2014

M.Sc (Mathematics) Curriculum & Syllabus

DEPARTMENT OF MATHEMATICS

MADRAS CHRISTIAN COLLEGE

MADRAS CHRISTIAN COLLEGE (AUTONOMOUS)

CHENNAI – 600 059

DEPARTMENT OF MATHEMATICS

M.Sc (Mathematics) Degree Programme

Curriculum & Syllabus (1st year)

(With effect from 2014-15)

Vision

Madras Christian College aspires to be an institution of excellence transforming lives through education with a commitment to service.

Mission

Madras Christian College with the inspiration of the love of God offers to people of all communities, education of the whole person which is congruous with God's revelation in Christ of the true nature of humanity and is appropriate to the needs of India and of the world.

Graduate Attributes (GAs)

The Madras Christian College defines the philosophy underpinning its academic programmes and student life experience on campus through the Graduate Attributes (GA), that describe the knowledge, competencies, values and skills students imbibe for holistic development and contribution to society. These attributes encompass characteristics that are transferable beyond the domain of study into the national and international realm fostered through curricular, co-curricular and extra-curricular engagements.

GA 1: Intellectual Competencies

- Graduates of MCC have a comprehensive and incisive understanding of their domain of study as well as the capability for cross-disciplinary learning.
- They have the ability to apply the knowledge acquired through the curriculum as well as self-directed learning to a broad spectrum ranging from analytical thinking to synthesise new knowledge through research.
- Forming independent individual opinions regarding academic cores and socially relevant issues

GA 2: Professional Ethics

- Graduates of MCC develop ethical and professional behaviour, which will be demonstrated in their chosen careers and constructive citizenship roles.
- They imbibe intellectual integrity and ethics in scholarly engagement and develop a spirit of inclusiveness through interactions with people of special needs and diversity.

GA3: Leadership Qualities

- Graduates of MCC inculcate leadership qualities & attitudes, and team behaviour along democratic lines through curricular, co-curricular and extra-curricular activities

- They develop managerial and entrepreneurial skills to ideate and create new opportunities along with career readiness and capacity to take up various competitive exams.

GA 4: Holistic Skill Development

- Graduates of MCC develop critical thinking, problem-solving, effective communication, emotional and social skills
- They develop digital competency to live, learn and serve in society.

GA 5: Cross-Cultural Competencies

- Graduates of MCC imbibe cross-cultural competencies through engaging with diverse linguistic, ethnic and religious communities providing scope to understand, accept and appreciate individuals at local, national and international levels.
- They develop a global perspective through contemporary curriculum, culture, language and international exchange programmes

GA 6: Service-Oriented Focus

- Graduates of MCC have sensitivity to social concerns and a conviction toward social justice through a commitment to active social engagement.
- They are endowed with a strong sense of environmental awareness through the curriculum and campus eco-system.

GA 7: Value-Based Spiritual Development

- Graduates of MCC are rooted in the principles of ethical responsibility and integrity permeated with Christian values leading to the building of character.
- They develop virtues such as love, courage, unity, brotherhood, industry and uprightness.

Programme Outcomes (POs) for M.Sc Degree Programmes

Programme Outcomes define the minimum level that students are expected to do, achieve and/or accomplish in order to graduate from a particular programme. These Outcomes are a framework to assess the nature of learning activity experienced within the programme. Upon completion of the programme, post graduate students should have shown evidence of being able to

PO		Descripton of PO	Mapped GA
PO 1	**Domain Knowledge**	• Develop intensive and extensive knowledge and expertise in their respective domains • Evaluate and create/construct domain specific knowledge in areas of learning, research and industry • Formulate and extrapolate the knowledge gained to apply in real – life situations and competitive examinations • Develop an aptitude for self-directed learning for excellence in their chosen area within the domain of stud	GA1, GA3, GA4
PO 2	**Applicative knowledge and Lateral Thinking**	• Translate theoretical understanding to experimental knowledge and solve complex problems using Systems/Design Thinking • Apply advanced knowledge and approaches to solve concrete and abstract problems in domain-related and multi-disciplinary issues. • Able to solve problems using unconventional and creative approaches	GA1, GA3, GA4
PO 3	**Innovation and Research**	• Develop aptitude for innovation and entrepreneurship • Identify contemporary research problems, analyze data and propose solutions	GA1, GA4, GA5, GA6
PO 4	**Scientific Communication skills**	• Document, prepare and present scientific work as reports and research articles in academic forums • Critically assess, review and present theories, principles and concepts	GA1, GA4, GA5, GA6
PO 5	**Digital Skills**	• Use of domain-related advanced software resources, computational skills and digital tools for data analysis, visualization and interpretation • Ethically apply digital skills to creatively communicate a wide range of ideas and issues related to academic experiences	GA1, GA2, GA3, GA4
PO 6	**Ethical practices**	• Apply domain specific ethical principles and practices in academic, professional and social engagements	GA2, GA6, GA7
PO 7	**Career readiness and higher education**	• Choose from diverse career options available in local, national and international realms. • Carry out further research or pursue higher education in the country or abroad	GA1, GA2, GA3

Programme Specific Outcomes (PSOs) for M.Sc (Mathematics)

At the time of graduation the students would be able to:

PSO	Description of PSO
PSO 1	• Develop intensive and extensive knowledge and expertise in the domain of mathematics • Evaluate and create/construct mathematical, analytical knowledge in areas of learning, research, industry and related context • Formulate and extrapolate the mathematical knowledge, relate and to apply in real – life situations and competitive examinations
PSO 2	• Translate concepts and mathematical understanding to experimental knowledge and solve complex problems using Systems/Design Thinking

	• Apply advanced and specialized mathematical knowledge and methods, AT/VR/ML tools to solve concrete and abstract problems in inter-diciplinary areas and suitable contexts. • Apply mathematical modelling and solve using unconventional and creative approaches
PSO 3	• Develop analytical and problem solving aptitude for innovation and entrepreneurship • Identify contemporary research problems, analyze data or model mathematical systems and propose solutions
PSO 4	• Document, prepare and present mathematical work, inferences and interpretations as reports and research articles in academic forums • Critically assess, review and present mathematical theories, principles and emerging concepts
PSO 5	• Use of advanced mathematical, statistical software resources, Generative AI tools, empirical knowledge, computational skills and digital tools for data analysis, visualization and interpretation • Ethically apply digital skills to creatively communicate a wide range of ideas and issues related to academic experiences and suitable contexts.
PSO 6	• Explore mathematical ideass that comply with ethical principles and apply in academic, professional and social engagements
PSO 7	• Choose career options such as teaching, research, project management, R&D laboratories, available in academic/industrial sectors, local, national and international realms. • Carry out applied and applicable research programmes or pursue higher education at the national and international level

Curriculum – M.Sc (Mathematics)

S. No.	Course	Hours	Credits
	Semester 1		
1	Algebra I	6	5
2	Real Analysis I	6	5
3	Ordinary and Partial Differential Equations	6	5
4	Mechanics	6	4
5	Graph Theory	6	4
	Total	**30**	**23**
	Semester II		
6	Algebra II	6	5
7	Real Analysis II	6	5

8	Number Theory and Cryptography	6	4
9	Java Programming	5	4
10	Elective 1 (Graph Alg. & Appli / Oper. Research)	5	4
	Soft Skill Programme	2	4
	Total	**30**	**26**
	Internship		**2**
	Semester III		
11	Complex Analysis I	6	5
12	Topology	6	5
13	Formal Languages and Automata	6	4
14	Elective 2 (**Int.Equ. & Calc. of Vari / Disc. Math**)	5	4
15	Elective 3 (Math. Stat / Comp. Geometry)	5	4
	Soft Skill Programme	2	4
	Total	**30**	**26**
	Semester IV		
16	Complex Analysis II	6	5
17	Differential Geometry	6	5
18	Functional Analysis	6	5
19	Elective 4 (**Fluid Dynamics / Theory of Computation**)	5	4
20	Elective 5 (**Fixed Point Theory / Fuzzy Sets & Appl**)	5	4
	Seminar	2	
	Total	**30**	**23**
	Grand Total		**100**

Electives to be chosen from the following pool of courses

1. **Operations Research**
2. **Graph Algorithms and Applications**
3. **Mathematical Statistics**
4. **Computational Geometry**
5. **Integral Equations and Calculus of Variations**
6. **Discrete Mathematics**
7. **Fluid Dynamics**
8. **Theory of Computation**
9. **Fixed Point Theory**
10. **Fuzzy Sets and Their Applications**
11. Algebraic Topology
12. Wavelets

13. Commutative Algebra
14. Soft Computing
15. Computational Biology

Course title:	**Algebra I**			
Course Code	**142MT1M01**			
Credits	**5**			
Hours / Cycle	**6**			
Category	**Mandatory**			
Semester	**I**			
Year of Implementation	**AY 2014-15**			
Course Structure	**Theory**	**Tutorial**	**Practical**	**Total Hours**
	75	**0**	**0**	**75**
Learning Objectives:	To repesent and understand the relationships between abstract algebraic structures with familiar numbers systems such as the integers and real numbers. To comprehend the relationships between operations satisfying various properties To demonstrate concepts and properties of various algebraic structures. To understand the importance of algebraic properties relative to working within various number systems. To develop the ability to form and evaluate conjectures.			
Course Outcome(s)	**PSO Addressed**	**Bloom's Taxonomy Levels**		
CO1: Demonstrate with the basic ideas of algebra including the concepts of	PSO1, PSO2, PSO7	K1, K2		

counting principle and Homomorphisms		
CO2: Apply the sylow theorems to describe the structure of certain finite groups	PSO1, PSO2, PSO7	K2, K3
CO3: Acquire the knowledge of direct products, finitely generated abelian groups	PSO1, PSO2, PSO7	K1, K3
CO4: Identify the theorems about linear transformations, canonical form of matrices and fundamental properties of matrices	PSO1, PSO2, PSO7	K3, K4
CO5: Classify the behaviour of Hermitian, Unitary and Normal transformations	PSO1, PSO2, PSO7	K2

Syllabus: Algebra I

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	UNIT I – Another Counting Principle – Sylow's Theorems (for Theorem 2.12.1, first proof only). Chapter 2: Sections 2.11, 2.12 (Section 2.12: Omit Lemma 2.12.5)	**15**	**CO1**	K1, K2
II	UNIT II – Solvability by Radicals – Direct Products – Finite Abelian Groups – Modules. Chapter 5: Section 5.7 (Lemma 5.7.1, Lemma 5.7.2, Theorem 5.7.1 only) Chapter 2: Sections 2.13, 2.14 (Section 2.14: Theorem 2.14.1 only) Chapter 4: Section 4.5	**15**	**CO2**	K2, K3
III	UNIT III – Canonical Forms: Triangular Form – Nilpotent Transformations. Chapter 6: Sections 6.4, 6.5	**15**	**CO3**	K1, K3
IV	UNIT IV – Canonical Forms: Jordan Form – Rational Canonical Form. Chapter 6: Sections 6.6, 6.7	**15**	**CO4**	K3, K4
V	UNIT V – Trace and Transpose – Hermitian, Unitary and Normal Transformations – Real Quadratic Forms. Chapter 6: Sections 6.8, 6.10, 6.11	**15**	**CO5**	K3, K5

Prescribed Books/Textbook(s)

I. N. Herstein, Topics in Algebra, Second Edition, Wiley India Pvt. Ltd., New Delhi, 2006

Reference Books

1. M. Artin, Algebra, Pearson - Prentice Hall, New Delhi, 2007
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra, Second (Indian) Edition, Cambridge University Press, 1997
3. I.S. Luther and I.B.S. Passi, Algebra, Vol. I-Groups, Narosa Publishing House, New Delhi, 1996
4. I.S. Luther and I.B.S. Passi, Algebra, Vol. II-Rings, Narosa Publishing House, New Delhi, 1999
5. D.S. Malik, J.N. Mordeson and M.K. Sen, Fundamentals of Abstract Algebra, McGraw-Hill (International Edition), New York, 1997
6. N. Jacobson, Basic Algebra, Vol. I & II, W.H. Freeman and co, USA 1980

Web Resources

1. www.math.iisc.ernet.in/~rakesh13/group_theory.pdf
2. https://youtu.be/yG8zAqV_Rxc
3. https://www.math.pku.edu.cn/teachers/anjp/textbook.pdf
4. http://www.astronomia.edu.uy/progs/algebra/Linear_Algebra,_4th_Edition__(2009) Lipschutz-Lipson.pdf
5. http://www.ddegjust.ac.in/studymaterial/msc-math/mal-521.pdf

Course Articulation Matrix for Algebra I

Course Outcome	Programme Outcomes							Programme Specific Outcomes							
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	Cog Level
CO 1	3	3	1	1	1	1	3	3	3	1	1	1	1	3	K1, K2
CO 2	3	3	1	1	1	1	3	3	3	1	1	1	1	3	K2, K3
CO 3	3	3	1	1	1	1	3	3	3	1	1	1	1	3	K1, K3
CO 4	3	3	1	1	1	1	3	3	3	1	1	1	1	3	K3, K4
CO 5	3	3	1	1	1	1	3	3	3	1	1	1	1	3	K2, K5
Avg.	3	3	1	1	1	1	3	3	3	1	1	1	1	3	

Course title:	**Real Analysis I**			
Course Code	**142MT1M02**			
Credits	**5**			
Hours / Cycle	**6**			
Category	**Mandatory**			
Semester	**I**			
Year of Implementation	**AY 2014-15**			
Course Structure	**Theory**	**Tutorial**	**Practical**	**Total Hours**
	75	**0**	**0**	**75**
Learning Objectives:	To describe fundamental properties of the real numbers that lead to the formal development of real analysis. To omprehend rigorous arguments developing the theory underpinning real analysis. To demonstrate an understanding of limits and how they are used in sequences, series, differentiation and integration. To appreciate how abstract ideas and rigorous methods in mathematical analysis can be applied to important practical problems.			
Course Outcome(s)	**PSO Addressed**	**Bloom's Taxonomy Levels**		
CO1: Remember different sequences and series of real numbers and analyse their convergence and divergence and various properties together with that for infinite products.	PSO1, PSO2, PSO7	K1, K4		
CO2: Understand different types of convergence of sequences and series of functions and related theorems.	PSO1, PSO2, PSO7	K2, K3		
CO3: Examine multivariable functions the	PSO1, PSO2, PSO7	K3		

geometric meaning of their derivatives.		
CO4: Apply the idea of extrema of real valued functions to maximize or minimize physical phenomenon like area, volume, temperature etc.	PSO1, PSO2, PSO7	K4
CO5: Appraise the necessity of the theoretical approach and solve problems in analysis.	PSO1, PSO2, PSO7	K3

Syllabus: Real Analysis I

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	UNIT I – Infinite Series and Infinite Products: Absolute and Conditional Convergence – Dirichlet's Test and Abel's Test – Rearrangements of Series – Riemann's Theorem on Conditionally Convergent Series – Double Sequences – Double Series – Rearrangement Theorem for Double Series – A Sufficient Condition for Equality of Iterated Series – Multiplication of Series – Infinite Products. Chapter 8: Sections 8.8, 8.15, 8.17, 8.18, 8.20, 8.21 - 8.24, 8.26	**15**	**CO1**	K1, K4
II	UNIT II – Sequences of Functions: Pointwise Convergence of Sequences of Functions – Examples of Sequences of Real Valued Functions – Definition of Uniform Convergence – Uniform Convergence and Continuity – The Cauchy Condition for Uniform Convergence – Uniform Convergence of Infinite Series of Functions. Power Series: Multiplication of Power Series – The Taylor's Series Generated by a Function – Bernstein's Theorem – Abel's Limit Theorem – Tauber's Theorem. Chapter 9: Sections 9.1 - 9.6, 9.14, 9.15, 9.19, 9.20, 9.22, 9.23	**15**	**CO2**	K2, K3
III	UNIT III – Fourier Series and Fourier Integrals: Introduction – Orthogonal Systems of Functions – The Theorem on Best Approximation – The Fourier Series of a Function Relative to an Orthonormal System – Properties of the Fourier Coefficients – The Riesz-Fischer Theorem – The Convergence and Representation Problems for Trigonometric Series – The Riemann-Lebesgue Lemma – The Dirichlet Integrals – An Integral Representation for the Partial Sums of Fourier Series – Riemann's Localization Theorem – Sufficient Conditions for Convergence of a Fourier Series at a Particular Point. Chapter 11: Sections 11.1 – 11.12	**15**	**CO3**	K2, K3
IV	UNIT IV – Multivariable Differential Calculus: Introduction – The Directional Derivative – Directional Derivatives and Continuity – The Total Derivative – The Total Derivative Expressed in terms of Partial Derivatives	**15**	**CO4**	K3, K4

	– An Application to Complex-Valued Functions - The Matrix of a Linear Function – The Jacobian Matrix – The Chain Rule – Matrix Form of the Chain Rule – The Mean Value Theorem for Differentiable Functions – A Sufficient Condition for Differentiability – A Sufficient Condition for Equality of Mixed Partial Derivatives. Chapter 12: Section 12.1 – 12.13			
V	UNIT V – Implicit functions and Extremum Problems: Introduction – Functions with non-zero Jacobian Determinant – The Inverse Function Theorem – The Implicit Function Theorem – Extrema of Real- Valued Functions of One Variable – Extrema of Real-Valued Functions of Several Variables Chapter 13: Sections 13.1 – 13.6	**15**	**CO5**	K3, K4

Prescribed Books/Textbook(s)

T.M. Apostol, Mathematical Analysis, Second Edition, Narosa Publishing House, New Delhi, 1985.

