B.A/B.Sc (Mathematics) Single Major

Semester 4

Course Code	Course Title	Course ID	L (Hrs)	T	P	L Credits	T	P	Credits	MARKS TI	TE	PI	PE	Total
Core Course(s)														
CC-A10	Solid Geometry	240/MAT/CC401	3	--	2	3	-	1	4	25	50	5	20	100
CC-A11	Sequence and Series	240/MAT/CC402	3	--	2	3	-	1	4	25	50	5	20	100
CC-A12	Linear Programming	240/MAT/CC403	3	--	2	3	-	1	4	25	50	5	20	100
Minor/ Vocational Course(s)														
MIC-4/VOC-1	One from Pool		2	-	4	2	-	2	4	15	35	15	35	100
Ability Enhancement Course(s)														
AEC-4	One from Pool		2	-	-	2	-		2	15	35	-	-	50
Value-added Course(s)														
VAC-3	One from Pool		2	-	-	2	-		2	15	35	-	-	50
Total Credits			**15**		**10**	**15**		**5**	**20**					**500**

240/MAT/CC401

Semester-IV			
Session: 2025-26			
Part A – Introduction			
Subject	Mathematics		
Semester	IV		
Name of the Course	Solid Geometry		
Course Code	CC-A10		
Course ID	240/MAT/CC401		
Course Type: (CC/MIC/ MDC/ /VOC/AEC/VA C/SEC)	CC		
Course Learning Outcomes(CLOs) CLO 5 is related to the practical Component.	After completing this course, the learner will be able to: 1. Gain knowledge of the concept of different conic sections, their properties. Understand to trace the conics. 2. Have knowledge of concept of sphere, cone, enveloping cone, cylinder and enveloping cylinder and attain procedural knowledge to solve them. 3. Learn about concepts of conicoids, tangent plane, director sphere, normal, and envelope and to make further use thereof. 4. Gain knowledge of Paraboloid, its circular section and plane section. Learn about generating lines, confocal conicoid and reduction of second degree equations. 5. Attain cognitive and technical skills required for solving practical problems related to assessing nature of conicoid, their characteristics.		
	Theory	**Practical**	**Total**
Credits	3	1	4

Contact Hours	3	2	5
Internal Assessment Marks	25	5	30
End Term Assessment Marks	50	20	70
Examination Time	3 Hours	3 Hours	100

Part B - Course Content

Instructions for Paper- Setter Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking Course Learning Outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topic	Contact Hours
I	General equation of second degree. Tracing of conics. Tangent at any point to the conic, chord of contact, pole of line to the conic, director circle of conic. System of conics. Confocal conics. Polar equation of a conic, tangent and normal to the conic.	12
II	Sphere: Plane section of a sphere. Sphere through a given circle. Intersection of two spheres, radical plane of two spheres. Co-oxal system of spheres Cones. Right circular cone, enveloping cone and reciprocal cone. Cylinder: Right circular cylinder and enveloping cylinder.	11
III	Central Conicoids: Equation of tangent plane. Director sphere. Normal to the conicoids. Polar plane of a point. Enveloping cone of a coincoid. Enveloping cylinder of a coincoid.	11
IV	Paraboloids: Circular section, Plane sections of conicoids. Generating lines. Confocal conicoid. Reduction of second degree equations.	11

Practical

The practical component of the course has two parts **(A) Problem Solving- Questions related to the following problems will be solved**	**30**

and their record will be maintained in the Practical Notebook:

1. Problems to find nature of the curve, center and the equation of the conic referred to center as the origin.
2. Problems to demonstrate the length of axes, eccentricity and the equations of the conic.
3. Problems related to reduction of a general equation to the standard form and to discuss nature of conicoid, when all the characteristics roots of discriminant cubic are different from zero.
4. Problems related to reduction of a general equation to the standard form and to discuss nature of conicoid, when one root of characteristics roots of discriminant cubic is zero.
5. Formulation and solution of real life situations which uses mathematical knowledge and characteristics of sphere (at least two).
6. Formulation and solution of real life situations which uses mathematical knowledge and characteristics of cone (at least two).
7. Formulation and solution of real life situations which uses mathematical knowledge and characteristics of cylinder (at least two).
8. Problems to find the equation of tangent planes subject to different conditions.
9. Problems to find the equation of generators of the hyperboloid, paraboloid.

