Department of Mathematics (Self-Supporting) is revising the M. Sc syllabus with effect from the academic year 2018- 2019 , (CBCS pattern)

PREAMBLE

As per the guidelines given by the University Grants Commission and the Tamil Nadu State Council for Higher Education , the M. Sc degree programme is designed in such a way that it has an extensive applications in both pure and applied Mathematics; an attitude towards problem formulation and solving; an analytical skill and accuracy; an appreciation of the approaching of mathematical techniques and research aptitude to mathematics. Every effort has been made to present the subject in easy, clear, lucid and systematic manner. References at the end of each syllabus are given to cover more advanced extension of the topics presented.

REGULATIONS

1. ELIGIBILITY FOR ADMISSION:

Candidates for admission to the first year of the degree of M. Sc. course should have Bachelor's degree in Mathematics of University of Madras or some other University accepted by the syndicate as equivalent .

2. ELIGIBILITY FOR THE AWARD OF DEGREE:

The candidate shall be eligible for the award of degree only if she has undergone the prescribed course of study for a period of not less than two academic years, passed the examinations of all the four semesters prescribed, earning 93 credits.

3. DURATION OF THE PROGRAMME : 2 YEARS

Each academic year is divided into two semester sessions. The first academic year shall comprise the first and second semesters. The second academic year, the third and fourth semesters. Each semester will have a minimum of 90 working days and each day will have 5 working hours. Teaching is organized into a modular pattern of credit courses. Credit is normally related to the number of teaching hours of a particular subject. It is also related to the number of tutorial and practical hours.

4. COURSE OF STUDY :

The main subject of study for Master Degree shall consist of the following:

Courses	Number	Credit per Course	Total Credits
Core Courses			
Theory	14	4	56
Theory & Practical	1	6	6
Elective Courses			
Major	5	3	15
Non Major	2	3	6
Soft Skill	4	2	8
Internship	1	2	2
Total			93

5. PASSING MINIMUM :

A candidate shall be declared to have passed in each paper of the main subject of study wherever prescribed, if she secured NOT LESS THAN 50 % of the marks prescribed for the End Semester Examination and also 50% in the sum of End Semester Examinations and Continuous Assessment. There is no passing minimum for Continuous Assessment..

6. CLASSIFICATION OF SUCCESSFUL CANDIDATES :

Successful Candidates passing the examination and securing the marks

1. 60% and above in aggregate shall be declared to have passed the Examination with first class
2. 50% and above but below 60% in the aggregate shall be declared to have passed the examination in the second class.

3. Candidates who pass all the examinations prescribed for the course in the FIRST ATTEMPT ITSELF ALONE are eligible for ranking .

7. QUESTION PAPER PATTERN

Template

Component	Nature of the question	Maximum marks
Section –A	Understanding Description/Problems- Two questions from every Unit	10 x 2 = 20
Section – B	Understanding Description/Problems- At least one question from every Unit	5 (out of 8) x 7= 35
Section – C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15 = 45

Department of Mathematics
PG Course Profile- 2018-2019

Sem	Code	Course Title	Core	Hours	L	T	P	Credits	C.A	S.E	Total
I	11SP18/1C/AL1	Algebra I	1	6	3	3	0	4	40	60	100
	11SP18/1C/RA1	Real Analysis-I	2	6	3	3	0	4	40	60	100
	11SP18/1C/ODE	Ordinary Differential Equations	3	6	3	3	0	4	40	60	100
	11SP18/1E1/GTY	Graph Theory	E1	5	2	3	0	3	40	60	100
	11SP18/1E2/OR1	Operations Research I	E2	5	2	3	0	3	40	60	100
	PG18/1S/PEW	Personality Enrichment Development Soft Skills	SS1	2				2			50
II	11SP18/2C/AL2	Algebra II	4	5	3	2	0	4	40	60	100
	11SP18/2C/RA2	Real Analysis-II	5	5	3	2	0	4	40	60	100
	11SP18/2C/PDE	Partial Differential Equations	6	5	3	2	0	4	40	60	100
	11SP18/2C/MTA	Mechanics and Tensor Analysis	7	5	3	2	0	4	40	60	100
	11SP18/2E3/OR2	Operations Research II	E3	4	2	2	0	3	40	60	100
	11SP18/2E/MCE	Mathematics for Competitive Examinations	EDE (1)	4	2	2	0	3	40	60	100
	PG18/2S/LCE PG18/2S/FRE PG18/2S/GER	Language and Communication in English (Soft Skills)	SS2	2				2			50
		Internship						2	50	50	100
		Total		60				46			

Sem	Code	Paper Title	Core	Hours	L	T	P	Credits	C.A	S.E	Total
III	11SP18/3C/CA1	Complex Analysis I	8	5	3	2	0	4	40	60	100
	11SP18/3C/TOP	Topology	9	5	3	2	0	4	40	60	100
	11SP18/3C/DGY	Differential Geometry	10	5	3	2	0	4	40	60	100
	11SP18/3C/CVI	Calculus of Variations and Integral Equations	11	5	3	2	0	4	40	60	100
	11SP18/3E4/MS1	Mathematical Statistics I	E4	4	2	2	0	3	40	60	100
	11SP18/3E/RMT	Resource Management Techniques	EDE (2)	4	2	2	0	3	40	60	100
	11SP18/3S/ASN	Analytical Skills for NET/SET. (Soft skill)	SS3	2	2	0	0	2			50
IV	11SP18/4C/CA2	Complex Analysis II	12	6	3	3	0	4	40	60	100
	11SP18/4C/FAN	Functional Analysis	13	6	3	3	0	4	40	60	100
	11SP18/4C/FSA	Fuzzy Set theory and its Applications	14	5				4	40	60	100
	11SP18/4C/PYP	Python Programming (Theory)	15	3	2	1	0	3	40	60	100
	11SP18/4C/PR1	Python Programming (Practical)	-	3	0	0	3	3	-	-	100
	11SP18/4E5/MS2	Mathematical Statistics II	E5	5	2	3	0	3	40	60	100
	11SP18/4S/LAT	LATEX-A Document Preparation System (Soft skill)	SS4	2	0	0	2	2			50
	Total			60				47			
Over all credits								93			

SEMESTER - I
ALGEBRA - I

Core - 1 **Course Code : 11SP18/1C/AL1**
Teaching Hours : 90 **Credits: 4** **LTP: 3 3 0**

OBJECTIVES :

To understand the concepts of advanced algebra. To get knowledge on application of class equation, linear Transformations and different forms of matrices.

COURSE OUTLINE :

UNIT I: **Group Theory**

Sylow's Theorem (For Theorem 2.12.1 First proof only).

Chapter 2 : Sections 2.12 (Omit Lemma 2.12.1, 2.12.2 & 2.12.5)

(20 hrs)

UNIT II : **Group Theory(contd.), Modules**

Direct Products - Finite Abelian groups - Modules.

Chapter 2 : Sections 2.13 and 2.14 (Theorem 2.14.1 only)
Chapter 4 : Section 4.5

(20 hrs)

UNIT III : **Linear Transformations**

Canonical Forms: Triangular Form.

Chapter 6 : Section 6.4

(15 hrs)

UNIT IV : **Linear Transformations(contd.)**

Canonical Forms: Nilpotent Transformations – A Decomposition of V: Jordan Form.

Chapter 6 : Sections 6.5 and 6.6 (15 hrs)

UNIT V : **Linear Transformations(contd.)**
Hermition, Unitary and Normal Transformations- Real Quadratic Forms.

Chapter 6 : Sections 6.10 and 6.11 (20 hrs)

RECOMMENDED TEXT :

I.N. Herstein, Topics in Algebra(II Edition), Wiley Eastern Limited, New Delhi, 1975

REFERENCE BOOKS:

1. M. Artin, Algebra, Prentice Hall of India, 19912.
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (II Edition) Cambridge University Press, 1997. (Indian Edition)
3. I.S. Luther and I.B.S Passi, Algebra, Vol - I Groups (1996): Vol II Rings, Narosa Publishing House, New Delhi, 1999.
4. N.Jacobson, Basic Algebra, Vol I & II, Hindustan Publishing Company, NewDelhi,1974.
5. John B. Fraleigh, A First Course in Abstract Algebra, Pearson Education Publishing Company.

Periodicals:

The Mathematics Intelligencer
Mathematic News Letter

Websites and e- learning sources

http//mathforum.org
http//www.opensource.org

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Section – C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15 = 45

SEMESTER - I

REAL ANALYSIS - I

CORE - 2 **Course Code : 11SP18 / 1C / RA1**
Teaching hours : 90 **Credits : 4 L T P : 3 3 0**

OBJECTIVES :
To work comfortably with functions of bounded variation, Riemann - Stieltjes Integration, convergence of double series, uniform convergence and its interplay between various limiting operations.

