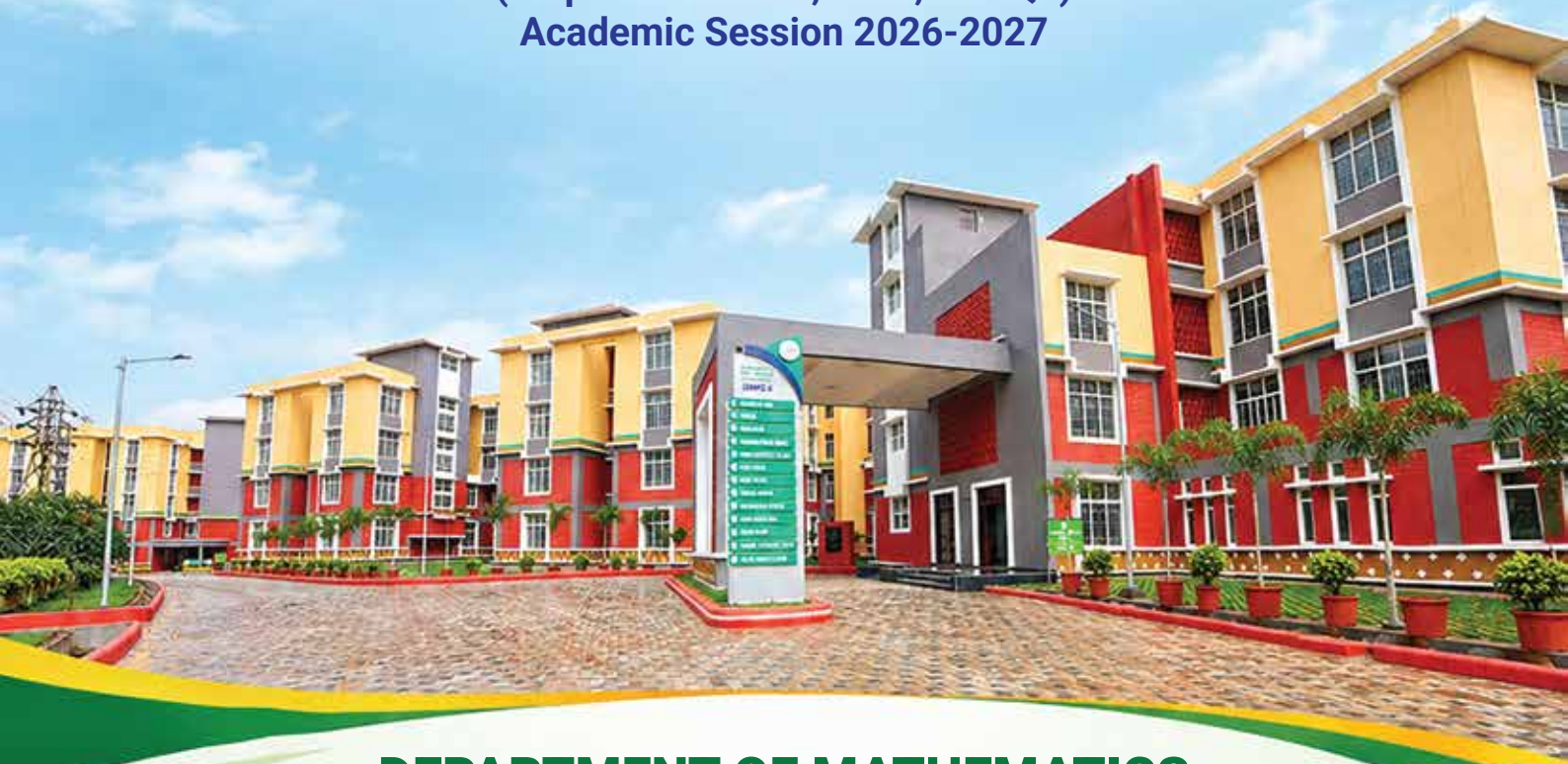
KISS

KALINGA INSTITUTE OF SOCIAL SCIENCES

CURRICULUM AND CREDIT FRAMEWORK FOR POSTGRADUATE PROGRAMME

MASTER OF SCIENCE (M.SC.) IN MATHEMATICS

(As per NEP-2020, NCrF, NHEQF)
Academic Session 2026-2027



DEPARTMENT OF MATHEMATICS

SCHOOL OF INDIGENOUS KNOWLEDGE, SCIENCE AND TECHNOLOGY

KALINGA INSTITUTE OF SOCIAL SCIENCES (KISS)
DEEMED TO BE UNIVERSITY

Higher Education Campus, KISS Campus-3, Bhubaneswar, Odisha, 751024
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I. About the Department / School and Programme

i.About the School

The School of Indigenous Knowledge, Science and Technology, KISS Deemed to be University, was established in 2017-18 with a view of Indigenous scientific knowledge and technological development in a symbiotic relationship with Nature. Indigenous people have an innate understanding of natural resources available in our ecosystem which was in a supinestate over the years. In the age of globalization, the tribes who are the real custodians of indigenous knowledge are far behind in the race of technological advancement.

Gradual developments of such people in varied facets of life enable them to explore their traditional knowledge for human welfare. As the over-exploitation of natural resources threatens the ecological balance and sustainable livelihood of tribal people, it is imperative to study our time-tested indigenous knowledge and tribal technology with greater vigour.

Hence, an innovative School –School of Indigenous Knowledge, Science and Technology – has been set up to promote, preserve and protect indigenous knowledge and implement it for sustainable development.

The importance of this School is to disseminate advanced knowledge by providing instructional and research facilities in tribal medicinal systems through physiochemical analysis, geosciences and their impact on the health conditions. The importance of gemology in their culture, Sutras

and sub-sutras of Vedic mathematics, a nutritional component of the food habit of tribes, intellectual property rights to preserve and conserve the biodiversity of indigenous people and advancement in technologies relating to the natural resources of the tribal areas as well as in other branches of learning as it may deem fit.

This could be possible by teaching innovative courses in Indigenous Knowledge and Intellectual Property Rights, Tribal Sports, Nutrition and Health Management, Indigenous People and the Science of Gemology and Vedic Mathematics. The courses attempt to examine indigenous knowledge and technology, blending both traditional and modern scientific methods from interdisciplinary and multidisciplinary approaches. The School of Indigenous Knowledge, Science and Technology constantly endeavors to improve the knowledge and practice content of its academic programme to match the local, regional, national and international standards.

This School has introduced four innovative interdisciplinary programmes viz. Physics, Chemistry, Mathematics and Computer Science with specialization in Indigenous Knowledge, Science and Technology in the first phase with the approval of UGC to provide impetus to research in Indigenous Knowledge, Science and Technology with multi-disciplinary education facility free of cost. Besides implementing Sustainable Development Goals of the United Nation, the school has been able to bring a bout the much needed socio-economic changes in the tribal hinter land of Odisha and its neighbouring states.

Because of the school's unique excellence to help the tribal students develop their vocational, entrepreneurial and lifeskills, it has been trying to break the vicious cycle of poverty and social isolation of tribal communities.The school also seeks to raise the consciousness of the tribal students that the people of their communities have a right to access varied indigenous resources and opportunities in order to live a self- sufficient, adequate and dignified life.

ii. About the Department

The **Department of Mathematics** at KISS Deemed to be University is a part of the **School of Indigenous Knowledge, Science and Technology (SIKST)**. The department is committed to providing quality education in mathematics while supporting the University's mission of empowering tribal and indigenous students through higher education, research, and innovation. KISS Deemed to be University, established in 2017 under Section 3 of the UGC Act, is the world's first university exclusively dedicated to the education of indigenous communities.

The department offers undergraduate and postgraduate programmes in Mathematics, with a curriculum designed to build strong theoretical foundations alongside practical and computational skills. The syllabus includes areas such as algebra, real and complex analysis, differential equations, linear algebra, numerical methods, vector calculus, probability, statistics, and mathematical modelling. Students are encouraged to develop analytical thinking, logical reasoning, problem-solving ability, and computational proficiency required for higher studies and professional careers.

The Department of Mathematics emphasizes innovative teaching methods, including classroom lectures, tutorials, seminars, assignments, projects, and the use of modern computational tools such as MATLAB and Python. Faculty members strive to create a student-centred learning environment that promotes conceptual understanding, critical thinking, and lifelong learning.

Research forms an integral part of the department's academic activities. Faculty members actively pursue research in various branches of pure and applied mathematics, including functional analysis, operator theory, summability theory, numerical analysis, linear algebra, and differential equations. The department encourages students to participate in seminars, workshops, conferences, and research projects to enhance their academic and research capabilities. The department also periodically reviews and updates its curriculum through its Board of Studies to align with contemporary developments in mathematics and the recommendations of the National Education Policy (NEP).

The department aims to produce competent graduates equipped with mathematical knowledge, computational skills, ethical values, and a scientific outlook. Graduates are prepared for careers in education, research, information technology, banking, finance, data science, government services, and higher education.