(B) The following practicals will be done using MAXIMA software and their record will be maintained in the practical note book:

1. Practical problems to find nature of the curve, center and the equation of the conic referred to center as the origin.
2. Practical problems to demonstrate the length of axes, eccentricity and the equations of the conic.
3. Practical problems related to reduction of a general equation to the standard form and to discuss nature of conicoid depending upon the characteristics roots of discriminant cubic
4. Practical problems on formulation and solution of real life situations which uses mathematical knowledge and characteristics of sphere, cone and cylinder.
5. Practical problems to find the equation of tangent planes subject to different conditions.
6. Practical problems to find the equation of generating lines and generators of the hyperboloid, paraboloid.

Suggested Evaluation Methods

Internal Assessment:	**End Term Examination:**
➢ **Theory 25** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 10 • Mid-Term Exam: 10 ➢ **Practicum 5** • Seminar/Demonstration/Viva-voce/Lab records etc.: 5	➢ **Theory 50** • Written Examination ➢ **Practicum 20** • Lab record, viva-voce, write up and execution of the program

Part C-Learning Resources

Recommended Books:

1. R. J. T. Bell (2022). *An Elementary Treatise on Coordinate Geometry of Three Dimensions*. Legare Street Press.
2. D. Chatterjee (2009). *Analytical Geometry: Two and Three Dimensions*. Narosa Publishing House.
3. S. Narayan & P.K. Mittal (2007). *Analytical Solid Geometry*. S. Chand and Company.
4. G. Fuller & D. Tarwater (1992). *Analytic Geometry* (7th edition). Pearson.
5. J. H. Kindle (1990). *Analytic Geometry*. McGraw-Hill
6. P. K. Jain & K. Ahmad (1999): A Textbook of Analytical Geometry of Three Dimensions, Wiley Eastern Ltd.
7. R. J. T. Bill (1994) , Elementary Treatise on Coordinary Geometry of Three Dimensions, MacMillan India Ltd.

240/MAT/CC402

Session: 2025-26			
Part A – Introduction			
Subject	Mathematics		
Semester	IV		
Name of the Course	Sequence and Series		
Course Code	CC-A11		
Course ID	240/MAT/CC402		
Course Type: (CC/MIC/ MDC/ /VOC/AEC/VA C/SEC)	CC		
Course Learning Outcomes(CLOs) CLO 5 is related to the practical Component.	After completing this course, the learner will be able to: 1. Understand basic concepts of compact set, denumerability, sequences, their limits and boundedness. 2. Learn about the convergence and divergence of a sequence. 3. Attain skills to determine convergence of a series of real numbers by applying various tests. 4. To know absolute and conditional convergence of alternating series and apply theory to check the convergence of arbitrary series.		
Credits	**Theory**	**Practical**	**Total**
	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	25	5	30
End Term Assessment Marks	50	20	70

Examination Time	3 Hours	3 Hours	100

Part B - Course Content

Instructions for Paper- Setter Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking Course Learning Outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topic	Contact Hours
I	Open covers, Compact sets and Heine-Borel Theorem. Denumerable and non-denumerable sets, Denumerability of integers, rationals and non-denumerability of real numbers. Sequence: Real Sequences and their convergence, Theorem on limits of sequence, Bounded and monotonic sequences,	11
II	Cauchy's sequence, Cauchy general principle of convergence, Subsequences, Sub sequential limits. Limit superior and limit inferior. Infinite series: Convergence and divergence of Infinite Series, Comparison tests of positive terms Infinite series, Cauchy's general principle of Convergence of series, Convergence and divergence of geometric series, Hyper Harmonic series or p-series.	12
III	D-Alembert's ratio test, Raabe's test, Logarithmic test, de Morgan and Bertrand's test, Cauchy's Nth root test, Gauss Test, Cauchy's integral test, Cauchy's condensation test. Alternating series, Leibnitz's test, Absolute and conditional convergence,	11
IV	Arbitrary series: Abel's lemma, Abel's test, Dirichlet's test, Insertion and removal of parenthesis, re-arrangement of terms in a series, Riemann's Re-arrangement theorem, Pringsheim's theorem (statement only), Multiplication of series, Cauchy product of series, (definitions and examples only).	11