COURSE OUTLINE :

UNIT I : **Functions of Bounded Variation**

Introduction - Properties of monotonic functions - Functions of bounded variation - total variation Additive property of Total variation -Total variation on [a, x] as a function of x - Functions of bounded variation expressed as the difference of increasing functions - continuous functions of bounded variation.

Chapter 6 : Sections - 6.1 to 6.8 (18 hrs)

UNIT II : **The Riemann - Stieltjes Integral**

Introduction - Notation - The definition of the Riemann - Stieltjes integral - Linear Properties - Integration by parts - Change of variable in a Riemann- Stieltjes integral - Reduction to a Riemann integral- Euler Summation formula - Monotonically increasing integrators-Upper and Lower integrals -, Additive And Linearity Properties of Upper and Lower Integrals- Riemann's Conditions.

Chapter - 7: Sections 7.1 to 7.13. (Omit 7.8 &7.9) (20 hrs)

UNIT III: **The Riemann - Stieltjes Integral**

Integrators of bounded variation - sufficient conditions for the existence of Riemann Stieltjes integrals Necessary conditions for the existence of Riemann Stieltjes integrals - Mean value theorems for Riemann - Stieltjes integrals - The integrals as a function of the interval-Second Fundamental theorem of integral calculus -Second Mean value theorem for Riemann integrals, Lebesgue's criterion for the existence of Riemann integrals.

Chapter-7: Sections 7.15 to 7.26 (Omit 7.21,7.23 to7.25) (20 hrs)

UNIT IV: **Sequences of Functions**

Point - Wise 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. Uniform convergence and Riemann - Stieltjes integration - Uniform Convergence and Differentiation- Sufficient conditions for uniform convergence of a series

Chapter 9: Sections 9.1-9.11 (Omit 9.7 & 9.9) (18hrs)

UNIT V: **Sequences 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 9.14 to 9.23 (Omit 9.16,9.17,9.18,9.21) (14 hrs)

RECOMMENDED TEXT :
Tom M. Apostol, 1974, Mathematical Analysis 2nd Edition, Addison Wesley publishing company Inc. New York.

REFERENCE BOOKS:
1.Bartle, R.G , Real Analysis, John Wiley and sons Inc, 1976.
2.Rudin.W, Principles of mathematical Analysis, 3rd Edition Mc.Graw Hill Company, NewYork, 1976.
3.A.L. Gupta and N.R. Gupta, Principles of Real Analysis, Pearson Education (India Print), 2003.

Periodicals:
The Mathematics Intelligencer
Mathematic News Letter

Websites and e- learning sources
http//mathforum.org
http//www.opensource.org

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Section – B	Understanding Description/Problems- At least one question from every Unit	5 (out of 8) x 7= 35
Section – C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15 = 45

SEMESTER - I
ORDINARY DIFFERENTIAL EQUATIONS

Core - 3 **Course Code : 11SP18/1C/ODE**
Teaching hours : 90 **Credits : 4 L T P : 3 3 0**

OBJECTIVES :
To develop strong background on finding solutions to linear differential equations with constant and variable coefficients and also with singular points, to study existence and uniqueness of the solutions of first order differential equations.

COURSE OUTLINE :

UNIT I : Linear Differential Equations Of Higher Order

Introduction- Higher order equations - A Modelling problem - Linear Independence - Equations with Constant Coefficients.

Chapter 2 : sections 2.1 to 2.5 (15 hrs)

UNIT II:Linear Differential Equations Of Higher Order(Contd.)

Equations with variable coefficients - Wronskian - Variation of parameters - Some Standard Methods - Method of Laplace Transforms

Chapter2: sections 2.6 to 2.10 (15 hrs)

UNIT III: Solutions In Power Series

Introduction - Second order Linear Equations with Ordinary Points -Legendre Equation and Legendre Polynomials - Second Order Equation with Regular Singular Points - Properties of Bessel Functions

Chapter 3: sections 3.1 to 3.5 (25 hrs)

UNIT IV: Systems of Linear Differential Equations

Introduction - System of First Order Equations - Existence and Uniqueness Theorem - Fundamental Matrix -. Linear Systems with Constant Coefficients - Linear Systems with Periodic Coefficients

Chapter 4: Section 4.1- 4.8 (Omit 4.3 & 4.6) (20 hrs)

UNIT V: Existence and Uniqueness of Solutions

Introduction - Preliminaries - Successive Approximations - Picard's Theorem - Some Examples.
Chapter 5: Section 5.1 to 5.5 (15 hrs)

RECOMMENDED TEXT :

S.G. Deo , V. Lakshmikantham , V .Raghavendra Text Book of Ordinary Differential Equations (Second Edition) Tata Mc Graw Hill, New Delhi, 1974

REFERENCE BOOKS :

1.Earl A. Coddington, An introduction to ordinary differential equations, (3rd edition), Prentice Hall of India Ltd, New Delhi, 1987
2.Williams E. Boyce and Richard C. DI Prima, Elementary differential equations and boundary value problems, John wiley and sons, New York, 1967
3.George F. Simmons, Differential equations with applications and historical notes, TataMc Graw Hill, New Delhi, 1974.
4.N.N. Labedev. Special functions and their applications, prentice Hall of India, New Delhi 1965
5.W.T. Raid, Ordinary Differential equations, John wiley and sons, New York, 1974.
6.P. Hartman, Ordinary Differential Equations, John wiley and sons, New York,1974.

Periodicals:

The Mathematics Intelligencer .
Mathematics News letter.

Websites And E-Learning Sources:

http:// mathforum.org
http:// ocw.mit edu/ocw/web/mathematics,
http:// www.opensource.org, www.mathpages.com

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Component	Nature of the question	Maximum marks
Section –A	Understanding Description/Problems- Two questions from every Unit	10 x 2 = 20
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Section – C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15 = 45

SEMESTER-I

GRAPH THEORY

Elective : E1 **Course Code: 11SP18/1E1/GTY**
Teaching hours : 75 **Credits : 3 L T P: 2 3 0**

OBJECTIVES: Graph Theory is a real life application subject. This paper enables the student to understand the subject deeply and apply the contents in various life situations like shortest path problem, time tabling problem etcetera. The students may pursue their studies in research also.

Course Outline:

UNIT 1: Graphs and Subgraphs

Graphs and simple graphs – Graph Isomorphism – The Incidence and Adjacency Matrices – Sub graphs – Vertex Degrees – Paths and Connection – Cycles

Chapter 1: Sections 1.1 – 1.7 (15 hours)

UNIT 2: Trees, Connectivity

Trees, Cut edges and Bonds, Cut vertices, Connectivity, Blocks

Chapter 2: Sections 2.1 - 2.3
Chapter 3: Sections 3.1, 3.2 (15 hours)

UNIT 3: Euler Tours And Hamilton Cycles, Matchings

Euler Tours, Hamilton Cycles, Matchings, Matchings and Coverings in Bipartite graphs

Chapter 4: Sections 4.1, 4.2,
Chapter 5: Sections 5.1, 5.2
(15 hours)

UNIT 4:Edge Colourings, Vertex Colourings

Edge chromatic number, Vizing's theorem, Chromatic number, Brook's Theorem

Chapter 6: 6.1, 6.2, Chapter 8: Sections 8.1, 8.2 (15 hours)

UNIT 5: Planar Graphs

Plane and planar graphs, Dual Graphs, Euler's formula, The five colour theorem and the four colour conjecture.

Chapter 9: Sections 9.1 - 9.6 (Omit 9.4 and 9.5) (15 hours)

RECOMMENDED TEXT:

Graph theory and its applications- J.A. Bondy and U.S.R. Murty, 5th Print, 1982

REFERENCEBOOKS:

1. Introduction to Graph Theory – Doughlas B. West, Second edition, PHI learning pvt ltd, 2011.
2. A.Gibbons,*Algorithmic Graph Theory*,CambridgeUniversity Press, Cambridge,1989.
3. S.A.Choudum, *A First Course in Graph Theory*, MacMillan India Ltd. 1987.

Periodicals:

The Mathematics Intelligencer
Mathematic News Letter

Websites and e- learning sources

https:// mathigon.org/course/graphs-and-networks
www.graphtheorysoftware.com
https://www.britannica.com/topic/graph-theory

Template

Component	Nature of the question	Maximum marks
Section –A	Understanding Description/Problems- Two questions from every Unit	10 x 2 = 20
Section – B	Understanding Description/Problems- At least one question from every Unit	5 (out of 8) x 7= 35
Section – C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15 = 45

SEMESTER I
OPERATIONS RESEARCH I

Elective - E2 **Course Code : 11SP18/1E2/OR1**
Teaching Hours : 75 **Credits : 3** **LT P: 2 3 0**

OBJECTIVES:
To understand the need of using Operations Research – a quantitative approach for effective decision making. To recognize, classify and use various models for solving a problem under consideration.

UNIT I: Integer Linear Programming

Introduction – Types of Integer Programming Problems – Enumeration and Cutting Plane Solution Concept – Gomory's All Integer Cutting Plane Method – Gomory's Mixed-Integer Cutting Plane Method.

