JEE Main 2020 Paper - 4th September 2020 — Shift 1 (Maths)

EE24BTECH11016-Mokshith

35) An aircraft has a level flight stalling speed of 60 m/s EAS (equivalent air speed). As per the $V-n$ diagram, what is the minimum speed at which it should be designed to withstand the maximum vertical load factor of 9?

a) 20 m/s
b) 60 m/s
c) 120 m/s
d) 180 m/s

36) Match each mode of aircraft motion listed in Group I to its corresponding property from Group II.

Group I: Aircraft mode	Group II: Property
P: Short period mode	1: Coupled roll-yaw oscillations
Q: Wing rock	2: Angle of attack remains constant
R: Phugoid mode	3: Roll oscillations
S: Dutch roll	4: Speed remains constant

TABLE 36: Caption

a) $P-2, Q-1, R-4, S-3$
b) $P-4, Q-3, R-2, S-1$
c) $P-4, Q-1, R-2, S-3$
d) $P-2, Q-3, R-4, S-1$

37) An aircraft is cruising at a true air speed (TAS) of 100 m/s under ISA conditions, at an altitude at which the density of free stream is 0.526 kg/m^3. What will be the equivalent air speed (EAS)?

a) 65.5 m/s
b) 72.5 m/s
c) 110.5 m/s
d) 152.7 m/s

38) In the definition of the aircraft Euler angles ϕ (roll), θ (pitch), and ψ (yaw), the correct sequence of rotations required to make the inertial frame coincide with the aircraft body frame is

a) (A) first ψ about the z axis, second θ about the y axis, third ϕ about the x axis
b) (B) first θ about the y axis, second ϕ about the x axis, third ψ about the z axis
c) (C) first ϕ about the x axis, second θ about the y axis, third ψ about the z axis
d) (D) first ψ about the z axis, second ϕ about the x axis, third θ about the y axis

39) To maximize the range of a jet engine aircraft, it should be flown at a velocity that maximizes
   a) (A) $\frac{C_L}{C_D}$
   b) (B) $\frac{C_L^{0.5}}{C_D}$
   c) (C) $\frac{C_L^{1.5}}{C_D}$
   d) (D) $\frac{C_L^2}{C_D}$

40) The primary function of the fin in the vertical tail of an aircraft is to provide
   a) yaw control
   b) yaw stability
   c) roll damping
   d) roll stability

41) An aircraft requires the trailing edge of the elevator to be deflected upwards from its initial position to lower the trim speed. Which of the following statements about the static stick-fixed stability of this aircraft is true?
   a) The aircraft is unstable.
   b) The aircraft is neutrally stable.
   c) The aircraft is stable.
   d) The stability of the aircraft cannot be determined from the given information.

42) Which of the following statements is true for an aircraft flying at a low angle of attack?
   a) Yawing motion generates yawing moment and pitching moment.
   b) Rolling motion generates rolling moment and pitching moment.
   c) Yawing motion generates yawing moment and rolling moment.
   d) Pitching motion generates yawing moment and rolling moment.

43) Consider $2-D$ flow with stream function $\psi = \frac{1}{2} ln\left(\sqrt{x^2+y^2}\right)$. The absolute value of circulation is along a unit circle centered at $(x = 0, y = 0)$:
   a) 0
   b) 1
   c) $\frac{\pi}{2}$
   d) π

44) Consider a symmetric airfoil at an angle of attack of 4 degrees. Using thin airfoil theory, the magnitude of the moment coefficient about the leading edge is:
   a) 2π
   b) π
   c) $\frac{\pi^2}{60}$
   d) $\frac{\pi^2}{90}$

45) Consider steady, inviscid flow in a convergent-divergent (CD) nozzle, with a normal shock in the divergent portion. The static pressure along the nozzle downstream of the normal shock:
   a) remains constant
   b) increases isentropically to the static pressure at the nozzle exit

c) decreases isentropically to the static pressure at the nozzle exit
d) can increase or decrease, depending on the magnitude of the static pressure at the nozzle exit

46) For a free stream Mach number of 0.7, the critical pressure coefficient $\left(C_{p,cr}\right)$ is −0.78. If the minimum pressure coefficient for a given airfoil in incompressible flow is −0.6, then the flow over the airfoil at a free stream Mach number of 0.7 is:
a) subsonic and compressible
b) completely supersonic
c) incompressible
d) partly subsonic and partly supersonic

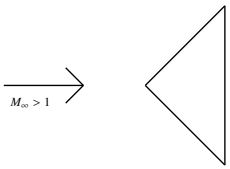
47) If the flow Mach number in a turbulent boundary layer over a flat plate is increased keeping the Reynolds number unchanged, the skin friction coefficient C_f:
a) decreases
b) increases
c) remains constant
d) initially decreases, followed by a rapid increase

48) In supersonic wind-tunnel design, an oblique shock diffuser is preferred over a normal shock diffuser because:
a) it reduces total pressure loss
b) the flow is slowed down more rapidly
c) the flow is accelerated more rapidly
d) it increases total pressure loss

49) The variation of downwash along the span of an untwisted wing of elliptic planform is:
a) sinusoidal
b) parabolic
c) elliptic
d) constant

50) Flow past an airfoil is to be modeled using a vortex sheet. The strength of the vortex sheet at the trailing edge will be:
a) 0
b) 1
c) 2π
d) ∞

51) Consider a 2-D body in supersonic flow with an attached oblique shock as shown below ($M > 1$): An increase in free stream Mach number M, will cause the oblique



shock wave to

a) move closer to the body
b) move away from the body
c) detach from the body
d) become a normal shock