Practical

The practical component of the course has two parts **(A) Problem Solving- Questions related to the following problems will be solved and their record will be maintained in the Practical Notebook:**	30

1. Problem demonstrating that the set of rational numbers is not order complete.
2. Practical Problems on finding lub and glb of a set.
3. Problem solving to find limit point of a set using Bolzano Weierstrass Theorem.
4. Problems solving using monotone convergence theorem.
5. Practical problems demonstrating the use of Cauchy's first and second theorems for convergence of sequences.
6. Problem solving on limit inferior and limit superior of a sequence.
7. Practical problem on convergence/divergence of positive term series demonstrating the application of various convergence tests.
8. Problem solving on
    i. Conditional convergence and
    ii. Absolute convergence of an alternating series.
9. Practical problem to demonstrate Cauchy product of two convergent series need not be convergent.
10. Practical problem to demonstrate Cauchy product of two divergent series need not be divergent.
11. Practical problem to demonstrate the denumerability of the cartesian product of denumerable sets.
12. Practical problem to demonstrate the non-denumerability of the set of irrationals

(B)The following practicals will be done using MAXIMA software and their record will be maintained in the practical note book:

1. Testing the convergence of infinite series of positive terms by the use of sequence of partial sums.
2. Testing the convergence of an infinite positive term series
3. Testing the absolute convergence of an alternating series and comment about conditional convergence.
4. Practical problems on the convergence of series with arbitrary terms.
5. Testing the convergence/divergence/oscillation behavior of sequences of real numbers.
6. Determine the lub and glb of the subset of real numbers and observe whether they belong to the set or not.

Suggested Evaluation Methods

Internal Assessment:	End Term Examination:
➢ **Theory 25** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 10 • Mid-Term Exam: 10 ➢ **Practicum 5** • Seminar/Demonstration/Viva-voce/Lab records etc.: 5	➢ **Theory 50** • Written Examination ➢ **Practicum 20** • Lab record, viva-voce, write up and execution of the program

Part C-Learning Resources

Recommended Books:

1. T. M. Apostol (2008). *Mathematical Analysis: A Modern Approach to Advanced Calculus*. Pearson Education.
2. C. Aliprantis& O. Burkinshaw (1998). *Principles of Real Analysis* (3rd edition). Academic D Pres.
3. R. G. Bartle & D. R. Sherbert (2015). *Introduction to Real Analysis* (4th edition). Wiley India.
4. G. G. Bilodeau, P. R. Thie & G. E. Keough (2015). *An Introduction to Analysis* (2nd edition), Jones and Bartlett India Pvt. Ltd.
5. E. Hewitt & K. Stromberg (2013). *Real and Abstract Analysis.* Springer-Verlag.
6. K. A. Ross (2013). *Elementary Analysis*: *The Theory of Calculus* (2nd edition). Springer.
7. W. Rudin (1976). *Principles of Mathematical Analysis* (3rd edition), Tata McGraw Hill.
8. R. R. Goldberg (1970). *Real Analysis*. Oxford & I. B. H. Publishing Co., New Delhi.
9. S. Narayan & P. K. Mittal (2005). *A Course in Mathematical Analysis.* S. Chand and company, New Delhi.
10. S. C. Malik & S. Arora (2021) . *Mathematical Analysis*. Wiley Eastern Ltd., Allahabad.