Chapter7: Sections 7.1 - 7.5 (15 hrs)

UNIT II : Dynamic Programming

Introduction – Dynamic Programming Terminology – Developing Optimal Decision Policy - Dynamic Programming under Certainty – Shortest Route Problem(Model I) – Multiplicative Separable Return Function and Single Additive Constraint(Model II)

Chapter 22: Sections 22.1 - 22.4 (Model I and Model II only) (15 hrs)

UNIT III : Dynamic Programming

Dynamic Programming under Certainty – Additive Separable Return Function and Single Additive Constraint (Model III) – Additively Separable Return Function and Multiplicative constraint(Model IV).

Chapter 22: Section 22.4 (Model III and IV only) (15 hrs)

UNIT IV : Classical Optimization Methods

Introduction – Unconstrained Optimization- Constrained Multivariable Optimization with Equality Constraints.

Chapter 23: Sections 23.1 - 23.3 (15 hrs)

UNIT V : Non-Linear Programming Methods:
Introduction – The General Non Linear Programming Problem –Graphical Solution Method- Quadratic Programming – Kuhn-Tucker Conditions – Wolfe's Modified Simplex Method.
Chapter 24: Sections 24.1 - 24.4 (upto Wolfe's Modified Simplex Method)

(15 hrs)

RECOMMENDED TEXT

J.K Sharma, Operations Research Theory and Applications 4th edition Macmillan Publishers India Ltd,2009.

REFERENCE BOOKS

1.Hamdy A. Taha Operations Research (9th Edition), Prentice Hall of India Private Limited, New Delhi,2013.
2.S.D. Sharma, Operations Research, Kedar Nath Ram Nath and Co., Meerut, 2010.
3.F.S Hiller and J. Liberman Introduction to Operations Research (7th edition),2010

Periodicals:
The Mathematics Intelligencer
Mathematic News letter.

Websites and e-Learning Sources
http:// ocw.nctu..edu.tw/uploads/classfbs
http://www.opensource.org

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Section –A	Understanding Description/Problems- Two questions from every Unit	10 x 2 = 20
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SEMESTER - II

ALGEBRA - II

Core - 4 **Course Code : 11SP18/2C/AL2**
Teaching hours : 75 **Credits : 4** **LTP: 3 2 0**

OBJECTIVES :

To impart important applications in the theory of numbers and to emphasize the aspects of field theory. To get introduced to finite fields.

COURSE OUTLINE :

UNIT I: Fields

Extension fields

Chapter 5: Section 5.1 (12 hrs)

UNIT II: Fields (contd.)

Roots of polynomials - More about roots

Chapter 5: Sections 5.3 and 5.5 (18 hrs)

UNIT III: Fields (contd.)

The Elements of Galois Theory - Solvability by Radicals.

Chapter 5: Sections 5.6 and 5.7
(Omit Lemma 5.7.1, Lemma 5.7.2.,Theorem 5.7.1) (18 hrs)

UNIT IV: Finite fields

Finite fields - Wedderburn's theorem on finite Division Rings.

Chapter 7: Sections 7.1 and 7.2
(Omit Lemma 7.2.1,7.2.2 and Theorem 7.2.2) (12 hrs)

UNIT V: Finite fields(contd.)

A Theorem of Frobenius - Integral Quaternions and Four-Square theorem

Chapter 7 : Sections 7.3 and 7.4 (15 hrs)

RECOMMENDED TEXT :

I.N. Herstein, Topics in Algebra(II Edition), Wiley Eastern Limited, New Delhi, 1975

REFERENCE BOOKS:

1. M. Artin, Algebra, Prentice Hall of India, 19912.
2. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra (II Edition) Cambridge University Press, 1997. (Indian Edition)
4. I.S. Luther and I.B.S Passi, Algebra, Vol - I Groups (1996): Vol II Rings, Narosa Publishing House, New Delhi, 1999.
5. N.Jacobson, Basic Algebra, Vol I & II, Hindustan Publishing Company, NewDelhi,1974.
6. John B. Fraleigh, A First Course in Abstract Algebra, Pearson Education Publishing Company.

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Websites and e-Learning Sources

http:// mathforum.org,
http://ocw.mit.edu/ocwweb/mathematics.
http:// www.opensource.org. www. algebra.com

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SEMESTER - II
REAL ANALYSIS - II

CORE - 5 **COURSE CODE : 11SP18/2C/RA2**
Teaching hours : 75 **Credits : 4** **L T P : 3 2 0**

OBJECTIVES
To introduce measure on the real line, To work comfortably with Fourier series and Integrals, in depth study in multivariable calculus

COURSE OUTLINE

UNIT I: Fourier Series
Introduction - Orthogonal systems of functions - The Theorem on best approximation - The fourier series of a function relative to an orthonormal system - Properties of Fourier coefficients. The Riesz- Fischer theorem. The convergence and representation problems for trigonometric series - The Riemann - Lebesgue Lemma - The Dirichlet Integrals(definition only) - an integral representation for the partial sums of a Fourier series - Riemann's Localization theorem. Sufficient conditions for convergence of a Fourier series at a particular point.

Chapter 11: Sections 11.1 to 11.12 (Omit sec-11.9) (15hrs)

UNIT II : **Multivariable Differential Calculus**
Introduction - The Directional Derivative- Directional Derivatives and continuity. The Total derivative - The total derivative expressed in terms of partial derivatives- the matrix of a linear function - The Jacobian Matrix - The Chain Rule- Matrix form of chain rule - The Mean Value theorem for differentiable functions - A sufficient condition for differentiable functions - A sufficient condition for differentiability - A sufficient condition for equality of mixed Partial derivatives - Taylor's formula for functions from R^n to R^1.

Chapter 12: Sections 12.1 to 12.14 (17 hrs)

UNIT III: Implicit Functions
Introduction-Functions with non – zero Jacobian determinants - The Inverse Function theorem - The Implicit Function Theorem.

Chapter 13: Sections 13.1 to 13.4 (13 hrs)

UNIT IV: **Measure on the Real Line**
Measures on the Real line: Lebesgue outer measure - Measurable sets - Regularity - Measurable functions .
Chapter 2 : Sections 2.1 to 2.4 (15 hrs)

UNIT V: **Integration of Functions of a Real Variable**

Integration of non-negative functions - The General integral - Riemann and Lebesgue Integrals

Chapter - 3 Sections 3.1, 3.2 and 3.4 (15 hrs)

RECOMMENDED TEXTS :

1. UNITS- I to III - Tom M. Apostol, 1974, Mathematical Analysis 2nd Edition, Addison Wesley publishing Company Inc. New York.

2. UNITS—IV & V - G.de.Barra, 1981 Measure Theory and Integration, Wiley Eastern Ltd. New Delhi.

REFERENCE BOOKS :

1. Bartle, R.G. 1976, Real Analysis John Wiley and sons Inc
2. Rudin.W. 1976. Principles of mathematical Analysis, 3rd Edition Mc.Graw Hill company.NewYork.
3. A.L. Gupta and N.R. Gupta 2003. Principles of Real Analysis pearson Education (India Print)

Periodicals:

The Mathematics Intelligencer .
Mathematics News letter.

Websites And e-Learning Sources:

http://ocw.mit.edu/ocwweb/Mathematics
http://Mathforum.org

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SEMESTER - II

PARTIAL DIFFERENTIAL EQUATIONS

Core - 6 **Course Code : 11SP18/ 2C /PDE**
Teaching hours : 75 **Credits : 4 LTP : 3 2 0**

OBJECTIVES:
To develop strong background on finding solutions to linear differential equations with constant and variable coefficients and also with singular points, to study existence and uniqueness of the solutions of first order differential equations, Cauchy problem, boundary value problems and method of separation of variables..

COURSE OUTLINE :

UNIT I :Mathematical models
Classification of second order equations, the classical equations, vibrating string, vibrating membrane, second order equation in two independent variables, canonical forms, equations with constant coefficients, general solution.

Chapter 2: Section 2.1- 2.3
Chapter 3: Section 3.1- 3.4 (15 hrs)

UNIT II: Cauchy problem

Cauchy problem, Cauchy Kowalewsky theorem, Homogeneous wave equation, initial Boundary value problems, finite string with fixed ends.

Chapter 4: Sections 4.1-4.6 (omit 4.5) (15 hrs)

UNIT III:Method of Separation of variables

Separation of variables, vibrating string problem, existing and uniqueness of solutions of the vibrating string problem, Heat conduction problem, The Laplace and Beam equations.

Chapter 6: Section 6.1-6.6 (Omit 6.5) (15 hrs)

UNIT IV:Boundary value problems

Boundary value problems, maximum and minimum principles, uniqueness and continuity theorem, Dirichlet problem for a circle, a circular annulus.

