Devi Ahilya University, Indore

Scheme of Examination

Class M.A./M.Sc. (Semester – III)

Subject : Mathematics

Paper	Title of the Paper	Max. Marks		Minimum Passing Marks	
	Compulsory	Theory	C.C.E.	Theory	C.C.E.
✓ I	Functional Analysis	85	15	28	05
	Optional Papers Four papers out of the following have to be chosen, opting not more than one from each group.	85	15	28	05
	Group I 1. Advanced Functional Analysis 2. Partial Differential Equations 3. Differentiable Structures on manifolds 4. General Theory of Relativity and Cosmology	85	15	28	05
	Group II 1. Algebraic Topology 2. Abstract Harmonic Analysis 3. Advanced Graph Theory 4. Advanced Special Functions*	85	15	28	05
	Group III 1. Theory of Linear Operators* 2. Mechanics 3. Advanced Numerical Analysis* # 4. Fuzzy Sets and their Applications	85	15	28	05
	Group IV 1. Operations Research* # 2. Computational Biology 3. Jacobi Polynomials & H-Functions 4. Fluid Mechanics	85	15	28	05
	Group V 1. Wavelets 2. Bio-Mechanics 3. Analytic Number Theory* 4. Integral Transform*	85	15	28	05
	Group VI 1. Fundamentals of Computer Science (Theory & Practical)* 2. Mathematics of Finance & Insurance 3. Integration Theory* 4. Spherical Trigonometry and astronomy	85 (50 Theory & 35 Practical)	15	28	05
	Grand Total	500			

* Optionals presently being offered.

Note: If any optional other than those marked by * are being offered, due intimation should be given to the University.

Jakalle 14-02-2019

knRajeswari/14.2.19.

14/2/19

P. K. Jose 14/2/19

14/2/13

14-02-19

= use of scientific calculator (Non-programmable) is allowed.

Department of Higher Education Govt. of M.P.

Semester wise syllabus for P.G.

As recommended by Central Board of Studies and

Approved by HE the Governor of M.P.

(Partially revised by the Board of Studies in Mathematics, DAVV, Indore on 09-02-2016 and to be effective from academic session 2016-2017)

Class	: M.Sc/ M.A. (Mathematics)
Semester	: III
Title of subject/Group	: Functional Analysis -I
Paper No.	: I
Compulsory / Optional	: Compulsory

Unit I

Normed linear spaces , Banach Spaces and examples. Properties of Normed linear Spaces. Completeness proof of Banaches Spaces. Quotient spaces.

(1.Chapter 2 Sect 2.2, 2.3 & Exercises)

Unit II

Finite dimensional Normed spaces & subspaces, Equivalent norms, Compactness and Finite Dimension, Riesz Lemma, Linear Operators.

(1. Chapter 2 Sect 2.4, 2.5, 2.6 & Exercises)

Unit III

Bounded and Continuous Linear Operators , Linear Functionals.

(1. Chapter 2 Sect 2.7, 2.8 & Exercises)

Unit IV

Linear Operators and Functionals on and Finite Dimensional Spaces, Normed Spaces of Operators, Dual Space.

(1. Chapter 2 Sect 2.9, 2.10 & Exercises)

Unit V

Zorns Lemma , Hahn-Banach Theorem , Hahn-Banach Theorem for Complex Vector Spaces and Normed Spaces , Application to Bounded Linear Functionals on C[a,b].

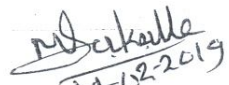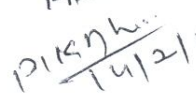(1.Chapter 4 Sect 4.1 to 4.4 & Exercises)

Text Books

1. E. Kreyszig Chapter 2 (2.1 to 2.10 & 4.1 to 4.4), Introductory Functional Analysis with applications, John Wiley & Sons New York.

Reference
1. G.F. Simmons, Introduction to Topology & Modern Analysis Mc Graw Hill New York 1963.

2. B. Choudhary and Sudarsan Nanda. Functional Analysis with applications, wiley Eastem Ltd.

उच्च शिक्षा विभाग, म0प्र0 शासन

(एम.एस.सी./एम.ए. (स्नातकोत्तर) कक्षाओं के लिये सेमेस्टर अनुसार पाठ्यक्रम
केन्द्रीय अध्ययन मण्डल द्वारा अनुशंसित तथा म.प्र. के राज्यपाल द्वारा अनुमोदित
Department of Higher Education, Govt. of M.P.
M.Sc./M.A (Post Graduates) Semester wise Syllabus
As recommended by Central Board of Studies and approved by the Governor of M.P.

Max. Marks/अधिकतम अंक : 50

अधिकतम अंक / Max. Marks 50

कक्षा Class	:	M.Sc./M.A (Mathematics)	
सेमेस्टर Semester	:	III	
विषय समूह का शीर्षक Title of Subject/ Group	:	Partial Differential Equations-I	
प्रश्न पत्र कं. Paper No.	:	II/III/IV/V	
अनिवार्य/ वैकल्पिक Compulsory/ Optional	:	~~Optional Gr-1 (2)~~ Compulsory	

Unit-1	Transport Equation-Intial Value Problem Non-homogeneous equations, Laplace's Equations - Fundamental Solution
Unit-2	Mean Formula properties of Harmonic functions, Green's Functions. Energy Methods.
Unit-3	Heat Equation - Fundamental Solution,
Unit-4	Mean Value Formula, Properties of Solutions, Energy Methods
Unit-5	Wave Equation - Solution by Spherical Means, Non - homogeneous Equations, Energy Methods.

Recommended Books :-

(1)   L.C. Evans, Partial Differential Equations, 1998.

Department of Higher Education Govt. of M.P.

Semester wise syllabus for P.G.

As recommended by Central Board of Studies and

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(Partially revised by the Board of Studies in Mathematics, DAVV, Indore on 09-02-2016 and to be effective from academic session 2016-2017)

Class	: M.Sc/ M.A. (Mathematics)
Semester	: III
Title of subject/Group	: Advanced Special functions-I
Paper No.	: II/III/IV/V
Compulsory / Optional	: Optional Gr-II(4)

Unit – I

The Gamma and Beta Functions : The Euler or Mascheroni constant γ, The Gamma function, A Series for $\Gamma'(z)/\Gamma(z)$, Evaluation of $\Gamma(1)$ and $\Gamma'(1)$, The Eular Product for $\Gamma(z)$, The Difference equation $\Gamma(z+1) = z \Gamma(z)$, The Beta function, the value of $\Gamma(z) \Gamma(1-z)$, the factorial function, Legendre's duplication formula, Gauss Multiplication theorem.

(3.Chapter 2 Page 19 - 41)

Unit –II

Hypergeometric functions : Hypergeometric functions, Integral Representation of F (a, b, c, z), Hypergeometric differential equation, Simple transformation, Quadratic transformation.