240/MAT/CC403

Session: 2025-26			
Part A – Introduction			
Subject	Mathematics		
Semester	IV		
Name of the Course	Linear Programming		
Course Code	CC-A12		
Course ID	240/MAT/CC403		
Course Type: (CC/MIC/ MDC/ /VOC/AEC/VA C/SEC)	CC		
Course Learning Outcomes(CLOs) CLO 5 is related to the practical Component.	After completing this course, the learner will be able to: 1. Understand the concepts of linear programming problems (LPP) and solve real-life problems using graphical methods. 2. Apply the Simplex method, Two-phase method, and Big-M method to solve linear programming problems. 3. Analyze and solve linear programming problems using duality concepts and the duality theorem. 4. Solve Transportation and Assignment problems using appropriate linear programming techniques. 5. Model and analyze scientific and social issues as linear programming problems using learned methods.		
	Theory	**Practical**	**Total**
Credits	3	1	4
Contact Hours	3	2	5
Internal Assessment Marks	25	5	30

End Term Assessment Marks	50	20	70
Examination Time	3 Hours	3 Hours	100

Part B - Course Content

Instructions for Paper- Setter Note: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking Course Learning Outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will contain 5 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unit and the compulsory question.

Unit	Topic	Contact Hours
I	Linear Programming Problems: Definition, Objective function, Constraints, Canonical and standard forms. Graphical approach for solving some linear programming problems, Limitations of graphical method. Convex and polyhedral sets, Extreme points, Basic solutions, Basic feasible solutions. Correspondence between basic feasible solutions and extreme points.	12
II	Theory of simplex method, Concept of initial basic feasible solution, Optimality criterion, Improving a basic feasible solution, Unboundedness. Simplex algorithm and its tableau format, Artificial variables, Two-phase method, Big-M method. Relation between maximization and minimization problems, Solving linear programming problems using simplex algorithm.	11
III	Formulation of the dual problem, Duality theorems, Unbounded and infeasible solutions in the primal, Solving the primal problem using duality theory.	11
IV	Transportation Problem: Definition and formulation, Methods of finding initial basic feasible solutions, North West corner rule, Least cost method, Vogel's Approximation method. Assignment Problem: Mathematical formulation and Hungarian method of solving	11

Practical

The practical component of the course has one parts of Problem Solving- Questions related to the following problems will be solved and their record will be maintained in the Practical Notebook: 1. To solve Linear Programming Problems using Graphical method with (i) Unbounded solution. (ii) Infeasible solution. (iii) Alternate or multiple solutions. 2. Solving LPP using Simplex method with (i) Unrestricted variables. (ii) Infeasible solution. 3. To solve Linear Programming Problem by Simplex method with unique solution or with unbounded solution. 4. To solve Linear Programming Problem by Two Phase method. 5. To solve Linear Programming Problem by Big M-Method. 6. To solve Linear Programming Problem using duality. 7. To obtain an optimal solution by Dual Simplex Method. 8. To determine optimal solution of a transportation problem using Vogel's method. 9. To determine optimal solution of transportation problem using (u v) method. 10. To determine an initial basic feasible solution of transportation problem by matrix method. 11. To determine solution of Allocation problems using Assignment model.	**30**

Suggested Evaluation Methods

Internal Assessment: ➢ **Theory 25** • Class Participation: 5 • Seminar/presentation/assignment/quiz/class test etc.: 10 • Mid-Term Exam: 10 ➢ **Practicum 5** • Seminar/Demonstration/Viva-voce/Lab records etc.: 5	**End Term Examination:** ➢ **Theory 50** • Written Examination ➢ **Practicum 20** • Lab record, viva-voce, write up and execution of the program

Part C-Learning Resources
Recommended Books: 1. F. S. Hillier, G. J. Lieberman, B. Nag & P. Basu (2021), *Introduction to Operations Research (11th Edition)*. McGraw-Hill Education. 2. H. A. Taha (2021), *Operations Research: An Introduction (10th Edition)*. Pearson. 3. M. S. Bazaraa, J.J. Jarvis & H. D. Sherali (2010), *Linear Programming and Network Flows (4th Edition)*. John Wiley & Sons Inc. 4. P. R. Thie & G. E. Keough (2008), *An Introduction to Linear Programming and Game Theory (3rd Edition)*. Wiley Interscience. 5. G. Hadley (2002), *Linear Programming*. Narosa Publishing House.