Chapter8: Section 8.1-8.5 (15 hrs)

UNIT V: Green's function

Green's function, the Delta function, Methods of Green's function, Dirichlet problem for the Laplace&Helmholtz operators.

Chapter 10: Section 10.1-10.5 (15 hrs)

RECOMMENDED TEXT :

Tyn Myint-U and Lokenath Debnath, Partial Differential Equations for Scientists and Engineers(Third Edition), North Hollan, New York,1987.

REFERENCEBOOKS:

1.W.E. Williams, Partial Differential Equations, Oxford,1990
2.I.N. Sneddon,The use of integral forms, Tata Mcgraw Hill, NewDelhi,1985
3.M.M.Smirnov, Second order Partial Differential Equations,NewDelhi 1983.
4.Introduction toPartial Differential Equations by R.Dennemayer, New York1968.
5.M.D.RaiSinghania,AdvancedDifferentialEquations,S.Chand&CompanyLtd. NewDelhi,2001.

Periodicals:

The Mathematics Intelligencer.
Mathematics News letter.

Websites And e-Learning Sources:

http:// mathforum.org,http://ocw.mit
nptel.ac.in/courses/111103021/
edu:// ocw.wweb/Mathematics,
http:// www.opensource.org,www. mathpages.com

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Component	Nature of the question	Maximum marks
Section –A	Understanding Description/Problems- Two questions from every Unit	10 x 2 = 20
Section – B	Understanding Description/Problems- At least one question from every Unit	5 (out of 8) x 7= 35
Section – C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15 = 45

SEMESTER – II
MECHANICS AND TENSOR ANALYSIS

Core - 7 **Course Code:11SP18/2C/MTA**
Teaching hours: 75 **Credits: 4** **LTP: 3 2 0**

OBJECTIVES:

To introduce the basic concepts of classical dynamics and tensor analysis and to make students get knowledge about mechanical systems and Hamiltonian theory.

COURSE OUTLINE:

UNIT - I : Introductory Concepts, Lagrange's Equations

The Mechanical System – Generalized Coordinates – Constraints – Virtual work – Derivation of Lagrange's Equations – Examples .

Chapter 1: Sections : 1.1,1.2, 1.3,1.4.
Chapter 2: Sections : 2.1 , 2.2 (15 hrs)

UNIT - II : Hamilton's Equations

Hamilton's Principle - Hamilton'sequations – Other variational principles

Chapter-4: Sections: 4.1, 4.2 ,4.3 (15 hrs)

UNIT - III : Hamilton Jacobi Theory, Canonical Transformations

Hamilton's Principal function – The Hamilton – Jacobi Equation - Special Transformations

Chapter 5: Section : 5.1 & 5.2, Chapter 6: Section : 6.2 (15 hrs)

UNIT IV: Tensor Theory

Scope of tensor analysis -Transformation of coordinates – Properties of admissible transformations of coordinates – Transformation by invariance – Transformation by covariance and contravariance – The tensor concept – Tensor character of covariant and contravariant laws – Algebra of tensors – quotient laws – symmetric and skew - symmetric tensors – Relative tensors.

Chapter 2 : Sections18 -28 (15 hrs)

UNIT V: Tensor Theory (Contd)

The Metric tensor - The fundamental and associated Tensors - Christoffel's Symbols - Transformation of Christoffel's. Symbols - Covariant differentiation of tensors - Formulas for covariant Differentiation - Ricci's Theorem - Riemann Christoffel Tensor properties of Riemann - Christoffel Tensors.

Chapter 2: Sections: 29 - 37 (15 hrs)

RECOMMENDED TEXTS

Unit I to Unit III: Donald. T. Greenwood, Classical Dynamics, Prentice Hall ofIndia, New Delhi 1985.
Unit IV to Unit V: I.S. Sokolnikoff, Tensor Analysis, John Wiley and Sons, New York 1964

REFERENCE BOOKS

1. U.C. De, Absos Ali Shaikh and Joydeep Sengupta, Tensor Calculus, Narosa Publishing House, New Delhi, 2004.
2. J.L.Synge and A.Schild, Tensor Calculus, Toronto, 1949.
3. A.S.Eddington. The Mathematical Theory of Relativity, Cambridge University Press, 1930.
4. P.G.Bergman, An Introduction to Theory of Relativity, New York, 1942
5. C.E.Weatherburn, Riemannian Geometry and the Tensor Calculus, Cambridge, 1938.

Periodicals:

The Mathematics Intelligencer .
Mathematics News letter.

Websites And e-Learning Sources

http://mathforum.org,
http://OCW.mit.edu/ocwweb/Mathematics

Template

Component	Nature of the question	Maximum marks
Section –A	Understanding Description/Problems- Two questions from every Unit	10 x 2 = 20
Section – B	Understanding Description/Problems- At least one question from every Unit	5 (out of 8) x 7= 35
Section – C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15 = 45

SEMESTER II
OPERATIONS RESEARCH II

Elective - E3 **Course Code : 11SP18/2E3/OR2**
Teaching Hours : 60 **Credit: 3 LT P: 2 2 0**

OBJECTIVES:
To understand the need of using Operations Research, a quantitative approach for effective decision making. To recognize, classify and use various models for solving a problem under consideration.

UNIT I : Decision Theory and Decision Trees

Introduction – Steps of Decision Making Process – Types of Decision Making Environments – Decision Making Under Uncertainty.

Chapter 11 Sections 11.1 - 11.4 (12 hrs)

UNIT II : Decision Theory and Decision Trees (Contd.)

Decision Making Under Risk - Decision Tree Analysis

Chapter 11 Sections 11.5, 11.7 (12 hrs)

UNIT III: Probabilistic Inventory Control Models

Continuous Demand Inventory control models without Set-up Cost (Model IV(a) and Model IV(b)) – Instantaneous Demand Inventory Control Model with Set - up Cost (Model V).

Chapter 15 Sections 15.3, 15.4 (12 hrs)

UNIT IV: Queuing Theory

Finite Calling Population Queuing Models

Chapter 16 Section 16.8 (12 hrs)

UNIT V: Replacement and Maintenance Models

Introduction – Types of Failure- Replacement of Items Whose Efficiency Deteriorates with Time.

Chapter 17 Sections 17.1 - 17.3 (12 hrs)

RECOMMENDED TEXT:

J.K Sharma, Operations Research Theory and Applications 4th edition Macmillan Publishers India Ltd,2009.

REFERENCE BOOKS

1.Hamdy A. Taha Operations Research (9th Edition), Prentice Hall of India Private Limited, New Delhi,2013.
2.S.D. Sharma, Operations Research, Kedar Nath Ram Nath and Co.,Meerut, 2003.
3.F.S Hiller and J. Liberman Introduction to Operations Research (7tedition),2010.

Periodicals:

The Mathematicvs Intelligencer
Mathematics News letter.

Websites and e-Learning Sources

http://courses.csail.mit.edu
http://www.brainkart.org

Template

Component	Nature of the question	Maximum marks
Section –A	Understanding Description/Problems- Two questions from every Unit	10 x 2 = 20
Section – B	Understanding Description/Problems- At least one question from every Unit	5 (out of 8) x 7= 35
Section – C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15 = 45

SEMESTER - II
MATHEMATICS FOR COMPETITIVE EXAMINATIONS
(Offered to other PG departments)

Elective – EDE 1 **Course Code : 11SP18 / 2E /MCE**
Teaching hours : 60 **Credits : 3 LTP : 2 2 0**

OBJECTIVES :
This course aims to develop general aptitude and logical reasoning and to equip with problem solving skills for competitive examinations.

COURSE OUTLINE:

UNIT I: Logical Reasoning

Problems of Ages, Problem of Time, Average, Grouping, Ranking, Arithmetic Reasoning, True discount, Banker's discount, Odd man out.
(15 hrs)

UNIT II: Logical Reasoning(contd.)

Time & work, Time & distance, Pipe & cisterns.
(15 hrs)

UNIT III: Quantitative Aptitude

Percentage, Profit and Loss, Ratio and Proportions (10 hrs)

UNIT IV: Business Applications

Permutations & Combinations, Stocks and Shares (10 hrs)

UNIT V: Statistics

Basic concepts in testing of hypothesis, Type I Error and Type II error, Level of significance, ANOVA classification-One way classification and Two way classification (Only Simple Problems) (10 hrs)

RECOMMENDED TEXTS :

UNIT I, II & IV : R.S. Aggarwal, Quantitative Aptitude, S. Chand &Co, Ltd.,2007
UNIT III & IV : P.R.Vittal, Business Mathematics,Margham Publications, 1999.
UNIT V : P.Sivarama Krishna Das, C. Vijayakumari, Statistics,Viji's Academy ,2010.

REFERENCE BOOKS:

1. U Mohan Rao,Quantitative Aptitude , Scitech Publication,2010.
2. P.R.Vittal, Business Statistics, Margham Publications, 2007.
3. P.R.Vittal, Allied Mathematics,Margham Publications,2009.

