GATE-2014 Aerospace Engineering (AE)

General Aptitude (GA)

Q. 1 – Q. 5 carry one mark each.

1. A student is required to demonstrate a high level of comprehension of the subject, especially in the social sciences.

The word closest in meaning to comprehension is

(A) Understanding (B) meaning

(C) concentration (D) stability

2. Choose the most appropriate word from the options given below to complete the following sentence.

One of his biggest _____ was his ability to forgive.

(A) vice (B) virtues (C) choices (D) strength

3. Rajan was not happy that Sajan decided to do the project on his own. On observing his unhappiness, Sajan explained to Rajan that he preferred to work independently?

Which one of the statements below is logically valid and can be inferred from the above sentences?

(A)Rajan has decided to work only in a group.

(B)Rajan and Sajan were formed into a group against their wishes.

(C)Sajan has decided to give in to Rajan's request to work with him.

(D)Rajan had believed that Sajan and he would be working together.

4. If $y = 5x^2 + 3$, then the tangent at $x = 0, y = 3$

(A) passes through $x = 0, y = 0$ (D) has a slope of $+1$

(C) is parallel to the x-axis (D) has a slope of -1

5. A foundary has a fixed daily cost f Rs. 50,000 whenever it operates and a variable cost of Rs. 800 Q, where Q is the daily production in tonnes. What is the cost of production in Rs Per tonne for a daily production of 100 tonnes?

Q. 6 – Q. 10 carry two marks each.

6. Find the odd one in the following group: ALRVX, EPVZB, ITZDF, OYEIK

(A) ALRVX (B) EPVZB (C) ITZDF (D) OYEIK

7. Anuj, Bhola, Chandan, Dilip, Eswar and Faisal live on different floors in a six storeyed building (the ground floor is numbered 1, the floor above it 2, and so on). Anuj lives on even-numbered floor. Bhola does not live on an odd numbered floor. Chandan does not live on any of the floors below Faisal's floor. Dilip does not live on floor number 2. Eswar does not live on the floor immediately above or immediately below Bhola. Faisal lives three floors above Dilip. Which of the following floor-person combinations is correct?

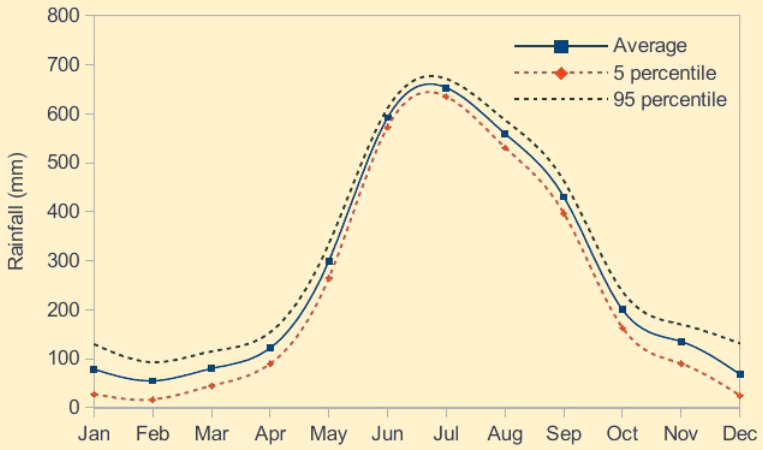
	Anuj	Bhola	Chandan	Dilip	Eswar	Faisal
(A)	6	2	5	1	3	4
(B)	2	6	5	1	3	4
(C)	4	2	6	3	1	5
(D)	2	4	6	1	3	5

8. The smallest angle of a triangle is equal to two thirds of the smallest angle of a quadrilateral. The ratio between the angles of the quadrilateral is 3:4:5:6. The largest angle of the triangle is twice its smallest angle. What is the sum, in degrees, of the second largest angle of the triangle and the largest angle of the quadrilateral?

9. One percent of the people of country X are taller than 6 ft. Two percent of the people of country Y are taller than 6 ft. There are thrice as many people in country X as in country Y. Taking both countries together, what is the percentage of people taller than 6 ft?

(A) 3.0 (B) 2.5 (C) 1.5 (D) 1.25

10. The monthly rainfall chart based on 50 years of rainfall in Agra shown in the following figure. Which of the following are true? (k Percentile is the value such that k percent of the data fall below that value)



(i) On average, it rains more in July than in December
(ii) Every year, the amount of rainfall in August is more than that in January
(iii) July rainfall can be estimated with better confidence than February rainfall
(iv) In August, there is at least 500 mm of rainfall

(A) (i) and (ii) (B) (i) and (iii)

(B) (ii) and (iii) (D) (iii) and (iv)

Aerospace Engineering

Q. 1 – Q. 25 carry one mark each.

1. For a real symmetric matrix $[A]$, which of the following statements is true:

(A)The matrix is always diagonalizable and invertible.

