AE:AEROSPACE ENGINEERING

Duration: Three Hours *Maximum Marks*:100

Please read the following instructions carefully:

General Instructions:

1. Total duration of examination is 180 minutes (3 hours).

2. The clock will be set at the server. The countdown timer in the top right corner of screen will display the remaining time available for you to complete the examination. When the timer reaches zero, the examination will end by itself. You will not be required to end or submit your examination.

3. The Question Palette displayed on the right side of screen will show the status of each question using one of the following symbols:

You have not visited the question yet.

You have not answered the question.

You have answered the question.

You have NOT answered the question, but have marked the question for review.

You have answered the question, but marked it for review.

The Marked for Review status for a question simply indicates that you would like to look at that question again. ***If a question is answered and Marked for Review, your answer for that question will be considered in the evaluation.***

Navigating to a Question

4. To answer a question, do the following:

   a. Click on the question number in the Question Palette to go to that question directly.
   b. Select an answer for a multiple choice type question. Use the virtual numeric keypad to enter a number as answer for a numerical type question.
   c. Click on **Save and Next** to save your answer for the current question and then go to the next question.
   d. Click on **Mark for Review and Next** to save your answer for the current question, mark it for review, and then go to the next question.
   e. **Caution: Note that your answer for the current question will not be saved, if you navigate to another question directly by clicking on its question number.**

5. You can view all the questions by clicking on the **Question Paper** button. Note that the options for multiple choice type questions will not be shown.

Answering a Question

6. Procedure for answering a multiple choice type question:
    a. To select your answer, click on the button of one of the options
    b. To deselect your chosen answer, click on the button of the chosen option again or click on the **Clear Response** button
    c. To change your chosen answer, click on the button of another option
    d. To save your answer, you MUST click on the **Save and Next** button
    e. To mark the question for review, click on the **Mark for Review and Next**button**.** ***If an answer is selected for a question that is Marked for Review, that answer will be considered in the evaluation.***

7. Procedure for answering a numerical answer type question:
    a. To enter a number as your answer, use the virtual numerical keypad
    b. A fraction (eg.,-0.3 or -.3) can be entered as an answer with or without '0' before the decimal point
    c. To clear your answer, click on the **Clear Response** button
    d. To save your answer, you MUST click on the **Save and Next**button
    e. To mark the question for review, click on the **Mark for Review and Next**button**.** ***If an answer is entered for a question that is Marked for Review, that answer will be considered in the evaluation.***

8. To change your answer to a question that has already been answered, first select that question for answering and then follow the procedure for answering that type of question.

9. Note that ONLY Questions for which answers are saved or marked for review after answering will be considered for evaluation.

Paper specific instructions:

1. There are a total of 65 questions carrying 100 marks. Questions are of multiple choice type or numerical answer type. A multiple choice type question will have four choices for the answer with only **one** correct choice. For numerical answer type questions, the answer is a number and no choices will be given**. A number as the answer should be entered** using the virtual keyboard on the monitor.
2. Questions Q.1 – Q.25 carry 1mark each. Questions Q.26 – Q.55 carry 2marks each. The 2marks questions include two pairs of common data questions and two pairs of 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 not attempted, then the answer to the second question in the pair will not be evaluated.
3. Questions Q.56 – Q.65 belong to General Aptitude (GA) section and carry a total of 15 marks. Questions Q.56 – Q.60 carry 1mark each, and questions Q.61 – Q.65 carry 2marks each.
4. Questions not attempted will result in zero mark. Wrong answers for multiple choice type questions will result in **NEGATIVE** marks. For all 1 mark questions, ⅓ mark will be deducted for each wrong answer. For all 2 marks questions, ⅔ mark will be deducted for each wrong answer. However, in the case of the linked answer question pair, there will be negative marks only for wrong answer to the first question and no negative marks for wrong answer to the second question. There is no negative marking for questions of numerical answer type.
5. Calculator is allowed. Charts, graph sheets or tables are **NOT** allowed in the examination hall.
6. Do the rough work in the Scribble Pad provided.