(3. Chapter 3 Page 42–72)

Unit –III

Generalized Hypergeometric functions : The function $_pF_q$, A differential equation, Contiguous function relations, a simple integral, Saalschutz theorem, Whipple's theorem, Dixon's theorem, Kummer's theorem, Ramanujan's theorem.

(3.Chapter 4 Page   73-106)

Unit –IV

Bessel Functions : Definition of $J_n(z)$, Bessel differential equation, Differential recurrence relations, pure recurrence relation, Generating function, Bassel's integral, Index half and n odd integer.

(3.Chapter 5 Page   107 ----156)

Unit –V

Legendre Polynomials: A generating function, Differential recurrence relations, pure recurrence relation, Legendre's differential equation, the rodrigues formula, Bateman's generating function, Additional generating functions, Hypergeometric forms of pn(x), Special properties of pn(x), More generating functions, Laplace's first integral form, Orthogonality.

(3. Chapter 6 Page   157- 208)

Text Books

1. Rainville. E.D, Special functions, The Macmillan co., New York 1971.

2. Srivastava, H.M. Gupta, K.C. and Goyal, S.P., the H-functions of one and Two Variables with applications, South Asian Publication, New Delhi.

3. Saran, N., Sharma S.D. and Trivedi, - Special Functions with application, Pragati prakashan, 1986.

Department of Higher Education Govt. of M.P.

Semester wise syllabus for P.G.

As recommended by Central Board of Studies and

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Class	: M.Sc/ M.A. (Mathematics)
Semester	: III
Title of subject/Group	: Theory of Linear operators– I
Paper No.	: II/III/IV/V
Compulsory / Optional	: Optional Gr-III(1)

Unit I

Spectral theory in normed linear spaces, basic concept concepts : regular value, resolvent, types of spectra(point, continuous and residual Spectra)and exercises explaining these concepts.

(1. Chapter 7 ,Sect 7.1,7.2).

Unit II

Spectral properties of Bounded Linear operators, Properties of Resolvent and spectrum, spectral mapping theorem for polynomials.

(1, Chapter 7, sect 7.3&7.4).

Unit III

Spectral radius of a bounded linear operator on a complex Banach space, Banach Algebras and their properties.

(1, Chapter 7, sect 7.5,7.6&7.7)

Unit IV

General properties of Compact linear operators

(1, Chapter 8, sect 8.1,8.2).

Unit V

Spectral properties of Compact linear operators on Normed Linear spaces (1, Chapter 8, sec.8.3,8.4)

Note : Exercises based on the theory are expected to be solved.

Recommended books:

1. **E.Kreyszig : Introductory Functional Analysis with applications,John wiley & sons, New York.**

Reference Books :

1. P.R.Halmos: Introduction to Hilbert space and the theory of spectral multiplicity, second edition, Chelsea publishing co.NY 1957

2. N.Dunford and J.T.Schwartz, Linear operator-part 3 Interscience/wiley, New York 1958-71

Department of Higher Education Govt. of M.P.

Semester wise syllabus for P.G.

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Class	: M.Sc/ M.A. (Mathematics)
Semester	: III
Title of subject/Group	: Advanced Numerical Analysis-I
Paper No.	: II/III/IV/V
Compulsory / Optional	: Optional Gr-III(3)

Unit – I

Introduction : Interpolation, Linear Interpolation and Higher Order Interpolation. Hermite Interpolation, Piecewise and Spline Interpolation, Piecewise quadratic Interpolation, Piecewise cubic interpolation, Piecewise cubic interpolation using Hermite Type Data, Quadratic Spline Interpolation, Cubic Spline Interpolation and its derivation, Problems .

(1.Chapter 4 section 4.1,4.5 and examples, section 4.6 and examples.)

Unit – II

Bivariate Interpolation : Lagranges and Newtons Bivariate Interpolation polynomials and their derivation, Approximation : Discrete and continuous data, Least Square Approximation.

(1. Chapter 4 section 4.7 and examples , section 4. 8 and examples, section 4.9 and examples.)

Unit – III

Orthogonal, Gram-Schmidt Orthogonalizing Process, Legendre and Chebyshev Polynomials.

(1.Chapter 4 section 4.9 definition 4.3 and 4.4 and subsections, examples.)

Unit- IV

Uniform Approximation, Uniform Polynomials Approximation (chebyshev), Chebyshev Polynomials Approximation and Lanczos Economization, Rational Approximation , Choice Of Methods.

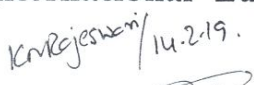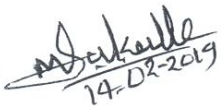(1.Chapter 4 section 4.10 and subsection, Examples, Section 4.11, Section 4.12, examples.)

Unit- V

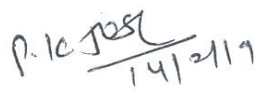Numierical Differentiation : Method Based On Interpolation, Non uniform and uniform nodal points, Quadratic Interpolation, Method based on Finite Difference Operators, Method based on Undetermined Coefficient, Optimum Choice Of Step Length.

(1.Chapter 5 section 5.2 and subsection, Examples, Section 5.3)

Text Book

1. **Numarical Methods, Jain, Iyanger and Jain, New Age International Edition 2012.**

Department of Higher Education Govt. of M.P.

Semester wise syllabus for P.G.

As recommended by Central Board of Studies and

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(Partially revised by the Board of Studies in Mathematics, DAVV, Indore on 09-02-2016 and to be effective from academic session 2016-2017)

Class	: M.Sc/ M.A. (Mathematics)
Semester	: III
Title of subject/Group	: OPERATIONS RESEARCH-I
Paper No.	: II/III/IV/V
Compulsory / Optional	: Optional Gr-IV(1)

Unit I

Operations Research - Introduction. Origin and Development of Operations Research, Nature and Features of Operations Research, Models in Operations Research, General Solution Methods for Operations Research, Phases of Operations Research, Uses and Limitations of Operations, Linear Programming Problems : Introduction Mathematical Formulation, Graphical Solution Method.

(1. Chapter 1 sect. 1.1 to 1.8, 1.10, Examples & Exercises, 1. Chapter 2 sect 2.1,2.2, 2.3, 2.4, Examples & Exercises ,1. Chapter 3 sect 3.1,3.2, Examples & Exercises)

(2. Chapter 1 sect 1.1,1.2,1.6, Chapter 2 sect 2.1,2.2)

Unit II

General Linear Programming Problem, Theory of Simplex method, Computational Procedure, Numerical problems, Solutions of simultaneous linear equations, inverse of a matrix using simplex method.

