Department
of
Mathematics and Statistics

School of Mathematical and Physical Science

Curriculum Framework
B.A./B.Sc. (Hons.) -Mathematics

Based on National Education Policy- 2020

Date of BoS -

Doctor Harisingh Gour Vishwavidyalaya
(A Central University)
Sagar-Madhya Pradesh-470003

About the Department:

The Department of Mathematics & Statistics was established with the very inception of the University in the year of 1946. The founder of the university and the founder vice-chancellor Dr. Harisingh Gour had himself appointed Mr. R.B. Rabugunday as the first Head of the Department. Mr. Rabugunday was a scholar of Madras University and a Wrangler of Cambridge tradition.

Curriculum Framework based on National Education Policy-2020

NEP-2020 has conceptualized the idea to develop well rounded competent individuals for making the nation a self-reliant and global leader. In the same spirit, we at Department of Mathematics and Statistics have developed a curriculum framework to encompass the goals of NEP 2020. To this end, we have incorporated choice of subject/disciplines of study, creating academic pathways having constructive combinations of disciplines for study with multiple entry and exit points as well as focus on **experiential learning** for students by introducing **multidisciplinary and skill enhancement courses** and actual Hand's on training in the recent and trending aspects in Mathematics.

Under Graduate Curriculum Framework for Bachelor of Science (Honours)

1. **Name of the Programme: B.A./ B.Sc. (Hons.) - Mathematics**
2. **About the Programme:**

   Mathematics is backbone of all discipline. Aim of this programme is to train young minds to handle the critical problems that occur in Mathematical Sciences as well as in real life.

3. **Objectives of the Programme**
   - To develop students' skills in mathematical science through various tools and techniques.
   - To provide rigorous instruction in fundamental mathematical concepts and skills presented in the context of real-world applications.
   - To introduce students to the enormous diversity and complexity of real-life problems in Mathematics.
   - To provide the opportunity to gain familiarity with the applications of mathematics.
4. **Programme Learning Outcomes :**

The programme learning outcomes are attained by learners through the essential learning acquired on completion of selected courses of study within a programme. The outcomes and attributes described in qualification descriptors are attained by students through learning acquired on completion of a programme of study.

a) After completion of this program of study the students will have an enhanced knowledge and understanding of mathematics.

b) The Mathematical skills learned through this course will provide analytical understanding for approaching problems that the students encounter in real life situations.

c) Students who will pass out this course be better able to draw inferences that rest on mathematical logics.

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19/2/25

25/02/25

19.2.25

Structure of the Programme for: B.A./ B. Sc. (Hons.) Mathematics

	Semester VII				
Level 8	**Nature of Course**	**Course Code**	**Course Title**	**Credits**	**Course Designer**
	Discipline Specific Major-1	MTS-DSM-711	Abstract Algebra	6	Dr. M.K. Yadav
	Discipline Specific Major-2	MTS-DSM-712	Advanced Real Analysis	6	Dr. R.K. Pandey
	Multi-Discipline: Major-3	MTS-MDM-711	Operations Research	6	Prof. U.K. Khedlekar
	Minor Project	MTS-SEC-711	Minor Project	2	
	Semester VIII				
	Nature of Course	**Course Code**	**Course Title**	**Credits**	**Course Designer**
	Discipline Specific Major-1	MTS-DSM-811	Measure Theory	6	Dr. R.K. Pandey
	Discipline Specific Major-2	MTS-DSM-812	Partial Differential Equations	6	Dr. Bipin Kumar
	Discipline Specific Dissertation	MTS-DSM-813	Dissertation	12	

1. **Teaching Learning Approach:**
   Mainly this programme will transact the under given pedagogic approach-
   - Lecture/ Seminar format
   - Demonstration
   - Readings/written assignments and Field Projects
   - Group discussions/tutorial Community visit
   - Project work
   - Field Visit/Survey/Dissertation
2. **Assessment**
   The learner in the programme will be assessed throughout the duration of the programme in a formative and summative evaluations i.e. Mid (I&II) and End Semester examinations. To be eligible to appear in End semester examination a student must appear in Mid semester examinations along with 75 per cent attendance in classroom processes

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B.A./ B.Sc.(Hons.) - Semester VII (Mathematics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L8 Sem VII	**MTS-DSM-711**	**Abstract Algebra**	**5**	**1**	**0**	**6**	**IA (Mid)-40 EA (End Sem)- 60**	**Dr. M. K. Yadav**

Lectures Hrs.: 90

Learning Objectives:

1. To inculcate the basic features of Advanced Abstract algebra.
2. To teach class equation, P-group and Sylow's theorem.
3. To teach solvable and nilpotent groups.
4. To introduce Galois Theory

Course Learning Outcomes:

CO1: After completion of this course the students will be able to understand the composition series.
CO2: Understand Jordan- Holder theorem, solvable groups, nilpotent groups.
CO3: Understand field extension and Galois Theory and solvability of polynomial equation using the Galois theory.