Q. 1 – Q. 25 carry one mark each.

Q.1 The directional derivative of the function $f(x,y)=\frac{x^2+xy^2}{\sqrt{5}}$ in the direction $\vec{a}=2\hat{i}-4\hat{j}$ at $(x,y)=(1,1)$ is

(A) $-\frac{1}{\sqrt{5}}$ (B) $-\frac{2}{\sqrt{5}}$ (C) 0 (D) $-\frac{1}{5}$

Q.2 The value of $\int_4^5 \frac{x+2}{x^2+4x-21}dx$ is

(A) $\ln\sqrt{24/11}$ (B) $\ln\sqrt{12/11}$ (C) $\ln\sqrt{2}$ (D) $\ln(12/11)$

Q.3 At $x=0$, the function $y=|x|$ is

(A) continuous but not differentiable
(B) continuous and differentiable
(C) not continuous but differentiable
(D) not continuous and not differentiable

Q.4 One of the eigenvectors of the matrix

$$A=\begin{pmatrix}1 & -1 & 0\\ 0 & 1 & -1\\ -1 & 0 & 1\end{pmatrix} \text{ is } v=\begin{bmatrix}1\\1\\1\end{bmatrix}.$$

The corresponding eigenvalue is _____

Q.5 Which one of the following is the most stable configuration of an airplane in roll?

(A) Sweep back, anhedral and low wing
(B) Sweep forward, dihedral and low wing
(C) Sweep forward, anhedral and high wing
(D) Sweep back, dihedral and high wing

Q.6 Which one of the following flight instruments is used on an aircraft to determine its attitude in flight?

(A) Vertical speed indicator

(B) Altimeter

(C) Artificial Horizon

(D) Turn-bank indicator

Q.7 A supersonic airplane is expected to fly at both subsonic and supersonic speeds during its whole flight course. Which one of the following statements is TRUE?

(A) Airplane will experience less stability in pitch at supersonic speeds than at subsonic speeds

(B) Airplane will feel no change in pitch stability

(C) Airplane will experience more stability in pitch at supersonic speeds than at subsonic speeds

(D) Pitch stability cannot be inferred from the information given

Q.8 Which one of the following is favorable for an airplane operation?

(A) Tail wind in cruise and head wind in landing

(B) Tail wind both in cruise and landing

(C) Head wind both in cruise and landing

(D) Head wind in cruise and tail wind in landing

Q.9 Which one of the following is TRUE with respect to Phugoid mode of an aircraft?

(A) Frequency is directly proportional to flight speed

(B) Frequency is inversely proportional to flight speed

(C) Frequency is directly proportional to the square root of flight speed

(D) Frequency is inversely proportional to the square root of flight speed

Q.10 The x and y velocity components of a two dimensional flow field are, $u = \frac{cy}{x^2 + y^2}, v = \frac{cx}{x^2 + y^2}$, where c is a constant. The streamlines are a family of

(A) hyperbolas (B) parabolas (C) ellipses (D) circles

Q.11 Which one of the following statements is NOT TRUE for a supersonic flow?

(A) Over a gradual expansion, entropy remains constant

(B) Over a sharp expansion corner, entropy can increase

(C) Over a gradual compression, entropy can remain constant

(D) Over a sharp compression corner, entropy increases

Q.12 Consider a compressible flow where an elemental volume of the fluid is $\delta\vartheta$, moving with velocity $\vec{V}$. Which one of the following expressions is TRUE?

(A) $\nabla \cdot \vec{V} = \frac{1}{\delta\vartheta}\frac{D\delta\vartheta}{Dt}$

(B) $\nabla \cdot (\nabla \times \vec{V}) = \frac{1}{\delta\vartheta}\frac{D\delta\vartheta}{Dt}$

(C) $\nabla \cdot \frac{D\vec{V}}{Dt} = \frac{1}{\delta\vartheta}\frac{D\delta\vartheta}{Dt}$

(D) $\vec{V} \cdot (\nabla \times \vec{V}) = \frac{1}{\delta\vartheta}\frac{D\delta\vartheta}{Dt}$

Q.13 Consider a thin flat plate airfoil at a small angle α to an oncoming supersonic stream of air. Assuming the flow to be inviscid, $\frac{C_d}{C_l^2}$ is