(1.Chapter 3 sect 3.3, 3.4, 3.5, Chapter 4 sect 4.1,4.2, 4.3, 4.6, 4.7, Examples & Exercises)

Unit III

Use of artificial variables, Big-M method, Two phase method, Problem of degeneracy and resolution of degeneracy, Applications of simplex method.
(1 Chapter 4 sect 4.4,4.5, 4.8 , Examples & Exercises)

Unit IV

Concept of duality : Introduction, General Primal-Dual pair, formulating a dual problem, primal-dual pair in matrix form, economic interpretation of duality, duality and simplex method, Fundamental Properties and Theorems of duality, complementary slackness, dual simplex method.
(1. Chapter 5 section 5.1, to 5.9, Examples and Exercises)

Unit V

Post optimality analysis, integer programming, revised simplex method.

(1. Chapter 6, Chapter 7: 7.1 to 7.4, Chapter 9: 9.1 to 9.2, Examples and Exercises)
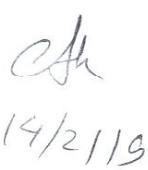
Recommended Books

1- Kanti Swarup, P.K. Gupta and Manmohan, Operations Research, Sultan Chand & Sons, New Delhi, fifteenth revised edition.

2- H.A. Taha, Operations Research - An introduction, Macmillan Publishing co. Inc. New york

Reference Books

1. S.D, Sharma, Operation Research,

2. F.S, Hiller and G.J. Lieberman, Industrial Engineering Series, 1995.

Department of Higher Education Govt. of M.P.

Semester wise syllabus for P.G.

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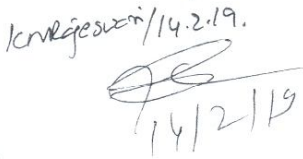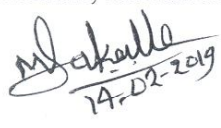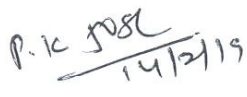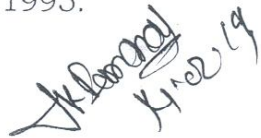(Partially revised by the Board of Studies in Mathematics, DAVV, Indore on 09-02-2016 and to be effective from academic session 2016-2017)

Class	: M.Sc/ M.A. (Mathematics)
Semester	: III
Title of subject/Group	: Analytic Number Theory-I
Paper No.	: II/III/IV/V
Compulsory / Optional	: Optional Gr-V(3)

Unit I

Characters of finite abelian groups, The character group, The orthogonality relations for characters, Dirichlet characters, Sums involving Dirichlet characters.

(1. Chapter 6, Section 6.4 to 6.10)

Unit II

Dirichlet characters, Sums involving Dirichlet characters, Dirichlet's theorem on primes in arithmetic progressions.

(1 Chapter 7, Section 7.1 to 7.8)

Unit III

The half-plane of absolute convergence of a Dirichlet series, the function defined by Dirichlet series, Euler products, The half-plane of convergence of Dirichlet series

(1. Chapter 11, Section 11.1 to 11.6)

Unit IV

Analytic properties of Dirichlet series , Mean value formulas for Dirichlet series Integral formula for the coefficient of Dirichlet series, Integral formula for the partial sums of a Dirichlet series.

(1. Chapter11, Section 11.7 to 11.12)

Unit V

Properties of the gamma function, Integral representation of Hurwitz zeta functions, Analytic continuation of Hurwitz zeta functions, Hurwitz Formula.

(1. Chapter12, Section 12.1 to 12.7)

*Exercise based on theory are expected to be solved.

Books Recommended:

1. **T.M. Apostol, Introduction to Analytic Number Theory, Narosa Pub.House,1989.**

Department of Higher Education Govt. of M.P.

Semester wise syllabus for P.G.

As recommended by Central Board of Studies and

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(Partially revised by the Board of Studies in Mathematics, DAVV, Indore on 09-02-2016 and to be effective from academic session 2016-2017)

Class	: M.Sc/ M.A. (Mathematics)
Semester	: III
Title of subject/Group	: **Integral Transform – I**
Paper No.	: II/III/IV/V
Compulsory / Optional	: Optional Gr-V(4)

Unit I

Laplace Transform of the derivative of f(t), Laplace Transform of Integrals multiplication by t, Multiplication by t^n, Division by t use of Laplace transform to unit step function(Heaviside's unit functions) use of Laplace Transform to Bessel function ,Inverse Laplace Transform of derivatives, convolution, Heaviside's expansion theorem , problem depends on Convolution.

(1. Chapter 1 section I (page 7-57), section II (Page 58-114)

Unit II

Application of Laplace Transform to Solutions of ordinary Differential Equations With constant Coefficients.

(1. Chapter 1 section III (page 115 - 139) excluding problem 1,4,5 (page 116-120))

Unit III

Solution of Simultaneous ordinary Differential Equations by Laplace Transform. Solution of ordinary differential equations with variable coefficients by Laplace Transform.

(1. Chapter 1 section III (page 140-149) problems 23-28 including problem 1,4,5 (page 116-120))
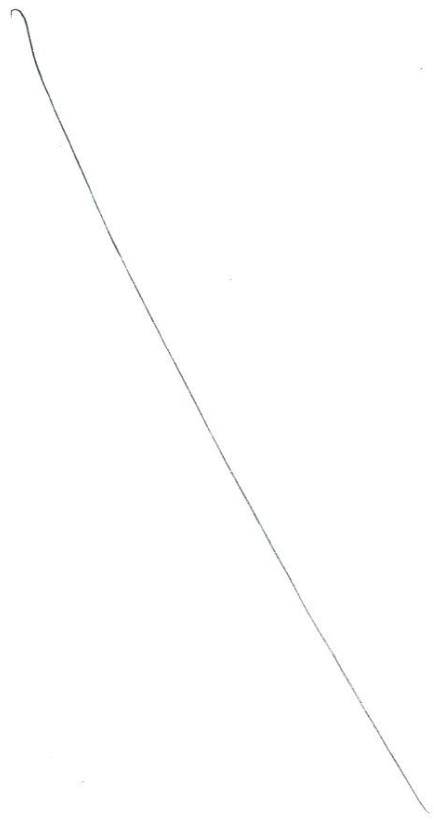
Unit IV

Solutions of Partial differential Equations by Laplace transform Application of Laplace transform to integral equation.

(1. Chapter 1 section III (page 150 - 160), section IV (Page 161-173)

Unit V

Heat conduction equations. Problems based on Heat conduction equation using Laplace transform.

(1. Chapter V (page 354 -361) including problems dependent on it on exercise page 371)

Books recommended:-

1. Integral Transform by Goyal & Gupta.

Department of Higher Education Govt. of M.P.

Semester wise syllabus for P.G.