(B) The matrix is always invertible but not necessarily diagonalizable.
(C) The matrix is always diagonalizable but not necessarily invertible
(D) The matrix is always neither diagonalizable nor invertible

2. The series $s = \sum_{m=1}^{\infty} \frac{m^2}{3^m}(x-2)^m$ converges for all x with $|x-2| \leq R$ given by

(A) $R = 0$ (B) $R = 3$ (C) $R = \infty$ (D) $R = 1/3$

3. The function given by $f(x) = \begin{cases} \sin(1/x), & x \neq 0 \\ 0, & x = 0 \end{cases}$ is

(A)Unbounded everywhere
(B)Bounded and continuous everywhere
(C)Bounded but not continuous at $x = 0$
(D)Continuous and differentiable everywhere

4. Given the boundary-value problem $\frac{d}{dx}\left(x\frac{dy}{dx}\right) + ky = 0, \quad 0 < x < 1$, with $y(0) = y(1) = 0$. Then the solutions of the boundary-value problem for $k = 1$ (Given by y_1) and $k = 5$ (given by y_5) satisfy:

(A) $\int_0^1 y_1 y_5 dx = 0$ (B) $\int_0^1 \frac{dy_1}{dx}\frac{dy_5}{dx}dx = 0$

(C) $\int_0^1 y_1 y_5 dx \neq 0$ (D) $\int_0^1 (y_1 y_5 + \frac{dy_1}{dx}\frac{dy_5}{dx})dx = 0$

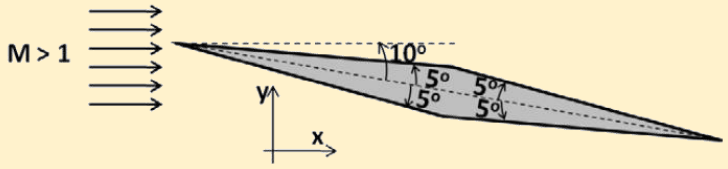
5. The value of $I = \int_0^1 1000x^4 dx$, obtained by using Simpson's rule with 2 equally spaced intervals is,

(A) 200 (B) 400 (C) 180 (D) 208

6. For a ***NACA*** 5-digit airfoil of chord c, the designed lift coefficient and location maximum camber along the chord from the leading edge are denoted by $\boldsymbol{C_L}$ and $\boldsymbol{X_m}$ respectively. For ***NACA 12018*** airfoil, which combination of $\boldsymbol{C_L}$ and $\boldsymbol{X_m}$ given below are correct?

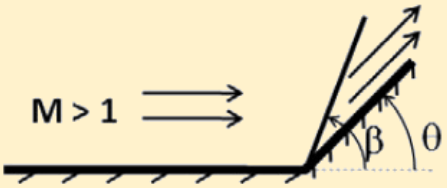
(A) $\boldsymbol{C_L}$ = 0.15 and $\boldsymbol{X_m}$ = 0.1c (B) $\boldsymbol{C_L}$ = 0.12 and $\boldsymbol{X_m}$ = 0.2c
(C) $\boldsymbol{C_L}$ = 0.12 and $\boldsymbol{X_m}$ = 0.18c (D) $\boldsymbol{C_L}$ = 0.15 and $\boldsymbol{X_m}$ = 0.2c

7. For inviscid, supersonic flow over a diamond shaped airfoil, shown in the figure, which statement is correct among the following?



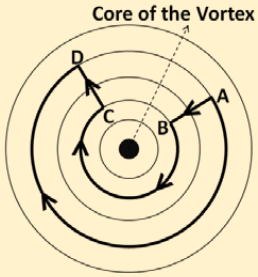
(A) The airfoil will experience zero lift and positive drag force.
(B) The airfoil will experience positive lift and zero drag force.
(C) The airfoil will experience negative lift and zero drag force.
(D)The airfoil will experience positive lift and positive drag force.

8. Consider supersonic flow near a corner (at an angle $\boldsymbol{\theta}$ from the horizontal) with an attached oblique shock (at an angle $\boldsymbol{\beta}$ with horizontal) as shown in the figure. If Mach number $\boldsymbol{M}$ decreases gradually from a high supersonic value, which of the following statements is correct?



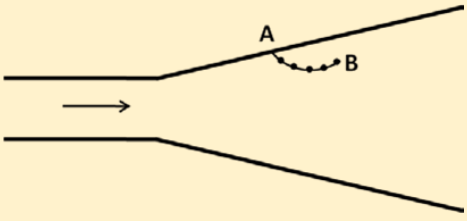
(A) $\boldsymbol{\beta}$ will decrease if the shock is a weak shock
(B) $\boldsymbol{\beta}$ will decrease if the shock is a strong shock
(C) $\boldsymbol{\beta}$ will increase for both weak and strong shocks
(D) $\boldsymbol{\beta}$ will remain unchanged for both weak and strong shocks

9. The streamlines of a potential line vortex is concentric circles with respect to the vortex center as shown in the figure. Velocity along these streamlines, outside the core of the vortex can be written as, $v_\theta = \frac{\Gamma}{2\pi r}$, where strength of the vortex is $\frac{\Gamma}{2\pi}$ and r is radial direction. The value of circulation along the curve shown in the figure is:



(A) Γ (B) -2Γ (C) 2Γ (D) 0

10. To observe unsteady separated flow in a diverging channel, bubbles are injected at each 10 ms interval at point A as shown in the figure. The bubbles act as tracer particles and follow the flow faithfully. The curved line **AB** shown at any instant represents:



(A) Streamline, streakline and pathline
(B) Streamline and pathline
(C) Only a pathline
(D) Only a streakline

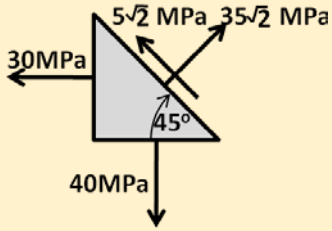
11. It is desired to measure the Young's Modulus and the Poisson's Ratio of a given homogeneous, isotropic material. A bar of length $20\ cm$ and cross-section $(10\ mm \times 10\ mm)$ of this material is subjected to a tensile load of $40\ kN$. Under this load, length increase to $20.1\ cm$ while the cross-section reduces to $9.98\ mm \times 9.98\ mm$. Young's Modulus and Poisson's ratio of the material are:

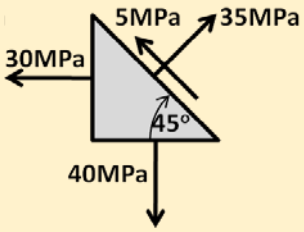
(A) $80\ GPa$ & 0.4 respectively
(B) $40\ GPa$ & -0.4 respectively
(C) $80\ GPa$ & -0.2 respectively
(D) $40\ GPa$ & 0.2 respectively

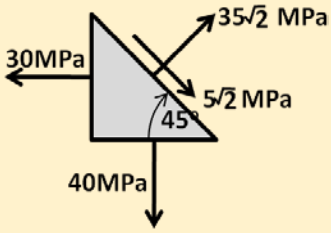
12. In general, for any given solid subjected to arbitrary loading, which of the following statements is ***always*** true?

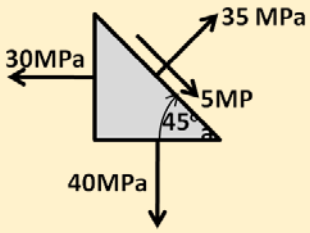
(A) Volume does not vary with loading
(B) Mass does not vary with loading
(C) Density does not vary with loading
(D)Volume, mass and density vary with loading

13. Which one of the following objects with inclined face at $45°$, subjected to the given stresses, are in static equilibrium:

(A)


(B)


(C)


(D)


14. A damped single degree of freedom system whose undamped natural frequency, $\boldsymbol{\omega_n} = 10\ Hz$, is subjected to sinusoidal external force. Power is half of the maximum for the two frequencies of $60.9469\ rad/s$ and $64.7168\ rad/s$. The damping factor associated with the vibrating system $(\text{in } \%)$ is _____.

15. The boundary conditions for a rod with circular cross-section, under torsional vibrations, are changed from fixed-free to fixed-fixed. The fundamental frequency of the fixed-fixed rod is $\boldsymbol{k}$ times that of fixed-free rod. The value of $\boldsymbol{k}$ is

(A) 1.5 (B) π (C) 2.0 (D) 0.5

16. Match the appropriate engine (in right column) with the corresponding aircraft (in left column) for most efficient performance of the engine.

a. Low speed transport aircraft i. Ramjet

b. High Subsonic Civilian aircraft	ii. Turboprop
c. Supersonic fighter aircraft	iii. Turbojet
d. Hypersonic aircraft	iv. Turbofan

(A) a-iv, b-iii, c-i, d-ii (B) a-ii, b-i, c-iii, d-iv
(C) a-i, b-ii, c-iv, d-iii (D) a-ii, b-iv, c-iii, d-i

17. For the given fuel flow rate and thermal efficiency, the take-off thrust for a gas turbine engine burning aviation turbine fuel (considering fuel-air ratio of $f \ll 1$) is

(A) Directly proportional to exhaust velocity
(B)Inversely proportional to exhaust velocity
(C) Independent of exhaust velocity
(D) Directly proportional to the square of the exhaust velocity

18. For a fifty percent reaction axial compressor stage, following statements are given:

I. Velocity Triangle at the entry and exit of the rotor are symmetrical
II. The whirl or swirl component of absolute velocity at the entry of rotor and entry of stator are same.
Which of the following options are correct?

(A) Both I and II are correct statements (B) I is correct but II is incorrect
(C) I is incorrect but II is correct (D) Both I and II are incorrect

19. A small rocket having a specific impulse of $200s$ produces a total thrust of $98\ kN$, out of which $10\ kN$ is the pressure thrust. Considering the acceleration due to gravity to be $9.8\ m/s^2$, the propellant mass flow rate in kg/s is

(A) 55.1 (B) 44.9 (C) 50 (D) 60.2

20. The thrust produced by a turbojet engine

(A) Increases with increasing compressor pressure ratio
(B) Decreases with increasing compressor pressure ratio
(C) Remains constant with increasing compressor pressure ratio
(D) First increases and then decreases with increasing compressor pressure ratio

21. The moment coefficient measured about the centre of gravity and about the aerodynamic centre of a given wing-body combination are 0.0065 and -0.0235 respectively. The aerodynamic centre lies 0.06 chord lengths ahead of the centre of gravity. The lift coefficient for this wing- body is _____.

22. The vertical ground load factor on a stationary aircraft parked in its hangar is:

(A) 0 (B) -1 (C) Not defined (D) 1

23. Under what condition should a glider be operated to ensure minimum sink rate?

(A) Maximum C_L/C_D (B) Minimum C_L/C_D
(C) Maximum $C_D/C_L^{3/2}$ (D) Minimum $C_D/C_L^{3/2}$

24. In most airplanes, the Dutch roll mode can be excited by applying

(A) a step input to the elevators (B) a step input to the rudder
(C) a sinusoidal input to the aileron (D) an impulse input to the elevators

25. Considering $\boldsymbol{R}$ as the radius of the moon, the ratio of the velocities of two spacecraft orbiting moon in circular orbit at altitudes $\boldsymbol{R}$ and $\boldsymbol{2R}$ above the surface of the moon is _____.

