Maniammai University

(UNDER SEC.3 OF THE UGC ACT.1956)

Periyar Nagar, Vallam, Thanjavur – 613403

Department of Mathematics

CURRICULUM

REGULATIONS – 2015

M.SC MATHEMATICS – CURRICULUM (FROM 2015-16 ONWARDS)

Semester	Course Code	Course Title	Lecture	Tutorial	Practical	Credit
I	YMA 101	Groups and Rings	4	0	0	4
	YMA 102	Analysis-I	4	0	0	4
	YMA 103	Differential Equations	4	0	0	4
	YMA 104	Discrete Mathematics	4	0	0	4
	YMA1E*	One among the list of Electives (1E)	3	0	0	3
	YMA1O	Open Elective	2	0	0	2
						21

*** List of Electives (1E)**

Elective Code	Course Title	L	T	P	C
01	Graph Theory	3	0	0	3
02	Coding Theory	3	0	0	3
03	Mathematical Logic	3	0	0	3

Semester	Course Code	Course Title	Lecture	Tutorial	Practical	Credit
II	YMA 201	Linear Algebra	4	0	0	4
	YMA 202	Analysis-II	4	0	0	4
	YMA 203	Differential Geometry	4	0	0	4
	YMA 204	Operations Research	4	0	0	4
	YMA2E*	One among the list of Electives (2 E)	3	0	0	3
	YMA2O	Open Elective	2	0	0	2
						21

*** List of Electives (2E)**

Elective Code	Course Title	L	T	P	C
01	Algebraic Number Theory	3	0	0	3
02	Data structures and Algorithms	3	0	0	3
03	Fuzzy sets and fuzzy logic	3	0	0	3

Semester	Course Code	Course Title	Lecture	Tutorial	Practical	Credit
III	YMA 301	Field Theory	4	0	0	4
	YMA 302	Topology	4	0	0	4
	YMA 303	Measure Theory	4	0	0	4
	YMA 304	Mathematical Statistics	4	0	0	4
	YMA3E*	One among the list of Electives (3 E)	3	0	0	3
	YMA3O	Open Elective	2			2
						21

*** List of Electives (3E)**

Elective Code	Course Title	L	T	P	C
01	Analytical Number Theory	4	0	0	4
02	Numerical Methods	4	0	0	4
03	Commutative Algebra	4	0	0	4

Semester	Course Code	Course Title	Lecture	Tutorial	Practical	Credit
IV	YMA 401	Complex Analysis	4	0	0	4
	YMA 402	Functional Analysis	4	0	0	4
	YMA 403	Stochastic Processes	4	0	0	4
		Open Elective	2			2
		Project work				8
						22

Total Number of Credits : 85

Semester I

COURSE CODE			COURSE TITLE	L	T	P	C
YMA101			GROUPS AND RINGS	4	0	0	4
C	P	A					
4	0	0		L	T	P	H
				4	0	0	4

PREREQUISITE: Basic concepts of sets, groups and rings

COURSE OUTCOMES:

Course outcomes:	Domain	Level
CO1: Define and Explain Subgroups, Normal subgroups and Quotient Groups, Lagrange's Theorem.	Cognitive	Remembering Understanding
CO2: Define and Explain Homomorphism Theorems, Isomorphism Theorems, Automorphisms Theorems, Cayley's theorem. Permutation groups, Another Counting principle.	Cognitive	Remembering Understanding
CO3: Define and Explain Sylow's Theorems and their simple applications, Direct Products: External and Internal, Finite Abelian Groups.	Cognitive	Remembering Understanding
CO4: Define and Explain Rings, Subrings, Ideals, Factor Rings, Homomorphism and Integral Domains. Maximal and prime ideals. The field of Quotients of an integral domain.	Cognitive	Remembering Understanding
CO5:Define and Explain Euclidean Ring, A Particular Euclidean Ring, Polynomial Ring, and Polynomial over the Rational Field, Polynomial Rings over Commutative Rings.	Cognitive	Remembering Understanding

UNIT I	**12**
Definition & examples: Groups, Subgroups, Normal subgroups and Quotient Groups, Lagrange's Theorem.	
UNIT II	**12**
Homomorphism Theorems, Isomorphism Theorems, Automorphisms Theorems, Cayley's theorem. Permutation groups, Another Counting principle.	
UNIT III	**12**
Sylow's Theorems and their simple applications, Direct Products: External and Internal, Finite Abelian Groups.	
UNIT IV	**12**
Rings, Subrings, Ideals, Factor Rings, Homomorphism, Integral Domains. Maximal and prime ideals. The field of Quotients of an integral domain.	
UNIT V	**12**
Euclidean Ring, A Particular Euclidean Ring, Polynomial Ring, Polynomial over the Rational Field, Polynomial Rings over Commutative Rings.	

LECTURE	TOTAL
60	60

TEXTBOOK

1. Herstein, I.N., "Topics in Algebra", Willey Eastern 1975.
   Unit I - Chapter 2 (Section 2.1 - 2.6)
   Unit II - Chapter 2 (Section 2.7 – 2.11)
   Unit III - Chapter 2 (Section 2.12 – 2.14)
   Unit IV - Chapter 3 (Section 3.1 - 3.6)

Unit V - Chapter 3 (Section 3.7 – 3.11)

REFERENCES

1. John B. Fraleigh, "A First Course in Abstract Algebra", Narosa Publication, Third Edition, 2003.
2. Cohn P. M., "Basic Algebra", Springer's Publications, Second Edition, 2005.

