



**QUESTION BANK**

**Year / Semester: I B.Tech I Semester**

**Regulation: R23**

**Subject and Code: LINEAR ALGEBRA & CALCULUS (23BSC114)**

**SYLLABUS**

**UNIT-I: MATRICES (9)**

Rank of a matrix by echelon form, normal form. Cauchy–Binet formulae (without proof). Inverse of Non- singular matrices by Gauss-Jordan method, System of linear equations: Solving system of Homogeneous and Non-Homogeneous equations by Gauss elimination method. Iterative methods: Jacobi and Gauss Seidel Methods.

**UNIT-II: EIGEN VALUES, EIGEN VECTORS AND ORTHOGONAL TRANSFORMATION (9)**

Eigen values, Eigenvectors and their properties, Diagonalization of a matrix, CayleyHamilton Theorem (without proof), finding inverse and power of a matrix by CayleyHamilton Theorem, Quadratic forms and Nature of the Quadratic Forms, Reduction of Quadratic form to canonical forms by Orthogonal Transformation.

**UNIT-III: CALCULUS (9)**

Mean Value Theorems: Rolle's Theorem, Lagrange's mean value theorem with their geometrical interpretation, Cauchy's mean value theorem, Taylor's and Maclaurin's theorems with remainders (without proof), Problems and applications on the above theorems.

**UNIT-IV: PARTIAL DIFFERENTIATION AND APPLICATIONS (MULTI VARIABLE CALCULUS) (9)**

Functions of several variables: Continuity and Differentiability, Partial derivatives, total derivatives, chain rule, Taylor's and Maclaurin's series expansion of functions of two variables. Jacobians, Functional dependence, maxima and minima of functions of two variables, method of Lagrange multipliers.

**UNIT-V: MULTIPLE INTEGRALS (MULTI VARIABLE CALCULUS) (9)**

Double integrals, Triple integrals, change of order of integration, change of variables to polar, cylindrical and spherical coordinates. Finding areas (by double integrals) and volumes (by double integrals and triple integrals).

**TEXT BOOKS:**

1. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers, 2017, 44th Edition
2. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons, 2018, 10th Edition.

**REFERENCE BOOKS:**

1. Thomas Calculus, George B. Thomas, Maurice D. Weir and Joel Hass, Pearson Publishers, 2018, 14th Edition.
2. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Alpha Science International Ltd., 2021 .
3. Advanced Modern Engineering Mathematics, Glyn James, Pearson publishers, 2018, 5th Edition.
4. Advanced Engineering Mathematics, Micheal Greenberg, Pearson publishers, 9th edition
5. Higher Engineering Mathematics, H. K Das, Er. Rajnish Verma, S. Chand Publications, 2014, Third Edition



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**Max Marks: 10**

S.No.	CO	Questions	BT
<b>UNIT I: MATRICES</b>			
1	1	A. Find the rank of the following matrix, by reducing into the echelon form $\begin{bmatrix} -1 & -3 & 3 & -1 \\ 1 & 1 & -1 & 0 \\ 2 & -5 & 2 & -3 \\ -1 & 1 & 0 & 1 \end{bmatrix}$ B. Find the rank of the following matrix, by reducing into the echelon form $\begin{bmatrix} 2 & 1 & 3 & 5 \\ 4 & 2 & 1 & 3 \\ 8 & 4 & 7 & 13 \\ 8 & 4 & -3 & -1 \end{bmatrix}$	<b>L2</b>
2	1	A. Find the rank of the following matrix, by reducing into the echelon form $\begin{bmatrix} 1 & 2 & -1 & 2 \\ 2 & 2 & -1 & 1 \\ -1 & -1 & 1 & -1 \\ 2 & 1 & -1 & 2 \end{bmatrix}$ B. Reduce the matrix $\begin{bmatrix} 1 & 2 & 3 \\ 3 & 4 & 5 \\ 2 & 6 & 5 \end{bmatrix}$ to normal form and hence find the rank	<b>L2</b>
3	1	Reduce the matrix $\begin{bmatrix} 1 & 2 & 3 & 0 \\ 2 & 4 & 3 & 2 \\ 3 & 2 & 1 & 3 \\ 6 & 8 & 7 & 5 \end{bmatrix}$ to normal form and hence find the rank.	<b>L2</b>
4	1	Solve $x + 2y + z = 4, 2x - y + 3z = 9, 3x - y - z = 2$	<b>L2</b>
5	1	Solve $x - y + z = 2, 3x - y + 2z = -6, 3x + y + z = -18$	<b>L2</b>
6	1	Show that the system of equations $x + y + z = 6, x + 2y + 3z = 14, x + 4y + 7z = 30$ is consistent and solve them	<b>L3</b>
7	1	Find the Inverse of $A = \begin{bmatrix} 2 & -1 & 3 \\ 1 & 1 & 1 \\ 1 & -1 & 1 \end{bmatrix}$ by Gauss-Jordan method	<b>L3</b>
8	1	Find the Inverse of $A = \begin{bmatrix} 1 & 2 & 1 \\ 3 & 2 & 3 \\ 1 & 1 & 2 \end{bmatrix}$ by Gauss-Jordan method	<b>L3</b>
9	1	Solve $6x + 2y - z = 4, x + 5y + z = 3, 2x + y + 4z = 27$ by Gauss-Jacobi Method	<b>L2</b>
10	1	Solve $3x - y + z = 1, 3x + 6y + 2z = 0, 3x + 3y + 7z = 4$ by Gauss-Seidal Iterative Method	<b>L2</b>



