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# MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

*(A constituent unit of MAHE, Manipal)*

## VII SEMESTER B.TECH. (AERONAUTICAL ENGINEERING)

## END SEMESTER EXAMINATIONS, NOV 2019

SUBJECT: UNSTEADY AERODYNAMICS [AAE 4004]

**REVISED CREDIT SYSTEM**
**(28/11/2019)**

Time: 3 Hours MAX. MARKS: 50

**Instructions to Candidates:**

- Answer **ALL** the questions.
- Missing data may be suitable assumed.
- Draw a neat sketch with pencil wherever necessary

**1A.** With reference to the unsteady sectional lift coefficient for a thin airfoil moving in a simple harmonic motion, explain the following cases. (i). Unsteady aerodynamics (ii). Quasi-unsteady aerodynamics and (iii). Quasi-steady aerodynamics. **(03)**

**1B.** Write a note on hypersonic aerodynamics. **(03)**

**1C.** With a neat sketch derive an expression for the lift coefficient for the flow over an airfoil using Kutta-Joukowski theorem. **(04)**

**2A.** Using linearization theory, deduce an expression for the downwash for the flow over a thin airfoil set at a lower angle of attack. **(03)**

**2B.** Write a note on initial and boundary conditions. **(03)**

**2C.** Obtain an expression for the unsteady energy equation. **(04)**

**3A.** State why it is necessary to study the turbulence modelling. Name few commonly used turbulence models. **(02)**

**3B.** The angle of attack of an airfoil is suddenly changed from $0^o$ to $12^o$. The reduced time is 30. Evaluate the lift coefficient based on the Wagner function. **(03)**

**3C.** Obtain an expression for the unsteady Kutta condition for an incompressible flow over an airfoil. **(05)**

**4A.** Write the final expression for the Weissinger's L-method and explain the physical significance of this method. **(02)**

**4B.** Write a note on arbitrary motion of a thin wing in subsonic incompressible flow. **(03)**

**4C.** Derive an expression for the geometric angle of attack using Prandtl's lifting line theory. **(05)**

**5A.** A free-stream flow takes place over a thin wing at $9^o$ angle of attack at a speed of 95 m/s. The wall normal displacement over the suction surface is given by the equation $0.05xt^2 + 0.2x^2$. Find the downwash for the suction surface at t = 4 s and x = 0.14 m. **(03)**

**5B.** With neat sketch describe different types of shock waves that may occur in a supersonic flow. **(03)**

**5C.** Describe the significance of Mach Box Method. Explain the criteria for the identification of subsonic and supersonic edge of an aerodynamic body using **(04)**

Mach Box Method. Show the subsonic and supersonic edge for (i). low sweep wing and (ii). Delta wing.