ASSIGNMENT 2: GATE 2011
AE : AEROSPACE ENGINEERING
AI25BTECH11029 - Samyak Gondane

Read the following instructions carefully

1. Questions must be answered using computers provided by the GATE at the examination centers. Each computer shall run specialized examination software that permits a maximum of one answer to be selected for questions of multiple choice type.

2. Your answers shall be updated and saved on the server periodically and at the end of the examination. The examination will automatically stop once the duration of the examination is over.

3. There are a total of **65** questions carrying 100 marks. All questions are of objective type.

4. Questions Q.1 – Q.25 carry 1-mark each, and questions Q.26 – Q.55 carry 2-marks each.

5. Questions Q.26 - Q.30 are of numerical answer type. For each of these questions, the correct answer is a number. All other questions are of multiple choice type. Each of these questions carries four choices for the answer labeled A, B, C and D. Only one of the four choices is the correct answer.

6. Questions Q.48 – Q.51 (2 pairs) are common data questions and question pairs (Q.52, Q.53) and (Q.54, Q.55) are linked answer questions. The answer to the second question of the linked answer questions depends on the answer to the first question of the pair. If the first question in the linked pair is wrongly answered or is unattempted, then the answer to the second question in the pair will not be evaluated.

7. Questions Q.56 – Q.65 belong to General Aptitude (GA). Questions Q.56 – Q.60 carry 1-mark each, and questions Q.61 – Q.65 carry 2-marks each.

8. Unattempted questions will result in zero mark. There is no negative marking for questions of numerical answer type, i.e., for Q.26 – Q.30. For questions of multiple choice type, wrong answers will result in **NEGATIVE** marks. For Q.1 – Q.25 and Q.56 – Q.60, $\frac{1}{3}$ mark will be deducted for each wrong answer. For Q.31 – Q.51 and Q.61 – Q.65, $\frac{2}{3}$ mark will be deducted for each wrong answer. The question pairs (Q.52, Q.53), and (Q.54, Q.55) are questions with linked answers. There will be negative marks only for wrong answer to the first question of the linked answer question pair, i.e. for Q.52 and Q.54, $\frac{2}{3}$ mark will be deducted for each wrong answer. There is no negative marking for Q.53 and Q.55.

9. Calculator is allowed whereas charts, graph sheets or tables are **NOT** allowed in the examination hall.

10. Rough work can be done in the specified area only.

11. Candidates may use the back side of this page to record their answers for their own convenience.

12. To login, type your Registration Number and password as per instructions provided in the envelope.

13. In order to answer a question, you may select the question using the left side selection panel on the screen and choose the correct answer by clicking on the radio button next to the answer. The answered questions shall be indicated by a solid black ball on the selection panel. In order to change the answer, you may just click on another option. If you wish to leave a previously answered question unanswered, you may click on DESELECT ANSWER button.

14. You may also select questions using NEXT and PREVIOUS buttons.

15. You may also mark questions for reviewing later using MARK button. All marked questions are indicated by a rectangle in the selection panel. Questions which are answered but are marked for the review are indicated by a solid black rectangle and questions which are not answered but are marked for the review are indicated by an outlined rectangle in the selection panel.

16. You must sign this sheet and leave it with the invigilators at the end of the examination.

Q.1 – Q.25 carry one mark each

1. Consider x, y, z to be right-handed Cartesian coordinates. A vector function is defined in this coordinate system as $\mathbf{v} = 3x\mathbf{i} + 3xy\mathbf{j} - yz^2\mathbf{k}$ where $\mathbf{i}, \mathbf{j}$ and $\mathbf{k}$ are the unit vectors along x, y, z axes, respectively. The curl of $\mathbf{v}$ is given by

   (a) $z^2\mathbf{i} - 3y\mathbf{k}$ (b) $z^2\mathbf{j} + 3y\mathbf{k}$ (c) $z^2\mathbf{i} + 3y\mathbf{j}$ (d) $-z^2\mathbf{i} + 3y\mathbf{k}$