Q. 26 – Q. 55 carry two marks each.

26. If $[A] = \begin{bmatrix} 3 & -3 \\ -3 & 4 \end{bmatrix}$. Then det $(-[A]^2 + 7[A] - 3[I])$ is

(A) 0 (B) -324 (C) 324 (D) 6

27. For the periodic function given by $f(x) = \begin{cases} -2, & -\pi < x < 0 \\ 2, & 0 < x < \pi \end{cases}$ with $f(x + 2\pi) = f(x)$, using Fourier series, the sum $s = 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \cdots$ converges to

(A) 1 (B) $\frac{\pi}{3}$ (C) $\frac{\pi}{4}$ (D) $\frac{\pi}{5}$

28. Let Γ be the boundary of the closed circular region A given by $x^2 + y^2 \leq 1$. Then $I = \int_\Gamma (3x^3 - 9xy^2)ds$ (where ds means integration along the bounding curve) is

(A) π (B) $-\pi$ (C) 1 (D) 0

29. Solution to the boundary – value problem

$-9\frac{d^2u}{dx^2} + u = 5x, 0 < x < 3$ with $u(0) = 0, \left.\frac{du}{dx}\right|_{x=3} = 0$ is

(A) $u(x) = \frac{15e}{1+e^2}\left(e^{-x/3} - e^{x/3}\right) + 5x$ (B) $u(x) = \frac{15e}{1+e^2}\left(e^{-x/3} + e^{x/3}\right) + 5x$

(C) $u(x) = -\frac{15\sin(x/3)}{\cos(1)} + 5x$ (D) $u(x) = -\frac{15\sin(x/3)}{\cos(1)} - \frac{5}{54}x^3$

30. The Laplace transform $L\big(u(t)\big) = U(s)$, for the solution $u(t)$ of the problem

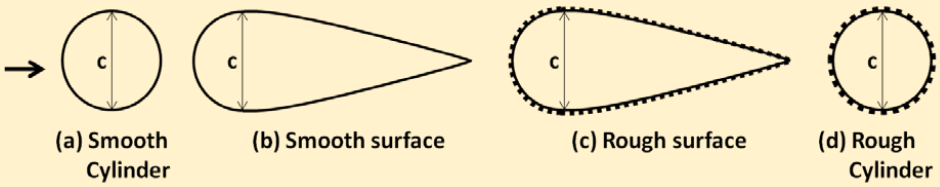
$\frac{d^2u}{dt^2} + 2\frac{du}{dt} + u = 1$, $t > 0$ with initial conditions $u(0) = 0, \frac{du(0)}{dt} = 5$ is given by:

(A) $\frac{6}{(s+1)^2}$ (B) $\frac{5s+1}{s(s+1)^2}$ (C) $\frac{1-5s}{s(s+1)^2}$ (D) $\frac{5s^2+1}{s(s+1)^2}$

31. For a steady, incompressible two-dimensional flow, represented in Cartesian co-ordinates (x, y), a student correctly writes the equation of pathline of any arbitrary particle as, $\frac{dx}{dt} = ax$ and $\frac{dy}{dt} = by$, where a and b are constants having unit of $(second)^{-1}$. If the value of a is 5, the value of b is _____.

32. Figures (a)-(d) below show four objects. Dimensions and surface conditions of the objects are shown in the respective figures. All four objects are placed independently in a steady, uniform flow of

same velocity and the direction of flow is from left to right as shown in (a). The flow field can be considered as 2-D, viscous and incompressible. Following statements are made regarding the drag that these objects experience.

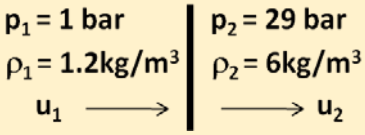


(i) Drag of object (a) is more than the drag of object (d)
(ii) Drag of object (a) is less than the drag of object (d)
(iii) Drag of object (b) is more than the drag of object (c)
(iv) Drag of object (c) is more than the drag of object (b)
(v) Drag of object (a) is more than the drag of object (b)

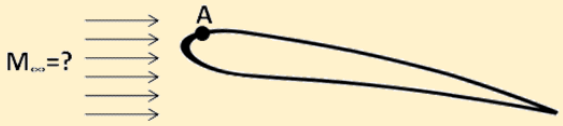
Choose the correct combination of statements from the options given above:

(A) (i),(iii),(v) (B) (ii),(iv),(v) (C) (i)(iv),(v) (D) (i),(iii)

33. A student needs to find velocity across a stationary normal shock. He measures density and pressure across the shock as shown in the figure below. $1\ bar = 10^5 Pa$. (No shock table is needed for the calculations.) The value of u_1 in m/s is _____.



34. For inviscid, compressible flow past a thin airfoil, shown in the figure, free-stream Mach number and pressure are denoted by $\boldsymbol{M}_\infty$ and $\boldsymbol{p}_\infty$ respectively. Ratio of pressure at point **A** and $\boldsymbol{p}_\infty$ is 0.8 and specific heat ratio is 1.4. If the Mach number at point **A** is 1.0 and rest of the flow field is subsonic, the value of $\boldsymbol{M}_\infty$ is



(A) 2.95 (B) 0.79 (C) 1.18 (D) 0.64

35. A student can measure free-stream velocity of a low-speed wind tunnel using a

(i) Pitot tube alone aligned with the flow direction
(ii) Pitot tube aligned with the flow direction with static pressure measurement at an appropriate position on the tunnel wall.
(iii) Pitot tube aligned with the flow direction along with barometer pressure reading of the outside ambient.

(iv) Pitot static tube alone aligned with the flow direction.
Considering the above statements, which of the following options is correct?