As recommended by Central Board of Studies and

Approved by HE the Governor of M.P.

(Partially revised by the Board of Studies in Mathematics, DAVV, Indore on 09-02-2016 and to be effective from academic session 2016-2017)

Class	: M.Sc/ M.A. (Mathematics)
Semester	: III
Title of subject/Group	: Fundamentals of Computer Science (Theory and Practical)–I
Paper No.	: II/III/IV/V
Compulsory / Optional	: Optional Gr-VI(1)

Unit I

Introduction to Object Oriented Programming in C++, Need of Object-Oriented Programming , Characteristics of Object-Oriented Languages, Class, Object and Scopes, Nested Classes.

1.Chapter 1 and sections, Chapter 6 and sections.

Unit II

Pointer class member , class initialization , constructor and destructor , assignment and distribution. Virtual Functions and Friend Functions

1.Chapter 6 and sections, Chapter 11 and sections.

Unit III

Overloading : Function and Operators, Templates , Types of Templates and class templates.

1.Chapter 8 and sections, Chapter 14 and sections.

Unit IV

Class Inheritance and their Types, Multiple and Virtual Inheritance.

1.Chapter 9 and sections.

Unit V

Operating System: Introduction, What Operating Systems Do, Computer-System Organization, Computer-System Architecture , Operating-System architecture, Operating-System Operations, Process Management, Memory Management ,Storage Management, Protection and Security, Distributed Systems, Special-Purpose Systems , Client-Server Computing , Peer to Peer Computing, Open-Source Operating Systems . (Only Basic Concept of these all.)

2. Chapter 1 section 1.1 to 1.13

Text Books

1. **Robert Lafore Object Oriented Programming in C++, Forth edition, Sams Publishing Indianapolis, IN 46290 USA**
2. **Abraham Silberschatz, Peter Baer Galvin, Greg Gagne , Operating System Concept Wiley India Pvt. Ltd, Eights edition**

References :

1. S.B. LIPMAN, , J. LAJOI, C++ PRIMER,ADDISON
2. B.Stroustruo, The c++ programming languages, Addison – Westey.
3. Andrew S Tanenbaum, Modern Operating System, Pearson International, Third edition.

Department of Higher Education Govt. of M.P.

Semester wise syllabus for P.G.

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Class	: M.Sc/ M.A.
	(Mathematics)
Semester	: III
Title of subject/Group	: Integration Theory-I
Paper No.	: II/III/IV/V
Compulsory / Optional	: Optional Gr-VI(3)

Unit I

General Measures: Examples and Properties, Semi-finite & sigma finite measures.

(1, Chapter 11, Sect.1)

Unit II

Completion of a measure and measurable functions.

(1, Chapter 11 ,relevant parts of Sec.1 & Sec.2).

Unit III

Integration of Measurable functions

(1, Chapter 11,Sec.3).

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Unit IV

Signed Measures, Hahn decomposition Theorem, Mutually singular measures, Jordan decomposition Theorem.

(1, Chapter 11,Sec.5).

48

Unit V

Radon Nykodym Theorem, Lebesgue decomposition Theorem

(1, Chapter 11,Sec.6).

Note : Exercises based on the theory are expected to be solved

Recommended Books:

1.H.L.Royden, Real Analysis, Macmillan publishing co.Inc,New York,4th edition,1993.

Reference Books:

1. P.R.Halmos,Measure Theory, Van Nostrand.

2. I.K.Rana, Introduction to Measure and Integration, Narosa Publishing House, New Delhi.

Devi Ahilya University, Indore

Scheme of Examination — 2016-17

Class M.A./M.Sc. (Semester – III)

Subject : Mathematics

Paper	Title of the Paper	Max. Marks		Minimum Passing Marks	
	Compulsory	Theory	C.C.E.	Theory	C.C.E.
I	Functional Analysis	85	15	28	05
	Optional Papers Four papers out of the following have to be chosen, opting not more than one from each group.	85	15	28	05
	Group I 1. Advanced Functional Analysis 2. Partial Differential Equations 3. Differentiable Structures on manifolds 4. General Theory of Relativity and Cosmology	85	15	28	05
	Group II 1. Algebraic Topology 2. Abstract Harmonic Analysis 3. Advanced Graph Theory 4. Advanced Special Functions*	85	15	28	05
	Group III 1. Theory of Linear Operators* 2. Mechanics 3. Advanced Numerical Analysis* 4. Fuzzy Sets and their Applications	85	15	28	05
	Group IV 1. Operations Research* 2. Computational Biology 3. Jacobi Polynomials & H-Functions 4. Fluid Mechanics	85	15	28	05
	Group V 1. Wavelets 2. Bio-Mechanics 3. Analytic Number Theory* 4. Integral Transform*	85	15	28	05
	Group VI 1. Fundamentals of Computer Science (Theory & Practical)* 2. Mathematics of Finance & Insurance 3. Integration Theory* 4. Spherical Trigonometry and astronomy	85 (50 Theory & 35 Practical)	15	28	05
	Grand Total	500			

* Optionals presently being offered.

Note: If any optional other than those marked by * are being offered, due intimation should be given to the University.

उच्च शिक्षा विभाग, म0प्र0 शासन

(एम.एस.सी./एम.ए (स्नातकोत्तर) कक्षाओं के लिये सेमेस्टर अनुसार पाठ्यक्रम
केन्द्रीय अध्ययन मण्डल द्वारा अनुशंसित तथा म.प्र. के राज्यपाल द्वारा अनुमोदित

Department of Higher Education, Govt. of M.P.
M.Sc./M.A (Post Graduates) Semester wise Syllabus
As recommended by Central Board of Studies and approved by the Governor of M.P.

Max. Marks/अधिकतम अंक : 50

D5516

अधिकतम अंक / Max. Marks 50

कक्षा Class	:	M.Sc./M.A (Mathematics)
सेमेस्टर Semester	:	III
विषय समूह का शीर्षक Title of Subject/ Group	:	Partial Differential Equations-I
प्रश्न पत्र कं. Paper No.	:	II/III/IV/V
अनिवार्य / वैकल्पिक Compulsory/ Optional	:	~~Optional Gr-I (2)~~ Compulsory

Unit-1	Transport Equation-Intial Value Problem Non-homogeneous equations, Laplace's Equations - Fundamental Solution
Unit-2	Mean Formula properties of Harmonic functions, Green's Functions. Energy Methods.
Unit-3	Heat Equation - Fundamental Solution,
Unit-4	Mean Value Formula, Properties of Solutions, Energy Methods
Unit-5	Wave Equation - Solution by Spherical Means, Non - homogeneous Equations, Energy Methods.

Recommended Books :-

(1) L.C. Evans, Partial Differential Equations, 1998.

