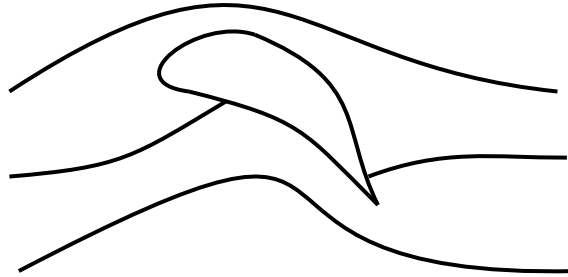


# XE-2022

EE24Btech11022 - Eshan Sharma

- 1) A two-dimensional potential flow solution for flow past an airfoil has a streamline pattern as shown in the figure. Which of the following conditions is additionally required to satisfy the Kutta condition?



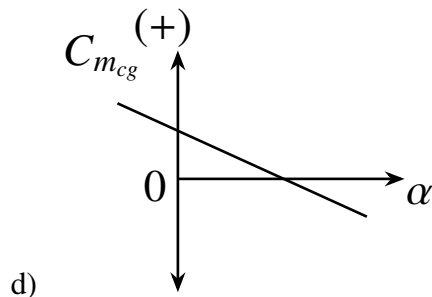
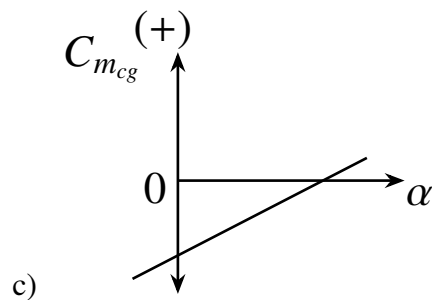
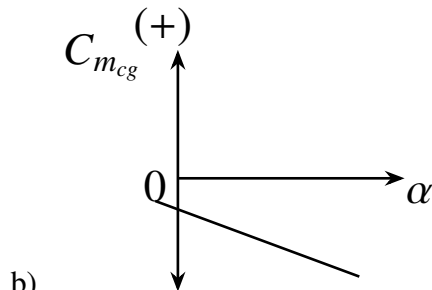
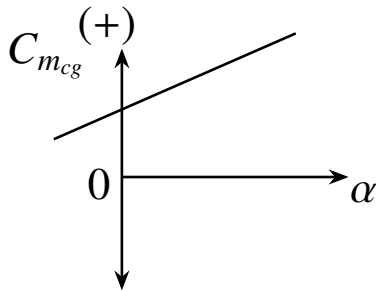
- Addition of a source of strength  $Q > 0$
  - Addition of a source of strength  $Q < 0$
  - Addition of a circulation of strength  $\Gamma > 0$  (counter-clockwise)
  - Addition of a circulation of strength  $\Gamma < 0$  (clockwise)
- 2) Consider the Blasius solution for the incompressible laminar flat plate boundary layer. Among the following options, select the correct relation for the development of the momentum thickness  $\Theta$  with distance  $X$  from the leading edge along the length of the plate.
- $\Theta \propto X^{2/3}$
  - $\Theta \propto X^{1/2}$
  - $\Theta \propto X^{1/7}$
  - $\Theta \propto X^{-2/3}$
- 3) In a two-dimensional potential flow, the doublet is a limit of the superposition of
- a uniform stream and a source
  - a source and a sink of equal strength
  - a uniform stream and a sink
  - a source and a vortex
- 4) An ideal glider has drag characteristics given by  $C_D = C_{D_0} + C_{D_i}$ , where  $C_{D_i} = KC_L^2$  is the induced drag coefficient,  $C_L$  is the lift coefficient, and  $K$  is a constant. For maximum range of the glider, the ratio  $C_{D_0}/C_{D_i}$  is
- 1
  - $\frac{1}{3}$
  - 3
  - $\frac{3}{2}$
- 5) The figures shown in the options are schematics of airfoil shapes (not to scale). For a civilian transport aircraft designed for a cruise Mach number of 0.8, which among them is aerodynamically best suited as a wing section?





- 6) For a longitudinally statically stable aircraft, which one of the following represents the relationship between the coefficient of pitching moment about the center of gravity  $C_{m_{cg}}$  and absolute angle of attack  $\alpha$ ?

