(1 Mark Questions)

1. A positive tail incidence angle setting, as compared to a negative tail incidence angle setting, will result in
   (a) less static stability (b) same static stability
   (c) more static stability (d) None of these

2. The static longitudinal stability of an airplane is provided by
   (a) the lift from wing and horizontal tail
   (b) product of the 'tail arm' and 'tail lift'
   (c) product of the 'tail arm' and 'wing lift'
   (d) None of the above

3. Due to some fault, pilot realized that maximum up and down elevator movement was reduced by 20%. To ensure that during landing reduced elevator movement required from trim, the pilot should request passenger to move
   (a) backward
   (b) forward
   (c) evenly by distribute on left and right sides of fusslage
   (d) None of the above

4. The conventional vertical tail of an aircraft contributes towards
   (a) longitudinal stability (b) lateral stability
   (c) directional stability
   (d) both lateral and directional stabilities

5. What is the value of phase error ($\Delta\theta$) to achieve minimum time for orbital rendezrous by Hohmann transfer?
   (a) 2π (b) zero (c) π (d) $\frac{\pi}{2}$

6. In an isentropic process
   (a) heat transfer is zero
   (b) work done is reversible
   (c) work done is zero
   (d) stagnation pressure is constant

7. The value of γ for CO_2 is 1.3, the value of C_V for CO_2 is equal to
   (a) 543 J/kg-K (b) 692 J/kg-K
   (c) 742 J/kg-K (d) 630 J/kg-K

8. For fans, the relation between discharge and speed is indicated by
   (a) $\frac{Q_1}{Q_2} = \frac{N_1}{N_2}$ (b) $\frac{Q_1}{Q_2} = \frac{N_1^2}{N_2^2}$
   (c) $\frac{Q_1}{Q_2} = \frac{N_1^3}{N_2^3}$ (d) None of these

9. Evaluate the heat of reaction of $C_2H_6(g)$,
   $$C_2H_6(g) + 3\frac{1}{2}O_2(g) \xrightarrow{298.15\,K} 2CO_2(g) + 3(H_2O)(g)$$

Given, $H^{\circ}_{f,CO_2} = 94$

$H^{\circ}_{f,H_2O} = 5.78$

$H^{\circ}_{f,C_2H_6} = 20.24$

$H^{\circ}_{f,O_2} = 0$

(a) 341.16 kcal (b) – 341.16 kcal
(c) 351.16 kcal (d) – 451.16 kcal

10. Find out air-fuel ratio in the combustion of C_8H_{18}.
(a) 0.05 kg air/kg of fuel (b) 0.04 kg air/kg of fuel
(c) 24.2 kg air/kg of fuel (d) 22.6 kg air/kg of fuel

11. A thin disk of mass *m* and radius *R* is connected by a massless shaft of length *L* to a free swivel joint at *O*. The disk spins about the shaft at constant rate ω, and proceeds in a steady slow procession (rate Ω) about the vertical.

Compute the disk's inertias I_{XX}, I_{YY}, I_{ZZ} about O.

