KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

'A' Grade
NAAC Re-accredited
(4th Cycle)

Semester-wise Code structure and Syllabus for

Faculty: Science and Technology

F. Y. B. Sc. (Mathematics)
(Honors/Research) Program

As per NEP 2020 for Affiliated Colleges

With effect from June2024

Abbreviations:	
• **T:**Theory Course • **P:**Practical course • **DSC:** Discipline Specific Core Course • **DSE:** Discipline Specific Elective Course • **MIN:** Minor subject • **VSEC:** Vocational skill and Skill enhancement courses • **VSC:** Vocational Skill Courses • **SEC:** Skill Enhancement Courses • **GE/OE:** Generic/open elective • **CI:** Constitution of India • **IKS:** Indian Knowledge System • **CEP:** Community engagement and service • **OJT**: On Job Training: Internship/Apprenticeship • **RP:** Research Project • **RM:** Research methodology • **ES:** Environment studies • **ENG:** English • **MIL:** Modern Indian language	• **Co-curricular Course (CC)** **a) CC-1:CC-120: Sports and Yoga** **b) CC-2:CC-130: Cyber Security** **c) CC-3: CC-220: Human Rights and Environment Law** **d) CC-4: CC-229: Communication Skills and Personality Development** • **Value Education Courses (VEC)** **a) VEC1: ES-118: Environmental Science** **b) VEC2: CI-129: Constitution of India** • **Indian Knowledge System(IKS):** **a) IK:119:Ayurvedic Medicine in Ancient India** • **Ability Enhancement Courses (AEC)** **a) AEC-1:EG:101–English -1** **b) AEC-2:EG:102–English -2** **c) AEC-3:MR: 201–Marathi-1** **d) AEC-3:HN: 201–Hindi-1** **e) AEC-3:MR: 202–Marathi-2** **f) AEC-3:HN: 202–Hindi-2**

Cognitive learning is a change in knowledge attributable to experience. This definition has three components: (1) learning involves a change, (2) the change is in the learner’s knowledge, and (3) the cause of the change is the learner’s experience.

Six levels of cognitive learning according to the revised version of Bloom's Taxonomy

Cognitive level	**1**	**2**	**3**	**4**	**5**	**6**
Cognitive task	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating

Semester-wise Code structure for B. Sc (Honors/Research) Program as per NEP2020, for Affiliated Colleges w.e.f – June 2024.												
B. Sc. (Honors/Research) – First Year, SEMESTER – I, Level – 4.5												
Course	**Course Type**	**Course Code**	**Course Title**	**Credits**	**Teaching Hours/Week**			**Marks (Total100)**				
					T	**P**	**Total**	**Internal(CA)**		**External(UA)**		
								T	**P**	**T**	**P**	
DSC-1	DSC	MT-111	Calculus	2	2	--	2	20	--	30	--	
DSC-2	DSC	MT-112	Practical course on Matrix Algebra	2	--	4	4	--	20	--	30	
OE-1	OE	MT-113	Mathematics for Competitive Examinations	2	2	--	2	20	--	30	--	
VEC-1	VEC	ES-118	Environmental Science	2	2	--	2	20	--	30	--	
IKS (Generic)	IKS	IK-119	Ayurvedic Medicine in Ancient India	2	2	--	2	20	--	30	--	
CC-1	CC	CC-120	Sports and Yoga	2	2	--	2	50	--	--	--	
AEC-1	AEC	EG-101	English-1	2	2	--	2	20	--	30	--	
B.Sc. (Honors/Research)–First Year,SEMESTER–II,Level–4.5												
DSC-4	DSC	MT-121	Theory of Equations	2	2	--	2	20	--	30	--	
DSC-5	DSC	MT-122	Practical course on Coordinate Geometry	2	--	4	4	--	20	--	30	
OE-2	OE	MT-123	Quantitative Aptitude and Logical Reasoning	2	2	--	2	20	--	30	--	
VEC-2	VEC	CI-129	Constitution of India	2	2	--	2	20	--	30	--	

Course	Course Type	Course Code	Course Title	Credits	Teaching Hours/Week			Marks(Total100)			
								Internal (CA)		External (UA)	
					T	P	Total	T	P	T	P
CC-2	CC	CC-130	**Cyber Security**	2	2	--	2	50	--	--	--
AEC-2	AEC	EG-102	**English-2**	2	2	--	2	20	--	30	--
Cumulative Credits for First Year–44											
Semester-wise Code structure for B.Sc (Honors/Research) Program as per NEP2020, for Affiliated Colleges w.e.f–June2024.											
B.Sc.(Honors/Research)–Second Year, SEMESTER–III, Level–5.0											
DSC-7	DSC	MT-211	Real Analysis-1	2	2	--	2	20	--	30	--
DSC-8 (IKS)	DSC (IKS)	MT-212	Vedic Mathematics	2	2	--	2	20	--	30	--
DSC-9	DSC	MT-213	Practical Course on GeoGebra	2	--	4	4	--	20	---	30
MIN-1	MIN	MT-214	Real Analysis	2	---	4	4	---	20	---	30
MIN-2	MIN	MT-215	Algebra	2	2	---	2	20	---	30	---
MIN-3	MIN	MT-216	Practical Course on Numerical Methods	2	---	4	4	---	20	---	30
OE-3	OE	MT-217	Financial Mathematics	2	2	---	2	20	---	30	---
SEC-1	SEC	MT-218	Numerical Methods	2	2	--	2	20	--	30	--
SEC-2	SEC	MT-219	Practical Course on Programming in SciLab	2	--	4	4	--	20	--	30
CC-3	CC	CC-220	**Human Rights and Environment Law**	2	2	--	2	20	--	30	--
		MR-201	**Marathi-1**	2	2	--	2	20	--	30	--

AEC-3	AEC	HN-201	Hindi-1	2	2	--	2	20	--	30	--
B.Sc.(Honors/Research)–SecondYear,SEMESTER–IV,Level–5.0											
DSC-11	DSC	MT-221	Group Theory	2	2	---	2	20	---	30	---
DSC-12	DSC	MT-222	Practical Course on SageMath	2	2	---	2	20	---	30	---
MIN-4	MIN	MT-225	Graph Theory	2	2	---	2	20	---	30	---
MIN-5	MIN	MT-226	Practical Course on Differential Equations	2	---	4	4	---	20	---	30
OE-4	OE	MT-227	Fundamentals of Mathematics (Set, Logic, functions, Relation, Graphs)	4	4	---	4	40	---	60	---
VC-1	VC	MT-228	Vector Calculus								
VC-2	VC	MT-229	Practical Course on C Language								
OJT/ CEP	OJT/ CEP	OJT/ CEP-230	OJT / CEP	2	2	---	2	20	---	30	---
CC-4	CC	CC-231	**Communication Skills and Personality Development**	2	2	--	2	20	--	30	--
AEC-4	AEC	MR-232	Marathi-2	2	2	--	2	20	--	30	--
		HN-232	Hindi-2	2	2	--	2	20	--	30	--
CumulativeCreditsforFirstYear–44											
* Students need to complete one month on job training **(OJT/CEP)** or internship in any industry related to major subject.											
Semester wise Code structure for B.Sc (Honors/Research)Program as per NEP2020,for Affiliated Colleges w.e.f–June2024.											
B.Sc.(Honors/Research)–ThirdYear,SEMESTER–V,Level–5.5											

