ADAMAS UNIVERSITY

SCHOOL OF BASIC AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS

B.SC. (HONS) MATHEMATICS PROGRAMME

SYLLABUS

ACADEMIC YEAR: 2022-23

ADAMAS UNIVERSITY, KOLKATA

SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF MATHEMATICS

VISION OF THE UNIVERSITY

To be an internationally recognized university through excellence in inter-disciplinary education, research and innovation, preparing socially responsible well-grounded individuals contributing to nation building.

MISSION STATEMENTS OF THE UNIVERSITY

M.S 01: Improve employability through futuristic curriculum and progressive pedagogy with cutting-edge technology

M.S 02: Foster outcomes based education system for continuous improvement in education, research and all allied activities

M.S 03: Instill the notion of lifelong learning through culture of research and innovation

M.S 04: Collaborate with industries, research centers and professional bodies to stay relevant and up-to-date

M.S 05: Inculcate ethical principles and develop understanding of environmental and social realities

CHANCELLOR / VICE CHANCELLOR

ADAMAS UNIVERSITY, KOLKATA

SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF MATHEMATICS

VISION OF THE SCHOOL

To be recognized globally as a provider of education in Basic and Applied Sciences, fundamental and interdisciplinary research.

MISSION STATEMENTS OF THE SCHOOL

M.S 01: Develop solutions for the challenges in sciences through value-based science education.

M.S 02: Conduct research leading to innovation in sciences.

M.S 03: Nurture students into scientifically competent professionals in the usage of modern tools.

M.S 04: Foster in students, a spirit of inquiry and collaboration to make them ready for careers in teaching, research and corporate world.

DEAN / SCHOOL CONCERNED

ADAMAS UNIVERSITY, KOLKATA

SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF MATHEMATICS

VISION OF THE DEPARTMENT

To create a Centre of academic excellence in Mathematics and Statistics through active teaching-learning and collaborative research

MISSION STATEMENTS OF THE DEPARTMENT

M.S 01: Deliver graduates with considerable Mathematical and Statistical skills along with real-world problem solving ability.

M.S 02: Create a framework to nurture students through outcome based education towards building a strong foundation in mathematical sciences for academia and industry.

M.S 03: Conduct fundamental and cutting-edge collaborative research on mathematical and interdisciplinary fields.

M.S 04: Contribute towards development of mathematical foundation in pan-university level.

HOD **DEAN / SCHOOL CONCERNED**

ADAMAS UNIVERSITY, KOLKATA
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF MATHEMATICS

Name of the Programme: B.Sc. (H) in Mathematics

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

PEO 01: Graduates will pursue higher education/research in recognized national/international institutes.

PEO 02: To prepare students with knowledge, abilities and insight in mathematics and related fields.

PEO 03: Graduates will work effectively as individuals and as team members in multidisciplinary projects.

PEO 04: Be able to formulate, investigate and analyze scientifically real life problems along with ethical attitude.

PEO 05: To facilitate students to recognize the need for and the ability to engage in life-long learning.

HOD **DEAN / SCHOOL CONCERNED**

ADAMAS UNIVERSITY, KOLKATA

SCHOOL OF BASIC AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS

Name of the Programme: B.Sc. (H) in Mathematics

GRADUATE ATTRIBUTE / PROGRAMME OUTCOME (PO)

GA 01 / PO 01: Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.

GA 02 / PO 02: Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.

GA 03 / PO 03: Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.

GA 04 / PO 04: Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.

GA 05 / PO 05: Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.

GA 06 / PO 06: Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.

GA 07 / PO 07: Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.

GA 08 / PO 08: Ethics: Understand ethical principle and commit to professional ethics, responsibly and norms in the society.

GA 09 / PO 09: Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.

GA 10 / PO 10: Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.

GA 11 / PO 11: Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.

GA 12 / PO12: Life Long Learning: Develop the ability to reasoning, abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.

HOD **DEAN / SCHOOL CONCERNED**

ADAMAS UNIVERSITY, KOLKATA

SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF MATHEMATICS

Name of the Programme: B.Sc. (H) in Mathematics

PROGRAMME SPECIFIC OUTCOME (PSO)

PSO 01: Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.

PSO 02: Develop deeper understanding and expanded knowledge in pure mathematics.

PSO 03: Apply mathematical methods to other disciplines such as physics, engineering, computer science.

HOD **DEAN / SCHOOL CONCERNED**

MTH11082	CLASSICAL ALGEBRA	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	12th level Mathematics				
Co-requisites	--				

Course Objectives:

1. To learn the fundamental concepts of number systems
2. To develop a modern approach to the treatment of the theory of integers and complex numbers
3. To understand the theory of polynomials and algebraic equations of higher degree
4. To develop the idea of basic notions on linear congruences, Euler's Phi function

Course Outcomes
On completion of this course, the students will be able to

CO1 **Explain** the concept and properties of complex numbers and related theorems.

CO2 **Solve** algebraic equations of higher degree.

CO3 **Solve** the problems of simple Inequalities.

CO4 **Explain** different properties of integers and related theorems.

Course Description:

Algebra is a very important part of higher mathematics. This course is focused on Classical Algebra. In this course, the students will learn about different number systems, inequalities, polynomials, and various methods for solving algebraic equations. The course elaborately discusses properties, operations and relevant theorems on complex numbers and integers. The class activities include lectures, tutorials, assignments, quizzes, and interactions. Moreover, the students will actively participate in discussion, problem solving in class and workout on board. The course will help the students to develop the fundamental knowledge of classical algebra, and in addition, to enhance the problem solving, interaction and presentation skills.

Course Content:

Unit I:
Complex Numbers: Short review of complex numbers, De Moivre's theorem and its applications, direct and inverse circular and hyperbolic functions, logarithm of a complex number, expansion of trigonometric functions, Gregory's series. **[12L]**

Unit II
Theory of Equations: Relation between the roots and coefficients of general polynomial equation of one variable, fundamental theorem of classical algebra and its consequences, nature of roots of an equation (surds or complex roots occur in pairs), statements of Descartes rule of signs and of Sturm's theorem and their applications, transformation of equations, multiple

roots, symmetric functions of roots, reciprocal equations, special roots, solutions of cubic equations (Cardan's method) and biquadratic equation (Ferrari's method). [**18 L**]

Unit III

Inequality: Cauchy-Schwarz inequality, inequality involving A.M. (including weighted), G.M., H.M. and their applications, m^{th} power theorem. [**10 L**]

Unit IV

Integers: Statements of well-ordering principle and principle of mathematical induction, second principle of mathematical induction, proof of some simple mathematical results by induction, divisibility of integers, division algorithm, the greatest common divisor (gcd) of integers a, b, existence and uniqueness of (gcd) of two integers, prime integers, Euclid's first and second theorems, congruence, Euler's function, Fermat's theorem. [**20 L**]

References:

1. S. K. Mapa, Classical algebra, Sarat book house.
2. I. N. Hernstein, Topics in algebra, Wiley India Pvt Ltd.
3. Burnside and Panton, The theory of equations, Vol. 1, Hodges Figgisand Company.
4. A. Kurosh, Higher algebra, Mir publishers.
5. Ghosh and Chakroborty, Higher algebra, U N Dhur& Sons.
6. Barnard and Child, Higher algebra, Mac Millan.
7. John B Fraleigh, First course in abstract algebra, Pearson.
8. Sen, Ghosh and Mukhopadhyay, Topics in abstract algebra, University press.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid Term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs)

Mappings between COs and POs		
Course Outcomes (COs)		**Mapped POs**
CO1	**Explain** the concept and properties of complex numbers and related theorems.	PO1, PO2,PO3, PSO1, PSO3
CO2	**Solve** algebraic equations of higher degree.	PO1, PO2, PO3, PSO1
CO3	**Solve** the problems of simple Inequalities.	PO1, PO2, PSO1
CO4	**Explain** different properties of integers and related theorems.	PO1, PO2, PO4,PSO1, PSO2

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MTH11082	Classical Algebra	3	3	1	1	-	-	-	-	-	-	-	-	2	1	1

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11083	REAL ANALYSIS I	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	10+2th level Mathematics				
Co-requisites	--				

Course Objectives:

To develop the concept of real numbers and its various properties including sequence and series.

Course Outcomes

On completion of this course, the students will be able to

CO1 **Define** the completeness and Archimedean property of real numbers.

CO2 **Define** the concept of countability and uncountability for the set of real numbers.

CO3 **Illustrate** the concept of open set, closed set and limit point for the set of real numbers.

CO4 **Extend** the idea of convergence of infinite sequences and series through various convergence test.

Course Description:

This course is intended to provide the basic idea of real numbers and its basic properties. Furthermore, many basic properties of real line such as completeness property, Archimedean property. Concepts of the open set closed set and derived set concept and related results will be discussed in this course. Also, an idea about bounded, convergent, divergent, Cauchy and monotonic sequences and calculation of their limits.is provided through this course.

Course Content:

Unit-I

Real number system: Intuitive idea of numbers, mathematical operations revisited with their properties (closure, commutative, associative, identity, inverse, distributive).
Sets and functions: definition and properties (union, intersection, complementation, injection, surjection, bijection). Field Axioms: concept of ordered field, bounded set, l.u.b. (supremum) and g.l.b. (infimum) of a set, properties of l.u.b. and g.l.b. of sum of two sets and scalar multiple of a set, least upper bound axiom or completeness axiom. Characterization of as a complete ordered field, definition of an Archimedean ordered field, Archimedean property of , Q is Archimedean ordered field but not ordered complete.

[16L]

Unit-II

Sets in R**:** Countable, Uncountable sets and Uncountability of **.** Intervals, the neighborhood of a point, interior point, open set, union, intersection of open sets, every open set can be expressed as disjoint union of open intervals, limit point and isolated point of a set, criteria for l.u.b. and g.l.b. of a bounded set to be limit point of the set, Bolzano- Weierstrass theorem on limit point. Definition of derived set, closed set, complement of open set and closed set, union

and intersection of closed sets as a consequence, no nonempty proper subset of IR is both open and Closed, dense set in as a set having non-empty intersection with every open Interval, Q and - Q are dense in.

[**20L**]

Unit-III

Sequences and Series of real numbers: Definition of a sequence as function from IN to , bounded sequence, convergence (formalization of the concept of limit as an operation in) and non-convergence, examples, every convergent sequence is bounded and limit is unique, algebra of limits, relation between the limit point of a set and the limit of a convergent sequence of distinct elements, monotone sequences and their convergence, sandwich rule, nested interval theorem.

Infinite series: Cauchy convergence criterion for series, positive term series, geometric series, comparison test, the convergence of p-series, Root test, Ratio test, alternating series, Leibnitz's test (Tests of Convergence without proof), definition and examples of absolute and conditional convergence. [**24L**]

References:

1. S.K. Mapa, Introduction to Real Analysis, 7th Edition, Sarat Publishers, India.
2. S.C. Malik and S Arora, Mathematical Analysis, New Age International Private Limited.
3. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis (3rd Edition), John Wiley and Sons (Asia) Pvt. Ltd., Singapore.
4. R.K. Ghosh and K.C Maity, An Introduction to Analysis: Differential Calculus: Part I.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid Term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs)

Mappings between COs and POs		
Course Outcomes (COs)		**Mapped POs**
CO1	**Define** the completeness and Archimedean property of real numbers.	PO1, PO2, PO3, P12, PSO1, PSO2
CO2	**Define** the concept of countability and uncountability for the set of real numbers.	PO1, PO2, PO3, P12, PSO1, PSO2
CO3	**Illustrate** the concept of open set, closed set and limit point for the set of real numbers.	PO1, PO2, PO3, P12, POS1, PSO2
CO4	**Extend** the idea of convergence of infinite sequences and series through various convergence test.	PO1, PO2, PO3, P12, PSO1, PSO2

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2	PS O3
MTH1 1083	Real Analys is I	3	3	3	-	-	-	-	-	-	-	-	3	3	3	-

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11084	CALCULUS I	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	$10+2^{th}$ level Mathematics				
Co-requisites	--				

Course Objectives:

1. To build the concept of limit, continuity and differentiability of a function of single variable, successive differentiation, Leibnitz's rule and its applications.
2. To acquire the knowledge of indefinite integrals, reduction formulae and differentiation under sign of integration.
3. To develop the concept of tracing of different curves and applications of integrals.

Course Outcomes

On completion of this course, the students will be able to

CO1	**Explain** the concept of limit, continuity and differentiability of a single variable function, L' Hospital's rule and chain rule.
CO2	**Develop** the concept of successive differentiation, Leibnitz's rule, mean value theorem, and maximum and minimum of function.
CO3	**Solve** the problems of indefinite integral, definite integrals, reduction formulae, and differentiation under integral sign.
CO4	**Develop** the knowledge of tracing of different curves and applications of integrals.

Course Description:

Calculus is a branch of mathematics dealing with the concepts of derivative and integration and the way of using them in the study of functions. In mathematics, differential calculus is a sub-field of calculus concerned with the study of the rates at which quantities change. The primary objectives for studying differential calculus are the derivative of a function, related notions such as the differential, and their applications. It is based on the concepts of real number; function; limit and continuity, which were formulated and assigned their modern content during the development of mathematical analysis and during studies of its foundations. Integral Calculus is the branch of calculus where we study integrals and their properties. Integral calculus was one of the greatest discoveries of Newton and Leibniz. Their work independently led to the proof, and recognition of the importance of the fundamental theorem of calculus, which linked integrals to derivatives. With the discovery of integrals, areas and volumes could thereafter be studied

Course Content:

Unit –I

Functions, limits, continuity and derivatives: Review of function, $\varepsilon - \delta$ definition of a limit, algebra of limits, limits at infinity, indeterminate forms and L'Hopital's rule, continuity, discontinuity and its type, derivative of a function and related theorems, Derivatives of polynomials and exponential functions, the product and quotient rules, derivatives of trigonometric functions, the chain rule, derivatives of logarithmic

functions. [**12L**]

Unit- II

Differentiation: successive differentiation, n-th derivative of implicit functions, Leibnitz's rule, exponential growth and decay, related rates, Mean-Value theorem, Rolle's Theorem, Lagrange's mean value theorem, Cauchy's mean value theorem. Taylor's and Maclaurin's theorems with Lagrange's and Cauchy's form of remainders, Maximum and minimum of functions of a single variable. [**18L**]

Unit –III

Integrals: Review the fundamental theorem of integral calculus, indefinite integrals and the net change theorem, substitution rule, Reduction formulae, techniques of integration, integration by parts, trigonometric integrals, trigonometric substitution, integration of rational functions by partial fractions, differentiation under integral sign. [**16L**]

Unit –IV

Curve tracing: Cartesian and polar forms of asymptotes, cycloid, asteroid, cardioid, Rose-Petals, sine-spiral.

Applications of integration: Length of plane curves, intrinsic equation to a curve, evaluation of area, area included between two curves, area in polar coordinates. [**14L**]

References:

1. Shanti Narayan, Differential calculus. S. Chand publishers
2. Shanti Narayan, P.K. Mittal, Integral Calculus, S. Chand.
3. N, Piskunov, Differential and integral calculus, Vol. I, CBS publishers & distributors.
4. B. N. Mukherjee, B. C. Das, Key to differential calculus, U N Dhur& Sons.
5. Vinay Kumar, Differential calculus, McGraw-Hill
6. K. C. Maity and R. K. Ghosh, Differential calculus, an introduction to analysis.
7. K. C. Maity, R. K. Ghosh, Integral Calculus, New Central Book Agency.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid Term	Class Assessment	End Term
Weightage (%)	20	30	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs)

Mappings between COs and POs		
Course Outcomes (COs)		Mapped POs
CO1	**Explain** the concept of limit, continuity and differentiability of a single variable function, L' Hospital's rule and chain rule.	PO1, PO2, PO3, PO4, P12, PSO1, PSO2

CO2	**Develop** the concept of successive differentiation, Leibnitz's rule, mean value theorem, and maximum and minimum of function.	PO1, PO2, PO3, P12, PSO1, PSO2
CO3	**Solve** the problems of indefinite integral, definite integrals, reduction formulae, and differentiation under integral sign.	PO1, PO2, PO3, P12, POS1, PSO2
CO4	**Develop** the knowledge of tracing of different curves and applications of integrals.	PO1, PO2, PO3, P12, PSO1, PSO2

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2	PS O3
MTH1 1084	Calcul us I	3	3	3	2	-	-	-	-	-	-	-	3	3	2	

1=weakly mapped
2= moderately mapped
3=strongly mapped

ENG11057	ENGLISH LANGUAGE AND LITERATURE	L	T	P	C
Version 1.0	**Contact Hours -30**	2	0	0	2
Pre-requisites/Exposure	Basic Knowledge in English Language and Literature				
Co-requisites	--				

Course Objectives:

1. To introduce the students to applied knowledge of English as a language
2. To give basic idea regarding the day-to-day usage of the language
3. To facilitate the students in various required writing techniques and skills
4. To give them the confidence to express themselves using basic communication skills of English as a language

Course Outcomes

On completion of this course, the students will be able to

CO1 **Explain** the ethical use of language at the work space.

CO2 **Recognize** the importance of language as lifelong process of learning.

CO3 **Develop** the capability to work as a team.

CO4 **Identify** their individual language related skills.

CO5 **Develop** the communication skills through speaking, reading and writing.

CO6 **Build** perceptions for accommodating all sorts of opinions.

Course Description:

English Language and Literature, is a foundational course for the students to sharpen their reading, writing, and speaking skills, using the language English. It would give them the confidence to speak their mind at a public form using English as the common language of communication and also would help them to perform extravagantly during any job interview on both national and international level. It would also train them in the basic applications of English as a language in their day-to-day lives at both formal and informal front.

Course Content:

Unit I: Communication

a) Types of Communication
b) Verbal and Non-verbal Communication
c) Barriers and Strategies of Communication

Unit II: Grammar and Syntax

a) Subject-verb agreement
b) Conjunction
c) Articles
d) Prepositions
e) Editing
f) Idioms
g) One- Word Substitutions

Unit III: Listening Skills

a) Active Listening
b) Types of Listening
c) Listening Exercises

Unit IV: Speaking Skills

a) Introduction
b) Extempore
c) Group Discussion
d) Mock Interview

Unit V: Writing Skills

a) Composition
b) Paragraph
c) Letter writing- CV and application letter
d) Report Writing
e) Notice writing
f) Business Communication

Unit VI: Reading and Textual analysis

a) Reading Comprehension
b) Interpreting Graphics

References:

1. Spoken English and Functional Grammar. P. C. Das.
2. Essential Grammar in Use. Raymond Murphy
3. Kaul Asha. Effective Business Communication. PHI Learning Pvt Ltd. 2014.
4. Wren and Martin. High School Grammar and Composition. S. Chand, 1995.
5. Lewis, Norman. Word Power Made Easy. Anchor: 2014.
6. Riordan, Daniel G & Pauley Steven A.: Technical Report Writing Today. 2004.
7. Hamp-Lyons and Heasely, B. Study Writing; A Course in Written English. For Academic and Professional Purposes, Cambridge Univ. Press, 2006.
8. Quirk R., Greenbaum S., Leech G., and Svartik, J. A Comprehensive Grammar of the English language, Longman: London, 1985.
9. Gupta, A. English Reading Comprehension. Ramesh Publishing House, 2009.
10. Balasubramaniam, T. A Textbook of English Phonetics for Indian Students. Macmillan: 2012.
11. A Practical Course in English Pronunciation. J Sethi, Kamlesh Sadanand and D.V. Jindal.
12. English for Technical Communication. NP Sudarshana and C Savitha.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid Term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs)

Mappings between COs and POs		
Course Outcomes (COs)		**Mapped POs**
CO1	**Explain** the ethical use of language at the work space.	PO8
CO2	**Recognize** the importance of language as lifelong process of learning.	PO12
CO3	**Develop** the capability to work as a team.	PO9
CO4	**Identify** their individual language related skills.	PO9
CO5	**Develop** the communication skills through speaking, reading and writing.	PO10
CO6	**Build** perceptions for accommodating all sorts of opinions.	PO11

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	**Contextualized Understanding:** Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	**Critical Thinking and Problem Solving Skills:** Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	**Problem Analysis:** Identify, formulate and analyze complex problems using mathematical principles.	**Modernization and Tools Usage:** Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	**Societal Implication:** Analyze complex social elements, their interrelation and its impact on geographically different society.	**Environment and Sustainability:** Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	**Ethics:** Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	**Individual and Team Work:** Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	**Communication:** Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	**Leadership Skills:** Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	**Life Long Learning:** Develop the ability to reasoning, abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
ENG11057	ENGLISH LANGUAGE AND LITERATURE								2	2	3	1	3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

CSE11655	Elective Programming Language I	L	T	P	C
Version 1.0	Contact Hours -60	3	1	0	4
Pre-requisites/Exposure	10+2 Level Mathematics, Knowledge of Basics of Computer				
Co-requisites	--				

Course Objectives:

1. To understand the nature of programming as human activity.
2. To practice the programming construct to solve multi-dimensional problems.
3. To relate and implement mathematical concepts through programming in order to solve
   computational problems.
4. To enable students to acquire structure and written expression required for their profession.
5. To understand the principles of data storage and manipulation.

Course Outcomes:

On the completion of this course the student will be able to

CO1	**Define** basics concepts of programming structure and implement the basics concepts of programming.
CO2	**Solve** and execute various problems using programming language and select the best solution.
CO3	**Apply** modularized solution and design such programs to appraise the solution.
CO4	**llustrate** the basic usage of memory and construct such memory in terms of array in a program.
CO5	**Define** and construct different data structures for various collection of data.

Course Description:

Programming skills are mandatory for designing or solving problems through digital device. It is the language through which computational/digital devices are communicated rather interfaced. To develop any software programming language is a must. In present era almost all aspect of life is somehow largely related to virtualization and digital data/information. Devices from smartphones to other handheld devices, drones, cameras, medical instruments etc. all needs programming at some part. In engineering it has become quintessential for the students/research scholars to learn programming. In this course, students will learn how to solve problems in various domains through a programming language. This course enables students with the basic skills of C Programming Language. Five Different related modules comprise this course. First Unit familiarizes students with basics of computers, algorithmic method to solve problem, introduction to generic programming construct. Basics of C Programming is upto iterative structure is depicted in

Unit II. In Unit III students will learn about modularization using functions and one advance concept of C Programming, Pointers. Unit IV will cover one of the most important concepts in C Programming, Array and Strings. Unit V will accomplish this course with the advance concept like Structure, Union and File Handling. After this course students will grow their analytical ability to solve problem and logical skill. Also, this course effectively creates the ability to grasp any other Programming Language in easier manner.

Course Content:

Unit I:

Basic Concepts of Programming: Introduction to components of a Computer System (disks, memory, processor, where a program is stored and executed, operating systems, compilers, etc.), Idea of Algorithm: steps to solve logical and numerical problems, Representation of Algorithms: Flowchart/Pseudo code with examples, From Algorithms to Programs; source code, variables and memory locations, Syntax and Logical Errors in compilation, Object and Executable code. **[10 L]**

Unit II:

Basics of C Programming : Characters used in C, Identifiers, Keywords, Data type & sizes, Constants &Variables, Various Operators used such as Arithmetic Operators, Relational & Logical Operators, Increment & Decrement Operators, Assignment Operators, Conditional or Ternary Operators, Bitwise Operators & Expressions; Standard Input & Output, formatted input scanf( ), formatted output printf( ); Flow of Control, if-else, switch-case, Loop Control Statements, for loop, while loop, do-while loop, nested loop, break, continue, goto, label and exit() function. **[15 L]**

Unit III:

Functions and Pointers: Definition of Function, Declaration or Prototype of Function, Various types of Functions, Call by Value, Call by Reference, Recursion, Tail Recursion, Definition of Pointer, Declaration of Pointer, Operators used in Pointer, Pointer Arithmetic, Functions with Pointer. **[12 L]**

Unit IV

Arrays and String: Definition, Single and Multidimensional Arrays, Representation of Arrays - Row Major Order, and Column Major Order, Application of arrays – searching and sorting, Sparse Matrices and their representations. Definition of a String, Declaration of a String, Initialization of a String, Various String Handling Functions with example.

Structures and Unions: Definition of a Structure, Declaration of a Structure & Structure Variable, Initialization of a Structure, Operators used in Structure, Structure within Structures, Union, Difference between a Structure and a Union.

Files: Types of File, File Processing, Handling Characters, Handling Integers, Random File Accessing, Errors During File Processing. **[15 L]**

Unit V

Overview of Stacks and Queues: Introduction to Stack, Primitive operations on Stack, Real-life applications of Stack, Introduction to Queues, Primitive operations on Queues, Real-life applications of Queues. **[8 L]**

References:

1. Balagurusamy, E., n.d. Programming In ANSI C. 5th ed. Bangalore: mcgraw-hill.
2. Gotfreid (196) Schaum's Outline of Programming with C, 2 edn., USA: McGraw-Hill
3. Brian W. Kernighan, Dennis Ritchie (1988) C Programming Language, 2 edn.,: Prentice Hall.
4. Al Kelley, Ira Pohl (1988) *A Book on C*, 4 edn., : Addision Wesley Longman

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs, POs and PSOs

Course Outcomes (COs)		Mapped POs and PSOs
CO1	**Define** basics concepts of programming structure and implement the basics concepts of programming	PO1, PO6, PO12, PSO3
CO2	**Solve** and execute various problems using programming language and select the best solution.	PO1, PO3, PO6, PO12, PSO2, PSO3
CO3	**Apply** modularized solution and design such programs to appraise the solution	PO1, PO3, PO6, PO12, PSO2, PSO3
CO4	**Illustrate** the basic usage of memory and construct such memory in terms of array in a program.	PO1, PO6, PO12, PSO3
CO5	**Define** and construct different data structures for various collection of data.	PO1, PO3, PO6, PO12, PSO2, PSO3

		Academic Excellence	**Contextualized Understanding**	**Design/development of solutions**	**Conduct investigations of complex problems**	**Quantitative Aspects**	**Modernization and Tools Usage**	**Societal Implication**	**Environment and Sustainability**	**Ethics**	**Individual and Team Work**	**Communication**	**Life Long Learning**	Have the versatility to work effectively in a	Be familiar with a variety of examples where	Enhance theoretical rigor with technical skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CSE 11655	Elective Programming Language I	2	-	2	-	-	3	-	-	-	-	-	3	-	2	2

1=weakly mapped
2= moderately mapped
3=strongly mapped

CSE12656	Elective Programming Language I Lab	L	T	P	C
Version 1.0	Contact Hours -60	0	0	2	2
Pre-requisites/Exposure	Discrete Mathematics, Calculus, Machine Learning				
Co-requisites	--				

Course Objectives:

1. To comprehend the practical nature of programming by solving through computer systems.
2. To practice the programming construct to solve multi-dimensional problems.
3. To relate and implement mathematical concepts through programming in order to solve computational problems.
4. To enable students to acquire structure and written expression required for their profession.
5. To understand the principles of data storage and manipulation.

Course Outcomes:

On the completion of this course the student will be able to

CO1. List and memorize various Unix commands. Also, students be able to construct various basic programs and appraise them.
CO2. Design and execute iterative statement in a program. Also, students be able to differentiate among different iterative structure.
CO3. Construct such programs that used to define user defined functions and to design library functions.
CO4. Develop array concept in 1-Dimensional and 2-Dimensional construct. Hence be able to design string functions to cater to various character array related problem.
CO5. Find the concept of Stack, Queue, and Linked List and appraise them in different cases.

Course Description:

Practical Programming skills are mandatory for designing or solving problems through digital device by implementation. To develop any software the behavior of a programming language is a must through problem solving. In present era almost all aspect of life is somehow largely related to virtualization and digital data/information. Devices from smartphones to other handheld devices, drones, cameras, medical instruments etc. all needs programming at some part. In engineering it has become quintessential for the students/research scholars to learn programming. In this course, students will learn how to solve problems in various domains through a programming language. This course enables students with the basic skills of C Programming Language. Five Different related modules comprise this course. First Unit familiarizes students with basics of computers, algorithmic method to solve problem, introduction to generic programming construct. Basics of C Programming is upto iterative structure is depicted in Unit II. In Unit III students will learn about modularization using functions and one advance concept of C Programming, Pointers. Unit IV will cover one of the most important concepts in C Programming, Array

and Strings. Unit V will accomplish this course with the advance concept like Structure, Union and File Handling. After this course students will grow their analytical ability to solve problem and logical skill. Also, this course effectively creates the ability to grasp any other Programming Language in easier manner. In all these modules related programming problems are practiced to understand the syntactical and semantical correctness of a program. Gradually students become more comprehensive through the progress of the course.

Course Content:

List of Experiments:

1. Familiarization with LINUX commands and vi editor.
2. Programs to demonstrate Decision Making, Branching and Looping, Use of break and continue statement etc.
3. Implementation involving the use of Arrays with subscript, String operations and pointers.
4. Implementation involving the use Functions and Recursion.
5. Implementation involving the use Structures and Files.
6. Implementation based on Stack Queues and Linked List for example Insertion and Deletion.

Text Books:

1. Balagurusamy, E., n.d. Programming In ANSI C. 5th ed. Bangalore: McGraw-hill.
2. Gotfreid (196) *Schaum's Outline of Programming with C*, 2nd ed., USA: McGraw-Hill
3. Brian W. Kernighan, Dennis Ritchie (1988) *C Programming Language*, 2nd ed., : Prentice Hall.
4. Das Sumitabha, UNIX Concepts and Applications, 4th Ed., New Delhi, Tata McGraw-Hill

Reference Books:

1. Al Kelley, Ira Pohl (1988) *A Book on C*, 4th ed. Addision Wesley Longman

Modes of Evaluation: Assignment/Quiz/Project/Presentation/Written Examination

Examination Scheme:

Components	Continuous Assessment	End Term Examination
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs, POs and PSOs

Course Outcomes (COs)		Mapped POs and PSOs
CO1	**List** and memorize various Unix commands. Also, students be able to construct various basic programs and appraise them.	PO1, PO2, PO3, PO6, PO12, PSO3

CO2	**Design** and execute iterative statement in a program. Also, students be able to differentiate among different iterative structure.	PO1, PO2, PO3, PO5, PO6, PO12, PSO3
CO3	**Construct** such programs that used to define user defined functions and to design library functions.	PO1, PO2, PO3, PO5, PO6, PO12, PSO3
CO4	**Develop** array concept in 1-Dimensional and 2-Dimensional construct. Hence be able to design string functions to cater to various character array related problem.	PO1, PO2, PO3, PO5, PO6, PO12, PSO3
CO5	**Find** the concept of Stack, Queue, and Linked List and appraise them in different cases.	PO1, PO2, PO3, PO6, PO12, PSO3

		Academic Excellence	**Contextualized Understanding**	**Design/development of solutions**	**Conduct investigations of complex problems**	**Quantitative Aspects**	**Modernization and Tools Usage**	**Societal Implication**	**Environment and Sustainability**	**Ethics**	**Individual and Team Work**	**Communication**	**Life Long Learning**	Have the versatility to work effectively in a broad range of analytic, scientific, government,	Be familiar with a variety of examples where	Enhance theoretical rigor with technical skills
Course Code	Course Title	PO 1	PO2	PO3	PO 4	PO5	PO 6	PO7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PS O2	PS O3
CSE12656	Elective Programming Language I Lab	3	3	3	-	3	3	-	-	-	-	-	3	-	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

CHM11151	ELECTIVE CHEMISTRY I	L	T	P	C
Version 1.0	**CONTACT HOURS- 60**	3	1	0	4
Pre-requisites/Exposure	Physics and Chemistry of class 12 or 10+2 level				
Co-requisites	Partial differentiation, model making, graph plotting				

Course Objectives:

1. To introduce important concepts required in the field of the course elective chemistry. This course gives students a thorough understanding regarding the prerequisites of basic chemistry knowledges in their course curriculums.
2. To introduce clear understanding of energy conditions necessary to execute a feasible chemical reaction.
3. To impart the basic notions of different properties of liquid states of chemical compounds and their effects with atmosphere.
4. To impart the concepts required for kinetics of a reaction mechanism and deeper understanding of the molecular interactions which can influence chemical reactivity. Students can understand the various kinds of reaction mechanisms occurring in their daily life cycle.
5. To learn the basic understanding of atomic structure of molecules important in our daily life and how nuclear reactions are pertinent to their structure.
6. To conceptualize the essence of molecular bonding of necessary molecules.

Course Outcomes:

On completion of this course, the students will be able to

CO1	**Explain** exclusive terminologies associated with thermodynamics and the basic concepts of thermodynamics i.e. heat transfer and its consequences with the thermodynamic system.
CO2	**Understand** the difference between what the molecules are doing in a solid, liquid, and gas, including movement, spacing, and organization, and the physical characteristics of these states.
CO3	**Understand** the properties of solutions that depends on the number of dissolved particles in solution, but not on the identities of the solutes.
CO4	**Learn** the concept of reaction rates, predict products, yields etc.
CO5	**Understand** the concept of using the symbols for protons, neutrons, electrons, positrons, alpha particles, beta particles, and gamma rays
CO6	**Interpret** periodic properties of elements, principles in molecular theory and bonding models to the study of inorganic compound.