(A) zero

(B) independent of α

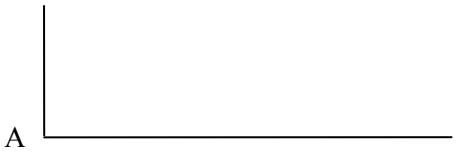
(C) proportional to α

(D) proportional to α^2

Q.14 The critical Mach number for a flat plate of zero thickness, at zero angle of attack, is _____

Q.15 A damped single degree-of-freedom system is vibrating under a harmonic excitation with an amplitude ratio of 2.5 at resonance. The damping ratio of the system is _____

Q.16 The cross-section of a long thin-walled member is as shown in the figure. When subjected to pure twist, point A



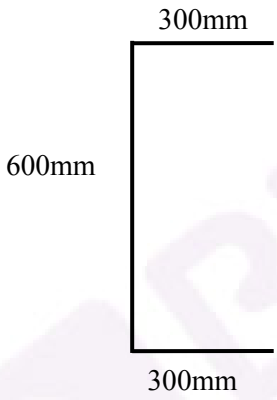
(A) does not move horizontally or axially, but moves vertically

(B) does not move axially, but moves both vertically and horizontally

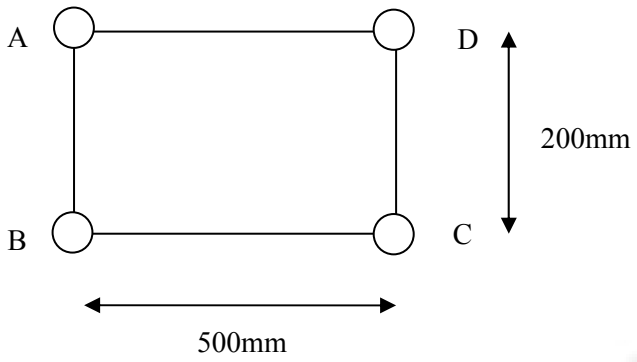
(C) does not move horizontally, vertically or axially

(D) does not move vertically or axially, but moves horizontally

Q.17 The channel section of uniform thickness 2mm shown in the figure is subjected to a torque of 10 Nm. If it is made of a material with shear modulus of 25 GPa, the twist per unit length in radians/m is _____



Q.18 The stiffened cross-section of a long slender uniform structural member is idealized as shown in the figure below. The lumped areas at A, B, C and D have equal cross-sectional area of 3 cm^2. The webs AB, BC, CD and DA are each 5 mm thick. The structural member is subjected to a twisting moment of 10 kNm. The magnitudes of the shear flow in the webs, q_{AB}, q_{BC}, q_{CD}, and q_{DA} in kN/m are, respectively



(A) 20, 20, 20, 20

(B) 0, 0, 50, 50

(C) 40, 40, 0, 0

(D) 50, 50, 50, 50

Q.19 Consider two engines P and Q. In P, the high pressure turbine blades are cooled with a bleed of 5% from the compressor after the compression process and in Q the turbine blades are not cooled. Comparing engine P with engine Q, which one of the following is NOT TRUE?

(A) Turbine inlet temperature is higher for engine P

(B) Specific thrust is higher for engine P

(C) Compressor work is the same for both P and Q

(D) Fuel flow rate is lower for engine P

Q.20 The mass flow rate of air through an aircraft engine is 10 kg/s. The compressor outlet temperature is 400 K and the turbine inlet temperature is 1800 K. The heating value of the fuel is 42 MJ/kg and the specific heat at constant pressure is 1 kJ/kg-K. The mass flow rate of the fuel in kg/s is approximately _____

Q.21 For a given inlet condition, if the turbine inlet temperature is fixed, what value of compressor efficiency given below leads to the lowest amount of fuel added in the combustor of a gas turbine engine?