Reference Books

1. W. Rudin, Principles of Mathematical Analysis, Third Edition, McGraw-Hill Company, New York, 1976
2. S.C. Malik and S. Arora, Mathematical Analysis, Wiley Eastern Limited, New Delhi, 1991
3. S. Arora and B. Lal, Introduction to Real Analysis, Satya Prakashan, New Delhi, 1991
4. B.R. Gelbaum and J. Olmsted, Counter Examples in Analysis, Holden day, San Francisco, 1964
5. R.G. Bartle, The Elements of Real Analysis, Second Edition, John Wiley and Sons Inc., USA 1976

Web Resources

1. www.//ufsj.edu.br/portal2-repositorio/File/demat/PASTAPROF/jorge/T_F_I_e_T_F_I_Apostol.pdf
2. www.//notendur.hi.is/vae11/%C3%9Eekking/principles_of_mathematical_analysis_walter_rudin.pdf
3. www.nptel.com

Course Articulation Matrix for Real Analysis I

Course Outcome	Programme Outcomes							Programme Specific Outcomes							
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	Cog Level
CO 1	3	3	1	1	1	1	3	3	3	1	1	1	1	3	K1, K4
CO 2	3	3	1	1	1	1	3	3	3	1	1	1	1	3	K2, K3
CO 3	3	3	1	1	1	1	3	3	3	1	1	1	1	3	K3
CO 4	3	3	1	1	1	1	3	3	3	1	1	1	1	3	K4
CO 5	3	3	1	1	1	1	3	3	3	1	1	1	1	3	K3, K4

Avg.	**3**	**3**	**1**	**1**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**1**	**1**	**3**	

Course title:	Ordinary and Partial Differential Equations			
Course Code	142MT1M03			
Credits	**5**			
Hours / Cycle	**6**			
Category	**Mandatory**			
Semester	**I**			
Year of Implementation	**AY 2014-15**			
Course Structure	**Theory**	**Tutorial**	**Practical**	**Total Hours**
	75	**0**	**0**	**75**
Learning Objectives:	To aware the students about initial value and boundary value problems and theircorresponding equivalent integral equations. To aware the students about concepts of approximate solution and existence theorem. To familiarize the students about Adjoint system in detail.The objective of this course is to present the main results in the context of partial differential equations that allow learning about these models and to study numerical methods for the approximation of their solution. To discuss some methods to solve Laplace, Heat, and Wave Equations			

Course Outcome(s)	**PSO Addressed**	**Bloom's Taxonomy Levels**
CO1 To understand the linear differential equations with variable coefficients and their solutions.	PSO1, PSO2, PSO7	K2
CO2: To analyse linear independence and dependence of solutions of linear differential equations with variable coefficients using Wronskians	PSO1, PSO2, PSO7	K4
CO3: To solve the ordinary differential equations by series solution method.	PSO1, PSO2, PSO7	K3
CO4: To understand the conditions for the existence and uniqueness of solutions for initial value problems.	PSO1, PSO2, PSO7	K2
CO5: To understand the fundamental concepts of partial differential	PSO1, PSO2, PSO7	K3, K5

equations, analyse canonical form of partial differential equations and classify them.		

Syllabus: Ordinary and Partial Differential Equations

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	UNIT I – Linear Equations with Variable Coefficients: Introduction – Initial Value Problems for the Homogeneous Equation – Solutions of the Homogenous Equation – The Wronskian and Linear Independence – Reduction of the Order of a Homogenous Equation – The Non-Homogeneous Equation – Homogenous Equations with Analytic Coefficients – The Legendre Equation. Chapter 3: Sections 1 – 8	**15**	**CO1**	**K1, K2**
II	UNIT II – Linear Equations with Regular Singular Points: Introduction – The Euler Equation – Second Order Equations with Regular Singular Points – An Example – Second Order Equations with Regular Singular Points – The General Case – The Exceptional Cases – The Bessel Equation – The Bessel Equation (continued). Chapter 4: Sections 1 – 4, 6 – 8	**15**	**CO2**	**K2, K3**
III	UNIT III – Existence and Uniqueness of Solutions to First Order Equations: Introduction – Equations with Variables Separated – Exact Equations – The Method of Successive Approximations – The Lipschitz Condition – Convergence of the Successive Approximations. Chapter 5: Sections 1 – 6 Content and Treatment as in E.A. Coddington, An Introduction to Ordinary Differential Equations, Eastern Economy Edition, Prentice-Hall of India Ltd., New Delhi, 1987.	**15**	**CO3**	**K3, K4**
IV	UNIT IV – First order Partial Differential Equation: Introduction – Partial Differential Equations of First Order in Two Independent Variables – Formulation of First Order Partial Differential Equations – Compatibility of First Order Partial Differential Equations – Classification of the Solutions of First Order Partial Differential Equations – Solution of Non-Linear Partial Differential Equations of First Order: Charpit's Method – Jacobi's Method. Second Order Partial Differential Equation: Origin of Second Order Partial Differential Equations – Linear Partial Differential Equation with Constant Coefficients – Classification of Second Order Partial Differential Equation: Canonical Forms. Chapter1: Sections 1.1 – 1.3, 1.7 – 1.9 (Only 1.9.1 & 1.9.2) Chapter2: Sections 2.1, 2.2, 2.4	**15**	**CO4**	**K3, K4**

V	UNIT V – Elliptic Differential Equations: Occurrence of the Laplace and Poisson Equations – Boundary Value Problems – Separation of Variables Method. Parabolic Differential Equations: Occurrence and Derivation of the Diffusion Equation – Boundary Conditions – Separation of Variables Method. Hyperbolic Differential Equations: Occurrence of the Wave equation – Derivation of One- Dimensional Wave Equation – D'Alemberts Solution of One-Dimensional Wave Equation. Chapter 3: Sections 3.1 - 3.3 Chapter 4: 4.1 - 4.3 Chapter 5: 5.1, 5.2, 5.4	**15**	**CO5**	**K4, K5**

Prescribed Books/Textbook(s)

J.N. Sharma and K. Singh, Partial Differential Equations for Engineers and Scientists, Second Edition, Narosa Publishing House, New Delhi, 2009

Reference Books

1. G.F. Simmons, Differential Equations with Application and Historical Notes, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 1972
2. M.D. Raisinghania, Ordinary and Partial Differential Equations, Fifteenth Revised Edition, S. Chand & Company Ltd., 2013
3. D. Somasundaram, Ordinary Differential Equations, Narosa Publishing House, 2001

Web Resources

1. www.//gibbs.if.usp.br/~marchett/fismat2/linear-ode_coddington-carlson.pdf
2. www.math.iitb.ac.in>~siva>afso7
3. www.//www.math.psu.edu>notesDiffEqn
4. www.//lib.vcomsats.edu.pk/library/MTH343/COURSE%20CONTENT/HAND%20OUT/Hand_Outs%20MTH343.pdf
5. www.//www.goodreads.com/author/show/8004837.K_Sankara_Rao

Course Articulation Matrix for Ordinary and Partial Differential Equations

Course Outcome	Programme Outcomes							Programme Specific Outcomes							
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	Cog Level
CO 1	3	3	1	1	1	1	3	3	3	1	1	1	1	3	K2
CO 2	3	3	1	1	1	1	3	3	3	1	1	1	1	3	K4
CO 3	3	3	1	1	1	1	3	3	3	1	1	1	1	3	K3
CO 4	3	3	1	1	1	1	3	3	3	1	1	1	1	3	K2
CO 5	3	3	1	1	1	1	3	3	3	1	1	1	1	3	K3, K5
Avg.	3	3	1	1	1	1	3	3	3	1	1	1	1	3	

Course title:	**Mechanics**			
Course Code	**142MT1M04**			
Credits	**4**			
Hours / Cycle	**6**			
Category	**Mandatory**			
Semester	**I**			
Year of Implementation	**AY 2014-15**			
Course Structure	**Theory**	**Tutorial**	**Practical**	**Total Hours**
	75	**0**	**0**	**75**
Learning Objectives:	To demonstrate knowledge and understanding of the fundamental concepts in the dynamics of system of particles, motion of rigid body, Lagrangian and Hamiltonian formulation of mechanics To represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulation of classical mechanics. To understand theory of relativity, principles of deneral and special relativity and noyions of time dilation, dopler effect, accelerated systems, etc.			

Course Outcome(s)	**PSO Addressed**	**Bloom's Taxonomy Levels**
CO1: To establish a relation between work , Force , kinetic and potential Energy .	PSO1, PSO4, PSO7	K2, K3
CO2: To understand Lagranges , Hamilton's and Euler - Lagrange equations , and their applications .	PSO1, PSO4, PSO7	K2
CO3: To Classify forces , constraints and examine their applications	PSO1, PSO4, PSO7	K3
CO4: To understand the notions of time, space in theory of relativity	PSO1, PSO4, PSO7	K2
CO5: To comprehend the special and general theories, accelerated systems, relativistic dynamics	PSO1, PSO4, PSO7	K3, K5

Syllabus: Mechanics

Unit	**Content**	**Hours**	**COs**	**Bloom's Taxonomy Level**
I	UNIT I – Mechanical Systems: The Mechanical system – Generalised Coordinates – Constraints – Virtual Work – Energy and Momentum Chapter 1: Sections 1.1 – 1.5	**15**	**CO1**	K2, K3
II	UNIT II – Lagrange's Equations: Derivation of Lagrange's Equations – Examples.	**15**	**CO2**	K2

	Hamilton's Equations: Hamilton's Principle. Chapter 2: Sections 2.1, 2.2 Chapter 4: Section 4.1			
III	UNIT III – Hamilton's Equations – Hamilton's Equation. Hamilton-Jacobi Theory: Hamilton Principle function – Hamilton Jacobi Equation. Chapter 4: Section 4.2 Chapter 5: Sections 5.1, 5.2	**15**	**CO3**	K3
IV	UNIT IV – Introduction to Relativity: Introduction– Relativistic Kinematics. Chapter 7: Sections 7.1, 7.2	**15**	**CO4**	K2
V	UNIT V – Relativistic Dynamics, Accelerated Systems. Chapter 7: Sections 7.3, 7.4	**15**	**CO5**	K3, K5

Prescribed Books/Textbook(s)
Donald T. Greenwood, Classical Dynamics, Prentice-Hall Inc, 1977.

Reference Books

1. H. Goldstein, Classical Mechanics, Second Edition, Narosa Publishing House, New Delhi, 2000
2. N.C. Rana and P.S. Joag, Classical Mechanics, Tata Mc-Graw Hill Publishing Company Ltd., New Delhi, 1991

Web Resources

1. www.//gibbs.if.usp.br/~marchett/fismat2/linear-ode_coddington-carlson.pdf
2. www.math.iitb.ac.in>~siva>afso7
3. www.//www.math.psu.edu>notesDiffEqn

Course Articulation Matrix for Mechanics

Course Outcome	Programme Outcomes							Programme Specific Outcomes							
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**Cog Level**
CO 1	**3**	**2**	**1**	**3**	**1**	**1**	**3**	**3**	**2**	**1**	**3**	**1**	**1**	**3**	**K2, K3**
CO 2	**3**	**2**	**1**	**3**	**1**	**1**	**3**	**3**	**2**	**1**	**3**	**1**	**1**	**3**	**K2**
CO 3	**3**	**2**	**1**	**3**	**1**	**1**	**3**	**3**	**2**	**1**	**3**	**1**	**1**	**3**	**K3**

CO 4	**3**	**2**	**1**	**3**	**1**	**1**	**3**	**3**	**2**	**1**	**3**	**1**	**1**	**3**	**K2**
CO 5	**3**	**2**	**1**	**3**	**1**	**1**	**3**	**3**	**2**	**1**	**3**	**1**	**1**	**3**	**K3, K5**
Avg.	**3**	**2**	**1**	**3**	**1**	**1**	**3**	**3**	**2**	**1**	**3**	**1**	**1**	**3**	

Course title:	**Graph Theory**			
Course Code	**142MT1M05**			
Credits	**4**			
Hours / Cycle	**6**			
Category	**Mandatory**			
Semester	**I**			
Year of Implementation	**AY 2014-15**			
Course Structure	**Theory**	**Tutorial**	**Practical**	**Total Hours**
	75	**0**	**0**	**75**
Learning Objectives:	To understand and apply the fundamental concepts in graph theory To apply graph theory based tools in solving practical problems To improve the proof writing skills.			

Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels
CO1 To understand the basic ideas of graphs and developments.	PSO1, PSO2, PSO3, PSO7	K2
CO2: To understand the various graph structures and their properties in solving the underlying physical problems.	PSO1, PSO2, PSO3, PSO7	K2, K3
CO3: To know the connectivity concepts and its importance and to realize the Eulerian and Hamiltonian circuits..	PSO1, PSO2, PSO3, PSO7	K3, K4
CO4: To discuss the importance of matching, covering and colouring concepts.	PSO1, PSO2, PSO3, PSO7	K4
CO5: To analyse the planar graphs and its properties	PSO1, PSO2, PSO3, PSO7	K4, K5

Syllabus: Graph Theory

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	UNIT I – Graphs and Subgraphs: Graphs and Simple Graphs – Graph Isomorphism – The Incidence and Adjacency Matrices – Subgraphs – Vertex Degrees – Paths and Connection – Cycles. Trees: Trees – Cut Edges and Bonds – Cut Vertices. Chapter 1: Sections 1.1 – 1.7 Chapter 2: Sections 2.1 – 2.3	**15**	**CO1**	**K2**
II	UNIT II – Connectivity: Connectivity – Blocks. Euler Tours and Hamilton Cycles: Euler Tours – Hamilton Cycles – The Chinese Postman Problem Chapter 3: Sections 3.1, 3.2 Chapter 4: Sections 4.1 – 4.3	**15**	**CO2**	**K2, K3**
III	UNIT III – Matchings: Matchings – Matchings and Coverings in Bipartite graphs. Edge Colourings: Edge Chromatic number – Vizing's Theorem. Chapter 5: Sections 5.1, 5.2 Chapter 6: Sections 6.1, 6.2	**15**	**CO3**	**K3, K4**
IV	UNIT IV – Independent Sets and Cliques: Independent Sets – Ramsey's Theorem. Vertex Colorings: Chromatic Number – Brook's Theorem – Chromatic Polynomials. Chapter 7: Sections 7.1, 7.2	**15**	**CO4**	**K4**

	Chapter 8: Sections 8.1, 8.2, 8.4			
V	UNIT V – Planar Graphs: Plane and Planar Graphs – Dual Graphs – Euler's Formula – The Five-Color Theorem and The Four-Color Conjecture. Chapter 9: Sections 9.1 – 9.3, 9.6	**15**	**CO5**	**K4, K5**

Prescribed Books/Textbook(s)

J.A. Bondy and U.S.R Murthy, Graph Theory and Applications, Macmillan, London, 1976.