Websites and e-Learning Sources

http:// mathforum.org
http:// ocw.mit edu/ocwweb/mathematics,
http:// www.opensource.org, www.casact

Template

Component	Nature of the question	Maximum marks
Section –A	Description/Problems	5 x 8 = 40
Section – B	Description/Problems	3 x 20 = 60

Section – A: Five questions to be answered out of eight questions covering all the Five units. Each question carries eight marks.

Section – B: Three questions to be answered out of five questions covering all the Five units. Each question carries twenty marks.

INTERNSHIP

Credits : 2 **Duration: 45 days**

Students have to undergo an Internship Programme during the summer vacation immediately after the second semester and are required to submit a project report.

Internal Evaluation (Viva voce) only.

SEMESTER – III

COMPLEX ANALYSIS – I

Core – 8 **Course Code : 11SP18/3C/CA1**
Teaching hours : 75 **Credits : 4** **LT P : 3 2 0**

Objectives:
To study Cauchy integral formula, local properties of analytic functions, general form of Cauchy's theorem and harmonic functions, power series expansions, partial functions and entire functions.

COURSE OUTLINE:

Unit I : Complex Integration
Cauchy's Integral Formula: The index of a point with respect to a closed curve - The integral formula – Higher derivatives.
Local properties of Analytical functions: Removable singularities --Taylor's theorem – Zeros and poles – The Local mapping – The Maximum principle.

Chapter 4 : Section 2: 2.1 – 2.3
Section 3: 3.1 – 3.4 (15 hrs)

Unit 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 : Section 4: 4.1 – 4.7
Section 5: 5.1 –5.2 (15 hrs)

Unit III : Harmonic Functions
Definition and Basic properties – The mean value property – Poisson's formula - Schwartz's Theorem – The reflection principle

Chapter 4 : Section 6: 6.1 – 6.5 (15 hrs)

Unit IV: Series and Product Developments
Power series Expansions : The Weierstrass's theorem – The Taylor series – The Laurent series

Chapter 5 : Section 1: 1.1 – 1.3 (15 hrs)

Unit V: Partial Fractions and Factorization

Partial fractions – Infinite products – Canonical Products – The Gamma function. Entire functions: Jenson's formula -- Hadamard's theorem (Statement only)

Chapter 5 : Section 2: 2.1 -2.4
Section 3: 3.1,3.2 (15 hrs)

RECOMMENDED TEXT:

Lars.V.Ahlfors, Complex Analysis(3rd Edition)Mc Graw Hill Co., New York,1979.

REFERENCE BOOKS:

1. H.A. Prestly, Introduction of Complex Analysis, Clarendon Press, Oxford, 1990.
2. J.B. Conway, Functions of one complex variable, Springer-Verlag, International Student Edition,Narosa Publishing Co., 1996.
3. E.Hille, Analytic function theory(2 Vols.)Gonm & Co. 1959.
4. M.Heins, Complex function theory, Academic Press Newyork, 1968.
5. Tom Apostol, Introduction to Analytic Number Theory, Narosa Publications, New Delhi, 5th printing, 1998

Periodicals:

The Mathematicvs Intelligencer
Mathematics News letter

Websites and e-Learning Sources

http://mathforum.org,
http://OCW.mit.edu/ocwweb/Mathematics,
http://www.opensource.org

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Component	Nature of the question	Maximum marks
Section –A	Understanding Description/Problems- Two questions from every Unit	10 x 2 = 20
Section – B	Understanding Description/Problems- At least one question from every Unit	5 (out of 8) x 7= 35
Section – C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15 = 45

SEMESTER – III
TOPOLOGY

Core - 9 **Course Code : 11SP18/3C/TOP**
Teaching hours : 75 **Credits : 4 L T P: 3 2 0**

OBJECTIVES:

- To understand about the topological spaces, connectedness and compactness.
- To learn about Countability and Separation Axioms.

COURSE OUTLINE:

UNIT I :Topological Spaces and Continuous Functions

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

Chapter 2 : Sections : 12 - 16 (15 hrs)

UNIT II :Connectedness and Compactness

Connected spaces and Connected subspaces of the Real line, Components and Local Connectedness

Chapter 3 : Sections : 23 - 25 (15 hrs)

UNIT III :Connectedness and Compactness(Contd.)

Compact spaces, Compact subspaces of the Real line and Limit point Compactness, Local Compactness.

Chapter 3 : Sections: 26- 29 (15 hrs)

UNIT IV:**Countability and Separation**

The Countability Axioms, The separation Axioms, Normal spaces.

Chapter 4 : Sections : 30 -32 (15 hrs)

Unit V:Countability and Separation Axioms(Contd.)

The Urysohn Lemma, The Urysohn Metrization Theorem, The Tietze ExtensionTheorem.

Chapter 4 : Sections : 33, 34 and 35 (15 hrs)

RECOMMENDED TEXT

James R. Munkres, Topology, Second Edition, 2002.

REFERENCE BOOKS

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. G. Bachman and L. Narici, Functional Analysis Academic Press, New York, 1966.
4. H.C. Goffman and G. Fedrick, First course in Functional Analysis, Prentice Hall of India, New Delhi, 1987.
5. E. Kreyszig, Introductory Functional Analysis with Application, John Wiley & Sons, New York, 1978.

Periodicals

The Mathematics Intelligencer .
Mathematics News letter.

Websites and e-Learning Sources

http://mathworld.wolfram.com/
https://en.wikipedia.org

Template

Component	Nature of the question	Maximum marks
Section –A	Understanding Description/Problems- Two questions from every Unit	10 x 2 = 20
Section – B	Understanding Description/Problems- At least one question from every Unit	5 (out of 8) x 7= 35
Section – C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15 = 45

SEMESTER - III
DIFFERENTIAL GEOMETRY

Core - 10 **Course Code : 11SP18/3C/DGY**
Teaching hours: 75 **Credits : 4 LTP : 3 2 0**

OBJECTIVES:
This course introduces space curves and then intrinsic properties of Surface and Geodesics. Non- Intrinsic Properties of Surface.

COURSE OUTLINE:

UNITI: **The Theory of Space Curves**
Definitions - Arc length - tangent, normal and binormal - Curvature and torsion of a curve given as the intersection of two surfaces - Contact between curves and surfaces.

Chapter I: Sections : 2 to 6. (15 hrs)

UNITII: The Theory of Space Curves (Contd.)
Tangent surface, involutes, evolutes - Intrinsic equation,fundamentalExistence theorem for space curves - Helices.

Chapter I: Sections: 7 to 9. (15 hrs)

UNITIII: **Local Intrinsic Properties of a Surface**
Definition of a surface - Curves on a Surface - Surface of revolution -Helicoids.

Chapter II: Sections: 1 to 4. (15 hrs)

UNITIV: **Local Intrinsic Properties of a Surface(Contd.)**
Metric - Direction Coefficients - Families of curves – Isometric correspondence - Intrinsic properties - Geodesics - Canonical Geodesic equations.

Chapter II: Section : 5 to 11 (15 hrs)

UNIT V: Local Intrinsic and Local non intrinsic Properties of a Surface
Normal property of Geodesics - Geodesic Parallels - Geodesic Curvature - Gauss - Bonnet Theorem - Gaussian Curvature. The Second fundamental form, Principal Curvature- Lines of curvature

Chapter II: Sections : 12 to 17 (Omit Section 13) , Chapter III Sections 1 to 3
(15 hrs)

RECOMMENDED TEXT:

T.J. Willmore, An introduction to Differential Geometry, Oxford University Press (17^{th} Impression)

REFERENCE BOOKS

1. Stuik, D.T. Lectures on Classical Differential Geometry Addision - Wesley Mass, 1950.
2. Mittal & Agarwal, Differential Geometry, Krishna Prakasham Media Pvt. Ltd., 27^{th} edition (1999).

Periodicals:

The Mathematics Intelligencer .
Mathematics News letter.

Websites and e-Learning Sources:

http://ocw.mit.edu/ocwweb/Mathematics
http://Mathforum.org

Template

Component	Nature of the question	Maximum marks
Section –A	Understanding Description/Problems- Two questions from every Unit	10 x 2 = 20
Section – B	Understanding Description/Problems- At least one question from every Unit	5 (out of 8) x 7= 35
Section – C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15 = 45

SEMESTER – III

CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS

Core - 11 **Course Code: 11SP18/3C/CVI**
Teaching hours: 75 **Credits: 4 L T P : 3 2 0**

OBJECTIVES :

The Main aim of the course is to help the students to solve integral equations which is used in various real life applications.

UNIT I Variational Problems With Fixed and Moving Boundaries
The Concept of Variation and its properties – Euler's equation – Variational problems for functional of form – Functionals dependent on higher order derivatives – Functional of form I(y(x))=$\int_{x_1}^{x_2} F(x, y, y') dx$. – Movable boundary for a functional dependent on two functions.