Course Description:

This course gives a detailed understanding of the basics of physical and inorganic chemistry required in other disciplines. This course will include expert instructors who will introduce thermodynamics of chemical reaction, colligative properties of liquid states, the structures of nucleus and subatomic particles and their relations with the chemical properties and especially molecular bonding of important molecules of our daily life. All the lectures will be devoted on discussions of elementary concepts and cutting-edge topics, focusing on practical

implementation of knowledge. Instructors will conduct theory classes by taking lecture as well as power point presentations, audio visual virtual lab sessions as per requirement of the course. The tutorials and required assignments will acquaint the students with practical problem-solving techniques led by the course coordinator. After finishing this course, students from different disciplines will strongly grasp the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content:

Physical Chemistry-I

Unit- 1-Thermodynamics

Thermodynamics: Definition of thermodynamic terms; Concept of heat and work; First law of thermodynamics; Concept of enthalpy (H); Expansion of ideal gas under isothermal and adiabatic conditions for reversible and irreversible processes; Concept of standard state, Standard enthalpy changes of physical and chemical transformations: fusion, sublimation, vaporization,..-- solution, dilution, neutralization, ionization.; Hess's law of constant heat summation, Second law

of thermodynamics; Heat engine; Carnot cycle and its efficiency; Entropy (S) as a state function. Spontaneous processes; Concept of Free Energy (G and A). **[10L]**

Unit-2-Liquid state:

Liquid States and Viscosity of Fluids: Nature of the liquid state (short range order and long range disorder); Physical properties of liquids; Vapor pressure, Surface tension; Surface energy, General features of fluid flow (streamline flow and turbulent flow); Coefficient of viscosity and their determination. **[4L]**

Unit-3-Colligative properties

Colligative Properties: What are colligative properties? Dependence of colligative properties; Freezing point depression; boiling point elevation, Raoult's Law and Vapor Pressure Lowering ; osmotic pressure. **[6L]**

Unit-4: Chemical kinetics

Chemical kinetics and catalysis: Order and molecularity of reactions; Rate laws and rate equations for first order and second order reactions (differential and integrated forms); Zero order reactions; Determination of order of reactions; Temperature dependence of reaction rate, energy of activation; Catalytic reactions: homogeneous and heterogeneous catalytic reactions. Enzyme catalysis. **[10L]**

Inorganic Chemistry-I

Unit-I: Atomic structure

Extra-nuclear Structure of atoms, Bohr's model. quantum numbers and their significance, Pauli's exclusion principle, Hund's rule, electronic configuration of many¬, electron atoms, Aufbau principle. **[10L]**

Unit-II: Chemical Periodicity

Classification of elements on the basis of electronic configuration; Positions of hydrogen and noble gases; Atomic and ionic radii; ionization potential; electron affinity; and

electronegativity; periodic and group-wise variation of above properties in respect of s- and p-block elements. **[5L]**

Unit-III: Radioactivity and Nuclear Structure of Atoms

Natural radioactivity, group displacement law, law of radioactive decay, half-life of radio elements. Atomic Nucleus: Stability of 'atomic nucleus, nuclear binding energy, Nuclear reactions: fission, fusion, transmutation of elements. **[5L]**

Unit-IV: Chemical Bonding

Ionic Bonding: General characteristics of ionic compounds; Lattice energy; Born Haber cycle. Covalent bonding: General characteristics of covalent compounds; valence-bond approach**,** directional character of covalent bond; hybridization involving s-, p-, d orbitals; multiple bonding; Valence Shell Electron Pair Repulsion (VSEPR) concept; Partial ionic character of covalent bonds; Fajan's rules. Hydrogen bonding and its effect on physical and chemical properties. **[10L]**

References:

1. D. A. McQuarrie and J. D. Simon: Physical Chemistry — A Molecular Approach

2.G. W. Castellan: Physical Chemistry

3. P. W. Atkins: Physical Chemistry

4. J. E Huheey, E. A. Keiter, R. L. Keiter: Inorganic Chemistry (Principle and structure and reactivity).

5. N. N. Greenwood, A. Earnshaw: Chemistry of the Elements

6. D. F. Shriver, P. W. Atkins, C. H. Langford: Inorganic Chemistry

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs)

Mappings between COs and POs		
Course Outcomes (COs)		**Mapped POs**
CO-1	**Explain** exclusive terminologies associated with thermodynamics and the basic concepts of thermodynamics i.e. heat transfer and its consequences with the thermodynamic system.	PSO1, PO1, PO2
CO-2	**Understand** the difference between what the molecules are doing in a solid, liquid, and gas, including movement, spacing, and organization, the physical characteristics of these states.	PSO1, PO1, PO4
CO- 3	**Understand** the properties of solutions that depends on the number of dissolved particles in solution, but not on the identities of the solutes.	PSO1, PO1, PO2, PO7
CO- 4	**Learn** the concept of reaction rates, predict products, yields etc.	PSO1, PO1, PO5, PO7

CO- 5	**Understand** the concept of using the symbols for protons, neutrons, electrons, positrons, alpha particles, beta particles, and gamma rays.	PSO3, PO1, PO4, PO7
CO- 6	**Interpret** periodic properties of elements, principles in molecular theory and bonding models to the study of inorganic compound.	PSO3, PO1, PO3, PO5, PO7

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2	PS O3
CHM 11151	ELECTIVE CHEMISTRY I	3	3	3		2							3	3		3

1=weakly mapped
2= moderately mapped
3=strongly mapped

CHM12152	ELECTIVE CHEMISTRY LAB I	L	T	P	C
Version 1.0		0	0	3	2
Pre-requisites/Exposure	Physics and Chemistry of class 12 or 10+2 level				
Co-requisites					

Course Objectives

1. To introduce important concepts required in the field of the practical field of elective chemistry. This course gives students a detailed understanding of lab-based chemistry knowledges in their course curriculums.
2. To introduce hands on training of standard solutions essential in every practical courses.
3. To impart the elementary ideas of physical methods of determination of surface tension, viscosity of organic solvents and acid catalysed hydrolysis of ester.
4. To learn the basic quantitative methods of titration of alkaline mixtures using various indicators.
5. To learn the determination methods of ionization constant of a weak acid by conductometric method.
6. To introduce the pH metric determination procedure of neutralization of acid-base titration.
7. To impart the determination method for rate constant of decomposition of H2O2 by acidified KI solution using clock reactions.

Course Outcomes:

On completion of this course, the students will be able to

CO1	Develop skills in the proper handling of apparatus and chemicals.
CO2	Develop experimental skill of quantitative volumetric analysis and determination of physical properties of substances.
CO3	Develop skills in the determinant of the concentration or the mass of the minimum formula from the titrated chemical material composing a pure liquid or a solution.

Course Description:

This course gives a detailed understanding of the basics of chemistry lab techniques required in other disciplines. This course will include expert instructors who will introduce a detailed description of lab-based chemistry knowledges in their course curriculums, methods of determination of surface tension and viscosity of common liquids, correlation of theories of kinetics in the light of acid catalysed hydrolysis of ester, different quantitative methods of acid-base titrations using direct and pH mediated methods, determination of ionization constants of weak acids by conductometric titration and clock reaction mediated rate constant determinations. All the lectures will be devoted on discussions of elementary concepts and cutting-edge topics, focusing on practical implementation of knowledge. Instructors will conduct demonstration classes by taking lecture followed by practical hands on training per requirement of the course. The tutorials and required assignments will acquaint the students with practical problem-solving techniques led by the course coordinator. After finishing this course, students from different disciplines will strongly acquire the hands-on training via experiencing practical lab sessions with the coordinator.

Course Content:

[15L]

General Chemistry Lab:

Preparation of Solution: Normal Solution; Molar Solution

Determination of surface tension of a given solution by drop weight method using a stalagmometer, considering aqueous solutions of NaCl, acetic acid, ethanol etc, as systems.

Determination of viscosity of organic solvents with Ostwald Viscometer at room temperature.

To determine the rate constant for the acid catalysed hydrolysis of an ester.

Inorganic Chemistry Lab:

Titration of Na4CO3 + NaHCO3 mixture vs HCl using phenolphthalein and methyl orange indicators.

Determination of ionization constant of a weak acid by conductometric method

Determination of neutralization point of the reaction between HC1 and NaOH with the help of pH meter .

Determination of rate constant of decomposition of H202 by acidified KI solution using clock reactions.

References:

1. Palit, S.R., De, S. K. Practical Physical Chemistry Science Book Agency

2. Handbook of Inorganic Analysis (First Edition): U.N Dhur & Sons Private Ltd.

3. Das, S.C. Advanced Practical Chemistry.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Continuous Assessment	End Term Examination
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs)

Mappings between COs and POs		
Course Outcomes (COs)		Mapped POs
CO- 1	Develop skills in the proper handling of apparatus and chemicals and preparation of standard solutions which are perquisite in respective course curriculum.	PSO1, PO3, PO4
CO- 2	Develop experimental skill of quantitative volumetric analysis and determination of physical properties of substances.	PSO1,PSO3, PO1, PO2, PO3
CO- 3	Develop skills in the determination of the concentration or the mass of the minimum formula from the titrated chemical material composing a pure liquid or a solution.	PSO1,PSO3, PO1, PO2, PO3, PO4

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2	PS O3
CHM 12152	ELEC TIVE CHEM ISTRY LAB I	3	3	3		2							3	3		3

1=weakly mapped
2= moderately mapped
3=strongly mapped

DGS11011	DESIGN THINKING	L	T	P	C
Version 1.0		**2**	**0**	**0**	**2**
Pre-requisites/Exposure	Knowledge of analyzing society problems and product usage problems and a zeal to improve the current situation, in addition to knowing to using laptop/computers, internet, social media interaction, file sharing and uploading, email and communication etiquettes.				
Co-requisites	--				

Course Objectives:

1. To enable students to acquire knowledge, imagination and be more assertive on opinions on problems in society.
2. To enable students to learn basics of research, data collection, analysis, brainstorming to find solutions to issues.
3. To make them understand Design Thinking methodologies to problems in field of study and other areas as well.
4. To help students to understand future Engineering positions with scope of understanding dynamics of working between inter departments of a typical OEM.

Course Outcomes:

On completion of this course, the students will be able to

Examine design thinking concepts and principles

CO1. Practice the methods, processes, and tools of design thinking

CO2. Apply the Design Thinking approach and model to real world scenarios

CO3. Analyze the role of primary and secondary research in the discovery stage of design thinking

Course Description:

Design thinking course is a completely online course offered to the first year UG programs across all streams. This course is designed to help understand the steps followed in the process of designing a solution to a problem.

Course Content

UNIT I: WHAT IS DESIGN THINKING [2 L]

Designers seek to transform problems into opportunities. Through collaboration, teamwork, and creativity, they investigate user needs and desires on the way to developing human-centered products and/or services. This approach is at the very heart of design thinking.

UNIT II: THE DESIGN THINKING MODEL [2 L]

A tool that helps guide you along a design thinking path. The model does this by providing a series of activities that that will help you effectively design a product, service or solution to a user's need. The model presents the approach as a process, allowing us to look at each step – or phase – along the journey to the development of a final design.

UNIT III: PHASE 1: DISCOVER [4 L]

Begin the design thinking process with the Discover phase, where you will identify the specific problem your design is intended to solve, as well as important usability aspects from those who

will use your design. Discovery can be performed through a variety of different research methods which you will learn in this module.

UNIT IV: PHASE 2: DEFINE [4 L]

In the Define phase, you come to understand the problem. We often refer to this as framing the problem. You can do this by using a variety of tools, including storytelling, storyboarding, customer journey maps, personas, scenarios, and more.

UNIT V: PHASE 3: DEVELOP [4 L]

Turn your attention to solving the problem. In this phase you brainstorm custom creative solutions to the problems previously identified and framed. To do this, you conceptualize in any way that helps, putting ideas on paper, on a computer, or anywhere whereby they can be considered and discussed.

UNIT VI: PHASE 4: DELIVER [4 L]

This phase is all about testing and building concepts. Here you take all of the ideas that have been discussed to this point and bring them a little closer to reality by building a concept; something that makes it easier for a user to experience a design. This concept is referred to as a prototype.

UNIT VII: PHASE 5: ITERATE [4 L]

You will test the prototype of your design solution, collecting and acting on feedback received. These actions may mean minor or major revisions to your design, and are repeated as often as necessary until a solution is reached. Tools such as focus groups and questionnaires are used to help you collect feedback that can help with your final design.

UNIT VIII: BEYOND DESIGN THINKING [2 L]

The Design Thinking Model is a tool that helps guide you along a design thinking path. The model does this by providing a series of activities that that will help you effectively design a product, service or solution to a user's need. The model presents the approach as a process, allowing us to look at each step – or phase – along the journey to the development of a final design.

Reference:

1. All the references are available to download in the online course.
2. Brown, Tim. "What We Can Learn from Barn Raisers." Design Thinking: Thoughts by Tim Brown. Design Thinking, 16 January 2015. Web. 9 July 2015.
3. Knapp, Jake. "The 8 Steps to Creating a Great Storyboard." Co.Design. Fast Company & Inc., 21 Dec. 2013. Web. 9 July 2015.
4. Van der Lelie, Corrie. "The Value of Storyboards in the Product Design Process." Journal of Personal and Ubiquitous Computing 10.203 (2006): 159–162. Web. 9 July 2015.
5. Millenson, Alisson. "Design Research 101: Prototyping Your Service with a Storyboard." Peer Insight.

Modes of Evaluation: Assignment/Quiz/Project/Presentation/Written Examination

Examination Scheme:

Components	Mid-term Examination	Continuous Assessment	End Term Examination
Weightage (%)	20	30	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs, POs and PSOs

Course Outcomes (COs)		Mapped POs and PSOs
CO1	Examine design thinking concepts and principles	PO1, PO11
CO2	Practice the methods, processes, and tools of design thinking	PO1, PO2
CO3	Apply the Design Thinking approach and model to real world scenarios	PO1, PO2
CO4	Analyze the role of primary and secondary research in the discovery stage of design thinking	PO1, PO5

		Academic Excellence	**Contextualized Understanding**	**Design/development of solutions**	**Conduct investigations of complex problems**	**Quantitative Aspects**	**Modernization and Tools Usage**	**Societal Implication**	**Environment and Sustainability**	**Ethics**	**Individual and Team Work**	**Communication**	**Life Long Learning**	Have the versatility to work effectively in a	Be familiar with a variety of examples where	Enhance theoretical rigor with technical skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
DGS11001	DESIGN THINKING	3	2	-	-	2	-	-	-	-	-	2	-	-	-	-

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11085	DIFFERENTIAL EQUATION I	L	T	P	C
Version 1.0	Contact Hours - 60	3	1	0	4
Pre-requisites/Exposure	12th level Mathematics				
Co-requisites					

Course Objectives:

The primary objective of this course is to provide students the basic concept of differential equations and to develop skill for solving and applying first order ordinary differential equations.

Course Outcomes

On completion of this course, the students will be able to

CO1 **Explain** the concept of differential equation, its formulation and solution.

CO2 **Solve** ordinary differential equations of first order and first degree.

CO3 **Solve** ordinary differential equations of first order and but not of first degree.

CO4 **Apply** knowledge of differential equation in solving practical problems.

Course Description:

This course has been design in such a way that students will develop their concept in fundamental as well as applications of first and second order linear differential equations. The course deals with different types of first order differential equation and their solutions with applications in biological, physical and engineering problems. It also deals with existence and uniqueness of solution of ordinary differential equations. Solutions of second and higher order ordinary differential equations have been also included in this syllabus. After the successful completion of this course student may formulate the some physical models in the form of ordinary differential equation and may solve by suitable method.

Course Content:

Unit I:

Introduction, Classification of differential equations; Characteristics of ordinary differential equation (ODE); Formulation; Solution of a differential equation and its geometrical significance; General, particular, explicit, implicit and singular solutions of an ODE. Lipschitz condition; non-local existence of solutions, uniqueness of solutions, existence and uniqueness theorem for first order equations, statement of existence and uniqueness theorem for the solutions of ordinary differential equation of order *n*. [**15 L**]

Unit II:

Solution of ODE using variable separation method; Homogeneous and reducible to homogeneous differential equations, exact differential equations, Equations reducible to exact, integrating factors; First order linear equation and Bernoulli's equations; special integrating factors and transformations. [**16 L**]

Unit-III

Differential equation of first order but not first degree; equations solvable for *p, y, x*; Clairaut's equation; singular solutions and its geometric meaning; orthogonal trajectories and related problems. [**15 L**]

Unit-IV

Applications of ODE: Introduction to compartmental model – Velocity-acceleration problem, exponential decay model, predator-prey model and its analysis, epidemic model of influenza and its analysis, exponential growth of population. [**14 L]**

References:

1. R.K. Ghosh ad K.C. Maity, An Introduction to Differential Equations, New Central Book Agency
2. M.D. Raisinghania, Ordinary Differential Equations, S Chand & Company LTD.
3. H.T.H. Piaggio, Differential Equations, G.Bell& Sons Ltd. 1921
4. S. L. Ross, Differential Equations, John Wiley and Sons, India, 2004.
5. William E. Boyce and Richard C. Di-Prima, Elementary Differential Equations and Boundary Value Problems, 7th edition, John Wiley & Sons, Inc.
6. C. H. Edwards and D. E. Penny, Differential Equations and Boundary Value Problems: Computing and Modeling, Pearson Education, India, 2005.
7. Belinda Barnes and Glenn R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach Using Maple, Taylor and Francis, London 2002.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid Term	Class Assessment	End Term
Weightage (%)	20	30	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs)

Mappings between COs and POs		
Course Outcomes (COs)		Mapped POs
CO1	**Explain** the concept of differential equation, its formulation and solution.	PO1, PO2, PO3, P12, PSO1, PSO2
CO2	**Solve** ordinary differential equations of first order and first degree.	PO1, PO2, PO3, P12, PSO1, PSO2
CO3	**Solve** ordinary differential equations of first order and but not of first degree.	PO1, PO2, PO3, P12, POS1, PSO2
CO4	**Apply** knowledge of differential equation in solving practical problems.	PO1, PO2, PO3, P12, PSO1, PSO2, PSO3

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2	PS O3
MTH1 1085	Differe ntial Equatio n I	3	3	3	-	-	-	-	-	-	-	-	3	3	3	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11086	MODERN ALGEBRA I	L	T	P	C
Version 1.0	Contact Hours - 60	3	1	0	4
Pre-requisites/Exposure	$10+2^{th}$ level Mathematics				
Co-requisites	--				

Course Objectives:

This course gives the basic concept of set, relation and mapping. Furthermore, the knowledge of groups, subgroups and cyclic groups will be discussed in this course. In the last part, this course gives an idea about permutations to define permutation group, alternating group and study their properties.

Course Outcomes

On completion of this course, the students will be able to

CO1 **Explain** the concept of set, relation, mapping and different algebraic structures on a set.

CO2 **Extend** the knowledge of group theory.

CO3 **Illustrate** the concept of subgroups, cyclic subgroups and study their properties.

CO4 **Explain** the concept of permutation groups, alternating groups and study their properties.

Course description:

In this course basic theory of groups are introduced with the related results. In the first unit, notions of set theory, functions are discussed with the notion of binary operations and algebraic structures. After that in unit II, notion of groups is introduced with related important concepts. Also, some special groups are being introduced in this unit. After developing some concepts on groups, in the third unit, notions of subgroups, cyclic groups are introduced with important results. In the last unit, the notion of permutation is introduced with the notion of permutation group.

Course Content:

Unit I

Set, relation and mapping: Basic properties of sets, set operations, De Morgan's laws, Cartesian product of sets, relation, equivalence relation, relation between equivalence relation and partition, congruence of integers, congruence classes. Mapping: Injection, surjection, bijection, identity and inverse mappings, composition of mappings and its associativity.

Binary operations: Definitions and examples, commutative and associative binary operations, identity and inverse elements.

Algebraic structure: Concept of algebraic structure, definition (only) of groupoid, semi-group, monoid. [**15L**]

Unit-II

Group, Abelian group, examples of groups from number system, root of unity, matrices, symmetries of squares, triangles etc., groups of congruence classes, Klein's 4 group, properties

deducible from definition of group including solvability of equations like $ax = b,\ ya = b$, any finite semi-group having both cancellation laws is a group, integral power of elements and laws of indices in a group, order of an element of a group, order of a group. [**18L**]

Unit-III

Subgroups, necessary and sufficient condition for a subset of group to be a subgroup, intersection and union of subgroups, necessary and sufficient condition for union of two subgroups to a subgroup, properties of cyclic groups, classification of subgroups of cyclic groups. [**12L**]

Unit-IV

Cycle notation for permutations, properties of permutations, even and odd permutations, permutation groups and quaternion groups, alternating group with some properties. [**15 L**]

References:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. M.R. Adhikari, A.Adhikari, Basic Modern Algebra with Applications, Springer Verlag.
4. Joseph A. Gallian, Contemporary Abstract Algebra (8th Edn.), Narosa Publishing House, New Delhi.
5. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
6. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid Term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs)

Mappings between COs and POs		
Course Outcomes (COs)		**Mapped POs**
CO1	**Explain** the concept of set, relation, mapping and different algebraic structures on a set.	PO1, PO2, PO3, PO12, PSO1, PSO2
CO2	**Extend** the knowledge of group theory.	PO1, PO2, PO3, PO12, PSO1, PSO2
CO3	**Illustrate** the concept of subgroups, cyclic subgroups and study their properties.	PO1, PO2, PO3, PO12, PSO1, PSO2,
CO4	**Explain** the concept of permutation groups, alternating groups and study their properties.	PO1, PO2, PO3, PO12, PSO1, PSO2

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	**Contextualized Understanding:** Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	**Critical Thinking and Problem Solving Skills:** Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	**Problem Analysis:** Identify, formulate and analyze complex problems using mathematical principles.	**Modernization and Tools Usage:** Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	**Societal Implication:** Analyze complex social elements, their interrelation and its impact on geographically different society.	**Environment and Sustainability:** Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	**Ethics:** Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	**Individual and Team Work:** Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	**Communication:** Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	**Leadership Skills:** Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	**Life Long Learning:** Develop the ability to reasoning, abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MTH1 1086	Modern Algebra I	3	3	3	-	-	-	-	-	-	-	-	3	3	3	-

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11087	REAL ANALYSIS II	L	T	P	C
Version 1.0	Contact Hours - 60	3	1	0	4
Pre-requisites/Exposure	Real Analysis-I				
Co-requisites	--				

Course Objectives:

To develop the concept of Riemann integration and improper integral of real numbers and its various properties including the concept of sequence and series of functions.

Course Outcomes

On completion of this course, the students will be able to

CO1 **Define** the concept of Riemann integration and their properties.

CO2 **Illustrate** the concept of improper integral and its properties on real numbers.

CO3 **Explain** the idea of Beta and Gamma function and its properties.

CO4 **Extend** the idea of convergence of sequences and series of functions through various convergence test.

Course Content:

Unit-I:

Riemann integration: Definition, inequalities of upper and lower sums; Riemann conditions of integrability. Riemann sum and definition of Riemann integral through Riemann sums; equivalence of two definitions; Riemann integrability of monotone and continuous functions, Properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions. Intermediate Value theorem for Integrals; Fundamental theorems of Calculus. **[25L]**

Unit-II:

Improper Integration: Definition, types of improper integration, necessary and sufficient condition for convergence of improper integral in both cases.

Tests of convergence: Comparison and M-test. Absolute and non-absolute convergence and inter-relations, statement of Abel's and Dirichlet's test for convergence on the integral of a product. Convergence and working knowledge of Beta and Gamma function and their relations**.** **[18L]**

Unit-III:

Sequences and series of functions: Pointwise and uniform convergence. M_n-test, M-test, statements of the results about uniform convergence and integrability and differentiability of functions, Power series and radius of convergence, interval of convergence. **[17L]**

References:

1. S.K. Mapa, Introduction to Real Analysis, 7th Edition, Sarat Publishers, India.

2. S.C. Malik and S Arora, Mathematical Analysis, New Age International Private Limited.
3. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis (3rd Edition), John Wiley and Sons (Asia) Pvt. Ltd., Singapore.
4. R.K. Ghosh and K.C Maity, An Introduction to Analysis: Integral Calculus.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid Term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs)

Mappings between COs and POs		
Course Outcomes (COs)		**Mapped POs**
CO-1	**Define** the concept of Riemann integration and their properties.	PO1, PO2, PO3, PO12, PSO1, PSO2
CO-2	**Illustrate** the concept of improper integral and its properties on real numbers.	PO1, PO2, PO3, PO12, PSO1, PSO2
CO-3	**Explain** the idea of Beta and Gamma function and its properties.	PO1, PO2, PO3, PO12, PSO1, PSO2, PSO3
CO-4	**Extend** the idea of convergence of sequences and series of functions through various convergence test.	PO1, PO2, PO3, PO12, PSO1, PSO2

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	**Contextualized Understanding:** Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	**Critical Thinking and Problem Solving Skills:** Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	**Problem Analysis:** Identify, formulate and analyze complex problems using mathematical principles.	**Modernization and Tools Usage:** Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	**Societal Implication:**Analyze complex social elements, their interrelation and its impact on geographically different society.	**Environment and Sustainability:** Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	**Ethics:** Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	**Individual and Team Work:** Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	**Communication:** Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	**Leadership Skills:** Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	**Life Long Learning:** Develop the ability to reasoning, abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MTH11087	Real Analysis II	3	3	3	-	-	-	-	-	-	-	-	3	3	3	2

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11091	ANALYTICAL GEOMETRY 2D	L	T	P	C
Version 1.0	Contact Hours - 60	3	1	0	4
Pre-requisites/Exposure	Algebra				
Co-requisites	--				

Course Objective: To give students the knowledge of two-dimensional geometry which is useful to study several real-life phenomena.

Course Outcomes

On completion of this course, the students will be able to

CO1 **Explain** the notions of transformation of rectangular axes and pair of straight lines.

CO2 **Choose** appropriate translations and rotations of the coordinate axes to classify the conic section by reducing them to their canonical form.

CO3 **Explain** the concepts of tangent & normal to the conics.

CO4 **Illustrate** the idea of poles, polars to a conic, polar equations of the conics and diameters.

Course Description: Analytic geometry is also known as coordinate geometry or Cartesian geometry. Analytic geometry is the study of geometry using a coordinate system. It is used in modern fields of geometry, including algebraic, differential, discrete and computational geometry, physics, engineering, and also in aviation, rocketry, space science, and spaceflight. In analytic geometry, the plane is given a coordinate system, by which every point has a pair of real number coordinates. In polar coordinates, every point of the plane is represented by its distance r from the origin and its angle θ. This course describes transformation of axes, pair of straight lines, general second degree equation, tangent, normal, pole, polars, etc.

Course Content:

Unit-I

Coordinate Geometry, straight line, various forms of straight lines, angles and bisectors of two straight lines. Transformation of rectangular axes- Translation, Rotation, translation followed by rotation, general orthogonal transformation. Invariants associated with the coefficients of the general degree equation. Pair of straight lines: Equation of pair of straight lines, angle between pair of straight lines, bisectors of the angles between the pair of straight lines.

[14L]

Unit-II

General equation of second degree: necessary and sufficient conditions for the general second degree equation to represent a pair of straight lines, reduction of the general second degree equation to canonical form, classification of conics, and pair of straight lines**,** center of conics, lengths and position of the axes of a central conic, intersection of a conic and straight line in a given direction, intersection of two conics. **[16L]**

Unit-III

Tangent: Equation of tangent to a conic at a point, Condition of a tangency of a straight line to a conic, Number of tangents from an external point to a central conic, equation of pair of

tangents from an external point to a central conic, equation of chord of contact of tangents to a central conic.

Normal: Equation of normal at a given point on a conic, Number of normals from a given point to a conic, equation of the curve through the co-normal points of an ellipse, sub-tangent and sub-normal of a parabola. **[14L]**

Unit-IV

Poles and polars with respect to a non -singular conic, properties of poles and polars, Condition for conjugate lines.

Diameters: Diameter and its properties conjugate diameters of conics, properties of conjugate diameters of an ellipse, hyperbola. Equi-conjugate diameters of an ellipse.

Polar equations: Polar equations of straight lines, circle and conics (with a focus as pole), equation of chord of conic, equation of tangent and normal of conic, equation of chord of contact of tangents, asymptotes, co-axial systems of circles. **[16L]**

References:

1. S.L. Loney, The Elements of Coordinate Geometry, McMillan and Company, London.

2. J. G. Chakravorty and P.R. Ghosh, Advanced Analytical Geometry, U.N.Dhur & Sons Pvt Ltd, 2018.

3**.** P.K.Jain and K.Ahmad, Analytical Geometry of Two Dimensions, New Age International (P) Ltd., 1996.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid Term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs)

Mappings between COs and POs		
Course Outcomes (COs)		**Mapped POs**
CO-1	**Explain** the notions of transformation of rectangular axes and pair of straight lines.	PO1, PO3, PSO3
CO-2	**Choose** appropriate translations and rotations of the coordinate axes to classify the conic section by reducing them to their canonical form.	PO1, PO2, PO3, PO12, PSO1, PSO2
CO-3	**Explain** the concepts of tangent & normal to the conics.	PO1, PO2, PO3, PO12, PSO1, PSO2, PSO3
CO-4	**Illustrate** the idea of poles, polars to a conic, polar equations of the conics and diameters.	PO1, PO2, PO3, PO9, PO12, PSO1, PSO2, PSO3

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	**Contextualized Understanding:** Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	**Critical Thinking and Problem Solving Skills:** Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	**Problem Analysis:** Identify, formulate and analyze complex problems using mathematical principles.	**Modernization and Tools Usage:** Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	**Societal Implication:**Analyze complex social elements, their interrelation and its impact on geographically different society.	**Environment and Sustainability:** Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	**Ethics:** Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	**Individual and Team Work:** Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	**Communication:** Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	**Leadership Skills:** Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	**Life Long Learning:** Develop the ability to reasoning, abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MTH11091	Analytical Geometry 2D	3	3	3	3	-	-	-	-	1	-	-	3	3	3	2

1=weakly mapped
2= moderately mapped
3=strongly mapped

EVS11105	ENVIRONMENTAL SCIENCE	L	T	P	C
Version 1.1	Contact Hours – 30	2	0	0	2
Pre-requisites/Exposure	Basic physics, chemistry, biology and mathematics				
Co-requisites	--				
Academic year					

Course Objectives

1. To understand the intrinsic relation between humans and environment, our position in the ecosystem around us
2. To comprehend the significance of the biodiversity surrounding us.
3. To figure out the importance and need for energy resources, various sources of energy, renewable and non-renewable sources, conventional and unconventional sources.
4. To have basic concepts about sustainability, our dependence on nature and the consequences of overexploitation.
5. To enable students to appreciate the importance and how much we owe to the earth systems for our survival.
6. To have a basic concept about the types of pollution and mitigation procedures.
7. To have an overall idea about the environmental legal framework in our country and about the EIA and environmental audit procedures.

Course Outcomes

On completion of this course, the students will be able to

CO1	Relate to multidimensional complex nature of environmental problems, various types of ecosystems, ecosystem dynamics, perceive and appreciate the surrounding nature.
CO2	Perceive with the intrinsic relation between humans and environment, our position in the ecosystem around us, and importance of biodiversity.
CO3	Classify the presence of various pollutants, their significance, and impacts, and develop the underlying concepts involved in various air pollution prevention and mitigation measures.
CO4	Summarise the routes of generation, classification, management, and environmental significance of solid waste.
CO5	Illustrate water chemistry, deduce the relationship between various water pollutants, and understand the principles of various water and wastewater treatment procedures.
CO6	Create awareness and concern about importance of environmental resources and their damage and protection.
CO7	Compare the different approaches and practices of biodiversity conservation and management.
CO8	Explain the legal framework in our country for safeguarding the environment including pollution prevention, control, management, and wildlife management.
CO9	Defend as responsible citizens for various global environmental issues and motivate others for active participation in minimizing the environmental damage already caused.

Course Description:

To distinguish between various types of ecosystems, ecosystem dynamics, perceive and appreciate the surrounding nature and feel connected, develop the concept of innate relationship of humans and biodiversity, need for conservation and different conservation strategies. The students will be developed in a way so that they can spontaneously comprehend the importance of studying about the various air pollutants, their significance and impacts, and

develop the underlying concepts involved in various air pollution prevention and mitigation measures, understand fundamental water chemistry, deduce the relationship between various water pollutants, and understand the principles of various water and wastewater treatment procedures. They will understand the routes of generation, classification, management and environmental significance of solid waste, apply the basic concepts of waste management in their daily lives, and understand the need of the 5Rs of waste management, importance of waste minimization.