COURSE CODE			COURSE TITLE	L	T	P	C
YMA102			ANALYSIS 1	4	0	0	4
C	P	A					
4	0	0		L	T	P	H
				4	0	0	4

PREREQUISITE:

COURSE OUTCOMES: Basic concepts of real numbers

Course outcomes:	Domain	Level
CO1: Define and Explain Ordered sets, The real field, The complex field, Euclidean spaces.	Cognitive	Remembering Understanding
CO2: Define and Explain Finite, Countable and Uncountable sets, Metric space, Compact sets, Perfect Sets, Connected Sets.	Cognitive	Remembering Understanding
CO3: Define and Explain Convergent sequences (in Metric Spaces), subsequences, Cauchy sequences, Upper and Lower Limits, Some Special Sequences, and Series, Series of Negative terms, The root and ratio tests.	Cognitive	Remembering Understanding
CO4: Define and Explain Limits of functions (in metric spaces) Continuous functions, Continuity and Compactness, Continuity and Connectedness, Discontinuities, Monotonic functions, Uniform continuity, Infinite Limits and Limits at Infinity.	Cognitive	Remembering Understanding
CO5: Define and Explain The Derivative of a Real Function, Mean Value Theorems, The Continuity of Derivatives, L'Hospital's Rule, Derivatives of Higher Order, and Taylor's Theorem.	Cognitive	Remembering Understanding

UNIT I The Real and Complex Number Systems:	**12**
Ordered sets, The real field, The complex field, Euclidean spaces.	
UNIT II Basic Topology:	**12**
Finite, Countable and Uncountable sets, Metric space, Compact sets, Perfect Sets, Connected Sets.	
UNIT III Numerical Sequences and Series:	**12**
Convergent sequences (in Metric Spaces), subsequences, Cauchy sequences, Upper and Lower Limits, Some Special Sequences, Series, Series of Negative terms, The root and ratio tests.	
UNIT IV Continuity:	**12**
Limits of functions (in metric spaces) Continuous functions, Continuity and Compactness, Continuity and Connectedness, Discontinuities, Monotonic functions, Uniform	

Continuity, Infinite Limits and Limits at Infinity.

UNIT V Differentiation:	**12**

The Derivative of a Real Function, Mean Value Theorems, The Continuity of Derivatives, L'Hospital's Rule, Derivatives of Higher Order, Taylor's Theorem.

LECTURE	**TOTAL**
60	**60**

TEXTBOOK

1. Walter Rudin,"Principles of Mathematical Analysis", (3rd Edition) McGraw-Hill, 2016.

Unit I - Chapter 1 (Pages: 3-5, 8-11, 12-16)
Unit II - Chapter 2 (Pages: 24 - 42)
Unit III - Chapter 3 (Pages: 47-63, 65-69)
Unit IV - Chapter 4 (Pages: 83-97)
Unit V - Chapter 5 (Section 103-111)

REFERENCES

1. Shanti Narayan,"A Course of Mathematical Analysis", S.Chand & Co, 2005.
2. Apostol, T.M,"Mathematical Analysis", 2nd Edition,1996.
3. Malik, S.C,"Mathematical Analysis", Wiley Eastern Ltd, 2017.

COURSE CODE			**COURSE TITLE**	**L**	**T**	**P**	**C**
YMA103			**DIFFERENTIAL EQUATIONS**	**4**	**0**	**0**	**4**
C	**P**	**A**					
4	**0**	**0**		**L**	**T**	**P**	**H**
				4	**0**	**0**	**4**

PREREQUISITE: Differentiation and Integration

COURSE OUTCOMES:

Course outcomes:	**Domain**	**Level**
CO1: Find The general solution of the homogeneous equations using various methods.	Cognitive	Remembering Understanding
CO2: Solve the homogeneous linear system with constant coefficients and special functions.	Cognitive	Applying
CO3: Find the critical points and stability for linear systems by Liapounov's direct method.	Cognitive	Remembering Understanding
CO4: Solve First order linear partial differential equations using various methods.	Cognitive	Applying
CO5: Solve initial and boundary value problems.	Cognitive	Applying

UNIT I	**12**

The general solution of the homogeneous equation – The use of one known solution to find another – The method of variation of parameter – Power series solutions – Series solutions of first order equations – Second order linear equations – ordinary points – Regular singular points – Gauss hyper geometric equations – the point 0 at infinity.

UNIT II	**12**
Legendre polynomials – Properties of Legendre polynomials – Bessel functions – The gamma function – Properties of Bessel function – linear systems – Homogeneous linear system with constant coefficients.	

UNIT III	**12**
The existence and uniqueness of solutions – The method of Successive approximation – Picard's theorem – Types of critical points – Critical points and stability for linear systems – Stability by Liapunov's direct method.	

UNIT IV	**12**
First order partial differential equations – Linear equations of the first order – Partial differential equations – Compatible systems – Charpit's method – Jacobi's method – Integral surface through a given circle.	

UNIT V	**12**
Solution of initial and boundary value problems – Characteristics – D'Alembert's solution – Significance of characteristic curves – Laplace transforms solutions for displacement in a string – a long string under its weight – Longitudinal vibration of a elastic bar with prescribed force on one end – free vibrations of string.	

LECTURE		**TOTAL**
60		**60**

TEXTBOOK

1. Simmons, G.F.,"Differential Equations with Applications and Historical Notes", TMH, New Delhi, 2003
2. T. Amarnath, "An Elementary Course in Partial Differential Equations", Narosa, New Delhi, 1997.

   Unit I- Chapter 3: Sections – 15,16,19, Chapter 5: Sections – 26 to 31
   Unit II- Chapter 8: Sections – 44 to 47, Chapter 10: Sections – 54 to 56
   Unit III- Chapter 13: Sections – 68, 69, Chapter 11: Sections – 60, 61
   Unit IV – Chapter 1: Sections – 1.4 to 1.9
   Unit V - Chapter 2: Sections – 2.1, 2.2, 2.3.1, 2.3.2, 2.3.3, 2.3.5, 2.5.1, 2.5.2

REFERENCES

1. W.T.Reid, "Ordinary Differential Equations", John Wiley, New York, 1971.
2. E.A.Coddington and E.Levinson, "Theory of ODE", Mc Graw Hill Publishing Company, New york, 1955 .
3. J.N. Sneddon, "Elements of Partial Differential Equations", Mc Graw Hill Publishing Company, New york, 1957.

COURSE CODE			COURSE TITLE	L	T	P	C
YMA104			DISCRETE MATHEMATICS	4	0	0	4
C	P	A					
4	0	0		L	T	P	H
				4	0	0	4

PREREQUISITE: algebra

COURSE OUTCOMES:

Course outcomes:	Domain	Level
CO1: Define and Explain Basic logical operations.	Cognitive	Remembering Understanding
CO2: Define and Explain The theory of inference for the statement Calculus.	Cognitive	Remembering Understanding
CO3: Solve Recurrence Relations using Generating Functions**.**	Cognitive	Applying
CO4: Define and Explain Lattices and Boolean Algebra.	Cognitive	Remembering Understanding
CO5: Define and Explain Grammar and Languages.	Cognitive	Remembering Understanding

UNIT I Mathematical Logic : **12**

Basic logical operations, conditional and biconditional statements, tautologies, contradiction, Normal forms.

