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AEROSPACE ENGINEERING

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ENGINEERING MATHEMATICS

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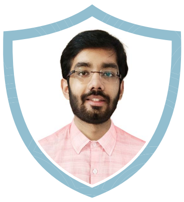

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GATE-2023 AE

SRIRAM R
SSN COLLEGE CHENNAI
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Akriti
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SHREYASHI SARKAR
IIEST, SHIBPUR
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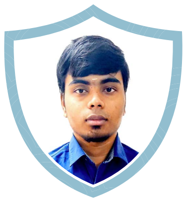

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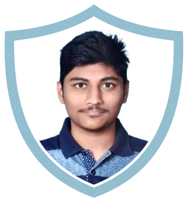

HRITHIK S PATIL
RVCE, BANGALORE
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GATE-2022 AE

SUBHROJYOTI BISWAS
IIEST, SHIBPUR
AIR - 4

SANJAY. S
AMRITA UNIV, COIMBATORE
AIR - 7

AKILESH . G
HITS, CHENNAI
AIR - 7

D. MANOJ KUMAR
AMRITA UNIV, COIMBATORE
AIR - 10

DIPAYAN PARBAT
IIEST, SHIBPUR
AIR - 14

And Many More ....

OUR PSU JOB ACHIEVERS

HAL DT ENGINEER 2023

S.S Sanjay
Amrita Univ - Coimbatore

Shashi Kanth M
Sastra Univ - Tanjore

Vagicharla Dinesh
Lovely Professional Univ - Punjab

Anantha Krishan A.G
Amrita Univ - Coimbatore

HAL DT ENGINEER 2022

Fathima J
MIT - Chennai

Mohan Kumar H
MVJCE - Bangalore

HAL DT ENGINEER 2021

Arathy Anilkumar Nair
Amrita Univ - Coimbatore

Sadsivuni Tarun
Sastra Univ - Tanjore

DRDO & ADA Scientist B

Job Position for Recruitment (2021-23) Based on GATE AE score

Abhilash K
Amrita Univ - Coimbatore

Ajitha Nishma V
IIST - Trivendrum

Dheeraj Sappa
IIEST - Shibpur

F Jahangir
MIT - Chennai

Goutham
KCG College - Chennai

M Kumar
MVJ College - Bangalore

Mohit Kudal
RTU - Kota

Niladhari Pahari
IIEST - Shibpur

Nitesh Singh
Sandip Univ - Nashik

Ramanathan A
Amrita Univ - Coimbatore

Shruti S Rajpara
IIEST - Shibpur

RAM GOPAL SONI
GVIET - PUNJAB

OUR PSU JOB ACHIEVERS

DGCA Air Safety & Worthiness Officer

Job Position for Recruitment (2023)

Abhishek Shukla
FGIET - Raebareli

Aishwarya PS
BMS College - Bangalore

Anil Kumar Nakkala
Malla Reddy College - Hyderabad

Ayush Boral
KIIT - Bhubaneswar

Dhiraj Rajendra Kapte
Priyadarshini College - Nagpur

Govardhan K
RVCE - Bangalore

R Selvaraj
Sri Ramakrishna College - Coimbatore

Rithik Gowda M
ACS College - Bangalore

Samhit Sumnampa
PEC - Chandigarh

Uttam Kumar Maurya
UPES - Dehradun

Thirthankar Majumdar
Amity University - Noida

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S Komesh
Sathyabama University - Chennai

Shrenith Suhas
IIEST - Shibpur

Ankur Vats
School Of Aeronautics - Neemrana

2. Engineering Mathematics

GATE AE - 2007

One Mark Questions.

1. If $f(\theta) = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix}$, then $f(\alpha)f(\beta) =$

(A) $f(\alpha/\beta)$ (C) $f(\alpha-\beta)$

(B) $f(\alpha+\beta)$ (D) 2×2 zero matrix

2. The Euler iteration formula for numerically integrating a first order nonlinear differential equation of the form $\dot{x} = f(x)$, with a constant step size of Δt is

(A) $x_{k+1} = x_k - \Delta t \times f(x_k)$

(B) $x_{k+1} = x_k + (\Delta t^2/2) \times f(x_k)$

(C) $x_{k+1} = x_k - (1/\Delta t) \times f(x_k)$

(D) $x_{k+1} = x_k + \Delta t \times f(x_k)$

3. The minimum Value of $J(x) = x^2 - 7x + 30$ occurs at

(A) $x = 7/2$ (C) $x = 30/7$

(B) $x = 7/30$ (D) $x = 30$

Two Marks Questions.

4. Let P and Q be two square matrices of same size. Consider the following statements

(i) PQ = 0 implies P = 0 or Q = 0 or both

(ii) $PQ = I^2$ implies $P = Q^{-1}$

(iii) $(P+Q)^2 = P^2 + 2PQ + Q^2$

(iv) $(P-Q)^2 = P^2 - 2PQ + Q^2$

Where I is the identity matrix. Which of the following statements is correct?

(A) (i), (ii) and (iii) are false, but (iv) is true

(B) (i), (ii) and (iv) are false, but (iii) is true

(C) (ii), (iii) and (iv) are false, but (i) is true

(D) (i), (iii) and (iv) are false, but (ii) is true

5. The eigenvalues of the matrix $A = \begin{bmatrix} 2 & 1 \\ 0 & 3 \end{bmatrix}$ are

(A) 1 and 2 (C) 2 and 3

(B) 1 and 4 (D) 2 and 4

6. The eigenvalues of the matrix A^{-1}, where $A = \begin{bmatrix} 2 & 1 \\ 0 & 3 \end{bmatrix}$, are

(A) 1 and 1/2 (C) 2 and 3

(B) 1 and 1/3 (D) 1/2 and 1/3

7. Let a system of linear equations be as follows:

$x - y + 2z = 0$

$2x + 3y - z = 0$

$2x - 2y + 4z = 0$

This system of equations has

(A) No non-trivial solution

(B) Infinite number of non-trivial solutions

(C) An unique non-trivial solution

(D) Two non-trivial solutions

8. An athlete starts running with a speed V_0. Subsequently, his speed decreases by an amount that is proportional to the distance that he has already covered. The distance covered will be

(A) Linear in time

(B) Quadratic in time

(C) Exponential in time

(D) Logarithmic in time

9. At a stationary point of a multi-variable function, which of the following is true?

(A) Curl of the function becomes unity

(B) Gradient of the function vanishes

(C) Divergence of the function vanishes

(D) Gradient of the function is maximum

10. Numerical value of the integral

$$J = \int_0^1 \frac{1}{1+x^2} dx$$

If evaluated numerically using the Trapezoidal rule with $dx = 0.2$ would be

(A) 1
(B) $\pi/4$
(C) 0.7837
(D) 0.2536

11. The Newton-Raphson iteration formula to find a cube root of a positive number c is

(A) $x_{k+1} = \frac{2x_k^3 + \sqrt[3]{c}}{3x_k^2}$
(B) $x_{k+1} = \frac{2x_k^3 - \sqrt[3]{c}}{-3x_k^2}$
(C) $x_{k+1} = \frac{2x_k^3 + c}{3x_k^2}$
(D) $x_{k+1} = \frac{x_k^3 + c}{3x_k^2}$

12. $\lim_{x\to 0} \sin x / e^x x$

(A) 10
(B) 0
(C) 1
(D) ∞

13. Let a dynamical system be described by the differential equation $2\frac{dx}{dt} + \cos x = 0$ Which of the following differential equations describes this system in a close approximation sense for small perturbation about $x = \pi/4$?

