Department
of
Mathematics and Statistics

School of Mathematical and Physical Science

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

Based on National Education Policy- 2020

Date of BoS -

अधिष्ठाता/DEAN
गणितीय एवं भौतिक विज्ञान अध्ययनशाला
School of Mathematical & Physical Science
डॉ. हरीसिंह गौर विश्वविद्यालय सागर (म.प्र.)
Dr. Harisingh Gour Vishwavidyalaya, Sagar

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

Department of Mathematics and Statistics
डॉ. हरीसिंह गौर विश्वविद्यालय, सागर (म.प्र.)
Dr. H.S. Gour Vishwavidyalaya, Sagar, M.P.

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 Dr. R.B. Rabugunday as the first Head of the Department. Dr. Rabugunday was a scholar of Madras University and a wrangler of Cambridge tradition.

Curriculum Frame work based on National Education Policy-2020

NEP-2020 has conceptualized the idea to develop well rounded competent individuals for making the nation self-reliant and global leader. Department of Mathematics and Statistics has developed a curriculum framework to encompass the goals of NEP-2020.Department has incorporated choice of subjects/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 statistics.

1. **Name of the Programme: B.A./B.Sc. (Hons.) - Statistics**
2. **About the Programme:**
   Statistics is a backbone of many sciences and social science discipline. Aim of this UG programme is to train young minds in order to handle the critical problems that occur in data handling with application of statistical tools.
3. **Objectives of the Programme**
   - To develop student's kills in Statistical science through various tools and techniques.
   - To provide rigorous instructions in fundamental statistical 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 statistics.
   - To provide the opportunity to get expertise in the applications of statistics.
4. **Programme Learning Outcomes :**
   The programme learning outcomes are attained by learners through the essential learning acquired on completion of selected course of study with in 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 about statistical applications.
   b) The statistical skills learned through this program will provide analytical understanding for solving problems in real life situations.
   c) Students who will complete this program be able to draw sound inferences through data analysis.

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

	Semester VII				
Level 8	**Nature of Course**	**Course Code**	**Course Title**	**Credits**	**Course Designer**
	Discipline Specific Major-1	STAT-DSM-711	Abstract Algebra	6	Dr. M.K. Yadav
	Discipline Specific Major-2	STAT-DSM-712	Advanced Real Analysis	6	Dr. R.K. Pandey
	Multi-Discipline: Major-3	STAT-MDM-711	Mathematical Finance	6	Prof. R.K. Gangele
	Skill Enhancement Course	STAT-SEC-711	Minor Project	2	
	Semester VIII				
	Nature of Course	**Course Code**	**Course Title**	**Credits**	**Course Designer**
	Discipline Specific Major-1	STAT-DSM-811	Measure Theory	6	Dr. R.K. Pandey
	Discipline Specific Major-2	STAT-DSM-812	Advanced Sampling Techniques	6	Prof. D. Shukla
	Discipline Specific Dissertation	STAT-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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Syllabus as per NEP-2020
B.A./ B.Sc.(Hons.) - Semester VII (Statistics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L8 Sem VII	STAT-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. 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. N. Jacobson, Basic Algebra, Vol. I, II & III Hindustan Publishing Company.
2. S. Lang, Algebra, Addision-Wisley.
3. I.S. Luther & IBS Passi, Algebra Vol. I, II & III Narosha Pub. House, New Delhi.
4. 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

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

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L8 Sem-VII	**STAT-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.

अध्यक्ष 9/2/22
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Syllabus as per NEP-2020
B.A./ B.Sc.(Hons.)- Semester VII (Statistics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L8 Sem -VII	STAT-MDM-711	Mathematical Finance	5	1	0	6	IA (Mid) - 40 EA(End Sem)- 60	Prof. R.K. Gangele

Lectures Hrs.: 90

Learning Objectives:

(1) To study random variable and its properties.
(2) To understand Trinomial processes & Brownian motion.
(3) To explain transition Wiener processes & Forward contracts.
(4) To study standard pricing models in the term of Black-Scholes options.
(5) To understand Arbitrage relationship for American options.

Course Learning Outcomes:

(1) After completion of this course the students will understand the basic concept of different models and use in daily life.
(2) To financial advisor in Mutual finance.
(3) To useful in stock trading company.
(4) To stock technical analysis for investor.

Unit Wise Learning Outcomes:

UO1. Learning of probability setup including random variables.
UO2. Learning about stochastic process.
UO3. Understanding of stock market variations.
UO4. Knowledge of various solution approaches.
UO5. Learning of advance methodologies used in mathematical finance.