In line with the vision of KISS Deemed to be University, the Department of Mathematics is dedicated to academic excellence, social responsibility, and inclusive education. Through quality teaching, meaningful research, and community engagement, it contributes to the University's goal of empowering indigenous youth and promoting sustainable national development.

iii. Vision & Mission of the School

VISION:

Be an internationally acclaimed School, recognized for excellence in teaching, research, consultancy and outreach; skill development and social entrepreneurship for tribal youth by promoting Indigenous Science and Technology

MISSION:

1. Foster all-round development of students through multi-faceted education.
2. Focus on Indigenous Science and Technology with the help of innovative courses like Vedic Mathematics, Indigenous people and the Science of Gemology, Tribal Sports, Nutrition and Health Management, Indigenous Knowledge and Intellectual Property Rights.
3. Engage with local, national and global communities to get ideas about Indigenous Science and Technological applications for contemporary needs and problems and become successful in life.
4. Manage resources for self-employment and create employment for others.

II. M.Sc.in Mathematics Programme

The M.Sc. Mathematics with Specialization in Indigenous Knowledge, Science and Technology is a two-year postgraduate programme designed in alignment with the National Education Policy 2020, the National Credit Framework, the National Higher Education Qualification Framework (Level 8), and the UGC Curriculum and Credit Framework for Postgraduate Programmes (2023). The programme integrates core competencies in Mathematics with Indigenous Knowledge Systems, preparing students for advanced research, industry roles, entrepreneurship, and community-based innovation. Students develop strong foundations in both pure and applied mathematics like analysis algebra, differential equation, Numerical analysis, different mathematics software with different computer programming , while also exploring Indigenous scientific knowledge and its contemporary applications. Students get opportunities to develop core competencies in Mathematics and build successful careers in academia, research, industry and higher education. In addition, the curriculum incorporates lectures, case studies, field works, SWAYAM MOOC Courses, research projects and presentations are organized from time to time ensuring a holistic and experiential learning environment consistent with NEP 2020.

III. Process of Curriculum Development

The department of Mathematics under the School of Indigenous Knowledge, Scienceand Technology follows consultative process in the development of the course curriculum.

1. Formation of Syllabus Committee with domain experts.
2. Consultation with stakeholders (students, alumni, employers, community).
3. Review and approval by School faculty.
4. Vetting by Board of Studies (BoS) with external experts.
5. Final approval by Academic Council.
6. Integration of NEP-2020, CBCS, NCrF, and NHEQF guidelines.

IV. Definitions of Components

(i) '**Academic Programme'** means the entire course of study comprising its programme structure, course details, evaluation schemes etc. designed to be taught and evaluated in a teaching programme or jointly under more than one such programme.

(ii) **Course'** means a segment of a subject that is part of an Academic Programme.

(iii)**'Course Structure'** means a list of courses (Core, Specialization, Discipline Specific Elective, MOOCs/Open Elective and skill based) that makes up an Academic Programme, specifying the syllabus, Credits, hours of teaching, evaluation and examination schemes, minimum number of credits required for successful completion of the programme etc. prepared in conformity to University Rules, eligibility criteria for admission.

(iv) **'Core Course'** means a course that a student admitted to a particular programme must successfully complete to receive the degree and which cannot be substituted by any other course.

(v) **'Discipline Specific Elective'** Courses offered in the same Programme of the School.

(vi)**'Open Elective Course'**means an elective course which is available for students of all programmes, including students of same department and the students of other Programme will opt these courses.

(vii) **'Skill Enhancement Courses'** means the skill-based courses and are aimed at providing hands-on-training, competencies, skill- based knowledge.

(viii)**'Credit'** means the value assigned to a course which indicates the level of instruction; One hour lecture per week equals 1 Credit, 2 hours practical class per week equals 1 credit.

(ix) **'SGPA' means 'Semester Grade Point Average'** calculated for individual semester and 'CGPA' is 'Cumulative Grade Points Average' calculated for all courses completed

by the students at any point of time. CGPA is calculated each year for both the semesters clubbed together. To benefit the student a formula for conversation of Grand CGPA into percentage marks is given in the Transcript.

V. NCrF-Aligned Components (National Credit Framework)

Operational Definition of Credit (NCrF Standard)

"1 Credit = 30 Notional Learning Hours."

A standard 4-credit course = 120 Notional Learning Hours.

i) NCrF-Compliant Course Engagement Table

Component	Operational Definition	Hours (Example for 4-credit course)
Face-to-Face Lectures	**Concept delivery, interactive instruction**	**45**
Tutorials / Labs / Field	**Hands-on practice, experimentation**	**30**
Independent Self-Study	**Pre-reading, journal review**	**20**
Continuous Assessment	**Assignments, quizzes, mid-term**	**12**
Final Semester Exam Preparation	**Revision, project completion**	**13**
Total Notional Hours	**Must equal 30 hours × credits**	**120**

MOOC Courses (SWAYAM and SWAYAM Plus)

According to the UGC guidelines integrated into the new curriculum structures, Higher Education Institutions (HEIs) are permitted to allow students to take up to 40% of their total courses in a semester through the national MOOC platform, SWAYAM (or SWAYAM Plus for industry-aligned courses).

Credits earned via SWAYAM are mapped directly against the appropriate NHEQF academic level and digitally stored in the student's Academic Bank of Credits (ABC) to count toward their final degree, diploma, or certificate.

ii)NCrF Category Wise Credit Distribution (UGC CCFUP Compatible)

This programme is a two-year course divided into four-semesters. The course is of 90 credits and for the award of degree a student will be required to complete the credits as per the University norm.

Course Credit Scheme

Semester	Core Courses		IKS		Dissertation		Grand Total Credits
	No. Of Papers	Total Credits	No. Of Papers	Total Credits	No. Of Papers	Total Credits	
I	5	20	1	4			24
II	5	20	1	4			24
III	5	18	1	4			22
IV	-	-			1	20	20
Total Credits for the Course		58		12		20	90

These exit awards correspond to progressive NHEQF / NSQF levels and are fully NCrF-compliant for credit accumulation, mobility and re-entry through the Academic Bank of Credits.

Skill Enhancement Courses (SEC), Multidisciplinary Courses (MDC), value-added courses and internships are creditised as per NCrF, recognising vocational, experiential and community-based learning alongside academic coursework. These courses are designed at appropriate NSQF levels, with clear competency descriptors and notional hours.

VI. Eligibility for Admissions with No. of Seats

As per the admission guidelines and brochure of the KISS Deemed to be University.

VII. Examination Pattern: As per NEP 2020

The medium of examination is English which will be reflected in their final grade sheet/certificate. Provided that for a language subject answers are to be in that language. Sanskrit may be written in Odia script but language has to be Sanskrit.

(i) **Duration of the Examinations-Mid Semester & End Semester:**

Duration of examination for all term End examination shall be for 2.5 hours and for all Mid Term examination for 1 hour irrespective of full marks in the course/subjects and irrespective of credit. The practical examinations shall be of 2 hours duration.

Each School shall have a designated faculty as Examination Coordinator to be decided by the Vice Chancellor in addition to the Controller of Examinations of the University.

Continuous Evaluation and Mid Semester Examination:

a) Mid semester examination will be of 1-hour duration for 20/10 marks (20 for subjects having no practical and 10 for subject with practical papers). There shall be no pass mark in Mid Semester examination.

b) The Mid-Semester Examination shall be conducted and valued by the Faculty who are teaching the corresponding paper. A student who fails to appear in a Mid-Semester Examination **will be allowed one more chance to** take the same examination before appearing the concerned term-end examination. There will be no provision to re-appear in the Mid-Semester Examination for improvement.

c) For subjects with practical there will be a Mid-Semester practical examination carrying 10 marks.

d) The University authority of the valuation zones will preserve the answer Script of the End Semester examination for 06 months from the date of publication of the result for reference.

e) A student has to appear for the mid semester examination positively. Absence in the mid semester examination will be considered as fail however the candidate may be allowed to appear the mid semester examination before commencement of the concerned Term-End examination under special case duly considered by the HoD (for the ***candidates who represent the University or State for Inter- University or inter-state competitions in Games and Sports or attending different recognized National level camps/any critical medical case duly certified by the designated medical officer).***

(ii)**Distribution of Marks in End Semester and Continuous Evaluation:**
(Irrespective of credit in a course/Paper)

Course Type	Maximum Marks	Semester-End theory Mark	Continues Evaluation Marks /Sessional	Mid Semester theory Mark	Semester-End and Practical mark	Mid Semester Practical Mark
Without Practical	**100**	**60**	**20**	**20**	**----**	**--**
With Practical	**100**	**50**	**10**	**10**	**20**	**10**
Thesis/ Dissertation/ Seminar/Field Work	**100**	**------**	**-------**	**-------**	**-------**	**-------**

The **modes of evaluation** of **Thesis/ Dissertation/ Seminar/Field Work** shall be as follows:

Literature Review
Synopsis Presentation

Field Work / Data Collection and Data Analysis
Findings and Conclusions
Presentation and Viva-Voce

(iii)Distribution of Sessional Marks:(Continuous Evaluation)

Course Type	**Maximum Mark**	**Mid Semester**	**Attendance**	**Surprise Test/Quiz/Viva**	**Assignment/ Presentation**
Without Practical	**40**	**20**	**Above 95%- 5 Marks** **85%-94%- 4 Marks** **75%-84%- 3 Marks**	**10**	**05**
With Practical	**30**	(Theory 10 + Practical 10)=20		**05**	**Nil**

(iv) Examination Question Pattern of End Term Examination and Mark Distribution:

The evaluation process may cover summative and formative aspects and assess understanding applications, articulation, program and course outcome.