Course Content:

Unit I:

Multidisciplinary nature of environmental sciences; scope and importance; need for public awareness; concept of sustainability and sustainable development
Forest resources: Function of forests, cause and effects of deforestation, case studies.
Water resources: distribution of water, hydrological cycle, use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems
Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies
Food Resources: World food problems and environmental concern, Food security, case studies
Energy resources: Concept of energy, SI Units of Work, Heat and Power, World energy use, Energy consumption pattern in India and U.S., Environmental aspects of energy utilization Renewable and non-renewable sources; Fossil fuel: types, use and environmental impacts, Solar energy: Solar Radiation – Passive and active solar systems – Flat Plate and Concentrating Collectors – Solar direct Thermal Application– Fundamentals of Solar Photo Voltaic Conversion- advantages and disadvantages of Solar Power generation, Solar energy status in India; Wind Energy: site selection, Wind turbine: basic working principle and types, Wind energy status in India, advantages and disadvantages of Wind Power generation; Hydroelectric power : How is it generated, advantages and disadvantages; Biomass energy: various types, generations of biofuel, Biogas plants, Bio diesel; Geothermal Energy: source, advantages and disadvantages, Nuclear Power: nuclear fission, moderation of reaction, nuclear reactor: pressurized water reactor, advantages and disadvantages **[5 L]**

Unit II: Ecosystems

Concept of an ecosystem, Structure and function of an ecosystem, Producers, consumers and decomposers, Food chains, food webs and ecological pyramids, energy flow, ecological succession. **[5 L]**

Unit III: Biodiversity and its conservation

Levels of Biodiversity: genetic, species and ecosystem diversity. Biogeographical classification of India, Values of biodiversity, Biodiversity at global, National and local levels, India as a mega-diversity nation, Biodiversity hotspots, Threats to Biodiversity, In-situ and Ex-situ conservation of Biodiversity. **[5 L]**

Unit – IV: Environmental Pollution and Waste Management

Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution, marine pollution; case studies. Nuclear hazards and human health risks.
Sources and generation of solid wastes, their characterization, chemical composition and classification. Different methods of disposal and management of solid wastes (Hospital Wastes and Hazardous Wastes) Recycling of waste material. Waste minimization technologies. Hazardous Wastes Management and Handling Rules, 1989. **[10 L]**

Unit – V: Global Issues and Environmental Acts

Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents.
Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD). **[5 L]**

References:

1. Principles of Environmental Science, 4th edition by Cunningham, W.P. and Cunningham, M.A. (2002), Tata McGraw-Hill Publishing Company, New Delhi

2. Basic Environmental Engineering & Elementary Biology by Monidranath Patra and Rahul Kumar Singha, Aryan Publishing house

3. Introduction to Environmental Engineering and Science, by Masters, G.M., Prentice Hall of India, Second Indian Reprint.

4. Wastewater Engineering: Treatment and Reuse, 4th Edition, Metcalf and Eddy, Inc. McGraw-Hill, Inc., New York, 2002

5. Environmental Engineering", Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, McGraw-Hill Education (India) Private Limited, New Delhi

6. Introduction to Environmental Engineering, 2nd Ed. by Davis, M. L. and Cornwell D. A. McGraw Hill, Singapore.

7. Environmental Sciences: The Environment and Human Impact by Jackson, A.R.W. and Jackson, J.M., Longman Publishers

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid Term	Class Assessment	End Term
Weightage (%)	20	30	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

	Mappings between COs and POs	
	Course Outcomes (COs)	**Mapped POs**
CO1	Relate to multidimensional complex nature of environmental problems, various types of ecosystems, ecosystem dynamics, perceive and appreciate the surrounding nature.	**PO6, PO7**
CO2	Perceive the intrinsic relation between humans and environment, our position in the ecosystem around us, and importance of biodiversity.	**PO7, PO8**
CO3	Classify the presence of various air pollutants, their significance, and impacts, and develop the underlying concepts involved in various air pollution prevention and mitigation measures.	**PO3, PO6, PO7**
CO4	Summarise the routes of generation, classification, management, and environmental significance of solid waste.	**PO3, PO6, PO7**
CO5	Illustrate water chemistry, deduce the relationship between various water pollutants, and understand the principles of various water and wastewater treatment procedures.	**PO3, PO6, PO7, PSO3**
CO6	Create awareness and concern about importance of environmental resources and their damage and protection.	**PO8, PO12, PSO3**
CO7	Compare the different approaches and practices of biodiversity conservation and management.	**PO2, PO7, PO8**
CO8	Explain the legal framework in our country for safeguarding the environment including pollution prevention, control, management, and wildlife management.	**PO6, PO8**
CO9	Defend as responsible citizens for various global environmental issues and motivate others for active participation in minimizing the environmental damage already caused.	**PO1, PO2, PO3, PO6, PO8**

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	**Contextualized Understanding:** Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	**Critical Thinking and Problem Solving Skills:** Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	**Problem Analysis:** Identify, formulate and analyze complex problems using mathematical principles.	**Modernization and Tools Usage:** Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	**Societal Implication:** Analyze complex social elements, their interrelation and its impact on geographically different society.	**Environment and Sustainability:** Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	**Ethics:** Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	**Individual and Team Work:** Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	**Communication:** Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	**Leadership Skills:** Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	**Life Long Learning:** Develop the ability to reasoning, abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EVS11 105	Environ mental Science	1	1	1	-	-	3	3	2	-	-	-	1	-	-	1

1=weakly mapped
2= moderately mapped
3=strongly mapped

CSE11657	Elective Programming Language II	L	T	P	C
Version 1.0	Contact Hours – 60 Hours	3	1	0	4
Pre-requisite/Exposure	10+2 Level Mathematics, Knowledge of Basics of Computer				
Co-requisite	NIL				

Course Objectives:

Students will be motivated to solve the problems in engineering using the concepts of object-oriented programming.

Course Outcomes:

On the completion of this course the student will be able to

CO1. Define Abstraction in all forms and in a holistic way
CO2. Illustrate object-oriented modelling techniques like classes and Instances modelling techniques
CO3. Solve programs using standard design patterns
CO4. Interpret fundamentals of object-oriented programming in Java, including defining Classes, invoking methods, using class libraries, etc.
CO5. Construct programming solutions with exception handling and multi-threading concept
CO6. Solve GUI program with proper event handling techniques

Course Description:

This course investigates object-oriented methods including object-oriented programming methodologies and techniques. Current methodology is emphasized. The use of object-oriented features such as encapsulation, information hiding, inheritance and polymorphism is reinforced by class assignments and programming exercises. The importance of multi-threading and exception handling is introduced in this course.

Course Content:

Unit I: 12 lecture hours

OOP Concepts - Data Abstraction, Encapsulation, Inheritance, Benefits of Inheritance, Polymorphism, Classes and Objects, Procedural and OOP Paradigms. Introduction To Java, Data Types, Variables & Constants, Scope & Life Time Of Variables, Precedence Of Operator, Expressions, Type Casting, Enumerated Types, Block Scope, Control Flow, Conditional Statements, Loops, Break & Continue Statements, Arrays, Console Input/Output, Formatting Output, Constructors Methods, Parameter Passing, Static Fields & Methods, Access Control, “This” Reference, Method Overloading, Recursion, Garbage Collection, Building Strings, String Class.

Unit II: **12 lecture hours**

Inheritance - Hierarchical Inheritance: Super And Sub Classes, Member Accessing Rules, Super Keyword, And Preventing Inheritance: Final Classes And Methods, Object Class And Its Methods.

Polymorphism - Dynamic Binding, Method Overriding, Abstract Classes and Methods

Interfaces - Interfaces and Abstract Classes, Definition, Implementation, Accessing Implementations by Interface References, Extending Interfaces.

Inner Classes - Usage, Local, Anonymous and Static Inner Classes, Examples.

Packages - Definition, Creation And Accessing A Package, Understanding CLASSPATH, Importing Packages.

Unit III: **12 lecture hours**

Exception Handling - Dealing With Errors, Advantages Of Exception Handling, The Classification - Exception Hierarchy, Checked And Unchecked Exceptions, Try, Catch, Throw, Throws And Finally, Exceptions-Throwing, Exception Specification, Built In Exceptions, Creating Exception Sub Classes.

Multithreading - Difference Between Multiple Processes And Multiple Threads, Thread States, Creating And Interrupting Threads, Thread Priorities, Synchronizing Threads, Inter-Thread Communication, Procedure Consumer Pattern.

Unit IV: **12 lecture hours**

Collection Framework - Introduction, Generics and Common Use Of Collection Classes, Array List, Vector, Hash Table, Stack, Enumeration, Iterator, String Tokenizer, Random, Scanner, Calendars And Properties.

Files - Streams - Byte Streams, Character Streams, Text Input/Output, Binary Input/Output, Random Access of File Operations, File Management.

Connecting To Database – JDBC / ODBC Type 1 To 4 Drivers, Connection And Handling Databases With JDBC.

Unit V: **12 lecture hours**

GUI Programming - The AWT Class Hierarchy, Introduction To Swing, Swing Vs, AWT, Hierarchy Of Swing Components, Containers - Jframe, Japplet, Jdialog, Jpanel, Overview Of Swing Components: Jbutton, Jlabel, Jtextfield, Jtextarea, Swing Applications, Layout Management - Types - Border, Grid And Flow

Event Handling - Events, Sources, Classes, Listeners, Event Sources And Listeners, Delegation Event Model, Examples. Handling Mouse Events, Adapter Classes.

Applets - Inheritance Hierarchy For Applets, Differences Between Applets And Applications, Life Cycle, Passing Parameters To Applets, Applet Security Issues.

Text Books:

1. Java Fundamentals - A Comprehensive Introduction, Illustrated Edition By Daleskrien, Herbert Schildt, Mcgraw-Hill Education.

Reference Books:

1. Java for Programmers, 2nd Edition by Paul Deitel and Harvey Deitel, Pearson Education.
2. Thinking In Java, Low Price Edition By Bruce Eckel, Pearson Education

Modes of Evaluation: Assignment/Quiz/Project/Presentation/Written Examination

Examination Scheme:

Components	Mid-term Examination	Continuous Assessment	End Term Examination
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs, POs and PSOs

Course Outcomes (COs)		Mapped POs and PSOs
CO1	Define Abstraction in all forms and in a holistic way	PO1, PO12, PSO3
CO2	Illustrate object-oriented modelling techniques like classes and Instances modelling techniques	PO1, PO3, PO5, PO12, PSO3
CO3	Solve programs using standard design patterns	PO1, PO2, PO3, PO4, PO5, PO12, PSO3
CO4	Interpret fundamentals of object-oriented programming in Java, including defining Classes, invoking methods, using class libraries, etc.	PO1, PO3, PO12, PSO3
CO5	Construct programming solutions with exception handling and multi-threading concept	PO1, PO3, PO4, PO5, PO12, PSO3
CO6	Solve GUI program with proper event handling techniques	PO1, PO3, PO4, PO5, PO12, PSO3

		Academic Excellence	Contextualized Understanding	Design/development of solutions	Conduct investigations of complex problems	Quantitative Aspects	Modernization and Tools Usage	Societal Implication	Environment and Sustainability	Ethics	Individual and Team Work	Communication	Life Long Learning	Have the versatility to work effectively in a	Be familiar with a variety of examples where	Enhance theoretical rigor with technical skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CSE11657	Elective Programming Language II	3	1	3	3	3	-	-	-	-	-	-	3	-	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

CSE12658	Elective Programming Language II Lab	L	T	P	C
Version 1.0	Contact Hours – 60 Hours	0	0	2	2
Pre-requisite/Exposure	Discrete Mathematics, Calculus, Machine Learning				
Co-requisite					

Course Objectives:

To understand how to design, implement, test, debug, and document programs that use basic data types and computation, simple I/O, conditional and control structures, string handling, functions and object oriented approaches.

Course Outcomes:

On the completion of this course the student will be able to

CO1. **Define** classes, objects, members of a class and the relationships among them needed for a finding the solution to specific problem.
CO2. **Illustrate** object oriented modelling techniques like classes and Instances modelling techniques
CO3. **Solve** programs using standard design patterns.
CO4. **Interpret** fundamentals of object-oriented programming in Java, including defining Classes, invoking methods, using class libraries, etc.
CO5. **Construct** programming solutions with exception handling and multi-threading concept
CO6. **Solve** GUI program with proper event handling techniques.

Catalog Description:

This course investigates object-oriented methods including object-oriented programming methodologies and techniques. Current methodology is emphasized. The use of object-oriented features such as encapsulation, information hiding, inheritance and polymorphism is reinforced by class assignments and programming exercises. The importance of multi-threading and exception handling is introduced in this course.

Course Content:

List of Programs:

Experiment 1:

Assignments based on class, constructor.

Experiment 2:

Assignments based on overloading.

Experiment 3:

Assignments based on inheritance, overriding.

Experiment 4:

Assignments based on wrapper class, arrays.

Experiment 5:

Assignments based on developing interfaces- multiple inheritances, extending interfaces

Experiment 6:

Assignments based on creating and accessing packages

Experiment 7:

Assignments based on multithreaded programming

Experiment 8:

Assignments based on applet programming

Text Books:

1. Java Fundamentals - A Comprehensive Introduction, Illustrated Edition By Daleskrien, Herbert Schildt, Mcgraw-Hill Education.

Reference Books:

1. Java for Programmers, 2nd Edition by Paul Deitel and Harvey Deitel, Pearson Education.
2. Thinking in Java", Low Price Edition By Bruce Eckel, Pearson Education

Modes of Evaluation: Assignment/Quiz/Project/Presentation/Written Examination

Examination Scheme:

Components	Continuous Assessment	End Term Examination
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs, POs and PSOs

Course Outcomes (COs)		Mapped POs and PSOs
CO1	**Define** classes, objects, members of a class and the relationships among them needed for a finding the solution to specific problem.	PO1, PO12, PSO3
CO2	**Illustrate** object-oriented modelling techniques like classes and Instances modelling techniques	PO1, PO3, PO5, PO12, PSO3
CO3	**Solve** programs using standard design patterns.	PO1, PO2, PO3, PO4, PO5, PO12, PSO3
CO4	**Interpret** fundamentals of object-oriented programming in Java, including defining Classes, invoking methods, using class libraries, etc.	PO1, PO3, PO12, PSO3
CO5	**Construct** programming solutions with exception handling and multi-threading concept	PO1, PO3, PO4, PO5, PO12, PSO3
CO6	**Solve** GUI program with proper event handling techniques.	PO1, PO3, PO4, PO5, PO12, PSO3

		Academic Excellence	**Contextualized Understanding**	**Design/development of solutions**	**Conduct investigations of complex problems**	**Quantitative Aspects**	**Modernization and Tools Usage**	**Societal Implication**	**Environment and Sustainability**	**Ethics**	**Individual and Team Work**	**Communication**	**Life Long Learning**	Have the versatility to work effectively in a broad range of analytic, scientific, government,	Be familiar with a variety of examples where	Enhance theoretical rigor with technical skills
Course Code	Course Title	PO 1	PO2	PO3	PO 4	PO5	PO 6	PO7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PS O2	PS O3
CSE12658	Elective Programming Language II Lab	3	1	3	3	3	-	-	-	-	-	-	3	-	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

CHM11153	ELECTIVE CHEMISTRY II	L	T	P	C
Version 1.0		3	1	0	4
Pre-requisites/Exposure	Physics and Chemistry of class 12 or 10+2 level				
Co-requisites	Partial differentiation, model making, graph plotting				

Course Objectives:

1. To introduce important concepts required in the field of the course advanced elective chemistry. This course gives students a thorough understanding regarding fundamental knowledge of various branches of chemistry.
2. To introduce clear understanding of regarding the stabilization of colloidal systems and how solution properties are affected with different dissolutions.
3. To impart the basic notions of chemical equilibrium.
4. To impart detailed descriptions of basic properties of organic molecules and their related reaction mechanism which play major roles in everyday life cycle.
5. To learn the elementary concepts of acid-base chemistry required for daily life chemistry.
6. To understand the major role of inorganic complexes in living organisms which are very essential concepts in the course curriculum of some disciplines.
7. To introduce important tools of different spectroscopic methods required in structure analysis of molecules.

Course Outcomes:

On completion of this course, the students will be able to

CO1	Describe fundamental principles and theories for stabilisation/destabilisation of colloidal systems.
CO2	Explain, using LeChâtelier's Principle, how the equilibrium quantities of reactants and products are shifted by changes in the parameters of the chemical reactions
CO3	Understand the properties of solutions that depends on the number of dissolved particles in solution, but not on the identities of the solutes
CO4	Justify a reasonable mechanism for a chemical reaction
CO5	Study the acid-base concept in aqueous and non-aqueous media and reactions in non-aqueous media.
CO6	Understand the fundamental tasks performed by inorganic elements in living organisms as well as the related methods.
CO7	Identify the structure of unknown/new compounds with the help of different spectroscopic methods like UV-Visible, IR and NMR spectroscopic Technique.

Course Description:

This course gives a detailed understanding of the basics of physical, organic, bioinorganic and spectroscopic knowledge required in other disciplines. This course will include expert instructors who will introduce the importance of chemical equilibrium, property of colloidal states, preliminary concepts of organic chemistry, stereochemistry and some and their various

mechanisms, basic bioinorganic chemistry and spectroscopic methods required in analysing chemical structures. All the lectures will be devoted on discussions of elementary concepts and cutting-edge topics, focusing on practical implementation of knowledge. Instructors will conduct theory classes by taking lecture as well as power point presentations, audio visual virtual lab sessions as per requirement of the course. After finishing this course, students from different disciplines will strongly grasp the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content:

Physical Chemistry-II

Unit-I: Colloids

Colloids and crystalloids; classification of colloids; Preparation and purification of colloids; Properties of colloids: Brownian motion, peptization, dialysis, Tyndal effect and its applications. Protecting colloids, Gold number, Isoelectric points, Coagulation of colloids by electrolytes, Schulze-Hardy rule. **[5L]**

Unit II: Chemical and Ionic equilibrium

Concept of Gibbs Free Energy; Criteria for thermodynamic equilibrium and spontaneity of a process; Chemical equilibria of homogeneous and heterogeneous systems, Derivation of expression of equilibrium constants; Temperature, pressure and concentration dependence of equilibrium constants (Kp, K. Kx); Le Chatelier's principle of dynamic equilibrium. Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di-and triprotic acids (exact treatment).Concept of salt hydrolysis; Buffer solution and buffer capacity. **[10L]**

Organic Chemistry I

Unit-I: Fundamentals of Organic Chemistry and Stereochemistry:

Functional group-based classification and nomenclature; Sources I origin of different compounds; Concept of hybridization; resonance (including hyperconjugation); inductive effect; steric effect; steric inhibition of resonance. Orbital pictures of bonding (spa, sp2, sp: C-C, C-N & C-O system).

Stereochemistry: Symmetry elements, Molecular chirality, Concept of Stereo Centre, Representation of molecules in Fischer projection, Concept of E/Z and Cis-Trans stereo-isomers. [**5L]**

Unit-II:

Mechanistic classification: ionic, radical and pericyclic; heterolytic and homolytic bond cleavage and bond formation; representation of mechanistic steps using formalism. Reactive intermediates: carbocations (cabenium and carbonium ions), Carbanions, Carbon radicals, Carbenes-structure using orbital picture, Electrophilic/nucleophilic behaviour, Stability, generation and fate (elementary idea); Nucleophilic and electrophilic substitution reaction (only sp centre); Introduction to Elimination reaction and its types. **[3L]**

Unit-III:

Basic Organic Reactions: (Addition, Substitution, Elimination, Rearrangement Reactions) Addition Reactions: Halogenations, Hydration, Hydrogenation, Epoxidation, Hydroxylation,

Ozonolysis, electrophilic addition to diene; Hydroboration-oxidation reaction; Radical addition: HBr addition, Birch Reduction. Nucleophilic addition to carbonyl group.

Substitution Reactions: SN 1 , SN2, NGP, Elimination Reactions: El, E2, Elimination vs. Substitution, Rearrangement Reactions: Rearrangement to electron-deficient carbon: Wagner-Meerwein rearrangement, pinacol-pinacolon and related rearrangements, dienone-phenol.

[7L]

Inorganic Chemistry-II:

Unit-I:

Acids-Bases and Redox: Bronsted- Lowry concept of acid-base reaction, solvated proton, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle. Theory of acid-base titration and significance of Acid-base indicators. Common ion effect ;Ion-electron method of balancing equation of redox reaction. Elementary idea on standard redox potentials with sign conventions; Nernst equation (without derivation); redox indicators. **[7L]**

Unit-II:

Bioinorganic Chemistry:

Elements of life: essential major, trace and ultra-trace elements; Basic chemical reactions in the biological systems and the role of metal ions (specially Na+, K+, Mg2+, Ca2+, Fe3+, 12+ , Cu2+, R- ,and Zn2+);Biological functions of haemoglobin and myoglobin. **[8L]**

Spectroscopy: **[15L]**

Unit-I:

UV-Vis Spectra: Electronic transition, relative positions of k-max, Woodward's empirical rule; Lambert-Beers Law.

Unit-II:

IR Spectra: Modes of molecular vibrations, application of Hooke's law, characteristic stretching frequencies and factors effecting stretching frequencies.

Unit-III:

NMR Spectra: Preliminary idea of NMR, Nuclear spin, NMR active nuclei, Equivalent and non-equivalent carbons and protons; Chemical shift 6; Shielding deshielding, Upfield and Downfield shifts.

Unit-IV:

Photochemistry: Fluorescence and phosphorescence; Quantum Yield; Jablonsky diagram

References:

Physical Chemistry:

1. D. A. Mcquarrie and J. D. Simon: Physical Chemistry — A Molecular Approach

2. G. W. Castellan: Physical Chemistry

3. P. W. Atkins: Physical Chemistry

Organic Chemistry:

1. D. Nasipuri: Stereochemistry of organic compounds: Principles and Applications
2. P. Sykes: A Guide to Mechanism in Organic Chemistry
3. R. T. Morrison and R. N. Boyd: Organic Chemistry

Inorganic Chemistry:

1. Bioinorganic Chemistry. Asim K. Das.

Spectroscopy:

Organic Spectroscopy. William Kemp.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs)

Mappings between COs and POs		
Course Outcomes (COs)		**Mapped POs**
CO- 1	Describe fundamental principles and theories for stabilisation/destabilisation of colloidal systems.	PSO1, PO1, PO3
CO- 2	Explain, using LeChâtelier's Principle, how the equilibrium quantities of reactants and products are shifted by changes in the parameters of the chemical reactions.	PSO1, PO1, PO2, PO3
CO- 3	Understand the properties of solutions that depends on the number of dissolved particles in solution, but not on the identities of the solutes.	PSO1, PO1, PO2, PO12
CO- 4	Justify a reasonable mechanism for a chemical reaction.	PSO1, PO1, PO5, PO12
CO- 5	Study the acid-base concept in aqueous and non-aqueous media and reactions in non-aqueous media.	PSO2, PO1, PO3, PO12
CO- 6	Understand the fundamental tasks performed by inorganic elements in living organisms as well as the related methods.	PSO1, PO1, PO3, PO5, PO12
CO-7	Identify the structure of unknown/new compounds with the help of different spectroscopic methods like UV-Visible, IR and NMR spectroscopic Technique.	PSO1, PO2, PO12

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering,
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CHM11153	ELECTIVE CHEMISTRY II	3	3	3	-	2	-	-	-	-	-	-	3	3	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

CHM12154	ELECTIVE CHEMISTRY LAB II	L	T	P	C
Version 1.0		0	0	3	2
Pre-requisites/Exposure	Physics and Chemistry of class 12 or 10+2 level				
Co-requisites	Partial differentiation, model making, graph plotting				

Course Objectives:

1. To introduce important concepts required in the field of the practical field of elective chemistry. This course gives students a detailed understanding of lab-based chemistry knowledges in their course curriculums.
2. To introduce hands on training of small instruments required for quantitative elemental determination.
3. To impart hand on training on qualitative determination of various acid and base radicals in inorganic complexes.
4. To introduce practical training on qualitative determination of functional groups present in an organic molecule.

Course Outcomes:

On completion of this course, the students will be able to

CO1 Explain various quantitative determination methods using small instruments.

CO2 Illustrate qualitative determination of various acid and basic radicals in an inorganic complex.

CO3 Identify various functional groups in the given organic compounds.

Course Description:

This course gives a detailed understanding of the basics of chemistry lab techniques required in other disciplines. This course will include expert instructors who will introduce a detailed description of lab-based chemistry knowledges in their course curriculums, methods of using small instruments like potentiometer, conductometer for quantitative titration, determination of acid and basic radicals in inorganic complexes and functional groups present in organic molecules. All the lectures will be devoted on discussions of elementary concepts and cutting-edge topics, focusing on practical implementation of knowledge. Instructors will conduct demonstration classes by taking lecture followed by practical hands on training per requirement of the course. The tutorials and required assignments will acquaint the students with practical problem-solving techniques led by the course coordinator. After finishing this course, students from different disciplines will strongly acquire the hands-on training via experiencing practical lab sessions with the coordinator.

Course Content:

Practical II a: [15 L]

1. Determination of E0 of Fe+3/Fe+2 couple in the hydrogen scale by potentiometric titration of ferrous ammonium sulfate solution using KMnO4, or, K2Cr2O7 as standard.

2.Determination of concentration of (i) AgNO3 solution and (ii) solubility product of AgC1 by potentiometric titration of standard KC1 solution against AgNO3 solution.

3. Detection of some acid and basic radicals present in water, soil etc.

Practical IIb: **[15L]**

1. To study the kinetics of inversion of sucrose using polarimeter.
2. Experiment A: Detection of special elements (N, Cl, and S) in organic compounds.
   Experiment B: Solubility and Classification (solvents: H20, dil. HC1, dil. NaOH)
   Experiment C: Detection of functional groups -NO2, -NH2, -COOH, carbonyl (-CHO, >C=0), -OH (phenolic) in solid organic compounds.

References:

1. Das, S.C. Advanced Practical Chemistry, Sixth edition

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs)

Mappings between COs and POs		
Course Outcomes (COs)		**Mapped POs**
CO1	Explain various quantitative determination methods using small instruments.	PSO1, PO3, PO5
CO2	Illustrate qualitative determination of various acid and basic radicals in an inorganic complex.	PSO1, PO1, PO2, PO3
CO3	Identify various functional groups in the given organic compounds.	PSO3, PO1, PO2, PO3, PO5

		Academic Excellence	**Contextualized Understanding**	**Design/development of solutions**	**Conduct investigations of complex problems**	**Quantitative Aspects**	**Modernization and Tools Usage**	**Societal Implication**	**Environment and Sustainability**	**Ethics**	**Individual and Team Work**	**Communication**	**Life Long Learning**	Have the versatility to work effectively in a broad range of analytic, scientific, government,	Be familiar with a variety of examples where	Enhance theoretical rigor with technical skills
Course Code	Course Title	PO 1	PO2	PO3	PO 4	PO5	PO 6	PO7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PS O2	PS O3
CHM 12154	ELECTIVE CHEMISTRY LAB II	3	3	3	-	2	-	-	-	-	-	-	3	3	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

EIC11001	Venture Ideation	L	T	P	C
Version 2.0		2	0	0	2
Pre-requisites/Exposure	Basic knowledge of English and computer applications such as Internet Explorer and MS Office				
Co-requisites	--				

Course Objectives:

1. To help the students understand the way to be an entrepreneur
2. To identify the right business opportunity
3. To empower students to perform a technical feasibility study and thereby developing a prototype
4. To help students in identifying their customers using primary and secondary research methods.
5. Expose students to various factors of market and competition with the help of market feasibility study, forecasting techniques, business model canvass and insights about financial statements.
6. To prepare students with finalizing their entrepreneurial Portfolio

Course Outcomes:

On completion of this course, the students will be able to:
CO1. Assess personal capacity in the context of the entrepreneurial process
CO2. Assess characteristics of successful entrepreneurs and entrepreneurial forms and processes
CO3. Apply resources, research and tools for Entrepreneurial ventures
CO4. Analyse and apply opportunity identification techniques, feasibility, terminology, processes and models
CO5. Develop Ideation and planning documents for entrepreneurial venture

Course Description

Over the last decade, the core of our economy has been transitioning from one of industrial might, large monolithic corporations and mass production towards one of networks, flexible enterprises comprising many smaller units and unique value. This new economy is based on innovation originating in creativity and design; it is also disrupting long-standing and established employment patterns and bringing to the fore the importance of entrepreneurship. This core unit will bring together creativity, design and entrepreneurship at the conceptual and more practical level. It aims to explore the nature, determinants and consequences of creativity, design and entrepreneurship as well as the interaction between them.

Course Content

Unit 1. Introduction **8 hours**

Preview of the Course, Introduction to the Course, Guest Lecture with U.S. Secretary of Commerce Penny Pritzker – Meaning of Innovation, Entrepreneurial opportunities, Factors influencing the feasibility of an innovation, Innovation strategy: technology-push or market-pull, Product-market fit, How to develop a business model, Walkthrough of the business model canvas, Welcome to Innovation for Entrepreneurs: From Idea to Marketplace.

Unit 2. Customer Discovery and Validation **6 hours**

Customer types, Customer archetypes, Customer segments and business models, Customer segments, value propositions, product features, value mapping, interviewing customer, insights of your customers.

Unit 3: Product Understanding and Marketing. **8 hours**

Customer value, The DNA of customer-centricity, Crossing the chasm, Qualitative and quantitative marketing research, importance and methods of market segmentation, Focusing on the target market, Beyond the chasm, Strategic implications of beyond the chasm, E-commerce: The internet as a selling platform.

Unit 4. Prototyping and Testing. 8 hours

Planning for prototyping, Rapid prototyping and development, Lean startup MVPs, Choosing a wire framing/UX prototyping tool, Anatomy of an experience map, What you'll learn from user testing, Analytics and insight, Troubleshooting your customer discovery, Levels of a product/service.

Modes of Evaluation: Assignment/Quiz/Project/Presentation/Written Examination

Examination Scheme:

Components	Mid-term Examination	Continuous Assessment	End Term Examination
Weightage (%)	20	30	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs, POs and PSOs

Course Outcomes (COs)		Mapped Program Outcomes
CO1	Assess personal capacity in the context of the entrepreneurial process	PO6, PO11
CO2	Assess characteristics of successful entrepreneurs and entrepreneurial forms and processes	PO6, PO11
CO3	Apply resources, research and tools for Entrepreneurial ventures	PO6, PO8, PO11
CO4	Analyze and apply opportunity identification techniques, feasibility terminology, processes and models	PO6, PO8, PO11
CO5	Develop Ideation and planning documents for entrepreneurial venture	PO6, PO8, PO11

		Academic Excellence	Contextualized Understanding	Design/development of solutions	Conduct investigations of complex problems	Quantitative Aspects	Modernization and Tools Usage	Societal Implication	Environment and Sustainability	Ethics	Individual and Team Work	Communication	Life Long Learning	Have the versatility to work effectively in a	Be familiar with a variety of examples where	Enhance theoretical rigor with technical skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
EIC11001	Venture Ideation	-	-	-	-	-	3	-	3	-	-	3	-	-	-	-

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11009	LINEAR ALGEBRA I	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	12th level Mathematics				
Co-requisites					

Course Objectives:

1. To help the students to acquire the knowledge of matrix theory
2. To enable the students to evaluate determinant of a square matrix
3. To give knowledge of elementary row operations on a matrix
4. To help the students to acquire the knowledge of vector spaces, linear independence, span, and basis
5. To help the students to understand the concepts of row space, column space and null space of a matrix
6. To give the idea about the solution procedures for solving system of linear equations and matrix equations
7. To give knowledge of linear transformations and their various properties

Course Outcomes

On completion of this course, the students will be able to

CO1. Define matrix including matrix operations, inverses, determinants and rank of a matrix
CO2. Define real vector spaces, subspaces and develop the idea of linear independence, span and basis
CO3. Find the rank and nullity of a matrix along the concept of row space, column space, and solution space of a system of linear equations
CO3. Define linear transformation and its various properties

Course Description:

In this course students can learn the basic and advance concept of Matrix theory. Here this course contains the detailed study of Vector space and linear transformation.

Course Content:

Unit I **[18 L]**

Matrices and determinants: Matrices of real and complex numbers, algebra of matrices, symmetric and skew-symmetric matrices. hermitian and skew-hermitian matrices, orthogonal matrices, definition & basic properties of determinants, minors and cofactors, Laplace's method, Vandermonde's determinant, symmetric and skew-symmetric determinants. (No proof of theorems), adjoint of a square matrix, invertible matrix, non-singular matrix, inverse of an orthogonal matrix, elementary operations on matrices, echelon matrix, rank of a matrix, determination of rank of a matrix, elementary matrices, statements and application of results on elementary matrices.