Reference Books

1.J. Clark and D.A. Holton, A First Look at Graph Theory, Allied Publishers, New Delhi, 1995
2.R. Gould, Graph Theory, Benjamin/Cummings. Menlo Park,1989
3.K.R. Parthasarathy, Basic Graph Theory, Tata McGraw-Hill Publishing Company Limited, 1994
4.S.A. Choudum, A First Course in Graph Theory, Macmillan India Ltd., 1987
5.D.B. West, Introduction to Graph Theory, PHI Learning Private Ltd., New Delhi, 2001

Web Resources

1.www.zib.de/groetschel/teaching/WS1314/BondyMurtyGTWA.pdf
2. https://www.elsevier.com/mathematics
3. https://www.ejgta.org
4. www.graphtheorysoftware.com

Course Articulation Matrix for Graph Theory

Course Outcome	Programme Outcomes							Programme Specific Outcomes							
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	Cog Level
CO 1	3	2	3	2	1	1	3	3	2	3	2	1	1	3	K2
CO 2	3	2	3	2	1	1	3	3	2	3	2	1	1	3	K2, K3
CO 3	3	2	3	2	1	1	3	3	2	3	2	1	1	3	K3, K4
CO 4	3	2	3	2	1	1	3	3	2	3	2	1	1	3	K4
CO 5	3	2	3	2	1	1	3	3	2	3	2	1	1	3	K4, K5
Avg.	3	2	3	2	1	1	3	3	2	3	2	1	1	3	

Course title:	**Algebra II**			
Course Code	**142MT2M01**			
Credits	**5**			
Hours / Cycle	**6**			
Category	**Mandatory**			
Semester	**II**			
Year of Implementation	**AY 2014-15**			
Course Structure	**Theory**	**Tutorial**	**Practical**	**Total Hours**
	75	**0**	**0**	**75**
Learning Objectives:	To understand the extensions of a field in the light of irreducible polynomials. To understand and identify the relationship between Galois groups To develop the ability to determine the nature of fileds To verify and evaluate the nature of given polynomials			
Course Outcome(s)	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**		
CO1: Understand the concept of extensions of a field, based on the study of irreducible polynomials.	PSO1, PSO2, PSO7	K1, K2		
CO2: Identify the relationship between the roots of the polynomial and its Galois group	PSO1, PSO2, PSO7	K2, K3		

CO3: Analyzing Galois groups in simple cases and to apply the group theoretic information to deduce results about fields and polynomials	PSO1, PSO2, PSO7	K1, K3
CO4: Determine the nature of fields having only a finite number of elements	PSO1, PSO2, PSO7	K3, K4
CO5:Verify the given polynomial is solvable by radicals or not	PSO1, PSO2, PSO7	K3, K5

Syllabus: Algebra II

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	UNIT I – Extension Fields – The Transcendence of e. Chapter 5: Sections 5.1, 5.2	**15**	**CO1**	K1, K2
II	UNIT II – Roots of Polynomials – More About Roots. Chapter 5: Sections 5.3, 5.5	**15**	**CO2**	K2, K3
III	UNIT III – The Elements of Galois Theory. Chapter 5: Section 5.6	**15**	**CO3**	K1, K3
IV	UNIT IV – Finite Fields – Wedderburn's Theorem on Finite Division Rings. Chapter 7: Sections 7.1, 7.2 (Theorem 7.2.1 only)	**15**	**CO4**	K3, K4
V	UNIT V – Solvability by Radicals – A Theorem of Frobenius – Integral Quaternions and the Four-Square Theorem. Chapter 5: Section 5.7 (Omit Lemma 5.7.1 Lemma 5.7.2 and Theorem 5.7.1). Chapter 7: Sections 7.3, 7.4	**15**	**CO5**	K3, K5

Prescribed Books/Textbook(s)

I. N. Herstein, Topics in Algebra, Second Edition, Wiley India Pvt. Ltd., New Delhi, 2006.

Reference Books

1.M. Artin, Algebra, Pearson - Prentice Hall, New Delhi, 2007
2.P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra, Second (Indian) Edition, Cambridge University Press, 1997
3.I.S. Luther and I.B.S. Passi, Algebra, Vol. I-Groups, Narosa Publishing House, New Delhi, 1996
4.I.S. Luther and I.B.S. Passi, Algebra, Vol. II-Rings, Narosa Publishing House, New Delhi,1999
5.D.S. Malik, J.N. Mordeson and M.K. Sen, Fundamentals of Abstract Algebra, McGraw-Hill (International Edition), New York. 1997
6.N. Jacobson, Basic Algebra, Vol. I & II, W.H. Freeman and co, USA, 1980

Web Resources

1. https://ocw.mit.edu/ (MIT OPEN COURSEWARE)

2. https://www.youtube.com/watch?v=Eao7SmYtMm4&list=PLOzRYVm0a65dsCb_gMYe3R-ZGs53jjw02 (NPTEL)

Course Articulation Matrix for **Algebra II**															
Course Outcome	**Programme Outcomes**							**Programme Specific Outcomes**							
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**Cog Level**
CO 1	**3**	**3**	**1**	**1**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**1**	**1**	**3**	**K1, K2**
CO 2	**3**	**3**	**1**	**1**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**1**	**1**	**3**	**K2, K3**
CO 3	**3**	**3**	**1**	**1**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**1**	**1**	**3**	**K1, K3**
CO 4	**3**	**3**	**1**	**1**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**1**	**1**	**3**	**K3, K4**
CO 5	**3**	**3**	**1**	**1**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**1**	**1**	**3**	**K3, K5**
Avg.	**3**	**3**	**1**	**1**	**1**	**1**	**3**	**3**	**3**	**1**	**1**	**1**	**1**	**3**	

Course title:	**Real Analysis II**			
Course Code	**142MT2M02**			
Credits	**5**			
Hours / Cycle	**6**			
Category	**Mandatory**			
Semester	**II**			
Year of Implementation	**AY 2014-15**			
Course Structure	**Theory**	**Tutorial**	**Practical**	**Total Hours**
	75	**0**	**0**	**75**
Learning Objectives:	To describe advavanced concepts of Lebesque measurability To demonstrate an understanding of Lebesgue integration and compare it with Riemann Integration To comprehend the concepts of Lebesgue measure in Euclidean space To appreciate how abstract ideas and rigorous methods in mathematical analysis can be applied to important practical problems.			
Course Outcome(s)	**PSO Addressed**	**Bloom's Taxonomy Levels**		
CO1: To understand the concept of Lebesgue Outer measure and Lebesgue measurability	PSO1, PSO2, PSO7	K1, K4		
CO2: To apply the notion of Lebesgue integration and compare it with Riemann Integration	PSO1, PSO2, PSO7	K2, K3		
CO3: To generalize the concept of Lebesgue measure to Abstract Measure Spaces	PSO1, PSO2, PSO7	K2, K3		
CO4: To apply the ideas of Lebesgue measure for solving problems	PSO1, PSO2, PSO7	K3, K4		
CO5: To understand the concepts of Lebesgue measure in Euclidean space	PSO1, PSO2, PSO7	K3, K4		

Syllabus: Real Analysis II				
Unit	**Content**	**Hours**	**COs**	**Bloom's Taxonomy Level**
I	UNIT I – Measure on the Real Line: Lebesgue Outer Measure – Measurable Sets – Regularity – Measurable Functions – Borel and Lebesgue Measurability. Chapter 2: Sections 2.1 – 2.5	**15**	**CO1**	K1, K4
II	Unit II Integration of Functions of a Real Variable: Integration of Non-Negative Functions – The General Integral – Integration of Series – Riemann and Lebesgue Integrals. Chapter 3	**15**	**CO2**	K2, K3
III	UNIT III – Abstract Measure Spaces: Measures and Outer measures – Extension of a Measure – Uniqueness of the Extension – Completion of a Measure – Measure Spaces – Integration with respect to a Measure. Inequalities and the L^p Spaces: The L^p Spaces – The Inequalities of Holder and Minkowski (Statements only) – Completeness of $L^p(\mu)$. Chapter 5, Chapter 6: Sections 6.1, 6.4, 6.5 (Section 6.4: Statements of Theorems 7 and 8 only)	**15**	**CO3**	K2, K3
IV	UNIT IV – Signed Measures and Their Derivatives: Signed Measure and Hahn Decomposition – The Jordan Decomposition – The Radon-Nikodym Theorem – Some Applications of the Radon-Nikodym Theorem. Chapter 8: Sections 8.1 – 8.4	**15**	**CO4**	K3, K4
V	UNIT V – Measure and Integration in a Product Space: Measurability in a Product Space – The Product Measure and Fubini's Theorem – Lebesgue Measure in Euclidean Space. Chapter 10: Sections 10.1 – 10.3	**15**	**CO5**	K3, K4

Prescribed Books/Textbook(s)

G. de Barra, Measure Theory and Integration, New Age International Pvt. Ltd., Publishers, New Delhi, 1981

Reference Books

1.J.C, Bukill, The Lebesgue Integral, Cambridge University Press, 1951
2.M.E. Munroe, Measure and Integration. Addison Wesley Mass., 1971
3.H.L. Roydon, Real Analysis, Macmillan Publishing Company, New York,1988
4.W. Rudin, Principles of Mathematical Analysis, Wiley Eastern Limited, New Delhi, 1979
5.S. Arora and B. Lal, Introduction to Real Analysis, Satya Prakashan, New Delhi, 1991

Web Resources

1. https://ocw.mit.edu/ (MIT OPEN COURSEWARE)
2. https://www.youtube.com/watch?v=lgZJohjjs10&list=PLgMDNELGJ1CYKDzKdGcM1-kuH_a1NCfQA (NPTEL)

Course Articulation Matrix for **Real Analysis II**															
Course Outcome	**Programme Outcomes**							**Programme Specific Outcomes**							
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**Cog Level**
CO 1	3	3	1	1	1	1	3	3	3	1	1	1	1	3	K1, K4
CO 2	3	3	1	1	1	1	3	3	3	1	1	1	1	3	K2, K3
CO 3	3	3	1	1	1	1	3	3	3	1	1	1	1	3	K2, K3
CO 4	3	3	1	1	1	1	3	3	3	1	1	1	1	3	K3, K4
CO 5	3	3	1	1	1	1	3	3	3	1	1	1	1	3	K3, K4
Avg.	3	3	1	1	1	1	3	3	3	1	1	1	1	3	

Course title:	Number Theory and Cryptography			
Course Code	142MT2M03			
Credits	**4**			
Hours / Cycle	**6**			
Category	**Mandatory**			
Semester	**II**			
Year of Implementation	**AY 2014-15**			
Course Structure	**Theory**	**Tutorial**	**Practical**	**Total Hours**
	75	**0**	**0**	**75**
Learning Objectives:	To demonstrate an understanding of the mathematical underpinning of cryptography To explain the fundamentals of cryptography, such as encryption, digital signatures and secure hashes To select appropriate techniques and apply them to solve a given problem To design and evaluate security protocols appropriate for a given situation			

Course Outcome(s)	**PSO Addressed**	**Bloom's Taxonomy Levels**
CO1: Understand different bases of number system and arithmetic operations in them with the estimates of the number of bit operations required to perform certain number theoretic tasks using computers.	PSO1, PSO2, PSO3, PSO7	K2
CO2: Learn to compute the greatest common divisor of pair of positive integers using Euclidean algorithm and other arithmetic operations like modular exponentiation, solving congruences and factorizing integers.	PSO1, PSO2, PSO3, PSO7	K3
CO3: Explain the concept of finite fields and identify the primitive roots of unity, quadratic residues and non-residues.	PSO1, PSO2, PSO3, PSO7	K3
CO4: Identify the basics of cryptosystems and the key elements in it together with different types of symmetric key cryptosystems.	PSO1, PSO2, PSO3, PSO7	K2, K3

CO5: Categorize different types of public key cryptosystems like RSA, Diffie-Hellman, Massey-Omura, Knapsack cryptosystems and analyse their limitations.	PSO1, PSO2, PSO3, PSO7	K3, K4

Syllabus: Number Theory and Cryptography

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	UNIT I – Some Topics in Elementary Number Theory: Time Estimates for Doing Arithmetic – Divisibility and Euclidean Algorithm – Congruences – Some Applications to Factoring. Chapter I: Sections 1 – 4	**15**	**CO1**	K2
II	UNIT II - Finite Fields and Quadratic Residues: Finite Fields – Quadratic Residues and Reciprocity. Chapter II: Sections 1, 2 (Section 2: Omit square roots modulo p)	**15**	**CO2**	K3
III	UNIT III – Cryptography: Some Simple Cryptosystems – Enciphering Matrices Chapter III: Sections 1, 2	**15**	**CO3**	K3
IV	UNIT IV – Public Key: The Idea of Public Key Cryptography – RSA – Discrete Log – Knapsack. Chapter IV: Sections 1 – 4 (Section 3: Omit algorithms for finding discrete logs in finite fields and index-calculus algorithm for discrete logs)	**15**	**CO4**	K2, K3
V	UNIT V – Primality: Pseudoprimes Elliptic Curves: Basic Facts – Elliptic Curve Cryptosystems. Chapter V: Sections 1 (Up to Proposition V.1.5) Chapter VI: Sections 1, 2	**15**	**CO5**	K3, K4

Prescribed Books/Textbook(s)

N. Koblitz, A Course in Number Theory and Cryptography, Second Edition, Springer-Verlag, New York, 1994

Reference Books

1.I. Niven, S. Zuckermann and H.L Montgomery, An Introduction to Theory of Numbers, Fifth Edition, Wiley India Pvt. Ltd., New Delhi, 2012

2.D.M. Button, Elementary Number Theory, Seventh Edition, Tata McGraw-Hill Edition, Tata McGraw-Hill Education Pvt. Ltd., New Delhi, 2012

3.W. Stallings, Cryptography and Network Security Principles and Applications, Sixth Edition, Pearson Education in South Asia, 2014

4.R. D. Stinson, Cryptography Theory and Practice, Discrete Mathematics and its Application Series, Third Edition, Special Indian Edition, 2011

5.S. Vaudenay, A Classical introduction to Cryptography Applications for Communication Security, Springer International Edition, 2009

6.J. Buchmann, Introduction to Cryptography, Undergraduate Text in Mathematics, Second Edition, Springer, 2001
Web Resources 1. https://ocw.mit.edu/ (MIT OPEN COURSEWARE) 2. https://www.youtube.com/watch?v=iTVyKbDCJrA&list=PLgMDNELGJ1CbdGLyn7OrVAP-IKg-0q2U2 (NPTEL) 3. https://www.youtube.com/watch?v=u7cBLb0b7pk&list=PLOzRYVm0a65fuj_5fuj1BLeQNULrM4Irj (NPTEL)

Course Articulation Matrix for Number Theory and Cryptography

Course Outcome	Programme Outcomes							Programme Specific Outcomes							
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	Cog Level
CO 1	3	2	3	2	1	1	3	3	2	3	2	1	1	3	K2
CO 2	3	2	3	2	1	1	3	3	2	3	2	1	1	3	K3
CO 3	3	2	3	2	1	1	3	3	2	3	2	1	1	3	K3
CO 4	3	2	3	2	1	1	3	3	2	3	2	1	1	3	K2, K3
CO 5	3	2	3	2	1	1	3	3	2	3	2	1	1	3	K3, K4
Avg.	3	2	3	2	1	1	3	3	2	3	2	1	1	3	

Course title:	JAVA Programming			
Course Code	142MT2M04			
Credits	4			
Hours / Cycle	5			
Category	Mandatory			
Semester	II			
Year of Implementation	AY 2014-15			
Course Structure	**Theory**	**Tutorial**	**Practical**	**Total Hours**

	75	**0**	**0**	**75**
Learning Objectives:	To learn why Java is useful for the design of desktop and web applications. To learn how to implement object-oriented designs with Java. To identify Java language components and how they work together in applications. To design and program stand-alone Java applications.			
Course Outcome(s)	**PSO Addressed**	**Bloom's Taxonomy Levels**		
CO1: Describe the core syntax and semantics of java programming.	PSO1, PSO2, PSO5, PSO7	K2		
CO2: Learn about the control structures.	PSO1, PSO2, PSO5, PSO7	K2		
CO3: Inculcate knowledge on object oriented techniques, arrays and strings and interpret multiple inheritance in java.	PSO1, PSO2, PSO5, PSO7	K3		
CO4: Implement multithreading concepts in java programs and to manage errors and exceptions.	PSO1, PSO2, PSO5, PSO7	K4		
CO5: Design webpages with applets.	PSO1, PSO2, PSO5, PSO7	K4		

Syllabus: JAVA Programming

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	UNIT I – Constants, Variables and Data Types – Operators and Expressions. Chapters: 4, 5	**15**	**CO1**	K2
II	UNIT II - Decision Making and Branching – Decision Making and Looping. Chapters: 6, 7	**15**	**CO2**	K2
III	UNIT III – Classes, Objects and Methods – Arrays, Strings and Vectors – Multiple Inheritance. Chapters: 8, 9, 10	**15**	**CO3**	K3
IV	UNIT IV – Multithreaded Programming – Managing Errors and Exceptions. Chapters: 12, 13	**15**	**CO4**	K4
V	UNIT V – Applet Programming. Chapter: 14	**15**	**CO5**	K4

Prescribed Books/Textbook(s)

E. Balagurusamy, Programming with Java – A Primer, Tata McGraw-Hill Education Private Ltd., New Delhi, 2010.

Reference Books

1.M. Waite and R. Lafore, Data Structures and Algorithms in Java, Techmedia (Indian Edition), New Delhi, 1999

2.A. Drozdek, Data Structures and Algorithms in Java, (Brown/Cole), Vikas Publishing House, New Delhi, 2001

3.H. Schildt, Java: The Complete Reference, Eight Edition, Tata McGraw-Hill Education Private Limited, 2011

Web Resources

1. https://ocw.mit.edu/ (MIT OPEN COURSEWARE)
2. https://www.youtube.com/watch?v=OjdT2l-EZJA&list=PLfn3cNtmZdPOe3R_wO_h540QNfMkCQ0ho

Course Articulation Matrix for JAVA Programming

Course Outcome	Programme Outcomes							Programme Specific Outcomes							
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	Cog Level
CO 1	3	2	1	1	3	1	3	3	2	1	1	3	1	3	K2
CO 2	3	2	1	1	3	1	3	3	2	1	1	3	1	3	K2
CO 3	3	2	1	1	3	1	3	3	2	1	1	3	1	3	K3
CO 4	3	2	1	1	3	1	3	3	2	1	1	3	1	3	K4
CO 5	3	2	1	1	3	1	3	3	2	1	1	3	1	3	K4
Avg.	3	2	1	1	3	1	3	3	2	1	1	3	1	3	

Computer Laboratory Exercises (JAVA Programming)

1. Design a class to represent a bank Account. Include the following members:

Data Members	Methods
(1)Name of the Depositor	(1) To Assign initial values.
(2)Account Number	(2) To deposit an amount.
(3)Type of account	(3) To withdraw an amount after checking the balance.
(4)Balance	(4) To display the name and balance.

