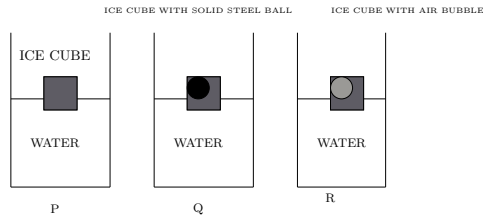# 2023 February 1 Shift 2

### AI24BTECH11004-Bheri Sai Likith Reddy

1 SECTION-A

1) The figure shows three glasses P, Q and R with water and floating ice cube. Glass P has a solid ice cube, glass Q has an air bubble. After the ice cube melts, the level of water in glasses P, Q and R, respectively:

ICE CUBE WITH SOLID STEEL BALL   ICE CUBE WITH AIR BUBBLE

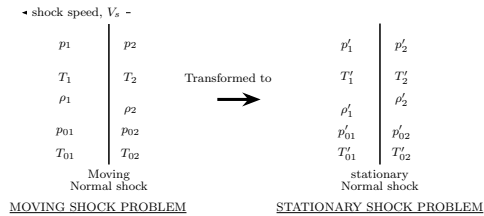ICE CUBE

WATER   WATER   WATER

P   Q   R

   a) remains same, increases, and decreases
   b) increases, decreases, and increases
   c) remains same, decreases, and decreases
   d) remains same, decreases, and increases

2) To estimate aerodynamic loads on an aircraft flying at $100 km/h$ at standard sea-level conditions, a one-fifth scale model is tsted in a varibel-density wind tunnel ensuring similarity of inertial and viscous forces. The pressure used in the wind runnel is 10 times the atmospheric pressure. Assuming ideal gas law to hold and the same temperature conditions in model and prototype, the velocity needed in the wind tunnel test-section is _____

   a) $25 km/h$
   b) $50 km/h$
   c) $100 km/h$
   d) $20 km/h$

3) The figure shows schematic of a set-up for visualization of non-uniform density field in the test section o fa supersonic wind tunnel. This technique of visualization of high speed flows is known as:

   a) schlieren
   b) interferometry
   c) shadowgraph
   d) holography

4) For a conventional fixed-wing aicraft in a $360°$ inverted vertical loop maneuver, what is the load factor (n) at the topmost point of the loop? Assume the flight to be steady at the topmost point.
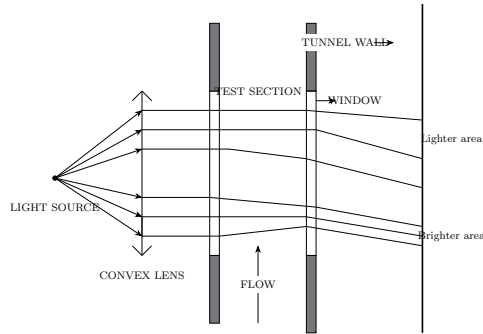
a) $n = 1$ b) $n < 1$ c) $n = -1$ d) $n > -1$

The next 5 question sare multiple select queestions and carry TWO mark each

5) Which of the following statement(s) is/are true about the function defined as $f(x) = e^{-x} |\cos x|$ for $x > 0$?

   a) Differentiable at $x = \frac{\pi}{2}$
   b) Differentiable at $x = \pi$
   c) Differentiable at $x = \frac{3\pi}{2}$
   d) Continuous at $x = 2\pi$

6) A two degree of freedom spring-mass system undergoing free vibration with generalized coordinates x_1 and x_2 has natural frequencies $\omega_1 = 233.9 rad/s$ and $\omega_2 = 324.5 rad/s$, respectively. The corresponding mode shapes are $\phi_1 = \begin{pmatrix} 1 \\ -3.16 \end{pmatrix}$ and $\phi_2 = myvec13.16$. If the system is disturbed with certain deflection sand zero initial velocities, then which of the following statement(s) is/are true?

   a) An initial deflection of $x_1(0) = 6.32 cm$ and $x_2(0) = -3.16 cm$ would make the system oscillate with only the second natural frequency.
   b) An initial deflection of $x_1(0) = 2 cm$ and $x_2(0) = -6.32 cm$ would make the system oscillate with only the first natural frequency.
   c) An initial deflection of $x_1(0) = 62 cm$ and $x_2(0) = -2 cm$ would make the system oscillate with a linear combination of first and second natural frequencies.
   d) An initial deflection of $x_1(0) = 1 cm$ and $x_2(0) = -6.32 cm$ would make the system oscillate with only the first natural frequency.