Question Pattern		With Practical	Without Practical
Part-I –Objective	Answer in MCQ/ in one word/in one sentence as directed	1x5=5	1x6=6
Part-II- Very Short Type	Answer within 50 words. Answer any 3 out of 5 questions (with practical) and Answer any 5 out of 7 question (without practical)	2x3=6	2x5=10
Part-III- Short Type	Answer within 250 words Answer any 3 out of 5 questions (with practical) and Answer any 4 out of 6 question (without practical)	5x3=15	5x4=20
Part-IV- Long Type	Answer within 800 words. Answer any 3 out of 5 questions	8x3=24	8x3=24
Total		50	60
For Practical Paper		One Major Experiment-10 Record- 05 Viva voce-05	---------

V.Examination Question Pattern of Mid Semester Examination and Mark Distribution

Question Pattern		With Practical	Without Practical
Part-I –Objective	Answer in MCQ/ in one word/in one sentence as directed	1x3=3	1x6=6
Part-II- Very Short Type	Answer within 50 words. Answer any 1out of 2 questions (with practical) and Answer any 2 out of 3 question (without practical)	2x1=2	2x2=4

Part-III- Short Type	**Answer within 250 words Answer any 1 out of 2 questions (with practical) and Answer any 2 out of 3 question (without practical)**	**5x1=5**	**5x2=10**
Total		**10**	**20**
For Practical Paper		**One Major Experiment- 5 Record- 02 Viva voce-03**	**---------**

VIII. Duration and Types of Courses and Process of Multiple Entry and Exit

NHEQF-Aligned Components (National Higher Education Qualifications Framework)

1. NHEQF Level Mapping for Multi-Entry / Multi-Exit

"This programme is structured according to the multi-entry, multi-exit parameters defined by UGC. The progressive qualification bands map directly onto the National Higher Education Qualifications Framework (NHEQF)."

Insert the following table:

Milestone / Year Completed	**Exit Award**	**NHEQF Level**	**Standard Credit Range**
Year 1 (Sem I–II)	Post Graduate Diploma	Level 6.0	48 Credit
Year 2 (Sem III–IV)	Master's degree in Mathematics	Level 6.5	90 Credits
	Doctoral Degree	Level 8.0	Credits for coursework and a thesis and published work

IX. Programme Educational Objectives (PEOS):

PEO1: **Employability**: Graduates will establish themselves as competent professionals in education, industry, government, finance, information technology, data analytics, and related sectors by applying mathematical

knowledge, analytical reasoning, computational skills, and problem-solving abilities to address real-world challenges..

PEO2: Entrepreneurship: Graduates will demonstrate entrepreneurial capabilities by creating self-employment opportunities, developing innovative mathematical and technological solutions, and contributing to sustainable livelihood generation, particularly within tribal and rural communities.

PEO3: Research Readiness: Graduates will pursue higher education, research, and professional development in mathematics and interdisciplinary domains, contributing to the advancement of knowledge through innovation, critical inquiry, and evidence-based problem-solving.

PEO4: Indigenous Knowledge Integration: Graduates will integrate mathematical concepts with indigenous knowledge systems and local practices to develop context-specific solutions, preserve cultural heritage, and contribute to the socio-economic empowerment of tribal and indigenous communities.

PEO5: Social Responsibility: Graduates will uphold professional ethics, social responsibility, and leadership qualities while addressing societal challenges through mathematical modelling, data-driven decision-making, and community-oriented initiatives that promote inclusive and sustainable development

X. Programme Outcomes (PO)

(Aligned with NEP-2020 Graduate Attributes; Schools may customize.)

PO1	Moral & Ethical Values	Apply ethical principles and commit to professional ethics and responsibilities and norms of the software professional practices
PO2	Disciplinary Knowledge	Acquire and apply the knowledge of mathematics and computer science to solve real life problems
PO3	Communication Skills	To develop an understanding of, and ability with the different forms of communication - writing, reading, speaking, listening-including visual and graphical, within science and beyond and the ability to apply these appropriately and effectively for different audiences.
PO4	Critical Thinking, Problem solving & analytical reasoning	Acquire an ability to think and work creatively, including the capacity for self-starting, and the ability to apply science skills to unfamiliar applications. It encompasses skills such as understanding risk management and risk-taking, "thinking outside the box", and questioning the norm to suggest new solutions for old problems. Develop an understanding of the scientific method of evidence-based knowledge acquisition, deduction, inference, and induction. Including problem-solving, critical thinking & analysis and the ability to discover new knowledge.
PO5	Indian Knowledge Systems (IKS)	Mathematics will be connected with astronomy, architecture, commerce, philosophy, and education in the Indian knowledge tradition. Students will appreciate the cultural, philosophical, and scientific contributions of Indian scholars to world mathematics.

PO6	Research-Related Skills	Use application-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO7	Cooperation/Teamwork	Function effectively as an individual, and as a member or in diverse teams, and in multidisciplinary settings
PO8	Digital Literacy	Create, select, and apply appropriate techniques, resources, and modern IT tools to model complex solutions with an understanding of their limitations.
PO9	Experiential & Life – long learning	Develop the capacity to engage in reflection and learning beyond formal educational contexts that are based on the ability to make effective judgments about one's own work and to undertake self-directed, curiosity motivated, learning. The capacity to learn in, and from, new disciplines to enhance the application of scientific knowledge and skills in professional contexts.
PO10	Leadership Qualities	To acquire skills to function as a leader which includes not only subject specific skills such as laboratory skills, computing skills or quantitative data handling skills, but also more generic skills such time management, personal organization, teamwork and negotiation.
PO11	Professional & Decision-making Skills	To acquire, develop, employ, and integrate a range of technical, practical and professional skills, in appropriate and ethical ways within a professional context, autonomously and collaboratively and across a range of disciplinary and professional areas.

PO12	Environment Awareness and Sustainability	To build an awareness of the role of science within a global culture and willingness to contribute to the shaping of community views on complex issues where the methods and findings of science are relevant. This includes an understanding of how science underpins society, the applications of science in different cultures and identifying and engaging with current and future challenges.

XI. Programme specific outcomes (PSOs) :

PSO1: Students would be able to recall facts and understand the basic concepts of Mathematics like Differential equations, Real Analysis, Complex Analysis, Functional Analysis, Abstract Algebra , Linear algebra ,Operation Research and Numerical Analysis. This program also applies and explains the ideas or concepts of those basics of Indigenous knowledge and management of resources

PSO2: Apply advanced mathematical techniques and logical reasoning to analyze, model, and solve complex problems in pure and applied mathematics..

PSO3: Use mathematical software and programming tools (such as MATLAB, Python, R, or Mathematica) for numerical computation, data analysis, and simulation.

PSO4: Apply mathematical concepts to interdisciplinary areas including physics, computer science, economics, statistics, data science, and engineering.

PSO5: Demonstrate readiness for careers in academia, research, teaching, analytics, finance, or competitive examinations through strong mathematical communication and ethical practices.

COURSE STRUCTURE FOR M.Sc. IN Mathematics

SEMESTER DETAILS: The Programme comprises of Four Semesters

Department of Mathematics
School of Indigenous Knowledge, Science and Technology

SEMESTER-I					
COURSE CODE	**NAME OF THE COURSE**	**CREDITS**			
		L	**T**	**P**	**TOTAL**
MT40001	Advanced Abstract Algebra	3	1	0	4
MT40003	Advanced Real Analysis	3	1	0	4
MT40005	Advanced Differential Equations	3	1	0	4
MT40007	Artificial Intelligence in Mathematics	3	1	0	4
IK40051	Scientific Research Methods	3	0	1	4
IK40053	Vedic Mathematics	3	1	0	4
	Total				**24 Credits**
SEMESTER-II					
COURSE CODE	**NAME OF THE COURSE**	**CREDITS**			
		L	**T**	**P**	**TOTAL**
MT40002	Partial Differential Equations and Transforms	3	1	0	4
MT40004	Complex Analysis	3	1	0	4
MT40006	Advanced Linear Algebra	3	1	0	4
MT40008	Functional Analysis	3	1	0	4
MT40010	Mathematical Methods	3	1	0	4
IK40052	Indigenous People and the Science of Gemology	3	1	0	4
	Total				**24 Credits**
Grand Total Credits					**48**
Exit Point: Postgraduate Diploma **Students who exist at the end of 1st year shall be awarded a Postgraduate Diploma**					
SEMESTER-III					
COURSE CODE	**NAME OF THE COURSE**	**CREDITS**			
		L	**T**	**P**	**TOTAL**
RM50001	Research Methodology	3	1	0	4
RE50003	Research and Publication Ethics	2	0	0	2
CA50005	Computer Application and Data Analysis	3	0	1	4
	Choose any two courses				
MT50031	Advanced Numerical Analysis	3	0	1	4
MT50033	Probability and Stochastic Process	3	1	0	4
MT50035	Optimization Theory	3	1	0	4
MT50037	Topology	3	1	0	4
IK50051	Indigenous Knowledge and	3	1	0	4

	Intellectual Property Rights				
	Total				**22 Credits**
SEMESTER-IV					
COURSE CODE	**NAME OF THE COURSE**	**CREDITS**			
		L	**T**	**P**	**TOTAL**
RT50082	Research Thesis	0	0	40	20
	Total				**20 Credits**
Grand Total					**90Credits**
Exit Point: Master's Degree **Students will be awarded PG degree in Mathematics if they secure 90 credits**					

Grand Total Credits = 78 + 12 = 90

*** One Credit = 1 hour for Theory classes (45 hours of lecture/tutorial)**

*** One Credit = 2 hours for Practical classes (30 hrs of practical)**

SEMESTER – I

Paper Code	Paper Name	Credits	L-T-P
MT40001	Advanced Abstract Algebra	4	3-1-0
MT40003	Advanced Real Analysis	4	3-1-0
MT40005	Advanced Differential Equations	4	3-1-0
MT40007	Artificial Intelligence in Mathematics	4	3-1-0
IK40051	Research Scientific Methods	4	3-0-1
IK40053	Vedic Mathematics	4	3-1-0

Course Code: MT40001
Course Title: Advanced Abstract Algebra

Total Credits: 04 (Credits: Theory-03, Tutorial-01)
Total Lectures: Theory- 45 and Tutorial-30

Course Learning Objectives: Students will be able to articulate and describe:

1 .Different algebraic structures like Groups, Subgroups, and special types of groups.