(A) 1 (B) 0.95 (C) 0.85 (D) 0.8

Q.22 A gas turbine engine is mounted on an aircraft which can attain a maximum altitude of 11 km from sea level. The combustor volume of this engine is decided based on conditions at

(A) sea level (B) 8 km altitude (C) 5.5 km altitude (D) 11 km altitude

Q.23 Consider the low earth orbit (LEO) and the geo synchronous orbit (GSO). Then

(A) ΔV requirement for launch to LEO is greater than that for GSO, and altitude of LEO is lower than that of GSO

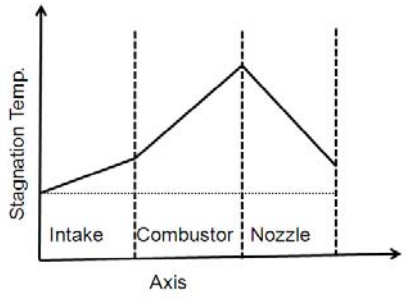
(B) ΔV requirement for launch to LEO is lower than that for GSO, and altitude of LEO is lower than that of GSO

(C) ΔV requirement for launch to LEO is greater than that for GSO, and altitude of LEO is greater than that of GSO

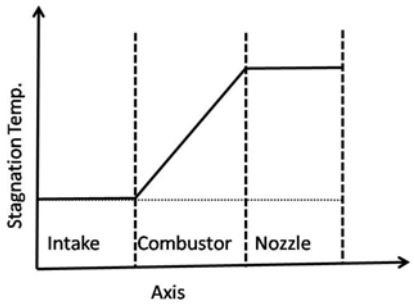
(D) ΔV requirement for launch to LEO is lower than that for GSO, and altitude of LEO is greater than that of GSO

Q.24 Which one of the following shows the CORRECT variation of stagnation temperature along the axis of an ideal ram jet engine?

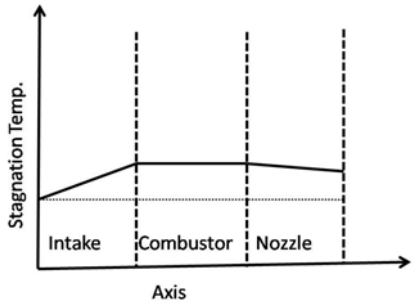
(A)



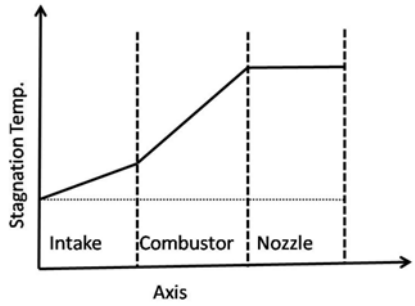
(B)



(C)



(D)



Q.25 A rocket motor has a chamber pressure of 100 bar and chamber temperature of 3000 K. The ambient pressure is 1 bar. Assume that the specific heat at constant pressure is 1 kJ/kg-K. Also assume that the flow in the nozzle is isentropic and optimally expanded. The exit static temperature in K is

(A) 805 (B) 845 (C) 905 (D) 945

Q. 26 to Q. 55 carry two marks each.

Q.26 Let $I = \iint_S (y^2 z\hat{i} + z^2 x\hat{j} + x^2 y\hat{k}) \cdot (x\hat{i} + y\hat{j} + z\hat{k}) dS$, where S denotes the surface of the sphere of unit radius centered at the origin. Here $\hat{i}, \hat{j}$ and $\hat{k}$ denote three orthogonal unit vectors. The value of I is

_____

Q.27 Given that the Laplace transform, $\mathcal{L}(e^{at}) = \frac{1}{s-a}$ then $\mathcal{L}\left(3e^{5t}\sinh 5t\right) =$

(A) $\frac{3s}{s^2 - 10s}$ (B) $\frac{15}{s^2 - 10s}$ (C) $\frac{3s}{s^2 + 10s}$ (D) $\frac{15}{s^2 + 10s}$

Q.28 Values of a, b and c, which render the matrix

$$Q = \begin{bmatrix} \frac{1}{\sqrt{3}} & \frac{1}{\sqrt{2}} & a \\ \frac{1}{\sqrt{3}} & 0 & b \\ \frac{1}{\sqrt{3}} & -\frac{1}{\sqrt{2}} & c \end{bmatrix}$$

orthonormal are, respectively

(A) $\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}, 0$

(B) $\frac{1}{\sqrt{6}}, -\frac{2}{\sqrt{6}}, \frac{1}{\sqrt{6}}$

(C) $-\frac{1}{\sqrt{3}}, -\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}$