UNIT II The theory of inference for the statement Calculus: **12**

Rules of inference, Consistency, Automatic Theorem proving, Predicate Calculus, quantifiers, Inference Theory of the Predicate Calculus.

UNIT III Recurrence Relations and Generating Functions: **12**

Polynomial expressions, telescopic form, recursion theorem, closed form expression, generating function, solution of recurrence relation using generating function.

UNIT IV Lattices and Boolean Algebra: **12**

Partial ordered sets, Properties of Lattices, Lattices as Algebraic Systems, Boolean Algebra.

UNIT V Grammar and Languages: **12**

Phrase structure grammars, rewriting rules, derivation sentential forms, language generated by grammar, regular, context free and context sensitive grammar and languages.

LECTURE	TOTAL
60	60

TEXTBOOK

1. P. Tremblay, R. Manohar,"Discrete Mathematical Structure with Applications to Computer Science", Mc Graw- Hill International Edition, 1997.

   Unit I - Chapter 1 (Section 1.1,1.2 & 1.3)

   Unit II - Chapter 1 (Section 1.4 ,1.5 & 1.6)

   Unit IV - Chapter 4 (Section 4.1& 4.2)

   Unit V – Chapter 4 (Section 4.6)

2. Alan Doerr, "Applied Discrete Structure for Computer Science", Pearson Education, 2013

Unit III – Chapter 8 (Section 8.1,8.2,8.3 &8.5)

REFERENCE

1. Kenneth H. Rosen, "Discrete Mathematics and Its Applications", Mc Graw- Hill International Edition, 2002.

COURSE CODE			COURSE TITLE	L	T	P	C
YMA105			GRAPH THEORY	3	0	0	3
C	P	A					
3	0	0		L	T	P	H
				3	0	0	3

PREREQUISITE:

COURSE OUTCOMES: Basic concepts of Graph Theory

Course outcomes:	Domain	Level
CO1: Define and Explain Graphs, subgraphs and trees.	Cognitive	Remembering Understanding
CO2: Define and Explain Connectivity - Blocks - Euler tours - Hamilton Cycles.	Cognitive	Remembering Understanding
CO3: Define and Explain Matchings and Coverings in Bipartite Graphs , Edge Chromatic Number and Vizing's Theorem.	Cognitive	Applying
CO4: Define and Explain independent sets and cliques, vertex colourings.	Cognitive	Remembering Understanding
CO5: Define and Explain Plane and planar Graphs, Dual graphs, Euler's Formula , The Five-Colour Theorem and the Four-Colour Conjecture- Applications.	Cognitive	Remembering Understanding

UNIT I GRAPHS, SUBGRAPHS AND TREES	**9**
Graphs and simple graphs - Graph Isomorphism - The Incidence and Adjacency Matrices - Subgraphs - Vertex Degrees - Paths and Connection - Cycles - Trees - Cut Edges and Bonds - Cut Vertices.	
UNIT II CONNECTIVITY, EULER TOURS AND HAMILTON CYCLES	**9**
Connectivity - Blocks - Euler tours - Hamilton Cycles – Applications.	
UNIT III MATCHINGS, EDGE COLOURINGS	**9**
Matchings - Matchings and Coverings in Bipartite Graphs - Edge Chromatic Number - Vizing's Theorem- Applications.	
UNIT IV INDEPENDENT SETS AND CLIQUES, VERTEX COLOURINGS	**9**
Independent sets - Ramsey's Theorem - Chromatic Number - Brooks' Theorem - Chromatic Polynomials- Applications.	
UNIT V PLANAR GRAPHS	**9**
Plane and planar Graphs - Dual graphs - Euler's Formula - The Five-Colour Theorem and the Four-Colour Conjecture- Applications.	

LECTURE		TOTAL
45		45

TEXTBOOK

1. J.A.Bondy and U.S.R. Murthy, "Graph Theory and Applications", Macmillan, London, 1976.
   Unit I - Chapter 1 (Section 1.1 - 1.7); Chapter 2 (Section 2.1 - 2.3)
   Unit II - Chapter 3 (Section 3.1 - 3.2); Chapter 4 (Section 4.1 - 4.2)
   Unit III - Chapter 5 (Section 5.1 - 5.2); Chapter 6 (Section 6.1 - 6.2)
   Unit IV - Chapter 7 (Section 7.1 – 7.2); Chapter 8 (Section 8.1 – 8.2, 8.4)
   Unit V - Chapter 9 (Section 9.1 - 9.3, 9.6)

REFERENCES

1.Harary , "Graph Theory" Narosa Publishing House., 2001.
2.A.Gibbons, "Algorithmic Graph Theory, Cambridge University Press, Cambridge, 1989.
3.R.J.Wilson and J.J.Watkins, "Graphs: An Introductory Approach", John Wiley and Sons, New York, 1989.
4.V.K. Balakrishnan, Schaum's Outlines of "Theory and problems of Graph Theory", Tata McGraw Hill Education Private Limited Delhi, 2004.
5.S.A.Choudum, "A First Course in Graph Theory", MacMillan India Ltd. 1987.

Semester II

COURSE CODE			COURSE TITLE	L	T	P	C
YMA201			LINEAR ALGEBRA	4	0	0	4
C	P	A					
4	0	0		L	T	P	H
				4	0	0	4

PREREQUISITE: Group theory and ring theory

COURSE OUTCOMES:

Course outcomes:	Domain	Level
CO1:Define and Explain Elementary Basic Concepts- Linear Independence and Bases.	Cognitive	Remembering Understanding
CO2: Define and Explain Dual Spaces- Inner Product Space- Modules.	Cognitive	Remembering Understanding
CO3: Solve The Algebra of Linear Transformations to find Characteristics Roots.	Cognitive	Applying
CO4: Define and Explain Canonical Forms, Triangular form, Nilpotent Transformations, Jordan Form and Rational Canonical form.	Cognitive	Remembering Understanding
CO5: Define and Explain Trace and Transpose, Determinants, Hermitian, Unitary and Normal Transformations, Real Quadratic forms.	Cognitive	Remembering Understanding

UNIT I **12**

Elementary Basic Concepts- Linear Independence and Bases.