Chapter 1 : 1.1 to 1.4 & 2.1-2.2 (15 hrs)

UNIT II Sufficient Conditions For an Extremum
Field of Extremals-Jacobi Condition - Weistrass function -Legendre Condition-problems.

Chapter 3 : 3.1 to 3.4 **(**10 hrs)

UNIT III Integral Equations
Introduction – Definition– Special kinds of Kernals – Eigen values and eigen functions – Convolution integral – Reduction to a system of algebraic equations – Examples – Fredholm alternative – Examples .

Chapter 1 : 1.1 , 1.3 to 1.5 & Chapter 2 : 2.1 to 2.4 **(**15 hrs)

Unit– IV Method Of Successive Approximations and Fredholm Theory
Iterative scheme – Examples – Volterra integral equations – Examples – Some results about the resolvent kernel – The method of solution of Fredholm equation – Fredholm First theorm(statement only) – Examples- Fredholm Second &Third theorems(Statement only)

Chapter 3 : 3.1 to 3.5 & Chapter 4 : 4.2 to 4.5 **(**20 hrs)

UNIT V Applications To Ordinary Differential Equations

Introduction – Fundamental properties of Eigen values and Eigen functions for symmetric kernels- Hilbert Schmidt Theorem(Statement only)-Solution of a Symmetric Integral Equation-Examples-Abel Integral Equation-Examples.
Chapter 7 : 7.1 , 7.2 , 7.4 , 7.5
Chapter 8 : 8.1 , 8.2 **(**15 hrs)

RECOMMENDED TEXT

1. A. S. Gupta, Calculus of Variations with Applications, PHI, New Delhi, 2005. (for Units I and II)
2. Ram P. Kanwal, Linear Integral Equations, Theory and Techniques, Academic Press, New York, 1971. (for Units III, IV and V)

REFERENCE BOOKS

1. L. Elsgolts, Differential Equations and Calculus of Variations, Mir Publishers, Moscow, 1973.
2. M. D. Raisinghania, Integral Equations and Boundary Value Problems, S. Chand & Co., New Delhi, 2007.
3. Sudir K. Pundir and Rimple Pundir, Integral Equations and BoundaryValue *Problems*, Pragati Prakasam, Meerut. 2005.

Periodicals:
The Mathematics Intelligencer .
Mathematics News letter.

Websites and e-Learning Sources:
http://www.nptel.ac.in/courses/111104025/
http://textofvideo.nptel.iitm.ac.in/video.php?courseId=111104025

Template

Component	Nature of the question	Maximum marks
Section –A	Understanding Description/Problems- Two questions from every Unit	10 x 2 = 20
Section – B	Understanding Description/Problems- At least one question from every Unit	5 (out of 8) x 7= 35
Section – C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15 = 45

SEMESTER – III

MATHEMATICAL STATISTICS I

Elective – E4 **Course Code :11SP18/3E4/MS1**
Teaching hours: 60 **Credits: 3 L T P : 2 2 0**

OBJECTIVES:

- To give a systematic introduction to modern probability theory.
- To present the possible applications of these theories.

COURSE OUTLINE:

UNIT I : Characteristic Functions

Properties of characteristic functions-The characteristic functions and their moments-Semi-invariants-The characteristic function of the sum of independent random variables-Determination of the distribution function by the characteristic functions-The characteristic function of multidimensional random vectors-Probability generating functions.

Chapter 4: Sections 4.1 to 4.7. (12 hrs)

UNIT II : Some Probability Distributions

One-point and two-point distributions-The Bernoulli scheme. The Binomial Distribution-The Polya and hypergeometric distributions-The Poisson distribution-The uniform distribution-The normal distribution-The gamma distribution-The Beta distribution-The Cauchy and Laplace distributions.

Chapter-5: Sections: 5.1 to 5.10 (omit 5.3) (12 hrs)

UNIT III : Limit Theorems

Preliminary remarks-Stochastic convergence-Bernoulli's law of large numbers-The convergence of a sequence of distribution functions-The Riemann-Stieljies integral-The Levy-Cramer theorem.

Chapter 6: Section 6.1 to 6.6 (12 hrs)

UNIT IV: Limit Theorems(Contd.)

The De-Moivre-Laplace theorem-The Lapunov theorem-The Gnedenko theorem-Poisson's, Chebychev's and Khintchin's laws of large numbers-The strong law of large numbers.

Chapter 6: Sections 6.7 to 6.12. (12 hrs)

UNIT V: Markov Chains

Preliminary remarks-Homogeneous Markov chains-The transition matrix-The ergodic theorem-Random variables forming a homogeneous Markov chain.

Chapter 7: Sections 7.1 to 7.5 (12 hrs)

RECOMMENDED TEXTS

M.Fisz, Probability Theory and Mathematical Statistics, John Wiley and sons, New York, 1963.

REFERENCE BOOKS

1. R.B. Ash, Real Analysis and Probability, Academic Press, New York, 1972
2. K.L.Chung, A course in Probability, Academic Press, New York, 1974.
3. Y.S.Chow and H.Teicher, Probability Theory, Springer Verlag. Berlin, 1988 (2nd Edition)
4. R.Durrett, Probability : Theory and Examples, (2nd Edition) Duxbury Press, New York, 1996.
5. V.K.Rohatgi An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi, 1988(3rd Print).
6. S.I.Resnick, A Probability Path, Birhauser, Berlin,1999.
7. B.R.Bhat ,Modern Probability Theory (3rd Edition), New Age International (P)Ltd, New Delhi, 1999
8. J.P. Romano and A.F. Siegel, Counter Examples in Probability and Statistics, Wadsworth and Brooks / Cole Advanced Books and Software, California, 1968

Periodicals:

The Mathematics Intelligencer .
Mathematics News letter.

Websites And E-Learning Sources

http://mathforum.org,
http://OCW.mit.edu/ocwweb/Mathematics

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Component	Nature of the question	Maximum marks
Section –A	Understanding Description/Problems-Two questions from every Unit	10 x 2 = 20
Section – B	Understanding Description/Problems-At least one question from every Unit	5 (out of 8) x 7= 35
Section – C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15 = 45

SEMESTER – III

RESOURCE MANAGEMENT TECHNIQUES
(Offered to other PG departments)

Elective-EDE - 2 **Course Code: 11SP18/3E/RMT**
Teaching hours :60 **Credits : 3 L T P : 2 2 0**

OBJECTIVES :
This course aims to Introduce the basics of LPP, Transportation and Assignments Problem's and the Fundamental concepts of Game Theory.

COURSE OUTLINE:

UNIT I : Linear Programming Problem

Formulation - Maximization Problems and Minimization problems - Solutions by Graphical Method,(simple problems). (10 hrs)

UNIT II: Transportation Problem

Northwest Corner Rule - Least Cost Method - Vogel's Approximation Method - Modi Method (degeneracy included)

(15 hrs)

UNIT III: Assignment Problem

Hungarian Assignment Method (balanced problem and unbalanced problem)

(10 hrs)

UNIT IV: Game Theory

Two person Zero Sum game, The maximin-minimax principle, saddle point and value of the games, Games without saddle points, mixed strategies, Dominance property.

(15 hrs)

UNIT V: Sequencing

Introduction, Sequencing Problem, General Assumptions, Sequencing decision problems for n jobs on two machines and three machines.

(10 hrs)

RECOMMENDED TEXT

R.K. Gupta, Linear Programming, Krishna Prakashan media pvt ltd., 2012.

REFERENCE BOOKS

1. S.K. Kalavathy, Operations Research, Vikas publishing house pvt ltd., 2008.
2. Hira & Gupta,Operations Research , S. Chand & Sons publications, 1991.
3. V.K. Kapoor , S.C.Gupta, Problems and Solutions in Operations Research , S.Chand & Sons publications, 2012.

Periodicals

The Mathematics Intelligencer .
Mathematics News letter.

Websites and e-Learning Sources

http:// mathforum.org,
http://ocw.mit.edu/ocwweb/mathematics
http:// www.opensource.org

Template

Component	Nature of the question	Maximum marks
Section –A	Description/Problems	5 x 8 = 40
Section – B	Description/Problems	3 x 20 = 60

Section – A: Five questions to be answered out of eight questions covering all the Five units. Each question carries eight marks.

Section – B: Three questions to be answered out of five questions covering all the Five units. Each question carries twenty marks.

SEMESTER – III

ANALYTICAL SKILLS FOR NET/SET

SOFT SKILLS -SS3 **Course Code: 11SP18/3S/ASN**
Teaching Hours: 30 **Credits: 2 L T P: 2 0 0**

OBJECTIVE:

Adequate subject matter has been provided to facilitate students to attempt objective type questions in competitive examination.