(a) $\frac{mR^2}{4}, \frac{mR^2}{4}, \frac{mR^2}{2}$

(b) $\frac{mR^2}{4} + mL^2, \frac{mR^2}{4}, \frac{mR^2}{2}$

(c) $\frac{mR^2}{4} + mL^2, \frac{mR^2}{4} + mL^2, \frac{mR^2}{2}$

(d) None of the above

12. In a compressible flow over a flat plate, boundary layer thickness (δ) is given by

(a) $\frac{5.0\,x}{Re_x}$ (b) $\frac{5.0\,x}{\sqrt{Re_x}}$

(c) $\frac{5.0\,x^2}{\sqrt{Re_x}}$ (d) $\frac{5.0\,x^2}{Re_x}$

13. In a stream tube, area-velocity relation is given by

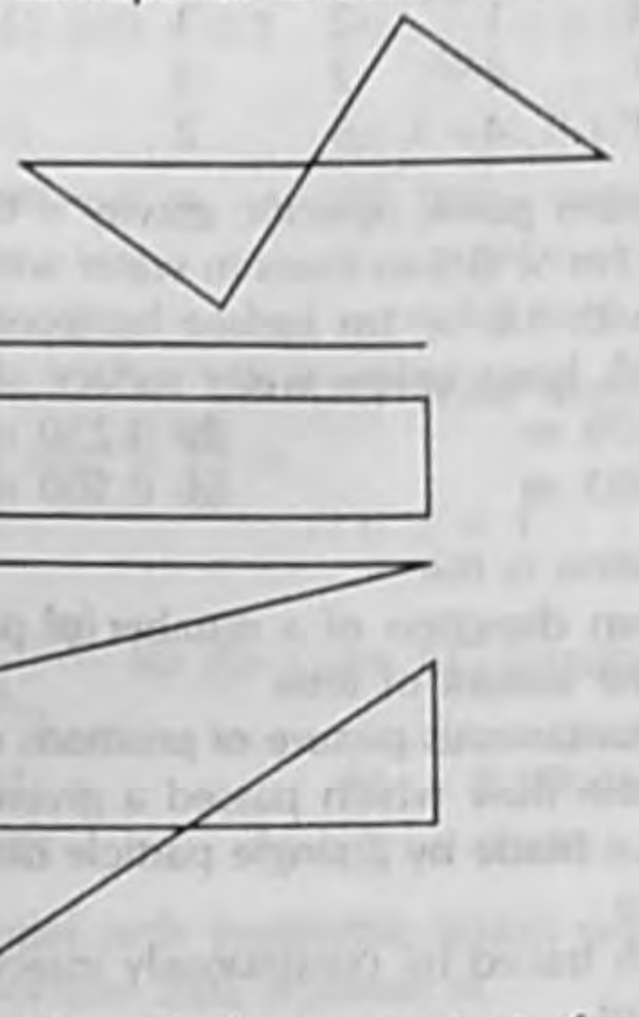
(a) $\frac{dA}{A} = (1 - M^2)\frac{dv}{v}$

(b) $\frac{dA}{A} = (M^2 - 1)\frac{dv}{v}$

(c) $\frac{dA}{A} = (M - 1)\frac{dv}{v}$

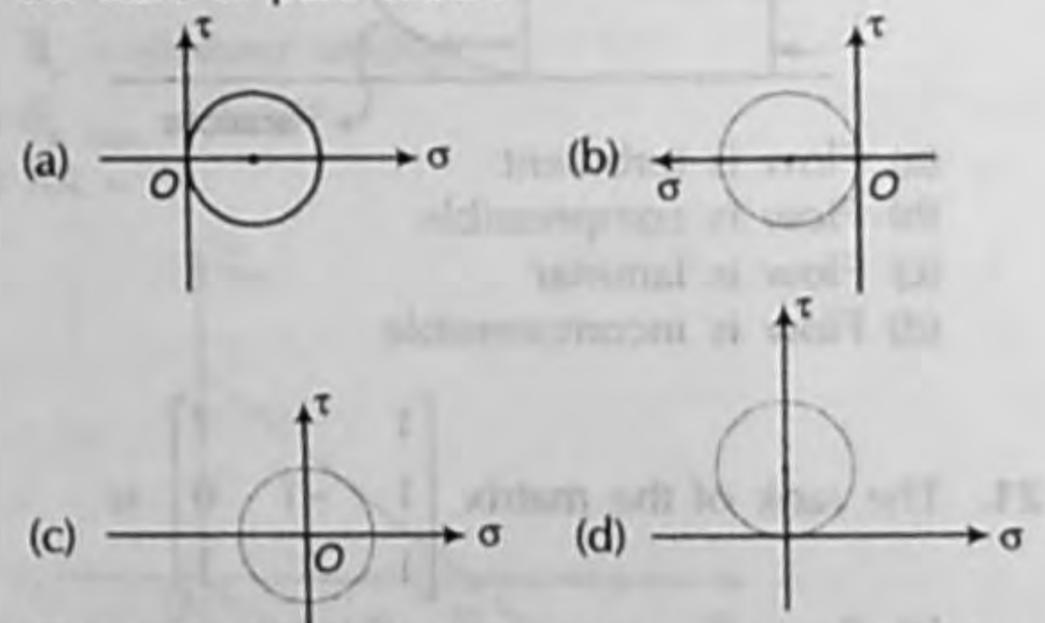
(d) $\frac{dA}{A} = (1 - M)\frac{dv}{v}$

14. The bending moment diagram shown in figure below, corresponds to shear force diagram in



15. The number of elastic constants for a completely anisotropic elastic material which follows Hooke's law, is
(a) 3 (b) 4
(c) 21 (d) 25

