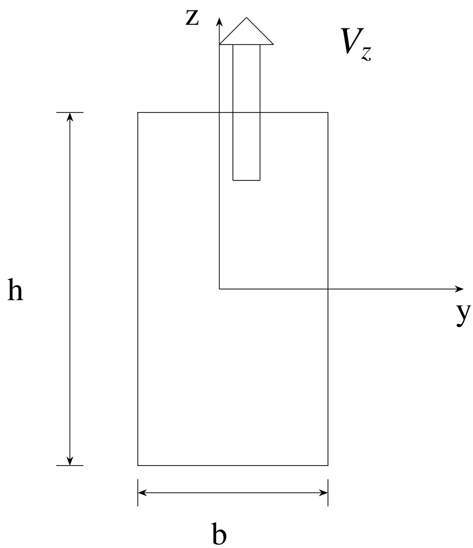
Assignment 7 - EE1030

ee24btech11018 - D. Swaraj Sharma

1) Combustion between fuel (*octane*) and oxidizer (*air*) occurs inside a combustor with the following stoichiometric chemical reaction: $2C_8H_{18} + (25O_2 + 94N_2) \rightarrow 16CO_2 + 18H_2O + 94N_2$ The atomic weights of carbon (C), hydrogen (H), oxygen (O), and nitrogen (N) are 12, 1, 16, and 14, respectively. If the combustion takes place with the fuel to air ratio 0.028, then the equivalence ratio of the fuel-oxidizer mixture is
   a) 0.094
   b) 0.422
   c) 0.721
   d) 2.371
2) The von Mises yield criterion or the maximum distrotion energy criterion for a plane stress problem with σ_1 and σ_2 as the principal stresses in the plane, and σ_3 as the yield stress, requires
   a) $\sigma_1^2 - \sigma_1\sigma_2 + \sigma_2^2 \leq \sigma_3^2$
   b) $|\sigma_1 - \sigma_2| \leq \sigma_3$
   c) $|\sigma_1| \leq \sigma_3$
   d) $|\sigma_2| \leq \sigma_3$
3) An Euler-Bernoulli beam having a rectangular cross-section, as shown in the figure, is subjected to a non-uniform bending moment along its length. $V_z = \frac{dM_y}{dx}$. The shear stress distribution τ_{xz} across its cross-section is given by
   a) $\tau_{xz} = \frac{V_z}{2l_y}\frac{z}{(h/2)}$
   b) $\tau_{xz} = \frac{V_z(h/2)^2}{2l_y}\left(1 - \frac{z^2}{(h/2)^2}\right)$
   c) $\tau_{xz} = \frac{V_z}{2l_y}\left(\frac{z}{(h/2)}\right)^2$
   d) $\tau_{xz} = \frac{V_z(h/2)^2}{2l_y}$
4) At a stationary point of a multi-variable function, which of the following is true?
   a) Curl of the function becomes unity
   b) Gradient of the function vanishes
   c) Divergence of the function vanishes
   d) Gradient of the function is maximum
5) In a rocket engine, the hot gas generated in the combustion chamber exits the nozzle with a mass flow rate $719kg/s$ and velocity $1794m/s$. The area of the nozzle exit section is $0.635m^2$. If the nozzle expansion is optimum, then the thrust produced by the engine is
   a) $811kN$
   b) $1290kN$
   c) $1354kN$
   d) $2172kN$



6) For the control volume shown in the figure below, the velocities are measured both at the upstream and the downstream ends. The flow of density ρ is incompressible, two dimensional and steady. The pressure is p_∞ over the entire surface of the control volume. The drag on the airfoil is given by,
   a) $\frac{\rho U_\infty^2 h}{3}$
   b) 0
   c) $\frac{\rho U_\infty^2 h}{6}$
   d) $2\rho U_\infty^2 h$
7) A gas turbine engine operates with a constant area duct combustor with inlet and outlet stagnation temperatures $540K$ and $1104K$ respectively. Assume that the flow is one dimensional, incompressible and frictionless and that the heat addition is driving the flow inside the combustor. The pressure loss factor $(stagnation pressure loss non-dimensionalized by the inlet dynamic pressure)$ of the combustor is
   a) 0
   b) 0.489
   c) 1.044
   d) 2.044
8) The diffuser of an airplane engine decelerates the airflow from the flight Mach number 0.85 to compressor inlet Mach number 0.38. Assume that the ratio of the specific heats is constant and equal to 1.4. If the diffuser pressure recovery ratio is 0.92, then the isentropic efficiency of the diffuser is
   a) 0.631
   b) 0.814
   c) 0.892