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S.No.	CO	Questions	BT
<b>UNIT II: EIGEN VALUES, EIGEN VECTORS AND ORTHOGONAL TRANSFORMATION</b>			
1	2	Find the Eigen values & Eigen vectors of the matrix $A = \begin{bmatrix} 8 & -6 & 2 \\ -6 & 7 & -4 \\ 2 & -4 & 3 \end{bmatrix}$	L2
2	2	Find the Eigen values & Eigen vectors of the matrix $A = \begin{bmatrix} 3 & -4 & 3 \\ 1 & 0 & 1 \\ 1 & 2 & -1 \end{bmatrix}$	L2
3	2	Verify Cayley – Hamilton theorem and hence find $A^{-1}$ where $A = \begin{bmatrix} 1 & -2 & 2 \\ 1 & -2 & 3 \\ 0 & -1 & 2 \end{bmatrix}$	L3
4	2	Verify Cayley – Hamilton theorem and hence find $A^4$ where $A = \begin{bmatrix} 1 & 2 & 0 \\ 2 & -1 & 0 \\ 0 & 0 & -1 \end{bmatrix}$	L3
5	2	Verify Cayley – Hamilton theorem and hence find the $A^{-1}$ and $A^4$ where $A = \begin{bmatrix} 1 & 2 & -1 \\ 2 & 1 & -2 \\ 2 & -2 & 1 \end{bmatrix}$	L3
6	2	Verify Cayley – Hamilton theorem and hence find the $A^{-1}$ and $A^4$ where $A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & -1 & 3 \\ 1 & 1 & 2 \end{bmatrix}$	L3
7	2	Diagonalize the matrix $A = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 2 & 1 \\ -4 & 4 & 3 \end{bmatrix}$	L2
8	2	Diagonalize the matrix $A = \begin{bmatrix} 1 & 0 & -1 \\ 1 & 2 & 1 \\ 2 & 2 & 3 \end{bmatrix}$	L3
9	2	Reduce the Quadratic form $3x^2 + 5y^2 + 3z^2 - 2yz + 2zx - 2xy$ to Canonical form by orthogonal transformation	L3
10	2	Reduce the Quadratic form $2x^2 + 2y^2 + 2z^2 - 2xy - 2yz - 2zx$ to Canonical form and state the nature.	L3



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S.No.	CO	Questions	BT
<b>UNIT III: CALCULUS</b>			
1	3	A. Verify Rolle's theorem for $f(x) = x^3 + x^2 - x + 1$ over $[-1,1]$ B. Verify Rolle's theorem for $f(x) = \frac{\sin x}{e^x}$ over $[0, \pi]$	L2
2	3	A. Verify Lagrange's theorem for $f(x) = (x-1)(x-2)(x-3)$ on $[0,4]$ B. Verify Lagrange's theorem for $f(x) = e^{-x}$ on $[-1,1]$	L2
3	3	Show that $\frac{x}{1+x} < \log(1+x) < x$ for $x > 0$ , by Lagrange's theorem	L2
4	3	Show that $\frac{b-a}{1+b^2} < \tan^{-1}b - \tan^{-1}a < \frac{b-a}{1+a^2}$ , $a < b$ and deduce $\frac{\pi}{4} + \frac{3}{25} < \tan^{-1}(4/3) < \frac{\pi}{4} + \frac{1}{6}$	L2
5	3	Verify Cauchy's Mean Value theorem for $f(x) = 3x^2 + 4x + 5, g(x) = x^2 - x + 25$ over $[1,2]$	L2
6	3	Verify Cauchy's Mean Value theorem for $f(x) = \sin x, g(x) = \cos x$ over $[0, \frac{\pi}{2}]$	L2
7	3	Expand $\log(1+e^x)$ in ascending powers of $x$	L2
8	3	Expand $e^{\sin^{-1}(x)}$ as a power series of $x$	L2
9	3	Obtain the Taylor's series expansion of $\cos x$ about $x = \frac{\pi}{2}$	L3
10	3	Express $\sin(2x)$ as a power series in $(x - \frac{\pi}{4})$	L3