16. Which one of the following Mohr's circles represents the state of pure shear?



17. The critical buckling load for the column of length *L* and flexural rigidity *EI* for different boundary conditions is
Match the following:

A. Fixed end columns; 1. $P_{cr} = \frac{2\pi^2 EI}{L^2}$

B. One end fixed and other hinged 2. $P_{cr} = \frac{\pi^2 EI}{4L^2}$

C. One end fixed and other free; 3. $P_{cr} = \frac{\pi^2 EI}{L^2}$

D. Both ends hinged; 4. $P_{cr} = \frac{4\pi^2 EI}{L^2}$

	A	B	C	D
(a)	4	1	3	2
(b)	4	1	2	3
(c)	1	4	2	3
(d)	1	4	3	2

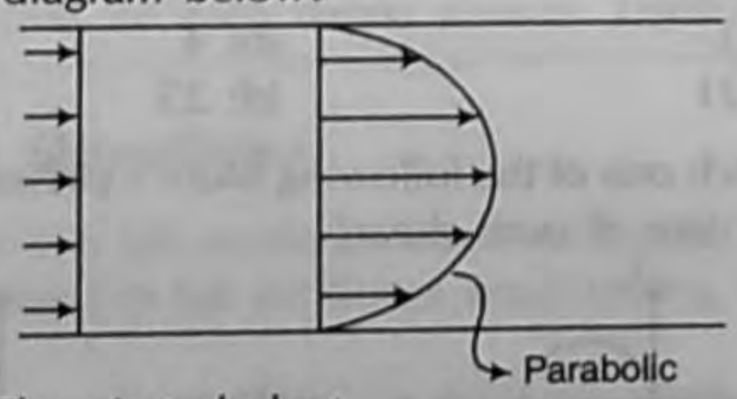
18. A wooden plank (specific gravity = 0.5) 1m × 1m × 0.5 m floats in water with 1.5 kN load on it with 1m × 1m surface horizontal. The depth of plank lying below water surface shall be

(a) 0.178 m (b) 0.250 m
(c) 0.403 m (d) 0.500 m

19. A pathline is the

(a) mean direction of a number of particles at the same instant of time
(b) instantaneous picture of positions of all particles in the flow which passed a given point
(c) trace made by a single particle over a period of time
(d) path traced by continuously injected tracer at a point

20. What can definitely be said about the tube flow in the diagram below?



(a) Flow is turbulent
(b) Flow is compressible
(c) Flow is laminar
(d) Flow is incompressible

21. The rank of the matrix $\begin{bmatrix} 1 & 1 & 1 \\ 1 & -1 & 0 \\ 1 & 1 & 1 \end{bmatrix}$ is

(a) 0 (b) 1
(c) 2 (d) 3

22. The eigen values and the corresponding eigen vectors of a 2 × 2 matrix are given by

Eigen value	Eigen vector
$\lambda_1 = 8$	$v_1 = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$
$\lambda_1 = 4$	$v_2 = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$

The matrix is

(a) $\begin{bmatrix} 6 & 2 \\ 2 & 6 \end{bmatrix}$ (b) $\begin{bmatrix} 4 & 6 \\ 6 & 4 \end{bmatrix}$
(c) $\begin{bmatrix} 2 & 4 \\ 4 & 2 \end{bmatrix}$ (d) $\begin{bmatrix} 4 & 8 \\ 8 & 4 \end{bmatrix}$

23. As x is increased from $-\infty$ to ∞, the function

$$f(x) = \frac{e^x}{1+e^x}$$

(a) monotonically increases
(b) monotonically decreases
(c) increases to a maximum value and then decreases
(d) decreases to a minimum value and then increases

24. Which one of the following functions is strictly bounded?

(a) $\frac{1}{x^2}$ (b) e^x
(c) x^2 (d) e^{-x^2}

25. Limit of the following series as x approaches $\frac{\pi}{2}$ is

$$f(x) = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!}$$

(a) $\frac{2\pi}{3}$ (b) $\frac{\pi}{2}$
(c) $\frac{\pi}{3}$ (d) 1

(2 Marks Questions)

26. For axial flow compressor, relationship between polytropic and overall efficiency is $\left(r = \frac{p_{03}}{p_{01}}\right)$