सत्र - ~~2019~~ 2020-2021

Devi Ahilya University, Indore

Scheme of Examination

Class M.A./M.Sc. (Semester – IV)

Subject : Mathematics

Paper	Title of the Paper	Max. Marks		Minimum Passing Marks	
	Compulsory	Theory	C.C.E.	Theory	C.C.E.
I	Functional Analysis	85	15	28	05
	Optional Papers Four papers out of the following have to be chosen, opting not more than one from each group.	85	15	28	05
	Group I 1. Advanced Functional Analysis 2. Partial Differential Equations 3. Differentiable Structures on manifolds 4. General Theory of Relativity and Cosmology	85	15	28	05
	Group II 1. Algebraic Topology 2. Abstract Harmonic Analysis 3. Advanced Graph Theory 4. Advanced Special Functions*	85	15	28	05
	Group III 1. Theory of Linear Operators* 2. Mechanics 3. Advanced Numerical Analysis* # 4. Fuzzy Sets and their Applications	85	15	28	05
	Group IV 1. Operations Research* # 2. Computational Biology 3. Jacobi Polynomials & H-Functions 4. Fluid Mechanics	85	15	28	05
	Group V 1. Wavelets 2. Bio-Mechanics 3. Analytic Number Theory* 4. Integral Transform*	85	15	28	05
	Group VI 1. Fundamentals of Computer Science (Theory & Practical)* 2. Mathematics of Finance & Insurance 3. Integration Theory* 4. Spherical Trigonometry and astronomy	85 (50 Theory & 35 Practical)	15	28	05
VI.	Job - Oriented Project Work.	100		33	
	Grand Total	600			

* Optionals presently being offered.

Note: If any optional other than those marked by * are being offered, due intimation should be given to the University.

P.K. Jes, 14/2/19

M.Jakoba 14-02-2019

K.M.Rajeswari 14.2.19.

14/2/19

14/2/19

14/2/19

Use of scientific calculator (Non-Programmable) is allowed.

Department of Higher Education Govt. of M.P.

Semester wise syllabus for P.G.

As recommended by Central Board of Studies and

Approved by HE the Governor of M.P.

(Partially revised by the Board of Studies in Mathematics, DAVV, Indore on 09-02-2016 and to be effective from academic session 2016-2017)

Class	: M.Sc/ M.A. (Mathematics)
Semester	: IV
Title of subject/Group	: Functional Analysis-II
Paper No.	: I
Compulsory / Optional	: Compulsory

Unit I

Inner Product Space Hilbert Space, Further Properties of Inner Product Spaces Orthogonal complements and Direct sum, Orthonormal Sets and Sequences. Schwarz, triangle and Bessel Inequality.

(1. Chapter 3 Sect 3.1 to 3.4 & Exercises)

Unit II

Series related to orthonormal sequences & sets, Total orthonormal sets & sequences Representation of Functionals on Hilbert Spaces , Riesz's Theorem, Riesz Representation Theorem.

(1. Chapter 3 Sect 3.5, 3.6, 3.8 & Exercises)

Unit III

Adjoint operator, Hilbert Adjoint Operator , Self Adjoint Operator, Unitary and Normal Operators

(1. Chapter 3 Sect 3.9 , 3.10, Chapter 4: 4.5 & Exercises)

Unit IV

Adjoint Operator, Reflexive Spaces, Category Theorem. Uniform Boundedness Theorem, Strong and Weak Convergence.

(1. Chapter 4 Sect 4.6 to 4.8 & Exercises)

Unit V

Convergence of Sequences of Operators and Functionals, Application of Summability of Sequences, Open Mapping Theorem, Closed Linear Operators, Closed Graph Theorem.

(1.Chapter 4 Sect 4.9, 4.10, 4.12, 4.13 & Exercises)

Text Books

1.E. Kreyszig Introductory Functional Analysis with applications, John Wiley & Sons New York.

Reference
1. G.F. Simmons, Introduction to Topology & Modern Analysis Mc Graw Hill,- New York 1963.
2. B. Choudhary and Sudarsan Nanda.Functional Analysis with applications, wiley Eastem Ltd.

उच्च शिक्षा विभाग, म0प्र0 शासन

(एम.एस.सी./एम.ए. (स्नातकोत्तर) कक्षाओं के लिये सेमेस्टर अनुसार पाठ्यक्रम
केन्द्रीय अध्ययन मण्डल द्वारा अनुशंसित तथा म.प्र. के राज्यपाल द्वारा अनुमोदित

Department of Higher Education, Govt. of M.P.
M.Sc./M.A (Post Graduates) Semester wise Syllabus
As recommended by Central Board of Studies and approved by the Governor of M.P.

Max. Marks/अधिकतम अंक : 50

अधिकतम अंक / Max. Marks 50

कक्षा Class	M.Sc./M.A (Mathematics)
सेमेस्टर Semester	IV
विषय समूह का शीर्षक Title of Subject/ Group	Partial Differential Equations-II
प्रश्न पत्र कं. Paper No.	II/III/IV/V
अनिवार्य/ वैकल्पिक Compulsory/ Optional	Optional Gr-1 (2)

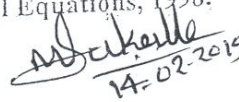| Unit-1	Nonlinear First order PDE. Complete integrals, Envelopes, Characteristics,
Unit-2	Hamilton Jacobi Equation (Calulus) of Variations, Hamiltons ODE, Legendre Transform, Hopf-Lax formulae, weak solution, Uniqueness.
Unit-3	Conservation Laws (Shocks, Entropy Condition Lax - Oleinic formula, Weak solutions, Uniqueness. Riemanns Problem Long Time behavior) Representation of Solution - Separation of Variables, Similarity Solutions (Plane and Traveling Waves - Solution
Unit-4	Similarity under Scaling Fourier and Lap lace Transform, Hopf - Cole Transform, Hodograph and Legendrey Transforms, Potential Functions, Asymptotes (Singular Perturbations, Lap laces Method, Geometric Optics
Unit-5	Stationary Phase Homogenization) Power Series (Non - characteristic surface, Real Analytic functions, Cauchy - Kovalevskaya Theorem

Recommended Books :-

(1)   L.C. Evans, Partial Differential Equations, 1998.

Department of Higher Education Govt. of M.P.

Semester wise syllabus for P.G.

As recommended by Central Board of Studies and

Approved by HE the Governor of M.P.

(Partially revised by the Board of Studies in Mathematics, DAVV, Indore on 09-02-2016 and to be effective from academic session 2016-2017)

Class	: M.Sc/ M.A. (Mathematics)
Semester	: IV
Title of subject/Group	: Advanced Special functions-II
Paper No.	: II/III/IV/V
Compulsory / Optional	: Optional Gr-II(4)

Unit – I

Hermite Polynomials :Definition of Hermite Polynomials $H_n(x)$, pure recurrence relations, Differential recurrence relations, Rodrigue's formula, other generating functions, Othogonality, Expansion of Polynomials, more generating functions.