Write a Java program for handling 10 customers.

2. Java lacks a complex datatype. Write a complex class that represents a single Complex number and includes methods for all the usual operations, ie: addition, subtraction, multiplication, division.

3. Write a Java program to handle different types of exceptions using try, catch and finally statements

4. Write a Java program to implement the behavior of threads.

(a)To create and run threads.

(b)To suspend and stop threads.

(c)To move a thread from one state to another.

(d)By assigning a prioity for each thread.

5.Write an applet to draw the following shapes:

a) Cone

b) Cylinder

c) Cube

d) Square inside a circle

e) Circle inside a square.

6. Creating a Java applet which finds palindromes in sentences. Your applet will have two input controls; One input will be a text field for entering sentences, the other input will be a text field or scroll bar for selecting the minimum length a palindrome to be shown. Your applet will output the first 10 palindromes it finds in the sentence.

7. Write a program which displays a text message coming down the screen by moving left to right and modify the above program instead of text moving from left to right it moves top to bottom.

8. Create a frame that contains 3 text fields and four buttons for basic arithmetic operations. You have to enter two numbers in first two text fields. On clicking the respective button that answer should be displayed in the last text filed.

9. Create a frame with check box group containing Rectangle, Circle, Triangle, Square. If the particular value is true then the corresponding shape should be displayed.

Course title:	Operations Research			
Course Code	142MT2E05			
Credits	**4**			
Hours / Cycle	**5**			
Category	**Elective**			
Semester	**II**			
Year of Implementation	**AY 2014-15**			
Course Structure	**Theory**	**Tutorial**	**Practical**	**Total Hours**
	75	**0**	**0**	**75**
Learning Objectives:	To impart Optimization Techniques. To make the students become familiar with the basic principle of LPP and enrich knowledge to formulate and solve an LPP using various methods			
Course Outcome(s)	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**		
CO1: 1. To solve linear programming problems	PSO1, PSO2, PSO3, PSO7	K3		

using appropriate techniques		
CO2: To develop mathematical skills to analyse and solve integer programming using different methods such as fractional cut method, Branch and bound method, etc.	PSO1, PSO2, PSO3, PSO7	K2
CO3: Analyse dynamic programming algorithm and apply it to solve linear programming problems	PSO1, PSO2, PSO3, PSO7	K4
CO4: Understand the types of inventories and analyse the various factors affecting inventory control.	PSO1, PSO2, PSO3, PSO7	K2
CO5: To develop mathematical models to analyse and optimize inventory systems	PSO1, PSO2, PSO3, PSO7	K3, K5

Syllabus: Operations Research

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	UNIT I – Duality in Linear Programming: Dual Simplex Method. Linear Programming Problem – Advanced Techniques: Introduction – Revised Simplex Method – Simplex Method verses Revised Simplex Method. Chapter 5: Section 5.9 Chapter 9: Sections 9.1 – 9.3	**15**	**CO1**	K3
II	UNIT II - Integer Programming: Introduction – Pure and Mixed Integer Linear Programming Problems – Gomory's All I.P.P. Method – Construction of Gomory's Constraints – Fractional Cut Method – All Integer Programming – Fractional Cut Method-Mixed Integer LPP – Branch and Bound Method. Dynamic Programming: Introduction – The Recursive Equation Approach – Characteristic of Dynamic Programming – Dynamic Programming Algorithm – Solution of LPP by Dynamic Programming. Chapters 7: Sections 7.1 – 7.7 Chapter 13: Sections 13.1 – 13.4, 13.7	**15**	**CO2**	K2
III	UNIT III – Inventory Control: Introduction – Types of Inventories – Reasons for Carrying Inventories – The Inventory Decisions – Objectives of Scientific Inventory Control – Costs Associated with Inventories – Factors Affecting Inventory Control – An Inventory Control Problem – The Concept of EOQ – Deterministic Inventory	**15**	**CO3**	K4

	Problems with No Shortages – Deterministic Inventory Problems with Shortages. Chapter 19: Sections 19.1 – 19.11			
IV	UNIT IV – Queuing Theory: Introduction - Queuing System – Elements of a Queuing System – Operating Characteristics of a Queuing System – Deterministic Queuing System – Probability Distributions in Queuing Systems – Classification of Queuing Models – Definition of Transient and Steady States – Poisson Queuing Systems. Chapter 21: Sections 21.1 – 21.9 (models VII, VIII and IX are not included)	**15**	**CO4**	K2
V	UNIT V – Non-Linear Programming: Introduction – General Non-Linear Programming Problem – Constrained Optimization with Equality Constraints – Constrained Optimization with Inequality Constraints. Non-Linear Programming Methods: Introduction – Kuhn-Tucker Conditions with Non-Negative Constraints - Quadratic Programming – Wolfe's Modified Simplex Method – Beale's Method. Chapters 27: Sections 27.1, 27.3 – 27.5 (problems involving mathematical formation are not included). Chapter 28: Sections 28.1, 28.3 – 28.6	**15**	**CO5**	K3, K5

Prescribed Books/Textbook(s)

K. Swarup, P.K. Gupta and M. Mohan, Operations Research, Fifteenth Edition, Sultan Chand & Sons Educational Publishers, New Delhi, 2010

Reference Books

1 J.K. Sharma, Operations Research Theory and Applications, Second Edition, Macmillan (India) New Delhi, 2005
2 M. Mohan and P.K. Gupta, Problems in Operation Research, Twelfth Edition, Sultan Chand & Sons Educational Publishers, 2009
3 H.A. Taha, Operations Research, Seventh Edition, Prentice-Hall of India Private Limited, New Delhi, 1997
4 F.S. Hiller and J. Lieberman, Introduction to Operations Research, Seventh Edition, Tata McGraw-Hill Company, New Delhi, 2001

Web Resources

1. https://ocw.mit.edu/ (MIT OPEN COURSEWARE)
2. https://www.youtube.com/watch?v=66aKgySf9vo&list=PLLy_2iUCG87Bq8RGMTdeFZiB-87V4i9p1 (NPTEL)

Course Articulation Matrix for Operations Research

Course Outcome	Programme Outcomes							Programme Specific Outcomes							
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	Cog Level
CO 1	3	2	3	2	1	1	3	3	2	3	2	1	1	3	K3

CO 2	**3**	**2**	**3**	**2**	**1**	**1**	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**3**	**K2**
CO 3	**3**	**2**	**3**	**2**	**1**	**1**	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**3**	**K4**
CO 4	**3**	**2**	**3**	**2**	**1**	**1**	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**3**	**K2**
CO 5	**3**	**2**	**3**	**2**	**1**	**1**	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**3**	**K3, K5**
Avg.	**3**	**2**	**3**	**2**	**1**	**1**	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**3**	

Course title:	Graph Algorithms and Applications			
Course Code	142MT2E05			
Credits	**4**			
Hours / Cycle	**5**			
Category	**Elective**			
Semester	**II**			
Year of Implementation	**AY 2014-15**			
Course Structure	**Theory**	**Tutorial**	**Practical**	**Total Hours**
	75	**0**	**0**	**75**
Learning Objectives:	To understand graphical representations of real-life problems To understand techniques of searching, sorting of information To apply algorithms and efficiently solve problems To compare algorithms and choose optimal and efficient methods			

Course Outcome(s)	**PSO Addressed**	**Bloom's Taxonomy Levels**
CO1: To understand and execute the Breadth and Depth first search algorithms on directed or undirected graphs and to represent graphs using the adjacency list or adjacency matrix representations. To apply the Depth-First search to toplogically sort a graph.	PSO1, PSO2, PSO3, PSO7	K2
CO2: To understand the minimum spanning tree problem and to gain a thorough understanding of how to grow a minimum spanning tree for a given	PSO1, PSO2, PSO3, PSO7	K2

graph using the algorithms of Kruskal and Prim.		
CO3: To gain an understanding about single source shortest paths in directed graphs and directed acyclic graphs. To obtain the single source shortest paths using Bellman-Ford and Dijkstra's algorithms.	PSO1, PSO2, PSO3, PSO7	K3
CO4: To explore algorithms such as the Floyd Warshall algorithm and Johnson's algorithm to solve the all pairs shortest path problem in a given graph. To understand the relationship between matrix multiplication and the all pairs shortest path problem.	PSO1, PSO2, PSO3, PSO7	K4
CO5: To understand the concept of a "Flow Network" with the aid of real life examples. To increase the amount of flow in a flow network using the Ford-Fulkerson method and to apply this method to obtain a maximum bi-partite matching in a given graph	PSO1, PSO2, PSO3, PSO7	K2, K3

Syllabus: Graph Algorithms and Applications

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	UNIT I – Elementary Graph Algorithms: Representations of Graphs – Breadth-First Search – Depth-First Search – Topological Sort. Chapter 22: Section 22.1 – 22.4	**15**	**CO1**	K3
II	UNIT II - Minimum Spanning Trees: Growing a Minimum Spanning Tree – The Algorithms of Kruskal and Prim. Chapter 23: Sections 23.1 - 23.2	**15**	**CO2**	K2
III	UNIT III – Single-Source Shortest Paths: The Bellman-Ford Algorithm – Single-Source Shortest Paths in Directed Acyclic Graphs - Dijkstra's Algorithm. Chapter 24: Sections 24.1 – 24.3	**15**	**CO3**	K4

IV	UNIT IV – All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication - The Floyd-Warshall Algorithm – Johnson's Algorithm for Sparse Graphs. Chapter 25: Sections 25.1 – 25.3	**15**	**CO4**	K2
V	UNIT V – Maximum Flow: Flow Networks – The Ford-Fulkerson Method - Maximum Bipartite Matching. Chapter 26: Sections 26.1 – 26.3	**15**	**CO5**	K3, K5

Prescribed Books/Textbook(s)

T.H. Cormen, Charles E. Leiserson, R.L. Rivest and C. Stein, Introduction to Algorithms, Third Edition, PHI Learning Private Limited, 2009

Reference Books

1. S. Dasgupta, C.H. Papadimitriou and U. Vazirani, Algorithms, First Edition, McGraw-Hill Education, 2006
2. U. Manber, Introduction to Algorithms: A Creative Approach, Addison-Wesley, 1989
3. A.V. Aho, J.E. Hopcroft and J.D. Ullman, Data Structures and Algorithms, Addison-Wesley, 1983

Web Resources

1. https://ocw.mit.edu/ (MIT OPEN COURSEWARE)
2. https://ranger.uta.edu/~chqding/cse5311/Lectures/GraphTheory.pdf

Course Articulation Matrix for Graph Algorithms and Applications

Course Outcome	Programme Outcomes							Programme Specific Outcomes							
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	Cog Level
CO 1	3	2	3	2	1	1	3	3	2	3	2	1	1	3	K3
CO 2	3	2	3	2	1	1	3	3	2	3	2	1	1	3	K2
CO 3	3	2	3	2	1	1	3	3	2	3	2	1	1	3	K4
CO 4	3	2	3	2	1	1	3	3	2	3	2	1	1	3	K2
CO 5	3	2	3	2	1	1	3	3	2	3	2	1	1	3	K3, K5
Avg.	3	2	3	2	1	1	3	3	2	3	2	1	1	3	

Course title:	Complex Analysis -I			
Course Code	142MT3M01			
Credits	5			
Hours / Cycle	6			
Category	Mandatory			
Semester	III			
Year of Implementation	AY 2014 - 15			
Course Structure	Theory	Tutorial	Practical	Total Hours
Course Objectives:	To study the Cauchy's theory of analytic functions in a more general setting along with the properties of harmonic functions. To acquire knowledge of infinite products and entire functions and related theorems.			
Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K6)		
CO1: Remember singularities of analytic functions, homology and properties of harmonic functions. Recall series expansion of holomorphic functions and properties of Gamma function.	PSO1 PSO3 PSO4 PSO5 PSO6 PSO7	K1		
CO2: Examine zeros, poles and residues of analytic functions. Explain Poisson formula of harmonic functions, reflection principle and infinite products of complex numbers.	PSO1 PSO2 PSO5 PSO6 PSO7	K2		
CO3: Apply standard results in Cauchy's theory, classify simply connected domains and solve real integrals using Cauchy's residue theorem. Illustrate Weierstrass theorem and Jensen's formula.	PSO1 PSO2 PSO3 PSO5 PSO6 PSO7	K3		

CO4: Investigate Cauchy's integral formula for higher order derivatives, proof of general Cauchy's theorem, and mean value property of harmonic function. Analyse Taylor's series expansion for holomorphic functions and partial fractions of meromorphic functions.	**PSO1 PSO2 PSO3 PSO4 PSO5 PSO6 PSO7**	K4
CO5: Justify maximum principle and argument principle. Access methods of evaluation of integrals over unit circle. Design the proof of Laurent series and Hadamard's theorem.	**PSO1 PSO2 PSO3 PSO4 PSO5 PSO6 PSO7**	K5

Syllabus:

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Cauchy's Integral Formula**: The Index of a Point with Respect to a Closed Curve – The Integral Formula – Higher Derivatives. **Local Properties of Analytic Functions**: Removable Singularities – Taylor's Theorem – Zeros and Poles – The Local Mapping – The Maximum Principle. **Chapter 4: Sections 2.1 – 2.3, 3.1 – 3.4**	**20**	CO1 CO2 CO3 CO4 CO5	K1 K2 K3 K4 K5
II	**The General Form of Cauchy's Theorem**: Chains and Cycles – Simple Connectivity – Homology – The General Statement of Cauchy's Theorem – Proof of Cauchy's Theorem – Locally Exact Differentials – Multiply Connected Regions. **The Calculus of Residues**: The Residue Theorem – The Argument Principle. **Chapter 4: Sections 4.1 – 4.7, 5.1, 5.2**	**22**	CO1 CO2 CO3 CO4 CO5	K1 K2 K3 K4 K5
III	Evaluation of Definite Integrals. **Harmonic Functions**: Definition and Basic Properties – The Mean-Value Property – Poisson's Formula. **Chapter 4: Sections 5.3, 6.1 – 6.3**	**15**	CO1 CO2 CO3 CO4 CO5	K1 K2 K3 K4 K5
IV	Schwarz's Theorem – The Reflection Principle. **Power Series Expansions:** Weierstrass's Theorem – The Taylor Series – The Laurent Series. **Chapter 4: Sections 6.4, 6.5** **Chapter 5: Sections 1.1 – 1.3**	**15**	CO1 CO2 CO3 CO4 CO5	K1 K2 K3 K4 K5

V	**Partial Fractions and Factorization**: Partial Fractions – Infinite Products – Canonical Products – The Gamma Function. **Entire Functions**: Jensen's Formula – Hadamard's Theorem. **Chapter 5: Sections 2.1 – 2.4, 3.1, 3.2**	18	CO1 CO2 CO3 CO4 CO5	K1 K2 K3 K4 K5

Prescribed textbook(s)

L. V. Ahlfors, Complex Analysis, Third Edition, McGraw-Hill Book Company, New Delhi, 1979.

Reference books for further reading:

1. S. Ponnusamy, Foundations of Complex Analysis, Second Edition, Narosa Publishing Company, 2005.
2. S. Kumaresan, A Pathway to Complex Analysis, First Edition, Techno World, 2021.
3. J.B. Conway, Functions of One Complex Variable, Second Edition, Narosa Publishing House, New Delhi, 1978.

Suggested books for further reading:

1. R. Remmert, Theory of Complex Functions, Springer International Edition, 1991.
2. T. W. Gamelin, Complex Analysis, Springer International Edition, Springer-Verlag, New York Inc., 2001.
3. S.Lang, Complex Analysis, Third Edition, Springer, 1993.

