AE - 2013

EE25BTECH11048 - Revanth Siva Kumar.D

1) The directional derivative of the function

$$f(x,y) = \frac{x^2 + xy^2}{\sqrt{5}}$$

in the direction

$$d = 2\hat{i} - 4\hat{j}$$

at (x, y) = (1, 1) is .

(GATE AE 2013)

a)
$$-\frac{1}{\sqrt{5}}$$
 b) $-\frac{2}{\sqrt{5}}$

c) 0 d)
$$-\frac{1}{3}$$

$$\int \frac{x+2}{x^2+4x-21} dx$$

is _____

(GATE AE 2013)

a)
$$\ln \sqrt{24/11}$$

c)
$$\ln \sqrt{2}$$

b)
$$\ln \sqrt{12/11}$$

d) ln(12/11)

3) At
$$x = 0$$
, the function $y = |x|$ is _____

(GATE AE 2013)

- a) continuous but not differentiable
- b) continuous and differentiable
- c) not continuous but differentiable
- d) not continuous and not differentiable
- 4) One of the eigenvectors of the matrix

$$A = \begin{pmatrix} 1 & -1 & 0 \\ 0 & 1 & -1 \\ -1 & 0 & 1 \end{pmatrix}$$

is

$$v = \begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}.$$

The corresponding eigenvalue is ______. (GATE AE 2013)

- 5) Which one of the following is the most stable configuration of an airplane in roll? (GATE AE 2013)
 - 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
- 6) Which one of the following flight instruments is used on an aircraft to determine its attitude in flight? _____

a) Vertical speed indicatorb) Altimeter	c) Artificial Horizond) Turn-bank indicator
7) A supersonic airplane is expected to fly at both s flight course. Which one of the following statem	ents is TRUE?
	(GATE AE 2013)
a) Airplane will experience less stability in pitchb) Airplane will feel no change in pitch stabilityc) Airplane will experience more stability in pitchd) Pitch stability cannot be inferred from the infer	h at supersonic speeds than at subsonic speeds
8) Which one of the following is favorable for an a	_
of which one of the following is favorable for an a	(GATE AE 2013)
a) Tail wind in cruise and head wind in landingb) Tail wind both in cruise and landingc) Head wind both in cruise and landingd) Head wind in cruise and tail wind in landing	
9) Which one of the following is TRUE with respec	_
	(GATE AE 2013)
 a) Frequency is directly proportional to flight spe b) Frequency is inversely proportional to flight spe c) Frequency is directly proportional to the squared d) Frequency is inversely proportional to the squared 	peed re root of flight speed are root of flight speed
10) The x and y velocity components of a two dimensional x	nsional 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 fam	ily of (GATE AE 2013)
) II.
a) hyperbolas	c) ellipses
b) parabolas	d) circles
11) Which one of the following statements is NOT 7	FRUE for a supersonic flow?
	(GATE AE 2013)
a) Over a gradual expansion, entropy remains combob) Over a sharp expansion corner, entropy can in c) Over a gradual compression, entropy can remain d) Over a sharp compression corner, entropy increase.	ain constant
12) Consider a compressible flow where an elementa	al volume of the fluid is $\delta\Omega$, moving with velocity
V. Which one of the following expressions is TF	
a) $\nabla \cdot \mathbf{V} = \frac{1}{\delta\Omega} \frac{D\delta\Omega}{Dt}$ b) $\nabla \cdot (\mathbf{V} \times \mathbf{r}) = \frac{1}{\delta\Omega} \frac{D\delta\Omega}{Dt}$ c) $\frac{D\mathbf{V}}{Dt} = \frac{1}{\delta\Omega} \frac{D\delta\Omega}{Dt}$ d) $\mathbf{V} \cdot (\nabla \times \mathbf{r}) = \frac{1}{\delta\Omega} \frac{D\delta\Omega}{Dt}$	(GATE AE 2013)
13) Consider a thin flat plate airfoil at a small angle C_d	α to an oncoming supersonic stream of air.
Assuming the flow to be inviscid, $\frac{C_d}{C_l^2}$ is	(GATE AE 2013)

a) zero
b) independent of α
14) The critical Mach n
15) A damped single de amplitude ratio of 2
16) The cross-section of twist, point A

- c) proportional to α
- d) proportional to α^2
- 14) The critical Mach number for a flat plate of zero thickness, at zero angle of attack, is

(GATE AE 2013)

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

(GATE AE 2013)