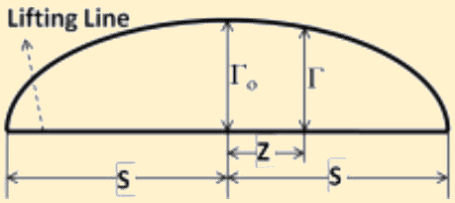
(A) (i) only (B) (i)&(ii) (C) (ii)&(iv) (D) (i)(iii)&(iv)

36. Induced velocity w at a point $z = z_1$ along the lifting line can be calculated using the formula

$w(Z_1) = -\frac{1}{4\pi}\int_{-s}^{s}\frac{d\Gamma}{dz}\frac{1}{z-z_1}dz.$

Given $\frac{\Gamma^2}{{\Gamma_o}^2}+\frac{z^2}{s^2}=1$ where z,Γ_o and s are given in figure below.

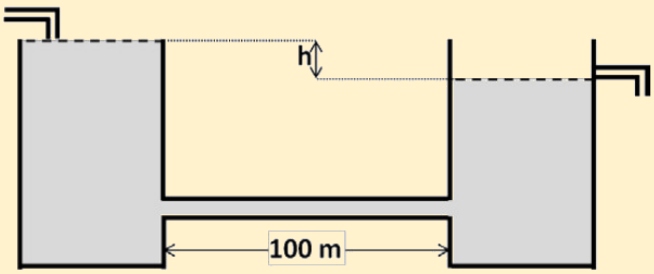
For the above semi-elliptic distribution of circulation, Γ, the downwash velocity at any point Z_1, for symmetric flight can be obtained as $w(Z_1)=\frac{\Gamma_o}{4\pi s}[\pi + z_1 I]$, where $I = Z_1\int_{-s}^{s}\frac{dz}{(\sqrt{s^2-z^2})(z-z_1)}$. Which of the following options is correct if the induced drag is D_i (given $\int_{-s}^{s}\sqrt{1-\frac{Z^2}{s^2}}dz=\frac{\pi s}{2}$)



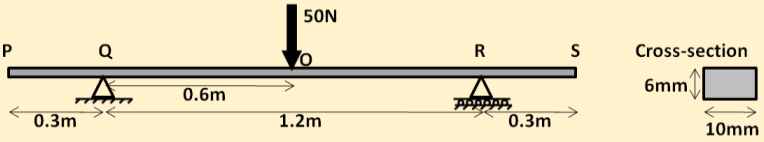
(A) $I=0$ and $D_i=\frac{8\rho{\Gamma_o}^2}{\pi}$ (B) $I=1$ and $D_i=\frac{8\rho{\Gamma_o}^2}{\pi}$

(C) $I=0$ and $D_i=\frac{\pi\rho{\Gamma_o}^2}{8}$ (D) $I=1$ and $D_i=\frac{\pi\rho{\Gamma_o}^2}{8}$

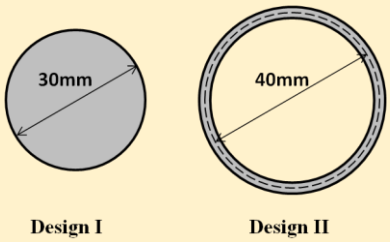
37. Two overflowing water reservoirs are connected with a $100\ m$ long pipe of circular cross-section (of radius,$R = 0.02\ m$), such that height difference $\boldsymbol{h}$ remains constant as shown in the figure below. The centreline velocity in the pipe is $10\ m/s$. The velocity profile inside the pipe over the entire length is $u=-\frac{R^2}{4\mu}\frac{dp}{dx}\left[1-\frac{r^2}{R^2}\right]$, where, $\frac{dp}{dx}$ is a constant pressure gradient along the pipe length, x is measured from the left end of the pipe along its central axis and r is radial location inside the pipe with respect to its axis. (Given data: Density and kinematic viscosity of water are $1000\ kg/m^3$ and $1\times10^{-6}\ m^2/s$ respectively; acceleration due to gravity is $10\ m/s^2$)
If all other losses except the frictional losses at the pipe wall are neglected, the value of h in meter is _____.



38. A $1.8\ m$ long steel beam of rectangular cross section $(10\ mm \times 6\ mm)$ is simply supported with a length of $1.2\ m$ between the supports and an overhang of $0.3\ m$ on either side. Young's modulus for the material of the beam is $200\ GPa$. For a $50\ N$ load applied at the center of the beam, magnitude of the slope of the beam at tip S is _____.

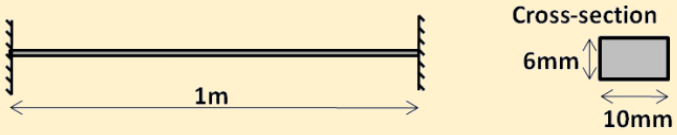


39. There are 2 designs proposed for a shaft of length $\boldsymbol{l}$,with a torque carrying capacity of $\boldsymbol{T}$.Design I is a solid circular cross-section shaft of diameter $30\ mm$. Design II is a thin–walled circular shaft of average diameter $40\ mm$.Thickness of the wall in $Design\ II$ has to be determined such that maximum shear stress is the same in both the designs for the given torque T (so that same material can be used for manufacturing both the shafts).Ratio of mass of shaft using $Design\ I$ to the mass of shaft using $Design\ II$ is



(A) 2.68 (B) 5.36 (C) 1.79 (D) 3.58

40. A structural member of rectangular cross-section $10\ mm \times 6\ mm$ and length $1\ m$ is made of steel (Young's Modulus is $200\ G\ Pa$ and coefficient of thermal expansion is 12×10^{-6}/℃). It is rigidly fixed at both ends and then subjected to a gradual increase in temperature. Ignoring the three dimensional effects, the structural member will buckle if the temperature is increased by ΔT ℃ which is