Unit Wise Learning Outcomes:

UO1. Student would enhance the knowledge of Class equation, p-group, Sylow's theorem.
UO2. Student able to understand normal series, solvable group and nilpotent group.
UO3. Student able to understand rings.
UO4. Student able to understand polynomial rings and its properties.
UO5. Student able to understand Galois theory and example.

Unit-I:	Inner Automorphism, Characteristic Subgroup, Conjugate element, Conjugate class of H in G, Class equation, p-groups, Sylow p-subgroups, Sylow theorems.
Unit-II:	Normal series, subnormal series of group, composition series, Jordan- Holder theorem, solvable groups, nilpotent groups.
Unit-III:	Rings, Subrings, Sum of two subrings, Product of Rings, Ideals, Sum and product of two Ideals, Prime and maximal ideals, Quotient rings, Homomorphisms and imbedding of rings, Unique factorization domain (UFD), Principal ideal domain (PID), Euclidean domain, Polynomial rings.
Unit-IV:	Irreducible polynomial, Gauss lemma, Einstein criterion, Adjunction of roots, Algebraic extensions, Algebraically closed fields. Splitting fields, Uniqueness of splitting fields, Normal extensions, Multiple roots, Finite fields, Separable & inseparable extensions.
Unit-V:	Fields, Subfields, Automorphism groups and fixed fields, Dedekind lemma, Fundamental theorem of Galois theory and example.

Essential Readings:

1. J.A. Gallian: Contemporary Abstract Algebra Cengage Ind Pvt Ltd. 2018.
2. N. Jacobson, Basic Algebra, Vol. I, II & III Hindustan Publishing Company.
3. S. Lang, Algebra, Addision-Wisley.
4. I.S. Luther & IBS Passi, Algebra Vol. I, II & III Narosha Pub. House, New Delhi.
5. M. Artin, Algebra, Prentice- Hall of India, 1991.

Suggested Readings

1. P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul, Basic Abstract Algebra, Cambridge University press.
2. I.N. Herstein, Topic in Algebra, Wiley Eastern, New Delhi.

Essential e-Recourse

1. https://www.cs.columbia.edu/~nadimpalli/data/AAL-Notes.pdf
2. https://archive.nptel.ac.in/courses/111/105/111105112/
3. https://nptel.ac.in/courses/111106113
4. https://www.youtube.com/watch?v=iobTKR4-19o
5. https://www.youtube.com/watch?v=MVojEjXdVgA

19.7.25

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Syllabus as per NEP-2020
B.A./ B.Sc.(Hons.)- Semester VII (Mathematics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L8 Sem-VII	**MTS-DSM-712**	**Advanced Real Analysis**	**5**	**1**	**0**	**6**	**IA (Mid) - 40 EA(End Sem)- 60**	**Dr. R. K. Pandey**

Lectures Hrs.: 90

Learning Objectives

1. To explain fundamentals of Riemann-Stieltjes integration and its uses.
2. To introduce the Rearrangement of series, Riemann's rearrangement theorem.
3. To explain sequence and series sequence of functions, uniform convergence.
4. To explain the derivation Inverse function and its applications.
5. To explain the concept of extremum in several variable and its applications.

Course Learning Outcomes: This course will enable the students to:

CO1: Learn R-S integrability and its relation with uniform convergence.
CO2: Understand rearrangement and Riemann rearrangement theorem.
CO3: To learn partial derivative, directional derivative and derivative of functions from R^n to R^m .

Unit wise Learning Outcomes: After completion of this course students will be able to:

UO1: Evaluate the integral of a function with respect to an increasing function using the concept of R-S integration. Also students will able to test the convergence of improper integrals.
UO2: Interpret meaning of rearrangement of infinite series and its examples.
UO3: Understand the concepts of uniform and point wise convergence and its consequences in preservation of limit, continuity, integration etc.
UO4: Understand the differentiability of functions of several variables and related theorems e.g. inverse function theorem, implicit function theorem.
UO5: Understand the proof of inverse function theorem and Lagrange multiplier method for extremum problems.