Unit-II **[16 L]**

Vector / linear space: Definitions and examples of vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, generators of vector space, linear independence, basis and dimension, replacement theorem, extension theorem,

deletion theorem, extraction of basis, dimension of a vector space, finite dimensional vector space, dimension of subspaces.

Unit-III [**14 L**]

Row space and column space of matrix, row rank and column rank of matrix, equality of row rank, column rank and rank of a matrix, systems of linear equations, solutions of system of equations by Matrix method, the invariance of solution set of systems of linear equations under row-equivalence, solution space, Rank-Nullity theorem, applications of linear systems.

Unit IV [**12L**]

Linear transformations: Definition and related results, null space, range space, rank and nullity of a linear transformation, algebra of linear transformations and related properties, composition of linear transformation, and isomorphism between two finite-dimensional vector spaces.

Text Books

T1. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.
T2. S. K. Mapa, Higher Algebra- Abstract and Linear, revised Ninth Edition, Sarat Book House, 2003.
T3. David C. Lay, Linear Algebra and its Applications (3rd Edition), Pearson Education.

Reference Books

R1. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.
R2. B. S. Vaatsa, Theory of matrix, New age publication.
R3. A Kurosh, Higher Algebra, Mir Publisher
R4. Hoffman and Kunze, Linear algebra, Pearson.
R5. D.T. Finkbeiner, Introduction to matrices and linear transformations, CBS Publishers, New Delhi.
R6. John Smith, Modern Engineering Mathematics, 5th Edition, Pearson Education.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs, POs and PSOs

Course Outcomes (COs)		Mapped POs and PSOs
CO-1	**Define** matrix including matrix operations, inverses, determinants and rank of a matrix	PO1, PO2, PO12, PSO1

CO-2	**Define** real vector spaces, subspaces and develop the idea of linear independence, span and basis	PO1, PO5, PSO1, PSO3
CO-3	**Find** the rank and nullity of a matrix along the concept of row space, column space,	PO1, PO3, PO12, PSO1, PSO3
CO-4	**Define** linear transformation and its various properties	PO1, PO2, PO3, PSO1

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2	PS O3
MTH1 1009	LINEA R ALGE BRA I	3	3	3	-	2	-	-	-	-	-	-	3	3	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11089	MODERN ALGEBRA II	L	T	P	C
Version 1.0	Contact Hours - 60	3	1	0	4
Pre-requisites/Exposure	10+2th level Mathematics				
Co-requisites	--				

Course Objectives:
To develop the concept of advanced algebraic structures like group theory, ring theory and field theory.

Course Outcomes
On completion of this course, the students will be able to

CO1. Explain the concept of cosets, Lagrange's theorem, normal subgroup and quotient groups with some related results.

CO2. Explain the concept of group homomorphism, automorphism, characteristic, commutator subgroups and study some applications.

CO3. Explain the concept of rings, subrings, ideals, and study some properties.

CO4. **Extend** the concept of group homomorphism to ring homomorphism and study related results.

Course description:

After the introduction of basic group theory in Modern Algebra I, some furthermore group theory is introduced with the related results. In the first unit, notions of cosets, normal subgroups, quotient groups are introduced. Then in unit II, the notions like group homomorphisms, commutator subgroups, characteristics subgroups are discussed. After that in unit III, basic ring theory is introduced with related important concepts like field, ideals and ring homomorphisms.

Course Content:

Unit -I
Cosets(Left & Right) with its properties and related results, Lagrange's theorem and consequences including Fermat's Little theorem, Normal subgroup, quotient group and related theorems. [**16L**]

Unit-II
Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, first, second and third isomorphism theorems, automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups, characteristic subgroups, commutator subgroup and its properties. [**22L**]

Unit -III
Rings and fields: rings, domains, integral domains, division rings, fields, Subrings, Zero Divisors, characteristic and other fundamental ring theoretic topics, ideals and ring

homomorphisms, kernel and image of a homomorphism, properties of ring homomorphism. [**22L**]

Text Books

T1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
T2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
T3. M.R. Adhikari, A.Adhikari, Basic Modern Algebra with Applications, Springer Verlag.

Reference Books

R1. Joseph A. Gallian, Contemporary Abstract Algebra (8th Edn.), Narosa Publishing House, New Delhi.
R2. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
R3. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	20	30	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs, POs and PSOs

Course Outcomes (COs)		Mapped POs and PSOs
CO-1	**Explain** the concept of cosets, Lagrange's theorem, normal subgroup and quotient groups with some related results.	PO1, PO2, PO12, PSO1
CO-2	**Explain** the concept of group homomorphism, automorphism, characteristic, commutator subgroups and study some applications.	PO1, PO5, PSO1, PSO3
CO-3	**Explain** the concept of rings, subrings, ideals, and study some properties.	PO1, PO3, PO12, PSO1, PSO3
CO-4	**Extend** the concept of group homomorphism to ring homomorphism and study related results.	PO1, PO2, PO3, PSO1

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2	PS O3
MTH1 1089	MODE RN ALGE BRA II	3	3	3	-	2	-	-	-	-	-	-	3	3	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11090	DIFFERENTIAL EQUATION II	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	12th level Mathematics				
Co-requisites	Knowledge of Differential Equation I				

Course Objectives:

The primary objectives of this course are:

1. To provide students the knowledge of solving second and higher order ordinary differential equations
2. To provide and concept of first and second order partial differential equations.

Course Outcomes:

On completion of this course, the students will be able to

CO1. Solve linear differential equations with constant coefficients
CO2. Solve ordinary differential equations in terms infinite series
CO3. Solve first order partial differential equations
CO4. Solve second order partial differential equations

Course Description:

Ordinary differential equation is an integral part of science and technology. Many physical, engineering and biological science problems may be modelled in the form of ordinary differential equation. This course includes existence and uniqueness of solution of ordinary differential equation, non-linear first order differential equation, orthogonal trajectory and application in biological and physical sciences. It also includes series solution by Frobenius method of Legendre's and Bessel's equations and its applications. After successful completion of this course student may get the idea about different applications of ordinary differential equation and concept of series solution.

Partial differential equations (PDE) is an important branch of Science. It has many applications in various physical and engineering problems. The proposed course is helpful to the learners from Mathematics, Physics and Engineering background. The course provides a thorough introduction to the mathematical theory of partial differential equations. Topics covered are first order equations, Cauchy's problems, characteristics, linear second-order equations, classification

Course Content:

Unit-I **[22 L]**

Linear Differential Equations with Constant Coefficients: Homogeneous equations with constant coefficients, general solution of homogeneous equation of second order, principle of super position for homogeneous equation, Wronskian and its properties and applications
Linear non-homogeneous equations of higher order with constant coefficients, Euler's equation, and method of undetermined coefficients, method of variation of parameters.

Systems of first order linear equations, homogeneous linear systems with constant coefficients, non-homogeneous linear systems.

Unit II [**18 L**]

Series Solution: Introduction, ordinary point, singular point and regular singular point, power series solution about an ordinary point, solutions about singular points, Frobenius method, Legendre's equation and Legendre's polynomials, Rodrigue's formula, Bessel's equation, Bessel's function and its application.

Unit – III [**12 L**]

First Order Partial Differential Equations: Formation of first order partial differential equations (PDE), Classification of first order PDE, special types of first-order equations, solutions of linear first order PDE, equation solvable by direct integration, Lagrange's method of solving quasi-linear PDE, Lagrange's linear equations with n independent variables, integral surfaces passing through a given curve, nonlinear first order PDE, Charpit's method.

Unit – IV [**8 L**]

Second Order PDE: Second and higher order homogeneous linear PDE with constant coefficients, Second order nonhomogeneous linear PDE with constant coefficients, methods of obtaining particular integrals; method of undetermined coefficients.

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Text Books:

T1. R.K. Ghosh ad K.C. Maity, An Introduction to Differential Equations, New Central Book Agency

T2. M.D. Raisinghania, Ordinary Differential Equations, S Chand & Company LTD.

T3. H.T.H. Piaggio, Differential Equations, G.Bell& Sons Ltd. 1921

T4. S. L. Ross, Differential Equations, John Wiley and Sons, India, 2004.

Reference Books:

R1. William E. Boyce and Richard C. Di-Prima, Elementary Differential Equations and Boundary Value Problems, 7th edition, John Wiley & Sons, Inc.

R2. C. H. Edwards and D. E. Penny, Differential Equations and Boundary Value Problems: Computing and Modeling, Pearson Education, India, 2005.

R3. Belinda Barnes and Glenn R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach Using Maple, Taylor and Francis, London 2002.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs, POs and PSOs

Course Outcomes (COs)		Mapped POs and PSOs
CO-1	**Solve** linear differential equations with constant coefficients	PO1, PO4, PO12, PSO1
CO-2	**Solve** ordinary differential equations in terms infinite series	PO1, PO5, PSO1,PO4, PSO3

CO-3	**Solve** first order partial differential equations	PO1, PO3, PO12, PSO1, PSO3
CO-4	**Solve** second order partial differential equations	PO1, PO2, PO3,PO4, PSO1

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2	PS O3
MTH1 1090	DIFFE RENTI AL EQUA TION II	3	2	3	3	2	-	-	-	-	-	-	3	3	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH13015	R PROGRAMMING	L	T	P	C
Version 1.0	**Contact Hours - 60**	1	0	3	3
Pre-requisites/Exposure	12th level Mathematics				
Co-requisites	Basic knowledge of matrix; Basic knowledge of statistics				

Course Objectives:

1. To learn fundamentals of R language and coding
2. To develop skill for high quality data visualization
3. To apply R for solving statistical and real-world problems

Course Outcomes:

On completion of this course, the students will be able to

CO1. Make use of R syntaxes to write programs
CO2. Develop high quality visualizations of given data set
CO3. Build user-defined functions
CO4. Utilize R programming to solve different mathematical and statistical problems

Catalog Description:

This course will introduce students to the fundamentals of R language, data visualization and its application to solve statistical problems. The course will provide information on R software, user interface and scripting; basic operations and in-built functions; defining and manipulating arrays; writing user defined functions; control statements – conditionals (if-else) and loops; importing and exporting data; data visualizations and applications. The class activities include lectures, hands-on practices, tutorials, assignments, quizzes, and interactions. Moreover, the students will actively participate in discussion, problem solving in class. The course will help the students to develop the fundamental knowledge of R language and writing programs, and in addition, to enhance the problem solving, interaction and presentation skills.

Course Content:

Unit I **[08L]**

History of R programming; Usefulness of R; Software (R and RStudio) installation; R software interface – command window, workplace, command history, script editor; use of R as calculator; writing code on command window and on script editor.

Unit II **[24L]**

Different types of objects – numeric, logical, string, factor, vector, matrix, list, data frame; creation, deletion, modification of different object types; operations on objects.
Simple Graphs with R: Line graphs, Scattered plots, Bar charts, Histograms, Box plots, Pie charts, Create subplots using par command, Export figures into different file formats.

Unit III **[16L]**

List of operators in R and their uses; conditional statements – if/else conditions; loops – for, while and repeat; use of break and next.
Different in-built functions and their uses; writing user-defined functions.

Unit IV **[12 L]**

Reading and writing data, importing data from different file formats, working with large data, subsampling, visualize data using R graphics

Reference Books

R1. R for Beginners, Emmanuel Paradis, Online source: https://cran.rproject.org/doc/contrib/Paradis-rdebuts_en.pdf

R2. R Programming, Tutorial point, Online source: https://www.tutorialspoint.com/r/r_tutorial.pdf

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs, POs and PSOs

Course Outcomes (COs)		Mapped POs and PSOs
CO-1	**Make** use of R syntaxes to write programs	PO2, PO4, PO5, PO12, PSO1, PSO3
CO-2	**Develop** high quality visualizations of given data set	PO1, PO2, PO5, PO12, PSO1, PSO3
CO-3	**Build** user-defined functions	PO2, PO5, PO12, PSO1
CO-4	**Utilize** R programming to solve different mathematical and statistical problems	PO1, PO2, PO4, PO5, PO12, PSO1, PSO3

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2	PS O3
MTH1 3015	R PROG RAM MING	2	-	3	2	3	-	3	-	-	-	-	3	3	-	2

1=weakly mapped
2= moderately mapped
3=strongly mapped

ECO11001	MICROECONOMICS	L	T	P	C
Version 1.0	**CONTACT HOURS- 90**	5	1	0	6
Pre-requisites/Exposure					
Co-requisites					

Course Objectives:

- Introduce students to the terminology and analytic principles used in microeconomics
- Introduce students to the application of these conceptual tools to several policy issues
- Explore the decisions of buyers and sellers and their interaction in market transactions.
- Explore different government interventions such as taxes on subsidies on equilibrium outcomes

Course Outcomes:

CO-1	**Understand** the terminology and analytic principles used in microeconomics in individual decision making framework
CO-2	**Understand** the application of these conceptual tools to several policy issues
CO-3	**Analyse** the decisions of buyers and sellers and their interaction in market transactions thereby shaping the equilibrium market outcomes.
CO-4	**Explore** different government interventions such as taxes on subsidies on equilibrium outcomes

Course Description:

This paper introduces students to the terminology and analytic principles used in microeconomics, which is broadly defined as the study of markets, and to the application of these conceptual tools to several policy issues. The decisions of buyers and sellers and their interaction in market transactions will be analyzed. This also explores how different market structures can shape economic results, and how markets can sometimes (but not always) help society achieve desirable outcomes.

Course Content:

Unit I: **Demand and Supply** **[15 L]**

Determinants of Demand; Law of Demand; Demand Function, Demand Schedule and Demand Curve; Determinants of Supply; Law of Supply; Supply Function, Supply Schedule and Supply Curve; Shift and movement along the Demand & Supply Curve; Elasticity of Demand – Price, Income, Cross; Elasticity of Supply; Substitutes & Complementary Goods, Normal & Inferior Goods. Equilibrium Determination, Impact of changes in Demand and Supply, Change in Equilibrium, Stability of Equilibrium; Consumer Surplus, Producer Surplus, Deadweight Loss, Change in surplus, Incidence of Tax, Impact of Subsidy.

Unit II: **Theory of Consumption** **[15 L]**

Budget Constraint: Composite goods, Budget Set, Properties of budget set, Budget Line, change in budget line due to change in income and prices, Application: Taxes, Subsidies, Rationing Preferences: Consumer Preferences, basic assumptions about preferences; Indifference Curves, Indifference Map, Marginal Rate of Substitution; Shape of Indifference curves: Perfect substitutes, perfect complements, Bads, Neutrals, Satiation, Discrete Goods

Utility: Cardinal Utility, Utility function, Total utility, Marginal Utility, Ordinal Utility, Preference, MRS Choice: Optimal Choice, Consumer's Equilibrium, Change in Equilibrium due to change in income, and prices, Income Consumption Curve, Engel Curve, Price Consumption Curve, Individual Demand, From individual to market demand; Price Effect: Hicks, Slutsky approach, Income Effect, Substitution Effect, Compensated Demand.

Unit III: Theory of Production [17 L]

Technological relationship between output and inputs, Production decision of a firm; Production function, short run versus long run production; Production with single variable input: TP, AP, MP, Law of diminishing marginal return; Production with two variable inputs: Isoquant, Economic region of production, Input flexibility, Input substitution; MRTS, Elasticity of substitution; Expansion Path, Returns to scale; Effects of changes in input prices on output. Special Cases: Homogeneous Production Function, Cobb-Douglas Production.

Unit IV: Costs of Production [08 L]

Different types of costs; opportunity cost, sunk cost; fixed cost, variable cost; Costs in the SR production, TC, AC, MC, Cost curves; Costs in the LR production, LR cost curves, relation between SR and LR cost curves; Shift in cost curves. Input choices, Iso-cost line, Change in technology and change in input prices; optimal choice of inputs, Economies of Scope, Economics of Scale, Learning Curve.

Unit V: Market: Perfect Competition [11 L]

Profit Maximization by a firm, Competition in a market, Different forms of Competition; Perfectly competitive market and its characteristics, Choosing output in Short Run, SR supply curve, Choosing output in the Long Run, LR Industry supply curve: Increasing cost industry, Decreasing cost industry, and Constant cost industry; Efficiency of a competitive market: Effect of Tax, Minimum Prices, Price Support, Production Quota, Impact of tax and subsidy.

Unit VI: Market: Imperfect Competition [09L]

Market Power, Sources, Monopoly, Monopsony, Bilateral Monopoly, Natural Monopoly; Monopolist's Output Decision, and pricing. Monopolistic Competition: Characteristics, Equilibrium in Short and Long run, Economic Efficiency; Branding Oligopoly: market structure, collusion, competition, equilibrium.

Text Books

T1. Intermediate Microeconomics: A Modern Approach. H.R. Varian. East West Press; 8th edition, 2010

T2. Modern Microeconomics. A. Koutsoyiannis. Palgrave Macmillan; 2nd edition, 2008

Reference Books

R1. Microeconomics: Theory and Applications. G.S. Maddala, and E. Miller. McGraw Hill Education (India) Private Limited; 3rd edition, 2004

R2. Microeconomics. R. S. Pindyck, D.L. Rubinfeld, and P.L. Mehta. Pearson, India, 7th edition, 2013

R3. Principles of Microeconomics. D. Salvatore. Oxford University Press (5th or later edition).

R4. Microeconomic Theory. Ferguson, and Gould. All India Traveler Book Sellers (6th edition).

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs, POs and PSOs

Course Outcomes (COs)		Mapped POs and PSOs
CO-1	**Understand** the terminology and analytic principles used in microeconomics in individual decision making framework	PO1, PO2, PO7, PO9, PO10
CO-2	**Understand** the application of these conceptual tools to several policy issues	PO1, PO2, PO3, PO7, PO9,PO12
CO-3	**Analyse** the decisions of buyers and sellers and their interaction in market transactions thereby shaping the equilibrium market outcomes.	PO2, PO3, PO4, PO7, PO9, PO10, PO12
CO-4	**Explore** different government interventions such as taxes on subsidies on equilibrium outcomes	PO4, PO7, PO10, PO12

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
ECO1 1001	MICR OECO NOMI CS	2	2	1	1	-	-	3	-	3	3	-	3	-	-	-

1=weakly mapped
2= moderately mapped
3=strongly mapped

PHY11015	ELECTIVE PHYSICS I	L	T	P	C
Version 1.2	Contact hours- 60	3	1	0	4
Pre-requisites/Exposure	12^{th} level Physics				
Co-requisites	Basic concept of Differential and Integral Calculus				

Course Objectives:

- To develop the capability of the students for understanding fundamental aspects of physics.
- To give students theoretical background, the key prerequisite for performing laboratory experiments.
- To build up idea on basic Newtonian mechanics, general properties of matters, electromagnetic theory and optics. These ideas can upgrade student's understanding in proper channel, so that they can flourish their career path.
- To explore every day phenomena of the macroscopic world from a scientific point of view.

Course Outcomes

On the successful completion of the course, students will be able to

CO-1	Develop knowledge of vector differentiation, integration, essential theorems and apply it in further study of physics.
CO-2	Relate and illustrate the fundamental principles of dynamics of a single particle and system of particles and apply it in real life problems.
CO-3	Define and develop the concepts of work and energy, Conservative and non-conservative forces and Central forces.
CO-4	Define and analyse the fundamentals of rotational dynamics of a rigid body, and estimate the Moment of Inertia of different objects, explain Coriolis and Centrifugal forces
CO-5	Define and explain the basic concepts of Elasticity, viscosity, surface tension and apply it in different relevant areas
CO-6	Develop the basic concepts of electromagnetic theory and apply it in practical situation
CO-7	Define, explain and estimate different phenomenon of wave and optics

Catalog Description

In Elective Physics I course different aspects of Mathematical Physics is enlisted to explain phenomena in the natural world. This information is then can be used for practical endeavours through a controlled Laboratory environment. In this course the focus will be on improving the logical learning moved into a physical environment. Newtonian mechanics, general properties of matter, electromagnetic theory, these basic field will be covered. We will combine traditional lectures with other active teaching methodologies like digital platform, group discussions, cooperative group solving problems, Course will be concluded with basic understanding of Optics which will make a background to perform optical experiments.

Course Content

Unit I: Vector Analysis **[8 L]**

Axial and polar vectors, dot product and cross product, scalar triple product and vector triple product. Scalar and vector fields --- gradient, divergence and curl, statement of divergence theorem, statement of Stokes' theorem.

Unit II: Newtonian Mechanics **[10 L]**

(a) Newton's laws of motion, principle of conservation of linear momentum, time and path integral of force, conservative force field, concept of potential, conservation of total energy, equation of motion of a system with variable mass.

(b) Rotational motion, angular velocity, angular acceleration, angular momentum, torque, fundamental equation of rotational motion, principle of conservation of angular momentum, radial and cross-radial acceleration.

(c)Central force and Gravitation**:** Central force and its properties, Differential equation of orbits under central force field, Gravitational potential and intensity due to thin uniform spherical shell and solid sphere of uniform density, escape velocity.

Unit III: Elasticity **[6 L]**

Elastic moduli and their interrelations, bending of a beam, cantilever, simply supported beam with concentrated load at the center.

Unit IV: Viscosity and Fluid Motion **[6 L]**

Streamline and turbulent motion, Poiseuille's formula, critical velocity, Reynolds number, Bernoulli's theorem, Stokes' law (statement only).

Unit V: Surface Tension **[6 L]**

Surface tension and surface energy, molecular theory, angle of contact, elevation and depression of liquid columns in a capillary tube, excess pressure in a spherical bubble and spherical drop.

Unit VI: **E M Theory** **[12 L]**

Gauss's Law in Electrostatics (in vacuum and in presence of dielectric), Laplace's Equation and Poisson's Equation, Lorentz Force, Motion of Charged Particles in crossed Electric & Magnetic fields, Velocity Selector & Magnetic focussing, Biot-Savart Law and Ampere's Law and their applications, Vector and Scalar potential, Electromagnetic induction, Faraday's Law, Maxwell's equations (differential and integral forms), Poynting vector, Poynting Theorem (Statement only), propagation of plane electromagnetic waves in vacuum, dielectric and conducting media.

Unit VII: Wave and Optics **[12 L]**

Differential equation and its solution, analytical treatment, Lissajous figures, natural, damped and forced vibration, resonance, sharpness of resonance. Light as an electromagnetic wave, full electromagnetic spectrum, properties of electromagnetic waves, Huygens' principle, Interference of light, Young's experiment, intensity distribution, conditions of interference, Diffraction of light, Fresnel and Fraunhofer class, Fresnel's half-period zones, zone plate. Fraunhofer diffraction due to a single slit and plane transmission grating (elementary theory). Polarization of light Different states of polarization, Brewster's law.

Text Books:

T1	Vector Analysis by Murray R Spiegel
T2	Theoretical mechanics by Spiegel
T3	An Introduction To Mechanics, by Robert J. Kolenkow and Daniel Kleppner
T4	A Treatise on General Properties of Matter, Sengupta Chatterjee
T5	Electromagnetic Fields (Theory and Problems), TVS Arun Murthy
T6	Principles of Optics, B.K. Mathur, 1995, Gopal Printing
T7	Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publications

Reference Books

R1. Mathematical Physics, H K Das, S Chand Publisher.

R2. Mathematical Methods for Physics and Engineering, K. F. Riley, M. P. Hobson, S. J. Bence, Cambridge University Press.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs, POs and PSOs

Course Outcomes (COs)		Mapped POs and PSOs
CO-1	Develop knowledge of vector differentiation, integration, essential theorems and apply it in further study of physics.	PO1, PO6, PO12, PSO1
CO-2	Relate and illustrate the fundamental principles of dynamics of a single particle and system of particles and apply it in real life problems.	PO1, PO5, PO7, PSO1, PSO3
CO-3	Define and develop the concepts of work and energy, Conservative and non-conservative forces and Central forces.	PO1, PO3, PO6, PO7, PO8, PO11, PSO3
CO-4	Define and analyse the fundamentals of rotational dynamics of a rigid body, and estimate the Moment of Inertia of different objects, explain Coriolis and Centrifugal forces	PO1, PO2, PO3, PO11, PSO3
CO-5	Define and explain the basic concepts of Elasticity, viscosity, surface tension and apply it in different relevant areas	PO1, PO3, PO7, PO9, PO10,PSO3
CO-6	Develop the basic concepts of electromagnetic theory and apply it in practical situation	PO1, PO7, PO9, PO10, PSO3

CO-7	Define, explain and estimate different phenomenon of wave and optics	PO1, PO3, PO7, PO9, PO10,PSO3

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2	PS O3
PHY1 1015	ELEC TIVE PHYSI CS I	3	-	2	-	-	2	2	2	3	3	1	3	-	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

PHY12016	ELECTIVE PHYSICS LAB I	L	T	P	C
Version 1.0	Contact Hours – 45 Hours	0	0	3	2
Pre-requisites/Exposure	Basic knowledge on physics experiment (12^{th} level Physics)				
Co-requisites	--				

Course Objectives

1. To develop the capability of the students for practical understanding of fundamental aspects of physics.
2. To give students experimental/laboratory-based background, the key prerequisite for performing research near future.
3. To build up real-time idea on basic Newtonian mechanics, general properties of matters, electromagnetic theory and optics. These ideas can upgrade student's understanding in proper channel, so that they can flourish their career path.

Course Outcomes:

CO 1	Estimate, demonstrate realistic understanding of measurement of general properties of matter and experiment of light
CO 2	Experiment, relate with measurement of Young's modulus by Flexure method
CO 3	Estimate, demonstrate the fundamental idea of experiment with some basic measurement instruments, such as slide callipers, screw gauge etc.
CO 4	Experiment, relate with measurement Rigidity modulus by Dynamic method
CO5	Experiment, relate with measurement of coefficient of viscosity by Poiseuille's capillary flow method, develop idea on conduct experiment with capillary tube
C06	Develop the practical understanding on measurement of surface tension by Jurin's law
CO7	Develop skill enhancement on experiment of light and estimate the Brewster's angle and refractive index of glass Hands-on knowledge on spectrometer (Schuster's focussing), estimate the idea of polarized and un-polarized light by using polaroid
CO8	Develop the visualization of interference pattern of monochromatic light by Newton's ring method and concept of wavelength measurement

Catalog Description:

In Elective Physics I Lab course different aspects of Physics lab is enlisted to explain phenomena in the natural world. This information is then can be used for practical endeavours through a controlled Laboratory environment. In this course the focus will be on improving the logical learning moved into a physical environment. Newtonian mechanics, general properties of matter, optics, these basic field-based laboratories will be covered. We will combine traditional lab classes with other active teaching methodologies like digital platform, group discussions, cooperative group solving problems, weekly viva.

Course Content:

Experiment 1: **[3 hours]**
Determination of Rigidity modulus by Dynamic method.

Experiment 2: **[6 hours]**
Determination of Young's Modulus by Flexure method.

Experiment 3: **[6 hours]**
Determination of coefficient of viscosity by Poiseuille's capillary flow method.

Experiment 4: **[6 hours]**
Determination of Surface Tension of a given liquid by Jurin's Law.

Experiment 5: **[6 hours]**

To determine the value of 'g' using Compound Pendulum.

Experiment 6: **[6 hours]**
To determine the wavelength of a monochromatic light by Newton's ring method.

Experiment 7: **[3 hours]**
Dispersive power of the material of the prism using spectrometer and Na light source.

Experiment 8: **[6 hours]**
Determination Brewster's Angle and Refractive Index of Glass by using spectrometer and Polaroid.

Experiment 9: **[3 hours]**
Determination of wavelength of a light by LASER diffraction method**.**

Text Books:
T1. Advanced Practical Physics, Volume-I, B. Ghosh & K. G. Mazumdar

Reference Books:
R1: An Advanced Course in Practical Physics, D. Chattopadhyay & P. C. Rakshit

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs , POs and PSOs		
	Course Outcomes (COs)	**Mapped POs and PSOs**
CO 1	Estimate, demonstrate realistic understanding of measurement of general properties of matter and experiment of light	**PO1, PO3, PO6, PO12, PSO3**
CO 2	Experiment, relate with measurement of Young's modulus by Flexure method	**PO1, PO, PO7, PO8, PO9, PO10**
CO 3	Estimate, demonstrate the fundamental idea of experiment with some basic measurement instruments, such as slide callipers, screw gauge etc.	**PO6, PO7, PO8, PO9, PSO3**
CO 4	Experiment, relate with measurement Rigidity modulus by Dynamic method	**PO 1, PO 3, PO 9, PO10, PO 12, PSO3**
CO5	Experiment, relate with measurement of coefficient of viscosity by Poiseuille's capillary flow method, develop idea on conduct experiment with capillary tube	**PO1, PO9, PO10, PO12, PSO3**
C06	Develop the practical understanding on measurement of surface tension by Jurin's law	**PO1, PO3, PO6, PO9, PO10, PSO3**
CO7	Develop skill enhancement on experiment of light and estimate the Brewster's angle and refractive index of glass Hands-on knowledge on spectrometer (Schuster's focussing), estimate the idea of polarized and un-polarized light by using polaroid	**PO1, PO9, PO10, PO7, PO8**
CO8	Develop the visualization of interference pattern of monochromatic light by Newton's ring method and concept of wavelength measurement	**PO1, PO8, PO10, PSO3**

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	**Contextualized Understanding:** Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	**Critical Thinking and Problem Solving Skills:** Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	**Problem Analysis:** Identify, formulate and analyze complex problems using mathematical principles.	**Modernization and Tools Usage:** Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	**Societal Implication:** Analyze complex social elements, their interrelation and its impact on geographically different society.	**Environment and Sustainability:** Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	**Ethics:** Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	**Individual and Team Work:** Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	**Communication:** Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	**Leadership Skills:** Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	**Life Long Learning:** Develop the ability to reasoning, abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PHY1 2016	Elective Physics I Lab	3	-	2	-	-	2	2	2	3	3	1	3	-	-	3

SOC14100	Community Service	L	T	P	C
Version 1.0		-	-	-	1
Pre-requisites/Exposure	Knowledge of Basic English				
Co-requisites	Knowledge of Basic Computer Skills				

Course Objectives:

1. To familiarize the students on the concept 'giving back to the society'.
2. To acquaint the students on the issues faced by marginalized communities.
3. To provide an experiential platform to the students on any one or two issues as an internship.

Course Outcomes:

On completion of this course, the students will be able to
CO1: Understand the concept of social responsibility through an internship.
CO2: Apply hands on experience in 'giving back to the society' through the concept of social responsibility through an internship.

Course Description:

Along with Intelligent Quotient, it is important for students to enhance their Emotional Quotient as well. The Social Internship offers opportunity to the student to be empathetic towards social issues facing our society. To help and support the affected community / cause through a field internship is the essence of the course in 'giving back to the society'.

Course Content

Unit I:

Introduction to the course. A brief on social issues facing the society with both global and Indian examples.

Unit II:

Minimum 24 hours of field work on a social issue and helping the marginalized / affected community / cause with photographs and testimonies.

Unit III:

Submission of individual reflection on the social service rendered.
The benefits that accrue to the students are

A.) Subjective

1. Psychosomatic benefits: Volunteering increases overall life satisfaction and also helps to relive stress and acts as an anti-depressant.
2. Intellectual benefits: Enhances knowledge through new experiences, and develops communication skills.
3. Career benefits: Enhances career prospects by acquisition of work-related skills, builds good references for employers and provides a forum to network with future potential employers. It also the experience allows gained helps students to take up leadership positions. Letters of recommendation can also be easily sought. Research shows that students who indulge in volunteer word perform better in studies as it invigorates their passion for learning
4. Personal benefits: Real world skills like leadership, problem-solving, collaboration with others, time management and communication skills, learn patience and empathy.
5. Connect learning to real world and enables deeper and lifelong learning.

B.) **Community**

1. Collective benefits: Strong interpersonal bonds are created, and leads to increased civic and social awareness and responsibility.

Further Reading:

1. Tadevosyan, Gohar & Schoenhuth, Michael. Participatory Research Approach: Principles, Challenges and Perspectives. http://ysu.am/files/01G_Tadevosyan_M_Schoenhuth.pdf
2. Bergold, Jarg& Thomas Stefan. Participatory Research Methods: A Methodological Approach in Motion http://www.qualitative-research.net/index.php/fqs/article/view/1801/3334

Plan of Work

1. Reading on social issues facing the society with both global and Indian examples.
2. Selecting an issue where the student wishes to contribute and wants to make a difference.
3. Areas - The internship may be broadly completed by getting in touch with NGO in your city / town / Police / Municipal Corporation / Local Gram Panchayat / Hospital / State Health Department / Women & Child Development Centre / CSR departments of Corporates /school / Old Age Home / Orphanage / Literacy Drive / Aanganwadi Centres / etc.
4. **Online Discussion –** Through discussion, students elaborate their preferred area of work with reference to the Global Scenario and India. Reason for choosing that area also needs and resources of the people in their area of Social Internship and also submit the testimonials, which include signature of the authority where students initiated their work, or the signature of the authority in whose area students are currently working or photographs of work (photographs must include students working).
5. **Final Report Submission** - Submission of the Testimonials include signatures of the authorities you have worked with, or the signature of the authority in whose area you have worked or photographs of your work (photographs must include you working). Students' accomplishment in their area of operation along with the major successes student experienced and major challenges faced.
6. Students will submit the complete elaborated report along with testimonials and completion certificate in the form of signed Template
7. The registration for all students will open twice, during winter and summer breaks. They may enroll for the internship in either of the two breaks.
8. The student will have to submit a continuous record of their 10 to 15 days internship in the form of photographs and testimonies (wherever required).