16) The cross-section of a long thin-walled member is as shown in the figure. When subjected to pure twist, point A _____ (GATE AE 2013)



Fig. 1

- 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
- 17) The channel section of uniform thickness 2 mm 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 (GATE AE 2013)

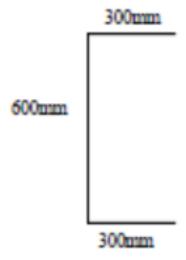


Fig. 2

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 cm². The

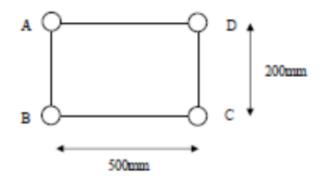


Fig. 3: Enter Caption

· · ·	des of the shear flow in the webs, q_{AB} , q_{BC} , q_{CD} and q_{DA} in kN/m (GATE AE 2013)
a) 20, 20, 20, 20 b) 0, 0, 50, 50	c) 40, 40, 0, 0 d) 50, 50, 50, 50
5% from the compressor after the	gine P For both P and Q
is 400 K and the turbine inlet ten	an aircraft engine is 10 kg/s. The compressor outlet temperature apperature is 1800 K. The heating value of the fuel is 42 MJ/kg pressure is 1 kJ/kg-K. The mass flow rate of the fuel in kg/s is (GATE AE 2013)
21) For a given inlet condition, if the	turbine inlet temperature is fixed, what value of compressor e lowest amount of fuel added in the combustor of a gas turbine (GATE AE 2013)
a) 1	c) 0.85
b) 0.95	d) 0.8
	on an aircraft which can attain a maximum altitude of 11 km lume of this engine is decided based on conditions at (GATE AE 2013)

23) Consider the low earth orbit (LEO) and the geo synchronous orbit (GSO). Then (GATE AE 2013)

c) 5.5 km altitude

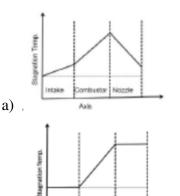
d) 11 km altitude

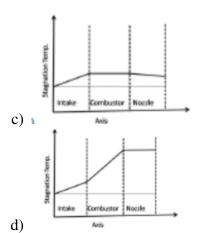
a) sea level

b) 8 km altitude

- 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
- 24) Which one of the following shows the CORRECT variation of stagnation temperature along the axis of an ideal ram jet engine? (GATE AE 2013)





- 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 (GATE AE 2013)
 - a) 805

b)

c) 905

b) 845

d) 945

26) Let

$$I = \iint_{S} (y^{2}\hat{i} + x^{2}\hat{j} + x^{2}y\hat{k})(x\hat{i} + y\hat{j} + z\hat{k}) dS,$$

where S denotes the surface of the sphere of unit radius centered at the origin. Here $\hat{i}, \hat{j}, \hat{k}$ denote three orthogonal unit vectors. The value of I is $_$ (GATE AE 2013)

a) 0

- c) $\frac{8\pi}{3}$ d) 4π
- 27) Given that the Laplace transform,

$$\mathcal{L}(e^{at}) = \frac{1}{s-a},$$

then

$$\mathcal{L}(3e^{5t}\sinh 5t) =$$

a)
$$\frac{3s}{s^2 - 10s}$$

c)
$$\frac{3s}{s^2 + 10s}$$

d)
$$\frac{13}{s^2 + 10s}$$

28) Values of a, b, c which render the matrix

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

orthonormal are, respectively

(GATE AE 2013)

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

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 (GATE AE 2013)

- a) *e*
- c) 1
- b) 0 d) -1

30) A glider is launched from a 500 m 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 (GATE AE 2013)

- 31) Which one of the following criteria leads to maximum turn rate and minimum radius in a level turn flight? (GATE AE 2013)
 - 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

32) Consider an airplane with rectangular straight wing at dihedral angle $\Gamma = 10^{\circ}$. Lift curve slope of wing airfoil section (constant over the whole span of the wing) is $c_{\ell\alpha} = 5.4/\text{rad}$. The roll stability derivative, $C_{\ell\beta}$ in per radian is ______ (GATE AE 2013)

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

(GATE AE 2013)