(3.Chapter 7 Page 209-238)

Unit –II

Simple Laguerre Polynomials : Solution of Laguerre's Differential Equation, Generating Function, Rodrigue's Formula, Recurrence Relations, Laguerre Polynomials for particular values of n and x, Differential Equation of $L_n(x)$, Orthogonal Property of $L_n(x)$, Other Integral Relation.

(3.Chapter 8-I Page 239 – 257)

Unit –III

Generalized Laguerre Polynomials :Definition, Recurrence Relations, Rodrigue's Formula and Othogonality, Expansion, Some Special Result, More Generating Relations.

(3.Chapter 8-II Page 257 – 279)

Unit –IV

Chebyshev Polynomials :Independent Solution of Chebyshev's Equation, Expansion of $T_n(x)$ and $U_n(x)$, Generating Functions, Recurrence Relations, To determine $T_n(x)$ and $U_n(x)$ for given value of n, Orthogonal Properties of $T_n(x)$ and $U_n(x)$.

(3.Chapter 9 Page 280 -293)

Unit –V

The Jacobi Polynomials: The Jacobi polynomials, Bateman's generating function, The Rodrigues formula, Orthogonality, Differential recurrence relations, pure recurrence relation

(3. Chapter 10 Page 294 – 325)

Text Book

1. Rainville. E.D,Special functions, The Macmillan co., New York 1971.

2. Srivastava, H.M. Gupta, K.C. and Goyal, S.P.,The H-functions of One and Two Variables with applications, South Asian Publication, New Delhi.

3. Saran,N.,Sharma S.D. and Trivedi, - Special Functions with application, Pragati prakashan ,1986.

KrnRajeswari/14.2.19.

14/2/19

14/2/19

P.K. Josbi 14/2/19

14-02-2019

14-02-19

Semester wise syllabus for P.G.

As recommended by Central Board of Studies and

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(Partially revised by the Board of Studies in Mathematics, DAVV, Indore on 09-02-2016 and to be effective from academic session 2016-2017)

Class	: M.Sc/ M.A. (Mathematics)
Semester	: IV
Title of subject/Group	: Theory of Linear Operators– II
Paper No.	: II/III/IV/V
Compulsory / Optional	: Optional Gr-III(1)

Unit I

Behaviour of compact linear operators with respect to solvability of operator equations, Fredholm type theorems, Fredholm alternative theorem, Fredholm alternative for integral equations.

(1, Chapter 8,Sec 8.5,8.6,8.7).

Unit II

Spectral properties of bounded self adjoint operators on complex Hilbert spaces.

(1, Chapter 9, sec. 9.1&9.2)

Unit III

Positive operators and their square roots.

(1, Chapter 9, sec. 9.3&9.4).

Unit IV

Projections on complex Hilbert spaces and their properties.

(1, Chapter 9, sec. 9.5&9.6,).

Unit V

Spectral family of a bounded self adjoint linear operator and Spectral representation of bounded self adjoint linear operator.

(1, Chapter 9, sec 9.7,9.8& 9.9).

Note : Exercises based on the theory are expected to be solved .

Recommended books:

1. E.Kreyszig : Introductory Functional Analysis with applications, John wiley & sons, New York.

Reference Books :

1. P.R.Halmos: Introduction to Hilbert space and the theory of spectral multiplicity, second edition, Chelsea publishing co.NY 1957

2. N.Dunford and J.T.Schwartz, Linear operator-part 3,Interscience/wiley, New York 1958-71

Department of Higher Education

Semester wise syllabus for P.G.

As recommended by Central Board of Studies and

Approved by HE the Governor of M.P.

(Partially revised by the Board of Studies in Mathematics, DAVV, Indore on 09-02-2016 and to be effective from academic session 2016-2017)

Class	: M.Sc/ M.A. (Mathematics)
Semester	: IV
Title of subject/Group	: Advanced Numerical Analysis-II
Paper No.	: II/III/IV/V
Compulsory / Optional	: Optional Gr-III(3)

Unit-I

Extrapolation Methods (Richardson Extrapolation) , Partial Differentiation and its estimations, Ordinary Differential Equations : Initial Value Problems, Reduction Of Higher Order Equation, Existence and Uniqueness, Test equations , System Of Linear First Order Differential Equation With Constant Coefficients and its theorem, Multi Step Methods , Various types of Explicit and Implicit Multistep Methods, General Multi Methods. Examples.

(1.Chapter 5 Section 5.4 , Section 5.5, Chapter 6 Section 6.1 and subsections, Section 6.6 , Definition 6.1,6.2,6.3,6.4 and examples)
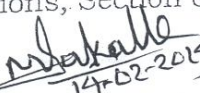
Unit- II

Maximum order of k-step methods and theorems, Convergence Of Multi Step Methods, Predicator and Corrector Method, Modified Predicator and Corrector Method, Stability Analysis of Multistep Methods and theorems : First Order and Second Order differential equations.
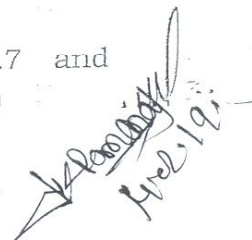
(1.Chapter 6 Section 6.6 and subsections , Definition , 6.5,6.6,6.7 and examples, Section 6.7 and subsections, Section 6.8 and subsections.)

Unit-III

Ordinary Differential Equation , Boundary Value Problems : Shooting Method, Alternate Method , Nonlinear Second Order Differential Equation.

(1.Chapter 7 section 7.1 , Section 7.2 and subsections)

Unit -IV

Finite Difference Methods Linear Second Order Differential Equations, Local Truncation Error, Derivative Boundary Conditions, Solutions Of Tridiagonal System, Nonlinear Second Order Differential Equation, Convergence Of Difference Schemes and theorems, Stability Of Finite Difference Schemes

(1.Chapter 7 section 7.3 and subsections)

Unit-V

Finite Element Method, Solution f the Variation Problem, Ritz Method (Galerkin equations),Finite Elements, Linear Lagrange Polynomial, Ritz Finite Element Method, Finite element solution of Linear Boundary Value Problems, Assembly Of Element Equations, Mixed Boundary Conditions

(Chapter 7 section 7.4 and subsections)

Text Book

1.   Numarical Methods, Jain, Iyanger and Jain, New Age International Edition 2012.

Department of Higher Education Govt. of M.P.

Semester wise syllabus for P.G.

