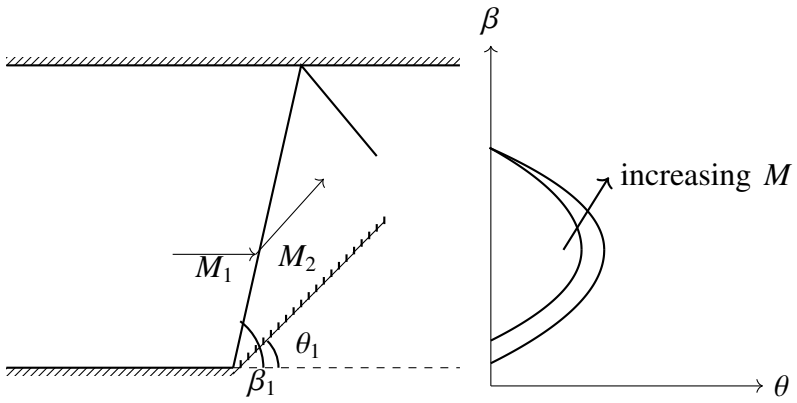
2019-AE-'27-39'

EE24BTECH11023

1) A supersonic flow in a constant area duct at Mach number M_1 encounters a ramp of angle θ_1(see Figure 1). The resulting oblique shock with shock angle β_1 is then reflected from the top wall. For the reflected shock, the turn angle is θ_2 and the shock angle is β_2.



a) $\beta_1 > \beta_2$
b) $\beta_1 < \beta_2$
c) $\theta_1 > \theta_2$
d) $\theta_1 < \theta_2$

2) Which of the following statements about adverse yaw of an airplane is/are correct?

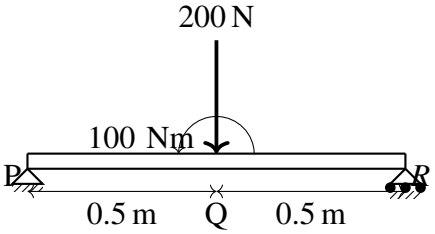
P. It is caused by flow separation resulting from large rudder deflection.
Q. It is caused by dissimilar drag forces acting on the two halves of the wing resulting from aileron deflections of same magnitude.
R. It can be eliminated by ensuring that the upward deflection of one aileron is greater than the downward deflection of the opposite aileron.

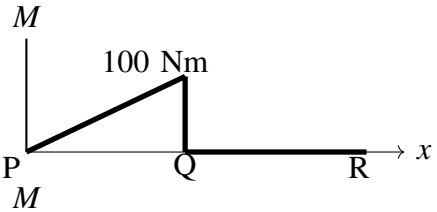
a) P only
b) Q only
c) P and R
d) Q and R

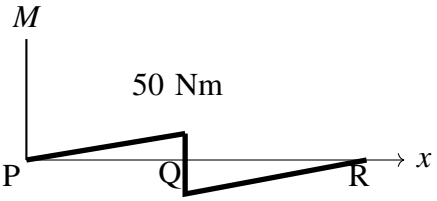
3) In a turbojet engine, the compressor outlet temperature increases with decreasing efficiency of the compressor. If the turbine inlet temperature remains constant, with decreasing efficiency of the compressor, the thrust specific fuel consumption of the engine

a) Decreases, as the heat input is lower.
b) Remains unchanged.
c) Increases, as the compressor needs more work input from the turbine.
d) Decreases, as the thrust produced is higher.

4) For a $1m$ simply supported beam with a concentrated vertical load of 200 N and a concentrated bending moment of 100 Nm at the center as shown in the figure, the correct bending moment diagram is:



(A)


(B)


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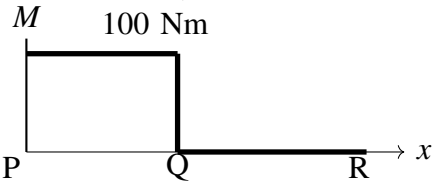
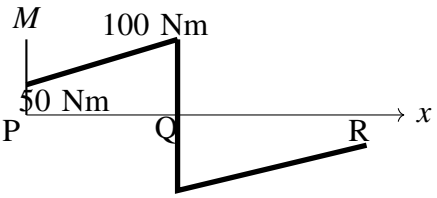
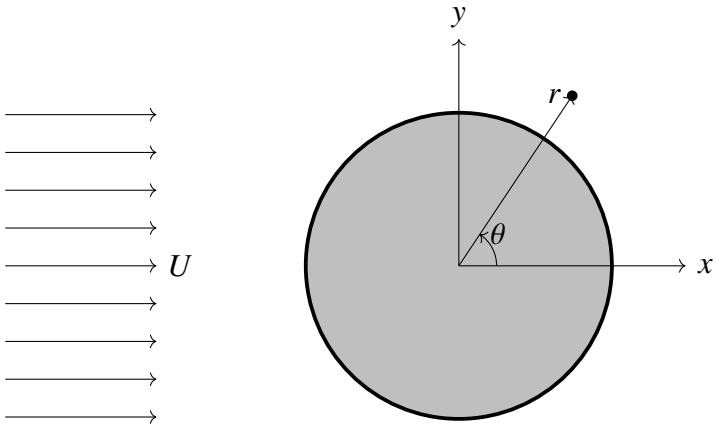