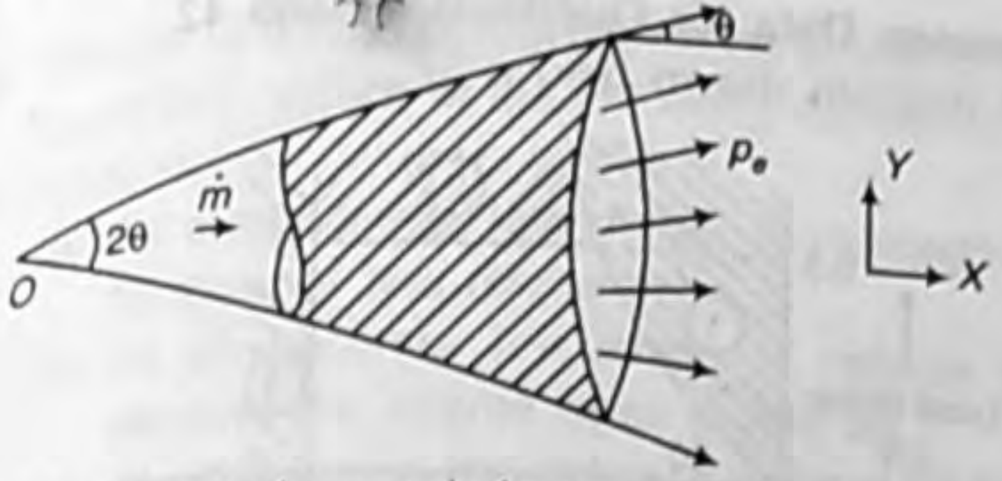
(a) $\eta_c = \frac{(r)^{(\gamma-1)/\gamma} + 1}{(r)^{(\gamma-1)/\gamma m_p} + 1}$ (b) $\eta_c = \frac{r^{(\gamma-1)/\gamma} - 1}{(r)^{(\gamma-1)/\gamma m_p} - 1}$
(c) $\eta_p = \frac{r^{(\gamma-1)/\gamma} - 1}{r^{(\gamma-1)/\gamma m_c} - 1}$ (d) $\eta_p = \frac{r^{(\gamma-1)/\gamma} + 1}{(r)^{(\gamma-1)/\gamma m_c} + 1}$

27. In the context of flow compressor, choose the correct statement.

(a) For rotor, rothalpy is constant and for stator, stagnation enthalpy is constant
(b) For rotor, rothalpy is constant and for stator, enthalpy is constant
(c) For rotor, relative stagnation enthalpy is constant and for stator, enthalpy is constant
(d) All of the above are correct

28. The exhaust gas from the rocket shown in the figure leaves the nozzel with a uniform velocity (u_e) but rather than being directed along the X-axis, it is directed along rays from point O as indicated. Determine the thrust for this rocket.

Note (1) Exit pressure is p_c
(2) $A_e = \pi R^2$
(3) $A_e' = 2\pi R^2 (1 - \cos \alpha)$