Web resources:

https://archive.nptel.ac.in/courses/111/106/111106084/
https://www.swayamprabha.gov.in/index.php/program/archive_he/38
https://www.youtube.com/playlist?list=PLyqSpQzTE6M_fDgY78f5lAT5zR6xHAajo
https://ocw.mit.edu/courses/18-04-complex-variables-with-applications-spring-2018/

Course Articulation Matrix

Co	Programme Outcomes							Programme Specific Outcomes							K Level
	PO	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	
CO 1	3	-	2	1	2	2	1	3	-	2	1	2	2	1	K1
CO 2	3	2	-	-	1	1	2	3	2	-	-	1	1	2	K2
CO 3	3	1	3	1	1	1	1	3	1	3	1	1	1	1	K3
CO 4	2	3	3	1	1	2	2	2	3	3	1	1	2	2	K4
CO 5	3	2	3	1	1	3	2	3	2	3	1	1	3	2	K5
Avg.	2.8	2	2.75	1	1.2	1.8	1.6	2.8	2	2.75	1	1.2	1.8	1.6	
Avg.	1.593							1.593							

Course title:	Topology			
Course Code	142MT3M02			
Credits	5			
Hours / Cycle	6			
Category	Mandatory			
Semester	III			
Year of Implementation	AY 2014-15			
Course Structure	Theory	Tutorial	Practical	Total Hours
	90	0	0	90
Learning Objectives:	To introduce the fundamental concept of a topology on a set, surveying various topologies and to study the fundamental notions of connectedness and compactness in a much broader setting and to study the condition for metrizability			

Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels
CO1 : Recall the concept of topology on a set and of other various topologies and to recall fundamental concepts of connectedness and compactness along with the countability and separation axioms	PSO1,PSO2,PSO3 PSO6,PSO7	K1
CO2: CO2 : Compare different topologies that can be defined on a set and to discuss connectedness, compactness, countability axioms and separation axioms	PSO1,PSO2,PSO3 PSO6,PSO7	K2
CO3 Apply the fundamental notions in order to produce conditions for a set to satisfy connectedness, compactness and the condition of metrizability	PSO1,PSO2,PSO3 PSO6,PSO7	K3
CO4: Apply the fundamental notions in order to produce conditions for a set to satisfy connectedness, compactness and the condition of metrizability	PSO1,PSO2,PSO3 PS04, PSO6,PSO7	K4
CO5: Assess the concepts of various topologies in relation with connectedness, compactness and construct the conditions for metrizability	PSO1,PSO2,PSO3 PS04, PSO6,PSO7	K5

Syllabus:

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	Topological Spaces: Topological Spaces – Basis for a Topology – The Order Topology – The Product	18	CO1 CO2	K1,K2,K3 K4,K5

	Topology on $X \times Y$ – The Subspace Topology – Closed Sets and Limit Points. Chapter 2: Sections 12 – 17		CO3 CO4 CO5	
II	Continuous Functions: Continuous Functions – The Product Topology – The Metric Topology. Chapter 2: Sections 18 – 21	18	CO1 CO2 CO3 CO4	K1,K2,K3 K4,K5
III	Connectedness: Connected Spaces – Connected Subspace of the Real Line – Components and Local Connectedness. Chapter 3: Sections 23 – 25	18	CO1 CO2 CO3 CO4	K1,K2,K3 K4,K5
IV	Compactness: Compact Spaces – Compact Subspaces of the Real Line – Limit Point Compactness – Local Compactness. Chapter 3: Sections 26 – 29	18	CO1 CO2 CO3 CO4	K1,K2,K3 K4,K5
V	Countability and Separation Axiom: The Countability Axioms – The Separation Axioms – Normal Spaces – The Urysohn Lemma – The Urysohn Metrization Theorem – The Tietze Extension Theorem. Chapter 4: Sections 30 – 35	18	CO1 CO2 CO3 CO4 CO5	K1,K2,K3 K4,K5

Prescribed textbook(s)

J.R. Munkres, Topology, Second (Indian) Edition, PHI Learning Pvt. Ltd., New Delhi, 2000

Reference books for further reading

1. J. Dugundji, Topology, Prentice Hall of India, New Delhi, 1966
2. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Education (India) Pvt. Ltd., New Delhi, 1963
3. J.L.R. Kelly, General Topology, Van Nostrand, Reinhold Co., New York, 1955

Suggested reading

1. L. Steen and J. Seeback, Counter Examples in Topology, Holt, Rinehart and Winston, New York, 1970
2. Steven G. Krantz, Essentials of Topology with Applications, Special Indian Edition, CRC Press, 2015

Web resources:

https://ocw.mit.edu/courses/18-901-introduction-to-topology-fall-2004/

https://onlinecourses.nptel.ac.in/noc23_ma99/preview

https://onlinecourses.nptel.ac.in/noc24_ma10/preview

Course Articulation Matrix															
Co	Programme Outcomes							Programme Specific Outcomes							K Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	
CO 1	3	2	1	-	-	1	2	3	2	1	-	-	1	2	K1
CO 2	3	2	2	-	-	2	3	3	2	2	-	-	2	3	K2
CO 3	3	2	2	-	-	2	2	3	2	2	-	-	2	2	K3
CO 4	2	1	3	2	-	2	2	2	1	3	2	-	2	2	K4
CO 5	1	2	1	2	-	2	3	1	2	1	2	-	2	3	K5
Avg.	2.4	1.8	1.6	2	-	1.8	2.4	2.4	1.8	1.6	2	-	1.8	2.4	
	2							2							

Course title	FORMAL LANGUAGES AND AUTOMATA		
Course Code	142MT3M03		
Credits	4		
Hours / Cycle	6		
Category	Core		
Semester	III		
Year of Implementation	AY 2014-15		
Course Structure	Theory	Practical	Total Hours
	90	-	90
Course Objectives:	To familiarise students with the foundations and principles of Automata theory and to strengthen their ability to carry out formal and rigorous arguments.		
Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Level	
CO1: Recall the notions of automata, formal languages, machine models, grammar structures and their properties.	PSO 1, PSO2, PSO3, PSO4, PSO5, PSO 7	K1	
CO2: Examine the functioning of machine models, grammar schemes and discuss the properties of those machine models and grammar schemes.	PSO 1, PSO2, PSO3, PSO5, PSO6, PSO 7	K2	
CO3: Classify the variants among machine models(FSA, PDA) and grammar schemes(LLG, RLG,CFG), representation of languages and solve related problems.	PSO 1, PSO2, PSO3, PSO4, PSO5, PSO 7	K3	
CO4: Identify the families of languages and investigate the finer properties of such families of languages.	PSO2, PSO3, PSO4, PSO5, PSO6, PSO7	K4	
CO5: Design algorithms and construct decisions based on the	PSO2, PSO4, PSO5, PSO6,	K5	

properties of machine models and grammar schemes.	**PSO7**	

FORMAL LANGUAGES AND AUTOMATA Syllabus:				
Unit	**Content**	**Hours**	**Cos**	**Bloom's Taxonomy Level**
I	**Introduction to the Theory of Computation:** Three Basic Concepts. **Finite Automata:** Deterministic Finite Accepters – Nondeterministic Finite Accepters –Equivalence of Deterministic and Nondeterministic Finite Accepters. **Regular Languages:** Regular Expressions – Connection between Regular Expressions and Regular Languages. **Chapter 1: Section 1.2** **Chapter 2: Sections 2.1 – 2.3** **Chapter 3: Sections 3.1, 3.2**	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5**
II	**Regular Grammars:** Regular Grammars. **Properties of Regular Languages:** Closure Properties of Regular Languages – Elementary Questions about Regular Languages – Identifying Nonregular Languages. **Chapter 3: Section 3.3** **Chapter 4: Sections 4.1 – 4.3**	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2 K3** **K4** **K5**
III	**Context-Free Languages:** Context-Free Grammars – Parsing and Ambiguity **Simplification of Context-Free Grammars and Normal Forms:** Methods for Transforming Grammars – Two Important Normal Forms. **Chapter 5: Sections 5.1, 5.2** **Chapter 6: Sections 6.1, 6.2**	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5**
IV	**Pushdown Automata:** Nondeterministic Pushdown Automata – Pushdown Automata and Context – Free Languages – Deterministic Pushdown Automata and Deterministic Context – Free Languages. **Chapter 7: Sections 7.1 – 7.3**	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5**
V	**Unit V** **Properties of Context-Free Languages:** Two Pumping Lemmas – Closure Properties and Decision Algorithms for Context – Free Languages.	**18**	**CO1** **CO2**	**K1 K2**

	Chapter 8		**CO3** **CO4** **CO5**	**K3** **K4** **K5**

Prescribed textbook(s)

P. Linz, An Introduction to Formal Languages and Automata, Sixth Edition, Jones & Bartlett Learning, LLC, First Indian Edition, 2017

Reference books:

1. J.E. Hopcroft and J.D. Ullman, Introduction to Automata Theory, Languages, and Computation, Narosa Publishing House, New Delhi, 1989
2. M. Sipser, Introduction to Theory of Computation, PWS Publishing Company, 1997
3. D. C. Kozen, Automata and Computability, Springer, New York, 1997
4. K. Krithivasan and R. Rama, Introduction to Formal Languages, Automata Theory and Computation, Pearson, New Delhi, 2009

Suggested books for further reading :

Grzegorz Rozenberg, Arto Salomaa, *Handbook of Formal Languages: Volume I-III*, Springer, 1997, ISBN 3-540-61486-9

.Web resources:

1. https://archive.nptel.ac.in/courses/106/103/106103070/#
2. https://ocw.mit.edu/courses/6-045j-automata-computability-and-complexity-spring- 2011/pages/lecture-notes/
3. https://www.iitg.ac.in/dgoswami/Flat-Notes.pdf

FORMAL LANGUAGES AND AUTOMATA Course Articulation Matrix

CO	Programme Outcomes							Programme Specific Outcomes							K Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	
CO 1	3	2	1	1	2	-	2	3	2	1	1	2	-	2	K1
CO 2	2	3	2	-	2	1	3	2	3	2	-	2	1	3	K2
CO 3	2	2	3	2	1	-	2	2	2	3	2	1	-	2	K3
CO 4	-	2	3	3	1	1	1	-	2	3	3	1	1	1	K4
CO 5	-	3	-	3	2	1	3	-	3	-	3	2	1	3	K5
Avg.	2.33	2.4	2.25	2.25	1.6	1	2.2	2.33	2.4	2.25	2.25	1.6	1	2.2	
	2							2							

Course title:	**INTEGRAL EQUATIONS AND CALCULUS OF VARIATIONS**			
Course Code	**142MT3E05**			
Credits	**5**			
Hours / Cycle	**5**			
Category	**Elective**			
Semester	**II**			
Year of Implementation	**AY 2014-15**			
Course Structure	**Theory**	**Tutorial**	**Practical**	**Total Hours**
Course Objectives:	To study various techniques of solving different types of integral equations and to know about the methods of solving different variational problems under fixed and moving boundary conditions			

Course Outcome(s)	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
CO1: Remember regularity conditions, Volterra and Fredholm integral equations and symmetric integral equations. Recall Euler equations and moving boundary problems.	**PSO1 PSO3 PSO4 PSO5 PSO6 PSO7**	**K1**
CO2: Examine systems of algebraic equations corresponding to Integral equations with separable kernels, resolvent kernel and eigen value problems. Compare different extremal problems based on corresponding Euler equations and moving boundary problems with more than one variable.	**PSO1 PSO2 PSO5 PSO6 PSO7**	**K2**
CO3: Apply approximate method, Fredholm method to solve Integral equations and Bilinear Form .Illustrate variational problems involving higher order derivatives and extremals using corners.	**PSO1 PSO2 PSO3 PSO5 PSO6 PSO7**	**K3**
CO4: Analyse Fredholm alternatives, iterative scheme , Hilbert-Schmidt Theorem and Investigate variational problems in parametric form and canonical forms of Euler's equation.	**PSO1 PSO2 PSO3 PSO4 PSO5 PSO6 PSO7**	**K4**
CO5: Evaluate Eigen values and Eigen functions of an integral equation and solutions of Volterra Integral equations by method of successive approximations Cauchy-Type	**PSO1 PSO2 PSO3 PSO4 PSO5**	**K5**

Integrals. Design solutions to practical variational problems and one-sided variational problem.	**PSO6** **PSO7**	

Syllabus:

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Introduction:** Definition – Regularity Conditions – Special Kinds of Kernels – Eigenvalues and Eigenfunctions – Convolution Integral – The Inner or Scalar Product of Two Functions. **Integral Equations with Seperable Kernels:** Reduction to a system of Algebraic Equations – Examples – Fredholm Alternatives – Examples – An Approximate Method. **Chapter 1: Sections 1.1 – 1.6** **Chapter 2: Sections 2.1 – 2.5**	**15**	**CO1** **CO2** **CO3** **CO4** **CO5**	K1 K2 K3 K4 K5
II	**Method of Successive Approximations:** Iterative Scheme – Examples – Volterra Integral Equations – Examples – Some Results about the Resolvent Kernel. **Classical Fredholm Theory:** The Method of Solution of Fredholm – Fredholm's First Theorem (statement only) – Examples – Fredholm's Second Theorem (statement only) – Fredholm's Third Theorem (statement only). **Chapter 3: Sections 3.1 – 3.5** **Chapter 4: Sections 4.1 – 4.5**	**15**	**CO1** **CO2** **CO3** **CO4** **CO5**	K1 K2 K3 K4 K5
III	**Symmetric Kernels:** Introduction – Fundamental Properties of Eigenvalues and Eigen functions for Symmetric Kernels – Expansion in Eigen functions and Bilinear Form – Hilbert-Schmidt Theorem and Some Immediate Consequences – Solution of a Symmetric Integral Equation – Examples. **Singular Integral Equations:** The Abel Integral Equation – Examples – Cauchy Principal Value for Integrals – The Cauchy-Type Integrals – The Cauchy-Type Integral Equation on the Real Line. **Chapter 7: Sections 7.1 – 7.6** **Chapter 8: Sections 8.1 – 8.5**	**15**	**CO1** **CO2** **CO3** **CO4** **CO5**	K1 K2 K3 K4 K5
IV	**The Method of Variations in Problems with Fixed Boundaries:** Variations and its Properties – Euler's Equation – Functionals of the form $\int F(x, y_1, y_2, \cdots, y_n, y_1', y_2', \cdots, y_n')dx$ – Functionals Dependent on Higher Order Derivative – Functionals Dependent on the Functions of Several Independent Variables – Variational Problems in Parametric Forms – Some Applications. **Chapter 6: Sections 1 – 7.**	**15**	**CO1** **CO2** **CO3** **CO4** **CO5**	K1 K2 K3 K4 K5

V	**Variational Problems with moving Boundaries and Certain Other Problems:** An Elementary Problem with Moving Boundaries – The Moving Boundary Problem for a functional of the form $\int_{x_0}^{x_1} F(x,y,z,y',z')dx$ – Extremals with Corners – One-sided Variations. **Sufficient Conditions for an Extremum: Field of Extremals** – The function $E(x,y,p,y')$ – Transforming the Euler's Equations to the Canonical Form. **Chapter 7: Sections 1 – 4** **Chapter 8: Sections 1 – 3**	**15**	**CO1** **CO2** **CO3** **CO4** **CO5**	K1 K2 K3 K4 K5

Prescribed textbook(s)

1. Ram P.Kanwal, Linear Integral Equations – Theory and Technique, Birkhauser, 1997 Edition.

2. L.Elsgolts, Differential Equations and the Calculus of Variations, University Press of the Pacific, Honolulu, Hawaii, 2004.

Reference books for further reading:

1. I.M. Gelfand and S.V. Fomin, Calculus of Variations, Prentice-Hall Inc., New Jersey, 1963
2. A. Jeffrey, Integral Equations: A Short Course, International Textbook Company Ltd., Scotland, 1976.
3. M.Rahman, Integral Equations and Their Applications, WIT Press, Boston, 2007.

Suggested books for further reading :

1. A.S.Gupta, Calculus of Variations, Prentice Hall of India Pvt Ltd., 1996

Web resources:

https://nptel.ac.in/courses/111104025
https://www.youtube.com/watch?v=SWSkX_e_Yyk
https://ocw.mit.edu/courses/18-086-mathematical-methods-for-engineers-ii-spring-2006/e94c05947ed036cd6ad0150102087062_am72.pdf

Course Articulation Matrix

Co	Programme Outcomes							Programme Specific Outcomes							K Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	
CO 1	3	-	2	1	2	2	1	3	-	2	1	2	2	1	K1
CO 2	3	2	-	-	1	1	2	3	2	-	-	1	1	2	K2
CO 3	3	1	3	1	1	1	1	3	1	3	1	1	1	1	K3
CO 4	2	3	3	1	1	2	2	2	3	3	1	1	2	2	K4
CO 5	3	2	3	1	1	3	2	3	2	3	1	1	3	2	K5
Avg.	2.8	2	2.75	1	1.2	1.8	1.6	2.8	2	2.75	1	1.2	1.8	1.6	
Avg	1.593							1.593							

Course title:	DISCRETE MATHEMATICS			
Course Code	142MT3E05			
Credits	5			
Hours / Cycle	6			
Category	Elective			
Semester	I			
Year of Implementation	AY 2014-15			
Course Structure	Theory	Tutorial	Practical	Total Hours
Course Objectives:	To learn the foundations of Mathematical logic. To understand lattices and Boolean algebra. To assimilate the features of coding theory.			

Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K6)
CO1: Recall various logical connectives, rules of inferences, different types of lattices. Understand the concept of Boolean algebra and coding theory.	PSO1, PSO2, PSO3, PSO6, PSO7	K1
CO2: Compare different types of statements, quantifiers and lattices. Examine various properties of Boolean algebras. Discuss the relevance of coding theory and information theory.	PSO1, PSO2, PSO3, PSO6	K2
CO3: Illustrate equivalence of formulas, different normal form, inference theory, predicate calculus, Boolean functions, algebraic properties of lattices, encryption and decryption of different codes.	PSO1, PSO2, PSO3, PSO4, PSO6	K3
CO4: Investigate tautology, contradiction, validity of formulas, predicate calculus, different lattices and Boolean algebra. Analyze block codes, variable length codes and information theory.	PSO3, PSO4, PSO5, PSO6, PSO7	K4
CO5: Evaluate different statement formulas and determine properties of lattices and Boolean algebras. Justify the use of codes in information theory.	PSO1, PSO2, PSO3, PSO4, PSO5, PSO6, PSO7	K5

Syllabus:

Unit	Content	Hours	COs	Bloom's Taxonomy Level

I	Mathematical Logic: Statements and Notation – Connectives – Normal Forms. Chapter 1: Section 1.1 – 1.3 (Section 1.2: Omit 1.2.5, 1.2.12-1.2.15)	**18**	**CO1, CO2, CO3, CO4, CO5**	**K1, K2, K3, K4, K5**
II	Mathematical Logic: The Theory of Inference for the Statement Calculus – The Predicate Calculus – Inference Theory of the Predicate Calculus. Chapter 1: Sections 1.4 – 1.6	**16**	**CO1, CO2, CO3, CO4, CO5**	**K1, K2, K3, K4, K5**
III	Lattice and Boolean Algebra: Lattices as Partial Ordered sets – Boolean Algebra – Boolean Functions – Representation and Minimization of Boolean Functions. Chapter 4: Sections 4.1 – 4.4	**20**	**CO1, CO2, CO3, CO4, CO5**	**K1, K2, K3, K4, K5**
IV	Coding Theory: Error-Correcting Codes – Linear Codes. Chapter 11: Sections 11.1, 11.2	**18**	**CO1, CO2, CO3, CO4, CO5**	**K1, K2, K3, K4, K5**
V	Coding Theory: Variable Length and Hamilton Codes – Information Theory. Chapter 11: Sections 11.3,11.4	**18**	**CO1, CO2, CO3, CO4, CO5**	**K1, K2, K3, K4, K5**

Prescribed textbook(s)

1. J.P. Tremblay, R. Manohar, Discrete Mathematical Structure s with Applications to Computer Science, Tata McGraw-Hill Education Pvt Ltd., New Delhi, 1997. (For Units 1,2,3)
2. J. Truss, Discrete Mathematics for Computer Scientists, Second Edition, Pearson Education, 1998.(For Units 4,5).

Reference books for further reading:

1. T. Veerarajan, Discrete Mathematics with Graph Theory and Combinatorics, Tata McGraw-Hill Computer Science Series, 2007.
2. C.I. Liu, Elements of Discrete Mathematics, Second Edition, Tata McGraw-Hill Computer Science Series, 1986.
3. M.K. Venkataraman, N.Sridharan and N.Chandrasekaran, Discrete Mathematics, The National Publishing Company, 2011.

Suggested Readings:

1. B. Kolman, R. Busby, S.C. Ross, Discrete Mathematical Structures, Fifth edition, Prentice-Hall of India, 2005
2. N.L. Bigs, Codes: An introduction to Information Communication and Cryptography, Springer, 2008
3. J.H.V. Lint, Introduction to Coding Theory, Third edition, Springer, 2004

Web resources:

1. http://cectl.ac.in/images/pdf_docs/studymaterial/cse/s3/dcs4.pdf
2. https://home.iitk.ac.in/%7Earlal/book/mth202.pdf
3. https://nptel.ac.in/courses/106108227
4. https://archive.nptel.ac.in/courses/108/104/108104092/

Course Articulation Matrix															
Co	Programme Outcomes							Programme Specific Outcomes							K Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	
CO 1	3	3	3	-	-	1	1	3	3	3	-	-	1	1	K1
CO 2	3	2	3	-	-	3	-	3	2	3	-	-	3	-	K2
CO 3	3	2	3	2	-	3	-	3	2	3	2	-	3	-	K3
CO 4	-	-	3	2	3	2	3	-	-	3	2	3	2	3	K4
CO 5	2	2	3	3	3	3	3	2	2	3	3	3	3	3	K5
Avg.	2.75	2.25	3	2.33	3	2.4	2.33	2.75	2.25	3	2.33	3	2.4	2.33	
	2.58							2.58							

Course title:	**Mathematical Statistics**			
Course Code	**142MT3E04**			
Credits	**4**			
Hours / Cycle	**5**			
Category	**Core**			
Semester				
Year of Implementation	**AY 2024-25**			
Course Structure	**Theory**	**Tutorial**	**Practical**	**Total Hours**
Course Objectives:	To understand functions of random variables, probability distributions, tests of hypothesis, theory of estimation and inference.			

Course Outcome(s)	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
CO1: Recall the concepts related to random variable, functions of a random variable, probability distributions, sampling, estimators of a population parameter, testing of hypothesis.	**PSO 1**	**K1**
CO2: Examine the properties of mathematical expectation, variance, generating functions, probability distributions, sampling distributions, optimum tests of hypothesis	**PSO 1, PSO 2**	**K2**
CO3: To solve problems based on random variables, test of significance, methods of estimation, optimum test of hypothesis	**PSO 1, PSO 2**	**K3**
CO4: To differentiate between the generating functions, analyse results related to convergence in probability, exact sampling distributions, bounds for estimators	**PSO 3**	**K4**
CO5: To develop a framework for testing of hypothesis, design optimum tests under different conditions	**PSO 4**	**K5**

Syllabus:				
Unit	**Content**	**Hours**	**COs**	**Bloom's Taxonomy Level**
I	**Random Variables and Distribution Functions:** Introduction – Distribution function – Discrete Random Variable – Continuous Random Variable. **Mathematical Expectation:** Introduction – Mathematical Expectation of a Random Variable – Expected Value of Function of a Random Variable – Properties of Expectation – Properties of Variance – Covariance. **Chapter 5: Sections 5.1 – 5.4** **Chapter 6: Sections 6.1 – 6.6**	**15**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5**
II	**Generating Functions and Law of Large Numbers:** Moment Generating function – Cumulants – Characteristic Function – Some Important Theorems – Chebychev's Inequality – Convergence in Probability – Weak Law of Large Numbers – Borel Cantelli Lemma. **Probability Distributions:** Rectangular Distribution – Gamma Distribution – Beta Distribution of First Kind – Beta Distribution of Second Kind – Exponential Distribution **Chapter 7: Sections 7.1 – 7.8** **Chapter 9: Sections 9.3, 9.5 - 9.8**	**15**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5**
III	**Large Sample Theory:** Introduction – Types of Sampling – Parameter and Statistic – Test of Significance – Procedure for Testing of Hypothesis – Tests of Significance of Large Samples – Sampling of Attributes - Sampling of Variables. **Chapter 14**	**15**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5**
IV	**Theory of Estimation:** Introduction – Characteristics of Estimators – Cramer Rao	**15**	**CO1**	**K1**

	Inequality – Methods of Estimation – Confidence Interval and Confidence Limits. **Chapter 17: Sections 17.1 – 17.3, 17.6, 17.7**		**CO2** **CO3** **CO4** **CO5**	**K2** **K3** **K4** **K5**
V	**Testing of Hypothesis:** Introduction – Statistical Hypothesis – Steps in Solving Testing of Hypothesis Problem – Optimum Test under Different Situations – Neymann and Pearson Lemma –Likelihood Ratio Test. Chapter 18: Sections 18.1 – 18.5, 18.6.1, 18.6.2	**15**	**CO1** **CO2** **CO3** **CO4** **CO5**	**K1** **K2** **K3** **K4** **K5**

Prescribed textbook(s)

S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Eleventh Edition, SultanChand & Sons, New Delhi, June 2002

Reference books for further reading:

1. M. Fisz**,** Probability and Mathematical Statistics, John Wiley and Sons, New York, 1963
2. V.K. Rohatgi, An Introduction to Probability Theory and Mathematical Statistics, Wiley EasternLtd., New Delhi, 1988.
3. R.V. Hogg and A.T. Craig, Introduction to Mathematical Statistics, Fifth Edition, PearsonEducation Ltd., New Delhi, 2002
4. A.M. Mood, F.A. Graybill and D.C. Boes, Introduction to the Theory of Statistics, Third Edition,Mc-Graw Hill, Singapore, 1974

Web resources:

1. **https://ocw.mit.edu/courses/18-655-mathematical-statistics-spring-2016/pages/lecture-notes/**
2. **https://archive.nptel.ac.in/courses/111/105/111105041/**
3. **https://archive.nptel.ac.in/courses/111/105/111105043/**

Course Articulation Matrix															
Co	**Programme Outcomes**							**Programme Specific Outcomes**							**K Level**
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	
CO 1	**3**	**1**	**1**	**1**	**2**	**1**	**2**	**3**	**1**	**1**	**1**	**2**	**1**	**2**	**K1**
CO 2	**3**	**3**	**2**	**1**	**1**	**1**	**2**	**3**	**3**	**2**	**1**	**1**	**1**	**2**	**K2**
CO 3	**3**	**3**	**2**	**1**	**1**	**1**	**2**	**3**	**3**	**2**	**1**	**1**	**1**	**2**	**K3**
CO 4	**1**	**2**	**3**	**2**	**1**	**2**	**2**	**1**	**2**	**3**	**2**	**1**	**2**	**2**	**K4**
CO 5	**1**	**2**	**1**	**3**	**1**	**1**	**2**	**1**	**2**	**1**	**3**	**1**	**1**	**2**	**K5**
Avg.	**2.2**	**2.2**	**1.8**	**1.6**	**1.2**	**1.2**	**2**	**2.2**	**2.2**	**1.8**	**1.6**	**1.2**	**1.2**	**2**	

Course title:	Computational Geometry			
Course Code	142MT3E04			
Credits	4			
Hours / Cycle	5			
Category	Elective			
Semester	III			
Year of Implementation	AY 2024-25			
Course Structure	**Theory**	**Tutorial**	**Practical**	**Total Hours**
Course Objectives:	To equip the student with knowledge about algorithms that can be used to solve real life problems of geometric nature.			

Course Outcome(s)	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
CO1: Recall concepts of algorithms, data structures, application domains of computational geometry, polygon triangulations, Voronoi diagrams and meshes		**K1**
CO2: Explain geometrical concepts such as convex hulls, line segment intersection, doubly connected edge lists, monotone polygons, Delaunay triangulations and quadtrees. Explain degeneracies and robustness of algorithms.		**K2**
CO3: Apply the knowledge of algorithms to compute convex hulls, doubly connected edge lists, Voronoi diagrams, meshes etc.		**K3**
CO4: Analyse running time of algorithms used. Identify geometric properties of convex hulls, doubly connected edge lists, monotone polygons, Delaunay triangulations and quadtrees.		**K4**
CO5: Justify the correctness of the algorithms used. Assess and improve the algorithms by addressing their degeneracies and robustness.		**K5**

Syllabus:

Unit	**Content**	**Hours**	**COs**	**Bloom's Taxonomy Level**
I	**Line Segment Intersection:** An Example: Convex Hulls – Degeneracies and Robustness – Application Domains – Line Segment Intersection – The Doubly-Connected Edge List –	**15**	**CO1, CO2, CO3,**	**K1,K2,K3,K4,K5**

	Computing the Overlay of Two Subdivisions – Boolean Operations. **Chapter 1: Sections 1.1 – 1.3, Chapter 2: Sections 2.1 – 2.4**		**CO4, CO5**	
II	**Polygon Triangulation:** Guarding and Triangulations – Partitioning a Polygon into Monotone Pieces – Triangulating a Monotone Polygon. **Chapter 3: Sections 3.1 – 3.3**	**15**	**CO1, CO2, CO3, CO4, CO5**	**K1,K2,K3,K4,K5**
III	**Voronoi Diagrams:** Definition and Basic Properties – Computing the Voronoi Diagram – Voronoi Diagram of Line Segments. **Chapter 7: Sections 7.1 – 7.3**	**15**	**CO1, CO2, CO3, CO4, CO5**	**K1,K2,K3,K4,K5**
IV	**Delaunay Triangulations:** Triangulations of Planar Point Sets – The Delaunay Triangulation – Computing the Delaunay Triangulation. **Chapter 9: Sections 9.1 – 9.3**	**15**	**CO1, CO2, CO3, CO4, CO5**	**K1,K2,K3,K4,K5**
V	**Quadtrees:** Uniform and Non-Uniform Meshes – Quadtrees for Point Sets – From Quadtrees to Meshes. **Chapter 14: Sections 14.1 – 14.3**	**15**	**CO1, CO2, CO3, CO4, CO5**	**K1,K2,K3,K4,K5**

Prescribed textbook(s)

Mark de Berg, Otfried Cheong, Marc van Kreveld and Mark Overmars, Computational Geometry – Algorithms and Applications, Third Edition, Springer-Verlag, 2008

Reference books for further reading:

1. F.P. Preparata and M.I. Shamos, Computational Geometry – An Introduction, Springer International Edition, 1985
2. J. O'Rourke, Computational Geometry in C, Second Edition, Cambridge University Press, 1997

Web resources:

Course Articulation Matrix															
Co	Programme Outcomes							Programme Specific Outcomes							K Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	
CO 1	**3**	**2**	**3**	**2**	**1**	**1**	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**3**	K1
CO 2	**3**	**2**	**3**	**2**	**1**	**1**	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**3**	K2
CO 3	**3**	**2**	**3**	**2**	**1**	**1**	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**3**	K3
CO 4	**3**	**2**	**3**	**2**	**1**	**1**	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**3**	K4
CO 5	**3**	**2**	**3**	**2**	**1**	**1**	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**3**	K5
Avg.	**3**	**2**	**3**	**2**	**1**	**1**	**3**	**3**	**2**	**3**	**2**	**1**	**1**	**3**	

Course title:	**COMPLEX ANALYSIS -II**			
Course Code	**142MT4M01**			
Credits	**5**			
Hours / Cycle	**6**			
Category	**Elective**			
Semester	**IV**			
Year of Implementation	**AY 2014-15**			
Course Structure	Theory	Tutorial	Practical	Total Hours
Course Objectives:	To study specific complex-valued functions and analyze its applications enabling directions for advanced studies in Complex Analysis.			
Course Outcome(s)	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**		
CO1: Recall product development of zeta function extending it to the whole complex plane, boundary behavior of analytic function functions, simply and doubly periodic functions. Remember conformal mapping and analytic continuation.	**PSO1 PSO3 PSO4 PSO5 PSO6 PSO7**	K1		
CO2 Examine the functional equations, zeros of zeta function, behaviour at an angle and representation of periodic functions by exponentials. Explain Weierstrass theory of analytic functions, germs and sheafs.	**PSO1 PSO2 PSO5 PSO6 PSO7**	K2		
CO3: Apply Arzela's theorem to analytic functions. Illustrate mean value	**PSO1 PSO2**	K3		

properties of harmonic functions along with unimodular transformation. Classify functions (z) , $\sigma(z)$ and homotopy of curves.	**PSO3** **PSO5** **PSO6** **PSO7**	
CO4: Analyze equicontinuity on normal families and harmonic functions. Categorize general properties of elliptic functions, conformal mapping by $\lambda(\tau)$ and sections of Riemann surfaces.	**PSO1** **PSO2** **PSO3** **PSO4** **PSO5** **PSO6** **PSO7**	K4
CO5: Evaluate the classical definitions, the period module, differential equations of Weierstrass and construct proof of Riemann Mapping theorem and Monodromy theorem.	**PSO1** **PSO2** **PSO3** **PSO4** **PSO5** **PSO6** **PSO7**	K5

Syllabus:				
Unit	**Content**	**Hours**	**COs**	**Bloom's Taxonomy Level**
I	**Riemann Zeta Function**: Product Development – Extension of ζ(s) to the Whole Plane – The Functional Equation – The Zeros of the Zeta Function. **Normal Families**: Equicontinuity – Normality and Compactness – Arzela's Theorem – Families of Analytic Functions – The Classical Definition. **Chapter 5: Sections 4, 5**	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	K1 K2 K3 K4 K5
II	**The Riemann Mapping Theorem**: Statement and Proof – Boundary Behaviour – Use of the Reflection Principle. **A Closer Look at Harmonic Functions**: Functions with Mean-Value Property – Harnack's Principle.	**18**	**CO1** **CO2** **CO3** **CO4**	K1 K2 K3

	Chapter 6: Sections 1, 2, 3 (Section 1: Omit 1.4, Section 2: Omit 2.4)		**CO5**	K4 K5
III	**Simply Periodic Functions**: Representation by Exponentials – The Fourier Development – Functions of Finite Order. **Doubly Periodic Functions**: The Period Module – Unimodular Transformations – The Canonical Basis – General Properties of Elliptic Functions. **Chapter 7: Sections 1, 2**	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	K1 K2 K3 K4 K5
IV	**Weierstrass Theory**: The Weierstrass $\wp$-functions – The functions $\varsigma(z)$ and $\sigma(z)$ – The Differential Equation – **Chapter 7: Section 3.1 – 3.3**	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	K1 K2 K3 K4 K5
V	**Analytic Continuation**: The Weirstrass Theory – Germs and Sheaves – Sections and Riemann Surfaces – Analytic Continuations along Arcs – Homotopic Curves – The Monodromy Theorem – Branch Points. **Chapter 8: Section 1**	**18**	**CO1** **CO2** **CO3** **CO4** **CO5**	K1 K2 K3 K4 K5

Prescribed textbook(s)

L. V. Ahlfors, Complex Analysis, Third Edition, McGraw-Hill Book Company, New Delhi, 1979.

Reference books for further reading:

1. S. Ponnusamy, Foundations of Complex Analysis, Second Edition, Narosa Publishing Company, 2005.
2. S. Kumaresan, A Pathway to Complex Analysis, First Edition, Techno World, 2021.
3. J.B. Conway, Functions of One Complex Variable, Second Edition, Narosa Publishing House, New Delhi, 1978.