UNIT II **12**

Dual Spaces- Inner Product Space- Modules.	
UNIT III	**12**
The Algebra of Linear Transformations- Characteristics Roots- Matrices.	
UNIT IV	**12**
Canonical Forms: Triangular form- Nilpotent Transformations- Jordan Form - Rational Canonical form.	
UNIT V	**12**
Trace and Transpose – Determinants- Hermitian, Unitary and Normal Transformations- Real Quadratic forms.	

LECTURE		**TOTAL**
60		**60**

TEXTBOOK

1. Herstein, I.N.,"Topics in Algebra", Willey Eastern 1975.
   Unit I - Chapter 4 (Section 4.1 & 4.2)

   Unit II - Chapter 4 (Section 4.4 – 4.5) Unit III - Chapter 6 (Section 6.1 – 6.3)

   Unit IV - Chapter 6 (Section 6.4 – 6.7) Unit V - Chapter 6 (Section 6.8 – 6.11)

REFERENCES

1. John B. Fraleigh, "A First Course in Abstract Algebra", Narosa Publication, Third Edition, 2013.
2. P. M. Cohn, "Basic Algebra", Springer's Publications, Second Edition, 2003.

COURSE CODE			**COURSE TITLE**	**L**	**T**	**P**	**C**
YMA202			**ANALYSIS II**	**4**	**0**	**0**	**4**
C	**P**	**A**					
4	**0**	**0**		**L**	**T**	**P**	**H**
				4	**0**	**0**	**4**

PREREQUISITE: Basic concepts of convergence and uniform convergence

COURSE OUTCOMES:

Course outcomes:	**Domain**	**Level**
CO1: Define and Explain Existence, Properties of the Integral, Integration and Differentiation.	Cognitive	Remembering Understanding
CO2: Define and Explain Uniform convergence and Continuity.	Cognitive	Remembering Understanding
CO3: Define and Explain Uniform convergence and Integration and Differentiation.	Cognitive	Remembering Understanding
CO4: Define and Explain Set functions, Construction of Lebesgue Measures, Measurable function, Simple functions in measure.	Cognitive	Remembering Understanding

CO5: Define and Explain Integration Comparison with the Riemann Integral, Integration of Complex functions, Functions of class J^2.	Cognitive	Remembering Understanding

UNIT I	**12**
Definition and Existence of the Integral, Properties of the Integral, Integration and Differentiation.	
UNIT II	**12**
Uniform Convergence, Uniform convergence and Continuity.	
UNIT III	**12**
Uniform convergence and Integration, Uniform convergence and Differentiation.	
UNIT IV	**12**
Set functions, Construction of Lebesgue Measures, Measurable function, Simple functions in measure.	
UNIT V	**12**
Integration Comparison with the Riemann Integral, Integration of Complex functions, Functions of class J^2.	

LECTURE	**TOTAL**
60	**60**

TEXTBOOK

1. Walter Rudin, "Principles of Mathematical Analysis", (3rd Edition), McGraw-Hill, 2016
   Unit I - Chapter 6 (Pages: 120-135)
   Unit II - Chapter 7 (Pages: 143-151)
   Unit III - Chapter 7 (Pages: 151-154)
   Unit IV - Chapter 11 (Pages: 300-314)
   Unit V - Chapter 5 (Section 314-325)

REFERENCES:

1. Shanti Narayan, "A course of Mathematical Analysis", S. Chand & Company Ltd New Delhi, 2005.
2. Apostol, T.M, "Mathematical Analysis", Narosa Book Distributors Pvt Ltd, 2nd Edition, New Delhi, 1996.
3. Malik, S.C, "Mathematical Analysis", Wiley Eastern Ltd. 2017.

COURSE CODE			COURSE TITLE	L	T	P	C
YMA203			DIFFERENTIAL GEOMETRY	4	0	0	4
C	**P**	**A**					
4	**0**	**0**		**L**	**T**	**P**	**H**
				4	**0**	**0**	**4**

PREREQUISITE: Multivariable calculus and vector calculus

COURSE OUTCOMES:

Course outcomes:	**Domain**	**Level**
CO1: Define and Explain Arc length, tangent, normal and binormal curvature and torsion, contact between curves and surfaces, Tangent surface involutes and evolutes.	Cognitive	Remembering Understanding

CO2: Define and Explain Surfaces of revolution, Helicoids, Families of curves and Isometric correspondence.	Cognitive	Remembering Understanding
CO3: Define and Explain Normal property of geodesic, Geodesic parallels, Gaussian curvature and Conformal mapping.	Cognitive	Remembering Understanding
CO4: Define and Explain Second fundamental form, Lines of curvature, Developables associated with curves on surfaces and Parallel surfaces.	Cognitive	Remembering Understanding
CO5: Define and Explain Compact surfaces whose points are umbilics, Hilbert's lemma, Characterization of complete surfaces.	Cognitive	Remembering Understanding

UNIT I	**12**
Definition of Space curves – Arc length – tangent – normal and binormal – curvature and torsion – contact between curves and surfaces – tangent surface – involutes and evolutes – intrinsic equations – Fundamental Existence Theorem for space curves – Helics.	

UNIT II	**12**
Definition of surface - Curves on a surface - Surfaces of revolution – Helicoids – Metric - Direction coefficients - Families of curves - Isometric correspondence - Intrinsic properties – Geodesics - Canonical geodesic equations.	

UNIT III	**12**
Normal property of geodesic - Existence theorems - Geodesic parallels - Geodesic curvature - Gauss Bonnet theorem - Gaussian curvature - Surfaces of constant curvature - Conformal mapping - Geodesic mapping.	

UNIT IV	**12**
Second fundamental form - Principal curvatures- Lines of curvature – Developables - Developables associated with space curves - Developables associated with curves on surfaces- Minimal surfaces and ruled surfaces - Fundamental equations of Surface theory - Parallel surfaces.	

UNIT V	**12**
Compact surfaces whose points are umbilics- Hilbert's lemma- Compact surfaces of constant Gaussian or mean curvature- Complete surfaces- Characterization of complete surfaces- Hilbert's theorem- Conjugate points on geodesics.	

LECTURE		**TOTAL**
60		**60**

TEXTBOOK

1. T. J. Wilmore, "An introduction to Differential Geometry", Oxford University Press, 1997.

REFERENCES

1. Do Carmo, "Geometry of curves and surfaces", Academic Press, 2017.
2. D.Somasundaram, "Differential Geometry", Narosa Publ. House, Chennai, 2005.
3. J.A.Thorpe, "Elementary Topics in Differential Geometry", Springer - Verlag, New York, 1979.