2. Which of the following functions is periodic?

   (a) $f(x) = x^2$ (b) $f(x) = \log x$ (c) $f(x) = e^x$ (d) $f(x) = const.$

3. The function $f(x_1, x_2, x_3) = x_1^2 + x_2^2 + x_3^2 - 4x_1 - 6x_2 + 14$ has its minimum value at

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

4. Consider the function $f(x_1, x_2) = x_1^2 + x_2^2 + 2x_1 - 2x_2 + e^{-(x_1^2 + x_2^2)}$. The vector pointing in the direction of maximum increase of the function at the point $(1, -1)$ is

   (a) $\begin{pmatrix} 2 \\ -5 \end{pmatrix}$ (b) $\begin{pmatrix} 1 \\ -5 \end{pmatrix}$ (c) $\begin{pmatrix} 0.73 \\ -6.73 \end{pmatrix}$ (d) $\begin{pmatrix} 2 \\ -4 \end{pmatrix}$

5. Two simultaneous equations given by $x + y = \pi$ and $x - y = -\pi$ have

   (a) a unique solution   (c) no solution

   (b) infinitely many solutions   (d) a finite number of multiple solutions

6. In three-dimensional linear elastic solids, the number of non-trivial stress–strain relations, strain–displacement equations and equations of equilibrium are, respectively,

   (a) 3, 3 and 3   (b) 6, 3 and 3   (c) 6, 6 and 3   (d) 6, 3 and 6

7. An Euler–Bernoulli beam in bending is assumed to satisfy

   (a) both plane stress as well as plane strain conditions

   (b) plane strain condition but not plane stress condition

   (c) plane stress condition but not plane strain condition

   (d) neither plane strain condition nor plane stress condition

8. A statically indeterminate frame structure has

    (a) same number of joint degrees of freedom as the number of equilibrium equations

    (b) number of joint degrees of freedom greater than the number of equilibrium equations

    (c) number of joint degrees of freedom less than the number of equilibrium equations

    (d) unknown number of joint degrees of freedom, which cannot be solved using laws of mechanics

9. Consider a single degree of freedom spring-mass-damper system with mass m, damping c and stiffness k. The logarithmic decrement of this system can be calculated using

    (a) $\frac{2\pi c}{\sqrt{4mk-c^2}}$

    (b) $\frac{\pi c}{\sqrt{4mk-c^2}}$

    (c) $\frac{2\pi c}{\sqrt{mk-c^2}}$

    (d) $\frac{2\pi c}{\sqrt{mk-4c^2}}$

10. Consider a single degree of freedom spring-mass system of spring stiffness k_1 and mass m which has a natural frequency of 10 rad/s. Consider another single degree of freedom spring-mass system of spring stiffness k_2 and mass m which has a natural frequency of 20 rad/s. The spring stiffness k_2 is equal to

