Indian Institute of Space Science and Technology

AE 111 - Introduction to Aerospace Engineering (I Semester)

Quiz 1

Duration: 60 minutes **Total Marks:30**

Standard sea level (SSL) atmospheric properties

- Pressure, P = 101.325 kPa
- Density, $\rho = 1.225$ kg/m^3
- Temperature, T = 15°C
- Gas constant of air, $R_{air} = 287.057$ J/(kg.K)
- Dynamic viscosity, $\mu = 1.789 \times 10^{-5}$ Pa.s
- Acceleration of gravity, $g_0 = 9.807$ m/s^2

1. Fill in the blanks

   (a) The angle of attack of an airfoil is the angle between the _____ and the _____. [1]

   (b) The rotation of the airplane about the longitudinal axis is _____. [1]

   (c) On an airfoil, the aerodynamic force components, _____ and _____ are vertical and parallel respectively to the _____. [1]

   (d) The line joining the leading edge and the trailing edge of an airfoil that is precisely midway between the upper and the lower surface is the _____. [1]

   (e) Lift augmentation device at the trailing edge of the wing is called _____. [1]

   (f) A spoiler deflection causes _____. [1]

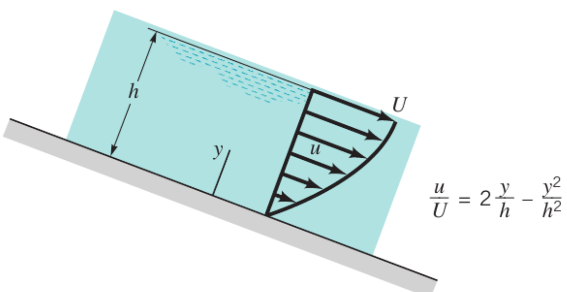
   (g) The control surface on the vertical stabilizer is called _____. [1]

   (h) A point along the streamline at which the velocity is zero is called _____. [1]

   (i) _____ similarity means that the flow maintains the streamline pattern between the model and the prototype. [1]

   (j) In defining geopotential altitude, _____ is taken as a constant equal to the sea level value. [1]

2. A layer of water flows down an inclined fixed surface with the velocity profile shown in figure. Determine the magnitude and direction of the shearing stress that the water exerts on the fixed surface for $U = 2m/s$ and $h = 0.1m$. Dynamic viscosity of water is 0.798×10^{-3} N.s/m^2. $\frac{u}{U} = 2\frac{y}{h} - \frac{y^2}{h^2}$. [3]

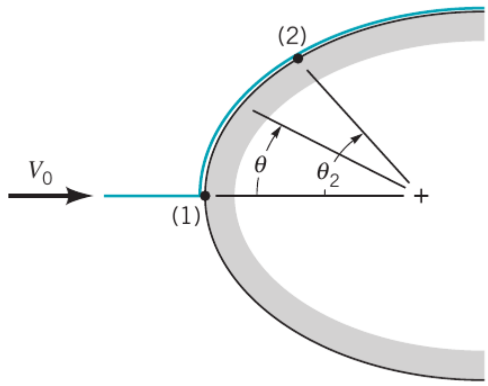


3. For the great depths that may be encountered in the ocean the compressibility of seawater may become an important consideration
   (a) Assume that the bulk modulus for seawater is constant and derive a relationship between pressure and depth which takes into account the change in fluid density with depth. [4]
   (b) Make use of part (a) to determine the pressure at a depth of 6 km assuming seawater has a bulk modulus of 2.3×10^9 Pa and a density of 1030 kg/m^3 at the surface. Compare this result with that obtained by assuming a constant density of 1030 kg/m^3. [2]

4. A balloon weighing 80 kg has a capacity of 1200 m^3. If it is filled with helium, how great a payload can it support? The density of helium is 0.18 kg/m^3 and the density of air is 1.30 kg/m^3. Express your answer in Newtons. [3]

5. The atmosphere of Jupiter is essentially made up of hydrogen, H_2. For H_2, the specific gas constant is 4157 J/(kg)(K). The acceleration of gravity of Jupiter is 24.9 m/s^2. Assuming an isothermal atmosphere with a temperature of 150 K and assuming that Jupiter has a definable surface, calculate the altitude above that surface where the pressure is one-half the surface pressure. [4]

6. An inviscid fluid flows steadily along the stagnation streamline shown in figure, starting with speed V_0 far upstream of the object. Upon leaving the stagnation point (point (1)) the fluid speed along the surface of the object is assumed to be given by $V = 2V_0 \sin\theta$, where θ is the angle indicated. At what angular position, θ_2, should a hole be drilled to give a pressure difference of $p_1 - p_2 = \rho V_0^2/2$? Gravity is negligible. [4]



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1. Standard atmosphere: Isothermal layer

$$\frac{p}{p_1} = e^{-[g_0/(RT)](h-h_1)}$$

2. Standard atmosphere: Gradient layer

$$\frac{p}{p_1} = \left(\frac{T}{T_1}\right)^{-g_0/(aR)}$$