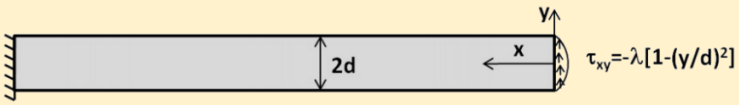
(A) 19.74 (B) 9.87 (C) 78.96 (D) 39.48

41. A gas cylinder (closed thin-walled cylindrical pressure vessel) of diameter $30\ cm$ and wall thickness $1\ mm$ is subjected to a design maximum internal pressure of $5\ bar(0.5\ MPa)$. The material used for manufacturing this cylinder has a failure stress of $260\ MPa$. Assuming von Mises failure criterion, the factor of safety (with respect to maximum allowable stress) for this cylinder is

(A) 2.8 (B) 2.0 (C) 6.9 (D) 4.0

42. A cantilevered beam is subjected to a parabolic distribution of shear traction at the right edge while the top and bottom surfaces are traction free. To solve this problem, following Airy's stress

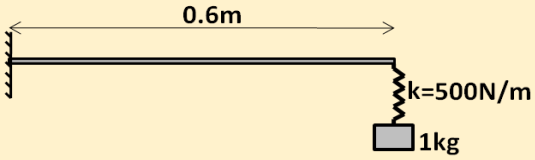
function is proposed: $\emptyset = C_1xy + C_2xy^3 + C_3\,x^2y^2 + C_4x^3y$ This is an admissible Airy's function that would satisfy the bi-harmonic equation as well as the boundary conditions if and only if



(A) $C_1 = 0, C_2 = \lambda, C_3 = 0, C_4 = \frac{\lambda}{3d^2}$ (B) $C_1 = \lambda, C_2 = \frac{\lambda}{3d^2}, C_3 = 0, C_4 = 0$

(C) $C_1 = 0, C_2 = 0, C_3 = \lambda, C_4 = -\frac{\lambda}{3d^2}$ (D) $C_1 = \lambda, C_2 = \frac{-\lambda}{3d^2}, C_3 = 0, C_4 = 0$

43. 1kg mass is hanging from a spring of stiffness $500\ N/m$ attached to a massless, symmetric beam of length $0.6\ m$, moment of inertia about the bending axis $I = 8.33 \times 10^{-10}\ m^4$ and Young's modulus $E = 210\ GPa$ as shown in the figure. The fundamental natural frequency $(\text{in } rad/s)$ of the system is



(A) 3.24 (B) 20.36 (C) 22.36 (D) 3.56

44. A single degree of freedom system is vibrating with initial (first cycle) amplitude of $5\ cm$. The viscous damping factor associated with the vibrating system is 2%. Vibration amplitude of the fifth cycle (in cm) is

(A) 1.65 (B) 4.41 (C) 2.67 (D) 3.02

45. A cruise missile with ***ideal*** ramjet engine is flying at Mach 4.0 at an altitude where the ambient temperature is $100\ K$. Consider ratio of specific heats $\gamma = 1.4$ and the specific gas constant $R = 287\ J/kgK$.If the stagnation temperature in the combustion chamber is equal to $2310\ K$, the speed of the exhaust gases$(\text{in } m/s)$is _____.

46. A gas turbine engine is operating under the following conditions:

Stagnation temperature at turbine inlet	$1350\ K$
Stagnation pressure at turbine inlet	$10\ bar$
Static temperature at turbine exit	$800\ K$
Velocity at turbine exit	$200\ m/s$
Total-to-total efficiency of turbine	0.96
γ (ratio of specific heats)	1.33
C_P (specific heat at constant temperature)	$1.147\ kJ/kgK$

The stagnation pressure (in bar) in the nozzle (considering isentropic nozzle) is equal to _____.

47. Air at a stagnation temperature of 300 K (ratio of specific heats $\gamma = 1.4$ and specific gas constant R= $287\ J/kgK$) enters the impeller of a centrifugal compressor in axial direction. The stagnation pressure ratio between the diffuser outlet and impeller inlet is 4.0. The impeller blade radius is 0.3 m

and it is rotating at $15000\ rev/min$. If the slip factor σ_s (ratio of tangential component of air velocity at the blade tip to the blade speed) is 0.88, the overall efficiency (total-to-total) of the compressor (in %) is _____.

48. A stationary two stage rocket with initial mass of $16000\ kg$, carrying a payload of $1000\ kg$, is fired in a vertical trajectory from the surface of earth. Both the stages of the rocket have same specific impulse I_{sp} of $300s$ and same structural coefficient of 0.14. The acceleration due to gravity is $9.8\ m/s^2$. Neglecting drag and gravity effects and considering both the stages with same payload ratio, the terminal velocity attained by the payload in m/s is _____.

49. An aircraft is flying at Mach 3.0 at an altitude where the ambient pressure and temperature are $50\ kPa$ and $200\ K$ respectively. If the converging-diverging diffuser of the engine (considered isentropic with ratio of specific heats, $\gamma = 1.4$ and specific gas constant $R = 287\ J/kgK$) has a throat area of $0.05\ m^2$, the mass flow rate through the engine in kg/s is

(A) 197 (B) 232 (C) 790 (D) 157

50. A cryogenic rocket has a specific impulse of $455s$ and characteristic velocity of $2386\ m/s$. The value of thrust coefficient for this rocket is

(A) 1.78 (B) 1.73 (C) 1.87 (D) 1.95

51. For a given plane with a given wing loading executing a turn in the vertical plane, under what conditions will the turn radius be minimum and the turn rate be maximum?