    (a) k_1

    (b) $2k_1$

    (c) $\frac{k_1}{4}$

    (d) $4k_1$

11. Consider a simply supported two-dimensional beam.
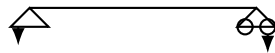

Figure 1

    If the beam is converted into a fixed-fixed beam,

Figure 2

    then the degree of static indeterminacy will

    (a) increase by 3

    (b) increase by 2

    (c) decrease by 1

    (d) decrease by 3

12. An impulsive launch of a rocket minimizes the loss of burn-out velocity due to

    (a) aerodynamic drag force only

3

(b) gravitational force only

(c) both aerodynamic drag and gravitational forces

(d) reaction jet control force

13. Multi-staging in rockets improves the burn-out performance by increasing mainly stage-wise

(a) payload mass ratios

(b) structural mass efficiencies

(c) propellant masses

(d) control system masses

14. In an un-powered glide of an aircraft having weight W, lift L and drag D, the equilibrium glide angle is defined as

(a) $\tan^{-1}(\frac{L}{D})$

(b) $\tan^{-1}(\frac{D}{L})$

(c) $\tan^{-1}(\frac{L}{W})$

(d) $\tan^{-1}(\frac{W}{L})$

15. Lift on an aircraft climbing vertically up is

(a) equal to its weight

(b) zero

(c) equal to the drag

(d) equal to the thrust

16. If an aircraft is performing a positive yawing manoeuvre, the side slip angle

(a) is always zero

(b) is never zero

(c) is always negative

(d) could be any value

17. For an airplane to be statically stable, its centre of gravity must always be

(a) ahead of wing aerodynamic centre

(b) aft of the wing aerodynamic centre

(c) ahead of neutral point

(d) aft of neutral point

18. It is seen that the drag polar of a certain aerofoil is symmetric about the C_d axis. This drag polar could refer to

(a) NACA 0012

(b) NACA 4415

(c) NACA 23012

(d) None of the above

19. The aerodynamic centre of a supersonic aerofoil, with chord c, is located at

(a) the leading edge

(b) $0.25c$

(c) $0.5c$

(d) $0.75c$

20. Winglets are used on wings to minimize

(a) skin friction drag

(b) profile drag

(c) wave drag

(d) induced drag

21. Consider a potential flow with free stream velocity V_∞, over a spinning circular cylinder of radius R and circulation Γ. The stream function ψ, where $\psi = 0$ on the cylinder surface, in cylindrical coordinates (r, θ) is given by

(a) $V_\infty r\left(1 - \frac{R^2}{r^2}\right)\cos\theta + \frac{\Gamma}{2\pi}\ln\frac{r}{R}$

(b) $V_\infty r\left(1 + \frac{R^2}{r^2}\right)\cos\theta + \frac{\Gamma}{2\pi}\ln\frac{r}{R}$

(c) $V_\infty r\left(1 - \frac{R^2}{r^2}\right)\sin\theta + \frac{\Gamma}{2\pi}\ln\frac{r}{R}$

(d) $V_\infty r\left(1 + \frac{R^2}{r^2}\right)\sin\theta + \frac{\Gamma}{2\pi}\ln\frac{r}{R}$

22. A main objective of by-pass in a turbo-fan engine is to increase

    (a) mass flow rate through engine inlet

    (b) turbine inlet temperature

    (c) mass flow rate through exhaust nozzle

    (d) compressor pressure ratio

23. The pressure ratio in any one stage of a jet engine compressor is limited by

    (a) entry stagnation temperature in that stage

    (b) entry Mach number in that stage

    (c) pressure-gradient-induced separation in that stage

    (d) mass flow rate in that stage

24. Thermodynamic cycle on which the jet engine operates can be

    (a) open Rankine cycle only

    (b) either open or closed Rankine cycle

    (c) open Brayton cycle only

    (d) either open or closed Brayton cycle

25. Propulsion efficiency of a jet engine is

    (a) directly proportional to both the thrust power and the air mass flow rate

    (b) inversely proportional to both the thrust power and the air mass flow rate

    (c) directly proportional to the thrust power and inversely proportional to the air mass flow rate

    (d) inversely proportional to the thrust power and directly proportional to the air mass flow rate

Q.26 – Q.55 carry two marks each.
Questions Q.26 to Q.30 are numerical answer type. The answer to each of these questions is either a positive whole number, or a positive real number with maximum of 2 decimal places.

26. Consider a cantilever beam having length $L = 1\ m$, square cross-section (width = depth = 0.01 m) and Young's modulus $50\ GPa$. The beam is subjected to a transverse load $P = 1\ N$ at the mid-span ($L/2$) at the center of the cross-section. Under the small deformation theory, the transverse deflection of the beam (in mm) at its free-end is _____.
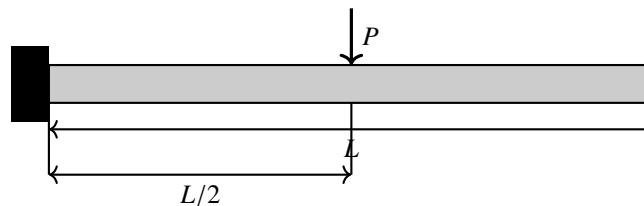

Figure 3

27. Consider a beam in bending with a solid circular cross-section of 1 mm², which is subjected to a transverse shear force of 1 N. The shear stress at the center of the cross-section (in N/mm²) is _____.