COURSE CODE			COURSE TITLE	L	T	P	C
YMA204			OPERATIONS RESEARCH	4	0	0	4
C	P	A					
4	0	0		L	T	P	H
				4	0	0	4

PREREQUISITE: nil

COURSE OUTCOMES:

Course outcomes:	Domain	Level
CO1: Define and Explain Decision theory in detail.	Cognitive	Remembering Understanding
CO2: Explain and solve problems in PERT and CPM	Cognitive	Understanding Applying
CO3: Explain deterministic inventory control models and probabilistic Inventory Control Models and **solve** problems by using the methods:	Cognitive	Understanding Applying
CO4: Explain Essential Features of Queueing System, Classification of Queueing Models and find solution of Queueing Models.	Cognitive	Understanding Remembering
CO5: Explain replacement and maintenance models and **solve** problems by using these methods.	Cognitive	Understanding Applying

UNIT I DECISION THEORY **12**

Steps in Decision theory Approach - Types of Decision-Making Environments - Decision Making Under Uncertainty - Decision Making under Risk - Posterior Probabilities and Bayesian Analysis - Decision Tree Analysis - Decision Making with Utilities.

UNIT II PROJECT MANAGEMENT : PERT AND CPM **12**

Basic Differences between PERT and CPM - Steps in PERT/CPM Techniques - PERT/CPM Network Components and Precedence Relationships - Critical Path Analysis - Probability in PERT Analysis - Project time-cost Trade Off - Updating the Project - Resource Allocation .

UNIT III DETERMINISTIC INVENTORY CONTROL MODELS **12**

Meaning of Inventory Control - Functional Classification - Advantage of Carrying Inventory - Features of Inventory System - Inventory Model building - Deterministic Inventory Models with no shortage - Deterministic Inventory with Shortages

Probabilistic Inventory Control Models:

Single Period Probabilistic Models without Setup cost - Single Period Probabilities Model with Setup cost.

UNIT IV QUEUES THEORY **12**

Essential Features of Queueing System - Operating Characteristic of Queueing System - Probabilistic Distribution in Queueing Systems - Classification of Queueing Models - Solution of Queueing Models - Probability Distribution of Arrivals and Departures - Erlangian Service times Distribution with k-Phases.

UNIT V REPLACEMENT AND MAINTENANCE MODELS **12**

Failure Mechanism of items - Replacement of Items Deteriorates with Time - Replacement of items that fail completely - other Replacement Problems.

LECTURE	TOTAL
60	60

TEXTBOOK

1. J.K.Sharma, "Operations Research Theory and Applications", Third Edition, Macmillan India Ltd., 2007,

Unit I - Chapter-11 (Section 11.1 - 11.8)
Unit II - Chapter-13 (Section 13.1 - 13.9)
Unit III - Chapter-14 (Section 14.1 - 14.8); Chapter-15 : (Section15.1 - 15.4)
Unit IV - Chapter-16 (Section 16.1 - 16.9);Appendix 16. A (PP 774-781)
Unit V - Chapter-17 (Section 17.1 - 17.5)

REFERENCES

1.F.S. Hillier and J.Lieberman, "Introduction to Operations Research" (8th Edition), Tata McGraw Hill Publishing Company, New Delhi, 2006.

2. Beightler. C, D.Phillips, B. Wilde, "Foundations of Optimization" (2nd Edition) Prentice Hall Pvt Ltd., New York, 1979

3.Bazaraa, M.S; J.J.Jarvis, H.D.Sharall, "Linear Programming and Network flow", John Wiley and sons, New York, 1990.

4. Gross, D and C.M.Harris, "Fundamentals of Queueing Theory", (3rd Edition), Wiley and Sons, New York, 1998.

5. Hamdy A. Taha , "Operations Research" (sixth edition), Prentice - Hall of India Private Limited, New Delhi. 2007

COURSE CODE			COURSE TITLE	L	T	P	C
YMAE205			FUZZY SETS AND FUZZY LOGIC	3	0	0	3
C	P	A					
3	0	0		L	T	P	H
				3	0	0	3

PREREQUISITE: Discrete Mathematics

COURSE OUTCOMES:

Course outcomes:	Domain	Level
CO1: Define and Explain basic definitions of Crisp sets, the notion of fuzzy sets and basic concepts of fuzzy sets.	Cognitive	Remembering Understanding
CO2: Define and Explain operation on Fuzzy Sets**.**	Cognitive	Remembering Understanding
CO3: Define and Explain Fuzzy Relations	Cognitive	Remembering Understanding
CO4: Define and Explain Classical Logic**..**	Cognitive	Remembering Understanding
CO5: Define and Explain Fuzzy logic, fuzzy tautologies - contradictions - equivalence and logical proofs.	Cognitive	Remembering Understanding

UNIT I Crisp Sets and Fuzzy Sets **9**

Crisp sets basic definitions - the notion of fuzzy sets - basic concepts of fuzzy sets.	
UNIT II Operation on Fuzzy Sets	**9**
Fuzzy complement - fuzzy union - fuzzy intersection - combination and general aggregation operations.	
UNIT III Fuzzy Relations	**9**
Crisp and fuzzy relations - binary relation - equivalence and similarity relations - tolerance relations - orderings.	
UNIT IV Classical Logic	**9**
Tautologies - contradictions - equivalence - exclusive OR and exclusive NOR - logical proofs.	
UNIT V Fuzzy Logic	**9**
Fuzzy logic - approximate reasoning - fuzzy tautologies - contradictions - equivalence and logical proofs.	

LECTURE	**TOTAL**
45	**45**

TEXTBOOK

1. George J. Klir & Tina A. Folger, "Fuzzy Sets, Uncertainty, and Information", Prentice Hall of India Pvt. Ltd., New Delhi, 1988
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications", 3rd edition, McGraw-Hill. Inc, 2010.

REFERENCES

1.Zimmermann. H.J, "Fuzzy Set Theory and Its Applications", 4th edition, Springer, Netherlands, 2015.