2. Algebraic structures like ring, types of rings with their properties

3. Algebraic structures like field and its properties

4. Some important results with their applications

Course Outcomes:

After completing this course the students will be able to:

CO1: Remember the concepts of group automorphism and its properties

CO2: Understand Parameters defining group, ring and field theory

CO3: Apply some important results like Sylow Theorems

CO4: Analyze Some results on roots of polynomials

CO5: Evaluate the different problems relating to the theorems.

CO-PO-PSO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	–	3	–	1	–	–	–	–	–	–	–	–	3	1	1	1	2
CO2	–	3	–	2	–	–	–	–	–	–	–	–	3	2	1	2	2
CO3	–	2	–	3	–	3	–	–	–	–	–	–	2	3	2	2	2
CO4	–	2	–	3	–	–	3	–	–	–	–	–	2	3	2	3	2
CO5	–	2	–	3	–	–	–	3	–	–	–	–	2	3	1	3	1

Course Duration: 45 hours

Course Inputs:

Unit - I : Group automorphism and its Properties(12 Classroom contact hours)

Automorphism, inner automorphism, automorphism groups, automorphism groups of finite andinfinite cyclic groups, applications of factor groups to automorphism groups. Characteristic subgroups. Commutator subgroup and its properties, Properties of external direct products, the group ofunits modulo n as an external direct product, internal direct products, Fundamental Theorem of finite abelian groups

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Unit-II : Group Actions and its applications(11 Classroom contact hours)

Group actions, stabilizers and kernels, permutation representation associated with a given group action, Application of group actions: Generalized Cayley's theorem, Index theorem. Groups acting on

themselves by conjugation, class equation and consequences, conjugacy in Sn, p – groups,Sylow's theorems and consequences, Cauchy's theorem, Simplicity of An for n ≥ 5,non–simplicity tests

Unit - III : Rings and its properties(11 Classroom contact hours)

Ring, Integral domain, Characteristic of an Integral domain, Homomorphism, Isomorphism, Ideals, Maximal ideal, Prime ideal, Quotient rings.

Unit - IV : Types of Rings(11 Classroom contact hours)

Euclidean rings, Gaussian integers, Polynomial rings, Principal ideal domain, unique factorization domain, Modules, Sub modules, Quotient modules, Direct Sums.

Unit-V:Galois Theory and Field Theory(11 Classroom contact hours)

The elements of Galois Theory, Solvability by Radicals, Galois groups over the Rationals .Extension of Fields, Transcendence of e, Roots of polynomials, construction with straight edge & compass, more about roots.

Recommended Learning Resources

Textbook:

1. Topics in Algebra, I.N. Herstein, Wiley India Pvt. Ltd, 2nd Edition, 2006.
2. Contemporary Abstract Algebra, Joseph A. Gillian, Cengage Learning, 9th Edition, 2017.

Reference Books:

1.Topics in Algebra, S. Nanda, Allied Publishers, New Delhi.

2.A First Course on Abstract Algebra, John B. Fraleigh, 7th Edition, 2008.

SDG Mapping

SDG NO.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Provides advanced conceptual knowledge, logical reasoning, and higher-order thinking skills essential for quality higher education.
SDG 9	Industry, Innovation and Infrastructure	Algebraic structures form the foundation for cryptography, coding theory, and technological innovation.

Course Code: MT40003
Course Title: Advanced Real Analysis

Total Credits: 04 (Credits: Theory-03, Tutorial-01)
Total Lectures: Theory- 45 and Tutorial-30

Course Learning Objectives: Students will be able to articulate and describe:

1 .Metric space, sequence and series of functions and its convergence .

2. continuity, uniform continuity and uniform convergence

3. Functions of several variables, Riemann integrals

4.. Lebesgue measure on the line, The L_P spaces,

Course Outcomes:
After completing this course the students will be able to:

CO1: Remember the concepts, nature and significance of Metric spaces

CO2: Understand Parameters defining Reimann integral, Lebesgue measure

CO3: Apply some important results on uniform continuity and uniform convergence

CO4: Analyse some results on The L_P spaces,

CO5: Evaluate the different problems relating to the theorems

CO-PO-PSO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	–	3	–	1	–	–	–	–	–	–	–	–	3	1	1	1	2
CO2	–	3	–	2	–	–	–	–	–	–	–	–	3	2	1	2	2
CO3	–	2	–	3	3	–	–	–	–	–	–	–	2	3	2	2	2
CO4	–	2	–	3	3	–	–	–	–	–	–	–	2	3	2	3	2
CO5	–	2	–	3	3	–	–	–	–	–	–	–	2	3	1	3	1

Course Inputs:

Unit – I: Introduction (10 Classroom contact hours)

Sequences of real numbers, Cauchy sequence, completeness, Bolzano Weierstrass theorem, Heine Borel's theorem, Series, convergence, tests of convergence Metric spaces, open sets, closed sets, Sequence and series of functions, uniform convergence, Weierstrass M Test, Weierstrass approximation theorem, Continuous functions, Definition and general properties, Uniform continuity, power series, Functions of bounded variation, Differentiation, properties , Mean value theorems, Taylor's theorem

Unit – II : Functions of several variables and Lebesgue measure(09 Classroom contact hours)

Functions of several variables, Differentiation in Rn, Partial derivatives, Directional derivatives, Jacobians, Contraction mapping principle, inverse function theorem, implicit function theorem, Lebesgue measure on the line, Outer measure, measurable sets, Properties of measurable sets, non measurable sets, measurable functions, simple functions, Lebesgue integration of simple and measurable functions, convergence theorems

Unit –III: Integration of vector valued functions (09 Classroom contact hours)

Integration of vector valued functions, rectifiable curves, equi-continuous families of function. The stone Weierstrass theorem , Fourier Series, Orthogonal and Orthonormal system of functions**.** Bersets inequality, Dirichlet-kernel, point wise convergence of Fourier series ,Approximation theorems,

Unit –IV : Basic properties of harmonic functions(09 Classroom contact hours)

Almost uniform convergence, Counter examples. Fourier Series. Parseval's theorem Harmonic function, Basic properties of harmonic functions, harmonic functions on a disk. Dirchlet problem, Green's function, Entire functions, Jensons Formula, Genus and order of an entire function, Hadmard factorization theorem

Unit – V : **L_P spaces and its properties(08 Classroom contact hours)**

The L_P spaces, convex function s, Jensen's inequality of Holder and Minkowski, Completeness of L_p, Convergence in measure, Almost uniform convergence, Counter examples. Fourier Series.

Text Books

1. Principles of Mathematical Analysis, Walter Rudin, Mc Graw Hill, 3rd edition, 1976.
2. G.De. Brra – Measure theory and integration (willey Eastern Ltd.),

References

1. S. Nanda and V.P Saxena, Real Analysis, Allied Publishers Pvt. Ltd. New Delhi 1999
2. Real Analysis, H.L. Royden, Prentice Hall of India, New Delhi, 3rd Edition, 1988

SDG Mapping

SDG NO.	SDG Title	Nature of Contribution

SDG 4	Quality Education	Strengthens advanced mathematical understanding, critical thinking, and rigorous proof techniques essential for quality higher education.
SDG 9	Industry, Innovation and Infrastructure	Provides analytical foundations used in scientific modeling, signal processing, data science, and technological innovation..

Course Code: MT40005
Course Title: Advanced Differential Equations

Total Credits: 04 (Credits: Theory-03, Tutorial-01)
Total Lectures: Theory- 45 and Tutorial-30

Course Learning Objectives: Students will be able to articulate and describe:

1 . Second order Linear Differential Equations.

2. Oscillations of second Order Equations

3. Existence and Uniqueness of Solutions

4.. System of Linear Differential Equation.

Course Outcomes:

After completing this course the students will be able to:

CO1: Remember the concepts, nature and significance of Differential equations

CO2: Understand Parameters defining ordinary differential equations and its solutions

CO3: Apply existence and uniqueness of solutions of differential equation

CO4: Analyze system of differential equations,

CO5: Evaluate the problems based on ordinary differential equations.

CO-PO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	–	3	–	1	–	–	–	–	–	–	–	–	3	1	1	1	2
CO2	–	3	–	2	–	–	–	–	–	–	–	–	3	2	1	2	2
CO3	–	2	–	3	3	–	–	–	–	–	–	–	2	3	2	2	2
CO4	–	2	–	3	3	–	–	–	–	–	–	–	2	3	2	3	2
CO5	–	2	–	3	3	–	–	–	–	–	–	–	2	3	1	3	1

Course Inputs:

Unit I: **Higher order differential equation(11 Classroom contact hours)**

exact Linear Differential Equations of nth order – condition of exactness for a linear equation of order n. Integrating factors. Non-linear differential equation of particular forms-exact non-linear differential equations. Riccati,s Equation, Homogeneous equations.