UNIT I: Analysis

Sequences and Series-Continuity- Differentiability- Cauchy-Riemann Equations-Singularities-Residues (10 hrs)

UNIT-II: Algebra

Groups-Cyclic Groups-Class Equations-Sylow Theorems-Rings-Fields (10 hrs)

UNIT-III: Differential Equations

First Order Ordinary Differential Equations-First Order Partial Differential Equation-Heat Equation-Wave Equations (10 hrs)

RECOMMENDED TEXTS

1. N.P.Bali ,Real Analysis , Laxmi Publications, 2009.
2. Arumugam,Complex Analysis , Scitech , 2007.
3. I.N.Herstein,Topics in Algebra, John Wiley & Sons, 2nd Edition, 2012.
4. Rai Singhania, Advanced Differential Equations S. Chand Ltd., 1995.

REFERENCE BOOKS

1. Robert G. Bartle, Introduction to Real Analysis John Wiley & Sons, 4th Edition.
2. Ponnusamy , First Course in Complex Analysis , Narosa Publishing House, 2nd Edition, 2005.
3. Joseph.A.Gallian , Contemporary Abstract Algebra, Cengage, India.
4. ShepleyRoss , Differential Equations John Wiley & Sons, 3rd Edition.

Periodicals

The Mathematics Intelligencer.
Mathematics News letter.

Websites and e-Learning Sources

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http://ocw.mit.edu/ocwweb/mathematics
http:// www.opensource.org

TEMPLATE

NATURE OF QUESTION	MAX MARKS
Objective Type	50 (50 x 1=50)

50 Questions to be answered each carrying 1 mark.

SEMESTER – IV

COMPLEX ANALYSIS – II

Core – 12 **Course Code : 11SP18/4C/CA2**
Teaching hours : 90 **Credits : 4 L T P : 3 3 0**

OBJECTIVE:
To get introduced to Riemann – zeta functions and doubly periodic functions. To impart the knowledge on normal families and analytic continuation.

COURSE OUTLINE:

UNIT I: Series and Product Developments
The Riemann Zeta Function: The Product Development-Extension of ς (s) to the whole plane- The functional equation - The Zeroes of the Zeta function.

Chapter 5: Section 4: 4.1 - 4.4 (15 hrs)

UNIT II: Normal Families
Equicontinuity-Normality and Compactness-Arzela's theorem-Families of Analytic functions-The Classical Definition.

Chapter 5: Section 5: 5.1 to 5.5 (20 hrs)

UNIT III: Conformal Mapping
The Riemann Mapping Theorem: Statement and Proof- Boundary Behaviour-Use of the Reflection Principle.
Conformal Mapping of Polygons : The Behaviour at an angle – The Schwarz-Christoffel Formula –Mapping on a Rectangle.

Chapter 6: Section 1: 1.1 to 1.3, Section 2: 2.1 to 2.3. (15 hrs)

UNIT IV: Conformal Mapping(Contd.,), Elliptic functions

A Closer Look at Harmonic Functions: Functions with the Mean Value Property-Harnack's Principle.
Simply Periodic Functions:Representation by Exponentials-The Fourier Development-Functions of Finite Order.
Doubly Periodic Functions: The Period Module-Unimodular Transformations.

Chapter 6: Section 3: 3.1, 3.2,
Chapter 7: Section 1: 1.1 to 1.3, Section 2: 2.1, 2.2 (20 hrs)

UNIT V: Elliptic functions (contd.,)

Doubly Periodic Functions : The Canonical Basis-General Properties of Elliptic Functions.

The Weierstrass's Theory: The Weierstrass ρ- function-The functions ς (z) and σ(z)-The Differential Equation.

Chapter 7: Section 2: 2.3, 2.4
Section 3: 3.1 to 3.3 (20 hrs)

RECOMMENDED TEXTS:

Lars.V.Ahlfors, Complex Analysis(3rd Edition)Mc Graw Hill Co., New York,1979.

REFERENCE BOOKS:

1. H.A. Prestly, Introduction of Complex Analysis, Clarendon Press, Oxford, 1990.
2. J.B. Conway, Functions of one complex variable, Springer-Verlag, International Student Edition,Narosa Publishing Co.,
3. E.Hille, Analytic function theory(2 Vols.)Gonm & Co. 1959.
4. M.Heins, Complex function theory, Academic Press Newyork, 1968.
5. Tom Apostol, Introduction to Analytic Number Theory, Narosa Publications, New Delhi.

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Component	Nature of the question	Maximum marks
Section –A	Understanding Description/Problems-Two questions from every Unit	10 x 2 = 20
Section – B	Understanding Description/Problems-At least one question from every Unit	5 (out of 8) x 7= 35
Section – C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15 = 45

SEMESTER –IV

FUNCTIONAL ANALYSIS

Core - 13 **Course Code : 11SP18/4C/FAN**
Teaching hours : 90 **Credits : 4** **LTP: 3 3 0**

OBJECTIVES :
To study the details of Banach and Hilbert spaces and to introduce Banach algebras.

COURSE OUTLINE:

UNIT I : Banach Spaces
The definition and some examples - Continuous linear transformations, The Hahn – Banach theorem.

Chapter : 9 Section : 46 , 47, 48 **(**20 hrs**)**

UNIT II : Banach Spaces (Contd..)
The natural imbedding of N in N**- The Open mapping theorem- The Conjugate of an operator

Chapter : 9 Section : 49 - 51 (20 hrs)

UNIT III : Hilbert Spaces
The definition and some simple properties - Orthogonal Complements – Orthonormal sets

Chapter : 9 Section : 52 - 54 (20 hrs)

UNIT IV: Hilbert Spaces (Contd..)
The Conjugate space H* - The adjoint of an operator - Self – adjoint operators

Chapter : 10 Section : 55 - 57 (15 hrs)

UNIT V: Hilbert Spaces & Banach Algebra
Normal and unitary operators – Projections - Banach algebra Definition and some examples – Regular and singular elements – topological divisors of zero.

Chapter : 10 Section : 58, 59
Chapter :12 Sections : 64 - 66 (15 hrs)

RECOMMENDED TEXTS:
G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill International Book Company, New York, 1963.

REFERENCE BOOKS

1. W.Rudin, Functional Analysis, Tata McGraw-Hill Publishing Company, New Delhi, 1973.
2. G. Bachman and L. Narici,Functional AnalysisAcademic Press, New York, 1966.
3. H.C. Goffman and G. Fedrick, First course in Functional Analysis, Prentice Hall of India, New Delhi, 1987.
4. E. Kreyszig , Introductory Functional Analysis with Application, John Wiley & Sons, NewYork, 1978

Periodicals

The Mathematics Intelligencer .
Mathematics News letter.

Websites And E- Learning Sources:
http://math-forum.org,
https://www.sciencedirect.com/journal/journal-of-functional-analysis
http://ocw.mit.edu/ocw web/Mathematics,
http://www.opensource.org,
http://en.wikiepedia.org

Template

Component	Nature of the question	Maximum marks
Section –A	Understanding Description/Problems- Two questions from every Unit	10 x 2 = 20
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Section – C	Application/ Analysis/ Synthesis/ Evaluation – One question from every Unit	3 (out of 5) x 15 = 45

SEMESTER IV

Fuzzy Set Theory And Its Applications

Core -14 **Course Code:11SP15/4C/FSA**

Teaching Hours : 75 **Credits: 4** **LTP: 3 2 0**

OBJECTIVE

To introduce fuzzy concepts and to offer fuzzy logic and fuzzy compositions and its applications

COURSE OUTLINE

UNIT I: INTRODUCTION TO FUZZY SET

Fuzzy sets- Basic Types And Basic Concepts, Paradigm Shift, Additional Properties Of Alpha Cut.

Chapter 1 & 2 Sections 1.3,1.4,1.5,2.1,2.2 (15 hrs)

UNIT II: OPERATION ON FUZZY SETS

Types of operations, Fuzzy Compliments t -norm , t- conorm.

Chapter 3: Sections 3.1,3.2,3.3,3.4 (20 hrs)

UNIT III FUZZY ARITHMETIC

Fuzzy numbers, Arithmetic Operations On Intervals, Arithmetic Operations On Fuzzy Numbers

Chapter 4 Sections: 4.2,4.3,4.4 (15 hrs)

UNIT IV FUZZY LOGIC

Classical logic, Multivalued logic, Fuzzy propositions, Fuzzy quantifiers

Chapter 8 Sections 8.1,8.2,8.3,8.4 (15 hrs)

UNIT V APPLICATIONS

Civil, Industrial & Mechanical Engineering. ` (10 hrs)

Recommended Texts

George j klir/ boyuan, fuzzy sets and fuzzy logic- theory and its applications, prince hall of India, New Delhi 2001

Reference Textbook

Fuzzy arithmetic by Kauffman

PERIODICALS:
The Mathematics Intelligencer .
Mathematics News letter.