Modes of Evaluation: Assignment/Quiz/Project/Presentation/Written Examination

Examination Scheme:

Components	Internal Assessment (Discussion+ Initiating Internship Template)	End Term (Detailed Report Submission + Testimonials Photographs / Student Experience Sharing Video)
Weightage (%)	**50**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs, POs and PSOs

Course Outcomes (COs)		**Mapped Program Outcomes**
CO1	Understand the concept of social responsibility through an internship.	**PO7, PO10, PO9, PO12**
CO2	Apply hands on experience in 'giving back to the society' through the concept of social responsibility through an internship.	**PO7, PO10, PO9, PO12**

		Academic Excellence	**Contextualized Understanding**	**Design/development of solutions**	**Conduct investigations of complex problems**	**Quantitative Aspects**	**Modernization and Tools Usage**	**Societal Implication**	**Environment and Sustainability**	**Ethics**	**Individual and Team Work**	**Communication**	**Life Long Learning**	Have the versatility to work effectively in a broad range of analytic, scientific, government,	Be familiar with a variety of examples where	Enhance theoretical rigor with technical skills
Course Code	Course Title	PO 1	PO2	PO3	PO 4	PO5	PO 6	PO7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PS O2	PS O3
SOC1 4100	Commu nity Service	-	-	-	-	-	-	3	-	3	3	-	3	-	-	-

1=weakly mapped
2= moderately mapped
3=strongly mapped

IDP14001	Inter-Disciplinary Project	L	T	P	C
Version 1.0		-	-	5	3
Pre-requisites/Exposure	Knowledge of Basic English				
Co-requisites	Knowledge of Basic Computer Skills				

Course Objectives

This course will develop a student's knowledge of and appreciation for the

- interdisciplinary nature of knowledge and learning
- importance and value of integrating knowledge and perspectives from multiple disciplines as a means to evaluating and understanding complex topics, problems, issues, phenomena, and events
- competencies learned during the educational process and to apply these competencies in a real-world application

Course Outcomes

Upon successful completion of the course, students will be able to

CO1. recognize the unique advantages of integrative research and learning
CO2. understand the fundamentals of research methods and practices of various academic disciplines
CO3. demonstrate an understanding of current issues and concerns
CO4. realize the importance of ethics in research process
CO5. understand the inter-disciplinary systems of research documentation

Typical Progress Roadmap

- After discussion with the Project Advisor(s), each student shallprepare an initial outline of their assigned project indicating the major sections of discussion, list the principal research sources for each section, and explain the overall objective of the project, including a justification of the interdisciplinary nature of the work.
- Each student shall meet with the Project Advisor(s)regularly as per the weekly Time-Table. Other meetings may be scheduled at the discretion of the Project Advisor(s) at mutually agreed upon timings.
- Typically, the progress will include a combination of industrial and academic mentoring , self study sessions, case studies, trend studies, presentation by students, interactive sessions, industrial visits etc.
- Regular submission of progress reports shall be required of each student-group as notified through the Project Advisor(s) from time to time.

Mode of Evaluation

Students will be evaluated by team participation and a team presentation at the end of the project. Interactive & continuous, task/assignment- based evaluation methodology will be applied for the course.

Modes of Examination: Assessment Scheme:

Components	Interactive & continuous	Team presentation
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs):

Course Outcomes (COs)		**Mapped Pos and PSOs**
CO1	**Identify** the unique advantages of integrative research and learning.	**PO1, PO8, PO9**
CO2	**U**nderstand the fundamentals of research methods and practices of various academic disciplines.	**PO1, PO8, PO9**
CO3	**D**emonstrate an understanding of current issues and concerns.	**PO1, PO3, PO8, PO9**
CO4	Recognize the importance of ethics in research process	**PO1, PO8, PO9**
CO5	Comprehend the inter-disciplinary systems of research documentation**.**	**PO1, PO3, PO8, PO9**

		Academic Excellence	**Contextualized Understanding**	**Design/development of solutions**	**Conduct investigations of complex problems**	**Quantitative Aspects**	**Modernization and Tools Usage**	**Societal Implication**	**Environment and Sustainability**	**Ethics**	**Individual and Team Work**	**Communication**	**Life Long Learning**	Have the versatility to work effectively in a	Be familiar with a variety of examples where	Enhance theoretical rigor with technical skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
IDP14001	Inter-Disciplinary Project	3	-	2	-	-	-	-	3	3	-	-	-	-	-	-

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11092	CALCULUS II	L	T	P	C
Version 1.0	**Contact Hours: 60**	3	1	0	4
Pre-requisites/Exposure	10th+2 Mathematics, Calculus I				
Co-requisites					

Course Objectives:

- To develop the concept of limit, continuity and differentiability of a function of several variables and apply these concepts to find the extreme value of a function.
- To develop the idea about the application of calculus to understand different geometric concepts like curvature, evolute, etc.
- To develop the knowledge of multiple integrals and its application

Course Outcomes

On completion of this course, the students will be able to

CO1. Illustrate different concepts related to the functions of several variables
CO2. Apply the concept of differentiation for finding several quantities related to the real world problem
CO3. Explain the concept of implicit function and its application
CO4. Develop the concept of double and triple integrals and its different applications

Course Description:

Real-life problems studies in many physical, engineering and biological sciences involve more than one parameter i.e., independent variables. Thus, functions of several variables play a very important role in most of the science field. The course has been framed out in this way that students will get a fundamental idea related to the functions of several variables. This course includes topics related to fundamentals of functions of several variables, partial differentiation, chain rule, directional derivative, the concept of a vector field with the evaluation of extremum using Lagrange's multiplier method. It also included pedal equation, radius, center, and chord of curvature of a curve, Jacobian of two and three variables, line and surface integrals, and its different applications.

Course Content:

Unit-I [**18 L**]

Functions of several variables, Limit and Continuity of a functions of two variables, Partial differentiation, Differentiability, Sufficient condition for differentiability, Chain rule for one and two independent variables; Directional derivatives, Definition of vector field, Gradient, Divergence and Curl, Maximal and normal property of the gradient, Geometric interpretation, Tangent planes and Normal lines, Linear approximation, Taylor's theorem for functions two variables

Unit-II [0**8 L**]

Extrema of functions of two or more variables, Saddle point, method of Lagrange multipliers, constrained optimization problems, Jacobian of two and three variables, simple properties including function dependence

Unit-III [1**2 L**]

Concept of implicit function: statement and simple application of implicit function theorem for two variables differentiation of implicit function, Pedal equation of a curve, pedal of a curve, curvature-radius of curvature, centre of curvature, chord of curvature, evolute of a curve, envelopes of families of straight lines and curves (cartesian and parametric equations),

Unit-IV [**22 L**]

Double and Triple integrals: Double integrals over rectangles, iterated integrals, some practical applications, Fubini's theorem, double integrals over general regions, change of order of integration, evaluation of triple integrals in Cartesian, polar, cylindrical and spherical coordinates, applications of Double and Triple integrals, area by double integration, volume of solids as double integrals, volume of solid of revolution, volume as triple integral.

Text Books:

T1. S. C. Mallik and S. Arrora, Mathematical Analysis, S. Chand.
T2. G.B. Thomas and R. L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.

Reference Books:

R1. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007
R2. E. Marsden, A. J. Tromba and A. Weinstein, Basic Multivariable Calculus, Springer (SIE), Indian reprint, 2005.
R3. James Stewart, Multivariable Calculus, Concepts and Contexts, 2nd Ed., Brooks /Cole,Thomson Learning, USA, 2001.
R4. Santosh K. Sengar, Advanced Calculus, Cengage Learning India Pvt. Ltd.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs, POs and PSOs

Course Outcomes (COs)		Mapped POs and PSOs
CO-1	**Illustrate** different concepts related to the functions of several variables	PO1, PO2, PO12, PSO1
CO-2	**Apply** the concept of differentiation for finding several quantities related to the real-world problem	PO1, PO3, PO5, PSO1, PSO3
CO-3	**Explain** the concept of implicit function and its application	PO1, PO3, PO4, PO12, PSO3
CO-4	**Develop** the concept of double and triple integrals and its different applications	PO1, PO3, PSO1

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MTH11092	CALCULUS II	3	3	3	-	2	-	-	-	-	-	-	3	3	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11012	LINEAR ALGEBRA II	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	Knowledge of matrix theory				
Co-requisites					

Course Objectives:

1. To help the students to acquire the knowledge of Matrix representation of a linear transformation.
2. To give the idea about the eigenvalues and eigenvectors of square matrices, eigen spaces of a linear operator, Cayley-Hamilton theorem, diagonalizability.
3. To give an idea about the general quadratic form and definiteness of matrices.
4. To enable the students to inner products space, associated norms and the operators on Inner product spaces.
5. To help the students to understand the concepts of Dual spaces.

Course Outcomes:

On completion of this course, the students will be able to

CO1. Relate matrix algebra to linear transformations.

CO2. Extend the knowledge of Matrix polynomial, Characteristic equation, eigenvalues and eigenvectors and use them in applications.

CO3. Extend the knowledge of matrix theory with Congruence of matrices, Normal form, real quadratic form involving three variables and study the definiteness of the associated matrices.

CO4. Extend the concept of vector spaces to inner products space including associated norms and the operators on Inner product spaces.

CO5. Define dual spaces, dual basis, double dual and use the concept of linear transformations on it.

Course Description:

In this course students can learn the matrix representation concept of linear transformation and eigen value and eigen space. In this course students can get the idea of inner product space and various normal and quadratic forms.

Course Content:

Unit I **[10 L]**

Matrix representation of a linear transformation, various properties of matrix representation, matrix of composite mapping, inverse mapping, basis change, linear space of linear mappings, linear operator and properties.

Unit II **[15 L]**

Eigenvalues and eigenvectors of square matrices, Cayley-Hamilton theorem, simple properties of eigenvalues and eigenvectors, AM and GM., Eigen spaces of a linear operator, the minimal polynomial for a linear operator, similar matrix, diagonalizability.

Unit-III **[15 L]**

Normal form of a matrix under congruence, real quadratic form involving three variables, reduction to normal form (Statements of relevant theorems and applications), general quadratic form, index, signature, characteristics of quadratic forms (positive definite, positive semi-definite, negative definite, negative semi-definite, indefinite).

Unit IV **[20 L]**

Inner product spaces and norms, various results of inner product spaces, Orthogonal projections and Spectral theorem, Gram-Schmidt orthogonalization process, Bessel's inequality, the adjoint of a linear operator, normal and self-adjoint operators, orthogonal complements, Least Squares Approximation, minimal solutions to systems of linear equations.

Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis.

Text Books:

T1. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.

T2. Hoffman and Kunze, Linear algebra, Pearson.

T3. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, Pearson.

Reference Books:

R1. R.K. Jain and S.R.K. Iyenger, Advanced Engineering Mathematics, Narosa Publishing House.

R2. S. K. Mapa, Higher Algebra- Abstract and Linear, revised Ninth Edition, Sarat Book House, 2003.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	20	30	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs, POs and PSOs

Course Outcomes (COs)		Mapped POs and PSOs
CO-1	**Relate** matrix algebra to linear transformations.	PO1, PO2, PO12, PSO1
CO-2	**Extend** the knowledge of Matrix polynomial, Characteristic equation, eigenvalues and eigenvectors and use them in applications.	PO1, PO4, PSO1, PSO3
CO-3	**Extend** the knowledge of matrix theory with Congruence of matrices, Normal form, real quadratic form involving three variables and study the definiteness of the associated matrices.	PO1, PO3, PO12, PSO1, PSO3
CO-4	**Extend** the concept of vector spaces to inner products space including associated norms and the operators on Inner product spaces	PO1, PO2, PO3, PO4, PSO1
CO-5	**Define** dual spaces, dual basis, double dual and use the concept of linear transformations on it.	

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem-Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning, abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2	PS O3
MTH1 1012	LINEA R ALGE BRA II	3	3	3	2	-	-	-	-	-	-	-	3	3	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

SDS11069	THEORY OF PROBABILITY	L	T	P	C
Version 1.1	Contact Hours: 60	3	1	0	4
Pre-requisites/Exposure	10th+2 Mathematics, Calculus				
Co-requisites					

Course Objectives:
To provide the students a good background knowledge of probability which will help them to understand and analyse different chance phenomena arises in real-life situations.

Course Outcomes
On completion of this course, the students will be able to

CO1. Explain of the principles of probability theory
CO2. Summaries the properties of univariate and bivariate random variables
CO3. Make use of mathematical expectation to derive different measures and properties for a range of probability distributions
CO4. Explain different discrete and continuous distribution of random variables with their fundamental properties

Course Description:
This course deals with probability and moment generating function, characteristic function, Markov's and Chebyshev's inequalities, De-Moivre Laplace and Lindeberg-Levy Central Limit Theorem and discrete and continuous probability distributions and its applications in science and engineering. After successful completion of this course a student will be able to analyse the different applications of probability and probability distributions in real world.

Course Content:

Unit-I
Basic Probability Theory: Random experiment, sample space, simple and compound events, algebra of events, Definition of Probability - classical, relative frequency and axiomatic, merits and demerits of these approaches of definition (only general ideas to be given), theorems on probability, Addition rule, conditional probability, independent events, multiplication rule, Baye's theorem and its applications **[10L]**

Unit-II
Random variables and distribution functions: Random variables and its types, distribution function, probability mass function, discrete distribution function, probability density function, continuous distribution function, transformation of random variables, two dimensional probability distributions, discrete and continuous distributions in two dimensions, two dimensional random variables, joint probability mass function, distribution function, marginal distribution functions, joint density function. **[12L]**

Unit – III
Mathematical expectation and generating functions: Mathematical expectation of a random variable and function of random variable, properties of expectation, mean, variance, moments, central moments, measures of location, dispersion, skewness and kurtosis, median, mode, quartiles; moment generating function and its limitations, properties and uniqueness theorem of moment generating function, characteristic function; two-dimensional expectation, covariance, correlation co-efficient, Multiplication rule for expectations, Conditional expectation. **[18L]**

Unit-IV

Discrete probability distributions: Discrete uniform, Bernoulli, Binomial, Poisson, negative binomial, geometric and hyper-geometric distributions and their moment generating functions and properties.

Continuous probability distributions: Uniform, triangular, gamma, exponential, Weibul, logistic distributions, beta distribution of first kind, beta distribution of second kind and their moment generating functions and applications. **[20L]**

Text Books:

1. S C Gupta and V K Kapoor, Fundamentals of Mathematical Statistics, S Chand & Sons
2. Vijay K. Rohatgi, A.K. Md. Ehsanes Saleh, An Introduction to Probability and Statistics, 2nd edition, Wiley

Reference Books:

1. R. V. Hogg, J Mckean, A T Craig, Introduction to Mathematical Statistics, 7e, Pearson Education India
2. S. Ross, A First Course in Probability, Pearson Education
3. S. Ross, Introduction to probability models, Academic Press, Indian Reprint 2007
4. Parimal Mukhopadhyay, An Introduction to the Theory of Probability, World Scientific, 2012
5. Amritava Gupta, Groundwork of Mathematical Probability and Statistics, Academic Publishers, 2015

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	20	30	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs, POs and PSOs

Course Outcomes (COs)		Mapped POs and PSOs
CO-1	**Explain** of the principles of probability theory	PO1, PO2, PO12, PSO2, PSO3
CO-2	**Summaries** the properties of univariate and bivariate random variables	PO1, PO2, PO3, PO4, PO5 PO12, PSO2, PSO1
CO-3	**Make use of** mathematical expectation to derive different measures and properties for a range of probability distributions	PO1, PO2, PO3, PO4, PO5 PO12, PSO2, PSO1
CO-4	**Explain** different discrete and continuous distribution of random variables with their fundamental properties	PO1, PO2, PO12, PSO2, PSO3

Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2	PS O3
		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
SDS11069	THEORY OF PROBABILITY	3	3	2	3	2	-	-	-	-	-	-	3	3	2	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11094	ANALYTICAL GEOMETRY 3D	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	Analytical Geometry 2D				
Co-requisites	--				

Course Objective: To give students the knowledge of three-dimensional geometry which is useful to study several real-life phenomena.

Course Outcomes
On completion of this course, the students will be able to

CO1. Explain the notions of cartesian coordinates in space, direction ratios and direction cosines, plane.
CO2. Build the knowledge of straight lines in three-dimensional space, shortest distance of skew Lines and transformation of axes.
CO3. Explain the concepts of sphere and evaluate equation of tangent plane, polar plane of a point w.r.t. a sphere.
CO4. Illustrate the idea of quadric surfaces: cone cylinder, ellipsoids, hyperboloids and Paraboloids

Course Description: Analytic geometry is the study of geometry using a coordinate system. It is used in modern fields of geometry, including algebraic, differential, discrete and computational geometry, physics, engineering, and also in aviation, rocketry, space science, and spaceflight. This course describes coordinates in space, equation of plane, straight line in space, direction cosines, shortest distance of two skew lines, equation of sphere, cone, cylinders, surfaces of revolution, etc.

Course Content:

Unit-I

Coordinate systems: Rectangular Cartesian coordinates in space, direction cosines and direction ratios of a directed line, projection, angle between two lines, equations of a plane, intercept, normal and general forms of plane, the sides of a plane, bisectors of the angles between two planes, parallelism and perpendicularity of two planes, position of the origin. **[14L]**

Unit-II

Straight Line, symmetrical form, intersection of plane and straight line, condition of coplanarity of two straight lines, perpendicular from a point on a line, Coplanar lines, shortest distance between two skew lines and its equation.
Transformation of axes: Change of origin with parallel axes, transformation of rectangular axes, combination of translation and
rotation. **[16L]**

Unit-III
Sphere: Equation of sphere, sphere on a diameter with given extremities, intersection of two spheres, sphere through a given circle, section of a sphere with a given center, intersection of

a straight line and a sphere, equation of tangent plane, polar plane of a point w.r.t. a sphere, pole of a plane w.r.t. a sphere, angle of intersection of two non-concentric spheres, Radial plane and radial line, Co-axial system of spheres. **[14L]**

Unit-IV

Quadric surfaces: Equation of a Cone with its vertex at the origin, equation of a quadratic cone with given vertex and given guiding curve, necessary condition for general equation of second degree to represent a cone, circular cone, Cylinder, Ellipsoids, Hyperboloids, paraboloids.

Spherical polar co-ordinates, Cylindrical polar co-ordinates. **[16L]**

Text Books:

T1 R.J.T. Bill, Elementary Treatise on Coordinate Geometry of Three Dimensions, McMillan India Ltd., 1994

T2. J. G. Chakravorty and P.R. Ghosh, Advanced Analytical Geometry, U.N.Dhur & Sons Pvt Ltd, 2018.

Reference Books:

R1. H. K. Dasse, H. C. Saxena, M. D. Raisinghania, Simplified Course in Solid Geometry(3D), S.Chand& Company.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs, POs and PSOs

Course Outcomes (COs)		Mapped POs and PSOs
CO-1	**Explain** the notions of cartesian coordinates in space, direction ratios and direction cosines, plane.	PO1, PO2, PO12, PSO1, PSO3
CO-2	**Build** the knowledge of straight lines in three-dimensional space, shortest distance of skew Lines and transformation of axes.	PO1, PO5, PSO1, PSO3
CO-3	**Explain** the concepts of sphere and evaluate equation of tangent plane, polar plane of a point w.r.t. a sphere.	PO1, PO3, PO12, PSO1, PSO3
CO-4	**Illustrate** the idea of quadric surfaces: cone cylinder, ellipsoids, hyperboloids and paraboloids,	PO1, PO2, PO3, PSO1

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2	PS O3
MTH1 1094	ANAL YTICA L GEOM ETRY 3D	3	3	3	-	2	-	-	-	-	-	-	3	3	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH13011	INTRODUCTION TO MATLAB	L	T	P	C
Version 1.1	**Contact Hours - 60**	1	0	3	3
Pre-requisites/Exposure	12th level Mathematics				
Co-requisites	Basic knowledge of matrix; Basic knowledge of statistics				

Course Objectives:

1. To learn fundamentals of MATLAB language and coding
2. To develop skill for high quality data visualization
3. To gain skill of working with different types of data files

Course Outcomes:

On completion of this course, the students will be able to

CO1. Make use of MATLAB syntaxes to write programs
CO2. Develop high quality visualizations
CO3. Build user-defined functions
CO4. Import and export data in different file format

Course Description:

This course will introduce students to the fundamentals of MATLAB language, data visualization and its application to solve mathematical and real-world problems. The course will provide information on MATLAB software, user interface and scripting; basic operations and in-built functions; defining and manipulating arrays; writing user defined functions; control statements – conditionals (if-else) and loops; importing and exporting data; data visualizations and applications. The class activities include lectures, hands-on practices, tutorials, assignments, quizzes, and interactions. Moreover, the students will actively participate in discussion, problem solving in class. The course will help the students to develop the fundamental knowledge of MATLAB language and writing programs, and in addition, to enhance the problem solving, interaction and presentation skills.

Course Content:

Unit I **[8 L]**

Introduction, History, Competitors, Starting MATLAB, Using MATLAB as a calculator, Quitting MATLAB, Familiar with MATLAB windows, Basic Operations, Arithmetic operators, Precedence of arithmetic operations, Predefined variables, Basic in-built functions; Input and output commands; Writing scripts.

Unit II **[15 L]**

Basics of MATLAB arrays, Vectors and Matrices, In-built functions related to matrices, Operations on matrices, Indexing elements, Extracting sub matrices, dealing with string (Array of characters).

Unit III **[17 L]**

In-built functions for plotting, Subplot, Line plot, Scattered plot, Bar chart, Use of meshgrid function, Mesh plot, Surface plot, Contour plot, Pcolor plot.

Unit IV **[20 L]**

Writing user-defined functions, Inline functions, Comparison between script file and function file, Relational and Logical Operators, If-else statements, Switch-case statements, For loop, While loop, Special commands (Break and continue), Import data from large database, Export data to own file or database

Note: All the experiments will be conducted based on the above mentioned topics

Text Books

T1: Brian R. Hunt, A Guide to MATLAB for Beginners and Experienced Users, Cambridge University Press, United Kingdom.

T2: Rao V. Dukhipati, MATLAB AN Introduction with applications, New Age International Publishers, New Delhi

T3: Rudra Pratap, Getting started with MATLAB: A quick introduction for scientists and engineering, Oxford University Press

Reference Books

R1. Partha S. Mallick, MATLAB and Simulink, Chennai Scitech publications (India) Pvt. Ltd
R2. Stehnen J. Chapman, MATLAB programming for engineering, Thompson Learning, Hyderabad

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs, POs and PSOs

Course Outcomes (COs)		Mapped POs and PSOs
CO-1	**Make use of** MATLAB syntaxes to write programs	PO2, PO4, PO5, PO12, PSO1, PSO3
CO-2	**Develop** high quality visualizations	PO1, PO2, PO5, PO12, PSO1, PSO3
CO-3	**Build** user-defined functions	PO2, PO5, PO12, PSO1
CO-4	**Import** and export data in different file format	PO1, PO2, PO4, PO5, PO12, PSO1, PSO3

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	**Contextualized Understanding:** Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	**Critical Thinking and Problem Solving Skills:** Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	**Problem Analysis:** Identify, formulate and analyze complex problems using mathematical principles.	**Modernization and Tools Usage:** Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	**Societal Implication:** Analyze complex social elements, their interrelation and its impact on geographically different society.	**Environment and Sustainability:** Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and	**Ethics:** Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	**Individual and Team Work:** Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	**Communication:** Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	**Leadership Skills:** Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	**Life Long Learning:** Develop the ability to reasoning, abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MTH13011	Introduction to MATLAB	2	-	3	2	3	-	3	-	-	-	-	3	3	-	2

1=weakly mapped
2= moderately mapped
3=strongly mapped

ECO11031	MACROECONOMICS	L	T	P	C
Version 1.0		5	1	0	6
Pre-requisites/Exposure	Physics and Chemistry of class 12 or 10+2 level				
Co-requisites	Partial differentiation, model making, graph plotting				

Course objectives:

1. To develop fundamentals ideas of macroeconomics.
2. The course will help to learn different theories associated with issues of open as well as closed economies.
3. The course will help to understand the role of money and different theories of inflation.
4. The course should develop idea of output and employment determination in a country.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Understand various theoretical issues related to an economy.

CO2: Develop ideas about measurement of aggregate macroeconomic variable like savings, investment, GDP and National Income.

CO3: Understand the role of money and different concepts of inflation.

CO4: Understand various alternative theories of output and employment determination in a closed economy in the short run as well as long run and the role of policy in this context.

Course Description:

The objective of the course is to make students understand and analyses how different macroeconomic variables are measured and can shape economic results. The course analyses different macroeconomic concepts and techniques in evaluating business decisions under different situations. Students will be able to understand the terminologies and analytic principles used in macroeconomics and the application of these conceptual tools to several strategic issues. Simple geometry and basic concepts of mathematics will be used in the course of teaching.

Course Content:

Unit 1: Introduction to Macroeconomics and National Income Accounting

Basic issues studied in macroeconomics; measurement of gross domestic product; income, expenditure and the circular flow; real versus nominal GDP; price indices

Unit 2: The Closed Economy in the Short Run

Classical and Keynesian systems; simple Keynesian model of income determination; ISLM model; fiscal and monetary multipliers

Unit 3: Aggregate Demand and Aggregate Supply Curves

Derivation of aggregate demand and aggregate and supply curves; interaction of aggregate demand and supply

Unit 4: Money and Inflation

Functions of money; quantity theory of money; determination of money supply and demand; credit creation; tools of monetary policy, cost push and demand pull inflation

Unit 5: Unemployment and Expectations

Aggregate supply- the Sticky-Price Model, the Imperfect Information Model; Okun’s Law; the short-run trade -off between inflation and unemployment; Phillips Curve; Shifts in the Phillips curve; the role of expectation; Natural Rate of unemployment; The Phillips curve and the

Aggregate supply curve; the debate

Text Books:

T1. N. Gregory Mankiw. Macroeconomics, Worth Publishers, 7th edition, 2010
T2. Dornbusch, Fischer and Startz, Macroeconomics, McGraw Hill, 11th edition, 2010
T3. Andrew B. Abel and Ben S. Bernanke, Macroeconomics, Pearson Education, Inc., 7th edition, 2011

Reference Books:

R1. Olivier Blanchard, Macroeconomics, Pearson Education, Inc., 5th edition, 2009
R2. Steven M. Sheffrin, Rational Expectations, Cambridge University Press, 2nd edition, 1996.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs, POs and PSOs

Course Outcomes (COs)		Mapped POs and PSOs
CO-1	Understand various theoretical issues related to an economy.	**PO1, PO2,PO3, PO7, PO10, PO12**
CO-2	Develop ideas about measurement of aggregate macroeconomic variable like savings, investment, GDP and National Income.	**PO2, PO3, PO4, PO7, PO9, PO10, PO12**
CO-3	Understand the role of money and different concepts of inflation.	**PO4, PO7, PO10, PO12**
CO-4	Understand various alternative theories of output and employment determination in a closed economy in the short run as well as long run and the role of policy in this context.	**PO1, PO2,PO3, PO7, PO10, PO12**

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
ECO11031	MACROECONOMICS	2	2	1	1			3		3	3		3			

1=weakly mapped
2= moderately mapped
3=strongly mapped

PHY11024	ELECTIVE PHYSICS II	L	T	P	C
Version 1.0	Contact hours-60	3	1	0	4
Pre-requisites/Exposure	Knowledge of Class12 level Physics				
Co-requisites	Basic concept of Differential and Integral Calculus				

Course Objectives

To understand the principles of kinetic theory of gasses.
To apply basic postulates of thermodynamics and to understand the first and second law of thermodynamics.
To analyse different experimental evidence related to the concept of Quantum theory and discuss the development of the subject.
To apply the knowledge of quantum mechanics to different systems.
To explore the elementary idea about different theories of statistical mechanics.
To understand the basic working principle of LASER.
To understand the structural configuration of different materials.

Course Outcomes

On completion of this course, the students will be able to

CO1: Acquire the basic concepts of kinetic theory of gasses.
CO2: Develop the preliminary concepts of thermodynamics.
CO3: Build up the fundamental knowledge of quantum mechanics and apply it to few simple quantum mechanical systems.
CO4: Gain the elementary idea about the distribution functions of statistical mechanics.
CO5: Develop the basic knowledge of different topics of modern physics like LASER and fibre optics, solid state physics, band theory of solids and magnetism.

Course Description:

Elective Physics II gives an advance overview of modern physics. It deals with the fundamental area of physics in which one can explore a large domain starting from the collective behavior of gas particles, fundamentals of quantum mechanics, solid state physics and many more.

Course Content

1. Kinetic Theory of Gases: [8 L]

Maxwell's distribution of molecular velocities (statement only). Calculation of r.m.s, mean and most probable velocities.

2. Thermodynamics: [10 L]

Basic concepts: (Thermodynamic system, Surroundings and boundary, Thermodynamic coordinates, State, State function Thermodynamic equilibrium), First law of thermodynamics and its application. Isothermal and adiabatic changes and their relations, indicator diagrams. Reversible and irreversible processes, second law of thermodynamics, Carnot cycle and its efficiency calculation, entropy and its physical interpretation.

3. Quantum Physics: [12 L]

Planck's concept of blackbody radiation and radiation formula (statement only), qualitative discussion of photo-electric effect and Compton effect in support of quantum theory, wave-particle duality, Heisenberg uncertainty principle, and Schrödinger equation, particle in a one-dimensional infinite well, energy eigenvalues, wave function and its probabilistic

interpretation. Bohr's theory of hydrogen spectra, concept of quantum number, Pauli Exclusion Principle.

4. Statistical Physics: [12 L]

Elementary idea about three distribution functions (Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics), Concepts of Bosons and Fermions.

5. Modern Physics: [18 L]

LASER and Fibre Optics, Einstein's A, B coefficient, Population Inversion, He-Ne LASER, Ruby LASER.

Concept of Lattice structure, Bravais Lattice, Free electron theory, Electrical and Thermal conductivity, Band Theory, Elementary idea about Magnetism and Superconductivity.

Reference Books

1. Arthur Beiser, S RaiChoudhury, ShobhitMahajan, (2009), Concept of Modern Physics, 6th Edition, Tata-McGraw Hill.
2. A J Dekker, Solid State Physics, Mcmillan India Ltd, 1st Ed. 2009
3. Thermal Physics, Roy and Gupta
4. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	20	30	50

Relationship between the Course Outcomes (COs) and Program Outcomes (POs)

Mapping between COs and POs		
	Course Outcomes (COs)	**Mapped Program Outcomes**
CO1	Acquire the basic concepts of kinetic theory of gasses.	**PO1, PO3, PO4**
CO2	Develop the preliminary concepts of thermodynamics.	**PO1,PO3, PO4**
CO3	Build up the fundamental knowledge of quantum mechanics and apply it to few simple quantum mechanical systems.	**PO1, PO2, PO3, PO4, POS3**
CO4	Gain the elementary idea about the distribution functions of statistical mechanics.	**PO1, PO2, PO3, PO4, POS3**
CO5	Develop the basic knowledge of different topics of modern physics like LASER and fibre optics, solid state physics, band theory of solids and magnetism.	**PO1,PO3, PO4**

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	**Contextualized Understanding:** Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	**Critical Thinking and Problem Solving Skills:** Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	**Problem Analysis:** Identify, formulate and analyze complex problems using mathematical principles.	**Modernization and Tools Usage:** Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	**Societal Implication:** Analyze complex social elements, their interrelation and its impact on geographically different society.	**Environment and Sustainability:** Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	**Ethics:** Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	**Individual and Team Work:** Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	**Communication:** Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	**Leadership Skills:** Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	**Life Long Learning:** Develop the ability to reasoning, abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PHY1 1024	Elective Physics II	3	2	1	1											2

1=weakly mapped
2=moderately mapped
3=strongly mapped

PHY12025	ELECTIVE PHYSICS LAB II	L	T	P	C
Version 1.0	Contact Hours -30	0	0	3	2
Pre-requisites/Exposure	Knowledge about basic higher secondary physics.				
Co-requisites					

Course Objectives

1. To develop the capability of the students for practical understanding of fundamental aspects of physics.
2. To give students experimental/laboratory-based background, the key prerequisite for performing research near future.
3. To build up real-time idea on basic Newtonian mechanics, general properties of matters, electromagnetic theory and optics. These ideas can upgrade student's understanding in proper channel, so that they can flourish their career path.