2. Bart Kosko, "Neural Networks and Fuzzy Systems", Prentice-Hall International, 1992.

Semester III

COURSE CODE			COURSE TITLE	L	T	P	C
YMA301			FIELD THEORY	4	0	0	4
C	**P**	**A**					
4	**0**	**0**		**L**	**T**	**P**	**H**
				4	**0**	**0**	**4**

PREREQUISITE: Algebra

COURSE OUTCOMES:

Course outcomes:	Domain	Level
CO1: Define and Explain Extension fields – Finite Extension – Algebraic Extension - Transcendence of e.	Cognitive	Remembering Understanding
CO2: Define and Explain Roots of Polynomials.- Remainder Theorem – Splitting field - More about roots.	Cognitive	Remembering Understanding
CO3: Define and Explain Elements of Galois Theory- Fixed field – Normal extension- Fundamental Theorem.	Cognitive	Remembering Understanding
CO4: Define and Explain Solvability by radicals – Solvable group – Galois group over the rational.	Cognitive	Remembering Understanding

CO5: Define and Explain Finite fields - Wedderburn's theorem on finite division rings – A Theorem of Frobenius.	Cognitive	Remembering Understanding

UNIT I	**12**
Extension fields – Finite Extension – Algebraic Extension - Transcendence of e.	
UNIT II	**12**
Roots of Polynomials.- Remainder Theorem – Splitting field - More about roots.	
UNIT III	**12**
Elements of Galois Theory- Fixed field – Normal extension- Fundamental Theorem.	
UNIT IV	**12**
Solvability by radicals – Solvable group – Galois group over the rational.	
UNIT V	**12**
Finite fields - Wedderburn's theorem on finite division rings – A Theorem of Frobenius.	

LECTURE	**TOTAL**
60	**60**

TEXTBOOK

1. N. Herstein,"Topics in Algebra", Willey Eastern, 1975.

REFERENCES

1. John B. Fraleigh,"A First Course in Abstract Algebra", Narosa Publication, Third Edition, 2013

2. P. M. Cohn,"Basic Algebra", Springers Publications, Second Edition, 2003.

COURSE CODE			**COURSE TITLE**	**L**	**T**	**P**	**C**
YMA302			**TOPOLOGY**	**4**	**0**	**0**	**4**
C	**P**	**A**					
4	**0**	**0**		**L**	**T**	**P**	**H**
				4	**0**	**0**	**4**

PREREQUISITE:

COURSE OUTCOMES:

Course outcomes:	**Domain**	**Level**
CO1: Define and Explain Topological Spaces	Cognitive	Remembering Understanding
CO2: Define and Explain Continuous Functions	Cognitive	Remembering Understanding
CO3: Define and Explain Connectedness	Cognitive	Remembering Understanding
CO4: Define and Explain Compactness	Cognitive	Remembering Understanding
CO5: Define and Explain Countability and Separation Axiom	Cognitive	Remembering Understanding

UNIT I Topological Spaces	**12**

Topological spaces - Basis for a topology - The order topology - The product topology on X x Y - The subspace topology.

UNIT II Continuous Functions **12**

Closed sets and limit points-Continuous functions - the product topology - The metric topology. - The metric topology (continued) - Uniform limit theorem.

UNIT III Connectedness **12**

Connected spaces - connected subspaces of the Real line - Components and local connectedness.

UNIT IV Compactness **12**

Compact spaces - compact subspaces of the Real line - Limit Point Compactness - Local Compactness.

UNIT V Countability and Separation Axiom **12**

The Countability Axioms - The separation Axioms - Normal spaces - The Urysohn Lemma - The Urysohn metrization Theorem - The Tietz extension theorem.

LECTURE		TOTAL
60		60

TEXTBOOK

1. James R. Munkres, "Topology", (2nd Edition) PHI Learning Pvt. Ltd., (Third Indian Reprint) New Delhi, 2014

Unit I - Chapter 2: Sections 12 to 17
Unit II - Chapter 2: Sections 18 to 21 (Omit Section 22)
Unit III - Chapter 3: Sections 23 to 25
Unit IV - Chapter 3: Sections 26 to 29
Unit V - Chapter 4: Sections 30 to 35

REFERENCES

1. J. Dugundji, "Topology", Prentice Hall of India, New Delhi, 1975.
2. George F.Sinmons, "Introduction to Topology and Modern Analysis", McGraw Hill Book Co., 1963.
3. J.L. Kelly, "General Topology", Van Nostrand, Reinhold Co., New York.1995
4. L.Steen and J.Subhash, "Counter Examples in Topology", Holt, Rinehart and Winston, New York, 1970.
5. S.Willard, "General Topology", Addison - Wesley, Mas.1970.

COURSE CODE			COURSE TITLE	L	T	P	C
YMA303			MEASURE THEORY	4	0	0	4
C	P	A					
4	0	0		L	T	P	H
				4	0	0	4

PREREQUISITE:

COURSE OUTCOMES:

Course outcomes:	Domain	Level

CO1: Define and Explain Measure Spaces – Measurable functions – Integration	Cognitive	Remembering Understanding
CO2: Define and Explain General Convergence Theorems – Signed measures – The Radon Nikodym Theorem.	Cognitive	Remembering Understanding
CO3: Define and Explain The L^p – spaces – Outer measure and measurability- The Extension Theorem.	Cognitive	Remembering Understanding
CO4: Define and Explain The Lebesgue-Stieltjes integral – Product measures – Integral operators.	Cognitive	Remembering Understanding
CO5: Define and Explain Inner measure – Extension by sets of measure zero- Caratheodory outer measure Hausdorff measure	Cognitive	Remembering Understanding

UNIT I	**12**
Measure Spaces – Measurable functions – Integration.	
UNIT II	**12**
General Convergence Theorems – Signed measures – The Radon Nikodym Theorem.	
UNIT III	**12**
The L^p – spaces – Outer measure and measurability- The Extension Theorem.	
UNIT IV	**12**
The Lebesgue-Stieltjes integral – Product measures – Integral operators.	
UNIT V	**12**
Inner measure – Extension by sets of measure zero- Caratheodory outer measure Hausdorff measure.	

LECTURE		**TOTAL**
60		**60**

TEXTBOOK

1.H.L.Royden, Real Analysis, 3rd Edition, Standford University , Prentice – Hall of India private Limited, New Delhi. 2002.

(Chapter 11 - Section 1 to 7, Chapter 12 - Section 1 to 9).

REFERENCES

1.P.R. Halmos, "Measure Theory", Graduate Text in Mathematics, Springer-Verlag, 1979.

2.Inder K. Rana, "An Introduction to Measure and Integration", (2nd ed.), Narosa Publishing House, New Delhi, 2004.