WEBSITES AND e-LEARNING SOURCES
http://mathforum.org,
http://OCW.mit.edu/ocwweb/Mathematics

Template

Component	Nature of the question	Maximum marks
Section –A	Understanding Description/Problems- Two questions from every Unit	10 x 2 = 20
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SEMESTER – IV
PYTHON PROGRAMMING

Core - 15	**Course Code :**	**11SP18/4C/PYP**
Teaching Hours : 45	**Credits : 3**	**LTP: 2 1 0**

OBJECTIVES :

- To do input/output with files in Python.
- To use Python data structures - lists, tuples, dictionaries.
- To define Python functions and call them.
- To develop Python programs with conditionals and loops.
- To read and write simple Python programs.

UNIT I : Program, variables, expressions and statements

The way of the program – The Python programming language - formal and natural languages. **variables, expressions and statements** – values and types- variables- variable names and keywords - statements- Evaluating expressions- operators and operands- Order of operations - operations on strings. (8 hrs)

UNIT II : **Functions, Conditionals and recursion**

Functions- Function calls- Type conversion- type coercion- Math functions- Composition- Adding new functions- Definitions and use- Flow of execution- Parameters and arguments- Variables and parameters are local- stack diagrams- Functions with results.

Conditionals and recursion – The modulus operator- Boolean expressions- Logical operators- Conditional execution- Alternative execution- Chained conditionals- Nested conditionals- The return statement- Recursion- Stack diagrams for recursive functions- Infinite recursion. (10 hrs)

UNIT III: **Fruitful functions and Iteration**

Fruitful functions – Return values- program development- composition- Boolean functions- More recursion- Leap of faith,examples.

Iteration – Multiple assignment- The while statement- Tables- Two –dimensional tables- Encapsulation and generalization- more encapsulation- local variables- more generalization functions. (7 hrs)

UNIT IV: Tuples and Dictionaries

Tuples – Mutability and tuples- Tuple assignment – Tuples as return values – Random numbers – List of random numbers – Counting – Many buckets – a single –pass solution.

Dictionaries - Dictionary operations – Dictionary methods – Aliasing and copying – Sparse matrices – Hints – Long integers – Counting letters. (10 hrs)

UNIT V: **Files, Exception, Classes and Objects**

Files and exception : Text files – Writing variables – Directories- pickling – Exceptions.

Classes and objects: User-defined compound types – Attributes – Instances as arguments – Sameness – Rectangles – Instances as return values-Objects are mutable-copying. (10 hrs)

RECOMMENDED TEXT :

1. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist'', 2nd edition, Updated for Python 3, Shroff/O'Reilly Publishers, 2016 .

REFERENCES:

1. Wesley J. Chun , Core Python Programming" , Prentice Hall Pub, Second Edition, 2006.
2. Charles Dierbach, "Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.
3. John V Guttag, "Introduction to Computation and Programming Using Python'', Revised and expanded Edition, MIT Press , 2013.
4. Paul Gries, Jennifer Campbell and Jason Montojo, "Practical Programming: An Introduction to Computer Science using Python 3", Second edition, Pragmatic Programmers, LLC,2013.

PERIODICALS:

International journal of computer science

WEBSITES AND e-LEARNING SOURCES

www.udemy.com/Python/Online-Course
http://greenteapress.com/wp/think- python

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PYTHON PROGRAMMING (PRACTICALS)
PRACTICAL PROGRAMS

Course Code : 11SP18/4C/PR1

Teaching Hours : 45 **Credits : 3** **LTP: 0 0 3**

1. Implementing programs on Strings
2. Working with Lists
3. Working with Tuples
4. Working with Dictionary
5. Working with conditional loops – if, else if
6. Working with conditional expressions – for, while, break, continue
7. Implementing programs on functions
8. Working with function – formal arguments and variable-length arguments
9. Working with Detecting and Handling Exception
10. Working with file handling

RECOMMENDED TEXT

Wesley J. Chun, "Core Python Programming", 2nd Edition, Pearson Education LPE, New Delhi, 2007.

REFERENCE BOOKS:

1. Mark Summerfield,Programming in Python 3, Pearson Education LPE, New Delhi, 1996.
2. Paul Gries, Jennifer Campbell and Jason Montojo, "Practical Programming: An Introduction to Computer Science using Python 3", Second edition, Pragmatic Programmers, LLC, 2013.

PERIODICALS:

International journal of computer science

WEBSITES AND e-LEARNING SOURCES

www.udemy.com/Python/Online-Course

Question Paper Pattern

Duration : 3 hours
Maximum Marks : 100
Practical Examination: 90 Marks
Record : 10 Marks

Two **internal examiners** (appointed in consultation with Head of the Department /Principal of the college) to be appointed to conduct the practical examination.

SEMESTER – IV
MATHEMATICAL STATISTICS II

Elective – E5 **Course Code: 11SP18/4E5/MS2**
Teaching hours:75 **Credits: 3** **LTP : 2 3 0**

OBJECTIVES:

- To give a systematic introduction to mathematical statistics.
- To get introduced to the basic concepts and theorems of the subject.

COURSE OUTLINE:

UNIT I : Sample Moments and their Functions

The notion of a sample-The notion of a statistic-The distribution of the arithmetic mean of the independent normally distributed random variables-The χ^2 distribution-The distribution of the statistic ($\bar{X}$,S)

Chapter 9: Sections 9.1 to 9.5. (15 hrs)

UNIT II :Sample Moments And Their Functions(Continued)

Student's t-distribution-Fisher's Z-distribution-The distribution of $\bar{X}$ for some non-normal populations-The distribution of sample moments and sample correlation coefficients of a two-dimensional normal population-The distribution of regression coefficients.

Chapter-9: Sections 9.6 to 9.10 (15 hrs)

UNIT III : Significance Tests

The concept of a statistical test-Parametric tests for small samples-Parametric tests for large samples- The χ^2 test-Tests of the Kolmogorov and Smirnov type The Wald-Wolfovitz and Wilcoxon-Mann-Whitney tests-Independence tests by contingency tables.

Chapter 12: Sections 12.1 to 12.7 (15 hrs)

UNIT IV:The Theory Of Estimation

Preliminary notions-consistent estimates-Unbiased estimates-The sufficiency of an estimate-The efficiency of an estimate-Asymptotically most efficient estimates-Methods of finding estimates-Confidence intervals.

Chapter 13: Sections 13.1 to 13.8. (15 hrs)

UNIT V:Theory of Hypothesis Testing:
The power function and the OC function-Most powerful tests-Uniformly most powerful test-Unbiased tests
Chapter 16: Sections 16.2 to 16.5 (15 hrs)

RECOMMENDED TEXTS:
M.Fisz, Probability Theory and Mathematical Statistics, John Wiley and sons, New York, 1963.

REFERENCE BOOKS:

1. R.B. Ash, Real Analysis and Probability, Academic Press, New York, 1972
2. K.L.Chung, A course in Probability, Academic Press, New York, 1974.
3. Y.S.Chow and H.Teicher, Probability Theory, Springer Verlag. Berlin, 1988 (2nd Edition)
4. R.Durrett, Probability : Theory and Examples, (2nd Edition) Duxbury Press, New York, 1996.
5. V.K.Rohatgi An Introduction to Probability Theory and Mathematical Statistics, Wiley Eastern Ltd., New Delhi, 1988(3rd Print).
6. S.I.Resnick, A Probability Path, Birhauser, Berlin,1999.
7. B.R.Bhat ,Modern Probability Theory (3rd Edition), New Age International (P)Ltd, New Delhi, 1999
8. J.P. Romano and A.F. Siegel, Counter Examples in Probability and Statistics, Wadsworth and Brooks / Cole Advanced Books and Software, California, 1968

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Websites And E-Learning Sources

http://mathforum.org,
http://OCW.mit.edu/ocwweb/Mathematics

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SEMESTER – IV

LATEX- A DOCUMENT PREPARATIONSYSTEM

SOFT SKILL - SS4 **Course Code :11SP18/4S/LAT**
Teaching Hours : 30 **Credits: 2 LTP : 0 0 2**

OBJECTIVES:

To introduce the basic concepts of Latex , which is a typesetting software primarily used for technical journals, books and research works.

COURSE OUTLINE:

UNIT I

The Basics- Document class – Page style – Page numbering – Formatting lengths – Parts of a document – Dividing the document –Bibliography. (10hrs)

UNIT II

The BIBTEX program – BIBTEX style files –Creating a bibliographic database - Table of contents, Index and Glossary**,** Keeping tabs - Tables .Floats-Cross References In Latex. (10hrs)

UNIT III

Typesetting Mathematics- The basics - Custom commands - More on mathematics - New operators –Symbols -Theorems in LATEX–Designer theorems, Several kinds of boxes. Footnotes, Marginpars, and Endnotes. (10 hrs)

REFERENCESBOOK:

1.LATEX: A document preparation system (2nd edition) by Leslie.
2.A beginner.s introduction to typesetting with LATEX Peter Flynn.

Websitesand E-Learning Sources:
https://www.tug.org/twg/mactex/tutorials/ltxprimer-1.0.pdf

Template

Duration – 2 hours**.**

Practical examination will be conducted for 50 marks.(Internal valuation only)