Suggested books for further reading:

1. R. Remmert, Theory of Complex Functions, Springer International Edition, 1991.
2. T. W. Gamelin, Complex Analysis, Springer International Edition, Springer-Verlag, New York Inc., 2001.
3. S.Lang, Complex Analysis, Third Edition, Springer, 1993.

Web resources:

https://archive.nptel.ac.in/courses/111/106/111106084/
https://ocw.mit.edu/courses/18-112-functions-of-a-complex-variable-fall-2008/pages/lecture-notes/
https://www.youtube.com/watch?v=EyBDtUtyshk

Course Articulation Matrix

Co	Programme Outcomes							Programme Specific Outcomes							K Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	
CO 1	3	-	2	1	2	2	1	3	-	2	1	2	2	1	K1
CO 2	3	2	-	-	1	1	2	3	2	-	-	1	1	2	K2

CO 3	**3**	**1**	**3**	**1**	**1**	**1**	**1**	**3**	**1**	**3**	**1**	**1**	**1**	**1**	K3
CO 4	**2**	**3**	**3**	**1**	**1**	**2**	**2**	**2**	**3**	**3**	**1**	**1**	**2**	**2**	K4
CO 5	**3**	**2**	**3**	**1**	**1**	**3**	**2**	**3**	**2**	**3**	**1**	**1**	**3**	**2**	K5
Avg.	**2.8**	**2**	**2.75**	**1**	**1.2**	**1.8**	**1.6**	**2.8**	**2**	**2.75**	**1**	**1.2**	**1.8**	**1.6**	
Avg.	**1.593**							**1.593**							

Course title:	**DIFFERENTIAL GEOMETRY**		
Course Code	**142MT4M02**		
Credits	**4**		
Hours / Cycle	**6**		
Category	**Core**		
Semester	**IV**		
Year of Implementation	**AY 2014-15**		
Course Structure	**Theory**	**Practical**	**Total Hours**
	90	**-**	**90**

Course Objectives:	To introduce the local and global properties of curves and surfaces. To study the first two fundamental forms of surfaces and their relevance to local properties along with the notion of geodesics on a surface	
Course Outcome(s)	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**
CO1 : Recall the notion of curvature of curves and surfaces along with the first and second fundamental forms and the notion of geodesic on a surface	**PSO1 PSO2 PSO3 PSO6 PSO7**	**K1**
CO2 : Explain the properties of various curves and surfaces	**PSO1 PSO2 PSO3 PSO6 PSO7**	**K2**
CO3: Apply the fundamental notions to classify different measures such as curvature, torsion, fundamental forms for curves and surfaces and to illustrate the concept of geodesic on a surface	**PSO1 PSO2 PSO3 PSO6 PSO7**	**K3**
CO4: Analyse curves and surfaces using their fundamental forms and	**PSO1 PSO2 PSO3**	**K4**

to investigate the properties of geodesics	**PSO4 PSO6 PSO7**	
CO5: Assess the nature of curves and surfaces along with properties of geodesics on surfaces	**PSO1 PSO2 PSO3 PSO4 PSO6 PSO7**	**K5**

DIFFERENTIAL GEOMETRY Syllabus:				
Unit	**Content**	**Hours**	**Cos**	**Bloom's Taxonomy Level**
I	**Curves:** Curve – Arc-length – Reparametrization. Curvature: Curvature – Plane Curves – Space Curves. **Chapter 1: Sections 1.1 – 1.3, Chapter 2: Sections 2.1 – 2.3**	**18**	**CO1 CO2 CO3 CO4 CO5**	**K1,K2,K3, K4,K5**
II	**Surfaces:** Surface – Smooth Surfaces – Tangents, Normals and Orientability – Examples of Surfaces – Quadric Surfaces – Triply Orthogonal Systems. **Chapter 4: Sections 4.1 – 4.6**	**18**	**CO1 CO2 CO3 CO4 CO5**	**K1,K2,K3, K4,K5**
III	**First Fundamental Form:** Lengths of Curves on Surfaces – Isometries of Surfaces – Conformal Mappings of Surfaces **Chapter 5: Sections 5.1 – 5.4**	**18**	**CO1 CO2 CO3 CO4 CO5**	**K1,K2,K3, K4,K5**
IV	**Curvature of Surfaces:** The Second Fundamental Form – The Curvature of Curves on Surfaces – The Normal and Principal Curvatures **Chapter 6: Sections 6.1 – 6.4,**	**18**	**CO1 CO2 CO3 CO4 CO5**	**K1,K2,K3, K4,K5**
V	**Gaussian Curvature** Gaussian and Mean Curvatures **Geodesics** Definition and Basic Properties – Geodesic Equations – Geodesics on Surfaces of Revolution **Chapter 7: Section 7.1 Chapter 8: Sections 8.1 – 8.3**	**18**	**CO1 CO2 CO3 CO4 CO5**	**K1,K2,K3, K4,K5**
Prescribed textbook(s): Andrew Pressley, Elementary Differential Geometry, Springer Undergraduate Mathematics Series, Springer, 2001**.**				

Reference books :

1. T. J. Wilmore, An Introduction to Differential Geometry, Oxford University Press, New Delhi, 1959
2. W. Klingenberg, A Course in Differential Geometry, Graduate Texts in Mathematics, Springer-Verlag 1978
3. J.A. Thorpe, Elementary Topics in Differential Geometry, Under Graduate Texts in Mathematics, Springer-Verlag 1979

Suggested books for further reading

1. D. Somasundaram, Differential Geometry – A First Course, Narosa Publishing House, 2005
2. Kristopher Tapp, Differential Geometry of Curves and Surfaces, Springer International Publishing Switzerland, 2016
3. https://press.princeton.edu/books/ebook/9780691219899/visual-differential-geometry-and- forms (e-book)

Web resources:

https://ocw.mit.edu/courses/18-950-differential-geometry-fall-2008/

https://nptel.ac.in/courses/111104095

DIFFERENTIAL GEOMETRY Course Articulation Matrix

Co	Programme Outcomes							Programme Specific Outcomes							K Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	
CO 1	3	2	1	-	-	1	2	3	2	1	-	-	1	2	K1
CO 2	3	2	2	-	-	2	3	3	2	2	-	-	2	3	K2
CO 3	3	2	2	-	-	2	2	3	2	2	-	-	2	2	K3
CO 4	2	1	3	2	-	2	2	2	1	3	2	-	2	2	K4
CO 5	1	2	1	2	-	2	3	1	2	1	2	-	2	3	K5
Avg.	2.4	1.8	1.6	2	-	1.8	2.4	2.4	1.8	1.6	2	-	1.8	2.4	
	2							2							

Course title:	FUNCTIONAL ANALYSIS		
Course Code	142MT4M03		
Credits	5		
Hours / Cycle	6		
Category	Core		
Semester	IV		
Year of Implementation	AY 2014-15		
Course Structure	Theory	Practical	Total Hours
	90	-	90
Course Objectives:			
Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Level	
CO1: Recall basic concepts such as normed linear Spaces, Linear operators, conjugate space, Banach algebra and commutative Banach algebras.	PSO1 PSO3 PSO6 PSO7	K1	
CO2: Examine the properties of continuous linear operators, orthogonal complements and adjoint of an operator. Explain regular elements and maximal ideals.	PSO1 PSO3 PSO6 PSO7	K2	
CO3: Illustrate Hahn-Banach theorem, conjugate of an operator, conjugate of Hilbert spaces. Classify topological	PSO1 PSO2 PSO3	K3	
divisors of zero and involutions in Banach algebras.	PSO6 PSO7		
CO4: Analyse second dual normed linear spaces, orthonormal sets and self-adjoint operators. Investigate singular elements and involutions in Banach algebras.	PSO1 PSO2 PSO6 PSO7	K4	
CO5: Assess the nature of a space and operators– Banach or Hilbert space, normal or unitary operators. Construct a formula for the spectral radius and the proof for Gelfand – Neumark Theorem.	PSO1 PSO2 PSO3 PSO6 PSO7	K5	

FUNCTIONAL ANALYSIS Syllabus:

Unit	Content	Hours	Cos	Bloom's Taxonomy Level
I	Banach Spaces: The Definition and Some Examples – Continuous Linear Transformations – The Hahn-Banach Theorem – The Natural Embedding of N in N^{**}. **Chapter 9: Sections 46 – 49**	**18**	**CO1 CO2 CO3 CO4 CO5**	**K1 K2 K3 K4 K5**
II	The Open Mapping Theorem – The Conjugate of an Operator. **Hilbert Spaces:** The Definition and Simple Properties – Orthogonal Complements – Orthonormal Sets. **Chapter 9: Sections 50, 51** **Chapter 10: Sections 52 – 54**	**18**	**CO1 CO2 CO3 CO4 CO5**	**K1 K2 K3 K4 K5**
III	The Conjugate Space $H*$ – The Adjoint of an Operator – Self-Adjoint Operators – Normal and Unitary Operators – Projections. **Chapter 10: Sections 55 – 59**	**18**	**CO1 CO2 CO3 CO4 CO5**	**K1 K2 K3 K4 K5**
IV	General Preliminaries on Banach Algebras: The Definition and some Examples – Regular and Singular Elements – Topological Divisors of Zero – The Spectrum – The Formula for Spectral Radius – The Radical and Semi-Simplicity. **Chapter 12: Sections 64 – 69**	**18**	**CO1 CO2 CO3 CO4 CO5**	**K1 K2 K3 K4 K5**
V	The Structure of Commutative Banach Algebras: The Gelfand Mapping – Applications of the Formula $r(x) = lim\|\|x^n\|\|^{\frac{1}{n}}$ – Involutions in Banach Algebras – Gelfand-Neumark Theorem. **Chapter 13: Sections 70 – 73**	**18**	**CO1 CO2 CO3 CO4 CO5**	**K1 K2 K3 K4 K5**
Prescribed textbook(s) G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill Education Pvt. Ltd., New Delhi, 1963				

Reference books:

1. M. Thamban Nair, Functional Analysis, A First Course, Prentice Hall of India Pvt. Ltd., New Delhi, 2002
2. H.C. Goffman and G. Fedrick, First Course in Functional Analysis, Prentice Hall of India Pvt. Ltd., New Delhi, 1987
3. E. Kreyzig, Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978
4. S. Ponnusamy, Foundations of Functional Analysis, Narosa Publishing House Pvt. Ltd., New Delhi, 2002
5. S.Kumaresan, D.Sukumar, Functional Analysis, A first course, Narosa Publishing House.

Suggested books for further readings:

1. W. Rudin, Functional Analysis, Tata McGraw-Hill Publishing Company Ltd., New Delhi 1973.
2. S. Kesavan, Topics in Functional Analysis and Applications, Wiley Eastern Ltd., New Delhi, 1988.
3. B.V. Limaye, Functional Analysis, Second Edition, New Age International Pvt. Ltd, 1997.

Web resources:

1. https://nptel.ac.in/courses/111106147
2. https://ocw.mit.edu/courses/18-102-introduction-to-functional-analysis-spring- 2021/video_galleries/lecture-videos/
3. https://onlinecourses.swayam2.ac.in/cec23_ma24/preview

FUNCTIONAL ANALYSIS Course Articulation Matrix

CO	Programme Outcomes							Programme Specific Outcomes							K Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	
CO 1	3	-	3	-	-	3	3	3	-	3	-	-	3	3	K1
CO 2	3	-	1	-	-	3	3	3	-	1	-	-	3	3	K2
CO 3	3	3	3	-	-	3	3	3	3	3	-	-	3	3	K3
CO 4	3	3	-	-	-	3	3	3	3	-	-	-	3	3	K4
CO 5	3	3	3	-	-	3	3	3	3	3	-	-	3	3	K5
Avg.	**3**	**3**	**2.5**	**-**	**-**	**3**	**3**	**3**	**3**	**2.5**	**-**	**-**	**3**	**3**	
Avg.	**2.9**							**2.9**							

Course title:	**Fluid Dynamics**			
Course Code	**142MT4E04**			
Credits	**4**			
Hours / Cycle	**5**			
Category	**Elective**			
Semester	**IV**			
Year of Implementation	**AY 2014-15**			
Course Structure	**Theory**	**Tutorial**	**Practical**	**Total Hours**
	75			**75**
Course Objectives:	To gain Knowledge on the behaviour of Fluids, equations of motion of fluids and 2D,3D flows.			
Course Outcome(s)	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**		
CO1 : Recall the concepts of streamlines, pathlines, pressure of a fluid, sources, sinks, doublets, stream functions and stress in a Real fluid.	**PSO1, PSO3, PSO6, PSO7**	**K1**		
CO2 : Compare fluids , various types of flows and explain velocity potentials, Axi-symmetry, Stoke's stream function, two dimensional flows and Laminar flow.	**PSO1, PSO2, PSO6, PSO7**	**K2**		
CO3: Solve problems applying equation of continuity, Bernoulli's equation, Axi-symmetry, complex velocity potentials and Navier-Stokes equation of motion.	**PSO1, PSO2, PSO3, PSO6, PSO7**	**K3**		
CO4: Categorize Local and particle rates of change and motion under conservative body forces. Investigate various cases of axi-symmetric flows, Stoke's stream function, complex velocity potentials for 2D-flow, Rate of strain and principal stresses.	**PSO1, PSO2, PSO6, PSO7**	**K4**		
CO5: Evaluate the equation of continuity, Bernoulli's equation, velocity potential for sources, sinks and doublets, problems on axi-symmetric flows , Milne-Thomson circle, and viscous flow.	**PSO1, PSO2, PSO3, PSO6, PSO7**	**K5**		

Syllabus:				
Unit	**Content**	**Hours**	**COs**	**Bloom's Taxonomy Level**
I	**Kinematics of Fluids in Motion :** Real Fluids and Ideal Fluids-Velocity of a Fluid at a point – Streamlines and Pathlines; Steady and Unsteady Flows – The Velocity Potential- The Velocity Vector – Local and Particle Rates of Changes- The Equation of Continuity-Worked Examples-Acceleration of a Fluid-Conditions at a Rigid Boundary. **Chapter 2: Sections 2.1-2.10**	**15**	**CO1, CO2, CO3, CO4, CO5**	**K1, K2, K3, K4, K5**
II	**Equations of Motion of a Fluid :** Pressure at a Point in a Fluid at Rest- Pressure at a point in a Moving Fluid-Conditions of a Boundary of Two Inviscid Immiscible Fluids - Euler's Equations of Motions – Bernoulli's Equation -Worked Examples-Discussion of the Case of Steady Motion under Conservation Body Forces – Some Flows Involving Axial symmetry- Some Further Aspects of Vortex Motion. **Chapter 3 : Sections 3.1-3.7, 3.9,3.12**	**15**	**CO1, CO2, CO3, CO4, CO5**	**K1, K2, K3, K4, K5**
III	**Some Three Dimensional Flows :** Introduction-Sources, Sinks and Doublets-Images in a Rigid Infinite Plane- Axi-Symmetric Flows; Stoke's Stream Function. **Chapter 4 : Sections 4.1-4.3, 4.5**	**15**	**CO1, CO2, CO3, CO4, CO5**	**K1, K2, K3, K4, K5**
IV	**Some Two Dimensional Flows :** Meaning of Two-Dimensional Flow- Use of Cylindrical Polar Coordinates – The Stream Function- The Complex Potential for Two-Dimensional Irrotational, Incompressible Flow -Complex Velocity Potentials for Standard Two-Dimensional Flows- Some Worked Examples- The Milne-Thomson Circle Theorem -The Theorem of Blasius. **Chapter 5: Sections 5.1-5.6, 5.8,5.9**	**15**	**CO1, CO2, CO3, CO4, CO5**	**K1, K2, K3, K4, K5**

V	**Viscous Flow :** Stress Components in a Real Fluid-Relations between Cartesian Components of Stress–Translational Motion of Fluid Element–The Rate of Strain Quadratic and Principal Stresses -Some Further Properties of the Rate of Strain Quadric-Stress Analysis in Fluid Motion- Relations between Stress and Rate of Strain-The Coefficient of Viscosity and Laminar Flow-The Navier-Stokes Equations of Motion of a Viscous Fluid-Some Solvable Problems in Viscous Flow. **Chapter 8: Sections 8.1-8.10**	15	**CO1, CO2, CO3, CO4, CO5**	

Prescribed textbook(s)

F. Chorlton, Text book of Fluid Dynamics, CBS Publishers and Distributors, New Delhi, 1985

Reference books for further reading:

1. S. Swarup, Fluid Dynamics, Krishna Prakashan Media Pvt. Ltd., Meerut, 1976.
2. R. K. Bansal, A textbook of Fluid Mechanics and Hydraulic Machines, Laxmi Publications Pvt. Ltd., New Delhi, 1983.
3. G.K.Batchelor,An Introduction to Fluid Dynamics, Cambridge Mathematical Library, 2nd Edition.
4. Yunus A. Cengel, John M. Climbala, Fluid mechanics fundamentals and Applications, Mc Graw Hill, Fourth edition in SI units.
5. R.K.Rajput,A Textbook of Fluid Mechanics, S.Chand, Revised Edition.