(A) $2\frac{dx}{dt} + \sin x = 0$
(B) $2\frac{dx}{dt} - \frac{1}{\sqrt{2}}x = 0$
(C) $\frac{dx}{dt} + \cos x = 0$
(D) $\frac{dx}{dt} + x = 0$

Statement for Linked Answer Qns 14 & 15:

Let $F(s) = \frac{(s+10)}{(s+2)(s+20)}$

14. The partial fraction expansion of F(s) is

(A) $\frac{1}{s+2} + \frac{1}{s+20}$
(B) $\frac{5}{s+2} + \frac{2}{s+20}$
(C) $\frac{2}{s+2} + \frac{20}{s+20}$
(D) $\frac{4/9}{s+2} + \frac{5/9}{s+20}$

15. The inverse Laplace transform of F(s) is

(A) $2e^{-2t} + 20e^{-20t}$
(B) $\frac{4}{9}e^{-2t} + \frac{5}{9}e^{-20t}$
(C) $5e^{-2t} + 2e^{-20t}$
(D) $\frac{9}{4}e^{-2t} + \frac{6}{5}e^{-20t}$

GATE AE - 2008

One Mark Questions.

16. The function defined by

$f(x) = \sin x, \quad x < 0$
$= 0, \quad x = 0$
$= 3x^3, \quad x > 0$

(A) is neither continuous nor differentiable at x=0
(B) is continuous and differentiable at x=0
(C) is differentiable but not continuous at x=0
(D) is continuous but not differentiable at x=0

17. The product of the eigenvalues of the matrix $\begin{bmatrix} 1 & 0 & 1 \\ 0 & 2 & 1 \\ 1 & 1 & -3 \end{bmatrix}$ is

(A) 4
(B) 0
(C) -6
(D) -9

18. Which of the following equations is a LINEAR ordinary differential equation?

(A) $\frac{d^2y}{dx^2} + \frac{dy}{dx} + 2y^2 = 0$
(B) $\frac{d^2y}{dx^2} + y\frac{dy}{dx} + 2y = 0$
(C) $\frac{d^2y}{dx^2} + x\frac{dy}{dx} + 2y = 0$
(D) $\left(\frac{dy}{dx}\right)^2 + \frac{dy}{dx} + 2y = 0$

Two Marks Questions.

19. The function $f(x,y,z) = \frac{1}{2}x^2y^2z^2$ satisfies

(A) grad f = 0
(B) div(grad f) = 0
(C) curl(grad f) = 0
(D) grad(div(grad f)) = 0

20. Which of the following is true for all choices of vectors $\vec{p}, \vec{q}, \vec{r}$?

(A) $\vec{p}\times\vec{q} + \vec{q}\times\vec{r} + \vec{r}\times\vec{p} = 0$
(B) $(\vec{p}\cdot\vec{q})\vec{r} + (\vec{q}\cdot\vec{r})\vec{p} + (\vec{r}\cdot\vec{p})\vec{q} = 0$
(C) $\vec{p}\cdot(\vec{q}\times\vec{r}) + \vec{q}\cdot(\vec{r}\times\vec{p}) + \vec{r}\cdot(\vec{p}\times\vec{q}) = 0$
(D) $\vec{p}\times(\vec{q}\times\vec{r}) + \vec{q}\times(\vec{r}\times\vec{p}) + \vec{r}\times(\vec{p}\times\vec{q}) = 0$

21. The value of the line integral $\frac{1}{2\pi}\oint(x\,dy - y\,dx)$ taken anticlockwise along a circle of unit radius is

(A) 0.5
(B) 1
(C) 2
(D) π

22. Which of the following is a solution of

$$\frac{d^2y}{dx^2}+2\frac{dy}{dx}+y=0?$$

(A) $e^{-x}+xe^{-x}$ (C) $e^{x}+e^{-x}$
(B) $e^{x}+xe^{-x}$ (D) $e^{-x}+xe^{x}$

23. Suppose the non-constant functions F(x) and G(t) satisfy $\frac{d^2F}{dx^2}+p^2F=0, \frac{dG}{dt}+c^2p^2G=0$, where p and c are constants. Then the function $u(x,t)=F(x)G(t)$ definitely satisfies

(A) $\frac{\partial^2u}{\partial t^2}=c^2\frac{\partial^2u}{\partial x^2}$ (C) $\nabla^2u=0$
(B) $\frac{\partial u}{\partial t}=c^2\frac{\partial^2u}{\partial x^2}$ (D) $\frac{\partial^2u}{\partial t^2}+c^2u^2=0$

24. The following set of equations

$$\begin{bmatrix}1&1&2\\1&0&1\\0&1&1\end{bmatrix}\begin{bmatrix}x_1\\x_2\\x_3\end{bmatrix}=\begin{bmatrix}1\\-1\\0\end{bmatrix}$$ has

(A) no solution
(B) a unique solution
(C) two solutions
(D) infinite solutions

25. The function $f(x)=x^2-5x+6$
(A) has its maximum value at $x=2.0$
(B) has its maximum value at $x=2.5$
(C) is increasing on the interval (2.0, 2.5)
(D) is increasing on the interval (2.5, 3.0)

26. Let Y(s) denote the Laplace transform L(y(t)) of the function $y(t)=\cos h(at)\sin(at)$. Then

(A) $L\left(\frac{dy}{dt}\right)=\frac{dY}{ds}, L(t\,y(t))=sY(s)$
(B) $L\left(\frac{dy}{dt}\right)=sY(s), L(t\,y(t))=-\frac{dY}{ds}$
(C) $L\left(\frac{dy}{dt}\right)=\frac{dY}{ds}, L(t\,y(t))=Y(s-1)$
(D) $L\left(\frac{dy}{dt}\right)=sY(s), L(ty(t))=e^{as}Y(s)$

Statement for Linked Answer Questions 27 & 28: The following two questions relate to Simpson's rule for approximating the integral $\int_a^b f(x)dx$ on the interval [a, b]

27. Which of the following gives the correct formula for Simpson's rule?

(A) $\frac{(b-a)}{2}\left[f(b)+f\left(\frac{a+b}{2}\right)\right]$
(B) $\frac{(b-a)}{2}\left[\frac{f(a)+f(b)}{2}+f\left(\frac{a+b}{2}\right)\right]$
(C) $\frac{(b-a)}{2}\left[\frac{f(a)+f(b)}{3}+\frac{4}{3}f\left(\frac{a+b}{2}\right)\right]$
(D) $\frac{(b-a)}{2}\left[\frac{f(a)+f(b)}{3}+\frac{4}{3}f\left(\frac{a+b}{3}\right)\right]$

28. The percentage error (with respect to the exact solution) in estimation of the integral $\int_0^1 x^3dx$ using Simpson's rule is
(A) 5.3 (C) 2.8
(B) 3.5 (D) 0

GATE AE - 2009

One Mark Questions.

29. The ordinary differential equation

$$\frac{d^2y}{dx^2}+ky=0$$

where k is real and positive
(A) is non-linear
(B) has a characteristic equation with one real and one complex root
(C) has a characteristic equation with two real roots
(D) has a complementary function that is simple harmonic

30. A non-trivial solution to the $(n\times n)$ system of equations $[A]\{x\}=\{0\}$, where $\{0\}$ is the null vector
(A) can never be found
(B) may be found only if [A] is not singular
(C) may be found only if [A] is an orthogonal matrix
(D) may be found only if [A] has at least one eigenvalue equal to zero

Two Marks Questions.