(D) $-\frac{1}{\sqrt{6}}, \frac{2}{\sqrt{6}}, -\frac{1}{\sqrt{6}}$

Q.29 A function $y(t)$ satisfies the differential equation $\frac{d^2y}{dt^2} - 2\frac{dy}{dt} + y = 0$ and is subject to the initial conditions $y(t=0) = 0$ and $\frac{dy}{dt}(t=0) = 1$. The value of $y(t=1)$ is

(A) e (B) 0 (C) 1 (D) -1

Q.30 A glider is launched from a 500m high hilltop. Following data is available for the glider: Zero lift drag coefficient $C_{D0} = 0.02$, aspect ratio $AR = 10$ and Oswald efficiency factor $e = 0.95$. The maximum range of the glider in km is _____

Q.31 Which one of the following criteria leads to maximum turn rate and minimum radius in a level turn flight?

(A) Highest possible load factor and highest possible velocity

(B) Lowest possible load factor and lowest possible velocity

(C) Highest possible load factor and lowest possible velocity

(D) Lowest possible load factor and highest possible velocity

Q.32 Consider an airplane with rectangular straight wing at dihedral angle $\Gamma = 10^0$. Lift curve slope of wing airfoil section (constant over the whole span of the wing) is $c_{l\alpha} = 5.4/rad$. The roll stability derivative, $C_{l\beta}$ in per radian is _____

Q.33 Consider one-dimensional isentropic flow at a Mach number of 0.5. If the area of cross-section of a streamtube increases by 3% somewhere along the flow, the corresponding percentage change in density is _____

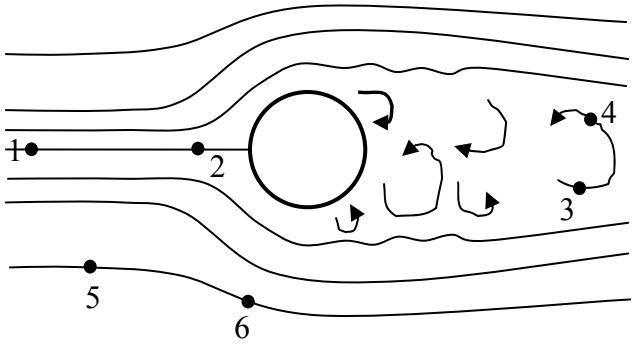
Q.34 The potential flow model for a storm is represented by the superposition of a sink and a vortex. The stream function can be written in the (r, θ) system as $\psi = -\frac{\Lambda}{2\pi}\theta + \frac{\Gamma}{2\pi}\ln r$, where $\Lambda = \Gamma = 100$ m^2/s. Assume a constant air density of 1.2 kg/m^3. The gauge pressure at a distance of 100 m from the storm eye is

(A) $-\infty$ (B) $-\frac{1.2}{\pi^2}$ (C) $-\frac{1.2}{2\pi^2}$ (D) $-\frac{1.2}{4\pi^2}$

Q.35 Three identical eagles of wing span s are flying side by side in a straight line with no gap between their wing tips. Assume a single horse shoe vortex model (of equal strength Γ) for each bird. The net downwash experienced by the middle bird is

(A) $\frac{\Gamma}{\pi s}$ (B) $\frac{\Gamma}{2\pi s}$ (C) $\frac{\Gamma}{3\pi s}$ (D) $\frac{4\Gamma}{3\pi s}$

Q.36 Streamline pattern of flow past a cylinder is shown in the figure below. The oncoming flow is steady, irrotational and incompressible. The flow is from left to right. Bernoulli's equation CANNOT be applied between the points



(A) 1 and 2 (B) 1 and 5 (C) 3 and 4 (D) 5 and 6

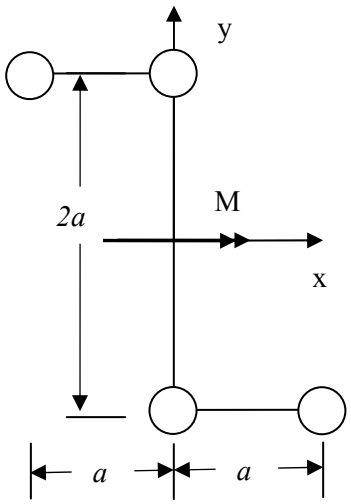
Q.37 Consider a supersonic stream at a Mach number M=2, undergoing a gradual expansion. The stream is turned by an angle of 3 degrees due to the expansion. The following data is given.