Course	Course Type	Course Code	Course Title	Credits	Teaching Hours/Week			Marks(Total100)			
					T	P	Total	Internal(CA)		External(UA)	
								T	P	T	P
DSC-15	DSC	MT-311	Abstract Algebra	2	2	---	2	20	---	30	---
DSC-16	DSC	MT-312	Real Analysis-2	2	2	---	2	20	---	30	---
DSC-17	DSC	MT-313	Dynamics	2	2	---	2	20	---	30	---
DSC-18	DSC	MT-314	Ordinary Differential Equations	2	---	4	4	---	20	---	30
DSC-19	DSC	MT-315	Graph Theory	2	---	4	4	---	20	---	30
			Practical Course on Algebra &Analysis								
			Practical Course on Dynamics& ODE								
DSE-1	DSE	MT-316(A)	Number Theory	2	2	---	2	20	---	30	---
		MT-316(B)	Differential Geometry	2	2	---	2	20	---	30	---
DSE-2	DSE	MT-317	Practical Course on Laplace Transform	2	---	4	4	---	20	---	30
SEC-3	SEC	MT-319	Programming in C++	2	2	---	2	20	---	30	---
FP	**FP**	**MT-320**	**Field Project**	4	--	8	8	--	40	--	60
B.Sc.(Honors/Research)–Third Year,SEMESTER–VI,Level– 5.5											
DSC-20	DSC	MT-321	Linear Algebra	2	2	---	2	20	---	30	---
DSC-21	DSC	MT-322	Metric Spaces	2	2	---	2	20	---	30	---

DSC-22	**DSC**	**MT-323**	Complex Variables	**2**	**2**	**---**	**2**	**20**	**---**	**30**	**---**
DSC-23	**DSC**	**MT-324**	Partial Differential Equations	**2**	**---**	**4**	**4**	**---**	**20**	**---**	**30**
DSC-24	**DSC**	**MT-325**	Practical-6 (Linear Algebra & Metric Spaces)	**2**	**---**	**4**	**4**	**---**	**20**	**---**	**30**
			Practical-7 (Complex Analysis & PDE)								
DSE-3	**DSE**	**MT-326(A)**	Fourier Transforms	**2**	**2**	**---**	**2**	**20**	**---**	**30**	**---**
		MT-326(B)	Operations Research	**2**	**2**	**---**	**2**	**20**	**---**	**30**	**---**
DSE-4	**DSE**	**MT-327**	Practical Course on Python	**2**	**---**	**4**	**4**	**---**	**20**	**---**	**30**
VC-3	**VC**	**MT-328**	Statistical Methods	**2**	**2**	**---**	**2**	**20**	**---**	**30**	**---**
VC-4	**VC**	**MT-329**	Combinatorics	**2**	**2**	**--**	**2**	**20**	**--**	**30**	**--**
***OJT/Int**	**OJT/Int**	**MT-330**	**On Job Training/Internship**	**4**	**--**	**8**	**8**	**--**	**40**	**--**	**60**
*Students need to complete one month on job training **(OJT)** or internship in any industry related To major subject.											

Semester wise Code structure for B.Sc (Honors/Research) Program as per NEP 2020, for Affiliated Colleges w.e.f– June 2024.											
B.Sc.(Honors/Research)– 4thYear(Research), SEMESTER–VII, Level–6.0											
Course	**Course Type**	**Course Code**	**Course Title**	**Credits**	**Teaching Hours/Week**			**Marks (Total100)**			
					T	**P**	**Total**	**Internal(CA)**		**External(UA)**	
								T	**P**	**T**	**P**
DSC-25	**DSC**	**MT-411**	Abstract Algebra	**4**	**4**	**---**	**4**	**40**	**---**	**60**	**---**

DSC-26	**DSC**	**MT-412**	Latex	2	2	---	2	20	---	30	---
DSC-28	**DSC**	**MT-414**	Topology	4	4	---	4	40	---	60	---
DSE-5	**DSE**	**MT-416(A)**	Theory of Special Functions	4	4	---	4	40	---	60	---
		MT-416(B)	Universal Algebra	4	4	---	4	40	---	60	---
RM	**RM**	**MT-417**	**Research Methodology**	4	4	--	4	40	--	60	--
RP	**RP**	**MT-417**	**Research Project**	4	--	8	8	--	40	--	60
B.Sc (Honors/Research)–4thYear(Research), SEMESTER–VIII, Level–6.0											
DSC-30	**DSC**	**MT-421**	Complex Analysis	4	4	---	4	40	---	60	---
DSC-31	**DSC**	**MT-422**	Analytic Number Theory	2	2	---	2	20	---	30	---
DSC-33	**DSC**	**MT-424**	Theory of Modules	4	4	---	4	40	---	60	---
DSE-6	**DSE**	**MT-426(A)**	Integral Equations	4	4	---	4	40	---	60	---
		MT-426(B)	Classical Mechanics	4	4	---	4	40	---	60	---
RP	**RP**	**MT-427**	**On Job Training / Internship**	8	--	16	16	--	80	--	120
*Students need to complete one month on job training **(OJT)** or internship in any industry related to major subject.											

- **One credit means:** One hour of theory or Two hours of laboratory work for a duration of a semester (13- 15 weeks) resulting in the award of one credit.
- **Passing standards: 40% marks in UA and CA separately**.

Semester–I

Course Code: MT-111
Course Title: Calculus

Course Code: MT-111	**Course Category: Core Course (DSC-1)**
Course Title: Calculus	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives:

- To know the concept of real numbers, supremum, infimum and completeness of real numbers.
- Assimilate the notion of limit of a sequence.
- Assimilate the notion of convergence of a series of real numbers.
- To know the limit of a function at a point.

Course Outcomes: After successful completion of this course, students are expected to:	Cognitive level
• Understand the notions of real numbers, supremum, infimum and completeness of real numbers.	5
• Understand the notion of limit of a sequence.	5
• Understand the notion of convergence of a series of real numbers.	5
• Calculate the limit of a function at a point.	5

Course Content:

Unit-1.Real Numbers **Hours-7, Marks-7**

1.1 Well-Ordering Property of $\mathbb{N}$, algebraic properties and order properties of $\mathbb{R}$
1.2 Arithmetic mean-Geometric mean inequality, Bernoulli's inequality
1.3 Absolute value function and its properties
1.4 Triangle inequality and its consequences
1.5 Neighbourhood of a point on a real line
1.6 Upper bound, Lower bound, bounded sets, supremum, infimum of subsets of $\mathbb{R}$
1.7 Completeness property of $\mathbb{R}$, Archimedean property and its consequences
1.8 The density theorem (without proof)
1.9 Intervals of real line, nested interval property (statement only).

Unit-2. Sequences **Hours-8, Marks-8**

2.1 Definition and examples of sequences of real numbers
2.2 Definition and examples of limit of sequence and uniqueness of limit

2.3 Relation between bounded and convergent sequence
2.4 Algebra of limits
2.5 Monotone sequences and Monotone convergence theorem
2.6 Subsequence and divergence criteria
2.7 Monotone Subsequence theorem (without proof)
2.8 Bolzano-Weierstrass theorem (first proof)
2.9 Definition and examples of Cauchy sequence.

Unit-3. Series **Hours-7, Marks-7**

3.1 Definition and examples of series
3.2 Sequence of partial sums
3.3 Convergent series and Divergent series
3.4 Some tests for convergence of series (statements and examples only).

Unit-4. Limits **Hours-8, Marks-8**

4.1 Functions and their Graphs
4.2 Definition and examples of cluster point
4.3 Limit of a function
4.4 Sequential criterion for limits
4.5 Divergence criteria
4.6 Algebra of limits (proofs using sequential criterion)
4.7 Squeeze theorem for limit
4.8 One sided limits
4.9 Infinite limits (without proof).