(a) $\dot{m}\,u_e + (p_e - p_a)\,A_e$

(b) $\dot{m}\,u_e\left(\frac{1+\cos\alpha}{2}\right) + (p_e - p_a)\,A'_e$

(c) $\frac{1+\cos\alpha}{2}\,[\dot{m}\,u_e + (p_e - p_a)\,A'_e]$

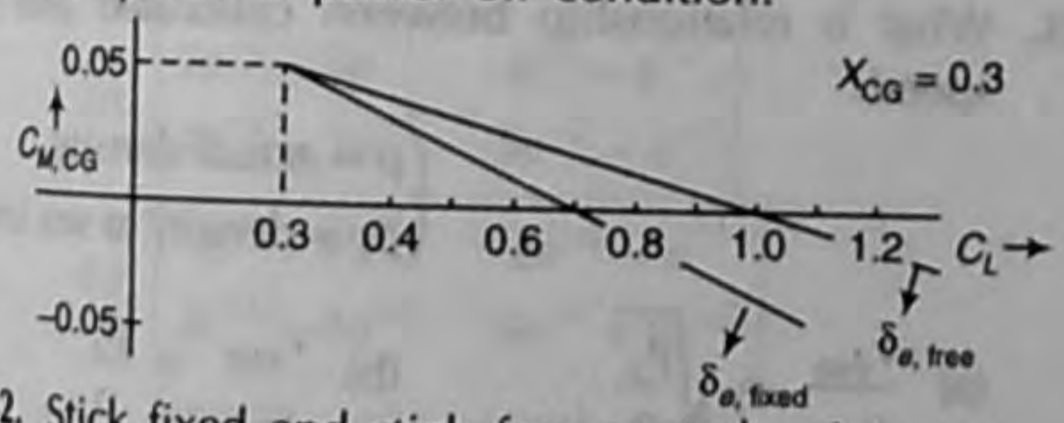
(d) None of the above

29. A mean-diameter design of a turbine stage having equal inlet and outlet velocities leads to the following data:
Mass flow, $m = 20$ kg/s
Inlet temperature $T_{01} = 1000$ K
Inlet pressure $p_{01} = 4.0$ bar
Axial velocity (c_a), constant through stage = 260 m/s
Blade speed $u = 360$ m/s
Stage exit angle $d_3 = 10°$
Nozzle efflux angle $d_2 = 65°$
The blade angles will be
(a) 57.35°, 37.23° (b) 62.23°, 25.67°
(c) 55.38°, 33.52° (d) None of these

30. For free vortex design, which of these are true?
(a) Stagnation enthalpy h_0 = Constant
(b) Entropy, S = Constant
(c) $r\,V_\theta$ = Constant, V_Z = Constant
(d) All of the above

31. An earth orbiting S/C is observed to have a velocity of 10.7654 km/s at an altitude of 1500 km. The angle made by velocity vector with normal to radius, is 23.174°. The shape of the orbit.
(a) circular (b) elliptic
(c) hyperbolic (d) Data insufficient

Statements for Linked Answer Questions 32 and 33
The wind tunnel tests showed the following characteristics for a airplane in power off condition:



32. Stick fixed and stick free neutral points are
(a) $0.2\,\bar{c}$ and $0.37\,\bar{c}$ (b) $0.4\,\bar{c}$ and $0.23\,\bar{c}$
(c) $0.4\,\bar{c}$ and $0.37\,\bar{c}$ (d) None of these

33. If (1) $C_{n\alpha} = -0.002$ (2) $C_{L\alpha}$ (2-D, wing) = 0.1,
(3) $C_{L\alpha}$ (2-D, tail) = 0.1 (4) $\frac{d\epsilon}{d\alpha} = 0.5$
(5) $\eta_t = 0.9$ (6) $k = -0.17$
(7) Tail span = 2 m (8) Tail aerodynamic centre to CG distance = 6.5 m
(9) $\bar{c} = 1.2$ (10) Wing aspect ratio = 6
(11) Wing span = 12 m
(12) $e = 1$ (13) $S_t = 1$

Then, $\frac{d\,(F_s/q)}{dC_L}$ for the given CG location is
(a) − 0.055 (b) + 0.0055
(c) − 0.0055 (d) + 0.055

34. An a/c model with symmetric airfoil was tested in wind tunnel and data reported is

(1) $\frac{dC_L}{d\alpha} = 0.08$/deg

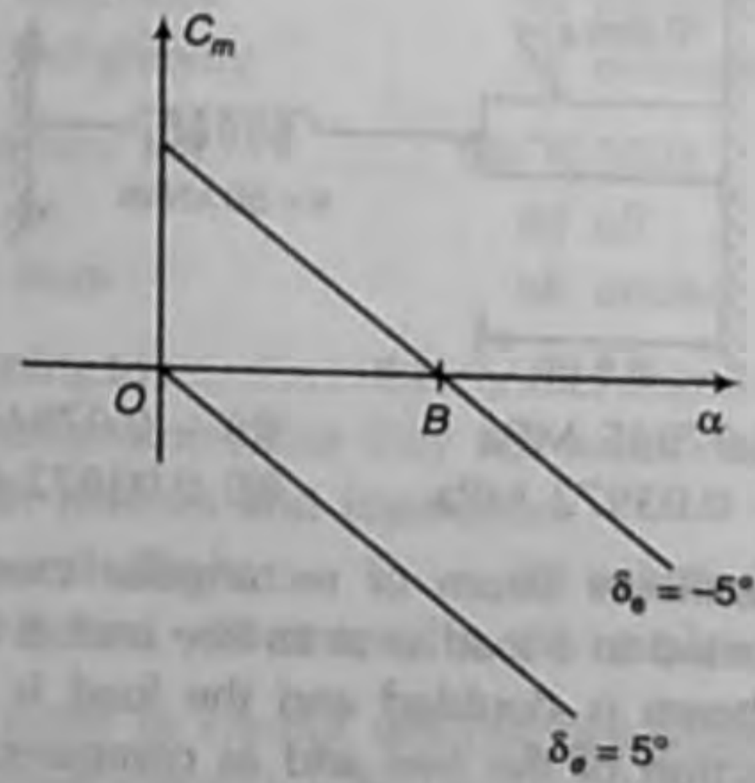
(2) $C_{m\alpha} = -0.01$/deg.