M	ν (Prandtl-Meyer function)
1.8	20.73
1.9	23.59
2.0	26.38
2.1	29.10
2.2	31.73
2.3	34.28
2.4	36.75

The Mach number downstream of the expansion is

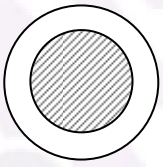
(A) 1.88 (B) 2.00 (C) 2.11 (D) 2.33

Q.38 The idealized cross-section of a beam is comprised of four identical booms connected by shear webs. The beam is subjected to a bending moment M as shown in the figure. The inclination of the neutral axis to the x-axis in degrees is



(A) 45 CW (B) 45 CCW (C) 26.6 CW (D) 63.4 CCW

Q.39 A composite circular shaft is comprised of a steel core surrounded by an aluminum annulus, perfectly bonded to each other as shown in the figure. If it subjected to a pure torque, which one of the following statements is TRUE?



(A) Only shear stress is continuous across the steel–aluminum interface

(B) Only shear strain is continuous across the steel–aluminum interface

(C) Both shear stress and shear strain are continuous across the steel–aluminum interface

(D) Both shear stress and shear strain are discontinuous across the steel–aluminum interface

Q.40 A horizontal rectangular plate ABCD is hinged at points A, B and C. AC and BD are diagonals of the plate. Downward force P is applied at D. The upward reactions R_A, R_B, and R_C at points A, B and C, respectively, are

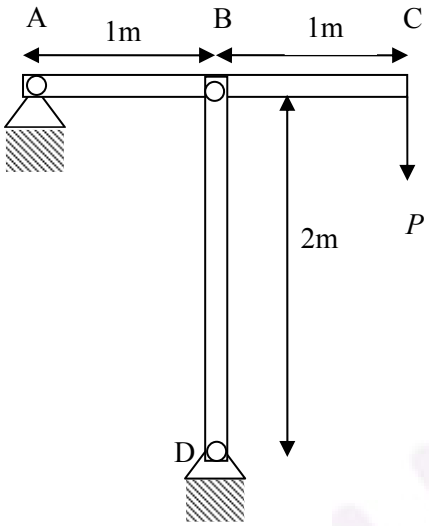
(A) indeterminate

(B) P, $-P$, P

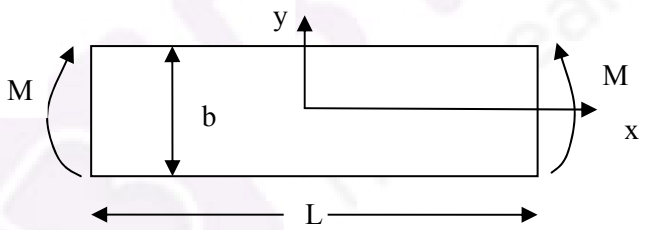
(C) 0, P, 0

(D) $P/3$, $P/3$, $P/3$

Q.41 In the steel structure (Young's modulus = 200 GPa) shown in the figure, all members have a circular cross-section of radius 10 mm. Column BD is pinned at B and D. The support at A is hinged. The minimum value of load P at which the column BD may buckle in *Newtons* is approximately _____



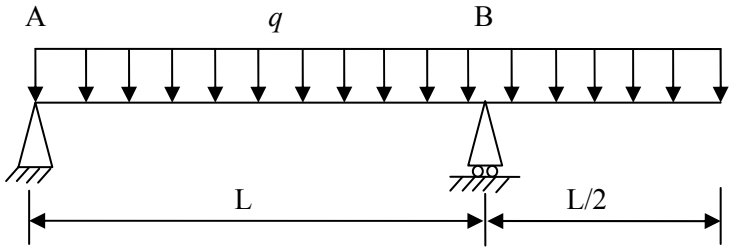
Q.42 The thin rectangular plate has dimensions $L \times b \times t$. It develops a stress field corresponding to an applied bending moment M as shown in the figure. A valid Airy's stress function is