Reference Books:

1. Bartle,R.G., and Sherbert,D.R., *Introduction to Real Analysis*(4th ed.). John Wiley and SonsInc.
2. Malik, S. C. (2011).*Principles of Real Analysis*(2nd ed.).New Academic Science.
3. Howard A., Bivens,I., and Stephan D. (2016). *Calculus* (10th ed.). WileyIndia.
4. Gabriel, K. (1986). *Aspects of Calculus*. Springer-Verlag.
5. Wieslaw, K.,andRai B. (2003). *Calculus with Maple Labs*. Narosa.
6. Prasad,G.(2016). *Differential Calculus* (19th ed.). Pothishala Pvt. Ltd.
7. Thomas, G. B., Hass, J., Heil,C., andWeir M. D. (2018). *Thomas' Calculus* (14th ed.). Pearson Education.

Course Code: MT-112
Course Title: Practical course on Matrix Algebra

Course Code: MT-112	**Course Category: Core Course (DSC-2)**
Course Title: Practical course on Matrix Algebra	**Type: Practical**
Total Contact Hours: 60 (4/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives: The main objectives are:

- To understand the concepts and practical oriented applications of matrices.
- To improve problem solving and logical thinking abilities of the students.
- To study the concepts of theory of matrices in linear algebra.
- To use theory of matrices in solving linear equations.

Course Outcomes: After successful completion of this course students are expected to:	Cognitive level
• Understand operations on matrices.	5
• Understand the concept of rank of a matrix and inverse of a matrix.	5
• Understand the concept of eigenvalues and eigenvectors.	5
• Understand the concept of orthogonal matrices, quadratic forms, diagonal forms and canonical forms.	5

Sr. No.	Content
1	**Practical No.-1: Adjoint of a matrix** Types of a matrices, elementary operations on matrices, Minors and Co-factors of a matrix, Adjoint of a matrix.
2	**PracticalNo.-2: Inverse of a matrix** Inverse of a matrix, Existence & uniqueness theorem of inverse of a matrix, Properties of inverse of a matrix
3	**PracticalNo.-3:Elementary matrices and normal form of a matrix** Elementary transformations, Elementary matrices, Inverse of matrices using elementary transformations, Reduction to normal form, Normal form (canonical form) of a matrix.
4	**PracticalNo.-4: Rank of a Matrix** Rankof matrix, Invariance of rank under elementary transformations,

	Rank of product of two matrices.
5	**PracticalNo.-5: Application of matrices to solve the system of linear equations** Homogeneous and non-homogeneous system of linear equations, Consistency and non consistency of system of linear equations, Solution the system of linear equations using matrices.
6	**PracticalNo.-6: Eigen values and Eigen vectors of matrices** Characteristic equation of a matrix, Cayley Hamilton theorem (statement only) and its use to find the inverse of a matrix, Eigen values and Eigen vectors of matrices.
7	**PracticalNo.-7: Orthogonal Matrices** Orthogonal Matrices, Properties of Orthogonal Matrices.
8	**PracticalNo.-8: Quadratic Forms** Quadratic forms: matrix representations, Elementary congruent transformations, Diagonal form of a quadratic form, Canonical forms.

List of Practicals

PracticalNo.-1: Adjoint of a matrix

1) For any square matrix A of order n, prove that

   $A(adjA) = (adjA)A = |A|I$ where I is an identity matrix of order n.

2) If A and B are any square matrices of same order, then prove that
$$adj(AB) = (adjB)(adjA)$$
3) If A is non-singular matrix of order n, then prove that

   i) $|adjA| = |A|^{n-1}$ ii) $adjA$ is non-singular matrix.

4) Let $A = \begin{bmatrix} 1 & -4 \\ -2 & 3 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 4 \\ 1 & 2 \end{bmatrix}$. Find $adjAB$ and $adjBA$.

5) Compute $\left\{(-2)\begin{bmatrix} 1 & -3 \\ 7 & 9 \\ 8 & 0 \end{bmatrix} + (3)\begin{bmatrix} 6 & 0 \\ 9 & 5 \\ 1 & 2 \end{bmatrix}\right\}\begin{bmatrix} 3 \\ -2 \end{bmatrix}$.

6) Find $adjA$, where $A = \begin{bmatrix} 1 & 0 & 1 \\ 2 & 3 & -1 \\ -1 & 4 & -3 \end{bmatrix}$.

7) If $= \begin{bmatrix} -3 & 1 & 0 \\ 2 & -2 & 1 \\ -1 & -1 & 1 \end{bmatrix}$, then show that $A(adjA)$ is a null Matrix.

8) Let $A = \begin{bmatrix} 2 & -1 \\ -3 & 5 \end{bmatrix}$ and $B = \begin{bmatrix} -1 & 4 \\ 1 & -2 \end{bmatrix}$. Verify $adj(AB) = (adjB)(adjA)$.

9) For the matrix $A = \begin{bmatrix} 2 & -2 & 3 \\ 3 & -1 & 2 \\ 1 & 2 & -1 \end{bmatrix}$, verify that $A(adjA) = (adjA)A = |A|I$.

10) Verify that $adj(2A) = 2^2 \cdot adjA$ where$A = \begin{bmatrix} 2 & 1 & 1 \\ -1 & 2 & 1 \\ 3 & 4 & 1 \end{bmatrix}$.

PracticalNo.-2: Inverse of a matrix

1) Prove that matrix A is invertible if and only if matrix A is non-singular.
2) If A and B are non-singular matrices of same order, then prove that $(AB)^{-1} = B^{-1}A^{-1}$.
3) If A is a non-singular matrix of order n and k a non-zero scalar, then prove that
    a) $(kA)^{-1} = \frac{1}{k}A^{-1}$
    b) $|A^{-1}| = \frac{1}{|A|}$
    c) $adj(adjA) = |A|^{n-2} \cdot A$
4) If A is non-singular matrix and n is natural number, then prove that $(A^n)^{-1} = (A^{-1})^n$.
5) Find the inverse of matrix $A = \begin{bmatrix} 1 & 2 & 4 \\ 7 & 2 & 0 \\ 0 & 1 & 2 \end{bmatrix}$.
6) Let$A = \begin{bmatrix} 1 & 0 & 1 \\ 2 & 5 & 7 \\ -1 & -2 & -3 \end{bmatrix}$. Then verify that $(A')^{-1} = (A^{-1})'$.
7) Let $A = \begin{bmatrix} 1 & -1 \\ 3 & -3 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 2 \\ 2 & 2 \end{bmatrix}$. Verify that $(AB)^{-1} = B^{-1}A^{-1}$

8) Find the inverse of a matrix $A = \begin{bmatrix} 7 & -2 \\ -2 & 3 \end{bmatrix}$ and verify $A \cdot A^{-1} = I$.

9) Using adjoint method find A^{-1} if exists where $A = \begin{bmatrix} 1 & 3 & 3 \\ 1 & 4 & 3 \\ 1 & 3 & 4 \end{bmatrix}$.

10) Find inverse of the matrix$A = \begin{bmatrix} 2 & 0 & -1 \\ 3 & 4 & 0 \\ -1 & 1 & 1 \end{bmatrix}$ using adjoint method.

Practical No.-3: Elementary matrices and normal form of a matrix

1) Prove that the inverse of elementary matrix is an elementary matrix of the same type.

2) Every nonsingular matrix can be expressed as a product of a finite number of elementary matrices.

3) If $A$is matrix of rank 'r' then prove that there exists non-singular matrices P and Q such that $PAQ = \begin{bmatrix} I_r & O \\ O & O \end{bmatrix}$, I_r is unit matrix of order r.

4) Compute i) $E_{13}(E_{23})^{-1}E'_{21}(-1)$ ii) $\left(E_2\left(\frac{1}{2}\right)\right)^{-1} E_{32}E'_{31}(2)$ of order 3.