(3) $C_{m_0} = \begin{cases} 0.08 & \text{for } \delta_e = -5° \\ 0 & \text{for } \delta_e = 5° \end{cases}$

δ_e = elevator settings

(4) $\delta_{e,\,max} = \pm 15°$

(5) AR = 5



Find $C_{m\delta_e}$ and $C_{L,\,max}$, where $C_{m\delta_e}$ is elevator control power and $C_{L,\,max}$ is maximum C_L that can be trimmed.
(a) − 0.08 deg^{-1} and 0.99
(b) − 0.008 deg^{-1} and 0.99
(c) + 0.008 deg^{-1} and 0.19
(d) + 0.08 deg^{-1} and 0.99

Statements for Linked Answer Questions 35 and 36

35. In a flight test, following data was obtained while trimming the airplane at different speeds.

	Speed (m/s)	α(deg)	Elevator (deg)	CG location
1.	100	5	3.0 up	30% of MAC
2.	140	3	1.0 down	30% of MAC
3.	100	4	0.0	40% of MAC
4.	140	1	1.5 down	40% of MAC

If the lift curve slope of a/c is 0.1 per degree and all variations are assumed linear, then stick fixed neutral point will be.

(a) 0.45 (b) 0.35
(c) – 0.45 (d) – 0.35

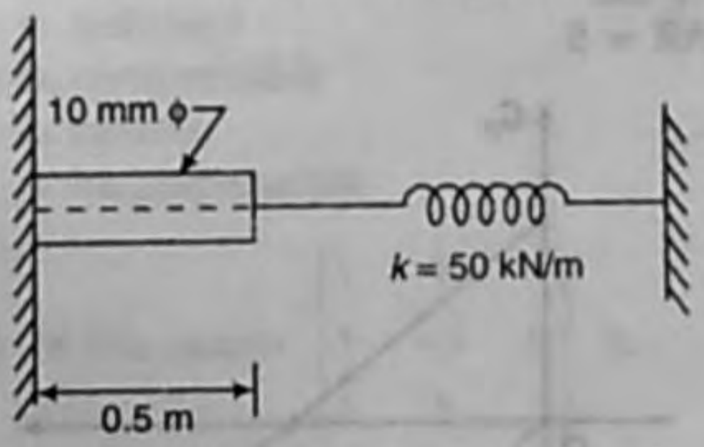
36. What is the most aft location of CG such that the a/c has a minimum stability margin of 5%?

(a) – 0.5 (b) – 0.4
(c) 0.5 (d) 0.4

37. Let an aircraft in a steady level flight be trimmed at certain speed. A level and steady flight at a higher speed be achieved by changing

(a) throttle only
(b) elevator only
(c) throttle and elevator together
(d) None of the above

38. If the rod fitted snugly between the supports as shown in the figure, is heated, the stress induced in it due to 20°C rise in temperature will be
($\alpha = 12.5 \times 10^{-6}$/°C, E = 200 GPa)



(a) 0.07945 MPa (b) – 0.07945 MPa
(c) – 0.03972 MPa (d) 0.03972 MPa

39. A cantilever beam of rectangular cross-section is subjected to a load w at its free end. If the depth of the beam is doubled and the load is halved, the deflection of the free and as compared to original deflection will be