7) A shock moving into a stationary gas can be transformedd to a stationary shock by a change in reference frame, as shown in the figure. Which of the following is/are true relation the flow properties in the two reference frames?

◄ shock speed, V_s ►

p_1	p_2		p_1'	p_2'
T_1	T_2	Transformed to	T_1'	T_2'
ρ_1	ρ_2	──►	ρ_1'	ρ_2'
p_{01}	p_{02}		p_{01}'	p_{02}'
T_{01}	T_{02}		T_{01}'	T_{02}'
Moving Normal shock			stationary Normal shock	

MOVING SHOCK PROBLEM   STATIONARY SHOCK PROBLEM

a) $T_1' > T_1, T_{01}' > T_{01}, p_{01}' > p_{01}, \rho_2' > \rho_1'$

b) $T_1' = T_1, T_2' < T_{01}, p_{01}' > p_{01}, \rho_2' = \rho_2$

c) $T_1' < T_1, p_1' > p_1, p_{01}' > p_{01}, \rho_2' > \rho_1$

d) $T_1' = T_1, p_2 > p_{01}, T_{01}' > T_{01}, p_{01}' > p_{10}$

8) For a conventional fixed-wing aircraft, which of rhe following statements are true?

   a) Making C_{m_α} more negative leads to an increase in the frequency of its short-period mode.

   b) Making C_{m_q} more negative leads to a decreased damping off the short-period mode.

   c) The peimary contribution towards C_{l_p} is from the aircraft wing.

   d) Increase the size of he vertical fin leads to a higher yaw damping.

9) Which of the folloing statement(s) is/are true?

   a) Service ceiling is higher than absolute ceiling for a piston-propeller aircraft.

   b) For a given aircraft, teh stall speed increase with increase in altitude.

   c) Everything else remaining the same, a tailwind increase the range of an aircraft.

   d) For a jet aircraft comstrained ro fly at constant altitude, there exists an altitude where its range is maximum.

10) A conventional fixed-wing aircraft, with a horizontal tail and vertical fin, in steady and level flight is subjected to small perturbations. Which of the following statement(s) is/are true?

   a) Vertical fin has a stabilizing effecgt on the lateral stabilithy of the aircraft.

   b) Vertical fin has a destabilizing effect on the directional stability of the aircraft.

   c) Presence of wing anhedral increase the lateral stability of the aircraft.

   d) Horizontal tail has a stabilizing effect on the longitudinal static stability of the aircraft.

The next 19 questions are Numerical answer type (*NAT*), carry TWO mark each (no negative marks)

11) The ratio of the product of eigenvalues to the sum of the eigenvalues of the given matrix

$$\begin{pmatrix} 3 & 1 & 2 \\ 2 & -3 & -1 \\ 1 & 2 & 1 \end{pmatrix}$$

is _____ (round off to nearest integer)

12) The definite integral $\int_1^5 x^2 dx$ is evaluated using four equal interval by two methods-first by the trapezoidal rule and then by the Simpson's onw-third rule. The absolute value of the difference between the two calculations is _____ (round off to two

decimal places).

13) The deflection y of a certain beam of length l and uniform weight per unit length w, is given as $y = \frac{w}{48EI}\left(2x^4 - 3lx^3 + l^3x\right)$, where x is the distance from the point of support andd EI us a constant. The non-dimensional location $\frac{x}{l}$, where the deflection of the beam is maximum,is _____ (round off to two decimal places).