5) Find nonsingular matrices P and Q such that PAQ is in normal form of A where $A = \begin{bmatrix} 2 & 6 \\ 1 & 3 \\ 3 & 9 \end{bmatrix}$.

6) Reduce matrix $A = \begin{bmatrix} 2 & 4 \\ 4 & -2 \\ 8 & 0 \end{bmatrix}$ to its normal form.

7) Reduce matrix $A = \begin{bmatrix} 2 & -1 & 0 \\ 1 & 3 & -2 \\ -1 & 0 & 1 \end{bmatrix}$ as a product of Elementary matrices and hence find the inverse.

8) Express a non-singular matrix $A = \begin{bmatrix} 13 & 3 & 3 \\ 4 & 1 & 1 \\ 4 & 0 & 1 \end{bmatrix}$ as a product of elementary matrices.

9) Find non-singular matrices P and Q such that PAQ is in normal form. Hence find rank of A where $A = \begin{bmatrix} 1 & 1 & 2 \\ 1 & 2 & 3 \\ 0 & -1 & -1 \end{bmatrix}$.

10) Reduce the matrix $\begin{bmatrix} 1 & -1 & 1 & -1 \\ -2 & 2 & -2 & 2 \\ 1 & 2 & 3 & 4 \\ 0 & 0 & 0 & 1 \end{bmatrix}$ to its normal form.

Practical No.-4: Rank of Matrices

1) If $A_{m\times n}$ is matrix of rank r, then prove that there exists a non-singular matrix P such that $PA = \begin{bmatrix} G \\ O \end{bmatrix}$ where G is $r \times n$ matrix of rank r and O is null matrix of order $(m - r) \times n$.

2) Find non-singular matrices P and Q such that PAQ is in normal form. Hence find rank of A where $\begin{bmatrix} 2 & 3 & 1 & 4 \\ 1 & 2 & 2 & 3 \\ 0 & -1 & -3 & -2 \end{bmatrix}$. Also find rank of A.

3) Prove that the rank of product of two matrices cannot exceed the rank of either matrix. i.e. $rank(AB) \leq min\{rankA,\ rankB\}$.

4) Reduce the matrix $A = \begin{bmatrix} 1 & 0 & 1 \\ 0 & 5 & 7 \\ 1 & 2 & 3 \end{bmatrix}$ to its normal form and hence determine its rank.

5) Reduce the matrix to its normal form and hence determine its rank where

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 3 & 2 & 1 \\ 1 & 3 & 2 \\ 2 & 1 & 3 \end{bmatrix}.$$

6) Reduce the matrix to its first canonical form and hence determine its rank where $A = \begin{bmatrix} 1 & -1 & 2 & -3 \\ 4 & 1 & 0 & 2 \\ 0 & 3 & 0 & 4 \\ 0 & 1 & 0 & 2 \end{bmatrix}$.

7) Determine the value of x(if any)that will make $\varrho(A) = 3$, where

$$A = \begin{bmatrix} x-3 & 1 & 3 \\ 0 & x & 9 \\ -3 & 3 & x \end{bmatrix}.$$

8) If $A = \begin{bmatrix} 2 & 0 & 2 \\ 0 & x & 1 \\ -2 & -1 & x \end{bmatrix}$, then find the values of x if $\varrho(A) = 3$.

9) Find the rank of matrix A and $A + B$, where

$$A = \begin{bmatrix} 1 & 1 & -1 \\ 2 & -3 & 4 \\ 3 & -2 & 3 \end{bmatrix} \text{and} B = \begin{bmatrix} -1 & -2 & -1 \\ 6 & 12 & 6 \\ 5 & 10 & 5 \end{bmatrix}.$$

10) Determine the value of x (if any) for which the matrix

$A = \begin{bmatrix} x & x & 1 \\ 1 & x & x \\ x & 1 & x \end{bmatrix}$ has a) rank 3 b) rank 2 and c) rank 1.

Practical No.-5: Application of matrices to solve the system of linear equations

1) Check which of the following system of linear equations is homogeneous:
   a) $x + y + z = 0, 2x + 5y + 6z = 0.$
   b) $x + y = 1, 2x + 5y = 0.$
   c) $x + y - 3 = 0, 2x + y - 2 = 0.$
   d) $x + y = 2, y + z = 2.$

2) Examine the following equations for consistency and if consistent solve them $x_1 - 2x_2 + x_3 - x_4 = -1$,
   $3x_1 - 2x_3 + 3x_4 = 4$,
   $5x_1 - 4x_2 + x_4 = 2.$

3) If $A = \begin{bmatrix} 2 & 1 & -1 \\ 1 & -2 & 3 \\ -1 & 3 & -4 \end{bmatrix}$, then find A^{-1} and hence solve the following system of linear equations

$2x + y - z = 0,\ x - 2y + 3z = 9,\ -x + 3y - 4z = -12.$

4) Solve the following system of linear equations

$x + y + z = 0,\ 2x + 5y + 6z = 0,\ x - 2y + z = 0.$

5) Solve the following system of linear equations

$$x_1 + 3x_2 + 4x_3 - 6x_4 = 0,$$
$$x_2 + 6x_3 = 0,$$
$$2x_1 + 2x_2 + 2x_3 - 3x_4 = 0,$$
$$x_1 + x_2 - 4x_3 - 4x_4 = 0.$$

6) For what values of λ the following equations have non-zero solutions

$$\lambda x_1 - x_2 - x_3 = 0,$$
$$-x_1 + \lambda x_2 - x_3 = 0$$
$$-x_1 - x_2 + \lambda x_3 = 0.$$

7) Solve the following system of linear equations
$2x + y - z = -1,\ x - 2y + 3z = 9,\ -x + 3y - 4z = -12.$

8) Consider the system
$2x + y - z = -1,\ x - 2y + 3z = 9,\ -x + 3y - 4z = -12.$
Write the matrix form of the system, find its normal form and solve the system.

9) Investigate for what values of λ and μ, the system $2x + 3y + 5z = 9,\ 7x + 3y - 2z = 8,\ 2x + 3y + \lambda z = \mu$ have i) no solution ii) a unique solution iii) an infinite number of solutions.

10) Examine non-trivial solutions for the homogeneous system of linear equations $4x - y + 2z + w = 0,$
$2x + 3y - z - 2w = 0,$
$7y - 4z - 5w = 0,$
$2x - 11y + 7z + 8w = 0.$

Practical No.-6: Eigen values and Eigen vectors

1) Find the characteristics equation of the matrix $A = \begin{bmatrix} 3 & 2 & -1 \\ 1 & 3 & 0 \\ 2 & -1 & 2 \end{bmatrix}$.

2) Find an eigenvalues of $\begin{bmatrix} 1 & 6 \\ 5 & 2 \end{bmatrix}$ and find the corresponding eigenvectors.

3) Find the eigenvalues and eigen vectors of $A = \begin{bmatrix} 4 & -1 \\ 2 & 1 \end{bmatrix}$.

4) Find the inverse of $A = \begin{bmatrix} 1 & 1 & 3 \\ 1 & 3 & -3 \\ -2 & -4 & -4 \end{bmatrix}$ using Cayley Hamilton theorem.

5) Verify the Caley Hamilton theorem for $A = \begin{bmatrix} 2 & 1 & 1 \\ 0 & 1 & 0 \\ 1 & 1 & 2 \end{bmatrix}$.

6) Find the eigenvalues of a matrix $\begin{bmatrix} 1 & 2 & 3 \\ 0 & 2 & 3 \\ 0 & 0 & 2 \end{bmatrix}$.