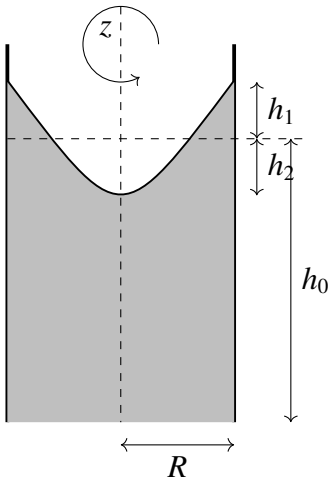
(D)


5) For real x, the number of points of intersection between the curves $y = x$ and $y = \cos x$ is _____.
6) One of the eigenvalues of the following matrix $\begin{bmatrix} x & 2 \\ -1 & 3 \end{bmatrix}$ is 1. The other eigenvalue is _____.
7) The curve $y = f(x)$ is such that its slope is equal to y^2 for all real x. If it passes through $(1, -1)$, the value of y at $x = -2$ is _____.(round off to 1 decimal place).
8) The inviscid, incompressible flow field resulting from a uniform flow past a circular cylinder of radius R centered at the origin is given by:
$u_r = U(1 - (\frac{R^2}{r^2}))\cos\theta$
$u_r = -U(1 + (\frac{R^2}{r^2}))\sin\theta$



where u_r and u_θ are the radial and azimuthal velocity components in polar coordinates,(r, θ),as shown in the figure.U is the free stream speed.Ignore the effects of gravity.The azimuthal location (in the first quadrant) on the cylinder at which the pressure coefficient is zero is _____ degrees(round off to the nearest integer).

9) A cylindrical container of radius $R = 50\,\text{cm}$ is filled with water up to a height h_o. Upon rotating the cylinder about its central axis at a constant angular speed, the free surface takes a parabolic shape (see figure),and is displaced upwards by $h_1 = 10\,\text{cm}$ at $r = R$. The magnitude of the downward displacement h_2 of the free surface at $r = 0$ is _____ cm (rounded off to the nearest integer).



10) A two-dimensional, incompressible fluid flow described by the stream function $\psi = xy^3m^2/s$ on the Cartesian plane. If the density and dynamic viscosity of the fluid are $1\,\text{kg/m}^3$ and $0.1\,\text{kg/m-s}$, respectively, the magnitude of the pressure gradient in the x-direction at $x = 1\,\text{m}$ and $y = 1\,\text{m}$ is _____ N/m^3 (rounded off to 1 decimal place):
11) The static pressure ratio across a stationary normal shock is given by

$$\frac{P_2}{P_1} = 1 + \frac{2\gamma}{\gamma + 1}(M_1^2 - 1)$$

where M_1 is the upstream Mach number.For a stationary normal shock in air ($\gamma = 1.4, R = 287\,\text{J/kg-K}$) with upstream flow conditions given by:speed $800m/s$, static temperature $300\,\text{K}$ and static pressure $1\,\text{atm}$, the static pressure downstream of the shock is _____ atm.(round off to 2 decimal places).
12) For a symmetric airfoil at an angle of attack of 10°, assuming thin airfoil theory, the magnitude of the pitching moment coefficient about the leading edge is _____(round off to 2 decimal places).
13) The span-wise distribution of circulation over a finite wing of span $b = 10\,\text{m}$ is

$$\Gamma(y) = \Gamma_0 \sqrt{1 - (\frac{2y}{b})^2}$$

If $\Gamma_0 = 20m^2/s$ and the free stream density and speed are $1.2\,\text{kg/m}^3$ and $100\,\text{m/s}$, respectively, the total lift is _____ kN (round off to 2 decimal places).