31. The value of the integral $\int_0^\pi \frac{dx}{1+x+\sin x}$ evaluated using the trapezoidal rule with two equal intervals is approximately
(A) 1.27 (C) 1.41
(B) 1.81 (D) 0.71

32. The product of the eigenvalues of the matrix $\begin{bmatrix} 2 & 1 & 1 \\ 1 & 3 & 1 \\ 1 & 1 & 4 \end{bmatrix}$ is

(A) 20 (C) 9
(B) 24 (D) 17

33. In the interval $1 \le x \le 2$, the function $f(x) = e^{\pi x} + \sin \pi x$ is

(A) maximum at $x = 1$
(B) maximum at $x = 2$
(C) maximum at $x = 1.5$
(D) monotonically decreasing

34. The inverse Laplace transform of $F(s) = \frac{(s+1)}{(s+4)(s-3)}$ is

(A) $\frac{3}{7}e^{4t} + \frac{4}{7}e^{-3t}$ (C) $\frac{5}{7}e^{-4t} + \frac{6}{7}e^{3t}$
(B) $\frac{3}{7}e^{-4t} + \frac{4}{7}e^{3t}$ (D) $\frac{5}{7}e^{4t} + \frac{6}{7}e^{-3t}$

35. The linear system of equations $Ax = b$ where $A = \begin{bmatrix} 1 & 2 \\ 2 & 4 \end{bmatrix}$ and $b = \begin{Bmatrix} 3 \\ 3 \end{Bmatrix}$ has

(A) no solution
(B) infinitely many problems
(C) a unique solution $x = \begin{Bmatrix} 1 \\ 1 \end{Bmatrix}$
(D) a unique solution $x = \begin{Bmatrix} 0.5 \\ 0.5 \end{Bmatrix}$

36. The correct iterative scheme for finding the square root of a positive real number R using the Newton Raphson method is

(A) $x_{n+1} = \sqrt{R}$
(B) $x_{n+1} = \frac{1}{2}\left(x_n + \frac{R}{x_n}\right)$
(C) $x_{n+1} = \frac{1}{2}\left(\sqrt{x_n} + \sqrt{x_{n-1}}\right)$
(D) $x_{n+1} = \frac{1}{2}\left(\sqrt{R} + x_n\right)$

Common Data for Questions 37 and 38

Consider the vector field $\vec{A} = (y^3 + z^3)\hat{\imath} + (x^3 + z^3)\hat{\jmath} + (x^3 + y^3)\hat{k}$ defined over the unit sphere $x^2 + y^2 + z^2 = 1$

37. The surface integral (taken over the unit sphere) of the component of $\vec{A}$ normal to the surface is

(A) π (C) 0
(B) 1 (D) 4π

38. The magnitude of the component of $\vec{A}$ normal to the spherical surface at the point $\left(\frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}, \frac{1}{\sqrt{3}}\right)$ is

(A) 1/3 (C) 3/3
(B) 2/3 (D) 4/3

GATE AE - 2010

One Mark Questions.

39. Two position vectors are indicated by $\bar{V}_1 = \begin{Bmatrix} x_1 \\ y_1 \end{Bmatrix}$ and $\bar{V}_2 = \begin{Bmatrix} x_2 \\ y_2 \end{Bmatrix}$. If $a^2 + b^2 = 1$, then the operation $\bar{V}_2 = \begin{bmatrix} a & -b \\ b & a \end{bmatrix} \bar{V}_1$ amounts to obtaining the position vector $\bar{V}_2$ from $\bar{V}_1$ by

(A) translation
(B) rotation
(C) magnification
(D) combination of translation, rotation and magnification.

40. The linear second order partial differential equation

$$5\frac{\partial^2 \phi}{\partial x^2} + 3\frac{\partial^2 \phi}{\partial x \partial y} + 2\frac{\partial^2 \phi}{\partial y^2} + 9 = 0$$

(A) Parabolic
(B) Hyperbolic
(C) Elliptic
(D) None of the above

41. The eigen-values of a real symmetric matrix are always

(A) Positive
(B) imaginary
(C) real
(D) complex conjugate pairs

42. The concentration x of a certain chemical species at time t in a chemical reaction is described by the differential equation $\frac{dx}{dt} +$

$kx = 0$, with $x(t = 0) = x_0$. Given that e is the base of the natural logarithms, the concentration x at $t = l/k$

(A) falls to the value $0.5x_0$
(B) rises to the value $2x_0$
(C) falls to the value x_0/e
(D) rises to the value ex_0

43. The definite integral

$$\int_{-1}^{+1} dx/x^2$$

(A) does not exist
(B) is equal to 2
(C) is equal to 0
(D) is equal to -2

Two Marks Questions.

44. Given that the Laplace transform of $y(t) = e^{-t}(2\cos 2t - \sin 2t)$ is $Y(s) = \frac{2s}{(s+1)^2+4}$, the Laplace transform of $y_t(t) = e^{t}(2\cos 2t - \sin 2t)$ is

(A) $\frac{2(s-2)}{(s-1)^2+4}$
(B) $\frac{2(s+2)}{(s+3)^2+4}$
(C) $\frac{2(s+2)}{(s+1)^2+4}$
(D) $\frac{2(s-1)}{(s-1)^2+4}$

45. In a certain region a hill is described by the shapes $z(x,y) = \frac{1}{50}x^4 + y^2 - xy - 3y$, where the axes x and y are in the horizontal plane and axis z points vertically upward. If $\hat{\imath}, \hat{\jmath}$ and $\hat{k}$ are unit vectors along x, y and z respectively, then at the point $x = 5, y = 10$ the unit vector in the direction of the steepest slope of the hill will be

(A) $\hat{\imath}$
(B) $\hat{\jmath}$
(C) $\hat{k}$
(D) $\hat{\imath} + \hat{\jmath} + \hat{k}$

46. The function $f(x,y) = x^2 + y^2 - xy - 3y$ has an extremum at the point

(A) (1, 2)
(B) (3, 0)
(C) (2, 2)
(D) (1, 1)

47. In finding a root of the equation: $x^2 - 6x + 5 = 0$ the Newton-Raphson method achieves an order of convergence equal to:

(A) 1.0
(B) 1.67
(C) 2.0
(D) 2.5

48. If e is the base of the natural logarithms then the equation of the tangent from the origin to the curve $y = e^x$ is

(E) $y = x$
(F) $y = \pi x$
(G) $y = x/e$
(H) $y = ex$

GATE AE - 2011

One Mark Questions.

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

(A) $z^2i - 3yk$
(B) $z^2j + 3yk$
(C) $z^2i + 3yj$
(D) $-z^2i + 3yk$

50. 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.

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

(A) (1, 2, 3)
(B) (0, 0, 0)
(C) (3, 2, 1)
(D) (1, 1, 3)

52. Consider the function $f(x_1, x_2) = x_1^2 + 2x_2^2 + e^{-x_1 - x_2}$. 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) $\begin{pmatrix} 2 \\ -4 \end{pmatrix}$

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

(A) a unique solution
(B) infinitely many solutions
(C) no solution
(D) a finite number of multiple solutions

Two Marks Questions.