7) Find the eigenvalues and eigenvectors of a matrix $A = \begin{bmatrix} -5 & 2 \\ -7 & 4 \end{bmatrix}$.

8) Verify the Cayley Hamilton theorem for $A = \begin{bmatrix} 1 & -5 \\ 3 & 2 \end{bmatrix}$ and hence find its inverse.

9) Find the characteristics equation and eigenvalues of the matrix $A = \begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{bmatrix}$.

10) Find the eigenvalues and eigenvectors of a matrix $A = \begin{bmatrix} 0 & 5 & -10 \\ 0 & 22 & 16 \\ 0 & -9 & -2 \end{bmatrix}$.

Practical No.-7: Orthogonal Matrices

1) If A is an orthogonal matrix, then prove that $|A| = \pm 1$ and $A^{-1} = A'$.

2) Prove that:
   i) Product of two orthogonal matrices of same order is an orthogonal matrix.
   ii) The inverse of an orthogonal matrix is orthogonal.

3) Find condition that $A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$ is an orthogonal matrix.

4) Prove that the matrix $A = \frac{1}{9}\begin{bmatrix} -8 & 4 & 1 \\ 1 & 4 & -8 \\ 4 & 7 & 4 \end{bmatrix}$ is orthogonal. Hence find A^{-1}.

5) Check whether $A = \begin{bmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$ is orthogonal.

6) Find l, m, n if the matrix$A$= $\begin{bmatrix} 0 & 2m & n \\ l & m & -n \\ l & -m & n \end{bmatrix}$ is orthogonal and write its inverse.

7) Frame four distinct orthogonal matrices of order two whose a_{11} element is $\frac{3}{5}$.

8) If $\bar{a} = (1,2,2), \bar{b} = (2,-2,1)$, show that $\bar{a} \perp \bar{b}$ and obtain two orthogonal matrices of order 3, whose first two rows are $\bar{a} \& \bar{b}$. Out of there two, without computing determinants, state which matrix is proper.

9) Examine the matrix $A = \begin{bmatrix} \frac{2}{3} & \frac{1}{3} \\ \frac{-1}{3} & \frac{2}{3} \end{bmatrix}$ is orthogonal matrix.Hence find its inverse.

10) Show that matrix $A = \begin{bmatrix} \frac{1}{\sqrt{3}} & \frac{1}{\sqrt{6}} & \frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{3}} & \frac{-2}{\sqrt{6}} & 0 \\ \frac{1}{\sqrt{3}} & \frac{1}{\sqrt{6}} & \frac{-1}{\sqrt{2}} \end{bmatrix}$ is proper orthogonal matrix.

Practical No.-8: Quadratic forms

1) Prove that if A and B are congruent matrices then by a finite sequence of elementary congruent transformations, A can be reduced to B.

2) Reduce the symmetric matrix A= $\begin{bmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & -3 \end{bmatrix}$ to the diagonal form.

3) Obtain the linear transformation of the quadratic form
$q = {x_1}^2 - {x_2}^2 + {x_3}^2 - 2x_1x_2 + 4x_2x_3$
under the linear transformation
$x_1 = y_1 + y_2 + y_3,$
$x_2 = y_2 - y_3,$
$x_3 = 2y_3.$

4) Find the matrix of the quadratic form $x_1^2 - 2x_2^2 - 3x_3^2 + 4x_1x_2 + 6x_1x_3 - 8x_2x_3$. Also determine the rank of a matrix.

5) Reduce the quadratic form$x_2^2 + 2x_1x_2 + 4x_1x_2 - 2x_2x_3$to its canonical form. Find its rank, index, and signature.
6) Obtain the linear transformation of the form $q = x_1^2 - x_2^2 + x_3^2 - 2x_1x_2 + 4x_2x_3$ Under linear transformations,
$x_1 = y_1 + y_2 + y_3,$
$x_2 = y_2 - y_3,$
$x_3 = 2y_3.$

7) Obtain a nonsingular matrix P such that $P'AP$ is diagonal matrix where matrix $A = \begin{bmatrix} -1 & 0 & 5 \\ 0 & 2 & 3 \\ 5 & 3 & 4 \end{bmatrix}$.

8) Reduced the quadratic form ${x_1}^2 + 2{x_2}^2 + 2{x_3}^2 + 2x_1x_2 - x_1x_3 + 2x_2x_3$ to its canonical form. Find the rank, index and signature and classify it.

9) Reduce the matrix $A = \begin{bmatrix} 6 & 2 & 9 \\ 2 & 3 & 2 \\ 9 & 2 & 14 \end{bmatrix}$ to its diagonal form.

10) Classify the quadratic forms
$q = {x_1}^2 - 2{x_2}^2 + 3{x_3}^2 - 2x_1x_3 \mp 4x_2x_3 - 10x_1x_2$
as positive definite /negative definite/semi definite /indeption.

Reference Books:

1. Datta, K. B. (2000). *Matrix and Linear Algebra*. Prentice Hall of India Pvt.. New Delhi..
2. Narayan, Shanti. (2010). *A Text Book of Matrices*. S. Chand Limited. New Delhi.

3. Bronson, Richord. (1989). *Schaum's Outline of Theory and Problem of MATRICES*. McGraw-Hill. New Delhi.
4. Vince, John A. (2010).*Mathematics for Computer Graphics*. Springer-Verlag London.

Course Code: MT-113
Course Title: Mathematics for Competitive Examinations

Course Code: MT-113	**Course Category: Core Course (OE-1)**
Course Title: Mathematics for Competitive Examinations	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives: The main objectives are:

- To develop skill to meet the competitive examinations for better job opportunity.
- To accommodate fundamental and mathematical aspects to instill confidence among students.
- To enrich their knowledge and develop their logical reasoning thinking ability.
- To acquire fundamental mathematics ratio, proportion, interests and percentage.

Course Outcomes: After successful completion of this course students are expected to:	Cognitive level
• Understand and appreciate usage of mathematical concepts which are utmost important in all walks of life.	2
• Solve the problems easily by using short-cut methods with time management which will be helpful for them to clear the competitive examinations for better job opportunities.	5
• Analyze the problems logically and approach the problems in a different manner.	4

Course Content:

Unit 1. Numbers **Hours-7, Marks-7**

1.1 Number Systems
1.2 LCM and HCF
1.3 Decimal Fractions
1.4 Simplification

Unit 2. ArithmeticProblems-I **Hours-8, Marks-8**

1.5 Square Roots and Cube Roots

2.1 Average

2.2 Problems on Numbers

2.3 Problems on Ages

Unit 3. Arithmetic Problems-II **Hours-7, Marks-7**

3.1 Surds and Indices

3.2 Logarithm

3.3 Percentage

3.4 Profit and loss

Unit 4. Aptitude Problems **Hours-8, Marks-8**

4.1 Ratio and proportion

4.2 Partnership

4.3 Chain rule

4.4 Pipe and Cisterns

Reference Books:

1. Aggarwal, R. S. (2016).*Quantitative Aptitude (Fully solved)*. S. Chand.
2. Praveen, R.V. (2013). *QuantitativeAptitude and Reasoning*. 2nd Revised Edition. Prentice-Hall of India Pvt.Ltd.
3. Ranganath,G. K.,Sampangiram, C. S. andRajaram, Y. (2008).*A text Book of business Mathematics*. Himalaya Publishing House.
4. Guha, A.(2016).*Quantitative Aptitude for Competitive Examination*. Tata McGraw hill Publications.