Web resources:

1. https://youtu.be/AirfUsq8aSo
2. https://www.edx.org/learn/fluid-mechanics/massachusetts-institute-of-technology-advanced-fluid-mechanics-1-fundamentals
3. https://ocw.mit.edu/courses/2-25-advanced-fluid-mechanics-fall-2013/

Course Articulation Matrix															
Co	**Programme Outcomes**							**Programme Specific Outcomes**							**K**
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**Level**
CO 1	3	3	1	1	1	3	3	3	1	3	1	1	3	3	K1
CO 2	3	3	1	1	1	3	3	3	3	1	1	1	3	3	K2
CO 3	3	3	1	1	1	3	3	3	3	3	1	1	3	3	K3
CO 4	3	3	1	1	1	3	3	3	3	1	1	1	3	3	K4
CO 5	3	3	1	1	1	3	3	3	3	3	1	1	3	3	K5
Avg.	3	3	1	1	1	3	3	3	2.6	2.2	1	1	3	3	

Course title:	THEORY OF COMPUTATION			
Course Code	142MT4E05			
Credits	5			
Hours / Cycle	6			
Category	Elective			
Semester	IV			
Year of Implementation	AY 2014-15			
Course Structure	Theory	Tutorial	Practical	Total Hours
	75			75
Course Objectives:	To design different variations and models of Turing machines. To categorize different grammar systems. To distinguish decidable and undecidable problem. To learn complexity classes.			

Course Outcome(s)	PSO Addressed	Bloom's Taxonomy Levels (K1 to K6)
CO1: Recall the basics of computation models, their relationships and relevant definitions.	PSO1, PSO2, PSO3, PSO4	K1
CO2: Discuss the relevance of Turing machines and other models.	PSO1, PSO2, PSO3, PSO4, PSO5, PSO6	K2
CO3: Illustrate different computational systems and compare them. Examine the limits of algorithmic computation and computational complexity.	PSO1, PSO2, PSO3, PSO4, PSO5, PSO6, PSO7	K3
CO4: Analyse different grammar systems. Investigate various hard problems with its complexity.	PSO1, PSO2, PSO3, PSO4, PSO5, PSO7	K4
CO5: Construct a hierarchy of formal languages. Compare decidable and undecidable problems and P and NP classes.	PSO1, PSO2, PSO3, PSO4, PSO5, PSO7	K5

Syllabus:

Unit	Content	Hours	COs	Bloom's Taxonomy Level
I	**Turing Machines:** The Standard Turing Machine – Combining Turing Machines for Complicated Task – Turing's Thesis. **Chapter 9**	18	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5
II	**Other Models of Turing Machines:** Minor Variations on the Turing Machine Theme – Turing Machines with More Complex Storage – Non-Deterministic Turing	18	CO1, CO2, CO3,	K1, K2, K3, K4, K5

	Machines – A Universal Turing Machine – Linear Bounded Automata. **Chapter 10**		**CO4, CO5**	
III	**A Hierarchy of Formal Languages and Automata:** Recursive and Recursively Enumerable Languages – Unrestricted Grammars – Context-Sensitive Grammars and Languages – The Chomsky Hierarchy. **Chapter 11**	**18**	**CO1, CO2, CO3, CO4, CO5**	**K1, K2, K3, K4, K5**
IV	**Limits of Algorithmic Computation:** Some Problems that cannot be Solved by Turing Machines – Undecidable Problems for Recursively Enumerable Languages – The Post Correspondence Problem – Undecidable Problems for Context-Free Languages – A Question of Efficiency. **Chapter 12**	**18**	**CO1, CO2, CO3, CO4, CO5**	**K1, K2, K3, K4, K5**
V	**An Overview of Computational Complexity:** Efficiency of Computation – Turing Machine Models and Complexity – Language Families and Complexity Classes – The Complexity Classes P and NP – Some NP Problems – Polynomial-Time Reduction – NP-Completeness and an Open Question. **Chapter 14**	**18**	**CO1, CO2, CO3, CO4, CO5**	**K1, K2, K3, K4, K5**

Prescribed textbook(s)

P. Linz, An Introduction to Formal Languages and Automata, Sixth Edition, Jones & Bartlett Learning, 2017.

Reference books for further reading:

1. J.E. Hopcroft and J.D. Ullman, Introduction to Automata Theory, Languages and Computation, Narosa Publishing House, 1989
2. M. Sipser, Introduction to Theory of Computation, PWS Publishing Company, 1997

Suggested Readings:

1. D.C. Kozen, Automata and Computability, Springer, New York, 1997.
2. K. Krithivasan and R. Rama, Introduction to Formal Languages, Automata Theory and Computation, Pearson, New Delhi, 2009

Web Resources:

1. https://ocw.mit.edu/courses/18-404j-theory-of-computation-fall-2020/
2. https://nptel.ac.in/courses/106104028
3. https://nptel.ac.in/courses/106104148
4. https://nptel.ac.in/courses/106106242

Course Articulation Matrix															
Co	Programme Outcomes							Programme Specific Outcomes							K Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	
CO 1	3	2	3	2	-	-	-	3	2	3	2	-	-	-	K1
CO 2	3	3	2	3	1	2	-	3	3	2	3	1	2	-	K2
CO 3	3	3	3	2	2	1	3	3	3	3	2	2	1	3	K3
CO 4	3	2	3	3	3	-	2	3	2	3	3	3	-	2	K4
CO 5	3	3	3	2	2	-	3	3	3	3	2	2	-	3	K5
Avg.	3	2.6	2.8	2.4	2	1.5	2.6	3	2.6	2.8	2.4	2	1.5	2.6	
	2.41							2.41							

Course title:	**Fixed Point Theory**			
Course Code	**142MT4E06**			
Credits	4			
Hours / Cycle	5			
Category	**Elective**			
Semester	IV			
Year of Implementation	**AY 2014-15**			
Course Structure	**Theory**	**Tutorial**	**Practical**	**Total Hours**
	75	**-**	**-**	**75**
Course Objectives:				
Course Outcome(s)	**PSO Addressed**	**Bloom's Taxonomy Levels (K1 to K6)**		
CO1: Remember Banach contraction principle, hyperconvex spaces, normal structured metric spaces, triangulation and contraction mappings.	**PSO1 PSO3 PSO4 PSO5 PSO6 PSO7**	**K1**		
CO2 : Demonstrate extensions of Banach contraction principle, properties of hyperconvex spaces, structure of fixed point set, Brouwer's theorem and non-expansive mappings.	**PSO1 PSO2 PSO5 PSO6 PSO7**	**K2**		
CO3: Identify Caristi's principle, different types of radii in metric spaces, metric spaces with uniform normal structure, Brouwer's theorem in higher dimensions and properties of the space l_1.	**PSO1 PSO2 PSO3 PSO5 PSO6 PSO7**	**K3**		
CO4: Understand equivalence of Ekeland's principle, fixed point theorem for hyperconvex spaces, uniform normal structure, Schauder's theorem and stability results.	**PSO1 PSO2 PSO3 PSO4 PSO5 PSO6 PSO7**	**K4**		
CO5: Interpret fixed point theorems for contractive mappings, hperconvex spaces, metric spaces	**PSO1 PSO2 PSO3 PSO4 PSO5**	**K5**		

with normal structures, Banach spaces and w-contractive spaces	**PSO6** **PSO7**	

Syllabus:				
Unit	**Content**	**Hours**	**COs**	**Bloom's Taxonomy Level**
I	**Metric Contraction Principles:** Banach's Contraction Principle – Further Extensions of Banach's Contraction Principle – The Caristi-Ekeland Principle – Equivalents of Caristi – Ekeland Principle. **Chapter 3: Sections 3.1 – 3.4**	**15**	**CO1** **CO2** **CO3** **CO4** **CO5**	K1 K2 K3 K4 K5
II	**Hyperconvex Spaces:** Introduction – Hyperconvexity – Properties of Hyperconvex spaces – A Fixed Point Theorem. **Chapter 4: Sections 4.1 – 4.4**	**15**	**CO1** **CO2** **CO3** **CO4** **CO5**	K1 K2 K3 K4 K5
III	**Normal Structures in Metric Spaces:** A Fixed Point Theorem – Structure of the Fixed Point Set – Uniform Normal Structure – Uniform Relative Normal Structure. **Chapter 5: Sections 5.1 – 5.4**	**15**	**CO1** **CO2** **CO3** **CO4** **CO5**	K1 K2 K3 K4 K5
IV	**Continuous Mappings in Banach Spaces:** Introduction – Brouwer's Theorem – Further Comments on Brouwer's Theorem – Schauder's Theorem. **Chapter 7: Sections 7.1 – 7.4**	**15**	**CO1** **CO2** **CO3** **CO4** **CO5**	K1 K2 K3 K4 K5
V	**Metric Fixed Point Theory:** Contraction Mappings – Basic Theorems for Nonexpansive Mappings – A Closer Look at l_1 – Stability Results in Arbitrary Spaces. **Chapter 8: Sections 8.1 – 8.4**	**15**	**CO1** **CO2** **CO3** **CO4** **CO5**	K1 K2 K3 K4 K5

Prescribed textbook(s)

1. **Mohamed A.Khamsi and William Kirk,** An Introduction To Metric Spaces and Fixed Point Theory, John – Wiley & Sons, Inc, 2001.

Reference books for further reading:

1. D.R. Smart, Fixed Point Theorems, Cambridge University Press, 1974.
2. E. Zeidler, Nonlinear Functional Analysis and its Applications I: Fixed Point Theory, Springer-Verlag, Berlin, 1986.

Suggested books for further reading:
1. S. Singh, B. Watson and P. Srivastava, Fixed Point Theory and Best Approximations: The KKM – map Principle, Kluwer Academic Publishers, 1997.
2. K. Goebel and W.A. Kirk, Topics in Metric Fixed Point Theory, Cambridge University Press, Cambridge, 1990.
Web resources: **Comprehensive resource is Not Available for this course**

Course Articulation Matrix

Co	Programme Outcomes							Programme Specific Outcomes							K Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	
CO 1	3	-	2	1	2	2	1	3	-	2	1	2	2	1	K1
CO 2	3	2	-	-	1	1	2	3	2	-	-	1	1	2	K2
CO 3	3	1	3	1	1	1	1	3	1	3	1	1	1	1	K3
CO 4	2	3	3	1	1	2	2	2	3	3	1	1	2	2	K4
CO 5	3	2	3	1	1	3	2	3	2	3	1	1	3	2	K5
Avg.	2.8	2	2.75	1	1.2	1.8	1.6	2.8	2	2.75	1	1.2	1.8	1.6	
Avg	1.593							1.593							

Course title:	Fuzzy sets and their applications			
Course Code	142MT4E07			
Credits	4			
Hours / Cycle	5			
Category	Mandatory			
Semester	IV			
Year of Implementation	2014-15			
Course Structure	**Theory**	**Tutorial**	**Practical**	**Total Hours**
	75	0	0	75
Learning Objectives:	To study the fundamental concepts of Fuzzy subsets, Fuzzy relations and the Functions of Fuzzy Variables.			
Course Outcome(s)	**PSO Addressed**	**Bloom's Taxonomy Levels**		
CO1: Recall the fundamental concepts in set theory and remember the definitions of Fuzzy Subsets and Fuzzy Relations.	**PSO1, PSO2, PSO4, PSO6, PSO7**	K1		
CO2: Discuss the properties of Set of Fuzzy Subsets, Fuzzy Binary Relations and Similitude and Resemblance relations and Fuzzy Groupoids. Explain the Logical Structure of a Function of Fuzzy variables.	**PSO1, PSO2, PSO3, PSO5, PSO6, PSO7**	K2		
CO3: Solve problems related to Fuzzy Subsets, Fuzzy Relations, Fuzzy Variables and Fuzzy Groupoids.	**PSO1, PSO2, PSO3, PSO4, PSO6, PSO7,**	K3		
CO4: Analyze the Operations on Fuzzy Subsets, Composition of Fuzzy Relations, Similitude Sub-relations in a Fuzzy Preorder, Operations on Fuzzy Numbers and Functions of Fuzzy Variables using Method of Marinos.	**PSO1, PSO2, PSO3, PSO6, PSO7**	K4		
CO5: Evaluate problems based on the theorems of Fuzzy Subsets, Fuzzy Relations, Fuzzy Variables and the Laws of Fuzzy Composition.	**PSO1, PSO2, PSO3, PSO4, PSO6, PSO7**	K5		

Syllabus: Fuzzy Sets and their Applications				
Unit	**Content**	**Hours**	**COs**	**Bloom's Taxonomy Level**
I	**UNIT I – Fundamental Notions:** Introduction – Review of the Notion of Membership – The Concept of a Fuzzy Subset – Dominance Relations – Simple Operations on Fuzzy Subsets – Set of Fuzzy Subsets for E and M Finite – Properties of the Set of Fuzzy Subsets – Product and Algebraic Sum of Two Fuzzy Subsets. **Chapter I**	14	CO1 CO2 CO3 CO4 CO5	K1,K2,K3, K4,K5
II	**UNIT II - Fuzzy Graphs and Fuzzy Relations:** Introduction – Fuzzy Graphs – Fuzzy Relations – Composition of Fuzzy Relations – Fuzzy Subsets Induced by a Mapping – Conditioned Fuzzy Subsets – Properties of Fuzzy Binary Relations – Transitive Closure of a Fuzzy Binary Relation – Paths in a Finite Fuzzy Graph. **Chapter II: Sections 10 – 18**	17	CO1 CO2 CO3 CO4 CO5	K1,K2,K3, K4,K5
III	**UNIT III** - Fuzzy Preorder Relations – Similitude Relations – Similitude Subrelations in a Fuzzy Preorder – Antisymmetry – Fuzzy Order Relations – Antisymmetric Relations without Loops, Ordinal Relations, Ordinal Functions in a Fuzzy Order Relations – Dissimilitude Relations – Resemblance Relations – Various Properties of Similitude and Resemblance – Various Properties of Fuzzy Perfect Order Relations – Ordinary Membership Functions. **Chapter II: Sections 19 – 30**	18	CO1 CO2 CO3 CO4 CO5	K1,K2,K3, K4,K5
IV	**UNIT IV - Fuzzy Logic:** Introduction – Characteristic Function of a Fuzzy Subset. Fuzzy Variables – Polynomial Forms – Analysis of a Function of Fuzzy Variables. Method of Marinos – Logical Structure of a Function of Fuzzy Variables – Composition of Intervals – Fuzzy Propositions and their Functional Representations – The Theory of Fuzzy Subsets and Theory of Probability. **Chapter III: Sections 31 – 36, 39, 40**	14	CO1 CO2 CO3 CO4 CO5	K1,K2,K3, K4,K5
V	**UNIT V - The Laws of Fuzzy Composition:** Introduction – Review of the Notion of a Law of Composition – Laws of Fuzzy Internal Composition. Fuzzy Groupoids – Principal Properties of Fuzzy Groupoids.	12	CO1 CO2 CO3 CO4	K1,K2,K3, K4,K5

	– Fuzzy Monoids – Fuzzy External Composition – Operations on Fuzzy Numbers. **Chapter IV**		CO5	

Prescribed Books/Textbook(s)

A. Kaufmann, Introduction to the Theory of Fuzzy Subsets, Vol. 1, Academic Press, New York, 1975.

Reference Books

1. H.J. Zimmermann, Fuzzy Set Theory and its Applications, Allied Publishers, Chennai, 1996
2. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic - Theory and Applications, Prentice Hall, New Delhi, 2001

Web Resources

1. https://onlinecourses.nptel.ac.in/noc22_ee21/preview
2. https://www.youtube.com/watch?v=K7S3TgfqnX0&list=PLFW6lRTa1g81F7CJ-CdlsyWKKAa43T62j

Course Articulation Matrix

Co	Programme Outcomes							Programme Specific Outcomes							K Level
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	
CO 1	3	3	-	2	-	3	3	3	3	-	2	-	3	3	K1
CO 2	3	2	3	-	1	3	3	3	2	3	-	1	3	3	K2
CO 3	3	1	3	2	-	3	3	3	-	3	2	-	3	3	K3
CO 4	3	2	3	-	-	3	3	3	2	3	-	-	3	3	K4
CO 5	3	1	3	2	-	3	3	3	1	3	2	-	3	3	K5
Avg.	3	1.8	2.4	1.2	0.2	3	3	3	1.8	2.4	1.2	0.2	3	3	
Avg.	2.086							2.086							