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

55. Consider the matrix $\begin{bmatrix} 2 & a \\ b & 2 \end{bmatrix}$ 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 $b > 0$ (C) $a < 0$ and $b < 0$
(B) $a > 0$ and $b < 0$ (D) $a = 0$ and $b = 0$

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

GATE AE - 2012

One Mark Questions.

57. The constraint $A^2 = A$ on any square matrix A is satisfied for

(A) the identity matrix only.
(B) the null matrix only.
(C) both the identity matrix and the null matrix.
(D) no square matrix A.

58. The general solution of the differential equation $\frac{d^2y}{dt^2} + \frac{dy}{dt} - 2y = 0$ is

(A) $Ae^{-t} + Be^{2t}$ (C) $Ae^{-2t} + Be^{t}$
(B) $Ae^{-2t} + Be^{-t}$ (D) $Ae^{t} + Be^{2t}$

59. The value of k for which the system of equations $x + 2y + kz = 1$; $2x + ky + 8z = 3$ has no solution is

(A) 0 (B) 2 (C) 4 (D) 8

60. If u(t) is a unit step function, the solution of the differential equation $m\frac{d^2x}{dt^2} + kx = u(t)$ in Laplace domain is

(A) $\frac{1}{s(ms^2 + k)}$ (C) $\frac{s}{ms^2 + k}$
(B) $\frac{1}{ms^2 + k}$ (D) $\frac{1}{s^2(ms^2 + k)}$

61. The general solution of the differential equation $\frac{dy}{dx} - 2\sqrt{y} = 0$ is

(A) $y - \sqrt{x} + C = 0$ (C) $\sqrt{y} - \sqrt{x} + C = 0$
(B) $y - x + C = 0$ (D) $\sqrt{y} - x + C = 0$

Two Marks Questions.

62. The integration $\int_0^1 x^3 dx$ computed using trapezoidal rule with n = 4 intervals is ____.

63. The n^{th} derivative of the function $y = \frac{1}{x+3}$ is

(A) $\frac{(-1)^n n!}{(x+3)^{n+1}}$ (C) $\frac{(-1)^n (n+1)!}{(x+3)^n}$
(B) $\frac{(-1)^{n+1} n!}{(x+3)^{n+1}}$ (D) $\frac{(-1)^n n!}{(x+3)^n}$

64. The volume of a solid generated by rotating the region between semi-circle $y = 1 - \sqrt{1 - x^2}$ and straight-line y = 1, about x axis, is

(A) $\pi^2 - \frac{4}{3}\pi$ (C) $\pi^2 - \frac{3}{4}\pi$
(B) $4\pi^2 - \frac{1}{3}\pi$ (D) $\frac{3}{4}\pi^2 - \pi$

65. One eigenvalue of the matrix $A = \begin{bmatrix} 2 & 7 & 10 \\ 5 & 2 & 25 \\ 1 & 6 & 5 \end{bmatrix}$ is -9.33. One of the other eigenvalues is

(A) 18.33 (C) $18.33 - 9.33i$

(B) -18.33 (D) $18.33 + 9.33i$

GATE AE - 2013

One Mark Questions.

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

(A) $-{}^{1}/_{\sqrt{5}}$ (C) 0

(B) $-{}^{2}/_{\sqrt{5}}$ (D) $-{}^{1}/_{5}$

67. The value of

$$\int_4^5 \frac{x+2}{x^2+4x-21} dx \text{ is}$$

(E) $\ln\sqrt{24/11}$ (G) $\ln\sqrt{2}$

(F) $\ln\sqrt{12/11}$ (H) $\ln(12/11)$

68. 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

69. One of the eigenvectors of the matrix

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

The corresponding eigenvalue is __________

Two Marks Questions.

70. Let $I = \iint_s (y^2z\hat{\imath} + z^2x\hat{\jmath} + x^2y\hat{k}) \cdot (x\hat{\imath} + y\hat{\jmath} + z\hat{k}) dS$, where S denotes the surface of the sphere of unit radius centered at the origin. Here $\hat{\imath}, \hat{\jmath}$ and $\hat{k}$ denote three orthogonal unit vectors. The value of I is__________

71. Given that the Laplace transform

$\mathcal{L}(e^{at}) = \frac{1}{s-a}$ then $\mathcal{L}(3e^{5t} \sin h\, 5t) =$

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

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

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

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

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

73. 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 (C) 1

(B) 0 (D) -1

GATE AE - 2014

One Mark Questions.

74. 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.

75. 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 (C) $R = \infty$

(B) R = 3 (D) $R = 1/3$

76. 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

77. Given the boundary-value problem $\frac{d}{dx}\left(x\frac{dy}{dx}\right)+ky=0, 0<x<1$, 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) $\int_0^1 y_1y_5dx=0$
(B) $\int_0^1 \frac{dy_1}{dx}\frac{dy_5}{dx}dx=0$
(C) $\int_0^1 y_1y_5dx\neq 0$
(D) $\int_0^1 \left(y_1y_5+\frac{dy_1}{dx}\frac{dy_5}{dx}\right)dx=0$

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

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

Two Marks Questions.

79. If $[A]=\begin{bmatrix}3 & -3\\ -3 & 4\end{bmatrix}$.

Then $\det(-[A]^2+7[A]-3[I])$ is

(A) 0 (C) 324
(B) −324 (D) 6

80. 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 $s=1-\frac{1}{3}+\frac{1}{5}-\frac{1}{7}+..$ converges to

(A) 1 (C) $\pi/4$
(B) $\pi/3$ (D) $\pi/5$

81. 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 (C) 1
(B) $-\pi$ (D) 0

82. Solution to the boundary-value problem $-9\frac{d^2u}{dx^2}+u=5x, 0<x<3$ with $u(0)=0$, $\left.\frac{du}{dx}\right|_{x=3}=0$

(A) $u(x)=\frac{15e}{1+e^2}(e^{-x/3}-e^{x/3})+5x$
(B) $u(x)=\frac{15e}{1+e^2}(e^{-x/3}+e^{x/3})+5x$
(C) $u(x)=-\frac{15\sin(x/3)}{\cos(1)}+5x$
(D) $u(x)=-\frac{15\sin\left(\frac{x}{3}\right)}{\cos(1)}-\frac{5}{54}x^3$

83. The Laplace transform $L(u(t))=U(s)$, 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) $\frac{6}{(s+1)^2}$ (C) $\frac{1-5s}{s(s+1)^2}$
(B) $\frac{5s+1}{s(s+1)^2}$ (D) $\frac{5s^2+1}{s(s+1)^2}$

GATE AE - 2015

One Mark Questions.

84. The partial differential equation

$\frac{\partial u}{\partial t}+\frac{\partial\left(\frac{u^2}{2}\right)}{\partial x}=0$ is

(A) linear and first order
(B) linear and second order
(C) non-linear and first order
(D) non-linear and second order

85. The system of equations for the variables x and y

$ax+by=e;\quad cx+dy=f$

has a unique solution only if

(A) $ad-bc\neq 0$ (C) $a+c\neq b+d$
(B) $ac-bd\neq 0$ (D) $a-c\neq b-d$

86. The function $y = x^3 - x$ has
(A) no inflection point
(B) one inflection point
(C) two inflection points
(D) three inflection points

Two Marks Questions.

87. In the solution of $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + y = 0$, if the values of the integration constants are identical and one of the initial conditions is specified as $y(0) = 1$, the other initial condition $y'(0)$ = ____.