28. A simply supported slender column of square cross section (width = depth = d) has to be designed such that it buckles at the same instant as it yields. Length of the column is 1.57 m and it is made of a material whose Young's modulus is 200 GPa and yield stress is 240 MPa. The width, d, of the column (in cm) should be _____.

29. A turbojet powered aircraft is flying at Mach number 0.8 at an altitude of 10 km. The inlet and exit areas of the engine are 0.7 m^2 and 0.4 m^2 respectively. The exhaust gases have velocity of 500 m/s and pressure of 60 kPa. The free stream pressure, density and speed of sound are 26.5 kPa, 0.413 kg/m^3 and 299.5 m/s respectively. The thrust of the engine (in kN) is _____.

30. A low speed wind tunnel has a contraction ratio of 14:1 and the cross-sectional area of the test section is 1 m^2. The static pressure difference between the settling chamber and the test section is 40 cm of water column. Assume $g = 9.81$ m/s^2, $\rho_{air} = 1.2$ kg/m^3 and $\rho_{water} = 1000$ kg/m^3. The speed of air in the test section (in m/s) is _____.

Questions Q.31 to Q.55 are multiple choice type.

31. Consider the function $f(x) = x - \sin x$. The Newton–Raphson iteration formula to find the root of the function starting from an initial guess $x^{(0)}$ at iteration k is

(a) $x^{(k+1)} = \frac{\sin x^{(k)} - x^{(k)} \cos x^{(k)}}{1 - \cos x^{(k)}}$

(b) $x^{(k+1)} = \frac{\sin x^{(k)} - x^{(k)} \cos x^{(k)}}{1 + \cos x^{(k)}}$

(c) $x^{(k+1)} = \frac{\sin x^{(k)} + x^{(k)} \cos x^{(k)}}{1 - \cos x^{(k)}}$

(d) $x^{(k+1)} = \frac{\sin x^{(k)} + x^{(k)} \cos x^{(k)}}{1 + \cos x^{(k)}}$

32. Consider the matrix $\begin{pmatrix} a & 2 \\ b & 2 \end{pmatrix}$ where a and b are real numbers. The two eigenvalues of this matrix λ_1 and λ_2 are real and distinct ($\lambda_1 \neq \lambda_2$) when

(a) $a > 0$ and $b < 0$ (b) $a > 0$ and $b > 0$ (c) $a < 0$ and $b < 0$ (d) $a = 0$ and $b = 0$

33. The solution of $\frac{dy}{dt} = y^3 e^t t^2$ with initial condition $y(0) = 1$ is given by

(a) $\frac{1}{9} e^t (t + 3)^2$

(b) $\sqrt{\frac{9}{5 + 2e^t(t^2 - 2t + 2)}}$

(c) $\frac{4e^t}{(t+2)^2}$

(d) $\sqrt{\frac{1}{5 - 2e^t(t^2 - 2t + 2)}}$

34. A jet engine is operating at a Mach number of 0.8 at an altitude of 10 km. The efficiency of the air intake is 0.8 and that of the compressor is 0.87. The total temperatures (in K) at the exits of the air intake and the compressor respectively are (Ambient pressure = 26.5 kPa; Ambient temperature = 223.3 K; $\gamma = 1.4$)

(a) 251.9 and 458.2   (b) 234.9 and 486.8   (c) 251.9 and 486.8   (d) 234.9 and 458.2

35. A rocket engine is tested on a test bed under the ideal condition of fully expanded jet. The exhaust velocity is 2000 m/s through a nozzle of area 2.5 m^2. The mass flow rate is 200 kg/s. The specific impulse of the propellant and the thrust developed respectively are (assume $g = 9.81$ m/s^2)

(a) 175.87 s and 200 kN

(b) 203.87 s and 400 kN

(c) 231.87 s and 200 kN

(d) 203.87 s and 200 kN

36. A body undergoes deformation under plane strain conditions when subjected to the following stresses (in MPa): $\sigma_{xx} = 450$, $\sigma_{yy} = 450$, $\tau_{xy} = 75$, $\tau_{xz} = 0$, $\tau_{yz} = 0$. What are the remaining components of stresses (in MPa) and strains? Assume the material to be isotropic and linear-elastic with Young's modulus $E = 200$ GPa and Poisson's ratio $\nu = 1/3$.