Unit-I:	Definition and existence of Riemann-Stieltjes integral, Conditions for R-S integrability. Properties of the R-S integral, R-S integrability of functions of a function. Improper integrals and test for convergence.
Unit-II:	Rearrangements of terms of a series, Riemann's theorem, Dirichlet's theorem. Sequences and series of functions, point wise and uniform convergence, Cauchy criterion for uniform convergence, Weierstrass M-test, Abel's and Dirichlet's tests for uniform convergence.
Unit-III:	Uniform convergence and continuity, uniform convergence and R-S integration; uniform convergence and differentiation, Power series, uniqueness theorem for power series.
Unit-IV:	Functions of several variables, derivatives in an open subset of R^n, derivative as linear transformations, directional derivative, chain rule; Partial derivatives, interchange of the order of differentiation, derivatives of higher orders.
Unit-V:	Taylor's theorem, inverse function theorem, implicit function theorem, Jacobians, extremum problems with constraints, Lagrange's multiplier method.

Essential Readings:

1. T.M. Apostal: Mathematical analysis, Narosa, 1985.
2. H.L. Royden: Real Analysis, Macmillan (Indian Edition).

Suggested Readings:

1. Walter Rudin: Principles of Mathematical Analysis, McGraw Hill.
2. Terence Tao, Analysis I, Hindustan Book Agency (third edition), 2014.
3. Terence Tao, Analysis II, Springer and Hindustan Book Agency (third edition), 2015.

E- Resource:

1. https://nptel.ac.in/courses/111106053
2. https://nptel.ac.in/courses/111105098
3. https://ocw.mit.edu/courses/18-100a-real-analysis-fall-2020/#:~:text=Course%20Description,the%20interchange%20of%20limit%20operations.

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B.A./B.Sc. (Hons.) - Semester VII (Mathematics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L8 Sem-VII	MTS-MDM-711	**Operations Research**	5	1	0	6	IA (Mid) - 40 EA(End Sem)- 60	Prof. U. K. Khedlekar

Lectures Hrs.: 90

Learning Objectives:

To study the objectives and scope of Operations Research. To learn techniques of Operations Research in business, marketing, assignment etc. To know the properties of convex set, modeling in business and project planning.

Course Learning Outcomes:

CO1: The inter-disciplinary course applicable in various businesses.
CO2: The study of this paper supports insurance, marketing and business strategies.
CO3: Students capable to design and manage any project.

Unit Wise Learning Outcomes:

UO1: Understand the Scope of Operations research and its necessity in real life.
UO2: Understand the method of problem solving using Simplex Method.
UO3: Understand the control and management of inventory system.
UO4: Understand the transportation and assignment problem.
UO5: Understand the project, evaluation and review of techniques.

Unit-I:	Operations Research and its scope. Necessity of Operations Research in Industry. Linear Programming Problem, Graphical Method, Simplex method.
Unit-II:	Convex sets, theory of the Simplex method, revised simplex method. Two-Phase simplex method. Big-M method, duality and dual simplex method and sensitivity analysis.
Unit-III:	Inventory models, Economic order quantity models with constant rate of demand. Production lot size model with shortage. Buffer stock.
Unit- IV:	Transportation problem-initial basic feasible solution. Initial Basic Feasible Solution by North-West Corner Method, Matrix minima method and Vogel's approximation method. Optimal solution, degeneracy in transportation problems. Assignment Problems: Hungarian Method for solution. Crew based problems, Traveling-Salesman (Routing) problems.
Unit- V:	Job Sequencing, processing n-jobs through 2 machines, processing n-jobs through 3 machines. Network analysis. Shortest path problems, minimum spanning tree problems. Critical path method, Project evaluation and review technique.

Essential Readings

1. H.A. Taha, Operations Research-An Introduction, Macmillan Publishing INC., New- York.
2. F.S. Hillier & G.J. Lieberman, Introduction to Operations Research, (sixth-edition), McGraw Hill International Edition

Suggested Readings

1. J.C.Pant, Operations Research and optimization, Jain publisher (7th edition)
2. S.D.Sharma. Operations Research, Kedar Nath Ram Sons & co. Publisher Meerut (thirteenth-edition) 2001.
3. Kanti Swarup, P.K. Gupta & Man Mohan, Operations Research., Sultan Chand &sons, New Delhi.