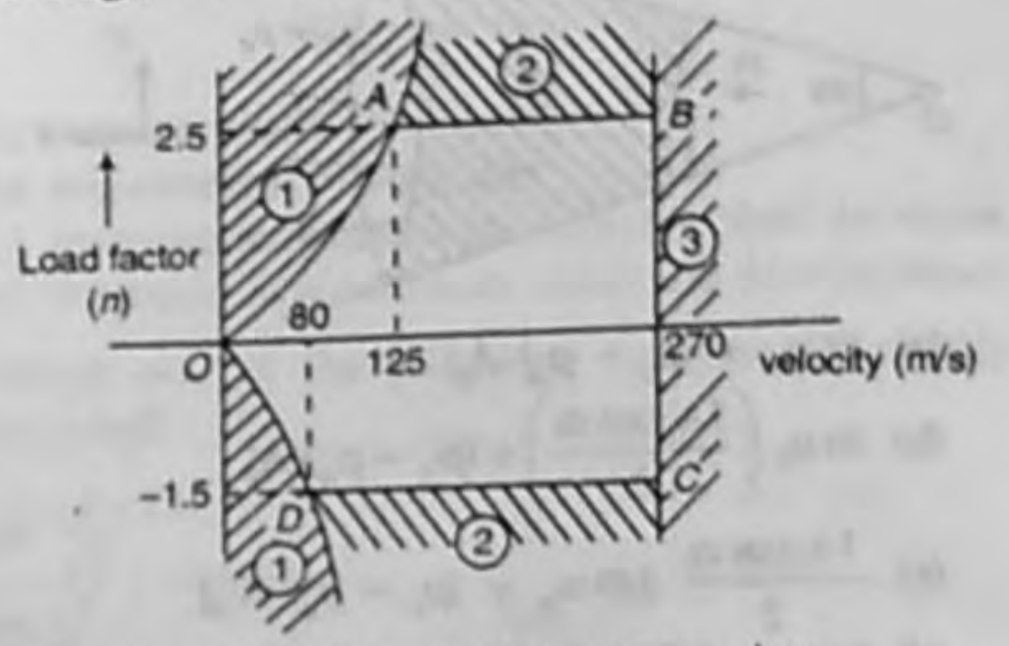
(a) half (b) one-eighth
(c) one-sixteenth (d) double

40. A thin cylinder contains fluid at a pressure of 500 N/m^2, the internal diameter of the shell is 0.6 m and the tensile stress in the material is to be limited to 9000 N/m^2. The shell must have a minimum wall thickness of nearly

(a) 9 mm (b) 11 mm
(c) 17 mm (d) 21 mm

Common Data for Questions 41 and 42

V-n diagram shown below.



41. Regions (1), (2) and (3) correspond to

(a) stall, propulsion limit and structural limit respectively
(b) stall, structural limit and propulsion limit respectively
(c) structural limit, stall and propulsion limit respectively
(d) propulsion limit, structural limit and stall respectively

42. What is the airplane's corner velocity at sea level?

(a) 80 m/s (b) 125 m/s
(c) 270 m/s (d) zero

43. Drag and lift on a circular cylinder with circulation in potential flow is
(ρ = denisty, u= freestream velocity)

(a) Drag = 0, Lift = $\rho u\Gamma$
(b) Drag > 0, Lift > $\rho u\Gamma$
(c) Drag < 0, Lift < $\rho u\Gamma$
(d) Drag > 0, Lift < $\rho u\Gamma$

44. Relationship between total and static temperatures is given by (M = Mach number)

(a) $\frac{T_0}{T} = 1+\frac{\gamma+1}{2}M^2$ (b) $\frac{T}{T_0} = 1+\frac{\gamma-1}{2}M^2$

(c) $\frac{T_0}{T} = 1+\frac{\gamma-1}{2}M^2$ (d) $\frac{T}{T_0} = 1-\left(\frac{\gamma+1}{2}\right)M^2$

45. What is relationship between calibrated and true speed?

(ρ = actual density, ρ_s = density at sea level)

(a) $\frac{V_{true}}{V_{cal}} = \sqrt{\frac{\rho_s}{\rho}}$ (b) $\frac{V_{true}}{V_{cal}} = \frac{\rho_s}{\rho}$

(c) $\frac{V_{true}}{V_{cal}} = \sqrt{\frac{\rho}{\rho_s}}$ (d) $\frac{V_{true}}{V_{cal}} = \frac{\rho}{\rho_s}$

46. Density of air has significant effects on the airplane's capability. Which of the following statements is not true?
(a) As air becomes less dense, it increases thrust because of less resistance
(b) As air becomes less dense, it reduces power because the engine takes in less air
(c) As air becomes less dense, it reduces lift because the thin air exerts less force on the airfoils
(d) All of the above

47. An increase in angle of attack has the following effect
(a) the lift increases
(b) the centre of pressure moves forward
(c) the centre of pressure moves backward
(d) Both (a) and (b)