Unit II: **Boundary Value Problems(12 Classroom contact hours)**

Oscillations of second Order Equations*:* Fundamental Results, Sturm's Comparison theorem, Hille-wintner theorem, Oscillations of $x''+a(t)x=0$. Introduction, Strum Liouville Problem, Green's functions, Picard's theorem. Method of Characteristics, Transport Equation, Burgers Equation, Riemann problem, Lax-Oleinik Formulae, Entropy Solution

Unit III: Existence and Uniqueness of Solutions and series solution((11 Classroom contact hours)

Existence of solution, uniqueness of solution, method of successive approximation, system of differential equation, dependence of solution on initial condition and parameters, maximum and minimum solution, variation of solutions Series Solutions of second order Linear Differential Equations, Method of Frobenius, Total differential Equation- Necessary & Sufficient condition for the total Differential Equations,Solution of a Total Equation involving four variables

Unit- IV: System of Differential Equations (11 Classroom contact hours)

System of first order equations, Existence and Uniqueness theorems, Fundamental Matrix, Homogeneous and Non Homogeneous linear systems with constant Co-efficient, linear system with periodic Co-efficient.

Textbook:

1. G. F. Simmons, Differential Equations with Applications, McGraw Hill International Edition, 1991.

2. S. G. Deo and V. Raghavendra, Ordinary Differential Equations and stability theory, TATA Mc Graw Hill Ltd, 1980. Chapter 2 (Quick Review) 4,5,6,7.

Reference Books:

1. G. Birkhoff and G. C. Rota-Ordinary Differential Equations-John Wiley and Sons, N.Y., 1989.

2. Cardington and Levinson, Theory of Ordinary Differential Equations, Krieger Pub Co (June 1984)

3. Tyn-Myint-U Ordinary Differential Equations, Elsevier North-Holland, 1987.

SDG Mapping

SDG NO.	SDG Title	Nature of Contribution

SDG 4	Quality Education	Develops advanced analytical, problem-solving, and modeling skills essential for quality higher education and research.
SDG 9	Industry, Innovation and Infrastructure	Differential equations are fundamental to engineering systems, control theory, signal processing, and technological innovation...
SDG 13	Climate Action	Used in climate modeling, environmental dynamics, and sustainability-related simulations.

Course Code: MT40007

Course Title: Artificial Intelligence in Mathematics (Credits – 4)

Total Credits: 04 (Credits: Theory-03, Practical-01)

Total Lectures: Theory- 45 and Practical-30

Course Learning Objectives:

To provide students with an understanding of the mathematical foundations of artificial intelligence (AI) and how these principles can be applied to solve complex problems, enabling them to analyze data, develop AI models, and apply these techniques to various areas of research, while fostering critical thinking, analytical reasoning, and collaborative skills.

Course Outcomes*:*

CO1: Remember mathematical concepts and techniques used in AI to solve complex problems (Complex problem-solving

CO2: **Understand** AI models and algorithms for their mathematical soundness and effectiveness

CO3: **Apply** and **implement** AI-based solutions using mathematical principles and appropriate tools

CO4: **Analyze** effectively in teams to develop AI applications

CO5: **Evaluate** technical concepts and findings related to AI and mathematics clearly and effectively

CO-PO-PSO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	–	3	–	2	–	2	–	–	–	–	–	–	3	1	1	1	2
CO2	–	3	–	3	–	3	–	–	–	–	–	–	3	2	1	2	2
CO3	–	3	–	2	–	2	–	–	–	–	–	–	2	3	2	2	2
CO4	–	2	–	2	–	1	–	3	–	–	–	–	2	3	2	3	2
CO5	–	2	–	2	–	1	–	–	3	–	–	–	2	3	1	3	1

Syllabus:

Unit 1: Introduction to AI and Mathematics (9 classroom contact hours)

Overview of AI and its importance in mathematics, Mathematical foundations of AI: Linear algebra, calculus, probability, and statistics, Applications of AI in various fields,Basic concepts of data science and AI,Case studies of AI applications in mathematics

Unit 2: Linear Algebra and AI (9 classroom contact hours)

Vectors, matrices, and operations**,** Eigenvalues and eigenvectors**,** Singular value decomposition (SVD)**,**Principal component analysis (PCA)**,**Practical implementation using Python and R

Unit 3: Probability, Statistics, and AI (9 classroom contact hours)

Probability theory and distributions**,** Statistical inference and hypothesis testing **,** Bayesian networks and probabilistic graphical models**,** Markov decision processes (MDP)**,**Practical implementation using Python and R

Unit 4: Optimization Techniques in AI (9 classroom contact hours)

Optimization problems and methods**,** Gradient descent and its variant, Convex optimization **,**Lagrange multipliers and duality**,** Practical implementation using Python and optimization libraries

Unit 5: Advanced Topics and Applications (9 classroom contact hours)

Machine learning algorithms: Regression, classification, clustering, Neural networks and deep learning

Reinforcement learning,Ethical considerations and data privacy in AI research,Future trends and research directions in AI and mathematics

Exercises:

1. Implement basic matrix operations using Python.
2. Perform eigenvalue and eigenvector calculations.
3. Apply singular value decomposition (SVD) to a dataset.
4. Implement principal component analysis (PCA) for dimensionality reduction.
5. Calculate probabilities and statistical measures for a given dataset.
6. Perform hypothesis testing and statistical inference.
7. Develop a Bayesian network for a given problem.
8. Implement a Markov decision process (MDP) for decision making.
9. Solve an optimization problem using gradient descent.
10. Implement convex optimization techniques for a given problem.
11. Apply Lagrange multipliers to solve constrained optimization problems.
12. Develop a regression model using machine learning techniques.
13. Implement a classification algorithm for a dataset.
14. Perform clustering on a dataset and interpret the results.
15. Develop a neural network model for a prediction task.
16. Implement a reinforcement learning algorithm.
17. Evaluate the ethical implications of an AI application.
18. Collaborate on a group project to develop an AI application.
19. Write a report on the application of AI in a specific area of mathematics.
20. Present a case study on the use of AI in mathematical research.

Textbook:

- **"Mathematics for Machine Learning"** by Marc Peter Deisenroth, A. Aldo Faisal, and Cheng Soon Ong

Reference Books:

- **"Pattern Recognition and Machine Learning"** by Christopher M. Bishop
- **"Machine Learning: A Probabilistic Perspective"** by Kevin P. Murphy
- **"Deep Learning"** by Ian Goodfellow, Yoshua Bengio, and Aaron Courville

SDG Mapping

SDG NO.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Develops advanced mathematical and AI skills, critical thinking, digital literacy, and lifelong learning competencies.
SDG 9	Industry, Innovation and Infrastructure	Directly linked to AI applications, algorithm development, and innovation in computational and industrial systems..
SDG 8	Decent Work and Economic Growth	AI and mathematical modeling skills prepare students for innovation, research, and careers in technology-driven sectors..

Course Code: IK40051
Course Title: Scientific Research Methods
Total Credits: 04 (Credits: Theory-03, Practical-01)
Total Lectures: Theory- 45 and Practical-30

Course Objectives:

This course introduces students to the principles and methodologies of scientific research. It develops skills in research design, literature review, hypothesis formulation, data collection, statistical analysis, ethical research practices, scientific writing, and publication, enabling students to conduct independent, rigorous, and high-quality research in interdisciplinary scientific and technological domains.

Course Outcomes:

CO1 Recall and describe the fundamental concepts of scientific research, research methodologies, research ethics, literature review, hypothesis formulation, research design, and data collection techniques

CO2 Explain and interpret the principles of qualitative and quantitative research methods, sampling techniques, statistical analysis, experimental design, research ethics, intellectual property rights, and scholarly communication

CO3 Apply appropriate research methodologies, statistical tools, and data analysis techniques to formulate research problems, conduct scientific investigations, and interpret research findings.

CO4 Analyze research literature, evaluate experimental results, assess the validity and reliability of data, and critically examine scientific findings using appropriate analytical and statistical methods..

CO5 Design and conduct independent research by integrating scientific methodologies, ethical practices, statistical analysis, and academic writing skills to prepare research proposals, technical reports, dissertations, and research publications.

CO-PO-PSO Mapping (High-3, Medium-2, Low-1)

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	2	–	2	2	3	1	–	2	2	3	2	1	–	2	2	–
CO2	–	2	–	3	–	3	–	3	2	–	2	–	3	–	3	1	2
CO3	1	3	2	3	1	3	1	2	2	–	2	–	2	1	3	2	1
CO4	–	2	3	2	–	2	1	3	2	–	2	–	2	–	2	2	1
CO5	3	2	2	2	2	3	–	1	2	2	3	1	1	–	2	2	–

Course Content:

UNIT-I: Scope of Research (5 classroom contact hours)

Introduction, overview of research process: define research problem, review literature, formulate hypothesis, design research/experiment, collect and analyse data, interpret and report, scope and importance.