Essential E-Resources

1. https://www.youtube.com/watch?v=BDBhpxRzImI&list=PLWoXNEI-KK1mCv_EL4OdF_-FXryaZ11N
2. www.cs.toronto.edu/~stacho/public/IEOR4004-notes1.pdf

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B.A./ B.Sc.(Hons.) - Semester VIII (Mathematics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L8 Sem VII	MTS-SEC-711	Minor Project	2	0	0	2	IA (Mid)-40 EA (End Sem)- 60	

Lectures Hrs. 30

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B.A./ B.Sc.(Hons.) - Semester VIII (Mathematics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L8 Sem VIII	MTS-DSM-811	Measure Theory	5	1	0	6	IA (Mid) - 40 EA (End Sem) - 60	Dr. R. K. Pandey

Lecture Hrs. 90

Learning Objectives:

1. To inculcate the basic features of Lebesgue measures.
2. To acquainted with Lebesgue Integration.
3. To introduce the L^p --space and some inequalities.
4. To teach Completeness of L^p --space and convergence in measure.

Course Learning Outcomes: After completion of this course, the students will be able to

CO1: Grasp the theory of outer measures, sigma-algebras, and measure spaces, and understand the basic problems measure arising in analysis.

CO2: Interpret the results in Measure Theory with a critical mind rigorously, whether a given statement in Measure Theory is correct or not.

CO3: Relate the theoretical structure of Measure Theory as a prerequisite for the future study subjects such as Harmonic Analysis, and Operator Theory.

Unit wise Learning Outcomes: After completion of this course successfully, the students will be able to:

UO1: Understand the basic concept of measure, the theory of outer measures, sigma-algebras, and understand the basic problems of measure arising in analysis. They conceive the notion of non-measurable sets.

UO2: Interpret the properties of Lebesgue measurable functions, Lebesgue integration Theory, Monotone convergence theorem, and solve basic problems about them.

UO3: Interpret monotone functions on measure spaces, Lebesgue differentiation theorem. Functions of bounded variation, and solve basic problems about them.

UO4: Interpret the results about convex functions, L^p spaces and important inequalities in Measure Theory, and solve basic problems about them.

UO5: Conceive the Completeness of Lp-space and convergence in measure and almost uniform convergence, and solve basic problems about them.

Unit-I:	Lebesgue outer measure, σ — algebra, measurable sets, regularity, Borel and Lebesgue measurability. Continuity of measures, non-measurable sets, and measurable functions.
Unit-II:	Lebesgue integration of measurable non-negative functions, the general Lebesgue integral, Fatou's Lemma, Monotone convergence Theorem, distinction between Reimann and Lebesgue integrals.
Unit-III:	Continuity of monotone functions. The Vitali Covering Lemma, The four derivatives, Lebesgue differentiation theorem. Functions of bounded variation, Jordan's Theorem.
Unit-IV:	Differentiation and integration. Convex functions, Jensen's inequality. The L^p-spaces, Inequalities of Young, Holder, and Minkowski.
Unit-V:	Completeness of L^p -space, convergence in measure, uniform convergence and almost uniform convergence. Egorff's Theorem.

Essential Readings:

1. H.L. Royden, Real Analysis, Macmillan, Indian Edition New Delhi.
2. Inder K. Rana, An introduction to measure and integration, Macmillan, Narosa Publishing House, India.

Suggested Readings and Link :

1. Walter Rudin, Principles of Mathematical Analysis, McGraw-Hill, New Delhi International student edition.
2. G. de Barra. Measure Theory and Integration, Wiley Eastern (Indian Edition).

Essential e-Resources

1. https://nptel.ac.in/courses/111106161
2. **https://nptel.ac.in/courses/111108135**
3. https://nptel.ac.in/courses/111101100
4. **https://ocw.mit.edu/courses/18-125-measure-and-integration-fall-2003/**

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Syllabus as per NEP 2020
B.A./ B.Sc.(Hons.) - Semester VIII (Mathematics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L8 Sem VIII	MTS-DSM-812	Partial Differential Equations	5	1	0	6	IA (Mid) - 40 EA (End Sem) - 60	Dr. Bipin Kumar

Lecture Hrs. 90

Learning Objectives:

1. To develop students' skills in the theory and applications of linear and nonlinear partial differential equations and to provide rigorous instruction to the fundamental concepts and skills.
2. To introduce students the diversity where the partial differential equations be applied and utilised.
3. To provide an advanced treatment of methods for solution of some standard PDEs by method of saperation of variables.

Course Learning Outcomes:

CO1: Students will have an enhanced knowledge and understanding of linear and nonlinear partial differential equations.

CO2: The PDE solving skills will provide an insight to students for the applications of PDEs in various fields.

CO3: Students will be able to apply method of separation of variables in their future research work.

Unit wise Learning Outcomes

UO1: Students be able to understand that how a partial differential equation originates and will also be able find their solutions by well-established methods.