Semester–II

Course Code: MT-121
Course Title: Theory of Equations

Course Code: MT-121	**Course Category:Core Course (DSC-1)**
Course Title: Theory of Equations	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives: The main objectives are:

- To study Principle of Mathematical Induction and Divisibility of numbers.
- To study roots of polynomial equations and Fundamental theorem of algebra.
- To know relations between roots and coefficients of polynomials of degree ≤ 4.
- To know roots of cubic equations by using Cardon's method, biquadratic equations by Descarte's method and roots of polynomial equations by Newton's method

Course Outcomes: After successful completion of this course students are expected to:	Cognitive level
• Use of Principle of Mathematical Induction and understand Divisibility of numbers with their properties	3
• Find out roots of any equation of degree ≤ 5.	5
• Know the relation between roots and coefficient of quadratic, cubic and biquadratic equations and their use for finding the roots of equation.	2
• Use of Cardon's method, Descarte's method for solving equations.	3

Course Content:

Unit-1.Divisibility of Integers **Hours-7, Marks-7**

1.1 Natural numbers
1.2 Well ordering principle (statement only)
1.3 Principle of Mathematical Induction
1.4 Divisibility of integers and theorems
1.5 Division algorithm
1.6 GCD and LCM
1.7 Euclidean algorithm
1.8 Unique factorization theorem

Unit-2. Polynomials **Hours-8, Marks-8**

2.1 Revision of Polynomials
2.2 Horner's method of synthetic division
2.3 Existence and uniqueness of GCD of two polynomials
2.4 Polynomial equations
2.5 Factor theorem and generalized factor theorem for polynomials
2.6 Fundamental theorem of algebra (Statement only)
2.7 Methods to find common roots of polynomial equation
2.8 Descarte's rule of signs
2.9 Newton's method of divisors for the integral roots

Unit-3. Theory of Equations-I **Hours-7, Marks-7**

3.1 Relation between roots and coefficient of general polynomial equation in one variable
3.2 Relation between roots and coefficient of quadratic equations
3.3 Cubic and biquadratic equations
3.4 Symmetric functions of roots

Unit-4.Theory of Equations –II **Hours-8, Marks-8**

4.1 Transformation of equations
4.2 Cardon's method of solving cubic equations
4.3 Biquadratic equations
4.4 Descarte's method of solving biquadratic equations

Reference Books:

1. Burton, D. M. (1989). *Elementary Number Theory*. W. C. Brown publishers, Dubuquolowa.
2. Hall, H. S., and Knight, S. R.(1994). *Higher Algebra*. H. M. Publications.
3. Datta, K. B. (2000). *Matrix and Linear Algebra*.Prentice Hall of India Pvt. Ltd., New Delhi.
4. Sharma, D. R. (1985). *Theory of Equations*.Sharma Publications, Jalandhar.

Course Code: MT-122
Course Title: Practical course on Coordinate Geometry

Course Code: MT-122	**Course Category:Core Course (DSC-4)**
Course Title: Practical course on Coordinate Geometry	**Type: Theory**
Total Contact Hours: 60 (4/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives: The main objectives are:

- To develop a strong foundation in two/three-dimensional geometry to understand shapes and concepts.
- To explore three-dimensional geometry, focusing on properties and interpretations of Sphere, Cone, and Cylinder.
- To acquire essential skills for solving geometric problems and applying these concepts in various mathematical contexts.

Course Outcomes: After successful completion of this course students are expected to:	Cognitive level
• Gain a thorough understanding of two-dimensional geometry, including principles of shapes, angles, and properties of various geometric figures.	5
• Acquire comprehensive knowledge of three-dimensional geometry, focusing on the properties and applications of spheres, cones, and cylinders.	5
• Demonstrate the ability to interpret and analyze three-dimensional shapes in real-world scenarios.	5
• Apply acquired geometric knowledge to solve practical problems and make informed decisions in relevant fields.	5

Sr. No.	Content
1	**Practical No.-1: Straight Line in 3D-1** Representation of line in 3D, Equation of line through a given point drawn in a given direction, Equation of a line through two points, Transformation from the unsymmetrical to the symmetrical form, Angle between two lines, General equation of first degree.
2	**Practical No.-2: Straight Line in 3D-2** Transformation to the normal form and angle between a line and a plane, Condition for a line to lie in a plane, Coplanar line and point of intersection of two lines, Angle between a line and a plane.

3	**Practical No.-3: Sphere-1** Equation of Sphere, General equation of sphere, Sphere through four given points, Sphere with a given diameter, Intersection of sphere and line.
4	**Practical No.-4: Sphere-2** Plane section of a sphere, Intersection of two sphere and touching spheres, Tangent line and tangent plane, Condition of tangency and Section of sphere by a plane, Equation of circle, Angle of intersection of two sphere.
5	**Practical No.-5: Cone-1** Equation of a cone with a conic as guiding curve, Intersection of Line with a cone
6	**Practical No.-6: Cone-2** Condition that the general equation of the second degree should represent a cone, Cone and Plane through its vertex, Enveloping cone of a sphere,Right Circular cones.
7	**Practical No.-7: Cylinder -1** Cylinder, Equation of a cylinder.
8	**Practical No.-8: Cylinder-2** Enveloping Cylinder, Right circular cylinder.

List of Practicals

Practical No.-1: Straight Line in 3D-1

1) Find the equations of line passing through a given point $A(x_1, y_{1,} x_1)$ and having direction cosines l, m, n.
2) Find the co-ordinates of the point of intersection of the line $\frac{x+1}{1} = \frac{y+3}{3} = \frac{z-2}{-2}$ with the plane $3x + 4y + 5z = 5$.
3) Express the equations of the line of intersection of the planes $x - 2y + 3z = 4, \quad 2x - 3y + 4z = 5$ in the symmetric form.
4) Put in symmetrical form, the equation of the line $3x - y + z + 1 = 0$, $5x + y + 3z + 0$. Also find the equation to a plane through $(2,1,4)$ and perpendicular to the given line.

5) Write the equation of the line $x = ay + b$ and $z = cy + d$ in the symmetrical form.
6) Find the equation of the line through the point $(1,2,3)$ parallel to the line $x - y + 2z = 5,\ 3x + y + z = 6$.
7) Find the length of the perpendicular from the point $(1,2,3)$ on the line $\frac{x-6}{3} = \frac{y-7}{2} = \frac{z-7}{-2}$.
8) Find the equation to a plane through the line $\frac{x-x_1}{l} = \frac{y-y_1}{m} = \frac{z-z_1}{n}$ and parallel to another line with direction cosines l_2, m_2, n_2.
9) Find the equation to a planepassing through the line $\frac{x-x_1}{l} = \frac{y-y_1}{m} = \frac{z-z_1}{n}$ and through the point(x_1, y_1, z_1).
10) If θ is the acute angle between the line $\frac{x-x_1}{l} = \frac{y-y_1}{m} = \frac{z-z_1}{n}$ and the plane $ax + by + cz + d = 0$, then show thatsin $\theta = \pm \frac{al+bm+cn}{\sqrt{a^2+b^2+c^2}\sqrt{l^2+m^2+n^2}}$.

Practical No.-2: Straight Line in 3D-2

1) Find the equation of the plane through the origin and containing the line $x - 3y + 2z + 3 = 0,\quad 3x - y + 2z - 5 = 0$.
2) Find the point where the line passing through $(0, -1, 2)$ and having direction ratios $2, -1, 3$meets the plane $x - y - 2z = 0$.
3) Find the angle between the line $\frac{x-1}{2} = \frac{y}{2} = \frac{z-3}{1}$ and the plane $3x + 2y - 6z = 4$.
4) Find the angle between the lines $x + y + 2z - 3 = 0 = 2x + y + z + 1$ and $\frac{x-1}{2} = \frac{y}{1} = \frac{z-2}{-1}$.
5) Show that the plane $2x - y + 3z = 6$ contains the line $\frac{x-4}{3} = \frac{y+7}{-6} = \frac{z+3}{-4}$.