88. For $x > 0$, the general solution of the differential equation $\frac{dy}{dx} = 1 - 2y$ asymptotically approaches ______.

89. For a parabola defined by $y = ax^2 + bx + c, a \neq 0$, the coordinates (x, y) of the extremum are
(A) $\left(\frac{-b}{2a} + \frac{\sqrt{b^2 - 4ac}}{2a}, 0\right)$
(B) $\left(\frac{-b}{2a}, \frac{-b^2 + 4ac}{2a}\right)$
(C) $\left(\frac{-b}{2a}, \frac{-b^2 + 4ac}{4a}\right)$
(D) $(0, c)$

90. If all the eigenvalues of a matrix are real and equal, then
(A) the matrix is diagonalizable
(B) its eigenvectors are not necessarily linearly independent
(C) its eigenvectors are linearly independent
(D) its determinant is necessarily zero

91. The value of the integral
$$\int_1^2 (4x^3 + 3x^2 + 2x + 1)\,dx$$
evaluated numerically using Simpson's rule with one step is
(A) 26.5
(B) 26
(C) 25.5
(D) 25.3

GATE AE - 2016

One Mark Questions.

92. Consider an eigenvalue problem given by $\mathbf{Ax} = \lambda_i \mathbf{x}$. If λ_i represent the eigenvalues of the non-singular square matrix $\mathbf{A}$, then what will be the eigenvalues of matrix $\mathbf{A}^2$?
(A) λ_i^4
(B) λ_i^2
(C) $\lambda_i^{1/2}$
(D) $\lambda_i^{1/4}$

93. If **A** and **B** are both non-singular $n \times n$ matrices, then which of the following statement is NOT TRUE. Note: det represents the determinant of a matrix.
(A) $\det(\mathbf{AB}) = \det(\mathbf{A})\det(\mathbf{B})$
(B) $\det(\mathbf{A} + \mathbf{B}) = \det(\mathbf{A}) + \det(\mathbf{B})$
(C) $\det(\mathbf{AA}^{-1}) = 1$
(D) $\det(\mathbf{A}^T) = \det(\mathbf{A})$

94. Let x be a positive real number. The function $f(x) = x^2 + 1/x^2$ has its minima at x = ____.

95. The vector $\vec{u}$ is defined $\vec{u} = y\hat{e}_x - x\hat{e}_y$, where $\hat{e}_x$ and $\hat{e}_y$ are the unit vectors along x and y directions, respectively. If the vector $\vec{\omega} = \vec{\nabla} \times \vec{u}$, then $|(\vec{\omega} \cdot \vec{\nabla})\vec{u}|$ = _______

96. The partial differential equation $\frac{\partial u}{\partial t} = \alpha \frac{\partial^2 u}{\partial x^2}$, where α is a positive constant, is
(A) circular.
(B) elliptic.
(C) hyperbolic.
(D) parabolic.

Two Marks Questions.

97. Consider a second order linear ordinary differential equation $\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 4y = 0$. with the boundary conditions $y(0) = 1; \left.\frac{dy}{dx}\right|_{x=0} = 1$. The value of y at x =1 is
(A) 0
(B) 1
(C) e
(D) e^2

98. Consider the following system of linear equations:

$2x - y + z = 1$

$3x - 3y + 4z = 6$

$x - 2y + 3z = 4$

This system of linear equations has

(A) no solution.

(B) one solution.

(C) two solutions.

(D) three solutions.

99. The value of definite integral

$\int_0^{\pi} (x \sin x) dx$ is ______.

100. Use Newton-Raphson method to solve the equation: $x e^x = 1$. Begin with the initial guess $x_0 = 0.5$. The solution after one step is x= ______.

GATE AE - 2017

One Mark Questions.

101. Given the vectors $\vec{v}_1 = \hat{\imath} + 3\hat{\jmath}; \vec{v}_2 = 2\hat{\imath} - 4\hat{\jmath} + 3\hat{k}$, the vector $\vec{v}_3$ that is perpendicular to both $\vec{v}_1$ and $\vec{v}_2$ is given by

(A) $\vec{v}_3 = \vec{v}_1 - (\vec{v}_1.\vec{v}_2)\frac{\vec{v}_2}{|\vec{v}_2|}$

(B) $\vec{v}_3 = \hat{k}$

(C) $\vec{v}_3 = \vec{v}_2 - (\vec{v}_1.\vec{v}_2)\frac{\vec{v}_1}{|\vec{v}_1|}$

(D) $\vec{v}_3 = \frac{\vec{v}_1 \times \vec{v}_2}{|\vec{v}_1 \times \vec{v}_2|}$

102. The value of the integral $I = \int_c \left((x - y)dx + x^2 dy\right)$. With C the boundary of the square $0 \le x \le 2; 0 \le y \le 2$, is _____.

103. Let $\overrightarrow{v(t)}$ be a unit vector that is a function of the parameter t. Then $\vec{v}.\frac{d\vec{v}}{dt}$ =_______

104. The eigenvalues λ_n and eigenfunctions $u_n(x)$ of the Strum-Liouville problem

$$\frac{d^2y}{dx^2} + k^2\lambda y = 0, 0 < x < 1;\ y(0) = 0, y(1) = 0$$

are given by:

(A) $\lambda_n = n^2\pi^2;\ u_n(x) = \sin\lambda_n x,\ n = 0, \pm1, \pm2 \dots \infty$

(B) $\lambda_n = n^2\pi^2/k^2;\ u_n(x) = \sin kn\pi x,\ n = 0, \pm1, \pm2 \dots \infty$

(C) $\lambda_n = n^2\pi^2/k^2;\ u_n(x) = \sin n\pi x,\ n = 0, \pm1, \pm2 \dots \infty$

(D) $\lambda_n = n^2\pi^2;\ u_n(x) = \sin n\pi x,\ n = 0, \pm1, \pm2 \dots \infty$

105. 3-point Gaussian integration formula is given by

$$\int_{-1}^{1} f(x)dx \approx \sum_{j=1}^{3} A_j f(x_j)$$

with $x_1 = 0, x_2 = -x_3 = -\sqrt{\frac{3}{5}};\ A_1 = \frac{8}{9},\ A_2 = A_3 = \frac{5}{9}$.

This formula exactly integrates

(A) $f(x) = 5 - x^7$

(B) $f(x) = 2 + 3x + 6x^4$

(C) $f(x) = 13 + 6x^3 + x^6$

(D) $f(x) = e^{-x^2}$

Two Marks Questions.

