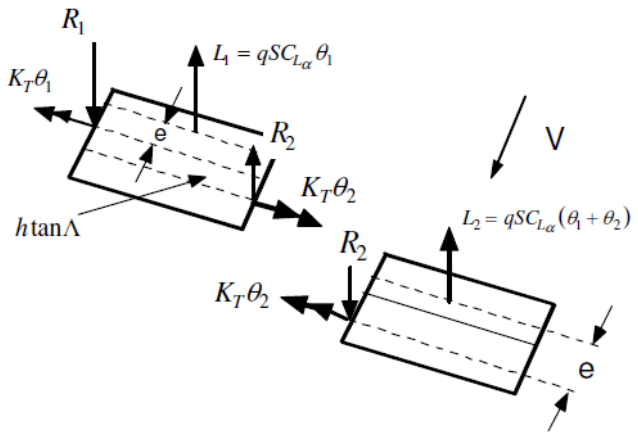

Figure 1.1

a) Develop the equations necessary to determine the divergence speed for this configuration.
b) Determine the divergence dynamic pressure q_D when $h/e = 10$, plot q_D versus angle Λ.

1B. What is aileron reversal? Does reversal dynamic pressure depend upon offset between aerodynamic center and elastic axis? (03)

2A. With a suitable example problem, explain how to apply energy formulation to continuous systems using Rayleigh-Ritz Approach and show that (07)

$$[K]\{q\} = [Q]$$

2B. Why do we use P-k method of flutter formulation instead of k method though later is still popular in industry? (03)

3A. (07)

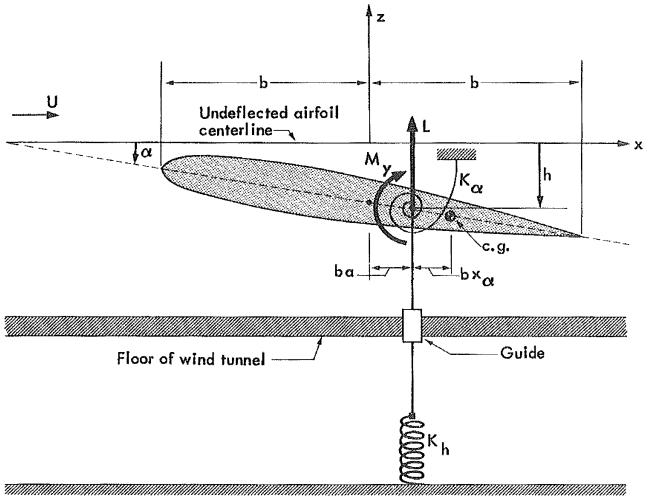

Figure 1.2

Figure 1.2 shows a two dimensional dynamic aeroelastic model representing the wing 75% of its span.

a) Redraw the model appropriately and using lagrange's equation derive the binary aeroelastic model in matrix format.
b) Show that what happens when the dynamic pressure is zero and when it is applicable?

3B. Explain the use of Maxwell and Betti Reciprocal theorem in analyzing the structural modeling (deformation of structures). (03)

4A. Using strip theory how do you explain the lift distribution on a tapered wing when there is deflection in the control surface as shown in figure 1.3? (any one case) (07)

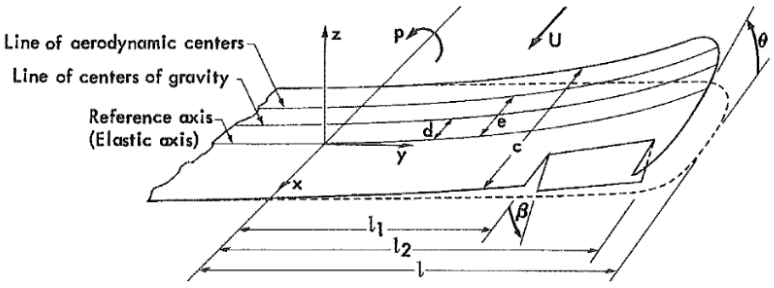

Figure 1.3

4B. What are admissible functions? How do you differentiate forced and geometric boundary conditions? (03)

5A. Figure 1.4 shows slender straight wing (no sweep) of length l in an incompressible flow with strip theory applicable at every 2-D section. By exact solutions, show that the divergence speed of this straight wing is given as: (07)

$$U_D = \frac{\pi}{2l}\sqrt{\frac{2GJ}{ecC_{l_\alpha}\rho}}$$

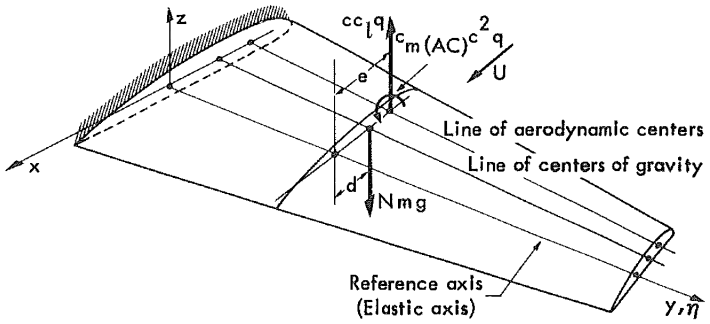

Figure 1.4

5B. What is the main advantage of using flutter conics? (03)

6A. A binary aeroelastic system (in SI Units) takes the form: (07)

$$\begin{bmatrix} 130 & 0 \\ 0 & 10 \end{bmatrix}\begin{bmatrix} \ddot{\theta} \\ \ddot{\gamma} \end{bmatrix} + \begin{bmatrix} 6V & 0 \\ -3V & V \end{bmatrix}\begin{bmatrix} \dot{\theta} \\ \dot{\gamma} \end{bmatrix} + \begin{bmatrix} k & 3V^2 \\ 0 & 2k - 3V^2 \end{bmatrix}\begin{bmatrix} \theta \\ \gamma \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$$

If $k = 1.173 \times 10^5 N/m$. Find the critical flutter speed, frequencies for which system is unstable using the Routh-Hurwitz Criterion.

6B. Although some loss in lifting capability may be experienced, but what is the primary motivation for sweeping a lifting surface? (03)