(a) $\sigma_{zz} = 0$, $\epsilon_{xx} = 0.00225$, $\epsilon_{yy} = 0.00225$, $\gamma_{xy} = 0.0020$, $\gamma_{xz} = 0$, $\gamma_{yz} = 0$

(b) $\sigma_{zz} = 300$, $\epsilon_{xx} = 0.001$, $\epsilon_{yy} = 0.001$, $\gamma_{xy} = 0.001$, $\gamma_{xz} = 0$, $\gamma_{yz} = 0$

(c) $\sigma_{zz} = 300$, $\epsilon_{xx} = 0.00225$, $\epsilon_{yy} = 0.00225$, $\gamma_{xy} = 0.001$, $\gamma_{xz} = 0$, $\gamma_{yz} = 0$

(d) $\sigma_{zz} = 0$, $\epsilon_{xx} = 0.001$, $\epsilon_{yy} = 0.001$, $\gamma_{xy} = 0.002$, $\gamma_{xz} = 0$, $\gamma_{yz} = 0$

37. Which of the following Airy's stress functions could satisfy the given boundary conditions, assuming constant values of $\sigma_{xx} = P$, $\sigma_{yy} = Q$ and $\tau_{xy} = R$, along the boundary?
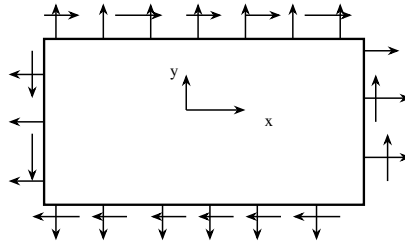

Figure 4

(a) $\phi = \frac{P}{2}x^2 + \frac{Q}{2}y^2 - Rxy$

(b) $\phi = \frac{P}{2}y^2 + \frac{Q}{2}x^2 + Rxy$

(c) $\phi = \frac{P}{2}y^2 + \frac{Q}{2}x^2 - Rxy$

(d) $\phi = \frac{P}{2}x^2 + \frac{Q}{2}y^2 + Rxy$

38. An aircraft is performing a coordinated turn manoeuvre at a bank angle of $30°$ and forward speed of 100 m/s. Assume $g = 9.81$ m s^{-2}. The load factor and turn radius respectively are

(a) $(2/\sqrt{3})$ and 1.76 km

(b) $\sqrt{3}$ and 17.6 km

(c) 2 and 0.18 km

(d) $(2/\sqrt{3})$ and 17.6 km

39. An aircraft in a steady level flight at forward speed of 50 m/s suddenly rolls by $180°$ and becomes inverted. If no other changes are made to the configuration or controls of the aircraft, the nature of the subsequent flight path taken by the aircraft and its characteristic parameter(s) are

(a) straight line path with a speed of 50 m/s

(b) upward circular path with a speed of 50 m/s and radius of 127.4 m

(c) downward circular path with a speed of 50 m/s and radius of 127.4 m

(d) downward circular path with a speed of 25 m/s and radius of 254.8 m

40. An aircraft with a mass of 5000 kg takes off from sea level with a forward speed of 50 m/s and starts to climb with a climb angle of $15°$. The rate of climb and excess thrust available at the start of the climb respectively are

(a) 13.40 m/s and 13146.0 N

(b) 12.94 m/s and 12694.1 N

(c) 13.40 m/s and 12694.1 N

(d) 12.94 m/s and 13146.0 N

41. A glider having a mass of 500 kg is taken to an altitude of 1000 m with a jeep moving on ground at 54 $kmph$. Upon reaching the required altitude in 50 s, the glider is released and starts its descent. Under the assumption of equilibrium glide, the range and endurance of the glider for a constant lift-to-drag ratio of 15 are

    (a) 15.0 km and 1002.2 s respectively

    (b) 15.0 km and 601.3 s respectively

    (c) 1.0 km and 601.3 s respectively

    (d) 1.0 km and 50 s respectively

42. An elliptic orbit has its perigee at 400 km above the Earth's surface and apogee at 3400 km above the Earth's surface. For this orbit, the eccentricity and semi-major axis respectively are (assume radius of Earth = 6400 km)