106. Matrix $[A] = \begin{bmatrix} 2 & 0 & 2 \\ 3 & 2 & 7 \\ 3 & 1 & 5 \end{bmatrix}$ and vector $\{b\} = \begin{Bmatrix} 4 \\ 4 \\ 5 \end{Bmatrix}$ are given. If vector $\{x\}$ is the solution to the system of equations $[A]\{x\} = \{b\}$, which of the following is true for $\{x\}$:

(A) Solution does not exist

(B) Infinite solutions exist

(C) Unique solution exists

(D) Five possible solutions exist

107. Let matrix $[A] = \begin{bmatrix} 2 & -6 \\ 0 & 2 \end{bmatrix}$. Then for any non-trivial vector $\{x\} = \begin{Bmatrix} x_1 \\ x_2 \end{Bmatrix}$, which of the following is true for the value of $K = \{x\}^T[A]\{x\}$:
(A) K is always less than zero
(B) K is always greater than zero
(C) K is non-negative
(D) K can be anything

108. Consider the initial value problem:
$$\frac{d^2y}{dt^2} + 4\frac{dy}{dt} + 6y = f(t); y(0) = 2, \left(\frac{dy}{dt}\right)_{t=0} = 1$$
If $Y(s) = \int_0^\infty y(t)e^{-st}\,dt$ and $F(s) = \int_0^\infty f(t)e^{-st}\,dt$ are the Laplace transforms of y(t) and f(t) respectively, then Y(s) is given by:
(A) $\frac{F(s)}{(s^2 + 4s + 6)}$
(C) $\frac{F(s)}{(-s^2 + 4s + 6)}$
(B) $\frac{F(s) + 2s + 9}{(s^2 + 4s + 6)}$
(D) $\frac{F(s) - 2s + 9}{(s^2 + 4s + 6)}$

109. Let u(x, t) denote the displacement of point on a rod. The displacement satisfies the following equation of motion:
$$\frac{\partial^2 u}{\partial t^2} - 25\frac{\partial^2 u}{\partial x^2} = 0, 0 < x < 1$$
With $u(x, 0) = 0.01 \sin(10\,\pi x), \frac{\partial u}{\partial t}(x, 0) = 0;$ $u(0, t) = 0, u(1, t) = 0$. The value of u (0.25 , 1) is _______ (in three decimal places)

110. The equation $x^2\frac{d^2y}{dx^2} + 5x\frac{dy}{dx} + 4y = 0$ has a solution y(x) that is:
(A) A polynomial in x
(B) Finite series in terms of non-integer fractional powers of x
(C) Consists of negative integer powers of x and logarithmic function of x
(D) Consists of exponential functions of x.

GATE AE - 2018

One Mark Questions.

111. Let $\vec{a}, \vec{b}$ be two distinct vectors that are not parallel. The vector $\vec{c} = \vec{a} \times \vec{b}$ is
(A) zero.
(B) orthogonal to $\vec{a}$ alone.
(C) orthogonal to $\vec{a} + \vec{b}$
(D) orthogonal to $\vec{b}$ alone.

112. Consider the function
$$f(x, y) = \frac{x^2}{2} + \frac{y^2}{3} - 5.$$
All the roots of this function
(A) form a finite set of points.
(B) lie on an elliptical curve.
(C) lie on the surface of a sphere.
(D) lie on a hyperbolic curve.

113. Consider a vector field given by $x\hat{i} + y\hat{j} + z\hat{k}$. This vector field is
(A) divergence-free and curl-free.
(B) curl-free but not divergence-free.
(C) divergence-free but not curl-free.
(D) neither divergence-free nor curl-free.

114. The determinant of the matrix $\begin{bmatrix} 1 & 1 & -1 \\ 2 & 1 & 0 \\ 3 & 1 & 1 \end{bmatrix}$ is ____ (accurate to one decimal place).

Two Marks Questions.

115. The solution of the differential equation
$$\frac{d^2y}{dx^2} + 3\frac{dy}{dx} = 0, \text{given that } y = 0 \text{ and } \frac{dy}{dx} = 1$$
at x = 0 is
(A) $x(1 - e^{-3x})$
(C) $\frac{1}{3}(1 + e^{-3x})$
(B) $\frac{1}{3}(1 - e^{-3x})$
(D) $\frac{1}{3}xe^{\frac{-3x}{2}}$

116. Consider the vector field $\vec{v} = -\frac{y}{r^2}\hat{i} + \frac{x}{r^2}\hat{j}$; where $r = \sqrt{x^2 + y^2}$. The contour integral $\oint \vec{v} \cdot \vec{ds}$, where $\vec{ds}$ is tangent to the contour that

encloses the origin, is ________ (accurate to two decimal places).

GATE AE - 2019

One Mark Questions.

117. The maximum value of the function $f(x) = xe^{-x}$ (where x is real) is

(A) $1/e$ (C) $(e^{-1/2})/2$

(B) $2/e^2$ (D) ∞

118. Vector $\vec{b}$ is obtained by rotating $\vec{a} = \hat{\imath} + \hat{\jmath}$ by 90° about $\hat{k}$, where $\hat{\imath}, \hat{\jmath}$ and $\hat{k}$ are unit vectors along the x, y and z axes, respectively. $\vec{b}$ is given by

(A) $\hat{\imath} - \hat{\jmath}$ (C) $\hat{\imath} + \hat{\jmath}$

(B) $-\hat{\imath} + \hat{\jmath}$ (D) $-\hat{\imath} - \hat{\jmath}$

119. A scalar function is given by $f(x, y) = x^2 + y^2$. Take $\hat{\imath}$ and $\hat{\jmath}$ as unit vectors along the x and y axes, respectively. At (x, y) = (3,4), the direction along which f increases the fastest is

(A) $\frac{1}{5}(4\hat{\imath} - 3\hat{\jmath})$ (C) $\frac{1}{5}(3\hat{\imath} + 4\hat{\jmath})$

(B) $\frac{1}{5}(3\hat{\imath} - 4\hat{\jmath})$ (D) $\frac{1}{5}(4\hat{\imath} + 3\hat{\jmath})$

120. A function f(x) is defined by $f(x) = \frac{1}{2}(x + |x|)$.

The value of $\int_{-1}^{1} f(x)dx$ is ________

(round off to 1 decimal place)

121. The value of the following limit is ______ (round off to 2 decimal places).

$$\lim_{\theta \to 0} \frac{\theta - \sin\theta}{\theta^3}$$

Two Marks Questions.

122. The following system of equations

$2x - y - z = 0,$

$-x + 2y - z = 0$

$-x - y + 2z = 0$

(A) has no solution.

(B) has a unique solution.

(C) has three solutions.

(D) has an infinite number of solutions.

123. For real x, the number of points of intersection between the curves y = x and y = cos x is ______.

124. One of the eigenvalues of the following matrix is 1. $\begin{pmatrix} x & 2 \\ -1 & 3 \end{pmatrix}$ The other eigenvalue is _______.

125. The curve $y = f(x)$ is such that its slope is equal to y^2 for all real x. If the curve passes through $(1, -1)$, the value of y at $x = -2$ is ________(round off to 1 decimal place).

GATE AE - 2020

One Mark Questions.

126. For $f(x) = |x|$, with $\frac{df}{dx}$ denoting the derivative, the mean value theorem is not applicable because

(A) f(x) is not continuous at $x = 0$

(B) $f(x) = 0$ at $x = 0$

(C) $\frac{df}{dx}$ is not defined at a $x = 0$

(D) $\frac{df}{dx} = 0$ at $x = 0$

127. For the function $f(x) = \frac{e^{-\lambda}}{\sigma\sqrt{2\pi}}$, where $\lambda = \frac{1}{2\sigma^2}(x - \mu)^2$ and σ and μ are constants, the maximum occurs at

(A) $x = \sigma$ (C) $x = 2\sigma^2$

(B) $x = \sigma\sqrt{2\pi}$ (D) $x = \mu$

128. $y = Ae^{mx} + Be^{-mx}$, where A, B and m are constants, is a solution of

(A) $\frac{d^2y}{dx^2} - m^2 y = 0$ (C) $B\frac{d^2y}{dx^2} + Ay = 0$

(B) $A\frac{d^2y}{dx^2} + m^2 y = 0$ (D) $\frac{d^2y}{dx^2} + my = m^2$

129. Given $A = \begin{pmatrix} \sin\theta & \tan\theta \\ 0 & \cos\theta \end{pmatrix}$, the sum of squares of eigenvalues of A is

(A) $\tan^2\theta$ (C) $\sin^2\theta$

(B) 1 (D) $\cos^2\theta$

Two Marks Questions.