UNIT-II: Literature Survey, Databases and Research metrics (15 classroom contact hours)

Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, Digital: Databases and their responsible use: Google Scholar, Web of science, Scopus, UGC INFONET, SciFinder, PubMed, ResearchGate, E-consortium, e-books; Search techniques: Phrase, Field, Boolean, Proximity, Concept, Limiting/Refining Search Results. Research metrics: Impact factor of Journal, h-index, i10 index, Altmetrics, Citation index. Author identifiers/or profiles: ORCID, Publons, Google Scholar, ResearchGate, VIDWAN

UNIT-III: Communication in Science (13 classroom contact hours)

Types of technical documents: Full length research paper, book chapters, reviews, short communication, project proposal, Letters to editor, and thesis. Thesis writing – different steps and software tools (Word processing, LaTeX, Chemdraw, Chemsketchetc) in the design and preparation of thesis, layout, structure (chapter plan) and language of typical reports, Illustrations and tables, bibliography, referencing: Styles (APA, Oxford etc), annotated bibliography, Citation management tools: Mendeley, Zotero and Endnote; footnotes. Oral presentation/posters – planning, software tools, creating and making effective presentation, use of visual aids, importance of effective communication, electronic manuscript submission, effective oral scientific communication and presentation skills.

UNIT-IV: Ethical Practices in Research and Publication (12 classroom contact hours)

Scientific Conduct: Ethics with respect to science and research, Scientific Misconducts: falsification, fabrication and plagiarism, similarity index, software tools for finding plagiarism (Turnitin, Urkundetc), redundant dublications Publication Ethics: Introduction, COPE (Committee on Publication Ethics) guidelines; conflicts of interest, publication misconduct: problems that lead to unethical behaviour and vice versa, types, violation of publication ethics, authorship and contributorship, predatory publishers and journals IPR - Intellectual property

rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual property rights (TRIPS).

Practicals: **Credits: 01**

(Laboratory periods: 15 classes of 2 hours each)

1. Collection of journal articles on a particular topic using Google Scholar and creating a database.
2. Collection of journal articles on a particular topic using Science Direct and creating a database.
3. Collection of journal articles on a particular topic using Scopus and creating a database.
4. Drawing chemical structure, reactions and mechanisms using Chemsketch or ISIS draw or any other software.
5. Collection of chemical structure using ChemSpider and creating a database.
6. Curve fitting using freely available softwares/apps (any one)
7. Making of power point presentation
8. Technical writing on topics assigned.
9. Demonstration for checking of plagiarism using recommended software

Essential Readings:

1. Kothari, C. R. &Garg, G. (2019). *Research Methodology: Methods and Techniques* (4th Edition). New Age International Publishers, New Delhi.
2. Day, R. A. &Gastel, B. (2024). *How to Write and Publish a Scientific Paper* (9th Edition). Cambridge University Press..
3. Gopalakrishnan, S. (2019). *Patent Law and Intellectual Property*. Eastern Book Company, Lucknow.
4. Bird, A. (2020). *Understanding Scientific Method*. Routledge, London..
5. Wallwork, A. (2020). *English for Writing Research Papers* (2nd Edition). Springer Nature, Cham.
6. Resnik, D. B. (2020). *The Ethics of Research with Human Subjects: Protecting People, Advancing Science, Promoting Trust*. Springer Nature, Cham.

SDG Mapping

SDG No.	SDG Title	Rationale
SDG 4	Quality Education	Strengthens research skills, ethical awareness and scientific communication for higher education
SDG 9	Industry, Innovation & Infrastructure	Supports innovation through responsible research, data analysis and publication practices
SDG 16	Peace, Justice & Strong Institutions	Encourages integrity, transparency, accountability and trust in scientific research

Course Code: IK40053
Course Title: Vedic Mathematics
Total Credits: 04 (Credits: Theory-03, Tuorial-01)
Total Lectures: Theory- 45 and Tutorial-30

Course Learning Objectives: Students will be able to articulate and describe:
1. Mathematics in Vedas, different sutras and sub sutras
2. Knowledge on Arithmetic progression in Ancient India and different techniques
3. Mathematical numbers in Indian Tradition and different types of problems relating to Vedic sutras
4. Mathematical Concept in Tribal Tradition

Course Learning Outcomes:

After completing this course the students will be able to:
CO1: Remember Mathematics in Vedas, different sutras and sub sutras, examples of sutras and sub sutras.
CO2: Understand Arithmetic progression in Ancient India and different techniques. Simple equations,
CO3: Apply the Factorization, H.C.F, Partial fractions, differential calculus in Vedic mathematics.
CO4: Analyze the Development and meaning of "ethno mathematics", Numerals and naming systems.
CO-5: Evaluate the problems based on different sutras and sub sutras.

CO-PO-PSO MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3	PSO4	PSO 5
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2
CO2	-	3	-	-	-	-	-	-	-	-	-	-	2	-	-	-	2
CO3	-	3	-	2	3	-	-	-	-	-	-	-	-	-	-	-	2
CO4	-	-	-	-	-	-	3	-	-	-	-	-	-	2	-	-	2
CO5	-	-	-	3	-	-	-	-	-	-	-	-	-	2	-	1	1

Course Syllabus:

Unit-I Introduction to Vedic Mathematics and Ancient Arithmetic (11 classroom contact hours)

Introduction to Mathematics in Vedas, different sutras and sub sutras, examples of sutras and sub sutras. Basic Concepts of Ancient Arithmetic, development and their uses. Different operations in Vedic mathematics: Addition, subtraction, multiplication, division, square, square root, cube and cube root and Examples.

Unit – II Vedic Methods for Algebraic Equations and Arithmetic Progressions(11 classroom contact hours)

Knowledge on Arithmetic progression in Ancient India and different techniques. Simple equations, quadratic equations, Cubic equation, biquadrate equation, simultaneous equation in Vedic mathematics.

Unit – III Vedic Mathematics: Number Systems, Factorization and Calculus(12 classroom contact hours)

Mathematical numbers in Indian Tradition and different types of problems relating to Vedic sutras. Factorization, H.C.F, Partial fractions, differential calculus in Vedic mathematics.

Unit – IV Tribal Mathematical Traditions and Applications of Vedic Mathematics(11 classroom contact hours)

Mathematical Concept in Tribal Tradition: Ethno mathematics: development and meaning of "ethno mathematics", Numerals and naming systems, Mathematics in folk art,
Informal mathematics. Pythagoras theorem, integration by partial fractions, Apollonius theorem, Analytical geometry in Vedic mathematics

Suggested Readings:

1. Vedic Mathematics space book by S,.JK. Cosmic Kapoor- 2005

2. Vedic Arithmetic and Development of basic concepts Dr. K.P. Chamola – 2006 Arithmetic

SDG Mapping

SDG	Rationale
SDG 4	Strengthening foundational numeracy
SDG 10	Promoting equity through accessible methods
SDG 11	Preserving cultural heritage
SDG 17	Knowledge partnerships and cultural exchange

SEMESTER-II

COURSE CODE	NAME OF THE COURSE	CREDITS	L-T-P
MT40002	Partial Differential Equations and Transforms	4	3-1-0
MT40004	Complex Analysis	4	3-1-0
MT40006	Advanced Linear Algebra	4	3-1-0
MT40008	Functional Analysis	4	3-1-0
MT40010	Mathematical Methods	4	3-1-0
IK40052	Indigenous People and the Science of Gemology	4	3-1-0

Course Code: MT40002

Course Title: Partial Differential Equations and Transforms

Total Credits: 04 (Credits: Theory-03, Tuorial-01)
Total Lectures: Theory- 45 and Tutorial-30

Course Objectives: Students will be able to articulate and describe:

1. Basic methods for solving Partial Differential Equations first order and second order
2 Charpit's Method, Jacobi Method
3. Methods to solve wave equation, heat equation
4. Classification of Partial Differential Equation and boundary value problems

Course Outcomes:

CO1: Remember the first order Partial differential equations, Semi-linear and quasi-linear equations

CO2: Understand Cauchy problem, method of characteristics for quasi-linear and non linear partial differential equation

CO3: Apply Linear Second order partial Differential Equations

CO4: Analyze the Laplace equation , Boundary value problems

CO5: Evaluate the problems relating to Cauchy problem, linear second order partial differential equation and transform problems

CO-PO-PSO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	–	3	–	3	–	2	–	–	–	–	–	1	3	1	1	1	2
CO2	–	3	–	2	–	2	–	–	–	–	–	2	3	2	1	2	2
CO3	–	3	–	3	–	3	–	–	–	–	–	2	2	3	2	2	2
CO4	–	3	–	3	–	3	–	–	–	–	–	2	2	3	2	3	2
CO5	–	3	–	3	–	3	–	–	–	–	–	2	2	3	1	3	1

Course Inputs:.

Unit - I : **Introduction to Partial differential equation(12 classroom contact hours)**

Meaning of Partial differential equation, Classification of first order Partial differential equations, Semi-linear and quasi-linear equations, Pfaffian differential equations, Lagrange's method, Compatible systems, Charpit's method, Jacobi's method,

Unit-II : **Quasi-linear and non linear partial differential equation(11 classroom contact hours)**

Integral surfaces passing through a given curve, Cauchy problem, method of characteristics for quasi-linear and non linear partial differential equation, Monge cone, characteristic strip. First order non-liner equations in two independent variables ,Complete integral.

Unit - III :**Linear Second order partial Differential Equations (11 classroom contact hours 20 lectures)**

Origin of second order PDEs, Classification of Second order Partial Differential Equations., One dimensional Wave equation, Vibration of an infinite string, origin of the equation, D'Alembert's solution, Vibrations of a semi finite string, Vibrations of a string of finite length, existence and uniqueness of solution, Riemann method.