    (a) 0.18 and 8300 km

    (b) 0.18 and 1900 km

    (c) 0.22 and 8300 km

    (d) 0.22 and 1900 km

43. An aircraft in level flight encounters a vertical gust, which excites the phugoid mode. The phugoid motion completes 10 cycles in 50 s and its amplitude reduces to half of its maximum value in 25 s. The eigenvalues of the phugoid mode are

    (a) $-0.05 \pm 0.02i$

    (b) $-0.5 \pm 0.2i$

    (c) $-0.028 \pm 1.26i$

    (d) $0.028 \pm 1.26i$

44. Consider the inviscid, adiabatic flow of air at free stream conditions, $M_1 = 2$, $p_1 = 1$ atm and $T_1 = 288$ K around a sharp expansion corner ($\theta = 20°$). The Prandtl–Meyer function is $\nu(M) = \sqrt{\frac{\gamma-1}{\gamma+1}} \tan^{-1} \sqrt{\frac{\gamma-1}{\gamma+1}(M^2-1)} - \tan^{-1} \sqrt{M^2-1}$. Assume air to be calorically perfect with $\gamma = 1.4$. The Mach number, M_2, downstream of the expansion corner is approximately
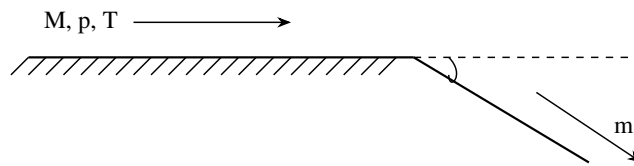
Figure 5

    (a) 2.00

    (b) 1.76

    (c) 2.83

    (d) 3.14

45. Consider a steady two-dimensional zero-pressure-gradient laminar flow of air over a flat plate. The free stream conditions are $U_\infty = 100$ m s^{-1}, $\rho_\infty = 1.2$ kg m^{-3}, $p_\infty = 1$ atm and $\mu_\infty = 1.8 \times 10^{-5}$ kg m^{-1} s^{-1}. The ratio of displacement thickness to momentum thickness of the boundary layer at a distance of 2 m from the leading edge is
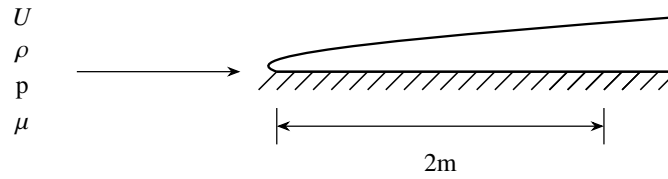
Figure 6

(a) 7.53   (b) 2.59   (c) 2.91   (d) 0.39

46. In the context of Prandtl's lifting line theory for a finite wing, which of the following combinations of statements is **TRUE**?
    P: The bound vortex is responsible for the lift force
    Q: The trailing vortices are responsible for the induced drag
    R: The bound vortex is responsible for the induced drag
    S: The trailing vortices are responsible for the lift force

    (a) P,Q   (b) Q,R   (c) R,S   (d) P,S

47. Consider flow over a thin aerofoil at Mach number $M_\infty = 0.5$ at an angle of attack α. Using the Prandtl–Glauert rule for compressibility correction, the formula for lift coefficient c_l can be written as

    (a) $4.54\,\alpha$ (b) $6.28\,\alpha$ (c) $7.26\,\alpha$ (d) $14.52\,\alpha$

Common Data Questions

Common Data Questions 48 and 49

The partial differential equation (PDE) governing free vibrations of a uniform Euler–Bernoulli beam is give by $\frac{\partial^2 w}{\partial t^2} + \frac{EI}{m}\frac{\partial^4 w}{\partial x^4} = 0$, where EI is the flexural stiffness, m is the mass per unit length, $w(x,t)$ is the bending displacement, x is the coordinate along the beam length, t is time and L is the beam length.
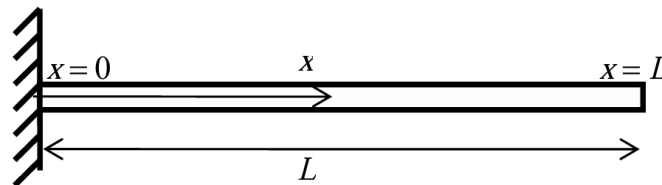