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<b>UNIT IV: PARTIAL DIFFERENTIATION AND APPLICATIONS (MULTI VARIABLE CALCULUS)</b>			
1	4	a) If $u = \sin\left(\frac{x}{y}\right)$ ; $x = e^t, y = t^2$ then find $\frac{du}{dt}$ b) If $u = x^2 + y^2$ ; $x = at^2, y = 2at$ then find $\frac{du}{dt}$	L2
2	4	If $u = \frac{x+y}{1-xy}, v = \tan^{-1}x + \tan^{-1}y$ then find $\frac{\partial(u,v)}{\partial(x,y)}$	L2
3	4	If $u = \frac{yz}{x}; v = \frac{zx}{y}; w = \frac{xy}{z}$ , show that $\frac{\partial(u,v,w)}{\partial(x,y,z)} = 4$	L2
4	4	If $u = xyz, v = x^2 + y^2 + z^2, w = x + y + z$ then $\frac{\partial(u,v,w)}{\partial(x,y,z)}$	L3
5	4	Prove that $u = x + y + z, v = xy + yz + zx, w = x^2 + y^2 + z^2$ are functionally dependent and find the relation between them	L3
6	4	Find the maximum and minimum values of $x^3 + y^3 - 3axy, a > 0$	L3
7	4	A rectangular box open at the top has a capacity of 32 cubic feet. Find the dimensions of the box requiring least material for its construction	L3
8	4	Find the volume of the largest rectangular parallelepiped that can be inscribed in the ellipsoid $\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{z^2}{c^2} = 1$	L3
9	4	Find the minimum value of $x^2 + y^2 + z^2$ given that $xyz = a^3$	L3
10	4	Find the minima of $x^2yz^3$ under the condition $2x + y + 3z = a$	L3



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<b>UNIT V: MULTIPLE INTEGRALS(MULTIPLE VARIABLE CALCULUS)</b>			
1	5	A. Evaluate $\int_0^5 \int_0^{x^2} x(x^2 + y^2) dx dy$ B. Evaluate $\int_0^a \int_0^{\sqrt{a^2-y^2}} \sqrt{a^2-x^2-y^2} dx \cdot dy$	L2
2	5	A. Evaluate $\int_a^{2a} \int_0^{\sqrt{2ax-x^2}} xy dy dx$ B. Evaluate $\int_0^1 \int_0^{\sqrt{1+x^2}} \frac{dy dx}{1+x^2+y^2}$	L2
3	5	Evaluate $\int_1^2 \int_1^z \int_0^{yz} (xyz) dx dy dz$	L2
4	5	Evaluate $\int_{-1}^1 \int_0^{x+z} \int_{x-z}^{x+z} (x + y + z) dy dx dz$	L3
5	5	Evaluate $\int_0^1 \int_0^{\sqrt{1-x^2}} \int_0^{\sqrt{1-x^2-y^2}} xyz dz dy dx$	L2
6	5	Evaluate $\int_0^{\pi/2} \int_0^{a \cos \theta} r \sin \theta dr d\theta$	L2
7	5	Evaluate $\iint_R (x^2 + y^2) dx dy$ where R is the region bounded by $y = x$ and $y^2 = 4x$	L3
8	5	Evaluate $\iint_R xy dx dy$ where R is the region bounded by X-axis, $x=2a$ and the curve $x^2 = 4ay$	L3
9	5	Change the order of integration and evaluates $\int_0^1 \int_x^{\sqrt{x}} xy dy dx$	L3
10	5	Change the order of integration and evaluate $\int_0^1 \int_0^{\sqrt{1-x^2}} y^2 dy dx$	L3

Note: L1-Remembering, L2-Understanding, L3-Applying, L4-Analyzing, L5-Evaluating, and L6-Creating



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## **Instruction to Faculty Members:**

### **The Six Levels of Bloom's Taxonomy:**

1. **Remembering:** Retrieving, recognizing, and recalling relevant knowledge from long-term memory (e.g., list, define, name, locate).
2. **Understanding:** Constructing meaning, explaining ideas, or concepts (e.g., summarize, interpret, classify, compare).
3. **Applying:** Using information in new situations or implementing procedures to solve problems (e.g., solve, use, demonstrate, implement).
4. **Analyzing:** Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure (e.g., contrast, categorize, distinguish, diagram).
5. **Evaluating:** Making judgments based on criteria and standards through checking and critiquing (e.g., judge, critique, justify, defend, argue).
6. **Creating:** Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure (e.g., design, construct, develop, formulate).