34) The potential flow model for a storm is represented by the superposition of a sink and a vortex. The stream function in the (r, θ) system is

$$\psi = -\frac{\Delta}{2\pi} r + \frac{\Gamma}{2\pi} \ln r,$$

where $\Delta = -\Gamma = 100 \text{ m}^2/\text{s}$. Assume a constant air density of 1.2 kg/m³. The gauge pressure at a distance of 100 m from the storm eye is (GATE AE 2013)

b)
$$\frac{1.2}{\pi r^2}$$

c)
$$-\frac{1.2}{2\pi r^2}$$

d) $\frac{1.2}{4\pi r^2}$

d)
$$\frac{1.2}{4\pi r^2}$$

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 horseshoe vortex model (of equal strength Γ) for each bird. The net downwash experienced by the middle bird is (GATE AE 2013)

a)
$$\frac{\Gamma}{\pi s}$$

c)
$$\frac{2\Gamma}{3\pi s}$$

d) $\frac{4\Gamma}{3\pi s}$

d)
$$\frac{4\Gamma}{3\pi s}$$

36) Streamline pattern of flow past a cylinder is shown in the figure. The oncoming flow is steady, irrotational and incompressible. The flow is from left to right. Bernoulli's equation cannot be applied between the points (GATE AE 2013)

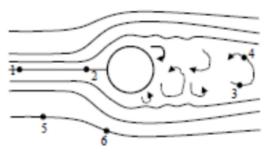


Fig. 4

- a) 1 and 2
- b) 1 and 5

- c) 3 and 4
- d) 5 and 6

37) Consider a supersonic stream at a Mach number M = 2, undergoing a gradual expansion. The stream is turned by an angle of 3° 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

(GATE AE 2013)

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 y-axis in degrees is

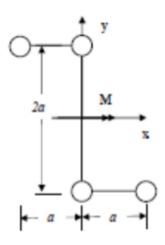


Fig. 5

a) 45 CW

c) 26.6 CW

b) 45 CCW

d) 63.4 CCW

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 subjected to a pure torque, which one of the following statements is TRUE?

(GATE AE 2013)

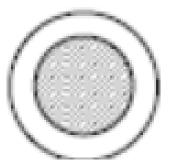


Fig. 6

- 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
- 40) A horizontal rectangular plate ABCD is hinged at points A, B and C, 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 (GATE AE 2013)

a) indeterminate

c) 0, P, 0

b) P, -P, P

d) P/3, P/3, P/3

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 ______.

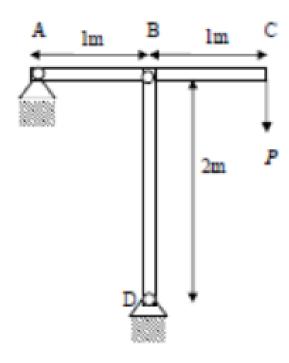


Fig. 7

(GATE AE 2013)

42) The thin rectangular plate has dimensions L x b x 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

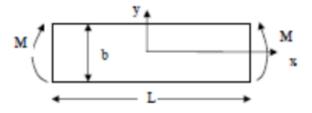


Fig. 8

a)
$$\frac{2M}{tb^3}x^3$$

b)
$$\frac{2M}{tb^3}y^3$$

c)
$$\frac{2M}{tb^3}(x^3 + y^3)$$

d) $\frac{2M}{tb^3}y^4$

$$d) \frac{2M}{tb^3} y^4$$

- 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 (GATE AE 2013)
- 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 (GATE AE 2013)

a)
$$\frac{qL^2}{16}$$
 sagging
b) $\frac{qL^2}{16}$ hogging

c)
$$\frac{3qL^2}{16}$$
 hogging d) $\frac{3qL^2}{16}$ sagging

b)
$$\frac{qL^2}{16}$$
 hogging

d)
$$\frac{3qL^2}{16}$$
 sagging

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 imp		
a) 3800b) 4000	c) 4200 d) 4400	
46) In a 50% reaction axial compressor stage, the loc component of velocity is 100 m/s. If the absolute done on the fluid by the stage in kJ/kg is	cal blade velocity is 300 m/s and the axial einlet flow angle $\alpha_1 = 45^\circ$, the work per unit mass (GATE AE 2013)	
a) 30b) 40	c) 50 d) 60	
weight. Rocket Q has a single stage with 400 kg	ge has 200 kg of propellant and 20 kg of structural	
a) 1.13b) 1.23	c) 1.33 d) 1.43	
Common Data for Questions 48 and 49: Data for an airplane are given as follows: weight $T_a = 4000$ N, wing planform area $S = 30$ m ² , may coefficient $C_D = 0.015 + 0.024C_L^2$. Assume air detail. Stall speed of the airplane in m/s is	aximum lift coefficient $C_{L_{max}} = 1.4$, and drag	
a) 17.36b) 34.22	c) 45.52 d) 119.46	
49) Minimum and maximum speeds of the airplane i respectively	n level flight condition at sea-level in m/s are	
	(GATE AE 2013)	
a) 17.36 and 180b) 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 $8314 \ J/kmol \cdot K$. 50) For which one of the nozzle exit Mach numbers given below is the propulsive efficiency highest? (GATE AE 2013)		
a) 1 b) 1.5	c) 2 d) 2.5	
51) For which one of the nozzle exit Mach numbers	given below is the thrust highest?	