Figure 7

48. To solve the PDE, the number of boundary conditions (BC) and initial conditions (IC) needed are

(a) 4 BC, 3 IC   (b) 2 BC, 2 IC   (c) 2 BC, 4 IC   (d) 4 BC, 2 IC

49. For a cantilever beam, which of the following **CANNOT** be a possible boundary condition?

    (a) $w(0, t) = 0$ (b) $\frac{\partial^2 w}{\partial x^2}(L, t) = 0$ (c) $\frac{\partial^2 w}{\partial x^2}(0, t) = 0$ (d) $\frac{\partial^3 w}{\partial x^3}(L, t) = 0$

Common Data questions 50 and 51

Consider an inviscid, adiabatic flow of air at free stream Mach number $M_\infty = 2$, across a compression corner ($\theta = 20°$). The free stream total enthalpy is $h_{0\infty} = 810$ kJ/kg. Assume that air is calorically perfect wit $\gamma = 1.4, R = 287 \; Jkg^{-1}K^{-1}$.

50. The shock angle β is

    (a) $= 20°$ (b) $> 20°$ and $< 30°$ (c) $= 30°$ (d) $> 30°$

51. The total temperature at point P is

    (a) 806.37 K   (b) 1128.92 K   (c) 1612.74 K   (d) 2257.84 K

Linked Answer Questions

Statement for Linked Answer Questions 52 and 53:

A thin-walled (thickness $<<$ radius), hollow shaft of length 1m and mean radius, $R = 5$ cm has to be designed such that it can transmit a torque, $T = 7$ kN-m. A survey of different commercially available materials was made and following data was obtained from the suppliers (E: Young's modulus, τ_y: yield stress in shear, ρ: density):

Material	E (GPa)	τ_y (MPa)	ρ (kg/m^3)
X	200	550	7700
Y	70	225	2700
Z	110	375	4875

Figure 8

52. Which of the above materials would you choose such that weight of the shaft is minimum?

    (a) X only   (b) Y only   (c) Z only   (d) X or Y

53. If you assume a factor of safety of 2, what should be the approximate thickness of such a shaft?

    (a) 0.5 mm   (b) 1 mm   (c) 2 mm   (d) 4 mm

Statement for Linked Answer Questions 54 and 55:

Prandtl's lifting line equation for a general wing is given by $\alpha(y_o) = \frac{\Gamma(y_o)}{\pi U_\infty c(y_o)} + \alpha_{L=0}(y_o) + \frac{1}{4\pi U_\infty} \int_{\frac{-b}{2}}^{\frac{b}{2}} \frac{(\delta\Gamma/\delta y)}{y_o - y} dy$, where U_∞ is the free-stream velocity, α is the angle of attack, $\Gamma_\alpha = \frac{\partial\Gamma}{\partial\alpha}$ is the angle of attack, y_o is the spanwise location, $\alpha_{L=0}(y_o)$ gives the spanwise variation of zero-lift angle, c is the chord, b is the span, and $\Gamma(y_o)$ gives the spanwise variation of circulation.

54. The rate of change of circulation with angle of attack $\Gamma_\alpha = \frac{\delta\Gamma}{\delta\alpha}$ is

(a) inversely proportional to α

(c) a linear function of α

(b) independent of α

(d) a quadratic function of α

55. Given that $C_L \propto \int_{-b/2}^{b/2} \Gamma(y)\,dy$, the corresponding lift curve-slope $\frac{\partial C_L}{\partial \alpha}$ is

(a) independent of α

(c) a quadratic function of α

(b) a linear function of α

(d) a cubic function of α

General Aptitude (GA) Questions

Q.56 - Q.60 carry one mark each.