Course Outcome:

CO1: Students shall be able to estimate the thermal conductivity of a bad conductor.

CO2: Students shall be able to verify different laws of network theorems of electrical circuits.

CO3: Students shall be able to study of the response of various non-ohmic devices like inductance, capacitance in the electrical circuits.

CO4: Students shall be able to study the characteristic curves of junction diodes and bipolar junction transistors.

Catalog Description:

This course introduces basic concepts about the experiments related to different domain of physics starting from thermal physics to electrical and electronic devices.

Course Content

Experiment 1: [6 hours]
Determination of thermal conductivity of a bad conductor of heat by Lee's and Charlton's method.

Experiment 2: [6 hours]
To verify the Thevenin and Norton theorem, Superposition theorem, and Maximum Power Transfer theorems.

Experiment 3: [6 hours]
To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.

Experiment 4: [6 hours]
To study V-I characteristics of a P-N junction diode and Light emitting diode.

Experiment 5: [6 hours]
To study the V-I characteristics of a Zener diode and its use as voltage regulator.

Experiment 6: [6 hours]
To study the characteristics of a Bipolar Junction Transistor in CE configuration.

Text Books:
1.Advanced Practical Physics, Volume-I, B. Ghosh & K. G. Mazumdar

Reference Books:
1. An Advanced Course in Practical Physics, D. Chattopadhyay & P. C. Rakshit

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Class Assessment	End Term
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs, POs and PSOs

Course Outcomes (COs)		Mapped POs and PSOs
CO-1	Students shall be able to estimate the thermal conductivity of a bad conductor	PO9, PO10, PO11, PO12
CO-2	Students shall be able to verify different laws of network theorems of electrical circuits.	PO9, PO10, PO11, PO12
CO-3	Students shall be able to study of the response of various non-ohmic devices like inductance, capacitance in the electrical circuits	PO9, PO10, PO11, PO12
CO-4	Students shall be able to study the characteristic curves of junction diodes and bipolar junction transistors	PO9, PO10, PO11, PO12

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PHY12025	ELECTIVE PHYSICS LAB II	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**1**	**1**	**-**	**-**	**-**

1=weakly mapped
2= moderately mapped
3=strongly mapped

PSG11021	HUMAN VALUES AND PROFESSIONAL ETHICS	L	T	P	C
Version1.0		2	0	0	2
Pre-requisites/Exposure	--				
Co-requisites	--				

Course Objectives:

1. To inculcate human values and professional ethics in students.
2. To enhance the understanding of students towards personal, professional & societal relationships and achieve harmony in life.
3. To develop moral responsibilities and ethical vision.

Course Outcomes:

At the completion of the course, the student should be able to:

CO1. Realize the importance of values, ethics, harmony and lifelong learning in personal and professional life
CO2. Apply the knowledge to perform self-exploration and transformation augmenting harmony, peace and positivity in the surroundings.
CO3. Infer core values that shape the ethical behaviour of a professional.

Course Description:

This course aims to develop an understanding for a movement from rule-based society to a relationship-based society. Apart from teaching values, this course encourages students to discover what values are for them and for society. Self-exploration also enables them to critically evaluate their pre-conditionings and present beliefs. It is designed in a way where students get familiar with the Ethical Code of Conduct, Ethical Dilemma, Conflict of Interest and all this will help them eventually in their professional life.

Course Content:

Unit I: Introduction to Human Values:

Character, Integrity, Credibility, Mutual Respect, Dedication, Perseverance, Humility and Perception. Self-Assessment & Analysis, Setting Life Goals, Consciousness and Self-Transformation. Team Work, Conflict Resolution, Influencing and Winning People, Anger Management, Forgiveness and Peace, Morality, Conscience. Yoga and Spirituality

Unit II: Harmony and Life Long Learning:

Harmony in human being, Nature and Existence. Harmony in family and society– Responsibilities towards society, Respecting teachers. Transition from School to College-Freedom & Responsibilities, Respecting Cultural Diversity, Learning beyond the Classrooms, Independent study and research

Unit III: Introduction to Professional Ethics:

Work Ethics, Engineering Ethics, Moral Dilemma, Moral Development Theories, Ethical Theories-Kantinism, Utilitarianism, etc, Case Studies for Choice of the theory, Code of Ethics

Unit IV: Individual to Global Issues:

Industrial Standards, A Balanced Outlook on Law, Safety, Responsibility, Rights, Confidentiality, Conflict of Interest, Occupational Crime, Whistle Blowing,

Environmental Ethics, Business Conduct in MNC, E-Professionalism (IPR, Internet Ethics & Privacy issues)

Text Books

Shetty, Foundation Course in Human Values and Professional Ethics [R.R. Gaur, R. Sangal, G.P. Bagaria]

Modes of Evaluation: Assignment/Quiz/Project/Presentation/Written Examination

Examination Scheme:

Components	Mid-term Examination	Continuous Assessment	End Term Examination
Weightage (%)	20	30	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Mapping between COs, POs and PSOs

Course Outcomes (COs)		Mapped POs and PSOs
CO1	Realize the importance of values, ethics, harmony and lifelong learning in personal and professional life.	PO9, PO12
CO2	Apply the knowledge to perform self- exploration and transformation augmenting harmony, peace and positivity in the surroundings.	PO7, PO12
CO3	Infer core values that shape the ethical behavior of a professional	PO9, PO12

		Academic Excellence	Contextualized Understanding	Design/development of solutions	Conduct investigations of complex problems	Quantitative Aspects	Modernization and Tools Usage	Societal Implication	Environment and Sustainability	Ethics	Individual and Team Work	Communication	Life Long Learning	Have the versatility to work effectively in a	Be familiar with a variety of examples where	Enhance theoretical rigor with technical skills
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
PSG11021	Human Values and Professional Ethics	-	-	-	-	-	-	2	-	3	-	-	3	-	-	-

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11016	FUNCTIONS OF COMPLEX VARIABLES	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	Real Analysis, Multivariable calculus				
Co-requisites	--				

Course Objectives:

To give students the lessons of understanding complex algebra and multivariable integration by the help of complex analysis.

Course Outcomes

On completion of this course, the students will be able to

CO1	**Find** the basic idea of complex number systems and differentiability.
CO2	**Demonstrate** the idea of analytic functions and unbox the concept of elementary functions like exponential and logarithmic function.
CO3	**Illustrate** the idea of complex integration along with Cauchy Goursat theorem and Cauchy's integral formula with their applications. Demonstrate the idea of bilinear transformation.
CO4	**Build** the concept of infinite series (Taylor series, Laurent series etc.) and study of their convergent analysis.
CO5	**Identify** singularity of a complex function and classification of various singular points along with their application in integration.

Course Description:

This course is a very important course in Mathematics. Complex Analysis give us many answers beyond the real number system. In this course, we try to cover from the basic complex number system till singularity. The course includes the idea of continuity and differentiability of multivariable calculus. Complex integration is also there in the course, by which many aspects of line or curve integrations can be covered. The tutorial or assignments will help the students to formulize the theoretical aspect of this pure mathematical topic in practical purpose.

Course Content:

Unit - I

Properties of complex numbers, regions in the complex plane, functions of complex variable, mappings, Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability. [**14L**]

Unit – II

Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, definite integrals of functions, contours, Contour integrals and its examples, upper bounds for moduli of contour integrals, Cauchy- Goursat theorem, Cauchy integral formula. [**16L**]

Unit – III

Liouville's theorem and the fundamental theorem of algebra, Convergence of sequences and series, Taylor series and its examples, Laurent series and its examples, absolute and uniform convergence of power series. [**12L**]

Unit – IV

Classification of singularities: Isolated and non-isolated singularities, removable singularities, poles, isolated singularities at infinity, Meromorphic functions, essential singularities, residues at a finite point, residues at the point at infinity, Cauchy's residue theorem, Rouche's theorem and evaluation of integrals. [**18L**]

References:

1. Murray. R. Spiegel, Theory and Problems of Complex Variables, Schaum outline series.
2. J. B. Conway, Functions of one Complex variable. Springer, Verlag.
3. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 8th Ed., McGraw Hill International Edition, 2009.
4. H K Kasana, Complex Variables: Theory and Applications: Second Edition, Prentice Hall India Learning Private Limited.
5. P. Duraipandianand K. Pachaiyappa, Complex Analysis, S. Chand Publishing.
6. S. Ponnusamy, Foundations of Complex Analysis, Narosa Pub. House

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes(PSOs)

Mappings between COs and POs and PSOs		
Course Outcomes (COs)		**Mapped POs and PSOs**
CO1	**Find** the basic idea of complex number systems and differentiability.	PO1, PO2 ,PSO1,PSO2
CO2	**Demonstrate** the idea of analytic functions and unbox the concept of elementary functions like exponential and logarithmic function.	PO1, PO2, PO12,PSO1,PSO2
CO3	**Illustrate** the idea of complex integration along with Cauchy Goursat theorem and Cauchy's integral formula with their applications. Demonstrate the idea of bilinear transformation.	PO1, PO2, PO3, PO4,PSO1
CO4	**Build** the concept of infinite series (Taylor series, Laurent series etc.) and study of their convergent analysis.	PO1, PO2 ,PSO3,PSO2
CO5	**Identify** singularity of a complex function and classification of various singular points along with their application in integration.	PO1, PO2, PO3, PO4,PSO1

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MTH11016	Functions of complex variables	3	3	3	3	-	-	-	-	-	-	-	1	3	3	2

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11021	Introduction to Linear Programming and Game Theory	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	Basic Mathematics				
Co-requisites	--				

Course Objectives:

1. To develop the concept of formulation of linear programming problem (LPP) and solution procedure of LPP by using Graphical method, simplex method.
2. To acquire the knowledge of special classes of LPPs such as Transportation problem, Assignment problem and build up the concept of application procedures of LPP to Game Theory.

Course Outcomes

On completion of this course, the students will be able to

CO1. Find the mathematical form of real-world problems in the form of LPP and solution procedure by using Graphical method. .

CO2. Illustrate the concept of Simplex method and Duality of LPP.

CO3. Choose appropriate techniques for solving related to transportation, assignment and network project management.

CO4. Build up the concept of application procedures of LPP to Games and strategies.

Course Description:

Linear Programming Problem (LPP) deals with the problem of minimizing or maximizing a linear function in the presence of linear inequalities. Since the development of the simplex method, linear programming has been extensively used in the military, industrial, governmental, and urban planning fields, among others. A large class of optimization problems are solved by techniques under the heading mathematical programing. Mathematical programing also includes non-linear programing, geometric programing, quadratic or integer programing. There are several other techniques to solve the optimization problems but LPP concerned with only solving the linear programing models in an iterative procedure which yields an exact solution in a finite number of steps. LPP is useful to solve the allocation problems. These problems require the allocation of limited available resources to the jobs that are to be done. There is a class of game which are intimately related to linear programing.

Course Content:

Unit – I

Introduction, definition of linear programming problem (LPP), formation of LPP from daily life involving inequalities, graphical solution of LPP, basic solutions and basic feasible solution (BFS) with reference to LPP, matrix formulation of LPP, degenerate and non-degenerate BFS, Hyperplane, convex set, cone, extreme points, convex hull and convex polyhedron, supporting and separating hyperplane, reduction of a feasible solution (FS) to a BFS, improving a BFS, optimality condition, unboundedness, alternate optima, infeasibility and related examples. [**16L**]

Unit – II

Theory of simplex method, optimality and un-boundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method, Big-M method and their comparison, Duality, formulation of the dual problem, primal-dual relationships, Duality them economic interpretation of the dual. [**14L**]

Unit – III

Transportation problem and its mathematical formulation, north-west corner method least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem, travelling salesman problem. [**18L**]

Unit – IV

Game theory: Concept of game theory, rectangular games, pure strategy and mixed strategy, saddle point and its existence, optimal strategy and value of the game, necessary and sufficient condition for a given strategy to be optimal in a game, concept of dominance, formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure, linear programming solution of games. [**12L**]

References:

1. KantiSwarup, P. K. Gupta and Man Mohan, Operations Research, S. Chand and Co. Pvt. Ltd.
2. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 9th Ed., Tata McGraw Hill, Singapore, 2009.
3. Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice Hall India, 2006. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.
4. N.V.R. Naidu, G. Rajendra and T. Krishna Rao-Operations Research, I.K. International Publishing House Pvt. Ltd., New Delhi, Bangalore.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	20	30	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes(PSOs)

Mapping between COs, POs and PSOs		
Course Outcomes (COs)		Mapped POs and PSOs
CO-1	**Find** the mathematical form of real-world problems in the form of LPP and solution procedure by using Graphical method.	PO1, PO2, PO12,PSO1,PSO3

CO-2	**Illustrate** the concept of Simplex method and Duality of LPP.	PO1, PO3, PO5, PSO1,PSO3
CO-3	**Choose** appropriate techniques for solving related to transportation, assignment and network project management.	PO1, PO2,PO3, PSO1,PSO3
CO-4	**Build** up the Concept of application procedures of LPP to Games and strategies. .	PO1, PO3, PSO1,PSO3

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2	PS O3
MTH1 1021	Introduct ion to Linear Program ming and Game Theory	3	3	3	-	2	-	-	-	-	-	-	3	3	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11017	Introduction to Numerical Analysis	L	T	P	C
Version 1.0	Contact Hours - 60	3	1	0	4
Pre-requisites/Exposure	Basic Mathematics				
Co-requisites	--				

Course Objectives:
To introduce the numerical approaches for solving various mathematical problems.

Course Outcomes
On completion of this course, the students will be able to
CO1. Find the errors in numerical methods, and numerical solutions of nonlinear equations with single variable.
CO2. Illustrate the solution procedure of system of linear algebraic equations.
CO3. Develop the basic knowledge of finite differences, interpolation and divided differences.
CO4. Demonstrate the concept of numerical differentiation and integration.
CO5. Solve the ordinary differential equations by several numerical methods.

Course Description:

Numerical analysis is the subject of study to find the numerical solutions of mathematical problems by computational methods. Numerical techniques are effective tools for providing solutions to mathematical problems which are not solved by analytical methods. It studies the numerical solutions to the problems involving nonlinear equations, system of linear algebraic equations, interpolation and approximation, empirical laws for curve fitting, differences, integrals, ordinary and partial differential equations, finite differences, etc. Numerical methods are normally being used to find the solution to a problem whose analytical solution is difficult to achieve, thus it is felt that a study in applied sciences and engineering is essential and found wide applications in all areas of science, technology and economics.

Course Content:

Unit-I **[14 L]**
Algorithms, Convergence, Errors: Relative, Absolute, Round off, Truncation errors, Propagation of errors, Roots of algebraic and transcendental equations: Bisection method, Regular-Falsi method, Secant method, Fixed point iteration method, Newton-Raphson method, Rate of convergence of these methods, Numerical solution to system of non-linear equation by Newton-Raphson
method.

Unit-II **[14 L]**
System of linear algebraic equations: Gaussian Elimination method, Pivot element, Gauss-Jordan method, LU-Decomposition methods and their applications, Ill-conditioned system and its solution, Gauss-Jacobi method, Gauss-Seidel method and their convergence analyses.

Unit-III [**14 L**]

Interpolation: Finite difference operators and their relations, Synthetic division, Newton's forward and backward difference formulae, Numerical differentiation and its applications.

Interpolation with unequal intervals: Lagrange's interpolation formula, Divided difference, Newton's divided difference interpolation formula.

Unit-IV [**18 L**]

Numerical integration: Newton-Cotes quadrature formula, Trapezoidal rule, Simpson's rules, Weddle's rule, Error analysis, Guassian-Quadrature formulae (2, 3-point rules).

Numerical solutions of ODE: Taylor's method, Picard's method, Euler's method, Modified Euler's method, Second and fourth order Runge-Kutta methods.

References:

1. T. Veerarajan, T. Ramachandran, Numerical Methods with Programs in C, Tata McGraw-Hill Publications.
2. S. Dey, S. Gupta, Numerical Methods, McGraw Hill Education.
3. S. S. Sastry, Introductory Methods of Numerical Analysis. PHI Learning Pvt. Ltd, 2012.
4. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New age International Publisher, India, 5th edition, 2007.
5. B. S. Grewal, Numerical Methods in Engineering & Science with Programs in C & C++, Khanna Publications, 2013.
6. S. S. Ray, Numerical Analysis with Algorithms and Programming. Chapman and Hall/CRC, 2018.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	20	30	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes(PSOs)

Mapping between COs, POs		
Course Outcomes (COs)		Mapped POs and PSOs
CO-1	**Find** the errors in numerical methods, and numerical solutions of nonlinear equations with single variable.	PO1, PO5,PSO1,PSO3
CO-2	**Illustrate** the solution procedure of system of linear algebraic equations.	PO1, PO3, PO5,PSO1,PSO3

CO-3	**Develop** the basic knowledge of finite differences, interpolation and divided differences.	PO1, PO3, PO12,PSO1,PSO3
CO-4	**Demonstrate** the concept of numerical integration and differentiation.	PO1, PO3, PO5,PSO1,PSO3
CO-5	**Solve** the ordinary differential equations by several numerical methods.	PO1, PO2, PO12,PSO1,PSO3

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	**Contextualized Understanding:** Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	**Critical Thinking and Problem Solving Skills:** Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	**Problem Analysis:** Identify, formulate and analyze complex problems using mathematical principles.	**Modernization and Tools Usage:** Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	**Societal Implication:** Analyze complex social elements, their interrelation and its impact on geographically different society.	**Environment and Sustainability:** Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	**Ethics:** Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	**Individual and Team Work:** Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	**Communication:** Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	**Leadership Skills:** Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	**Life Long Learning:** Develop the ability to reasoning, abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2	PS O3
MTH1 1017	Introduc tion to Numeric al Analysis	3	3	3	-	3	-	-	-	-	-	-	3	3	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH12019	INTRODUCTION TO NUMERICAL ANALYSIS LAB	L	T	P	C
Version 1.0	**Contact Hours - 45**	0	0	3	2
Pre-requisites/Exposure	Theory of Numerical Analysis				
Co-requisites	C/MATLAB- Programming				

Course Objectives:
To develop the student's skills in numerical approaches by using the coding-based computer facilities.

Course Outcomes:
On completion of this course, the students will be able to
CO1. Write the programming code for finding the roots of non-linear equations with single variable.
CO2. Write the programming code for finding the roots of system of linear algebraic equations.
CO3. Build the programming code for finding the interpolate value of a given data set values.
CO4. Develop the programming code for finding the solution of a given integral.
CO5. Discover the programming code for finding the solution of an ordinary differential equation.

Course Content:

Write and execute C/MATLAB-code for the following programs:

Sl. No.	Name of the experiment
1.	The root of non-linear equation using Bisection method.
2.	The root of non-linear equation using false position method.
3.	The root of non-linear equation using Newton-Raphson method.
4.	Solve the system of equation using Gauss-Elimination Method.
5.	Solve the system of equation using Gauss-Seidel iteration method.
6.	Interpolate values using Newton's forward interpolation.
7.	Interpolate values using Newton's backward interpolation
8.	Interpolate values using Lagrange's method.
9.	Evaluate the integral using Trapezoidal rule.
10.	Evaluate the integral using Simpson's rule.
11.	Evaluate the integral using Weddle's rule.
12.	Evaluate the differential equation by Euler's method.
13.	Evaluate the differential equation by Runge-Kutta methods.

References:

1. B. S. Grewal, Numerical Methods in Engineering & Science with Programs in C & C++, Khanna Publications, 2013.
2. S. S. Ray, Numerical Analysis with Algorithms and Programming. Chapman and Hall/CRC, 2018.
3. S. D. Conte and Carl de Boor, Elementary Numerical Analysis - An Algorithmic Approach, 3rd Edn., McGraw Hill, 1980.

4. T. Veerarajan, T. Ramachandran, Numerical Methods with Programs in C, Tata McGraw-Hill Publications.
5. Shah, N.H., Numerical Methods with C++ programming. PHI Learning Pvt. Ltd, 2008.
6. W.Y. Yang, W. Cao, J. Kim, K.W. Park, H. H. Park, J. Joung, J. S. Ro, H. L. Lee, C. H. Hong and T. Im, Applied numerical methods using MATLAB. John Wiley & Sons, 2020.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Continuous Assessment	End Term Examination
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes(PSOs)

Mapping between COs, POs		
Course Outcomes (COs)		Mapped POs and PSOs
CO-1	**Find** errors in numerical computation real roots of algebraic and transcendental equations using Bisection method, Regula-Falsi method and Newton Raphson method.	PO5, PO12,PSO1
CO-2	**Solve** system of linear equations using direct method and iteration method.	PO5, PO12,PSO1
CO-3	**Illustrate** several methods of finite differences to obtain interpolating and extrapolating values from a set of data using.	PO5, PO12,PSO1
CO-4	**Classify** Trapezoidal rule and Simpson's 1/3rd rule to obtain the value of an integral with finite limit.	PO5, PO12,PSO1
CO-5	**Utilize** Euler method, Runge-Kutta to obtain the solution to ordinary differential equations with initial conditions.	PO5, PO12,PSO1

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MTH12019	Introduction to Numerical Analysis Lab	-	-	-	-	3	-	-	-	-	-	-	3	3	-	-

1=weakly mapped
2= moderately mapped
3=strongly mapped

SDS11070	STATISTICS	L	T	P	C
Version 1.1	**Contact Hours: 60**	3	1	0	4
Pre-requisites/Exposure	Calculus, Probability Theory				
Co-requisites					

Course Objectives:

- To introduce the students with the notion of skewness, kurtosis which will help them to analyse the distribution more effectively
- To introduce with the concept of correlation coefficient which have applications in regression analysis and curve fitting
- To introduce the students with the concepts of central limit theorem, law of large numbers which will help them to know about the distribution of independently and identically distributed random variables in the long run
- To introduce the notion of estimator and their properties, MLE and confidence interval
- To introduce the students with the concept of testing of hypothesis which have many applications in statistics. In the concept of testing of hypothesis, the concept of normal distribution and sampling theory is needed

Course Outcomes:

On completion of this course, the students will be able to

CO1. Explain two or more frequency distributions with the help of skewness and kurtosis
CO2. Interpret bivariate and multivariate data with the help of correlation and regression analysis
CO3. Explain different inequalities and laws of statistics
CO4. Develop the knowledge about estimation theory
CO5. Explain of whether to accept or reject a testing hypothesis

Course Description:

In the beginning of the course the notions of measures of central tendency and dispersion is introduced for a set of observations and frequency distributions. Then the notion of central moments is introduced for a set of observations which will help the students to compute skewness and kurtosis of a set of frequency distributions. Then Chebyshev inequality, law of large numbers, central limit theorem is introduced to understand the probability distribution of a sequence of i.i.d random variables. Then Chapman-kolmogorov equations is introduced for classification of states. After that the area of testing of hypothesis is introduced to analyze whether to accept or reject a hypothesis. In the hypothesis testing normal distribution is needed. Then the coefficient of correlation and rank correlation is introduced to measure the degree of relationship exists between two variables. Then regression lines are introduced to compute the value of one variable if the value of the other variable in known. In fitting of curves method of least squares is used.

Course Content:

Unit-I **[18 L]**

Descriptive Statistics: Random sample, Concept of sampling and various types of sampling, Sample and population; Collection, tabulation and graphical representation, Grouping of data, Measures of location (or central tendency) and dispersion, moments, measures of skewness

and kurtosis, Bivariate sample, Scatter diagram, principle of least-square and fitting of polynomials and exponential curves

Unit-II [**10 L**]

Correlation and Regression: Introduction, linear regression and correlation, rank correlation, multiple and partial correlations (for 3 variates only), least square method of fitting regression lines

Unit-III [**10 L**]

Law of Large Number: Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers, Central Limit theorem for independent and identically distributed random variables with finite variance, Kolmogorov inequality

Unit-IV [**10 L**]

Estimation: Introduction to the theory of estimation, Characteristics of estimators (only basic idea), Methods of estimation: Maximum likelihood estimation and its properties, Method of minimum variance, Method of moments, Method of least squares; Confidence interval and confidence limit

Unit-V [**12 L**]

Testing of Hypothesis: Basic concepts, one- and two- tailed tests, test statistic, types of error, p-values for decision making testing hypotheses, pre-selection of a significance level, test for population mean, difference in means, population variance, one- and two- sample tests concerning variances, 2-goodness of fit test.

References:

1. S C Gupta and V K Kapoor, Fundamentals of Mathematical Statistics, S Chand & Sons
2. Vijay K. Rohatgi, A.K. Md. Ehsanes Saleh, An Introduction to Probability and Statistics, 2nd edition, Wiley
3. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007
4. Richard Johnson, Miller & Freund's "Probability and Statistics for Engineers", Prentice Hall of India, Seventh Edition, 2007
5. N.G. Das, "Statistical Methods" Volume 1 and 2, Manasi press, 2006

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes (PSOs)

Mapping between COs, POs		
Course Outcomes (COs)		**Mapped POs and PSOs**
CO-1	**Explain** two or more frequency distributions with the help of skewness and kurtosis	**PO1**,PSO1

CO-2	**Interpret** bivariate and multivariate data with the help of correlation and regression analysis	**PO1**,PSO1
CO-3	**Explain** different inequalities and laws of statistics	**PO1**,PSO1
CO-4	**Develop** the knowledge about estimation theory	**PO1**,PSO1
CO-5	**Explain** of whether to accept or reject a testing hypothesis	**PO1, PO3**,PSO1

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	**Contextualized Understanding:** Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	**Critical Thinking and Problem Solving Skills:** Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	**Problem Analysis:** Identify, formulate and analyze complex problems using mathematical principles.	**Modernization and Tools Usage:** Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	**Societal Implication:** Analyze complex social elements, their interrelation and its impact on geographically different society.	**Environment and Sustainability:** Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	**Ethics:** Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	**Individual and Team Work:** Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	**Communication:** Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	**Leadership Skills:** Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	**Life Long Learning:** Develop the ability to reasoning, abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
SDS11070	Statistics	3	-	1	-	-	-	-	-	-	-	-	-	3	-	-

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11018	VECTOR ANALYSIS AND TENSOR CALCULUS	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	12^{th} level Mathematics				
Co-requisites	--				

Course Objectives:

1. To build up the concept of a vector and a vector function. Learn vector differentiation and its geometrical interpretation and various application aspect.
2. To enable students the concept of vector integration and its applications.
3. To give the students a perspective to a tensor as a generalized concept of a vector in a Euclidean space E3, to generalize the idea in an n-dimensional space. Also, to enrich their concepts on Kronecker delta.
4. To enable students, acquire knowledge on Riemannian space, line element and different kind of tensors, Christoffel symbols and their laws of transformations, covariant differentiation of vectors and tensors.

Course Outcomes:

On completion of this course, the students will be able to

CO1. Explain the Vector differentiation and its geometrical interpretation and the physical interpretation of Solenoidal and Irrotational vector fields.
CO2. Explain line, surface, and volume integrals with examples. Green ‘s theorem, Gauss theorem, Stokes theorem and their physical interpretation.
CO3. Define a tensor as a generalized concept of a vector in a Euclidean space E3, to generalize the idea in an n-dimensional space, different kind of tensor, algebra of tensors.
CO4. Define Riemannian space, Christoffel symbols and their laws of transformations, covariant differentiation of vectors and tensors.

Course Description:

This course is intended to provide the concept of a vector and a vector function. Also it describes the algebra of vectors likes, vector addition, scalar multiplication, dot product and cross product etc. Moreover it includes a few analytical aspects of a space curve describe by a vector function. These aspects are vector differentiation, vector integration, unit tangent, principal normal and curvature of space curves etc. And some applications of these analytical concepts are included in this course. Furthermore, some basic ideas about a tensor as a generalized concept of a vector in a Euclidean space E^3, to generalize the idea in an n-dimensional space, definition of E^n are introduced and algebra of tensor are discussed. Also, an idea about Riemannian space and some relevant concepts are provided through this course.

Course Content:

Unit-I **[14 L]**

Vector Calculus: Scalar-valued functions over the plane and the space, definition with examples, curves and paths, vector fields, vector differentiation, formulae with problems, directional derivatives, the tangent plane, total differential, gradient, divergence and Curl, solenoidal and irrotational vector functions, derivations of relations between gradient, divergence and curl of a vector, Laplacian operator and its physical interpretation.

Unit-II **[16 L]**

Vector integration: Path, line, surface, and volume integrals with examples, line integrals of linear differential forms, integration of total differentials, conservative fields, conditions for

line integrals to depend only on the endpoints, the fundamental theorem on exact differentials, Frenet–Serret formulas, Green's theorem, Gauss theorem, Stokes theorem, problems on these three theorems.

Unit-III **[18 L]**

A tensor as a generalized concept of a vector in a Euclidean space E3, to generalize the idea in an n-dimensional space, definition of En, transformation of co-ordinates in En (n = 2, 3 as example), summation convention, contravariant and covariant vectors, invariants, contravariant, covariant and mixed tensors, the Kronecker delta, algebra of tensors, symmetric and skew-symmetric tensors, addition and scalar multiplication, contraction, outer and inner products of tensors, quotient law, reciprocal tensor.

Unit-IV **[12 L]**

Riemannian space, line element and metric tensor, reciprocal metric tensor, raising and lowering of indices with the help of metric tensor, associated tensor, magnitude of a vector, inclination of two vectors, orthogonal vectors, Christoffel symbols and their laws of transformations, covariant differentiation of vectors and tensors.

References:

1. Murray Spiegel and Seymour Lipschutz, Vector Analysis, Schaum's outlines
2. Barry Spain, Tensor Calculus: A Concise Course,Dover Books.
3. J.G. Chakravorty, P.R. Ghosh, Vector Analysis, U. N. Dhar& sons Pvt. Ltd.
4. J E Marsden and A Tromba, Vector Calculus by, 6th edition, Freeman.
5. David C. Kay, Schaums Outline of Tensor Calculus, Schaums' Outline Series, McGraw Hill Education.
6. A. Shaikh, U.C. De andJ. Sengupta,Tensor Calculus, 2nd edition,Narosa Book Distributors.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	20	30	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes (PSOs)

Mapping between COs, POs		
Course Outcomes (COs)		Mapped POs and PSOs
CO-1	**Explain** the Vector differentiation and its geometrical interpretation and the physical interpretation of Solenoidal and Irrotational vector fields.	PO1, PO2, PO3,PSO2,PSO3
CO-2	**Explain** line, surface, and volume integrals with examples. Green 's theorem, Gauss theorem, Stokes theorem and their physical interpretation.	PO1, PO2, PO3,PSO1,PSO3

CO-3	**Define** a tensor as a generalized concept of a vector in a Euclidean space E3, to generalize the idea in an n-dimensional space, different kind of tensor, algebra of tensors.	PO1, PO2, PO3,PSO2,PSO3
CO-4	**Define** Riemannian space, Christoffel symbols and their laws of transformations, covariant differentiation of vectors and tensors.	PO1, PO2, PO3,PSO1,PSO3

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	**Contextualized Understanding:** Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	**Critical Thinking and Problem Solving Skills:** Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	**Problem Analysis:** Identify, formulate and analyze complex problems using mathematical principles.	**Modernization and Tools Usage:** Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	**Societal Implication:**Analyze complex social elements, their interrelation and its impact on geographically different society.	**Environment and Sustainability:** Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	**Ethics:** Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	**Individual and Team Work:** Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	**Communication:** Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	**Leadership Skills:** Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	**Life Long Learning:** Develop the ability to reasoning, abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2	PS O3
MTH1 1018	Vector Analysis and Tensor Calculus	3	3	3	-	-	-	-	-	-	-	-	3	3	3	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11097	ANALYTICAL STATICS AND HYDROSTATICS	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	$10+2^{th}$ level Mathematics				
Co-requisites	--				

Course Objectives:

- To develop the basic concept of the components of a force in rectangular or non-rectangular coordinates.
- To develop the idea of the resultant of a system of forces.
- To develop the knowledge to analyse systems that include frictional forces.
- To develop fundamental knowledge of fluid, its properties and behaviour under various internal and external flow conditions.
- To develop an understanding of hydrostatic law, the principle of buoyancy and stability of a floating body and the application of mass, momentum and energy equation in fluid flow.

Course Outcomes:

On completion of this course, the students will be able to

CO1. Define law, angle, cone of friction and astatic centre to find the positions of equilibrium of a particle and the position of C. G. of any arc.

CO2. Illustrate the principle of virtual work and test of stability.

CO3. Make use of the moment of force.

CO4. Define and **apply** density and fluid pressure concepts to solve physical problems and absolute, gauge, and atmospheric pressure concepts.

CO5. State and **apply** Archimedes Principle and Pascal's law to solve the physical problem.