Unit - IV Boundary value problems(11 classroom contact hours)

Laplace equation , Boundary value problems, Maximum and minimum principles, Uniqueness and continuity theorems, Dirichilet problem for a circle, Dirichlet problem for a circular annulus, Neumann problem for a circle, Theory of Green's function for Laplace equation, Heat equation, Heat conduction problem for an infinite rod, Heat conduction in a finite rod, existence and uniqueness of the solution, Kelvin's inversion theorem, Equipotential surfaces.

Recommended Learning Resources

Textbook:

1. Ian Sneddon, Elements of Partial Differential Equations, International Students Edition.
2. Phoolan Prasad and Renuka Ravindran, Partial Differential Equations, New Age International, 1985.

Reference Books:

1.F. John - Partial Differential Equations, Springer-Verlag, New York, 1978.
2. Tyn-Myint-U - Partial Differential Equations North Holland Publication.

SDG Mapping

SDG NO.	SDG Title	Nature of Contribution
SDG 9	Industry, Innovation, and Infrastructure	PDEs and transforms are fundamental for modeling, simulation, and innovation in science, engineering, and technological infrastructure.
SDG 4	Quality Education	Develops advanced mathematical knowledge, problem-solving skills, and research orientation in PDEs and transforms
SDG 10	Reduced Inequalities	Encourages inclusive learning and equitable access to advanced mathematical education and resources.

Course Code: MT40004

Course Title: Complex Analysis

Total Credits: 04 (Credits: Theory-03, Tuorial-01)
Total Lectures: Theory- 45 and Tutorial-30

Course Objectives: Students will be able to articulate and describe:

1 . The theories for functions of a complex variable

2. Complex line integrals and Cauchy's theorem

3. Singularities and residues

4. The applications of the calculus of residues in the evaluation of integrals.

Course Outcomes:

After completing this course the students will be able to:

CO1: Remember the concepts ofcomplex number system and analytic functions

CO2: Understand the Complex line integrals and Cauchy's theorem

CO3: Apply the basics of Singularities and residues

CO4: **Analyze** the applications of the calculus of residues in the evaluation of integrals.

CO5: **Evaluate** the problems based on Cauchy integral formula and Cauchy theorem

CO-PO-PSO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	–	3	–	2	–	1	–	–	–	–	–	–	3	1	1	1	2
CO2	–	3	–	3	–	2	–	–	–	–	–	–	3	2	1	2	2

CO3	–	3	–	3	–	3	–	–	–	–	–	–	2	3	2	2	2
CO4	–	3	–	3	–	2	–	–	–	–	–	–	2	3	2	3	2
CO5	–	3	–	3	–	2	–	–	–	–	–	–	2	3	1	3	1

Course Inputs:.

Unit-I :**Complex Number and Conformal Mapping(12 Classroom Contact hours)**

The complex number system, The spherical representation, Analytic functions, Exponential and trigonometric functions, The Cauchy-Riemann equations, Power series, Functions defined by power series as holomorphic functions, The linear fractional transformations, Cross ratios and Conformal mappings.

Unit-II : **Complex Integrals (11 Classroom Contact hours)**

Complex line integrals and Cauchy's theorem, Cauchy's integral formula, The index of a closed curve, Cauchy's theorem for rectangle, Cauchy's theorem for disc, General form of Cauchy's theorem, Harmonic functions, Fundamental theorem of algebra, Morera's theorem, Open mapping theorem a Zeros of complex functions.

Unit-III : **Properties of Complex Integrals(11 Classroom Contact hours)**

Taylor's series, Laurent's series, Types of singularities, Calculus of residues, Evaluation of definite integrals, The argument principle, Rouche's theorem, The maximum modulus theorem and Schwarz's lemma.

Unit-IV: Application of Complex Analysis(11 Classroom Contact hours)

Normal families, Arzela's theorem, Product developments, Hadamard's theorem Riemann zeta functions, Riemann mapping theorem and Weriestrass' theorem.

Recommended Learning Resources

Textbook:

1.James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, Eighth Edition, Mc Graw Hill Education (India) Pvt. Ltd., 2017.

2. W. Rudin, Real and Complex Analysis, Third Edition, Tata McGraw- Hill Publishing Company Ltd., New Delhi.

3. J. B. Conway, Functions of One Complex Variable, Second Edition, Narosa Publishing House, New Delhi.(Sixteenth Reprint, 2002).

Reference Books:

.1. Lars V. Ahlfors, Complex Analysis, Third Edition, Mc Graw Hill Education (India) Pvt. Ltd., Chennai, 2016.

2.Robert E. Greene and Steven G. Krantz, Function Theory of One Complex Variable, Third Edition , American Mathematical Society (Indian Edition),Island, 2011

SDG Mapping

SDG NO.	SDG Title	Nature of Contribution
SDG 9	Industry, Innovation, and Infrastructure	PDEs and transforms are fundamental for modeling, simulation, and innovation in science, engineering, and technological infrastructure.
SDG 4	Quality Education	Develops advanced mathematical knowledge, problem-solving skills, and research orientation in PDEs and transforms
SDG 10	Reduced Inequalities	Encourages inclusive learning and equitable access to advanced mathematical education and resources.

Course Code: MT40006

Course Title:Advanced Linear Algebra

Total Credits: 04 (Credits: Theory-03, Tuorial-01)
Total Lectures: Theory- 45 and Tutorial-30

Course Objectives: Students will be able to articulate and describe:

1 . The concept of Vector Spaces, Subspaces

2. Solution of System of Linear equations

3. Concept of eigen values and Eigen vectors

4. Different canonical forms with examples

Course Outcomes:

After completing this course the students will be able to:

CO1: Remember the concept of Vector Spaces, Subspaces

CO2: Understand System of Linear equations, Characteristic roots

CO3: Apply the Diagonal forms, triangular forms, Jordan form, Quadratic form

CO4: Analyze the Euclidean space, unitary space

CO5: Evaluate the roots and of the system of linear equations.

CO-PO-PSO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	–	3	–	1	–	–	–	–	–	–	–	–	3	1	1	1	2
CO2	–	3	–	2	–	1	–	–	–	–	–	–	3	2	1	2	2
CO3	–	3	–	3	–	2	–	–	–	–	–	–	2	3	2	2	2
CO4	–	3	–	3	–	2	–	–	–	–	–	–	2	3	2	3	2
CO5	–	3	–	3	–	2	–	–	–	–	–	–	2	3	1	3	1

Course Inputs:.

Unit - I :**Vector space and its properties(12 classroom contact hours)**

Vector Spaces, Subspaces, Linear independence, bases, Dimension, Projection, Quotient spaces, Isomorphism of vector spaces, Algebra of matrices, Rank and Inverse of matrix, The Algebra of Linear transformation, Kernel, range, matrix representation of a linear transformation, Change of bases.

Unit - II : **System of Linear equations(11 classroom contact hours)**

System of Linear equations, Characteristic roots and Vectors, eigen values, eigen vectors, Cayley- Hamillton theorem, Annihilator, Modules, finitely generated module. Canonical forms .Canonical Forms: Diagonal forms, triangular forms, Jordan form, Quadratic form, Inner Product spaces.

Unit - III : **Canonical forms .(11 classroom contact hours)**

Diagonal forms, triangular forms, Jordan form, Quadratic form, Inner Product spaces, Nilpotent transforms, Index of nilpotent, A decomposition of V. Jordan form, Rational canonical form.

Unit-IV: **Unitary space and orthogonality (11 classroom contact hours)**

Euclidean space, unitary space, Cauchy –Schwartz inequality, orthogonal set, Orthogonal complement, orthogonal projection ,Bessel's inequality, Linear functional and adjoints, Linear operators, Unitary operator and Normal operators

Recommended Learning Resources

Textbook:

1.Ramachandra Rao and P. Bhimsankaram. Linear Algebra, Hindustan Book Agency; 2nd Revised edition edition

2. S. Kumaresan-Linear Algebra, Prentice Hall India Learning Private Limited; New title edition (2000).

3. P.P. Halmos - Finite Dimensional Vector Spaces, Springer; 1st ed. 1958. Corr. 2nd printing 1993 edition (August 20, 1993)

Reference Books:

4. N. Herstein - Topics in Algebra , John Wiley and Sons; 2nd Revised edition edition, 1975.

5. J. B. Fraleigh-A first Course in Algebra, Pearson, 7th Ed., 2013.

6. J. Gallian - Contemporary Abstract algebra, Brooks/Cole Pub Co; 8 edition (13 July 2012).

SDG Mapping

SDG NO.	SDG Title	Nature of Contribution
SDG 9	Industry, Innovation, and Infrastructure	Supports mathematical modeling, system analysis, optimization, and computational methods used in industry and technology
SDG 4	Quality Education	Strengthens mathematical foundations, analytical thinking, and problem-solving skills essential for higher education and lifelong learning
SDG 8	Decent Work & Economic Growth	Provides core skills required in engineering, data science, AI, finance, and research-based careers

Course Code: MT40008

Course Title: Functional Analysis

Total Credits: 04 (Credits: Theory-03, Tuorial-01)
Total Lectures: Theory- 45 and Tutorial-30

Course Learning Objectives: Students will be able to articulate and describe:

1. Different function spaces like Banach Spaces, Hilbert Spaces etc

2 Bounded and unbounded Linear Operators on Banach Spaces and its spectral Analysis

3.Solution of nonlinear equations, systems of linear equations, differential equations,

4.Riesz theorem; Hilbert adjoint operator and its basic properties.