6) Show that the two lines $\frac{x-1}{-1}=\frac{y-8}{7}=\frac{z-2}{2}$ and $\frac{x+1}{1}=\frac{y-2}{-1}=\frac{z+4}{1}$ are coplanar and find the equation of the plane containing them.

7) Find the equation of the plane which passes through the line $a_1x+b_1y+c_1z+d_1=0=a_2x+b_2y+c_2z+d_2$ and is parallel to the line $\frac{x}{l}=\frac{y}{m}=\frac{z}{n}$.

8) Find the condition that two given straight lines $\frac{x-x_1}{l_1}=\frac{y-y_1}{m_1}=\frac{z-z_1}{n_1}$ and $\frac{x-x_2}{l_2}=\frac{y-y_2}{m_2}=\frac{z-z_2}{n_2}$ are coplanar.

9) If the lines $\frac{x-\alpha}{l}=\frac{y-\beta}{m}=\frac{z-\gamma}{n}$ and $a_1x+b_1y+c_1z+d_1=0=a_2x+b_2y+c_2z+d_2$ are coplanar, then $\frac{a_1\alpha+b_1\beta+c_1\gamma+d_1}{a_1l+b_1m+c_1n}=\frac{a_2\alpha+b_2\beta+c_2\gamma+d_2}{a_2l+b_2m+c_2n}$.

10) Prove that $\frac{x+4}{3}=\frac{y+6}{5}=\frac{z-1}{-2}$ and $3x-2y+z+5=0=2x+3y+4z-4$ are coplanar. Find the point of intersection.

Practical No.-3: Sphere-1

1) Find the centre and radius of the following spheres:

   i) $x^2+y^2+z^2+4x-6y-8z=2$.

   ii) $2x^2+2y^2+2z^2+3x+4y-6z-4=0$.

2) Find the equation of the sphere with centre at $(1,-3,4)$ and passing through $(2,1,3)$.

3) If one end of a diameter of the sphere $x^2+y^2+z^2-6x-12y-2z+20=0$ is $(2,3,5)$, then find the coordinates of other end.

4) Find the equation of a sphere described on $(2,-3,1)$ and $(3,-1,2)$ as anextremities of a diameter.

5) Find the equation of the sphere which passes through the points $A(1,0,0), B(0,1,0), C(0,0,1)$ and has its radius as small as possible.

6) Derive equation of the sphere passing through four points $(x_1,y_1,z_1), (x_2,y_2,z_2), (x_3,y_3,z_3), (x_4,y_4,z_4)$.

7) Find the equation of the sphere passing through the points $(1, 2, 3), (0, -2, 4), (4, -4, 2), (3, 1, 4)$.
8) Find the intersection of a sphere $x^2 + y^2 + z^2 + 2ux + 2vy + 2wz + d = 0$ and a line $\frac{x-\alpha}{l} = \frac{y-\beta}{m} = \frac{z-\gamma}{n}$.
9) Find the co-ordinates of points of intersection of a sphere $x^2 + y^2 + z^2 = 49$ and a line $\frac{x+2}{4} = \frac{y+9}{3} = \frac{z-8}{-5}$.
10) From the point $(1, -1, 2)$ lines are drawn to meet the sphere $x^2 + y^2 + z^2 = 1$ and they are divided in the ratio $2:3$. Prove that the points of section lie on the sphere $5x^2 + 5y^2 + 5z^2 - 6x + 12y - 12z + 10 = 0$.

Practical No.-4: Sphere-2

1) Prove that the section of a sphere by a plane is a circle.
2) Find the condition that the plane $lx + my + nz = p$ touches the sphere $x^2 + y^2 + z^2 = a^2$.
3) Find the value of k if the plane $x + y + z = k$ touches the sphere $x^2 + y^2 + z^2 + 2x + 2y - 2z - 9 = 0$. Also find the point of contact.
4) Find the coordinates of the centre and radius of the circle $x^2 + y^2 + z^2 - 2y - 4z - 11 = 0,\ x + 2y + 2z = 15$.
5) Find the equation of tangent plane to the sphere $x^2 + y^2 + z^2 + 4x - 5y - 3z - 3 = 0$ at the point (1, 2, -1).
6) Find the equation of the sphere having the circle $x^2 + y^2 + z^2 + 10y - 4z - 8 = 0,\ x + y + z = 3$ as a great circle. Find itscentre and radius.
7) Derive the condition of orthogonality of two spheres.
8) Prove that the spheres $x^2 + y^2 + z^2 + 6y + 2z + 8 = 0$ and

   $x^2 + y^2 + z^2 + 6x + 8y + 4z + 20 = 0$are orthogonal.
9) Show that the spheres $x^2 + y^2 + z^2 = 25,\ x^2 + y^2 + z^2 - 24x - 40y - 18z + 225 = 0$ touch each other externally and determine the coordinates of their point of contact.

10) Show that the spheres $x^2 + y^2 + z^2 = 64$, $x^2 + y^2 + z^2 - 12x + 4y - 6z + 48 = 0$ touch each other internally and find the point of contact.

Practical No.-5: Cone-1

1) Show that the equation of a cone with vertex at origin is homogenous in x, y, z.
2) Show that every homogenous equation in x, y, z represent a cone whose vertex is the origin.
3) Find the equation of the cone whose vertex is at the origin and which passes through the curve given by the equations $ax^2 + by^2 + cz^2 = 1$, $lx + my + nz = p$.
4) Prove that the equation of the cone whose vertex is the origin and base the curve $z = k, f(x, y) = 0$ is $f\left(\frac{xk}{z}, \frac{yk}{z}\right) = 0$.
5) Find the equation of the cone generated by a line OP, where O is the origin & P describes the curve whose equation are $x^2 + y^2 + z^2 + x - 2y + 3z - 4 = 0, x^2 + y^2 + z^2 + 2x - 3y + 4z - 5 = 0$.
6) Obtain the general equation of cone passing through the three axes.
7) Obtain the equation of the cone which passes through the vertex and the lines $\frac{x}{2} = \frac{y}{1} = \frac{z}{3}$ and $\frac{x}{-3} = \frac{y}{1} = \frac{z}{-2}$.
8) Verify that the line $\frac{x}{2} = \frac{y}{-1} = \frac{z}{3}$ is the generator of the cone $x^2 + y^2 + z^2 + 4xy - xz = 0$.
9) The line $3x + 2y - z = 0, x + 3y + 2z = 0$ is a generator of the cone $2x^2 + y^2 - z^2 + 3yz - 2zx + axy = 0$. Find the value of a.
10) Find the equation of the cone with vertex at the origin and containing the curve $x^2 + y^2 = 4$, $z = 5$.