As recommended by Central Board of Studies and

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(Partially revised by the Board of Studies in Mathematics, DAVV, Indore on 09-02-2016 and to be effective from academic session 2016-2017)

Class	: M.Sc/ M.A. (Mathematics)
Semester	: IV
Title of subject/Group	: OPERATIONS RESEARCH-II
Paper No.	: II/III/IV/V
Compulsory / Optional	: Optional Gr-IV(1)

Unit I

Transportation problems : Introduction, General transportation problem, duality in TP, Transportation Table , LP formulation of T.P., Initial solution of transportation problem : North - West Corner Method, Least – Cost Method, Vogel's Approximation Method, test for optimality by MODI (u-v method) method, economic interpretation, degeneracy in transportation problems, stepping stone algorithm.

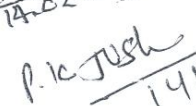(1.Chapter 10 sect 10.1 to 10.14, Examples and Exercises)

Unit II

Assignment problem : Introduction, Mathematical formulation of assignment problem, Solution of assignment problem : Hungarian Method , Special Cases: Unbalanced Assignment Problem, Maximisation Assignment Problems., Prohibited A.P., Dual of the assignment problem, Travelling Salesman problem. Dynamic Programming : Introduction, Characteristics , Dynamic Programming Algorithms.
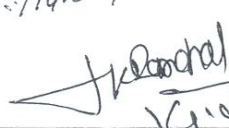
(1. Chapter 11 sect 11.1 to11.6, Chapter 13 sections 13.1 to 13.4, Examples and Exercises)

Unit III

Network analysis : Introduction , Basic Terminology/Components, Rules of network construction, Critical Path Method (CPM), PERT Calculation, Difference between CPM /PERT.

(1. Chapter 25, sections 25.1 to 25.11, Examples and Exercises)

Unit IV

Game theory : Introduction, Two- person Zero - Sum Games, Basic Terms, The Maximix -Minimax principle, games without saddle points - Mixed strategies, dominance property, Graphical solution of 2xm and mx2 games, Arithmetic method for nxn games, Solution of mxn games by Linear Programming, General solution of mxn rectangular games, Limitations.

(1. Chapter 17, section 17.1 to17.11, Examples and Exercises)

Unit V

Non-Linear programming Techniques Kuhn -Tucker Conditions with Non – negative Constraints, Quadratic Programming, Wolfe's simplex method, Beals method, Separable Convex Programming, Separable programming algoritham.

(1. Chapter 27, sections 27.1 to 27.7 , Chapter 28,   28.3 to 25.8, Examples and Exercises)

Recommended Books

1- Kanti Swarup, P.K. Gupta and Manmohan, Operations Research, Sultan Chand & Sons, New Delhi, fifteenth revised edition.

2- H.A. Taha, Operations Research - An introduction, Macmillan Publishing co. Inc. New york

Reference Books

1. S.D, Sharma, Operation Research,

2. F.S, Hiller and G.J. Lieberman, Industrial Engineering Series, 1

Semester wise syllabus for P.G.

As recommended by Central Board of Studies and

Approved by HE the Governor of M.P.

(Partially revised by the Board of Studies in Mathematics, DAVV, Indore on 09-02-2016 and to be effective from academic session 2016-2017)

Class	: M.Sc/ M.A. (Mathematics)
Semester	: IV
Title of subject/Group	: Analytic Number Theory-II
Paper No.	: II/III/IV/V
Compulsory / Optional	: Optional Gr-V(3)

Unit I

Functional equation for the Riemann zeta function , Functional equation for the Hurwitz zeta function, Properties of Bernoulli numbers and Bernoulli polynomials.

(1. Chapter12 Section 12.8 to 12.12)

Unit II

Analytic proof of prime number theorem: A contour integral representation for $\frac{\psi_1(x)}{x^2}$,Upper bounds for $|\zeta(s)|$ and $|\zeta'(s)|$ near the line $\sigma = 1$.

(1. Chapter13 Section 13.1 to 13.4)

Unit III

The non-vanishing of $\zeta(s)$ on the line $\sigma = 1$ completion of the proof of the prime number theorem, Zero-free regions for $\zeta(s)$.

(1. Chapter13 Section 13.5 to 13.8)

Unit-IV

Geometric representation of partitions, Generating functions of partitions, Euler's pentagonal number theorem.

(1. Chapter14 Section 14.1 to 14.5)

Unit V

Euler's recursion formula for p(n),Jacobi's triple product identity, The partition identity of Ramanujan.

(1. Chapter14 Section 14.6 to 14.11)

*Exercise based on theory are expected to be solved.

Books Recommended:

1. T.M. Apostol, Introduction to Analytic Number Theory, Narosa Pub.House,1989.

Department of Higher Education Govt. of M.P.

Semester wise syllabus for P.G.

As recommended by Central Board of Studies and

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(Partially revised by the Board of Studies in Mathematics, DAVV, Indore on 09-02-2016 and to be effective from academic session 2016-2017)

Class	: M.Sc/ M.A. (Mathematics)
Semester	: IV
Title of subject/Group	: Integral Transform – II
Paper No.	: II/III/IV/V
Compulsory / Optional	: Optional Gr-V(4)

Unit I

Laplace wave Equations, Problems based on wave equations using Laplace Transform.

(1.chapter 5 (page 362 – 373))

Unit II

Electric Circuits, Applications to Beams, Problems based on it using Laplace Transform.

(1.chapter 5 (page 342 – 334))

Unit III

The Complex Fourier Transform, Inversion Formula, Fourier cosine and sine Transform.

(1.chapter 2 section I(page 174 – 208) excluding section 2.3 and convolution theorem)

Unit IV

Properties of Fourier Transforms, Convolution & Parseval's identity.

(1.chapter 2 section II(page 213 – 216) Theorem 9 (convolution theorem) and 2.3))

Unit V

Fourier Transform of the derivatives, Finite Fourier Sine & Cosine Transform, Inversion formula for Sine & Cosine Transform, Operational and combined properties of finite Sine & Cosine Fourier Transform. Application of infinite Fourier Transform)

(1.chapter 2 section II(page 209) problem 8 – 26 (Page 222 – 240) , Chapter 6 problem 1-6 (page 375 – 380))

Books recommended:-

1. Integral Transform by Goyal & Gupta.

Department of Higher Education Govt. of M.P.

Semester wise syllabus for P.G.

As recommended by Central Board of Studies and

Approved by HE the Governor of M.P.

(Partially revised by the Board of Studies in Mathematics, DAVV, Indore on 09-02-2016 and to be effective from academic session 2016-2017)

Class	: M.Sc/ M.A. (Mathematics)
Semester	: IV
Title of subject/Group	: Fundamentals of Computer Science (Theory and Practical) –II
Paper No.	: II/III/IV/V
Compulsory / Optional	: Optional Gr-VI(1)

Unit I

Data Structure: Analysis of Algorithms time and space requirements, Rate of growth, Standards Notations Big O, Θ (Theta), Ω (Sigma) , Array as an ADT, Stacks, Queues and Linked Lists, their Operations and Representations/implementations.