d) 1.343

9) An airfoil section is known to generate lift when placed in a uniform stream of speed U_∞ at an incident α. A biplane consisting of two such sections of identical chord c, separated by a distance h is shown in the following figure: FIG With regard to this biplane, which of the following statements is true?

a) Both the airfoils experience an upwash and increased approach velocity.
b) Both the airfoils experience a downwash and decreased approach velocity.
c) Both the airfoils experience an upwash and airfoil A experiences a decreased approach velocity while airfoil B experiences an increased approach velocity.
d) The incidence for the individual sections of the biplane are not altered

10) Numerical value of the integral $J = \int_0^1 \frac{1}{1-x^2} dx$, if evalutaed numerically using the Trapezoidal rule with $dx = 0.2$ would be

a) 1
b) $\pi/4$
c) 0.7837
d) 0.2536

11) The purpose of a fuel injection system in the combustor is

a) to accelerate the flow in the combustor
b) to increase the stagnation pressure of the fuel-air mixture
c) to ignite the fuel-air mixture
d) to convert the bulk fuel into tiny droplets

12) Which one of the following values is nearer to the vaccum specific impluse of a rocket engine using liquid hydrogen and liquid oxygen as propellants?

a) $49sec$
b) $450sec$
c) $6000sec$
d) $40000sec$

13) A circular cylinder is placed in a uniform stream of ideal fluid with its axis normal to the flow. Relative to the forward stagnation point, the angular positions along the circumference where the speed along the surface of the cylinder is equal to the free stream speed are

a) 30, 150, 210 and 330 degrees
b) 45, 135, 225 and 270 degrees
c) 0, 90, 180 and 270 degrees
d) 60, 120, 240 and 300 degrees

14) The Newton-Raphson interation formula to find a cube root of a positive number c is

a) $x_{k+1} = \frac{2x_k^3 + \sqrt[3]{c}}{3x_k^2}$
b) $x_{k+1} = \frac{2x_k^3 - \sqrt[3]{c}}{-3x_k^2}$
c) $x_{k+1} = \frac{2x_k^3 + c}{3x_k^2}$
d) $x_{k+1} = \frac{x_k^3 + c}{3x_k^3}$

15) The torsion constant J of a thin-walled closed tube of thickness t and mean radius r is given by
    a) $J = 2\pi r t^3$
    b) $J = 2\pi r^3 t$
    c) $J = 2\pi r^2 t^2$
    d) $J = 2\pi r^4$
16) An aerospace system shown in the following figure is designed in such a way that the expansion generated at A is completely absorbed by wall B for $p_l = p_d$, where p_d corresponds to the design condition. FIG For $p_1 > p_\infty$ which of the following statements is NOT true?
    a) For $p_l < p_d$, the expansion fan from A gets reflected from B as a compression wave
    b) For $p_l > p_d$, the expansion fan from A gets reflected from B as an expansion wave
    c) For $p_l < p_d$, the expansion fan from A gets reflected from B as an expansion wave
    d) For $p_l > p_d$, B always sees an expansion
17) The span-wise lift distribution for three wings is shown in the following figure: FIG In the above figure, c_l refers to the section list coefficient, C_L refers to the lift coefficient of the wimd, y is the coordinate along the span and s is the span of the wing. A designer prefers to use a wing for which the stall begins at the root. Which of the wings will he choose?
    a) P
    b) Q
    c) R
    d) None