Course Description:

This course is intended to provide the concept of friction and the center of gravity of a particle. Also, it describes the principle of virtual work. Moreover, it includes a few basic aspects of astatic, stable and unstable equilibrium respectively. Some applications of forces in three dimensions are included in this course. Furthermore, some basic ideas of hydrostatic thrusts on the submerged plane surface are introduced. Also, an idea about Gas as a fluid particle and some relevant concepts are discussed in this course.

Course Content:

Unit -I **[9L]**

Friction: Law of Friction, Angle of friction, Cone of friction, To find the positions of equilibrium of a particle lying on an (i) rough plane curve, (ii) rough surface under the action of any given forces.

Astatic Equilibrium: Astatic Centre, Positions of equilibrium of a particle lying on a smooth plane curve under the action of a given force. Action at a joint in a framework.

Centre of Gravity: General formula for the determination of C.G. Determination of the position of C.G. of any arc, area of solid of known shape by the method of integration.

Unit- II

Virtual work: Principle of virtual work for a single particle. Deduction of the conditions of equilibrium of a particle under coplanar forces from the principle of virtual work. The principle

of virtual work for a rigid body. Forces that do not appear in the equation of virtual work. Forces that appear in the equation of virtual work. The principle of virtual work for any system of coplanar forces acting on a rigid body. Converse to the principle of virtual work.

Stable and unstable equilibrium: Coordinates of a body and a system of bodies. Field of forces. Conservative field. The potential energy of a system. The energy test of stability. Condition of stability of equilibrium of a perfectly rough heavy body lying on a fixed body. Rockingstones. [**14L**]

Unit -III

Forces in the three dimensions: Moment of a force about a line. Axis of a couple. Resultant of any two couples acting on a body. Resultant of any number of couples acting on a rigid body. Reduction of a system of forces acting on a rigid body. The resultant force is an invariant of the system but the resultant couple is not an invariant.

Conditions of equilibrium of a system of forces acting on a body. Deductions of the conditions of equilibrium of a system of forces acting on a rigid body from the principle of virtual work. Poison's central axis. A given system of forces can have only one central axis. Wrench, Pitch, Intensity and Screw. The condition that a given system of forces may have a single resultant. Invariants of a given system of forces. Equation of the central axis of a given system of forces. [**12L**]

Unit -IV

Hydrostatics: Hydrostatic Thrusts on Submerged Plane Surface: Centre of pressure, determination of coordinates of the centre of pressure. Hydrostatic Thrusts on Submerged Curved Surfaces. Buoyancy: Center of the buoyancy. Archimedes principle. Stability of Unconstrained Submerged Bodies in Fluid: Stable Equilibrium, Unstable Equilibrium, Neutral Equilibrium. Stability of Floating Bodies in Fluid: Metacentre, Metacentric height.

Gas: Pressure of gases, The Atmosphere, Relation between pressure, density and temperature, Pressure in an isothermal atmosphere, Atmosphere in convective equilibrium. [**25L**]

References:

1. An Elementary Treatise on Statics: S. L. Loney.
2. An Elementary Text-Book on Hydrostatics: William Briggs and G.H. Bryan, London: W.B.Clive.
3. Hydrostatics: A.S.Ramsey, Cambridge University Press, 2017.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	20	30	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes(PSOs)

Mapping between COs, POs	
Course Outcomes (COs)	**Mapped POs and PSOs**

CO-1	**Define** law, angle, cone of friction and astatic centre to find the positions of equilibrium of a particle and the position of C. G. of any arc.	PO1, PO2, PO3,PSO1,PSO3
CO-2	**Illustrate** the principle of virtual work and test of stability.	PO1, PO2, PO3,PSO1,PSO2
CO-3	**Make use of the** moment of force.	PO1, PO2, PO3,PO4,PSO1,PSO3
CO-4	**Define** and **apply** density and fluid pressure concepts to solve physical problems and absolute, gauge, and atmospheric pressure concepts.	PO1, PO2, PO3,PSO2,PSO3
CO-5	**State** and **apply** Archimedes Principle and Pascal's law to solve the physical problem.	PO4,PO7,PSO2,PSO3

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	**Contextualized Understanding:** Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	**Critical Thinking and Problem Solving Skills:** Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	**Problem Analysis:** Identify, formulate and analyze complex problems using mathematical principles.	**Modernization and Tools Usage:** Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	**Societal Implication:**Analyze complex social elements, their interrelation and its impact on geographically different society.	**Environment and Sustainability:** Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	**Ethics:** Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	**Individual and Team Work:** Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	**Communication:** Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	**Leadership Skills:** Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	**Life Long Learning:** Develop the ability to reasoning, abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2	PS O3
MTH1 1097	ANALYTI CAL STATICS AND HYDROS TATICS	3	3	3	2	-	-	1	-	-	-	-	3	3	3	3

1=weakly mapped 2= moderately mapped 3=strongly mapped

MTH11029	MATHEMATICAL MODELLING	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	Ordinary Differential Equation and Linear Algebra				
Co-requisites	--				

Course Objectives:
To give students the lessons of solving biological problems mathematically after converting it to a mathematical model.

Course Outcome:
On completion of this course, the students will be able to

CO1. **Define** a mathematical modelling with its various properties and limitations.

CO2. **Demonstrate** the nature of dynamical system and their stability.

CO3. **Apply** mathematical tools for different kind of mathematical models.

CO4. **Choose** various numerical solver for solving mathematical model effectively.

CO5. **Make use of** mathematical tools for spatial and discrete mathematical models.

Course Description:
This course is a modern course of Mathematics. Mathematical Modelling plays an important role between real life problems and mathematics quite effectively. Biological, fluid etc. concepts can be interpreted as a formulation of Mathematical Model. One of the main goals of this course is to study Stability Analysis of a mathematical model. For understanding stability analysis, linear algebra is a must needed pre-requisite. Also, for understanding the nature of the model Ordinary Differential Equation is also very much needed. Students will be encountering many graphs in this course to understand the geometry of the model equations. Along with the tutorial and real life problems, students will be able to apply the theoretical concepts in life.

Course Content:

Unit-I
Basic steps of mathematical modeling, its needs, types of models, limitations, elementary ideas of dynamical systems, autonomous dynamical systems in the plane-linear theory, equilibrium point, node, saddle point, focus, centre and limit-cycle ideas with simple illustrations and figures, linearization of non-linear plane autonomous systems, mathematical modeling in the biological environment. [**14L**]

Unit-II
Monte Carlo Simulation Modeling: simulating deterministic behavior (area under a curve, volume under a surface), Generating Random Numbers: middle square method, linear congruence, Queuing Models: harbor system, morning rush hour, Overview of optimization modeling, Linear Programming Model: geometric solution algebraic solution, simplex method, sensitivity analysis. [**16L**]

Unit-III

Differential equation-based models: Numerical solvers of systems of differential equations: stiff equations, delay differential equations, compartment models: population dynamics, infectious disease models. [**12L**]

Unit-IV

Spatial Models: One species model with diffusion, two species model with diffusion, Conditions for diffusive instability, Spreading colonies of microorganisms, Blood flow in circulatory system, Travelling wave solutions, Spread of genes in a population, Discrete Models: Overview of difference equations, steady state solution and linear stability analysis, Introduction to Discrete Models, Linear Models, Growth models, Decay models, Drug Delivery Problem, Discrete Prey-Predator models, Density dependent growth models with harvesting. [**18L**]

References:

1. TynMyint-U and LokenathDebnath, Linear Partial Differential Equation for Scientists and Engineers, Springer, Indian reprint, 2006.
2. Mattheij RMM, Rienstra SW, ten ThijeBoonkamp JHM, Partial differential Equations, Modeling Analysis, Computation. SIAM (Dimensional analysis)
3. Yang X.S, An Introduction to Computational Engineering with Matlab. CISP (Cellular automata)
4. Frank R. Giordano, Maurice D. Weir and William P. Fox, A First Course in Mathematical Modeling, Thomson Learning, London and New York, 2003.
5. Barnes B and Fulford GR, Mathematical Modeling with Case Studies. CRC Press.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam
Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes(PSOs)

Mapping between COs, POs		
Course Outcomes (COs)		**Mapped POs and PSos**
CO 1	**Define** a mathematical modelling with its various properties and limitations.	PO1, PO2, PO12,PSO1,PSO3
CO 2	**Demonstrate** the nature of dynamical system and their stability.	PO1, PO2,PSO1,PSO3
CO 3	**Apply** mathematical tools for different kind of mathematical models.	PO1, PO2, PO3, PO4, PO5, PO7,PSO1,PSO3
CO 4	**Choose** various numerical solver for solving mathematical model effectively.	PO1, PO2, PO3,PO4, PO5,PSO1,PSO3
CO 5	**Make use of** mathematical tools for spatial and discrete mathematical models.	PO1, PO2,PO3,PO4,PO5,PSO1,PSO3

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MTH11029	Mathematical modelling	3	3	3	3	2	-	2	-	-	-	-	1	3	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped.

MTH11098	NUMERICAL METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	Knowledge of Introduction to Numerical Analysis				
Co-requisites	Good knowledge of linear algebra				

Course Objectives:

In this course students can learn various topics in deferential equations and difference equation. They can also learn how to implement those in solving numerical problems.

Course outcomes:

On completion of this course students will be able to

CO1. **Define** the concept of difference equations.

CO2. Illustrate the idea of initial value problem in various numerical problems

CO3. **Define** the knowledge of system of linear differential equations.

CO4. Illustrate the idea of boundary value problem in various numerical problems

CO5. Apply the knowledge of finite element method for solving 2^{nd} order differential equations.

Course Description:

Ordinary differential equation is one of the important area of mathematics. This topic has vast application in various areas. It is always used for continuous cases. In case of discrete values we need to use difference equation. In this course we have both these topics. Also discussed various applications using finite element methods.

Course Content:

Unit I: **[8L]**

Differential and Difference equations: Differential equation (DE) problems: Practical examples, introduction to difference equations, difference equation problems, the Fibonacci difference equations, Routh-Hurwitz criterion, general solution of 2nd order difference equations.

Unit II: **[12L]**

Initial value problem (IVP): Introduction to initial value problem (IVP), existence and uniqueness, numerical methods for IVPs: Euler's methods, backward Euler, Runge-Kutta method of higher order, predictor-corrector methods, Milne's method, Adams-Bashforth method, convergence and stability Analysis.

Unit-III: **[12L]**

Linear system of differential equations: Introduction to system of DEs, Higher order initial value problem, Euler's methods, backward Euler, Taylor method, Runge-Kutta method, convergence and stability analysis, Stiff differential systems.

Unit IV: **[14L]**

Boundary Value problems (BVP): Introduction, shooting method for second order linear BVPs, finite difference method, solution of tridiagonal system, cubic spline method, solving nonlinear second order BVPs, convergence and stability of finite difference schemes.

Unit-V: **[14L]**

Finite element methods: Introduction, functionals, base functions, methods of approximation: Rayleigh- Ritz method, Galerkin method, Piece wise polynomial, Finite elements, Ritz finite element method, finite element method for one-dimensional linear 2nd order BVP problems.

References:

1. J. C. Butcher, Numerical Methods for Ordinary Differential Equations, Wiley
2. S. K. Pundir, Numerical Methods in Science and Engineering, CBC Publishers & Distribution Pvt. Ltd.
3. M.K Jain, S.R.K. Lyengar, R.K. Jain, Numerical Methods for Scientific and engineering computation, New age international Publishers.
4. S. S. Sastry, Introductory Methods of Numerical Analysis, PHI learning Pvt. Ltd.
5. J. Noye, Computational Techniques for Differential Equations, NH Mathematics Studies.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	20	30	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes(PSOs)

Mapping between COs, POs		
Course Outcomes (COs)		Mapped POs and PSOs
CO 1	**Define** the concept of difference equations.	PO1, PO2, PO12,PSO1,PSO3
CO 2	**Illustrate** the idea of initial value problem in various numerical problems	PO1, PO2,PSO1,PSO3
CO 3	**Define** the knowledge of system of linear differential equations.	PO1, PO2, PO3, PO4, PO5, PO7,PSO1,PSO3
CO 4	**Illustrate** the idea of boundary value problem in various numerical problems	PO1, PO2, PO3,PO4, PO5,PSO1,PSO3
CO 5	**Apply** the knowledge of finite element method for solving 2nd order differential equations.	PO1, PO2,PO3,PO4,PO5,PSO1,PSO3

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2	PS O3
MTH1 1098	Numeri cal Method s For Ordinar y Differe ntial Equatio ns	3	3	3	3	2	-	2	-	-	-	-	1	3		3

1=weakly mapped
2= moderately mapped
3=strongly mapped.

SDS11082	ELEMENTARY DATA SCIENCE AND VISUALIZATION	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	Knowledge of Probability Theory				
Co-requisites	--				

Course Objectives:

To give students the lessons of tools and techniques for solving problems related to elementary data analysis and visualization, which can be constructed from real life problems.

Course Outcomes:

On completion of this course, the students will be able to

CO1. Define concept of elementary data analysis and data visualization, summary statistics, Univariate & multivariate visualization and data abstraction.

CO2. Illustrate different types of variables, techniques of interpretation of the data, data import, data cleaning, elementary graphics of a Financial Dataset & Functional Data and common visualization idioms.

CO3. Solve problems related to exploratory data analysis and data visualization.

CO4. Interpret the data and summary statistics.

CO5. Explain data summarization and the use of Color & Size in Visualization.

CO6. Solve problems related to data abstraction, encoding Data, decision trees, k nearest neighbours.

Course Description:

This course includes exploratory data analysis and data visualization, summary statistics, interpretation of the data, data import, data cleaning, exploratory graphics, data abstraction, encoding Data, decision trees, k nearest neighbours. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will familiarize the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content:

Unit I

Introduction, Big Data and Data Science hype, getting past the hype, Datafication, Current landscape of perspectives, Statistical Inference - Populations and samples - Statistical modeling, probability distributions, fitting a model, Introduction to R 3. Exploratory Data Analysis and the Data Science Process - Basic tools (plots, graphs and summary statistics) of EDA - Philosophy of EDA - The Data Science Process - Case Study. **[14L]**

Unit II

Three Basic Machine Learning Algorithms, Linear Regression - k-Nearest Neighbors (k-NN), k-means, Applications, Filtering Spam, Data Wrangling: APIs and other tools for scrapping the Web, Feature Generation and Feature Selection (Extracting Meaning From Data), Feature

Selection algorithms – Filters; Wrappers; Decision Trees; Random Forests. **[16L]**

Unit III

Recommendation Systems: Building a User-Facing Data Product, Algorithmic ingredients of a Recommendation Engine - Dimensionality Reduction, Singular Value Decomposition, Principal Component Analysis with applications. Mining Social-Network Graphs, social networks as graphs, Clustering of graphs, Direct discovery of communities in graphs, Partitioning of graphs, Neighborhood properties in graphs. **[18L]**

Unit IV

Data Visualization, Basic principles, ideas and tools for data visualization, data Science and Ethical Issues, Discussions on privacy, security, ethics, A look back at Data Science and Next-generation data scientists. **[12L]**

References:

1. Haider, M. Getting Started with Data Science: Making Sense of Data with Analytics. IBM Press.
2. Cielen, D., Meysman, A. D. B. & Ali, M. Introducing Data Science: Big Data, Machine Learning, and more, using Python tools. Manning Publications Co., USA.
3. Yau, N. (2011). Visualize this: the Flowing Data guide to design, visualization, and statistics. John Wiley & Sons.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes(PSOs)

Mapping between COs, POs		
Course Outcomes (COs)		**Mapped POs and PSOs**
CO 1	**Define** concept of elementary data analysis and data visualization, summary statistics, Univariate & multivariate visualization and data abstraction.	PO1, PO2, PO12,PSO1,PSO3
CO 2	**Illustrate** different types of variables, techniques of interpretation of the data, data import, data cleaning, elementary graphics of a Financial Dataset & Functional Data and common visualization idioms.	PO1, PO2,PSO1,PSO3
CO 3	**Solve** problems related to exploratory data analysis and data visualization.	PO1, PO2, PO3, PO4, PO5, PO7,PO6,PSO1,PSO3

CO 4	**Interpret** the data and summary statistics.	PO1, PO2, PO3,PO4, PO5
CO 5	**Explain** data summarization and the use of Color & Size in Visualization.	PO2,PO4,PO6,PSO1,PSO3
CO 6	**Solve** problems related to data abstraction, encoding Data, decision trees, k nearest neighbours.	PO1, PO2,PO3,PO4,PO5,PO6,PSO1,PSO3

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2	PS O3
SDS11 082	Elementary Data Science and Visualization	3	3	3	3	2	2	1					1	3		3

1=weakly mapped
2= moderately mapped
3=strongly mapped.

MTH14020	Summer Internship	L	T	P	C
Version 1.0		0	0	0	2
Pre-requisites/Exposure	--				
Co-requisites	--				

Course Objectives:

To apply the theory of Mathematical sciences in relevance to practical solutions.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Apply** techniques using different methods of applying skills and knowledge acquired in the classroom.

CO2. **Understand** the professional requirements for access to and success in the field.

CO3. **Realize** the work ethic and skills required for success in the field.

Course Description:

Summer internship allows the student an opportunity to bridge theory and practice. It is a learning experience that permits students to apply knowledge acquired in the academic classroom within the professional setting. Such experiential learning supplements academic theory, helps the student to identify personal strengths and guides her/him into specialized fields within the profession (Research and development, teaching, Engineering, financial management, data analysis etc.). Perhaps equally as important is the chance for the student to begin to establish the professional network so essential for access to, and movement within, the profession. The student may personally research internship opportunities and interview for any opportunity that furthers the student's professional aspirations in the field.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Report Submission	Viva & Evaluation
Weightage (%)	50	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes(PSOs)

Mapping between COs, POs		
Course Outcomes (COs)		Mapped POs and PSOs
CO-1	**Apply** techniques using different methods of applying skills and knowledge acquired in the classroom.	PO1, PO2, PO3, PO4, PO5, PO12,PSO1,PSO3
CO-2	**Understand** the professional requirements for access to and success in the field.	PO6, PO7, PO9, PO10, PO11, PO12,PSO1,PSO3
CO-3	**Realize** the work ethic and skills required for success in the field.	PO8, PO9, PO10, PO11, PO12,PSO1,PSO3

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	**Contextualized Understanding:** Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	**Critical Thinking and Problem Solving Skills:** Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies	**Problem Analysis:** Identify, formulate and analyze complex problems using mathematical principles.	**Modernization and Tools Usage:** Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills	**Societal Implication:** Analyze complex social elements, their interrelation and its impact on geographically different society.	**Environment and Sustainability:** Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	**Ethics:** Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	**Individual and Team Work:** Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in	**Communication:** Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	**Leadership Skills:** Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	**Life Long Learning:** Develop the ability to reasoning, abstract thinking, critically evaluate theories, methods, principles, and applications of pure and	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MTH14020	Summer Internship	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11022	INTEGRAL TRANSFORMS	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	Calculus I, Differential Equation I and II				
Co-requisites	10^{th}+2 Mathematics				

Course Objectives:

- To acquire the knowledge of Laplace transform and applications.
- To develop the idea about Fourier series and Fourier transform with its properties.
- To build the concept of Z-transforms with applications in real life problems.

Course Outcomes

On completion of this course, the students will be able to

CO1. Build the concept of Laplace transform and its properties.
CO2. Develop the knowledge of Fourier series, half range series, Parseval's identity.
CO3. Develop the concept Fourier transform, sine, cosine transform and its applications
CO4. Acquire the idea of Z-transform, region of convergence and its properties.

Course Description:

This course includes Laplace transform of some standard functions, Fourier series expansion, Fourier transform and Z- transform. Solution of differential equations using properties and theories of several integral transform methods have been explained. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will familiarize the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content:

Unit-I [**20L**]

Laplace Transforms: Introduction, Existence conditions for Laplace transform, Laplace transforms of error function, Heaviside unit step function and Dirac delta function, Linearity property, Shifting theorems, Laplace transform of derivatives and integrals, Initial and final value theorem, Laplace transform of periodic functions, Inverse Laplace transform and their properties, Convolution theorem, applications to real life problems.

Unit-II [**10L**]

Fourier series: Trigonometric Fourier series, Dirichlet's condition, Fourier series of even and odd functions, Gibbs phenomenon, Fourier half-range series, Parseval`s identity, Complex form of Fourier series.

Unit-III [**16L**]

Fourier Transforms: Fourier integrals, Fourier sine and cosine integrals, Complex form of Fourier integral representation, Fourier transform, Fourier transform of derivatives and integrals, Fourier sine and cosine transforms and their properties, Convolution theorem, application to boundary value Problems.

Unit-IV [**14L**]

Z-Transform: Z–transform and inverse Z-transform of elementary functions, Region of convergence, Shifting theorems, Convolution theorem, Initial and final value theorem, inverse Z-transform, Application of Z-transforms to solve difference equations.

References:

1. R.K. Jain and S.R.K. Iyenger, Advanced Engineering Mathematics, Narosa Publishing House.
2. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2011.
3. H K Dass, Advanced Engineering Mathematics, S Chand.
4. A R Vasishtha and R K Gupta, Integral Transforms, Krishna Prakashan Media (P) Ltd.
5. Sudhir K Pundir, Integral Transforms Methods in Science & Engineering, CBS Publishers & Distributions Pvt. Ltd.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes(PSOs)

Mapping between COs, POs		
Course Outcomes (COs)		**Mapped POs and PSOs**
CO-1	**Build** the concept of Laplace transform and its properties.	PO1, PO2,PSO1,PSO3
CO-2	**Develop** the knowledge of Fourier series, half range series, Parseval's identity.	PO1, PO2, PO12,PSO1,PSO3
CO-3	**Develop** the concept Fourier transform, sine, cosine transform and its applications	PO1,PO2, PO3, PO5,PSO1,PSO3
CO-4	**Acquire** the idea of Z-transform, region of convergence and its properties.	PO1, PO2, PO12,PSO1,PSO3

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	**Contextualized Understanding:** Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	**Critical Thinking and Problem Solving Skills:** Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	**Problem Analysis:** Identify, formulate and analyze complex problems using mathematical principles.	**Modernization and Tools Usage:** Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	**Societal Implication:** Analyze complex social elements, their interrelation and its impact on geographically different society.	**Environment and Sustainability:** Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	**Ethics:** Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	**Individual and Team Work:** Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	**Communication:** Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	**Leadership Skills:** Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	**Life Long Learning:** Develop the ability to reasoning, abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MTH1 1022	Integral Transforms	3	3	3	-	3	-	-	-	-	-	-	2	3	-	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11095	ELEMENTARY DYNAMICS	L	T	P	C
Version 1.2	Contact Hours - 60	3	1	0	4
Pre-requisites/Exposure	10+2th level Mathematics and Physics				
Co-requisites	--				

Course Objectives:
To develop concept of kinematics of particles and rigid bodies with respect to fixed and moving coordinate systems.

Course Outcomes
On completion of this course, the students will be able to
CO1. Understand motion of a particle in a straight line.
CO2. Relate Newton's law to determine the forces acting on an object.
CO3. Explain motion in a plane curve, impulse, momentum, velocities after impact.
CO4. Determine velocities of a point on a rigid body and planar motion.

Course Description:
This course will teach students about force and motion, work-energy, impulse-momentum in view of Newton's laws of motion and its integration over time and displacement. The course also discusses the motion under central force, planetary motion, and collision of two elastic bodies. The class activities include lectures, tutorials, assignments, quizzes, and interactions. Moreover, the students will actively participate in discussion, problem solving in class and workout on board. The course will help the students to develop the fundamental knowledge of dynamics, and in addition, to enhance the problem solving, interaction and presentation skills.

Course Content:

Dynamics of a particle

Unit 1: **[10 L]**

Position, velocity, acceleration: Time, position, motion in a straight line: velocity, acceleration.

Motion in a straight line: Kinematics

Uniform velocity, falling bodies, body projected vertically upward, relative velocity and acceleration of two bodies, variable acceleration

Unit 2: **[20 L]**

Force and mass; Motion in a straight line: Laws of motion, weight carried up by a lift, air resistance on a falling body, collision momentum impulse, shot and gun, work energy power, kinetic energy due to impulse and collision, tension of a string, two particles connected by a string, work done in stretching a string, impulsive tension in a string, system of pulleys.

Forces in two dimension: Composition of displacement velocity and acceleration, work done by varying forces, centre of mass of a system of particles.

Unit 3: **[20 L]**

Simple harmonic motion.

Motion in a plane curve: Angular velocity, acceleration of a point moving in a plane curve, motion in a circle, conical pendulum, motion of a particle in a smooth curve in vertical plane, motion of a bead on a vertical smooth circular wire, motion inside of a vertical smooth circle, particle tied to the end of a weightless string, effect of rotation of a body on the surface of the earth, tension in a rotating band.

The simple pendulum, Projectiles.
Collision: Direct impact of two spheres, impulse and kinetic energy, oblique impact of two smooth spheres and oblique impact of rough spheres, impact against a fixed plane.

Dynamics of rigid bodies
Unit 4: [10 L]
Kinematics: Translation and rotation, instantaneous centre, acceleration of any point on a rigid body.
Rotation about a fixed axis: Kinetic energy of a body, work done by a torque, moment of inertia.
Motion of a rigid body in a plane: Energy of a rigid body moving in a plane, impulsive motion

References:

1. S. L. Loney, Dynamics of a Particle and of Rigid Bodies, G. K. Publication Ltd
2. Anil Rao, Dynamics of Particles and Rigid Bodies: A Systematic Approach.
3. E. T. Whittaker, A Treatise on the Analytical Dynamics of Particles and Rigid Bodies.
4. Joseph Whittington - Elementary dynamics, a textbook for engineers-University Press (1920)
5. R.J.A. Barnard - Elementary dynamics of the particle and rigid body (2005), Macmillan and Co. limited
6. A S Ramsey – Dynamics, Cambridge [Eng.] University Press (2009)
7. S Ganguly and S Saha- Analytical Dynamics of a Particle including Elements of Statics, 2016, New Central Book Agency (P) Ltd

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	20	30	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes (PSOs)

Mapping between COs, POs		
Course Outcomes (COs)		Mapped POs and PSOs
CO-1	**Understand** motion of a particle in a straight line.	PO1,PO2,PO4,PSO1,PSO3
CO-2	**Relate** Newton's law to determine the forces acting on an object.	PO1,PO2,PSO1,PSO3
CO-3	**Explain** motion in a plane curve, impulse, momentum, velocities after impact.	PO1,PO2,PO3,PSO1,PSO3
CO-4	**Determine** velocities of a point on a rigid body and planar motion.	PO1,PO2,PO4,PSO1

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	**Contextualized Understanding:** Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	**Critical Thinking and Problem Solving Skills:** Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	**Problem Analysis:** Identify, formulate and analyze complex problems using mathematical principles.	**Modernization and Tools Usage:** Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	**Societal Implication:** Analyze complex social elements, their interrelation and its impact on geographically different society.	**Environment and Sustainability:** Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	**Ethics:** Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	**Individual and Team Work:** Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	**Communication:** Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	**Leadership Skills:** Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	**Life Long Learning:** Develop the ability to reasoning, abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MTH11095	Elementary Dynamics	3	3	1	1									2		3

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11027	NUMBER THEORY	L	T	P	C
Version 1.0	Contact Hours - 60	3	1	0	4
Pre-requisites/Exposure	12th level Mathematics and Classical Algebra				
Co-requisites	--				

Course Objectives:
In this course students can learn various aspects of basic and advance number theory. This will help them to study computational aspects of mathematics. Here in this course they can able to understand advance level of modular arithmetic like primitive roots, quadratic residues. They can know the solvability of linear and nonlinear Diophantine equations.

Course Outcomes
On completion of this course, the students will be able to

CO1. Define the concept of a congruence and use various results related to congruences including the Chinese Remainder Theorem.
CO2. Illustrate certain number theoretic functions and their properties.
CO3. Explain the idea of primitive roots and its related properties.
CO4. **Demonstrate** Legendre symbol, quadratic congruences & their associated properties.

Course Description:
In this course students can learn various aspects of basic and advance number theory. This will help them to study computational aspects of mathematics. Here in this course they can able to understand advance level of modular arithmetic like primitive roots, quadratic residues. They can know the solvability of linear and nonlinear Diophantine equations. In this course students can acquire the knowledge of some basic ciphers. This can help them for further study in Cryptology.

Course Content:

Unit-I
Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues, Chinese Remainder theorem, Fermat's Little theorem, Wilson's theorem, pseudo primes. [**18L**]

Unit-II
Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function, Euler's phi-function, Euler's theorem, reduced set of residues, some properties of Euler's phi function [**20L**]

Unit-III
Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol and its properties, quadratic reciprocity, quadratic congruences with composite moduli. Fermat's Last theorem. [**22L**]

References:

1. Neville Robinns, Beginning Number Theory, 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2007.
2. David M. Burton, Elementary Number Theory, 6th Ed., Tata McGraw Hill, Indian reprint, 2007.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes(PSOs)

Mapping between COs, POs and PSOs		
Course Outcomes (COs)		**Mapped POs and PSOs**
CO-1	**Define** the concept of a congruence and use various results related to congruences including the Chinese Remainder Theorem.	PO1,PO2,PSO1,PSO2
CO-2	**Illustrate** certain number theoretic functions and their properties	PO1, PO3,PSO1,PSO3
CO-3	**Demonstrate** Legendre symbol, quardratic congruences & their associated properties.	PO1,PO2, PO3,PSO1,PSO3
CO-4	**Apply** how number theory is related to and used in cryptography.	PO1, PO2, PO3,PO5,PSO2,PSO2

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2	PS O3
MTH1 1027	Numb er Theory	3	3	3		2							3	3	2	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11099	METRIC SPACE AND TOPOLOGY	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	Set theory and functions				
Co-requisites	--				

Course Objectives:
To develop the concept of metric space and topology. Also, through this course, the main objective is to explain the relationship among these two concepts and study some useful results.

Course Outcomes
On completion of this course, the students will be able to
CO1. Explain the concept of metric spaces, open set, closed set and study related properties.
CO2. Develop the concept of subspace, dense set, seperable metric spaces and study continuous mappings between two metric spaces.
CO3. Develop the concept of contraction, contractive type mappings in metric spaces and study Banach fixed point theorem.
CO4. Extend the idea of metric spaces to topological spaces and study the concept of open set, closed set, limit points in more general abstract space.

Course description:
In this course basic theory of metric spaces and topology are introduced with the related results. In the first unit, basic notion of metric spaces with related important concepts is introduced like open sets, closed sets, Cauchy sequences, completeness etc. After that in unit II, notion of subspace, dense sets, continuous mapping between two metric spaces, Banach fixed point theorem has been discussed. After that, in the last unit, basic notion of topology has been discussed with other related notions basis, subspace, continuous functions with other concepts. In the last part, idea of homeomorphism has been discussed with examples and geometric interpretation.

Course Content:

Unit I **[20L]**
Metric spaces: Definition and examples, neighbourhood, open ball, open and closed set, interior point and interior of a set, closure and boundary of a set, diameter of a set and bounded set, distance between a point and a set, sequences in a metric space, Cauchy sequence, complete metric space, equivalent metrics.

Unit II **[20L]**
Subspaces, dense sets, separable spaces, Continuous mappings, sequential criterion and other characterizations of continuity, Uniform continuity, Contraction mapping, contractive mapping, Examples, Banach Fixed point theorem.

Unit III **[20L]**
Topological spaces, Definition of topology through open set axioms, Basis for a topology, the order topology, Subspace topology, Closed sets, Countability axioms, Limit points, Convergence of nets in topological spaces, Continuous functions and homeomorphism.

References:

1. G.F. Simmons, Topolgy and Modern analysis, Kreiger 2004.
2. K.D. Joshi, Introduction to General Topology, New Age International, 2002

3. B. K. Tyagi, First Course in Metric Spaces, Cambridge University Press.
4. Satish Shirali and H.Vasudeva, Metric Spaces, Springer
5. J.R.Munkres, Topology, Pearson Education India, 2001.
6. P. K. Jain and K. Ahmad, Metric Spaces, Narosa Publishing House, New Delhi, 1996.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam
Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes(PSOs)

Mapping between COs, POs and PSOs		
Course Outcomes (COs)		**Mapped POs, PSOs**
CO-1	**Explain** the concept of metric spaces, open set, closed set and study related properties.	**PO1, PO2, PO12,PSO1,PSO2**
CO-2	**Develop** the concept of subspace, dense set, seperable metric spaces and study continuous mappings between two metric spaces.	**PO2, PO12,PSO1,PSO2**
CO-3	**Develop** the concept of contraction, contractive type mappings in metric spaces and study Banach fixed point theorem.	**PO1, PO2, PO12,PSO1,PSO2**
CO-4	**Extend** the idea of metric spaces to topological spaces and study the concept of open set, closed set, limit points in more general abstract space.	**PO1, PO2, PO3, PO12,PSO1,PSO2**

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	**Contextualized Understanding:** Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	**Critical Thinking and Problem Solving Skills:** Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	**Problem Analysis:** Identify, formulate and analyze complex problems using mathematical principles.	**Modernization and Tools Usage:** Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	**Societal Implication:** Analyze complex social elements, their interrelation and its impact on geographically different society.	**Environment and Sustainability:** Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	**Ethics:** Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	**Individual and Team Work:** Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	**Communication:** Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	**Leadership Skills:** Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	**Life Long Learning:** Develop the ability to reasoning, abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PS O2	PS O3
MTH1 1099	Metric Space and Topolog y	3	3	1	-	-	-	-	-	-	-	-	3	3	3	-

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11100	NON-NEGATIVE MATRICES	L	T	P	C
Version 1.0	Contact Hours - 60	3	1	0	4
Pre-requisites/Exposure	Knowledge of Matrix Theory				
Co-requisites	--				

Course Objectives:

To develop the concept of spectral properties and structural properties of different kind of nonnegative matrices along with a few applications.