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

(GATE AE 2013)

	a) 1 b) 1.5	c) 2 d) 2.5	
	Statement for Linked Answer Questions 52 and Circulation theory of lift is assumed for a thin systream velocity is U .		ittack α . Free
52)	If the circulation at the quarter chord $(c/4)$ of the	e airfoil is Γ_1 , the normal veloci	ty is zero at (GATE AE 2013)
	a) c/4b) c/2	c) 3c/4d) all points on the chord	
53)	A second identical airfoil is placed behind the fit of the first. The second airfoil has an unknown conormal velocity becomes zero at the same chord-previous question. The values of Γ_1 and Γ_2 are respectively.	Firculation Γ_2 placed at its quarter-wise locations of the respective	er chord. The
	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 an	nd 55:	
	A wing-body alone configuration airplane with a	wing loading of $\frac{W}{S} = 1000 N/n$	n^2 is flying in
54`	cruise condition at a speed $V = 90 m/s$ at sea-levezero lift pitching moment coefficient of the airpla aerodynamic center from the wing leading edge. The airplane trim lift coefficient $C_{L_{trim}}$ is	rel (air density at sea-level, ρ_{∞} = ane is C_{m0} = -0.06 and the local	= $1.22 kg/m^3$). The tion of airplane
,	1 — trim		(GATE AE 2013)
	a) 0.502b) 0.402	c) 0.302 d) 0.202	
55)	Distance of center of gravity of the aircraft (X_{cg})	from the wing leading edge is	(GATE AE 2013)
	a) 0.447c	c) 0.547c	

b) -0.547c d) -0.25c

General Aptitude (GA) Questions

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

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

(GATE AE 2013)

a)
$$\frac{3}{5} \le \frac{X}{Y} \le \frac{8}{5}$$

b) $\frac{3}{11} \le \frac{X}{Y} \le \frac{8}{5}$
d) $\frac{3}{5} \le \frac{X}{Y} \le \frac{8}{11}$

57) The Headmaster ______ to speak to you.

Which of the following options is incorrect to complete the above sentence? (GATE AE 2013)

a) is wanting	c) want	
b) wants	d) was wanting	
58) Mahatma Gandhi was known for his humility as		(GATE AE 2013)
a) he played an important role in humiliating exit of British from India.b) he worked for humanitarian causes.	c) he displayed modesty in hisd) he was a fine human being.	
59) All engineering students(I) should learn mechan how to do computation.(IV) Which of the above underlined parts of the senter.		(GATE AE 2013)
a) I b) II	c) III d) IV	
60) Select the pair that best expresses a relationship pipe ::	similar to that expressed in the p	pair: water:
		(GATE AE 2013)
a) cart : roadb) electricity : wire	c) sea : beach d) music : instrument	
Q.61 to Q.65 carry two marks each.61) Velocity of an object fired directly in upward dir in seconds. When will the velocity be between 3	• •	where t (time) is (GATE AE 2013)
a) (2, 3/2) b) (1/2, 1)	c) (1/2, 3/2) d) (1, 3)	
62) In a factory, two machines M1 and M2 manufactures respectively. Out of the total production, 2% of I randomly drawn autocomponent from the combination that it was manufactured by M2?	M1 and 3% of M2 are found to	be defective. If a
a) 0.35 b) 0.45	c) 0.50 d) 0.40	

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 one third of the total number of tourists who visited India in (GATE AE 2013)

a) USA and Japan

c) England and France

b) USA and Australia

- d) Japan and Australia
- 64) If |-2X + 9| = 3 then the possible value of $|-X| X^2$ would be:

(GATE AE 2013)

a) 30

c) -42

b) -30

d) 42

65) All professors are researchers.

Some scientists are professors.

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

(GATE AE 2013)

a) All scientists are researchers

c) Some researchers are scientists

b) All professors are scientists

d) No conclusion follows

END OF THE QUESTION PAPER