130. The equation $x\frac{dx}{dy} + y = c$, where c is a constant, represents a family of

(A) Exponential curves
(B) Parabolas
(C) Circles
(D) Hyperbola

131. A closed curve is expressed in parametric form as $x = a\cos\theta$ and $y = b\sin\theta$, where a = 7 m and b = 5 m. Approximating $\pi = 22/7$ which of the following is the area enclosed by the curve?

(A) $110\ m^2$
(B) $74\ m^2$
(C) $35\ m^2$
(D) $144\ m^2$

132. In the equation

$$Ax = B, A = \begin{bmatrix} 1/\sqrt{2} & 0 & 1/\sqrt{2} \\ 0 & 1 & 0 \\ 1/\sqrt{2} & 0 & -1/\sqrt{2} \end{bmatrix}$$

$x = \begin{bmatrix} x \\ y \\ z \end{bmatrix}, B = \begin{bmatrix} 0 \\ 1 \\ -\sqrt{2} \end{bmatrix}$, where A is an orthogonal matrix, the sum of the unknowns, $x + y + z =$____ (round off to one decimal place).

133. If $\int_1^0 (x^2 - 2x + 1)\,dx$ is evaluated numerically using trapezoidal rule with four intervals, the difference between the numerically evaluated value and the analytical value of the integral is equal to ___ (round off to three decimal places)

GATE AE - 2021

One Mark Questions.

134. Consider the differential equation $\frac{d^2y}{dx^2} + 8\frac{dy}{dx} + 16y = 0$ and the boundary conditions $y(0) = 1$ and $y'(0) = 0$. The solution to this equation is

(A) $y = (1 + 2x)e^{-4x}$
(B) $y = (1 - 4x)e^{-4x}$
(C) $y = (1 + 8x)e^{-4x}$
(D) $y = (1 + 4)e^{-4x}$

135. u(x,y) is governed by the following equation

$$\frac{\partial^2 u}{\partial x^2} - 4\frac{\partial^2 u}{\partial x \partial y} + 6\frac{\partial^2 u}{\partial y^2} = x + 2y$$

The nature of this equation is:

(A) linear
(C) hyperbolic
(B) elliptic
(D) parabolic

136. $\lim_{x\to 0}\left(\frac{1}{\sin x} - \frac{1}{x}\right) =$ _______ (Round off to nearest integer).

137. Given that ς is the unit circle in the counter-clockwise direction with its center at origin, the integral $\oint_\varsigma \frac{z^3}{4z-i}dz =$ _______ (round off to three decimal place)

Two Marks Questions.

138. Which of the following statement(s) is/are true about the function defined as $f(x) = e^{-x}|\cos x|$ for $x > 0$?

(A) Differentiable at $x = \pi/2$
(B) Differentiable at $x = \pi$
(C) Differentiable at $x = 3\pi/2$
(D) Continuous at $x = 2\pi$

139. The ratio of the product of eigenvalues to the sum of the eigenvalues of the given matrix is____

$$\begin{bmatrix} 3 & 1 & 2 \\ 2 & -3 & -1 \\ 1 & 2 & 1 \end{bmatrix}$$

(round off to nearest integer)

140. The definite integral $\int_1^5 x^2\,dx$ is evaluated using four equal intervals by two methods –first by the trapezoidal rule and then by the Simpson's one-third rule. The absolute value of the difference between the two calculations is ______ (round off to two decimal places)

GATE AE - 2022

One Mark Questions.

141. The equation of the straight line representing the tangent to the curve $y = x^2$ at the point (1,1) is
(A) $y = 2x - 2$
(B) $x = 2y - 1$
(C) $y - 1 = 2(x - 1)$
(D) $x - 1 = 2(y - 1)$

142. Let $\hat{\imath}, \hat{\jmath}$ and $\hat{k}$ be the unit vectors in the x, y and z directions, respectively. If the vector $\hat{\imath} + \hat{\jmath}$ is rotated about positive $\hat{k}$ by 135°, one gets
(A) $-\hat{\imath}$
(B) $-\hat{\jmath}$
(C) $-\frac{1}{\sqrt{2}}\hat{\jmath}$
(D) $-\sqrt{2}\hat{\jmath}$

143. Let x be a real number and $i = \sqrt{-1}$. Then the real part of $\cos(ix)$ is
(A) $\sinh x$
(B) $\cosh x$
(C) $\cos x$
(D) $\sin x$

144. If $\hat{a}, \hat{b}, \hat{c}$ are three mutually perpendicular unit vectors, then $\hat{a} \cdot (\hat{b} \times \hat{c})$ can take the value(s)
(A) 0
(B) 1
(C) −1
(D) ∞

145. The arc length of the parametric curve: $x = \cos\theta$, $y = \sin\theta$, $z = \theta$ from $\theta = 0$ to $\theta = 2\pi$ is equal to _______ (round off to one decimal place).

Two Marks Questions.

146. The height of a right circular cone of maximum volume that can be enclosed within a hollow sphere of radius R is
(A) R
(B) 5/4 R
(C) 4/3 R
(D) 3/2 R

147. Consider the differential equation
$$\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + y = 0.$$
The boundary conditions are
$y = 0$ and $\frac{dy}{dx} = 1$ at $x = 0$.
Then the value of y at $x = \frac{1}{2}$ is
(A) 0
(B) $\sqrt{e}$
(C) $\sqrt{e}/2$
(D) $\sqrt{e/2}$

148. Consider the partial differential equation
$\frac{\partial^2 f}{\partial x^2} + \frac{\partial^2 f}{\partial y^2} = 0$ where x, y are real.
If $f(x,y) = a(x)b(y)$, where $a(x)$ and $b(y)$ are real functions, which one of the following statements can be true?
(A) a(x) is a periodic function and b(y) is a linear function
(B) both a(x) and b(y) are exponential functions
(C) a(x) is a periodic function and b(y) is an exponential function
(D) both a(x) and b(y)are periodic functions

149. The real function $y = \sin^2(|x|)$ is
(A) continuous for all x
(B) differentiable for all x
(C) not continuous at x = 0
(D) not differentiable at x = 0

150. $\vec{v} = x^3\hat{\imath} + y^3\hat{\jmath} + z^3\hat{k}$ is a vector field where $\hat{\imath}, \hat{\jmath}, \hat{k}$ are the base vectors of a cartesian coordinate system. Using the Gauss divergence theorem, the value of the outward flux of the vector field over the surface of a sphere of unit radius centered at the origin is____ (rounded off to one decimal place).

151. The largest eigenvalue of the given matrix is ____.
$$\begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix}$$

GATE AE - 2023

One Mark Questions.