48. Pick the wrong statement about the turbulent boundary layer.
(a) The turbulent boundary layer produces more skin friction drag than the laminar flow
(b) The turbulent boundary layer is more stable than the laminar boundary layer
(c) The turbulent boundary layer does not contribute to the lift an airfoil produces
(d) Both (b) and (c)

49. Pick the true statement about airfoil selection.
(a) Airflow separation occurs when there is adverse pressure gradient
(b) Airflow separation results in a sudden drop of drag and lift
(c) The point of airflow separation on an airfoil moves forward with a decrease in the angle of attack
(d) Both (a) and (b)

50. Incompressible flow is considered for
(a) $M < 0.3$ (b) $M > 0.3$
(c) $M > 1.0$ (d) $M < 1.0$

51. Consider the matrix $P = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$. The value of e^P is
(a) $\begin{bmatrix} 2e^{-2} - 3e^{-1} & e^{-1} - e^{-2} \\ 2e^{-2} - 2e^{-1} & 5e^{-2} - e^{-1} \end{bmatrix}$
(b) $\begin{bmatrix} e^{-1} + e^{-2} & 2e^{-2} - e^{-1} \\ 2e^{-1} - 4e^{-2} & 3e^{-1} + 2e^{-2} \end{bmatrix}$
(c) $\begin{bmatrix} 5e^{-2} - e^{-1} & 3e^{-1} - e^{-2} \\ 2e^{-2} - 6e^{-1} & 4e^{-2} + e^{-2} \end{bmatrix}$
(d) $\begin{bmatrix} 2e^{-1} - e^{-2} & e^{-1} - e^{-2} \\ -2e^{-1} + 2e^{-2} & -e^{-1} + 2e^{-2} \end{bmatrix}$

52. The system of linear equations
$$4x + 2y = 7$$
$$2x + y = 6$$
has
(a) a unique solution
(b) no solution
(c) an infinite number of solutions
(d) exactly two distinct solutions

53. The infinite series $1 + \frac{1}{2} + \frac{1}{3} + \ldots\ldots$
(a) converges (b) diverges
(c) oscillates (d) unstable

54. The volume generated by revolving the area bounded by the parobola $y^2 = 8x$ and the line $x = 2$ about Y-axis is
(a) $\frac{128\pi}{5}$ (b) $\frac{5}{128\pi}$
(c) $\frac{127}{5\pi}$ (d) None of these

55. Differential equation, $\frac{d^2x}{dt^2} + 10\frac{dx}{dt} + 25x = 0$ will have a solution of the form
(a) $(C_1 + C_2 t)\, e^{-5t}$ (b) $C_1 e^{-2t}$
(c) $C_1 e^{-5t} + C_2 e^{5t}$ (d) $C_1 e^{-5t} + C_2 e^{2t}$

General Aptitude

56. Judged by the results, the policy of the government was ..... successful.
(a) miscrably (b) naturally
(c) delightedly (d) eminently

57. The boy fell ..... the bicycle.
(a) of (b) off
(c) from (d) under

58. Hoping to ..... the conflict negotiators proposed a compromise that they felt would be ..... to both policies and legislation.
(a) end, likely (b) solve, divisive
(c) extend, detrimental (d) resolve, acceptable

59. In order to control deviout behaviour, sociologists suggest stabilizing the society that ..... it.
(a) defines (b) begets
(c) qualities (d) engenders

60. Two trains running in opposite directions cross a man standing in the platform in 27s and 17s respectively and they cross each other in 23s. The ratio of their speeds is
(a) 1 : 3 (b) 3 : 2
(c) 3 : 4 (d) None of these

61. Out of 7 consonants and 4 vowels, how many words of 3 consonants and 2 vowels can be formed?

(a) 210 (b) 1050

(c) 25200 (d) None of these

62. A, B and C can do a piece of work in 20, 30 and 60 days respectively. In how many days can A do the work, if he is assisted by B and C on every third day?

(a) 12 days (b) 15 days

(c) 16 days (d) 18 days

63. A two-digit number is such that the product of the digits is 8. When 18 is added to the number, then the digits are reversed. The number is

(a) 18 (b) 24

(c) 42 (d) 81

64. $\sqrt{1+\sqrt{1+\sqrt{1+\ldots}}}$

(a) is greater than 2 (b) lies between 1 and 2

(c) lies between 0 and 1 (d) equals 1

65. Which of the following diagrams indicates the best relation between cloth, cotton and shirt?

(a) 

(b) 

(c) 

(d)