Unit-I: Probability & conditional probability, Random variables, Expectation and conditional expectation, Variance & Covariance, correlation. Normal random variable and its properties. The central limit theorem.
Unit-II: Stochastic processes in discrete time, Binomial processes, Trinomial processes, General random walks, Geometric random walks. Binomial models with state dependent increments. Brownian motion.
Unit - III: Stochastic integration, Stochastic differential equations. The stock price as a stochastic process. Option pricing, Wiener processes. Derivatives, Forward contracts, spot price, forward price, future price, call & put options.
Unit - IV: Ito's lemma, Black-Scholes options pricing model, Binomial model for European options, Cox-Ross Rubinstein approach.
Unit - V: Numerical methods to solve Black-Scholes options pricing model. The arbitrage theorem and its applications, Basics of arbitrage.

Essential Readings:

1) Stanley L. S. (2012): A Course on Statistics for Finance, Chapman and Hall/CRC.

Suggested Readings:

1) Franke, J., Hardle, W.K. and Hafner, C.M. (2011): Statistics of Financial Markets: An Introduction, 3rd Edition, Springer Publications.

E book links: National Digital Library.

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

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L8 Sem-VII	**STAT-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 (Statistics)

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L8 Sem VIII	STAT-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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Department of [illegible]

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

Level & Semester	Course Code	Title of Course	Credits				Marks	Course Designer
			L	T	P	C		
L8 Sem VIII	STAT-DSM-812	Advanced Sampling Techniques	5	1	0	6	IA (Mid) - 40 EA (End Sem) - 60	Prof. D. Shukla

Lecture Hrs. 90

Learning Objectives:

(1) To understand the concept population and drawing appropriate sample.
(2) To learn various methods of drawing good samples and conducting field work.
(3) To learn procedure of getting the best method for sample estimate.
(4) To be aware of various sampling strategies.

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

CO1: Understand various types of sampling procedures and their mutual relative merits with adequate applications.
CO2: Student will be capable enough to design a questionnaire and perform field work as survey for data collection.

Unit Wise Learning Outcomes:

UO1. Aware about theory of advance procedure of sampling.
UO2. Learning of intense methods of stratification.
UO3. Understanding of PPS sampling.
UO4. Learning of use of auxiliary information in advance sampling
UO5. Awareness about randomized response techniques.

Unit – I: Concept of Fixed population and super-population approaches. Concepts and distinct features of probability sampling and non – probability sampling schemes, sampling designs and sampling error. Review of some important results in SRSWOR and SRSWR related to the estimation of population mean/total and proportions. Questionnaire Preparation and field work.
Unit – II: Estimation of population mean/total in stratified populations, Allocation problem in stratified random sampling (i) for fixed cost and (ii) for specified precision and corresponding expressions for variance of stratified sample mean. Post stratification, Deep stratification
Unit – III: Unequal probability sampling: PPSWR/PPSWOR methods of sample selection (including cumulative total method and Lahiri's scheme). Comparison of SRSWR and PPSWR schemes. Ordered estimators of Des Raj and Murthy (for n=2). Construction of unordered estimators from ordered estimators. Horvitz Thompson's estimator of a finite population total/mean. Expressions for variance of Horvitz Thompson's estimator and their unbiased estimators. Issue of negativity of estimated variance and its resolution.
Unit – IV: Double sampling scheme: Ratio, regression and product estimators in double sampling and their comparison with estimators with known population mean of auxiliary variable. Some unbiased ratio type estimators for population mean. Successive Sampling.
Unit –V: Concept of cluster sampling, two stage sampling with equal cluster sizes, interpenetrating sub-sampling. Kinds of non-sampling errors with special reference to non-response problems. Hansen and Hurwitz estimator for population mean. Concept of randomized response and some well-known randomized response techniques for sensitive characteristics.

Essential Readings:

1. Cochran, W.G.: Sampling Techniques (3rd edition. 1977), Wiley.
2. P.V Sukahtme, B.V. Sukhatme, S. Sukhatme and C.Asok: Sampling Theory of Surveys with Applications, ISAS Publication, New Delhi

Suggested Readings and Links:

1. Singh D. and Chaudhary, F.S. (1986): Theory and Analysis of Sample Survey Designs, New Age International
2. M.N. Murthy, Theory and Methods, Statistical Publishing Society, Calcutta
3. E-Books: National Digital Library

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

Level & Semester	Course Code	Title ofthe Course	Credits				Marks	Course Designer
			L	T	P	C		
L8 Sem VIII	**STAT-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
Department of Computer Science & Applications
Dr. H.S. Gour V.V. Sagar (M.P.)

Dr. Maheshwar Panda
Member & Assistant Professor
Department of Physics
Dr. H.S. Gour V.V. Sagar (M.P.)

Prof. R.K. Gangele
Chairman, School Board & Dean, SMPS
Dr. H.S. Gour V.V. Sagar (M.P.)

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