Practical No.-6: Cone-2

1) Find the condition that the equation $ax^2 + by^2 + cz^2 + 2fyz + 2gzx + 2hxy + 2ux + 2vy + 2wz + d = 0$ represent a cone.
2) Find the vertex of a cone $5x^2 + 3y^2 + z^2 - 2xy - 6yz - 4xz + 6x + 8y + 10z - 26 = 0$.
3) Examine whether the following equation represents a cone:
   $5x^2 + 3y^2 + z^2 - 2xy - 6yz - 4xz + 6x + 8y + 10z - 26 = 0$.
   If it represents a cone, then find its vertex.
4) Examine whether the following equation representsacone: $4x^2 + 3y^2 - 5z^2 - 6\mathrm{yz} - 8\mathrm{x} + 16\mathrm{z} - 4 = 0$. If it represents a cone, then find its vertex.
5) Show that the equation $x^2 - 2y^2 + 4z^2 + 6yz - 2zx + 4xy + 6x - 30y + 14z = 0$ represent a cone.
6) Find equation of the right circular cone with vertex at $v\ (\alpha, \beta, \gamma)$, semi-vertical angle θ and whose axis has direction ratiosa, b, c.
7) Find the equation of right circular cone whose vertex is origin, axis is z-axis and semi-vertical angle is of $30°$.
8) Find the equation of a right circular cone with its vertex at$(1, -2, -1)$, semi-vertical angle $60°$and the axis $\frac{x-1}{3} = \frac{y+2}{-4} = \frac{z+1}{5}$.
9) Find the enveloping cone of the sphere $x^2 + y^2 + z^2 - 2x + 4z - 1 = 0$ with its vertex at $(1, 1, 1)$.
10) Find the equation of right circular cone with vertex at $(1,2,-3)$,semi-vertical angle $\cos^{-1}\left(\frac{1}{\sqrt{3}}\right)$and the axis $\frac{x-1}{2} = \frac{y-2}{4} = \frac{z+3}{-2}$.

Practical No.-7: Cylinder -1

1) Find the equation of cylinder whose generators intersect the guiding plane curve $f(x, y, z) = 0;\ \ ax + by + cz + d = 0$ and parallel to the line $\frac{x}{l} = \frac{y}{m} = \frac{z}{n}$.

2) Obtain the equation of cylinder when the guiding curve is on XY-plane.

3) Find the equation of cylinder whose generators are parallel to the line $\frac{x}{1} = \frac{y}{-2} = \frac{z}{3}$ and which pass through $x^2 + 2y^2 = 1, z = 3$.

4) Find the equation of cylinder whose generators are parallel to the line $\frac{x}{1} = \frac{y}{2} = \frac{z}{3}$ and which pass through $x^2 + y^2 = 16, z = 0$.

5) Find the equation of cylinder whose generators are parallel to the line $\frac{x}{1} = \frac{y}{1} = \frac{z}{1}$ and guiding plane curve $x^2 + 2y^2 + 6yx - 2z + 8 = 0, x - 2y + 3 = 0$.

6) Find the equation of cylinder whose generators are parallel to the line $y = mx, z = nx$ which intersect the curve $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1, z = 0$.

7) Find the equation of cylinder whose generators have direction ratios $(1, -2, 3)$ whose guiding plane curve is $x^2 + 2y^2 = 1, z = 0$.

8) Find the equation of cylinder whose generators are parallel to the axis of z and intersect the curve $ax^2 + by^2 + cz^2 = 1, lx + my + nz = p$.

9) Find the equation of cylinder whose generators are parallel to the line $\frac{x}{1} = \frac{-y}{2} = \frac{z}{3}$ and which pass through $x^2 + y^2 = 16, z = 0$.

10) Show that the lines drawn through the points of the curve $x^2 + y^2 + z^2 = 4,\ x + y + z = 1$ parallel to the line $\frac{x}{2} = \frac{y}{-1} = \frac{z}{2}$ generates the cylinder.

Practical No.-8: Cylinder -2

1) Show that the equation of right circular cylinder with radius r and whose axis is the line $\frac{x-a}{l} = \frac{y-b}{m} = \frac{z-c}{n}$ is $[(x-a)^2 + (y-b)^2 + (z-c)^2 - r^2](l^2 + m^2 + n^2) = [l(x-a) + m(y-b) + n(z-c)]^2$.

2) Find the equation of right circular cylinder with radius 2and whose axis is passing through $A(1, -2, 4)$ and hasdirection ratios$2, 3, 6$.

3) Find the equation of right circular cylinder passing through the three points $(a,0,0),(0,a,0),(0,0,a)$ as the guiding circle.
4) Find the equation of right circular cylinder whose guiding circle is $x^2+y^2+z^2=9, x-y+z=3$.
5) Find the equation of right circular cylinder whose axis is $\frac{x-2}{2}=\frac{y-1}{1}=\frac{z}{3}$ passing through the point $(0,0,3)$.
6) Find the equation of right circular cylinder whose axis $x-2=z, y=0$ passing through the points (3,0,0).
7) Show that the equation to the enveloping cylinder of the surface $x^2+y^2+z^2=a^2$, in the direction of (l,m,n) is $(lx+my+nz)^2=(l^2+m^2+n^2)(x^2+y^2+z^2-a^2)$.
8) Find equation to the enveloping cylinder of the sphere $x^2+y^2+z^2-2x+4y-1=0$ having generators parallel to the line $x=y=z$. Also find its guiding curve.
9) Find equation to the enveloping cylinder of the sphere $x^2+y^2+z^2-2y-4z-11=0$ having generators parallel to the line $x=-2y=2z$.
10) A cylinder cuts the plane z = 0 in the curve $x^2+\frac{y^2}{4}=\frac{1}{4}$ has its axis parallel to $3x=-6y=2z$. Find its equation.

Reference Books:

1. Loney, S. L.(2016). *The Elements of Co-ordinate Geometry*. MacMillan and company. London.
2. Prasad,Gorakh, and Gupta,H.C. (2000).*Text Book on Co-ordinate Geometry*.Pothishala Pvt. Ltd. Allhabad.
3. Narayan,Shanti. (2007). *Analytical Solid Geometry*. S. Chand and Co..
4. Sharma, D. R. *Solid Geometry*. Sharma Publications, Jalandhar, 30th Edition.
5. Narayan, Shanti, and Mittal, P.K., *Analytical Solid Geometry*, S. Chand and Co.

6. Narayan, Shanti, and Mittal, P.K., *Analytical Solid Geometry*, S. Chand and Co.

Course Code: MT-123
Course Title: Quantitative Aptitude and Logical Reasoning

Course Code: MT-123	**Course Category:Core Course (OE-2)**
Course Title: Quantitative Aptitude and Logical Reasoning	**Type: Theory**
Total Contact Hours: 30 (2/week)	**Course Credits: 02**
College Assessment (CA): 20 Marks	**University Assessment (UA): 30 Marks**

Course Objectives: The main objectives are:

- To enhance the analytical skill and problem-solving skill of the students.
- To improve verbal ability skill of the students.
- To improve the critical thinking skills of the students.
- To make them prepare for various public and private sector exams & placement drives.

Course Outcomes: After successful completion of this course students are expected to:	Cognitive level
• Understand the basic concepts of quantitative ability.	2
• Understand the basic concepts of logical reasoning skills.	2
• Acquire satisfactory competency in use of reasoning.	3
• Solve campus placement aptitude papers.	3
• Prepare themselves for various competitive examinations.	6

Course Content:

Unit-1. Time, work and distances **Hours-7, Marks-7**

1.1 Time and work
1.2 Time and Distance
1.3 Boats and Stream

Unit-2.Arithmetic Problems **Hours-8, Marks-8**

2.1 Allegation and Mixtures
2.2 Simple interest
2.3 Compound interest

Unit-3.Aptitude Problems **Hours-7, Marks-7**

3.1 Calendar
3.2 Clocks
3.3 Height and Distances

Unit-4.Logical Reasoning **Hours-8, Marks-8**

4.1 Odd man out

4.2 Problems on Series
4.3 Problems on train

Reference Books:

1. Aggarwal, R. S. (2022). *Quantitative Aptitude*. S. Chand Publications.
2. Aggarwal, R. S. (2022). *A Modern Approach toLogical Reasoning*. S. Chand Publications.
3. Jaikishan, and Premkishan. (2022). *How to Crack Test of Reasoning in all competitive exams*. Arihant Publications.
4. Oswaal Editorial Book. (2023). *Quantitative Aptitude*. Oswaal Books & Learning Pvt. Ltd.