Course Outcomes

On completion of this course, the students will be able to

CO1. **Summarize** various results on eigenvalues and eigenvectors of nonnegative matrices
CO2. **Apply** eigenvalues and eigenvectors properties to various problems in our real life
CO3. **Extend** the knowledge of nonnegative matrices along with their various structural properties
CO4. **Develop** the concept of the different kinds of nonnegative matrices

Course Content:

Unit -I **[24 L]**

Nonnegative matrices: definition, examples and basic properties, eigenvalues and eigenvectors of nonnegative matrices and their basic properties, Perron theorem, spectral properties of nonnegative matrices, permutation matrices and generalized permutation matrices, irreducible matrices, graphs and matrices, Collatz-Wielandt function and its applications to nonnegative matrices, principal submatrices of nonnegative matrices and relevant results, maximal eigenvalues and maximal eigenvectors of a nonnegative matrix, dominating nonnegative matrix, Google page ranking, football team ranking, Frobenius coin problem: A few applications of nonnegative matrices and their eigenvalues.

Unit- II **[24 L]**

Structural properties of nonnegative matrices: Spectra of irreducible matrices and various results on it, Perron-Frobenius theorem, concept of primitive and imprimitive matrices and their various properties, (0,1)-matrices, the Frobenius form of an Irreducible matrix, matrices in superdiagonal block form, permanents: definition and basic results on it, the Frobenius-Konig theorem, bounds for permanents of (0,1)-matrices, nearly reducible and nearly decomposable matrices.

Unit -III **[12 L]**

Special matrices: Doubly stochastic matrices: definition**s** and early results, theorems of Muirhead and of Hardy, Littlehood and Polya, Birkhoff"s theorem, the Van der Waerden conjecture, Egorycev-Falikman theorem, relevant discussion on other class of nonnegative matrices as stochastic matrices: totally positive matrices, totally nonnegative matrices, oscillatory matrices, and M-matrices.

Text Books:

T1. Henryk Minc, Nonnegative Matrices. New York: Wiley.

T2. Richard A. Brualdi and Herbert J. Ryser, Combinatorial Matrix Theory. Cambridge University Press.

Reference Books:

R1. Roger A. Horn and Charles R. Johnson, Topics in Matrix Analysis. Cambridge University Press.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	20	30	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes(PSOs)

Mapping between COs, POs		
Course Outcomes (COs)		Mapped POs and PSOs
CO-1	**Summarize** various results on eigenvalues and eigenvectors of nonnegative matrices	PO1, PO2, PO3, PSO1, PSO2
CO-2	**Apply** eigenvalues and eigenvectors properties to various problems in our real life	PO1, PO2, PO4, PSO1, PSO2
CO-3	**Extend** the knowledge of nonnegative matrices along with their various structural properties	PO1, PO2, PO3, PSO1, PSO2
CO-4	**Develop** the concept of the different kinds of nonnegative matrices	PO1, PO2, PO4, PO5, PO9, PO11, PO12, PSO2, PSO3

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MTH1 1100	Non-Negative Matrices	3	3	2	2	1	-	-	-	1	-	1	1	3	3	1

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11101	GRAPH THEORY	L	T	P	C
Version 1.0	Contact Hours - 60 Hours	3	1	0	4
Pre-requisites/Exposure	10+2 Level Mathematics				
Co-requisites	--				

Course Objectives:
To develop an in-depth understanding of Graph theory and Trees with its significant properties.

Course Outcomes
On completion of this course, the students will be able to
CO1. Define the concept of basic graph theory with its various properties.
CO2. Explain the concept of trees and it's related algorithms.
CO3. Illustrate the concept of cut set and cut vertices.
CO4. Develop the concept of graph colouring and its properties.

Course Description:
In this course students can learn the detailed concept of graph theory along with the concept of trees. This course includes the applications of graph theory also.

Course Content:

Unit I:
Graph Theory: Graphs and digraphs, complement, isomorphism, connectedness and reachability, matrices of graph, Eulerian paths and circuits in graphs and digraphs, Hamiltonian paths and circuits in graphs. Weighted graphs, Dijkstra's algorithm to find shortest path. Floyd-Warshall algorithm. **[24L]**

Unit-II :
Tree and cut sets: Definition of Trees and their elementary properties. Definition of Planar graphs, Kuratowski's graphs. Spanning tree and Krushkal's algorithm and prim's algorithm for finding a minimal spanning tree. Distance, centre, radius and diameter of a graph, Cartesian product of graphs. Cut set and its properties **[20L]**

Unit-III:
Graph colouring: Vertex colouring, chromatic number and chromatic polynomial, k- critical graphs, Greedy colouring algorithm, Brooks theorem, chromatic polynomial, Map colouring, Five colour theorem, The Four colour theorem (statement and brief history). Applications of graph Colouring. **[16L]**

References:

1.V Somasundaram, Discrete Mathematics with Graph Theory and Combinatory, Tata McGraw- Hill.

2. Narshing and Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice Hall India Learning Private Limited.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes(PSOs)

Mapping between COs, POs		
Course Outcomes (COs)		**Mapped POs and PSOs**
CO-1	**Define** the concept of basic graph theory with its various properties.	PO1,PO3,PSO1,PSO2
CO-2	**Explain** the concept of trees and it's related algorithms.	PO1,PO4,PSO1,PSO2
CO-3	**Illustrate** the concept of cut set and cut vertices.	PO1,PO4,PSO1,PSO2
CO-4	**Develop** the concept of graph colouring and its properties.	PO1,PO2,PSO1,PSO2

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	**Contextualized Understanding:** Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	**Critical Thinking and Problem Solving Skills:** Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	**Problem Analysis:** Identify, formulate and analyze complex problems using mathematical principles.	**Modernization and Tools Usage:** Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	**Societal Implication:** Analyze complex social elements, their interrelation and its impact on geographically different society.	**Environment and Sustainability:** Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	**Ethics:** Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	**Individual and Team Work:** Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	**Communication:** Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	**Leadership Skills:** Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	**Life Long Learning:** Develop the ability to reasoning, abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MTH1 1101	Graph Theory	3	1	2	1	-	-	-	-	-	-	-	3	3	3	-

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11102	INTRODUCTION TO OPTIMIZATION	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	$10+2^{th}$ level Mathematics				
Co-requisites	--				

Course Objectives:

1. To develop the concept of optimization problems and build up the knowledge of local and global optima
2. Able to demonstrate the concept of descent methods, conjugate direction and Quasi-Newton's methods
3. To acquire the knowledge of constrained optimization problems and duality

Course Outcomes

On completion of this course, the students will be able to

CO5. **Classify** the optimization models and gain the knowledge of convex analysis
CO6. **Explain** the optimal conditions of first order and second order
CO7. **Build** the knowledge of constraint qualifications
CO8. **Explain** the theoretical aspects and solution techniques of nonlinear optimization, viz., descent methods, conjugate direction and Quasi-Newton's methods.

Course Description:

Optimization is a subject that is widely and increasingly used in science, engineering, economics, management, industry, and other areas. It deals with selecting the best of many possible decisions in real-life environment, constructing computational methods to find optimal solutions, exploring the theoretical properties, and studying the computational performance of numerical algorithms implemented based on computational methods. This course focuses on algorithms for solving optimization problems and also study applications involving such problems. Some of the topics covered include nonlinear optimization (convex and non convex), discrete optimization, approximation techniques and heuristic approaches.

Course Content:

Unit-I

Introduction: Optimization history, modelling of optimization problems, classification of optimization models, applications and modelling examples**,** Soft and hard constraints.
Convex analysis: Convexity of sets, the projection of a vector onto a convex set, convex and concave functions, minimization and maximization of convex functions, zero-order conditions.
[12L]

Unit-II

Optimality Conditions: An introduction to optimality conditions, local and global optimality, existence of optimal solutions, optimality in unconstrained optimization, optimization over convex sets, near-optimality in convex optimization, continuity of convex functions, geometric optimality conditions, local first-order optimality conditions, the fritz–john conditions, the Karush–Kuhn–Tucker (KKT) conditions, sufficiency of KKT–conditions under convexity,

constraint qualifications (CQ), Mangasarian–Fromovitz CQ (MFCQ), Slater CQ, Linear independence CQ (LICQ), Affine constraints, local second-order optimality conditions.**[24L]**

Unit-III

Optimization over Convex Sets: Unconstrained optimization- descent directions, line searches, approximate line search strategies, convergent algorithms, finite termination criteria, a comment on non-differentiability, trust region methods, conjugate gradient, conjugate direction methods, conjugate gradient methods, a Quasi-Newton method, Davidon–Fletcher–Powell method, convergence rates, feasible direction methods, Frank–Wolfe method, gradient projection algorithm. [**24L**]

References:

1. Kanti Swarup, P. K. Gupta and Man Mohan, Operations Research, S. Chand and Co. Pvt. Ltd.
2. Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice Hall India, 2006.
3. W. Forst, D. Hoffmann, Optimization—Theory and Practice, Springer, 2010.
4. N. Andr´easson, A. Evgrafov, and M. Patriksson, An Introduction to Continuous Optimization: Foundations and Fundamental Algorithms, Dover Publications, 2020.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	20	30	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes (PSOs)

Mapping between COs, POs		
Course Outcomes (COs)		Mapped POs and PSOs
CO-1	**Classify** the optimization models and gain the knowledge of convex analysis	PO1, PO3,PSO1,PSO3
CO-2	**Explain** the optimal conditions of first order and second order	PO1,PO4,PSO1,PSO3
CO-3	**Build** the knowledge of constraint qualifications	PO1,PO4,PSO1,PSO3
CO-4	**Explain** the theoretical aspects and solution techniques of nonlinear optimization, viz., descent methods, conjugate direction and Quasi-Newton's methods.	PO1,PO2,PSO1,PSO3

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	**Contextualized Understanding:** Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	**Critical Thinking and Problem Solving Skills:** Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	**Problem Analysis:** Identify, formulate and analyze complex problems using mathematical principles.	**Modernization and Tools Usage:** Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	**Societal Implication:** Analyze complex social elements, their interrelation and its impact on geographically different society.	**Environment and Sustainability:** Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	**Ethics:** Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	**Individual and Team Work:** Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	**Communication:** Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	**Leadership Skills:** Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	**Life Long Learning:** Develop the ability to reasoning, abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MTH1 1102	Introduction to Optimization	3	1	2	1	-	-	-	-	-	-	-	3	3	3	-

1=weakly mapped
2= moderately mapped
3=strongly mapped

SDS11092	INTRODUCTION TO STOCHASTIC PROCESS	L	T	P	C
Version 1.0	Contact Hours: 60	3	1	0	4
Pre-requisites/ Exposure	Probability and Statistics				
Co-requisites					

Course Objectives:

- To understand the basic components of stochastic process
- To build the knowledge about discrete-time and continuous-time Markov chain
- To understand different Queuing model
- To build the knowledge about Martingales, Brownian motion, Renewal process and Branching process

Course Outcomes

On completion of this course, the students will be able to

CO1. Interpret probability generating function and its use in stochastic process

CO2. Explain different concepts related to discrete-time Markov chain

CO3. Apply the knowledge of continuous-time Markov chain in real-world problem

CO4. Illustrate the concepts of Martingales, Brownian motion, Renewal process and Branching process

Course Content:

Unit-I

Review of probability theory, random variable and distribution; Probability generating function and its properties, Sequence of random variables; Simple stochastic process: Definition, classification and Examples. **[12L]**

Unit-II

Discrete-time Markov chains: Introduction, Definition and Transition Probability Matrix, Chapman-Kolmogorov Equations, Classification of States, Limiting and Stationary Distributions, Ergodicity, Time Reversible Markov Chain, Application of Irreducible Markov chains in Queuing Models; Reducible Markov Chains. **[14L]**

Unit-III

Continuous-time Markov chains: Definition, Kolmogorov Differential Equation and Infinitesimal Generator Matrix, Limiting and Stationary Distributions, Birth and Death Processes, Poisson processes, M/M/1 Queuing model; Simple Markovian Queuing, Applications of Continuous-time Markov chain, Queueing networks, Communication systems, Stochastic Petri Nets. **[14L]**

Unit-IV

Martingales: Conditional expectations, definition and examples of martingales, inequality, convergence and smoothing properties

Brownian motion: Definition and Properties; Processes Derived from Brownian motion, Stochastic Differential Equation

Renewal Processes: Renewal Function and Equation, Generalized Renewal Processes and Renewal Limit Theorems, Markov Renewal and Markov Regenerative Processes, Non-Markovian Queues, Application of Markov Regenerative Processes

Branching Processes: Definition and examples branching processes, probability generating function, mean and variance, Galton-Watson branching process, probability of extinction. **[20L]**

Text Books:

1. J. Medhi, Stochastic Processes, New Age International (P) Ltd., New Delhi,2nd Edition, 2001.
2. S.M. Ross, Stochastic Processes, 2nd Edition, Wiley, 1996 (WSE Edition).

Reference Books:

1. H.M. Taylor and S. Karlin, An Introduction to Stochastic Modeling, 3rd Edition, Academic Press, New York, 1998.
2. Liliana Blanco Castaneda, Viswanathan Arunachalam, Selvamuthu Dharmaraja, Introduction to Probability and Stochastic Processes with Applications, Wiley, 2012.
3. G. R. Grimmett and D. R. Stirzaker, Probability and Random Processes, 3rd Edition, Oxford University Press, 2001.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	20	30	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes(PSOs)

Mapping between COs, POs		
Course Outcomes (COs)		Mapped POs and PSOs
CO-1	**Interpret** probability generating function and its use in stochastic process	PO1, PO2, PO4, PO12, PSO1, PSO3
CO-2	**Explain** different concepts related to discrete-time Markov chain	PO1, PO2, PO3, PO4, PO5, PO12, PSO1, PSO3
CO-3	**Apply** the knowledge of continuous-time Markov chain in real-world problem	PO1, PO2, PO3, PO4, PO12, PSO1, PSO3
CO-4	**Illustrate** the concepts of Martingales, Brownian motion, Renewal process and Branching process	PO1, PO2, PO3, PO4, PO12, PSO1, PSO3

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2	PS O3
SDS1 1092	INTRODUCTION TO STOCHASTIC PROCESS	3	3	3	3	1							3	3		3

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11103	INTRODUCTION TO FINANCIAL RISK ANALYTICS	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	10+2 Level Mathematics				
Co-requisites	Good knowledge of Probability and statistics, Linear algebra				

Course Objectives:

The objective of the course is:

1. To understand introductory knowledge of financial risk through mathematical applications and learn the basics of financial analysis in terms mathematics and statistics.
2. To solve and analysis some basic problems in financial risk management and asset management by using their mathematical and statistical concept and skills.

Course Outcomes:

After completion of the course the students will be able to

CO1: Apply the concept of basic calculus and portfolio theory for simple financial problems.

CO2: Utilize the linear regression models and ANOVA in financial modeling.

CO3: Apply various numerical techniques to calculate the risk and bond yield in financial applications.

CO4: Explain the various types of risk, portfolios and related theories, capital asset pricing model.

CO5: Find eigen vectors and eigen values in applications to linear portfolios.

Course Content

Unit I **[12L]**

Basic Calculus for Finance: Functions and graphs, inverse function, exponential and natural logarithm function with example in finance, equations and roots, Taylor expansion, monotonic, concave and convex functions, review of partial derivatives: function of two variables, stationary points and constrained optimization, some financial applications.

Analysis of financial returns: Portfolio holdings and portfolio weights, profit and loss: discrete time and continuous time, percentage and log returns, geometric Brownian motion and its applications in finance.

Unit II **[10L]**

Review of probability distributions, univariate normal distribution, bivariate normal mixture distributions and its properties, introduction to linear regression, ANOVA and goodness of fit, autocorrelation and heteroscedasticity, applications of linear regression in finance: testing a theory, analyzing empirical market behavior.

Unit III **[10L]**

Numerical Methods in Finance: Calculation of risk and bond yield using bisection, Newton-Raphson method and gradient methods; interpolation and extrapolation, some applications in finance.

Unit IV **[20L]**

Introduction to portfolio theory, portfolio preference, some standard utility functions, mean–variance criterion, portfolio allocation, portfolio diversification, minimum variance portfolios, the Markowitz problem, efficient frontier, optimal allocation.

Portfolio credit risk, counterparty credit risk, portfolios of derivatives, operational risk, credit risk. theory of asset pricing, capital asset pricing model, testing the CAPM, risk adjusted performance measures, sharpe ratio, making decisions using the sharpe ratio.

Unit V: **[8 L]**

Eigenvectors and eigenvalues and its properties, eigenvalues and eigenvectors of a 2×2 correlation matrix, eigenvalue test for definiteness, applications to linear portfolios.

Reference Books

1. Alexander, C. (2008). Quantitative methods in finance. Wiley.
2. Skoglund, J., & Chen, W. (2015). Financial risk management: Applications in market, credit, asset and liability management and firmwide risk. John Wiley & Sons.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	20	30	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes(PSOs)

Mapping between COs, POs		
Course Outcomes (COs)		Mapped POs and PSOs
CO-1	**Apply** the concept of basic calculus and portfolio theory for simple financial problems.	PO2,PO4,PO12,PSO1,PSO3
CO-2	**Utilize** the linear regression models and ANOVA in financial modeling.	PO2, PO3, PO4,PO5,PO12, PSO1,PSO3
CO-3	**Apply** various numerical techniques to calculate the risk and bond yield in financial applications.	PO2, PO3, PO4,PO12, PSO1,PSO3
CO-4	**Explain** the various types of risk, portfolios and related theories, capital asset pricing model.	PO2, PO3, PO4,PO12,PSO1,PSO3
CO-5	**Find** eigen vectors and eigen values in applications to linear portfolios.	PO2,PO3, PO4,PO12,PSO1,PSO3

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PS O2	PS O3
MTH 11103	INTRODUCTION TO FINANCIAL RISK ANALYTICS	-	3	3	3	1							3	3		3

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH11104	INTRODUCTION TO PORTFOLIO OPTIMIZATION	L	T	P	C
Version 1.0	**Contact Hours - 60**	3	1	0	4
Pre-requisites/Exposure	Good knowledge of probability, statistics, linear algebra				
Co-requisites	some programming knowledge and basics calculus				

Course Objectives: The objective of this course is to understand the theoretical and practical aspects of Portfolio Optimization, Theory of asset pricing, and its uses.

Course Outcomes:

On completion of this course, the students will be able to

CO1: Identify the various types of probability distributions and calculate its moments.
CO2: Solve various optimization problems by using the linear, non-linear, and multi objective programing.
CO3: Demonstrate the concept of portfolio of asset and equities, and various terms related to financial market and risk.
CO4: Analyze the expected risk and return of a portfolio, VAR, and calculate risk adjusted performance measures.
CO5: Solve various problems related to Capital market theory, asset pricing, index tracking optimization models.

Course Description:

This course includes the portfolio and investment analysis in different financial markets and capital market theory. All the lectures will be devoted on discussions of basic theories and advanced topics, focusing on practical implementation of knowledge. Classes will be conducted by lecture as well as power point presentation, audio visual virtual lab session as per requirement. The tutorials will familiarize the students with practical problem-solving techniques led by the course coordinator. Students will strongly grab the basic concepts of the subject via exercise and discussions with the coordinator.

Course Content:

Unit-I
Review of Probability and statistics: Discrete and continuous random variables, some probability distributions, higher order moments of them. Linear and nonlinear programing: Linear programing, quadratic programing, non linear programming, multi objective optimization. **[20L]**

Unit-II
Financial markets, investment objectives, measures of return and risk, types of risks, risk free assets, mutual funds.
Introduction to Portfolio Theory: Utility theory, properties of utility functions, risk preference, risk aversion, portfolio of assets, portfolio of equities: price and returns. [**10L**]

Unit-III

Risk return analysis: Expected risk and return of portfolio, portfolio allocation, diversification, mean-variance portfolio optimization- the Markowitz model and the two-fund theorem, min maximum loss model, value at risk (VAR), mean conditional value at risk model, mean Gini model, risk-free assets and one fund theorem, efficient frontier, portfolios with short sales, risk adjusted performance measures. [**20L**]

Unit-IV

Theory of asset pricing: Capital market theory, capital assets pricing model- the capital market line, beta of an asset, beta of a portfolio, security market line. index tracking optimization models, portfolio performance evaluation measures. [**10L**]

References:

1. F. Cesarone, Computational Finance MATLAB@ oriented modelling. Taylor & Francis Group.
2. M.J. Best, Portfolio Optimization, Chapman and Hall, CRC Press, 2010.
3. D.G. Luenberger, Investment Science, 2nd Ed., Oxford University Press, 2013.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Mid term	Class Assessment	End Term
Weightage (%)	**20**	**30**	**50**

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes(PSOs)

Mapping between COs, POs		
Course Outcomes (COs)		**Mapped POs and PSOs**
CO-1	**Identify** the various types of probability distributions and calculate its moments.	PO1,PSO1,PSO3
CO-2	**Solve** various optimization problems by using the linear, non-linear, and multi objective programing.	PO1, PO3,PSO1,PSO3
CO-3	**Demonstrate** the concept of portfolio of asset and equities, and various terms related to financial market and risk.	PO1, PO3,PSO1,PSO3
CO-4	**Analyze** the expected risk and return of a portfolio, VAR, and calculate risk adjusted performance measures.	PO1, PO2, PO3,PSO1,PSO3
CO-5	**Solve** various problems related to Capital market theory, asset pricing, index tracking optimization models.	PO1, PO2,PSO1,PSO3

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MTH11104	Introduction to Portfolio Optimization	3	3	3									3	3		3

1=weakly mapped
2= moderately mapped
3=strongly mapped

MTH15031	DISSERTATION	L	T	P	C
Version 1.0		0	0	12	10
Pre-requisites/Exposure	--				
Co-requisites	--				

Course Objectives:

1. To address the real world problems and find the required solution.
2. To fabricate and implement the mini project intended solution for project based learning
3. To improve the team building, communication and management skills of the students

Course Outcomes

On completion of this course, the students will be able to

CO1. Identify the requirements for the real world problems.
CO2. Demonstrate and build the project successfully by reviewing and analyzing the results.
CO3. Study and enhance Mathematical skills.
CO4. Explain the findings of the study conducted in the preferred domain.

Course Description:

The role of Projects in life of science students are very crucial. Minor Project helps you to explore and strengthen the understanding of fundamentals through practical application of theoretical concepts. Every phenomenon around you is being justified by our greatest Mathematicians to date. In this article we, will be covering what is Mathematics and mini-projects that can be done by mathematicians during their academics.

It acts like a beginners guide to do larger projects later in their career. It not just affects the grades of learner but also matter a lot for good CV/Resume. So before choosing the minor and major project, you should explore the options and pick the correct domain where the opportunities are immense.

Modes of Examination: Assignment/Quiz/Project/Presentation/Written Exam

Examination Scheme:

Components	Presentation	Project report	Viva
Weightage (%)	25	25	50

Relationship between the Course Outcomes (COs) with Program Outcomes (POs) and Programme Specific Outcomes (PSOs)

Course Outcomes (COs)		Mapped POs and PSOs
CO1	Identify the requirements for the real world problems.	PO1, PO2, PO3, PO4, PO12,PSO1,PSO2,PSO3
CO2	Demonstrate and build the project successfully by reviewing and analyzing the results.	PO6, PO7, PO9, PO10, PO12,PSO1,PSO2,PSO3
CO3	Study and enhance Mathematical skills.	PO9, PO10, PO12,PSO1,PSO2,PSO3
CO4	Explain the findings of the study conducted in the preferred domain	PO1, PO2, PO3, PO4, PO12,PSO1,PSO2,PSO3

		Academic Excellence: Apply theoretical knowledge of Mathematics for the solution of different problems related to science and technology.	Contextualized Understanding: Develop mathematical concepts in all the fields of learning and recognize the need in science and technology.	Critical Thinking and Problem Solving Skills: Investigate various problems with effective solutions or techniques to crack competitive examinations and higher studies.	Problem Analysis: Identify, formulate and analyze complex problems using mathematical principles.	Modernization and Tools Usage: Design and solve critical problems using sophisticated mathematical modelling with modern tools and programming skills.	Societal Implication: Analyze complex social elements, their interrelation and its impact on geographically different society.	Environment and Sustainability: Design a system, component, or process to meet desired needs within realistic constraints such as environmental, health, safety, manufacturability, and sustainability.	Ethics: Understand ethical principle and commit to professional ethics, responsibilities and norms in the society.	Individual and Team Work: Work as an individual or in teams on multi-disciplinary projects in research organizations, industries and participate in academic discussion.	Communication: Build up effective communication skills, both written and verbal, to specialized and non-specialized audiences.	Leadership Skills: Undertake a major, individual, mathematics-related project and discuss the results in a full scientific report with a presentation.	Life Long Learning: Develop the ability to reasoning , abstract thinking, critically evaluate theories, methods, principles, and applications of pure and applied science.	Understand basic concepts of mathematics to develop problem solving skills which are required for higher education and get placed in gov./ private organizations.	Develop deeper understanding and expanded knowledge in pure mathematics.	Apply mathematical methods to other disciplines such as physics, engineering, computer science.
Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
MTH15031	Dissertation	2	2	2	2	-	1	1	-	2	2	-	3	3	3	3

1=weakly mapped
2= moderately mapped
3=strongly mapped

ADAMAS UNIVERSITY
SCHOOL OF BASIC AND APPLIED SCIENCES
DEPARTMENT OF MATHEMATICS

CO – PO & PSO MAPPING

Name of the Programme: B.Sc. (Hons) Mathematics

Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
MTH11082	CLASSICAL ALGEBRA	3	3	1	1	-	-	-	-	-	-	-	-
MTH11083	REAL ANALYSIS I	3	3	3	-	-	-	-	-	-	-	-	3
MTH11084	CALCULUS I	3	3	3	2	-	-	-	-	-	-	-	3
ENG11057	ENGLISH LANGUAGE AND LITERATURE	-	-	-	-	-	-	-	-	2	3	1	3
CSE11655	ELECTIVE PROGRAMMING LANGUAGE I	2	-	2	-	-	3	-	-	-	-	-	3
CSE12656	ELECTIVE PROGRAMMING LANGUAGE I LAB	3	3	3	-	3	3	-	-	-	-	-	3
CHM11151	ELECTIVE CHEMISTRY I	3	3	3	-	2	-	-	-	-	-	-	3
CHM12152	ELECTIVE CHEMISTRY I LAB	3	3	3	-	2	-	-	-	-	-	-	3
DGS11001	DESIGN THINKING	3	2	-	-	2	-	-	-	-	-	2	-
MTH11085	DIFFERENTIAL EQUATION I	3	3	3	-	-	-	-	-	-	-	-	3
MTH11086	MODERN ALGEBRA I	3	3	3	-	-	-	-	-	-	-	-	3
MTH11087	REAL ANALYSIS II	3	3	3	-	-	-	-	-	-	-	-	3
MTH11091	ANALYTICAL GEOMETRY 2D	3	3	3	3	-	-	-	-	1	-	-	3
EVS11112	ENVIRONMENTAL SCIENCE	1	1	1	-	-	3	3	2	-	-	-	1
CSE11657	ELECTIVE PROGRAMMING LANGUAGE II	3	1	3	3	3	-	-	-	-	-	-	3
CSE12658	ELECTIVE PROGRAMMING LANGUAGE II LAB	3	1	3	3	3	-	-	-	-	-	-	3

CHM11153	ELECTIVE CHEMISTRY II	3	3	3	-	2	-	-	-	-	-	-	3
CHM12154	ELECTIVE CHEMISTRY LAB II	3	3	3	-	2	-	-	-	-	-	-	3
EIC11001	VENTURE IDEATION	-	-	-	-	-	3	-	3	-	-	3	-
MTH11009	LINEAR ALGEBRA I	3	3	3	-	2	-	-	-	-	-	-	3
MTH11089	MODERN ALGEBRA II	3	3	3	-	2	-	-	-	-	-	-	3
MTH11090	DIFFERENTIAL EQUATION II	3	2	3	3	2	-	-	-	-	-	-	3
MTH13015	R PROGRAMMING	2	-	3	2	3	-	3	-	-	-	-	3
ECO11001	MICROECONOMICS	2	2	1	1	-	-	3	-	3	3	-	3
PHY11015	ELECTIVE PHYSICS I	3	-	2	-	-	2	2	2	3	3	1	3
PHY12016	ELECTIVE PHYSICS LAB I	3	-	2	-	-	2	2	2	3	3	1	3
SOC14100	COMMUNITY SERVICE							3		3	3		3
IDP14001	INTER-DISCIPLINARY PROJECT	3		2					3	3			
MTH11092	CALCULUS II	3	3	3	-	2	-	-	-	-	-	-	3
MTH11012	LINEAR ALGEBRA II	3	3	3	2	-	-	-	-	-	-	-	3
SDS11069	THEORY OF PROBABILITY	3	3	2	3	2	-	-	-	-	-	-	3
MTH11094	ANALYTICAL GEOMETRY 3D	3	3	3	-	2	-	-	-	-	-	-	3
MTH13011	INTRODUCTION TO MATLAB	2	-	3	2	3	-	3	-	-	-	-	3
ECO11031	MACROECONOMICS	2	2	1	1			3		3	3		3
PHY11024	ELECTIVE PHYSICS II	3	2	1	1								
PHY12025	ELECTIVE PHYSICS II LAB									3	2	1	1
PSG11021	HUMAN VALUES AND PROFESSIONAL ETHICS							2		3			3
MTH11016	FUNCTIONS OF COMPLEX VARIABLES	3	3	3	3	-	-	-	-	-	-	-	1
MTH11021	INTRODUCTION TO LINEAR PROGRAMMING AND GAME THEORY	3	3	3	-	2	-	-	-	-	-	-	3
MTH11017	INTRODUCTION TO NUMERICAL ANALYSIS	3	3	3	-	3	-	-	-	-	-	-	3
MTH12019	INTRODUCTION TO NUMERICAL ANALYSIS LAB	-	-	-	-	3	-	-	-	-	-	-	3

SDS11070	STATISTICS	3	-	1	-	-	-	-	-	-	-	-	-
MTH11018	VECTOR ANALYSIS AND TENSOR CALCULUS	3	3	3	-	-	-	-	-	-	-	-	3
MTH11097	ANALYTICAL STATICS & HYDROSTATICS	3	3	3	2	-	-	1	-	-	-	-	3
MTH11029	MATHEMATICAL MODELLING	3	3	3	3	2	-	2	-	-	-	-	1
MTH11098	NUMERICAL METHODS FOR ORDINARY DIFFERENTIAL EQUATIONS	3	3	3	3	2	-	2	-	-	-	-	1
SDS11082	ELEMENTARY DATA SCIENCE AND VISUALIZATION	3	3	3	3	2	2	1					1
MTH14020	SUMMER INTERNSHIP	2	2	2	2	2	2	2	2	3	3	3	3
MTH11022	INTEGRAL TRANSFORMS	3	3	3	-	3	-	-	-	-	-	-	2
MTH11095	ELEMENTARY DYNAMICS	3	3	1	1								
MTH11027	NUMBER THOERY	3	3	3		2							3
MTH11099	METRIC SPACE AND TOPOLOGY	3	3	1	-	-	-	-	-	-	-	-	3
MTH11100	NON-NEGATIVE MATRICES	3	3	2	2	1	-	-	-	1	-	1	1
MTH11101	GRAPH THEORY	3	1	2	1	-	-	-	-	-	-	-	3
MTH11102	INTRODUCTION TO OPTIMIZATION	3	1	2	1	-	-	-	-	-	-	-	3
SDS11092	INTRODUCTION TO STOCHASTIC PROCESS	3	3	3	3	1							3
MTH11103	INTRODUCTION TO FINANCIAL RISK ANALYTICS	-	3	3	3	1							3
MTH11104	INTRODUCTION TO PORTFOLIO OPTIMIZATION	3	3	3									3
MTH15096	DISSERTATION	2	2	2	2	-	1	1	-	2	2	-	3
Average of CO-PO Mapping		2.83	2.63	2.5	2.15	2.18	2.33	2.2	2.33	2.54	2.78	1.62	2.71