152. The direction in which a scalar field $\phi(x, y, z)$ has the largest rate of change at any point with position vector $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$ is the same as that of the vector

(A) $\nabla\phi$
(B) $\nabla \times (\phi\vec{r})$
(C) $\phi\vec{r}$
(D) $(\nabla\phi \cdot d\vec{r})\vec{r}$

153. If a monotonic and continuous function $y = f(x)$ has only one root in the interval $x_1 < x < x_2$, then

(A) $f(x_1)f(x_2) > 0$
(B) $f(x_1)f(x_2) = 0$
(C) $f(x_1)f(x_2) < 0$
(D) $f(x_1) - f(x_2) = 0$

154. Consider the one-dimensional wave equation $\frac{\partial u}{\partial t} + \frac{\partial u}{\partial x} = 0$ for $-\infty < x < \infty, t \geq 0$. For an initial condition $u(x, 0) = e^{-x^2}$, the solution at $t = 1$ is

(A) $u(x, 1) = e^{-(x-1)^2}$
(B) $u(x, 1) = e^{-1}$
(C) $u(x, 1) = e^{-x^2}$
(D) $u(x, 1) = e^{-(x+1)^2}$

155. Which of the following statement(s) is/are true with respect to eigenvalues and eigenvectors of a matrix?

(A) The sum of the eigenvalues of a matrix equals the sum of the elements of the principal diagonal.
(B) If λ is an eigenvalue of a matrix A, then $1/\lambda$ is always an eigenvalue of its transpose (A^T).
(C) If λ is an eigenvalue of an orthogonal matrix A, then $1/\lambda$ is also an eigenvalue of A.
(D) If a matrix has n distinct eigenvalues, it also has n independent eigenvectors.

156. The system of equations

$x - 2y + \alpha z = 0$
$2x + y - 4z = 0$
$x - y + z = 0$

has a non-trivial solution for $\alpha =$ _____. (Answer in integer)

Two Marks Questions.

157. Given the function $y(x) = (x + 3)(x - 2)$, for $-4 < x < 4$. What is the value of x at which the function has a minimum?

(A) $-3/2$
(B) $-1/2$
(C) $1/2$
(D) $3/2$

158. Consider the equation $\frac{dy}{dx} + ay = \sin \omega x$, where a and ω are constants. Given $y = 1$ and $x = 0$, select all correct statement(s) from the following as $x \to \infty$.

(A) $y \to 0$ if $a \neq 0$
(B) $y \to 1$ if $a = 0$
(C) $y \to A\exp(|a|x)$ if $a < 0$; A is constant
(D) $y \to B\sin(\omega x + c)$ if $a > 0$; B and C are constant

159. Given the vectors

$\vec{A} = 9\hat{i} - 5\hat{j} + 2\hat{k}$
$\vec{B} = 11\hat{i} + 4\hat{j} + \hat{k}$
$\vec{C} = -7\hat{i} + 14\hat{j} - 3\hat{k}$

Which of the following statement(s) is/are TRUE?

(A) Vectors $\vec{A}, \vec{B}$ and $\vec{C}$ are coplanar.
(B) The scalar triple product of the vectors $\vec{A}, \vec{B}$ and $\vec{C}$ is zero.
(C) $\vec{A}$ and $\vec{B}$ are perpendicular.
(D) $\vec{C}$ is parallel to $\vec{A} \times \vec{B}$

160. Consider the differential equation

$$x^2\frac{d^2y}{dx^2} + 4x\frac{dy}{dx} + 2y = 0 \text{ for } x \geq 1$$

with initial conditions $y = 0, \frac{dy}{dx} = 1$ at $x = 1$.

The value of y at x = 2 is _______. (round off to two decimal places).

GATE AE - 2024

One Mark Questions.

161. The following system of linear equations

$7x - 3y + z = 0$

$3x - y + z = 0$

$x - y - z = 0$

has:

(A) infinitely many solutions

(B) a unique solution

(C) no solution

(D) three solutions

162. Two fair dice with numbered faces are rolled together. The faces are numbered from 1 to 6. The probability of getting odd numbers on both the dice is ____________ (rounded off to 2 decimal places).

163. Using Trapezoidal rule with one interval, the approximate value of the definite integral:

$$\int_1^2 \frac{dx}{1+x^2}$$

(rounded off to 2 decimal places).

Two Marks Questions.

164. Given $y = e^{px} \sin qx$, where p and q are non-zero real numbers, the value of the differential expression

$$\frac{d^2y}{dx^2} - 2p\frac{dy}{dx} + (p^2+q^2)y$$

is

(A) 0

(B) 1

(C) $p^2 + q^2$

(D) pq

165. Consider the function

$$f(x) = \begin{cases} x^2 & \text{for } x < 0 \\ x & \text{for } x \geq 0 \end{cases}$$

where x is real. Which of the following statements is/are correct?

(A) The function is continuous for all x

(B) The derivative of the function is discontinuous at x = 0

(C) The derivative of the function is continuous at x = 1

(D) The function is discontinuous at x = 0

166. Consider the matrix $A = \begin{bmatrix} 5 & -4 \\ k & -1 \end{bmatrix}$, where k is a constant. If the determinant of A is 3, then the ratio of the largest eigenvalue of A to constant k is ________. (rounded off to 1 decimal place).

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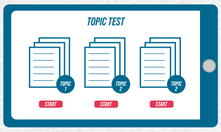

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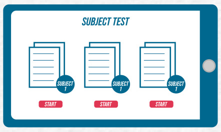

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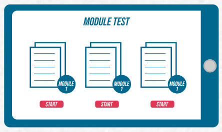

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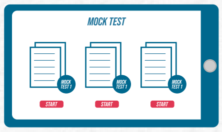

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6	D	7	B	8	C	9	B	10	C
11	C	12	C	13	A	14	D	15	B
16	D	17	D	18	C	19	C	20	D
21	B	22	A	23	B	24	A	25	D
26	B	27	C	28	D	29	D	30	D
31	C	32	D	33	B	34	B	35	A
36	B	37	C	38	B	39	B	40	C
41	C	42	C	43	A	44	A	45	B
46	A	47	C	48	D	49	D	50	D
51	A	52	B	53	C	54	A	55	C
56	D	57	C	58	C	59	C	60	A
61	D	62	0.26 to 0.27	63	A	64	A	65	A
66	D	67	A	68	A	69	0 to 0	70	0 to 0
71	B	72	D	73	A	74	C	75	B
76	C	77	A	78	D	79	A	80	C
81	D	82	A	83	B	84	C	85	A
86	B	87	1.9 to 2.1	88	0.49 to 0.51	89	C	90	B
91	B	92	B	93	B	94	1.0 to 1.0	95	0.0 to 0.0
96	D	97	A	98	A	99	3.13 to 3.15	100	0.56 to 0.58
101	D	102	11.9 to 12.1	103	0 to 0	104	C	105	B
106	B	107	D	108	B	109	0.008 to 0.012	110	C
111	C	112	B	113	B	114	0.0 to 0.0	115	B
116	6.25 to 6.35	117	A	118	B	119	C	120	0.5 to 0.5
121	0.16 to 0.17	122	D	123	1 to 1	124	2 to 2	125	0.5 to 0.5
126	C	127	D	128	A	129	B	130	C
131	A	132	0.9 to 1.1	133	0.010 to 0.012	134	D	135	B
136	0 to 0	137	0.02 to 0.03	138	B; D	139	8 to 8	140	0.66 to 0.68
141	C	142	D	143	B	144	B, C	145	8.6 to 9.1
146	C	147	C	148	C	149	A, B	150	7.4 to 7.7
151	2 to 2	152	A	153	C	154	A	155	A, C, D
156	3 to 3	157	B	158	C, D	159	A, B	160	0.24 to 0.26
161	A	162	0.24 to 0.26	163	0.35 to 0.35	164	A	165	A, B, C
166	1.4 to 1.6