SECTION A

1. A NACA 0012 airfoil has a trailing edge flap. The airfoil is operating at an angle of attack of 5 degrees with un-deflected flap. If the flap is now deflected by 5 degrees upwards, the $C_L$ versus $\alpha$ curve

(a) Shifts right and slope increases ☐  (c) Shifts left and slope stays the same ☐
(b) Shifts left and slope increases ☐  (d) Shifts right and slope stays the same ☐

2. The velocity profile in an incompressible, laminar boundary layer is shown in the figure below. $U$ is the free-stream velocity; $u(y)$ is the stream-wise velocity component. The area of the black shaded region in the figure below represents the

(a) boundary layer thickness ☐  (c) displacement thickness ☐
(b) momentum thickness ☐  (d) shape factor ☐

3. The pitching moment of a positively cambered NACA airfoil about its leading edge at zerolift angle of attack is

(a) Negative ☐  (c) Positive ☐
(b) Indeterminate ☐  (d) Zero ☐
4. In theory of elasticity a point of stress singularity occurs at corners where the angle is
(a) less than $180^0$  □  (c) equal to $180^0$  □
(b) more than $180^0$ □  (d) equal to $90^0$ □

5. Mohr circle can be used to transform the stresses and strains in a solid from one axis system at a point to another axis system at the same point inclined at angle $\alpha$. It can also be used for transforming further for the following
(a) Moments of Inertia only □  (c) Moments of Inertia and curvatures □
(b) Curvatures only □  (d) No other parameters □

6. The polar moment inertia of a square section of side “a” is
(a) $a^4/12$ □  (c) $a^4/3$ □
(b) $a^4/6$ □  (d) $a^4/24$ □

7. A fixed – fixed column of length $l$, area of cross section $A$ and bending stiffness $EI$ is subjected to compression load $P$. At what load level will the column buckle? Choose one from the following:
(a) $\pi^2 EI/l^2$ □  (c) $4\pi^2 EI/l^2$ □
(b) $2\pi^2 EI/l^2$ □  (d) None of the above □

8. Across a normal shock
(a) Flow is always subsonic □  (c) Can be either subsonic or supersonic □
(b) Always supersonic □  (d) None of the above □

9. For a neutrally stable aircraft
(a) $dCm/d\alpha > 0$ □  (c) $dCm/d\alpha = 0$ □
(b) $dCm/d\alpha < 0$ □  (d) None of the above □

10. Lateral acceleration and radio altitude are typical parameters recorded on the:
(a) FDR □  (c) CVR □
(b) ULB □  (d) None of the above □

11. Isotropic antenna will radiate:
(a) Only in one direction □  (c) Uniformly in all directions □
12. The standard for sharing the data between the avionics systems in civilian aircrafts is defined in:

(a) ARINC 573  □  (c) ARINC 429  □
(b) ARINC 635  □  (d) Mil std 1553  □

13. From a sealed box containing a dozen apples it was found that 3 apples are perished. When an apple is drawn at random, the probability of getting one perished apple is:

(a) 9/22  □  (c) 6/11  □
(b) 1/22  □  (d) none of the above  □

14. The volume of a tetrahedron whose coterminous edges are $\vec{a}$, $\vec{b}$ and $\vec{c}$ is

(a) $\vec{a} \cdot (\vec{b} \times \vec{c})$  □  (c) $\vec{a} \times (\vec{b} \times \vec{c})$  □
(b) $\vec{a} \cdot (\vec{b} \cdot \vec{c})$  □  (d) $\frac{1}{6} (\vec{a} \cdot (\vec{b} \times \vec{c})$  □

15. If $x = r \cos(\theta)$, $y = r \sin(\theta)$, the Jacobian of $(x, y)$ with respect to $(r, \theta)$ is

(a) $r$  □  (c) $\cos(\theta)$  □
(b) $-r$  □  (d) 1  □

SECTION B

Write any THREE of the following full questions:

1a. What is shear centre of a section?

1b. Mark the shear centre (qualitatively) of the sections shown in figures below and explain the reason for your choice of the shear centre location.
1c. What is the importance of shear centre in design of wing section?

2a. Enumerate the advantages of composite materials over the conventional metallic materials used in aerospace primary structural components.

2b. List various fibres and matrix material used in aerospace composites.

2c. Name an Indian designed aircraft with carbon fibre composites used in Wing and fuselage.

3. Illustrate the effect of back pressure on flow through a supersonic nozzle with suitable sketches.

4. What are the advantages of using aft-loaded or supercritical airfoil sections in modern jetliners cruising at high subsonic Mach number?

5. Explain briefly about TCAS (Traffic and Collision Avoidance System).

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