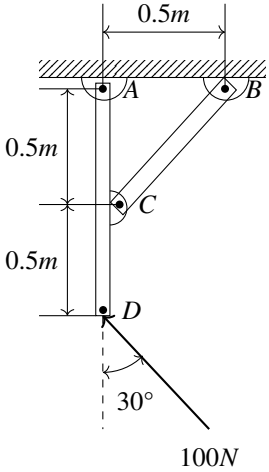
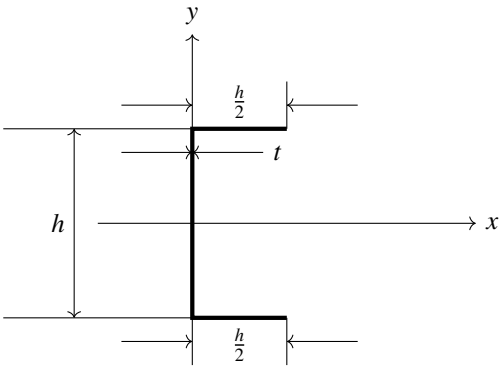
AE : Aerospace Engineering

AI24BTECH11022 - Pabbuleti Venkata Charan Teja

53) In the figure shown below, the magnitude of internal force in member BC is _____ N (rounded off to 1 decimal place).



54) The cross section of a thin-walled beam with uniform wall thickness t, shown in the figure, is subjected to a bending moment $M_x = 10Nm$. If $h = 1m$ and $t = 0.001m$, the magnitude of maximum normal stress in the cross section is _____ N/m^2 (answer in integer).



55) The equations of motion for a two degrees of freedom undamped spring-mass system are :

$$mx_1 + 2kx_1 - kx_2 = 0$$

$$mx_2 - kx_1 + 2kx_2 = 0$$

where m and k represent mass and stiffness respectively, in corresponding SI units, and x_1 and x_2 are the degrees of freedom. The larger of the two natural frequencies is given by: $\omega = \alpha \sqrt{\frac{k}{m}} rad/s$. The value of α is _____ (rounded off to 2 decimal places).

56) Consider the plane strain field given by

$$\epsilon_{xx} = 10xy^2, \epsilon_{yy} = -5x^2y \text{ and } \gamma_{xy} = Axy(2x - y)$$

where, A is a constant and γ_{xy} is the engineering shear strain. The value of the constant A for the strain field to be compatible is _____ (rounded off to 1 decimal place).

57) A chemical rocket with an ideally expanded flow through the nozzle produces $5 \times 10^6 N$ thrust at sea level. The specific impulse of the rocket is $200s$ and acceleration due to gravity at the sea level is $9.8 m/s^2$. The propellent mass flow rate out of the rocket nozzle is _____ kg/s (rounded off to the nearest integer).

58) A centrifugal compressor is designed to operate with air. At the leading edge of the tip of the inducer (eye of the impeller), the blade angle is 45°, and the relative Mach number is 1.0. The stagnation temperature of the incoming air is $300K$. Consider $\gamma = 1.4$. Neglect pre-whirl and slip. The inducer tip speed is _____ m/s (rounded off to the nearest integer).

59) Consider the following Fanno flow problem: Flow enters a constant area duct at a temperature of $273K$ and a Mach number 0.2 and eventually reaches sonic condition (Mach number = 1) due to friction. Assume $\gamma = 1.4$. The static temperature at the location where sonic condition is reached is _____ K (rounded off to 2 decimal places).

60) Consider an artificial satellite moving around the Moon in an elliptic orbit. The altitude of the satellite from the Moon's surface at the perigee is $25km$ and that at the apogee is $134km$. Assume the Moon to be spherical with a radius of $1737km$. The trajectory is considered with reference to a coordinate system fixed to the center of mass of the Moon. The ratio of the speed of the satellite at the perigee to that at the apogee is _____ (rounded off to 2 decimal places).

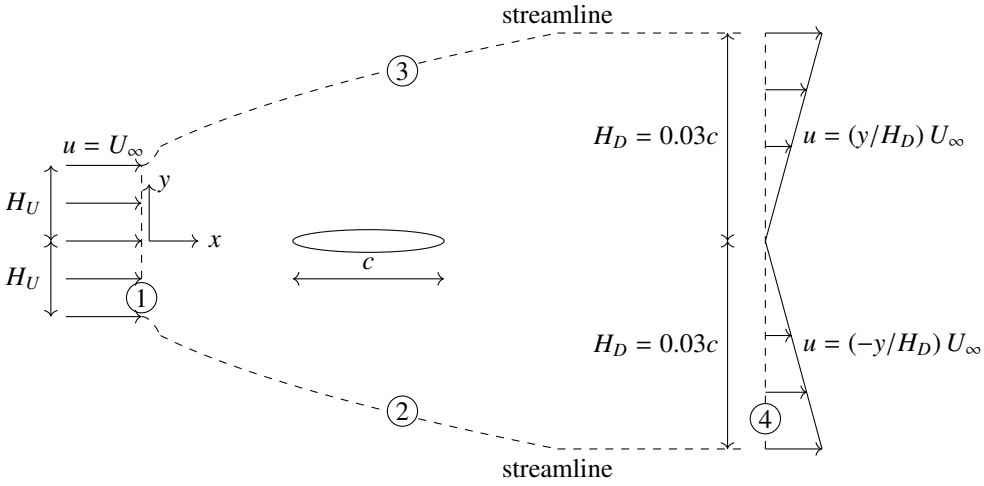
61) For an aircraft moving at $4km$ altitude above mean sea level at a Mach number of 0.2, the ratio of equivalent air speed to true air speed is _____ (rounded off to 2 decimal places).

The density of air at mean sea level is $1.225 kg/m^3$ and at $4km$ altitude is $0.819 kg/m^3$.

62) For a general aviation airplane, one of the complex conjugate pair of eigenvalues for longitudinal dynamics is given by $-0.039 \pm 0.0567i$ (in SI units). If the system is disturbed to excite only this mode, the time taken for the amplitude of response to become half in magnitude is _____ s (rounded off to 1 decimal place).

63) The figure (not to scale) shows a control volume to estimate the forces on the airfoil with elliptic cross-section. Surfaces 2 and 3 are streamlines. Velocity profiles are measured at the upstream end (surface 1) and at the downstream end (surface 4) of the control volume. The drag coefficient for the airfoil is defined as $C_d = \frac{D}{\frac{1}{2}\rho U_\infty^2 c}$, where D is the drag force on the airfoil per unit span and ρ is the density of the air.

The static pressure, p_∞, is constant over the entire surface of the control volume. Assuming the flow to be incompressible, two-dimensional and steady, the C_d for the airfoil is _____ (rounded off to 3 decimal places).



64) An airplane of mass $1000kg$ is in a steady level flight with a speed of $50m/s$. The wing has an elliptic planform with a span of $20m$ and planform area $31.4m^2$. Assuming the density of air at that altitude to be $1kg/m^3$ and acceleration due to gravity to be $10m/s^2$, the induced drag on the wing is _____ N (rounded off to 1 decimal place).

65) It is desired to estimate the aerodynamic drag, D, on a car traveling at a speed of $30m/s$. A one-third scale model of the car is tested in a wind-tunnel following the principles of dynamic similarity. The drag on the scaled model is measured to be D_m. The ratio D/D_m is _____ (rounded off to 1 decimal place).