(A) Highest possible C_L and lowest possible load factor
(B) Lowest possible C_L and lowest possible load factor
(C) Lowest possible C_L and highest possible load factor
(D) Highest possible C_L and highest possible load factor

52. Lift-off distance for a given aircraft of weight $\boldsymbol{W}$ is $\boldsymbol{S_{LO}}$. If the take-off weight is reduced by 10%, then the magnitude of percentage change in the lift-off distance (assume all other parameters to remain constant) is _____.

53. Which of the following design parameters influence the maximum rate-of-climb for a jet-propelled airplane?

P. Wing is loading
Q. Maximum thrust-to-weight ratio
R. Zero-lift drag coefficient
S. Maximum lift-to-drag ratio

(A)P and Q alone (B)P, Q, R and S (C)P, Q and S alone (D)Q, R and S alone

54. Consider the following four statements regarding aircraft longitudinal stability:

P. $\boldsymbol{C_{M,cg}}$ at zero lift must be positive
Q. $\boldsymbol{\partial C_{M,cg}/\partial \alpha_a}$ must be negative ($\boldsymbol{\alpha_a}$ is absolute angle of attack)
R. $\boldsymbol{C_{M,cg}}$ at zero lift must be negative

S. Slope of C_L versus α_a must be negative

Which of the following combination is the necessary criterion for stick fixed longitudinal balance and static stability?

(A) Q and R only (B) Q, R and S only (C) P and Q only (D) Q and S only

55. Data for a light, single-engine, propeller driven aircraft in steady level flight at sea level is as follows: velocity $V_\infty = 40\ m/s$, weight $W = 13000\ N$, lift coefficient $C_L = 0.65$, drag coefficient $C_D = 0.025 + 0.04C_L^2$ and power available $P_{av} = 100{,}000\ J/s$. The rate of climb possible for this aircraft under the given conditions (in m/s) is