UO2: Students will be able to understand Cauchy's method of characteristics, and its applications in various cases.

UO3: Students will be able to classify II order partial differential equations in parabolic, hyperbolic, and elliptical PDEs.

UO4: The Reduction to canonical form of a system of linear partial differential equations will be studied in detail.

UO5: Students will be acquainted with the knowledge of solving non homogeneous PDEs by the method of eigen function expansion, together with the method of separation of variables.

Unit-I:	Partial differential equations, Origins of the first order PDEs. PDEs with constant coefficient, Cauchy problem for first order equations. Linear equations of the first order.
Unit-II:	Cauchy's method of characteristics. The method of characteristics for PDEs with more than two independent variables. The method of characteristics for a fully nonlinear first-order PDEs.
Unit-III:	Charpit's methods for solving first order nonlinear PDEs, The general class of second-order linear PDEs. Classification of second order PDEs in parabolic, hyperbolic and elliptic PDEs.
Unit-IV:	Reduction to canonical form of a system of linear partial differential equations. General solution of higher order PDEs with constant coefficients.
Unit-V:	Solving nonhomogeneous PDEs by the method of eigenfunction expansion. Method of separation of variables for solving Laplace, Heat and Wave equations.

Essential Readings

1. S. L. Ross, DIFFERENTIAL EQUATIONS: Wiley India Pvt.Ltd , 2010.
2. Ian N. Sneddon, ELEMENTS OF PARTIAL DIFFERENTIAL EQUATIONS, Dover Books on Mathematics, 2006.
3. Stanley J. Farlow, Partial Differential Equations for Scientists and Engineers · 2012
4. I. G. Petrovsky,Lectures on Partial Differential Equations, Dover Publications, 2012.

Suggested Readings

1. P. W. Berg and J. L. Mc Gregor , Elementary Partial Differential Equations. Holden- Day , 1966.
2. M. D. Raisinghania, Ordinary and Partial Differential Equations, S. CHAND & COMPANY LTD, 2013.

e-Resources

1. https://nptel.ac.in/courses/111101153
2. **https://nptel.ac.in/courses/111108144**

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B.A./ B.Sc.(Hons.) Semester-VIII (Mathematics)

Level & Semester	Course Code	Title of the Course	Credits				Marks	Course Designer
			L	T	P	C		
L8 Sem VIII	**MTS-DSM-813**	**Dissertation**	**10**	**2**	**0**	**12**	**IA (Mid) -40 EA (End Sem) - 60**	

Lecture Hrs. 180

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School Board Meeting held on 25 February, 2025

The School Board has approved the minute of meeting of BOS of Department of Mathematics and Statistics held on 19/02/2025.

Prof. A.K. Saxena
External Member
Department of Mathematics, Maharaja Chhatrasal University, Chhatarpur (M.P.)

Prof. K.S. Varsney
External Member
HoD Physics, D.S. College, Aligarh, U.P.

Prof. Narendra Pandey
External Member
Department of Physics,
University of Lucknow (U.P.)

Prof. Diwakar Shukla
Member
Department of Mathematics & Statistics
Dr. H.S. Gour V.V. Sagar (M.P.)

Prof. Ashish Verma
Member
HoD, Department of Physics
Dr. H.S. Gour V.V. Sagar (M.P.)

Prof. Ranveer Kumar
Member
HoD, Department of Physics
Dr. H.S. Gour V.V. Sagar (M.P.)

Prof. U.K. Patil
Member
Department of Pharmaceutical Science,
Dr. H.S. Gour V.V. Sagar (M.P.)

Prof. R.K. Rawat
Member
Department of Applied Geology,
Dr. H.S. Gour V.V. Sagar (M.P.)

Dr. Rekha Garg Solanki
Member & Associate Professor
Department of Physics
Dr. H.S. Gour V.V. Sagar (M.P.)

Prof. U.K. Khedlekar
Member
Department of Mathematics & Statistics
Dr. H.S. Gour V.V. Sagar (M.P.)

Dr. Abhishek Bansal
Member & Associate Professor
HoD, Department of Computer Science & Applications
Dr. H.S. Gour V.V. Sagar (M.P.)

Dr. Shivani Khare
Member & Assistant Professor
Department of Mathematics & Statistics
Dr. H.S. Gour V.V. Sagar (M.P.)

Dr. Mahesh Kumar Yadav
Member & Assistant Professor
Department of Mathematics & Statistics
Dr. H.S. Gour V.V. Sagar (M.P.)

Mr. Kamal Kant Ahirwar
Member
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