(A) $\frac{2M}{tb^3}x^3$ (B) $\frac{2M}{tb^3}y^3$ (C) $\frac{2M}{tb^3}\left(x^3+y^3\right)$ (D) $\frac{2M}{tb^3}y^4$

Q.43 A cantilever beam of negligible mass is 0.6 m long. It has a rectangular cross-section of width 8 mm and thickness 6 mm and carries a tip mass of 1.4 kg. If the natural frequency of this system is 10 rad/s, Young's modulus of the material of the beam in GPa is _____

Q.44 A simply supported beam with overhang is loaded by uniformly distributed load of intensity q as shown in the figure. The bending moment at the mid-point of AB is



(A) $\frac{qL^2}{16}$ sagging (B) $\frac{qL^2}{16}$ hogging (C) $\frac{3qL^2}{16}$ hogging (D) $\frac{3qL^2}{16}$ sagging

Q.45 Thrust of liquid oxygen - liquid hydrogen rocket engine is 300 kN. The O/F ratio used is 5. If the fuel mass flow rate is 12.5 kg/s, the specific impulse of the rocket motor in Ns/kg is

(A) 3800 (B) 4000 (C) 4200 (D) 4400

Q.46 In a 50 % reaction axial compressor stage, the local blade velocity is 300 m/s and the axial component of velocity is 100 m/s. If the absolute inlet flow angle $\alpha_1 = 45^o$, the work per unit mass done on the fluid by the stage in kJ/kg is

(A) 30 (B) 40 (C) 50 (D) 60

Q.47 Consider two rockets P and Q fired vertically up with identical specific impulse and a payload of 2 kg. Rocket P has 2 identical stages, and each stage has 200 kg of propellant and 20 kg of structural weight. Rocket Q has a single stage with 400 kg of propellant and 40 kg of structural weight. Neglecting drag and gravity effects, the ratio of the change in velocity of P to that attained by Q is

(A) 1.13 (B) 1.23 (C) 1.33 (D) 1.43

Common Data Questions

Common Data for Questions 48 and 49: Data for an airplane are given as follows: weight $W = 30kN$, thrust available at sea-level $T_0 = 4000N$, wing planform area $S = 30m^2$, maximum lift coefficient $C_{L\max} = 1.4$, and drag coefficient $C_D = 0.015 + 0.024C_L^2$. Assume air density at sea-level $\rho_\infty = 1.22kg/m^3$.

Q.48 Stall speed of the airplane in m/s is

(A) 17.36 (B) 34.22 (C) 45.52 (D) 119.46

Q.49 Minimum and maximum speeds of the airplane in level flight condition at sea-level in m/s are respectively

(A) 17.36 and 180 (B) 17.36 and 34.22

(C) 34.22 and 119.46 (D) 17.36 and 119.46

Common Data for Questions 50 and 51: An aircraft is flying at Mach number M = 1.5, where the ambient temperature is 250 K. The stagnation temperature of gases at the entry to the nozzle is 800 K. The nozzle is choked and always under expanded. Assume the molecular weight of the exhaust gases to be 29, the ratio of specific heats to be 1.4 and the universal gas constant is 8314 J/kmol-K.

Q.50 For which one of the nozzle exit Mach numbers given below is the propulsive efficiency highest?

(A) 1

(B) 1.5

(C) 2

(D) 2.5

Q.51 For which one of the nozzle exit Mach numbers given below is the thrust highest?

(A) 1

(B) 1.5

(C) 2

(D) 2.5

Linked Answer Questions

Statement for Linked Answer Questions 52 and 53: Circulation theory of lift is assumed for a thin symmetric airfoil at an angle of attack α. Free stream velocity is U.