1. Chapter 1, Section 1.2 Chapter 2, Section 2.1,2.2,2.3.Chapter 4 section 4.1,4.2
2. Chapter 1 and sections (Exercise)

Unit II

Introduction to Trees and Binary Trees , Representation of general tree and Binary Tree, Sequential and Lists Representations of Binary tree, Binary search tree Implementations and evaluation, Extended ,Threaded and AVL Tree , B-Tree (concept only).

1. Chapter 5, Section 5.1,5.2,5.4,5.54 , Chapter 7 Section 7.2.
2. Chapter 8 and Sections

Unit III

Hashing – Open and Closed, Hash Function, sorting techniques, selection sort, Shell Sort, Quick Sort, Heap Sort, bubble sort and their analysis.

1. Chapter 7, Section 7.4
2. Chapter 9 and Sections.

Unit IV

An Introduction to database System, Purpose and role of database system, Database Architecture. Database Users and Administrators. Structure of Relational Databases Database Schema, Keys, Schema Diagrams , Relational Query Languages , Relational Operations

Introduction to the Relational Model- Relational Algebra, Tuple Relational Calculus, Domain Relational Calculus

3. Chapter 1 section 1.11-1.12, Chapter 2, 2.1-2.6 ,Chapter 6 Section 6.1 – 6.4.

Unit V

Introduction to SQL, Overview of the SQL Query Language, SQL Data Definition, Basic Structure of SQL Queries ,Additional Basic Operations, Set Operations ,Null Values ,Aggregate Functions ,Nested Subqueries , Modification of the Database.

Join Expressions , Views , Transactions ,Integrity Constraints , SQL Data Types and Schemas ,Authorization

Relational Database design Normalization upto BCNF, Query Optimization strategies.

3. Chapter 3 Section 3.1 – 3.9, Chapter 4 Section 4.1-4.6, Chapter 8 Section 8.1,8.2,8.3 Chapter 13 Section 13.1

Text Book

1. Data Structures Using C and C++, Yedidyah Langsam,Moshe J.,A.M. Tenenbaum, Pearson Eduction.

2. Yashwant Kanetkar, BPB publications Ltd. New Delhi, Ist Edition.

3. DATABASE SYSTEM CONCEPTS Abraham Silberschatz,Henry F. Korth, S. Sudarshan, Published by McGraw-Hill Sixth edition.

4. Robert L. Kruse, Bruce P. leung, Clovis L. Tondo, Data Structures and Program Design in C, Prentice- Hall Of India, New Delhi

Department of Higher Education Govt. of M.P.

Semester wise syllabus for P.G.

As recommended by Central Board of Studies and

Approved by HE the Governor of M.P.

(Partially revised by the Board of Studies in Mathematics, DAVV, Indore on 09-02-2016 and to be effective from academic session 2016-2017)

Class	:	M.Sc/ M.A. (Mathematics)
Semester	:	IV
Title of subject/Group	:	Integration Theory – II
Paper No.	:	II/III/IV/V
Compulsory / Optional	:	Optional Gr-VI(3)

Unit I

Outer Measure and Measurability.

(1, Chapter 12,Sec.1).

Unit II

Measure on algebra, Measure on semi-algebra, Extension theory of these measures.

(1, Chapter 12,Sec.2).

Unit – III

Product Measures, Fubini's Theorem,Tonelli's Theorem, Examples to illustrate these theorems.

(1, Chapter 12,Sec.4).

Unit IV

Basic results on Locally compact Hausdorff Spaces, Baire Sets, Baire Measures,regularity of measures on locally compact Hausdorff Spaces.

(1, Chapter 13, Sec.1&2).

Unit V

Costruction of Borel Measures, Integration of continuous functions with compact support on locally compact spaces, Riesz-Markov Theorem.

(1, Chapter 13, Sec.3&4).

Note : Exercises based on the theory are expected to be solved .

Recommended Books:

1. H.L.Royden, Real Analysis, Macmillan publishing co.Inc,New York,4th edition,1993.

Reference Books:

1. P.R.Halmos,Measure Theory, Van Nostrand.

2. I.K.Rana, Introduction to Measure and Integration, Narosa Publishing House, New Delhi.

3. Ole A.Nielson, An Introduction to Integration and Measure Theory , Canadian Mathematical Society Series of Monographs and advanced Texts, Wiley-Interscience Publication.

उच्च शिक्षा विभाग, म0प्र0 शासन

(एम.एस.सी. / एम.ए. (स्नातकोत्तर) कक्षाओं के लिये सेमेस्टर अनुसार पाठ्यक्रम

केन्द्रीय अध्ययन मण्डल द्वारा अनुशंसित तथा म.प्र. के राज्यपाल द्वारा अनुमोदित

Department of Higher Education, Govt. of M.P.

M.Sc./M.A (Post Graduates) Semester wise Syllabus

As recommended by Central Board of Studies and approved by the Governor of M.P.

Max. Marks/अधिकतम अंक : 50   85

अधिकतम अंक / Max. Marks 50   85 / 125

कक्षा Class	M.Sc./M.A (Mathematics)
सेमेस्टर Semester	IV
विषय समूह का शीर्षक Title of Subject/ Group	Partial Differential Equations-II
प्रश्न पत्र कं. Paper No.	II/III/IV/V
अनिवार्य / वैकल्पिक Compulsory/ Optional	Optional Gr-1 (2)

Unit-1	Nonlinear First order PDE. Complete integrals, Envelopes, Characteristics,
Unit-2	Hamilton Jacobi Equation (Calulus) of Variations, Hamiltons ODE, Legendre Transform, Hopf-Lax formulae, weak solution, Uniqueness.
Unit-3	Conservation Laws (Shocks, Entropy Condition Lax - Oleinic formula, Weak solutions, Uniqueness. Riemanns Problem Long Time behavior) Representation of Solution - Separation of Variables, Similarity Solutions (Plane and Traveling Waves - Solution
Unit-4	Similarity under Scaling Fourier and Laplace Transform, Hopf - Cole Transform, Hodograph and Legendrey Transforms, Potential Functions, Asymptotes (Singular Perturbations, Laplaces Method, Geometric Optics
Unit-5	Stationary Phase Homogenization) Power Series (Non - characteristic surface, Real Analytic functions, Cauchy - Kovalevskaya Theorem

शैक्षणिक विभाग
देवी अहिल्या विश्वविद्यालय
इन्दौर

Recommended Books :-

(1)   L.C. Evans, Partial Differential Equations, 1998.

KNRajeswon
13-3-12

13-3-12

KNRajeswon / 24.3.17
KNRajeswon
9.2.16

9-2-2012