COURSE CODE			COURSE NAME	L	T	P	C
YMA304			MATHEMATICAL STATISTICS	4	0	0	4
C	P	A					
4	0	0		L	T	P	H
				4	0	0	4

PREREQUISITE:

COURSE OUTCOMES:

Course outcomes:	Domain	Level
CO1: Define and Explain Estimation Theory.	Cognitive	Remembering Understanding
CO2: Explain and solve Tests based on normal, t and f distributions for testing of means, variance and proportions – Analysis of r × c tables – Goodness of fit	Cognitive	Understanding Applying
CO3: Explain and solve Correlation And Regression.	Cognitive	Understanding Applying
CO4: Explain and solve Design of Experiments	Cognitive	Understanding Applying
CO5: Explain and solve Statistical Quality Control by X , R charts, p, c and np charts.	Cognitive	Understanding Applying

UNIT I Estimation Theory **12**

Estimators: Un biasedness, Consistency, Efficiency and Sufficiency – Maximum likelihood estimation – Method of moments.

UNIT II Testing Of Hypothesis **12**

Tests based on normal, t and f distributions for testing of means, variance and proportions – Analysis of r × c tables – Goodness of fit.

UNIT III Correlation And Regression **12**

Multiple and Partial correlation – Method of least squares – Plane of Regression – Properties of residuals – Coefficient of multiple correlation – Coefficient of partial correlation - Multiple correlation with total and partial correlation – Regression and Partial correlations in terms of lower order co-efficient.

UNIT IV Design of Experiments **12**

Analysis of variance – One way and two way classifications – Completely randomized design – Randomized block design – Latin square design.

UNIT V Statistical Quality Control **12**

Analysis of variance: Control charts for measurements (X and R charts) – control charts for attributes (p, c and np charts) – Tolerance limits – Acceptance sampling, Introduction to SPSS.

LECTURE	TOTAL
60	60

TEXTBOOK

1. Gupta. S.C., and Kapoor. V.K., "Fundamentals of Mathematical Statistics", Sultan Chand and sons, Thirteenth Edition, 2014.

REFERENCES

1. J.E. Freund, "Mathematical Statistical", 5th Edition, Prentice Hall of India, 2001.

2. Jay L. Devore, "Probability and Statistics for Engineering and the Sciences",5th Edition, Thomas and Duxbury, Singapore, 2002.

COURSE CODE			COURSE TITLE	L	T	P	C
YMA3E02			NUMERICAL METHODS	3	0	0	3
C	P	A					
3	0	0		L	T	P	H
				3	0	0	3

PREREQUISITE: algebra

COURSE OUTCOMES:

Course outcomes:	Domain	Level
CO1: Find the solution by using Bisection method-Newton-Raphson Method-Curve fitting straight line and parabola.	Cognitive	Remembering
CO2: Solve Simultaneous Linear Equations.	Cognitive	Remembering Understanding
CO3: Find the value of y = f(x) using interpolation formula.	Cognitive	Remembering Understanding
CO4: Find the first and second derivative of f(x) and to find the value of integrals using numerical methods.	Cognitive	Remembering Understanding
CO5: Solve ordinary differential equations by using various methods.	Cognitive	Remembering Understanding

UNIT I	**9**
Solution of Numerical Algebraic Equations & Curve fitting Bisection method-Newton-Raphson method-Curve fitting straight line and parabola.	
UNIT II	**9**
Solution of Simultaneous Linear Equations-Gauss-Elimination method-Method of factorization-Gauss Jacobi and Gauss-Seidel methods	
UNIT III	**9**
Interpolation - Gregory-Newton forward and backward interpolation formulae Sterling's formula-Lagrange's formula.	
UNIT IV	**9**
Numerical Differentiation and Integration, Numerical differentiation, Trapezoidal rule-Simpson's one-third rule –Simpson's three-eighth rule.	
UNIT V	**9**
Numerical Solution of Ordinary Differential Equations, Euler's method – fourth order Runge-Kutta method-Milne's predictor corrector method.	

LECTURE		TOTAL
45		45

TEXTBOOK

1. Sastry.S.S, "Introductory Methods of Numerical Analysis", Prentice Hall of India, 2000.

REFERENCES

1. Gerald, Curtis and Wheatley, Patrick.O,"Applied Numerical Analysis", (Fifth Edition) Addison-Wesley, 1989.
2. Kandasamy.P, Thilakavathy.K, Gunavathy.K-Numerical Methods, S.Chand & Co. Ltd, New Delhi, Reprint 2001.

Semester IV

COURSE CODE			COURSE NAME	L	T	P	C
YMA401			COMPLEX ANALYSIS	4	0	0	4
C	P	A					
4	0	0		L	T	P	H
				4	0	0	4

PREREQUISITE:

COURSE OUTCOMES:

Course outcomes:	Domain	Level
CO1: Define and Explain Line Integrals- Rectifiable arc – Line integrals as functions of arc- Cauchy's Theorem for rectangle- Cauchy's Theorem for disc	Cognitive	Remembering Understanding
CO2: Define and Explain Integral Formula – Higher derivatives – Removable singularities – Taylor's theorem – Zeros and Poles – The Local Mapping – The Maximum Principle.	Cognitive	Remembering Understanding
CO3: Define and Explain The General Statement of Cauchy's Theorem – Proof of Cauchy's Theorem – Locally Exact Differentials – Multiply Connected Regions.	Cognitive	Remembering Understanding
CO4: Define and Explain The Residue Theorem – The Argument Principle – Evaluation of Definite Integrals – The Mean – value property – Poisson's formula- Schwarz's Theorem – The Reflection Principle.	Cognitive	Remembering Understanding
CO5: Define and Explain Weierstrass's Theorem – The Taylor Series – The Laurent Series – Partial Fractions- Jensen's Formula – Hadamard's Theorem	Cognitive	Remembering Understanding

UNIT I	**12**
Line Integrals- Rectifiable arc – Line integrals as functions of arc- Cauchy's Theorem for rectangle- Cauchy's Theorem for disc.	
UNIT II	**12**
The Index of a point - Integral Formula – Higher derivatives – Removable singularities – Taylor's theorem – Zeros and Poles – The Local Mapping – The Maximum Principle.	
UNIT III	**12**

Chains and Cycles – Simple Connectivity – Homology – The General Statement of Cauchy's Theorem – Proof of Cauchy's Theorem – Locally Exact Differentials – Multiply Connected Regions.