Q.52 If the circulation at the quarter chord ($c/4$) of the airfoil is Γ_1, the normal velocity is zero at

(A) $c/4$ (B) $c/2$ (C) $3c/4$ (D) all points on the chord

Q.53 A second identical airfoil is placed behind the first one at a distance of $c/2$ from the trailing edge of the first. The second airfoil has an unknown circulation Γ_2 placed at its quarter chord. The normal velocity becomes zero at the same chord-wise locations of the respective airfoils as in the previous question. The values of Γ_1 and Γ_2 are respectively

(A) $\frac{4}{3}\pi cU\alpha,\ \frac{2}{3}\pi cU\alpha$

(B) $\frac{2}{3}\pi cU\alpha,\ \frac{2}{3}\pi cU\alpha$

(C) $\frac{2}{3}\pi cU\alpha,\ \frac{1}{3}\pi cU\alpha$

(D) $\frac{4}{3}\pi cU\alpha,\ \frac{4}{3}\pi cU\alpha$

Statement for Linked Answer Questions 54 and 55: A wing-body alone configuration airplane with a wing loading of $W/S = 1000 N/m^2$ is flying in cruise condition at a speed $V = 90 m/s$ at sea-level (air density at sea-level $\rho_\infty = 1.22 kg/m^3$). The zero lift pitching moment coefficient of the airplane is $C_{mac}^{wb} = C_{m0} = -0.06$ and the location of airplane aerodynamic center from the wing leading edge is $X_{ac} = 0.25c$. Here c is the chord length.

Q.54 The airplane trim lift coefficient $C_{L\ trim}$ is

(A) 0.502 (B) 0.402 (C) 0.302 (D) 0.202

Q.55 Distance of center of gravity of the aircraft (X_{CG}) from the wing leading edge is

(A) $0.447c$ (B) $-0.547c$ (C) $0.547c$ (D) $-0.25c$

General Aptitude (GA) Questions

Q. 56 – Q. 60 carry one mark each.

Q.56 If $3 \leq X \leq 5$ and $8 \leq Y \leq 11$ then which of the following options is TRUE?

(A) $\frac{3}{5} \leq \frac{X}{Y} \leq \frac{8}{5}$

(B) $\frac{3}{11} \leq \frac{X}{Y} \leq \frac{5}{8}$

(C) $\frac{3}{11} \leq \frac{X}{Y} \leq \frac{8}{5}$

(D) $\frac{3}{5} \leq \frac{X}{Y} \leq \frac{8}{11}$

Q.57 The Headmaster _____ to speak to you.

Which of the following options is incorrect to complete the above sentence?

(A) is wanting

(B) wants

(C) want

(D) was wanting

Q.58 Mahatama Gandhi was known for his humility as

(A) he played an important role in humiliating exit of British from India.

(B) he worked for humanitarian causes.

(C) he displayed modesty in his interactions.

(D) he was a fine human being.

Q.59 All engineering students (I) should learn mechanics, (II) mathematics and (III) how to do computation (IV).

Which of the above underlined parts of the sentence is not appropriate?

(A) I (B) II (C) III (D) IV

Q.60 Select the pair that best expresses a relationship similar to that expressed in the pair: **water: pipe**::

(A) cart: road
(B) electricity: wire
(C) sea: beach
(D) music: instrument

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

Q.61 Velocity of an object fired directly in upward direction is given by $V = 80 - 32\,t$, where t (time) is in seconds. When will the velocity be between 32 m/sec and 64 m/sec?

(A) (1, 3/2)
(B) (1/2, 1)
(C) (1/2, 3/2)
(D) (1, 3)

Q.62 In a factory, two machines M1 and M2 manufacture 60% and 40% of the autocomponents respectively. Out of the total production, 2% of M1 and 3% of M2 are found to be defective. If a randomly drawn autocomponent from the combined lot is found defective, what is the probability that it was manufactured by M2?

(A) 0.35 (B) 0.45 (C) 0.5 (D) 0.4

Q.63 Following table gives data on tourists from different countries visiting India in the year 2011.

Country	Number of Tourists
USA	2000
England	3500
Germany	1200
Italy	1100
Japan	2400
Australia	2300
France	1000

Which two countries contributed to the one third of the total number of tourists who visited India in 2011?

(A) USA and Japan

(B) USA and Australia

(C) England and France

(D) Japan and Australia

Q.64 If $|-2X + 9| = 3$ then the possible value of $|-X| - X^2$ would be:

(A) 30 (B) -30 (C) -42 (D) 42

Q.65 All professors are researchers
Some scientists are professors

Which of the given conclusions is logically valid and is inferred from the above arguments:

(A) All scientists are researchers

(B) All professors are scientists

(C) Some researchers are scientists

(D) No conclusion follows

END OF THE QUESTION PAPER