(A) 7.20 (B) 5.11 (C) 6.32 (D) 4.23

END OF THE QUESTION PAPER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390 AIR Ritu Raj
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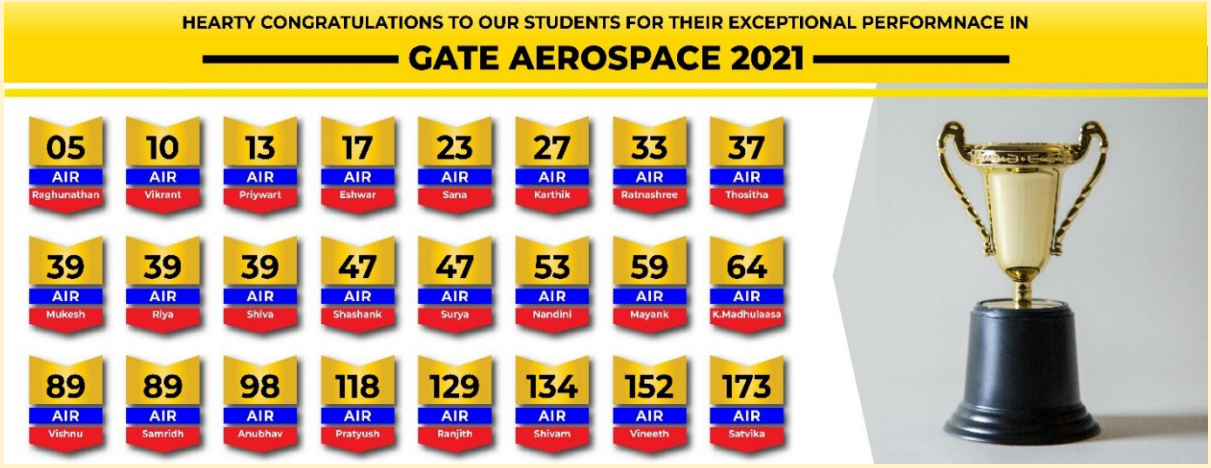
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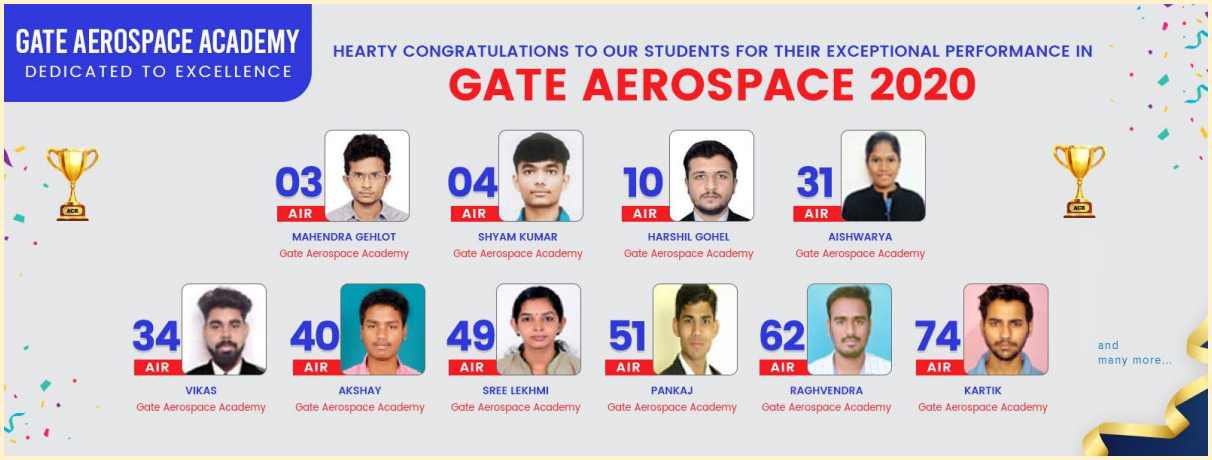
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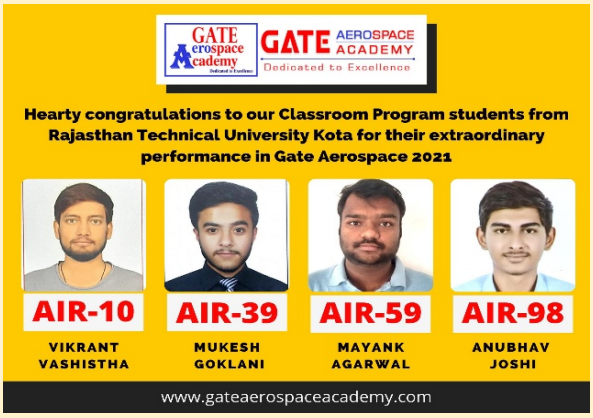
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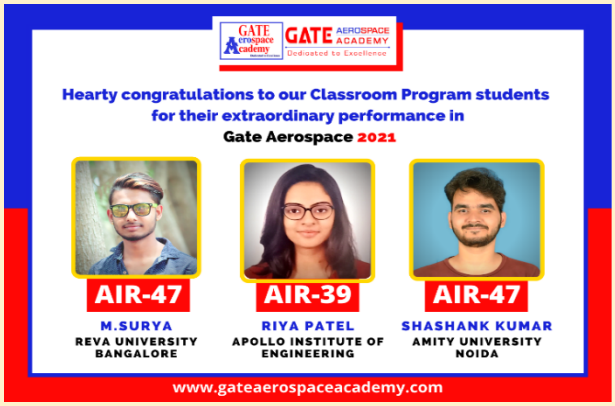
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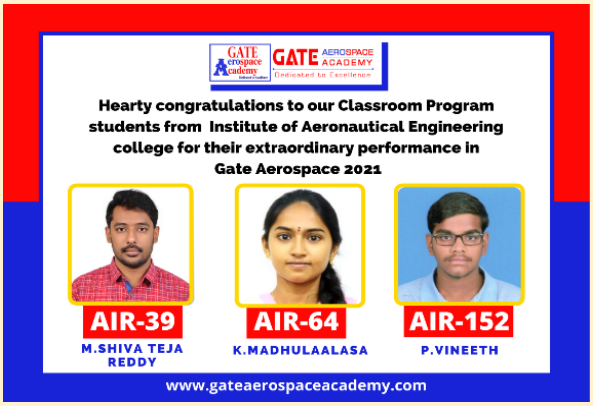
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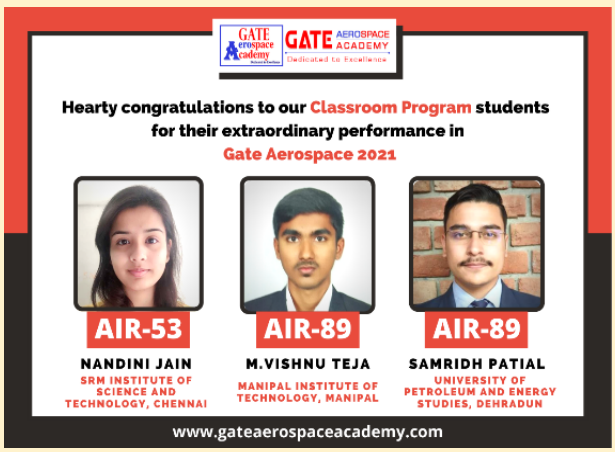
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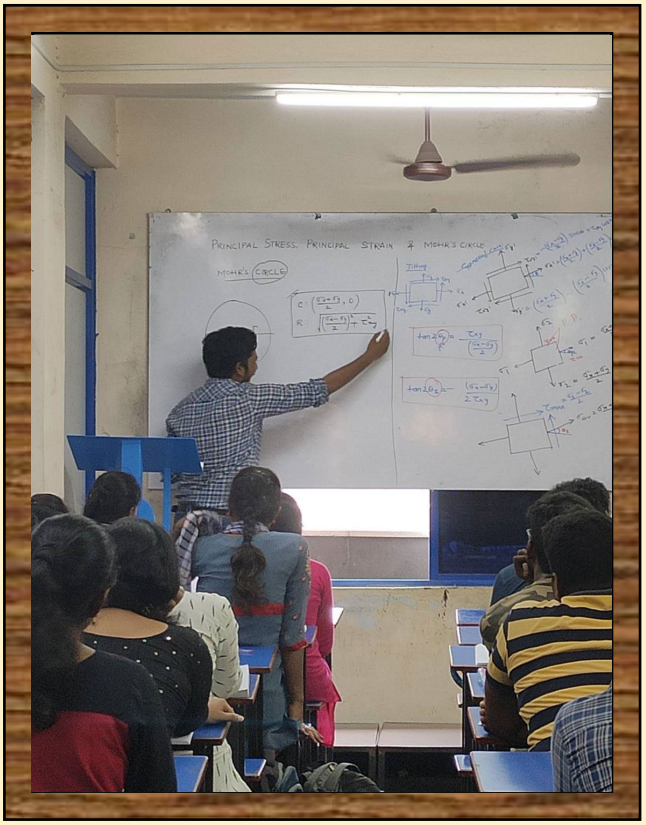
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