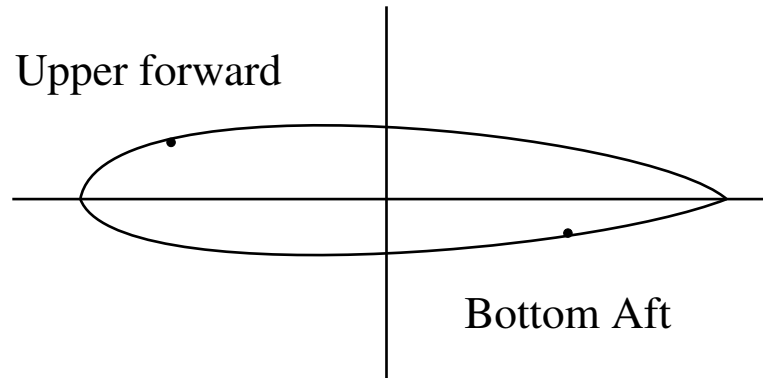
(Note: nose-up moment is positive.)



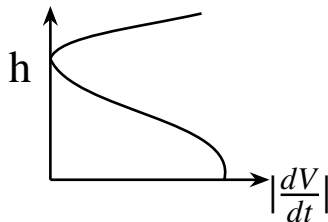
- 7) In a single-spool aviation turbojet engine, which of the following is the correct relationship between the total work output  $W_t$  of a 2-stage axial turbine and the total work required  $W_c$  by a 6-stage axial compressor, neglecting losses?

a)  $W_t = 2W_c$

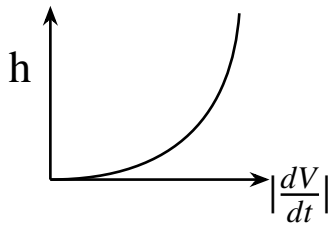
- b)  $W_t = 6W_c$   
 c)  $W_t = W_c$   
 d)  $W_t = 3W_c$
- 8) For a stage of a 50% reaction ideal axial flow compressor (symmetrical blading), select the correct statement from the options given.  
 a) The stagnation enthalpy rise across the rotor is 50% of the rise across the stage.  
 b) The static enthalpy rise across the rotor is 50% of the rise across the stage.  
 c) Axial velocity component of the flow at the rotor exit is 50% of that at the rotor entry.  
 d) The static pressure rise across the rotor is 50% of the rise across the stator.
- 9) An aircraft is cruising with a forward speed  $V_a$  and the jet exhaust speed relative to the engine at the exit is  $V_j$ . If  $\frac{V_j}{V_a} = 2$ , what is the propulsive efficiency?  
 a) 0.50  
 b) 1.00  
 c) 0.33  
 d) 0.67
- 10) Consider the four basic symmetrical flight loading conditions corresponding to the corners of a typical V-n diagram. For one of these flight loading conditions, it is observed that (i) the compressive bending stresses have a maximum value in the bottom aft region (see figure) of the wing cross-section; and (ii) the tensile bending stresses are maximum in the upper forward region (see figure) of the wing cross-section. For the preceding observations, select the corresponding flight loading condition from the options given.



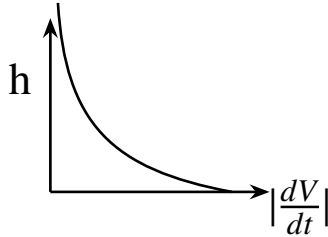
- a) Positive high angle of attack  
 b) Positive low angle of attack  
 c) Negative high angle of attack  
 d) Negative low angle of attack
- 11) Which one of the following figures represents the qualitative variation of absolute deceleration  $|\frac{dV}{dt}|$  with altitude  $h$  (measured from the mean sea level) for a space vehicle undergoing a ballistic entry into the Earth's atmosphere?



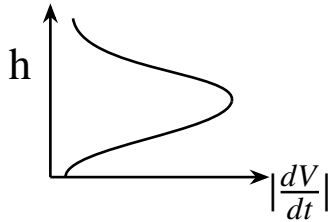
a)



b)



c)



d)

- 12) Which of the following statement(s) is/are true about harmonically excited forced vibration of a single degree-of-freedom linear spring-mass-damper system?
- The total response of the mass is a combination of free vibration transient and steady-state response.
  - The free vibration transient dies out with time for each of the three possible conditions of damping (under-damped, critically damped, and over-damped).
  - The steady-state periodic response is dependent on the initial conditions at the time of application of external forcing.
  - The rate of decay of free vibration transient response depends on the mass, spring stiffness and damping constant.
- 13) Which of the following statement(s) is/are true about the state of stress in a plane?
- Maximum or major principal stress is algebraically the largest direct stress at a point.
  - The magnitude of minor principal stress cannot be greater than the magnitude of major principal stress.
  - The planes of maximum shear stress are inclined at 90 degrees to the principal axes.
  - The normal stresses along the planes of maximum shear stress are equal.