UNIT IV **12**

The Residue Theorem – The Argument Principle – Evaluation of Definite Integrals – The Mean – value property – Poisson's formula- Schwarz's Theorem – The Reflection Principle.

UNIT V **12**

Weierstrass's Theorem – The Taylor Series – The Laurent Series – Partial Fractions- Jensen's Formula – Hadamard's Theorem**.**

LECTURE	**TOTAL**
60	**60**

TEXTBOOK

1.Lars V.Ahlfors, "Complex Analysis", 3rd Edition McGraw Hill Education (India) Private Ltd.2013.

Chapter 4 - Section 1.1 to 1.5, Section 2.1 to 2.3, Section 3.1 to 3.4, Section 4.1 to 4.7, Section 5.1 to 5.3 , Section 6.1 to 6.5.

Chapter 5 - Section 1.1 to 1.3, Section 2.1, Section 3.1 & 3.2.

REFERENCES:

1. S. Poonusamy, "Complex Analysis", Alpha Science International Ltd; 2nd Revised edition, 2005.

COURSE CODE	**COURSE NAME**	**L**	**T**	**P**	**C**
YMA402	**FUNCTIONAL ANALYSIS**	**4**	**0**	**0**	**4**

C	**P**	**A**					
4	**0**	**0**		**L**	**T**	**P**	**H**
				4	**0**	**0**	**4**

PREREQUISITE:

COURSE OUTCOMES:

Course outcomes:	**Domain**	**Level**
CO1: Define and Explain Normed Spaces – Continued of Linear Maps – Hahn – Banach Theorems.	Cognitive	Remembering Understanding
CO2: Define and Explain Banach Spaces – Uniform Boundedness Principle – Closed Graph and Open Mapping Theorems.	Cognitive	Remembering Understanding
CO3: Define and Explain Bounded Inverse Theorem – Spectrum of a Bounded Operator.	Cognitive	Remembering Understanding
CO4: Define and Explain Inner Product Spaces – Orthonormal Sets – Projection and Riesz Representation Theorems.	Cognitive	Remembering Understanding
CO5: Define and Explain Bounded Operators and adjoint, Normal , Unitary and Self-adjoint Operators.	Cognitive	Remembering Understanding

UNIT I **12**

Normed Spaces – Continued of Linear Maps – Hahn – Banach Theorems.

UNIT II	**12**
Banach Spaces – Uniform Boundedness Principle – Closed Graph and Open Mapping Theorems.	
UNIT III	**12**
Bounded Inverse Theorem – Spectrum of a Bounded Operator.	
UNIT IV	**12**
Inner Product Spaces – Orthonormal Sets – Projection and Riesz Representation Theorems.	
UNIT V	**12**
Bounded Operators and adjoint, Normal , Unitary and Self-adjoint Operators.	

LECTURE	**TOTAL**
60	**60**

TEXTBOOK

1.Balmohan V Limaye, "Functional Analysis", 3rd Edition, New Age International (P) Limited Publishers, New Delhi, 2017.

REFERENCES

1. G.F. Simmons, "Introduction to Topology and Modern Analysis", McGraw Hill International Book Company, New York, 1963.
2. W. Rudin, "Functional Analysis", Tata McGraw-Hill Publishing Company, New Delhi, 1973.
3. E. Kreyszig, "Introductory Functional Analysis with Applications", John Wiley & Sons, New York, 1978.
4. H. C. Goffman and G.Fedrick, "First Course in Functional Analysis", Prentice Hall of India, New Delhi, 1987.

COURSE CODE			**COURSE NAME**	**L**	**T**	**P**	**C**
YMA403			**STOCHASTIC PROCESSES**	**4**	**0**	**0**	**4**
C	**P**	**A**					
4	**0**	**0**		**L**	**T**	**P**	**H**
				4	**0**	**0**	**4**

PREREQUISITE:

COURSE OUTCOMES:

Course outcomes:	**Domain**	**Level**
CO1: Define and Explain Specification of Stochastic processes, Stationary processes, Markov Chains with examples	Cognitive	Remembering Understanding
CO2: Define and Explain Classification of states and chains.	Cognitive	Remembering Understanding

CO3: Define and Explain Markov processes with Discrete state space.	Cognitive	Remembering Understanding
CO4: Define and Explain Queuing system	Cognitive	Remembering Understanding
CO5: Define and Explain Auto-correlation functions, cross-correlation functions and their properties	Cognitive	Remembering Understanding

UNIT I	**12**
Stochastic Processes: Some notions, Specification of Stochastic processes, Stationary processes, Markov Chains – Definitions and examples – Higher Transition probabilities – Generalization of Independent Bernoulli trails – Sequence of chain – Dependent trains.	
UNIT II	**12**
Markov chains: Classification of states and chains – determination of Higher transition probabilities – stability of a Markov system – Reducible chains – Markov chains with continuous state space.	
UNIT III	**12**
Markov processes with Discrete state space: Poisson processes and their extensions – Poisson process and related distribution – Generalization of Poisson process- Birth and Death process – Markov processes with discrete state space (continuous time Markov Chains).	
UNIT IV	**12**
Stochastic processes in Queuing – Queuing system – General concepts – the queuing model M/M/1 – Steady state behaviour – transient behaviour of M/M/1 Model- Birth and death processes in queuing theory: Muti-channel models.	
UNIT V	**12**
Auto-correlation functions, cross-correlation functions - properties, power spectral density - Cross-spectral density – Properties - Wiener-Khinchine relation, linear time invariant system - system transfer function – auto-correlation and cross-correlation functions of input and output.	

LECTURE	**TOTAL**
60	**60**

TEXTBOOK

1.J. Medhi, "Stochastic Processes", New Age International (P) Limited, Publishers – Second edition. 2013

2. T. Veerarajan, "Random Processes", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008

REFERENCES:

1. Peebles, P.Z., "Probability, Random Variables and Random Signal Principles", Tata McGraw Hill, 4th edition, New Delhi, (2002).
2. Srinivasan and Metha, Stochastic Processes,
3. Miller, S.L. and Childers, D.G.,"Probability and Random Processes with Applications to Sigpnal Processing and Communications", Academic Press, (2004).
4. R. Nelson, Probability, "Stochastic Processes, and Queuing Theory: The Mathematics of Computer Performance Modeling", Springer-Verlag, New York, 1995.