56. Choose the word from the options given below that is most nearly opposite in meaning to the given word: **Deference**

(a) aversion

(b) resignation

(c) suspicion

(d) contempt

57. Choose the most appropriate word(s) to complete the sentence: **We lost confidence in him because he never _____ the grandiose promises he had made.**

(a) delivered

(b) delivered on

(c) forgot

(d) reneged on

58. Choose the word or phrase that best completes the sentence: **_____ in the frozen wastes of Arctic takes special equipment.**

(a) To survive

(b) Surviving

(c) Survival

(d) That survival

59. In how many ways 3 scholarships can be awarded to 4 applicants, when each applicant can receive any number of scholarships?

(a) 4   (b) 12   (c) 64   (d) 81

60. Choose the most appropriate word to complete the sentence: **The _____ of evidence was on the side of the plaintiff since all but one witness testified that his story was correct.**

(a) paucity

(b) propensity

(c) preponderance

(d) accuracy

Q. 61 to Q. 65 carry two marks each.

61. If $(2y+1)/(y+2) < 1$, which alternative gives the **CORRECT** range of y?

(a) $-2 < y < 2$ (b) $-2 < y < 1$ (c) $-3 < y < 1$ (d) $-4 < y < 1$

62. A student attempted to solve a quadratic equation in x twice. In the first attempt he incorrectly wrote the constant term and got roots $(4, 3)$. In the second attempt he incorrectly wrote the coefficient of x and got roots $(3, 2)$. The roots of the correct quadratic equation are

    (a) $(-3, 4)$ (b) $(3, -4)$ (c) $(6, 1)$ (d) $(4, 2)$

63. L, M and N are waiting in a queue meant for children to enter the zoo. There are 5 children between L and M, and 8 children between M and N. If there are 3 children ahead of N and 21 children behind L, then what is the minimum number of children in the queue?

    (a) 28   (b) 27   (c) 41   (d) 40

64. Four archers P, Q, R and S try to hit a bull's eye during a tournament consisting of seven rounds. As illustrated, a player receives 10 points for the bull's eye, 5 points for the inner circle and 1 point for the outer circle.
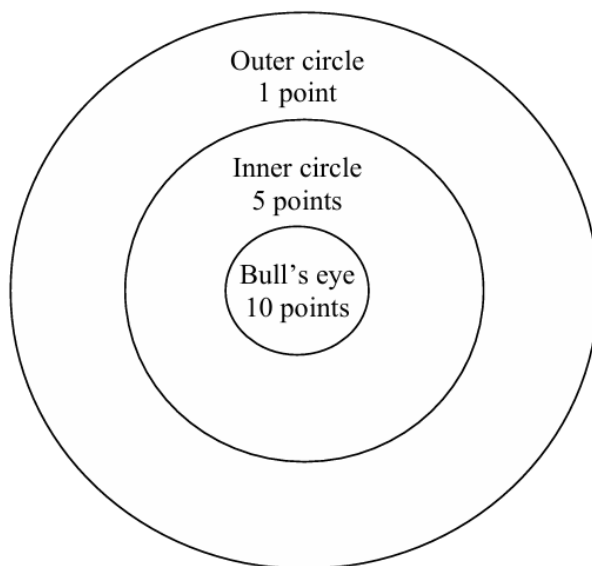

Figure 9

The final scores received by the players during the tournament are listed in the table below.

Round	P	Q	R	S
1	1	5	1	10
2	5	10	10	1
3	1	1	1	5
4	10	10	1	1
5	1	5	5	10
6	10	5	1	1
7	5	10	1	1

Figure 10

The most accurate and the most consistent players during the tournament are respectively

(a) P and S   (b) Q and R   (c) Q and Q   (d) R and Q

65. **Nimbus clouds are dark and ragged, stratus clouds appear dull and cover the entire sky. Cirrus clouds are thin and delicate, whereas cumulus clouds look like cotton balls.**

It can be inferred that

(a) A cumulus cloud on the ground is called fog

(b) It is easy to predict the weather by studying clouds

(c) Clouds are generally of very different shapes, sizes and mass

(d) There are four basic cloud types: stratus, nimbus, cumulus and cirrus

END OF THE QUESTION PAPER