Course Outcomes:

After completing this course the students will be able to:

CO1: Remember definition, examples and basic properties of normed spaces

CO2: Understand definition and basic properties of bounded linear operators

CO3: Apply Definition and basic properties of Inner product spaces

CO4: Analyze Hilbert spaces and finite dimensional normed spaces as examples of reflexive spaces

CO5: Evaluate different fixed point theorems

CO-PO-PSO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	–	3	–	2	–	2	–	–	–	–	–	–	3	1	1	1	2
CO2	–	3	–	3	–	2	–	–	–	–	–	–	3	2	1	2	2
CO3	–	3	–	2	–	3	–	–	–	–	–	–	2	3	2	2	2
CO4	–	3	–	2	–	3	–	–	–	–	–	–	2	3	2	3	2
CO5	–	3	–	3	–	3	–	–	–	–	–	–	2	3	1	3	1

Course Syllabus:

UNIT I :**Normed spaces(09 classroom contact hours)**

Definition, examples and basic properties of normed spaces; completeness and equivalence of norms on finite dimensional normed spaces; characterization of compact sets in finite dimensional normed spaces; Banach space (definition), L_p space. Cauchy-Schwarz Inequality, Minkowski's inequality, Holder's inequality.

UNIT II :**Linear operators on normed spaces(09 classroom contact hours)**

Definition and basic properties of bounded linear operators; connection between continuity and boundedness of linear operators; continuity of linear operators on finite dimensional spaces; completeness of normed space of operators; dual spaces of R^n and l^p spaces, Hahn Banach theorem and its extension for normed spaces and its consequences.

UNIT III : **Inner product spaces(IPS) (09 classroom contact hours)**

Definition and basic properties of IPS; Hilbert spaces; Riesz lemma; existence of minimizing vector; orthogonality; Projection theorem; orthogonal complement of a set and its basic properties; Bessel's inequality; total orthonormal sets; Parseval's relation; connection between separability and orthonormal sets; isomorphism of Hilbert spaces of same dimension.

UNIT IV :**Reflexive spaces and fundamental theorems(09 classroom contact hours)**

Reflexive spaces; Hilbert spaces and finite dimensional normed spaces as examples of reflexive spaces; separability of dual normed space as a sufficient condition for the separability of the normed space; Baire's theorem; uniform boundedness theorem and its application to space of polynomials; Open mapping and closed graph theorems.

UNIT V : **Fixed Point Theorems(09 classroom contact hours)**

Riesz theorem; Hilbert adjoint operator and its basic properties; basic properties of self adjoint, unitary and normal operators, Banach fixed point theorem.

Recommended Learning Resources

Textbook:

1. B. V. Limaye, Function Analysis Wiley Eastern Ltd

Reference Books:

1. B. Choudhary and S. Nanda, Functional Analysis with Applications. New Age International (P) Limited.
2. P. K. Jain, O.P. Ahuja, and K. Ahmed, Functional Anaysis, New Age International (P) Limited.
3. Bachman, G. and Narici, L., (1966), Functional Analysis, Academic Press New York.
4. Rynne, B. P. and Youngson, M. A., (2008), Linear Functional Analysis, 2nd edition, Springer.
5. Siddiqi, A. H., (2004), Applied Functional Analysis, Marcel-Dekker, New York.
6. I. J. Maddox, Elements of Functional Analysis, Cambridge University Press

SDG Mapping

SDG NO.	SDG Title	Nature of Contribution
SDG 9	Industry, Innovation, and Infrastructure	Supports mathematical modeling, operator theory, and functional frameworks applied in engineering, signal processing, and computational research
SDG 4	Quality Education	Develops abstract reasoning, analytical thinking, and problem-solving skills for advanced mathematics and lifelong learning
SDG 8	Decent Work & Economic Growth	Builds core skills required in analytics, data science, AI, finance, and research-based careers

Course Code: MT40010

Course Title: Mathematical Methods

Total Credits: 04 (Credits: Theory-03, Tutorial-01)

Total Lectures: Theory-45 and Practical-30

Course Learning Objectives: Students will be able to articulate and describe:

1. Concept of Laplace transforms and its application to PDE
2. Basic concepts of Volterra Integral Equations and its properties
3. Basic concepts of Fredholm Integral Equations and its properties
4. The concept of variation of a functional and its properties

Course Outcomes:
After completing this course the students will be able to:

CO1: Remember the concept of Laplace transforms and its application to PDE

CO2: Understand basic concepts of Volterra Integral Equations and its properties

CO3: Apply the basic concepts of Fredholm Integral Equations and its properties

CO4: Analyze the concept of variation of a functional and its properties

CO5: Evaluate the problems relating to Laplace transform, Volterra integral and fredholm integrals

CO-PO-PSO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	–	3	–	2	–	2	–	–	–	–	–	–	3	1	1	1	2
CO2	–	3	–	3	–	2	–	–	–	–	–	–	3	2	1	2	2
CO3	–	3	–	2	–	3	–	–	–	–	–	–	2	3	2	2	2
CO4	–	3	–	2	–	3	–	–	–	–	–	–	2	3	2	3	2
CO5	–	3	–	3	–	3	–	–	–	–	–	–	2	3	1	3	1

Course Inputs:.

Unit-I :**Laplace transforms(12 Classroom contact hours)**

Definitions, Properties, Laplace transforms of some elementary functions, Convolution Theorem, Inverse Laplace transformation, Applications. Fourier transforms, Definitions, Properties, Fourier Transforms of some elementary functions, Convolution, Fourier transforms as a limit of Fourier Series, Applications to PDE.

Unit-II : **Volterra Integral Equations(11 Classroom contact hours)**

Basic concepts, Relationship between Linear differential equations and Volterra integral equations, Resolvent Kernel of Volterra In- tegral equations, Solution of Integral equations by Resolvent Kernel, The Method of successive approximations, Convolution type equations, Solutions of integral differential equations with the aid of Laplace transformations.

Unit-III :**Fredholm Integral equations (11 Classroom contact hours)**

Fredholm equations of the second kind Fundamental, Iterated Kernel, Constructing the resolvent Kernel with the aid of iterated Kernels, Integral equations with degenerate Kernels, Characteristic numbers and eigen functions, solution of homogeneous integral equations with degenerate Kernel- non homogeneous symmetric equations Fredholm alternative.

Unit-IV : **Extremal of Functionals (11 Classroom contact hours)**

The variation of a functional and its properties , Euler's equations, Field of extremals, Sufficient conditions for the Extremum of a Functional conditional Extremum Moving boundary problem, Discontinuous problems, one sided variations, Ritz method.

Recommended Learning Resources

Textbook:

1.A. J. Jerri, Introduction to Integral Equations with Applications, John-Wiley & SONS, INC., 1999.

2. Gelfand and Fomin, Calculus of Variations, Dover Pub, 2003.

Reference Books:

1.Sneddon I., The use of Integral Transformations (Tata McGraw Hill), 1972.

2. Murray R Spiegel, Schaum's Series, Laplace Transforms, 1965.

3 Krasnov, Problems and Exercises in Calculus of Variations(Mir Publ), 1970

4. Ram P Kanwa, Linear Integral Equations (Academic Press), 2013.

SDG Mapping

SDG NO.	SDG Title	Nature of Contribution
SDG 9	Industry, Innovation, and Infrastructure	Supports modeling, simulations, and computational frameworks used in industrial and technological applications
SDG 4	Quality Education	Enhances analytical thinking, problem-solving skills, and mathematical knowledge for lifelong learning
SDG 8	Decent Work & Economic Growth	Builds mathematical and computational skills required in engineering, data analytics, AI, and scientific research

Course Code: IK40052

Course Title: Indigenous People and the Science of Gemology

Total Credits: 04 (Credits: Theory-03, Tutorial-01)
Total Lectures: Theory- 45 and Tutorial-30

Course Objectives

The main objective of this course is to look at the course in a more general way, then Gemology mainly involves topics related to the identification of gems, physical and chemical properties of gems, differentiating gems on the various basis, grading and assorting gems, processing them, and designing them for accessories etc.

Course Outcomes:

Upon successful completion of this course, students should be able to:

CO1. Acquire skills in gems mineralogy and genesis.
CO2. Acquire skills to identify and characterize different gemstones by means of physical and optical techniques.
CO3. Explain the physical and optical properties of gemstones
CO4. Apply the acquired knowledge for grading and engraving.
CO5. Explain the science behind different colours of gemstones and their healing effects

CO-PO-PSO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	–	3	–	1	–	1	–	–	–	–	–	–	3	1	1	1	2
CO2	–	3	–	2	–	1	–	–	–	–	–	–	3	2	1	2	2
CO3	–	2	–	3	–	2	–	–	–	–	–	–	2	3	2	2	2
CO4	–	2	–	3	–	2	–	–	–	–	–	–	2	3	2	3	2
CO5	–	2	–	3	–	2	–	–	–	–	–	–	2	3	1	3	1

Unit-I: Introduction to the world of Gemstones(08 classroom contact hours)

Ancient history of Gem stones, Mythology related to Gem stones, Use of Gems among indigenous people, Crystallography, study on crystal growth, formation of atomic lattice, origin and structure of gem stones, twinned crystal, Rough gemstone identification, knowledge of identification process

UNIT:2 Properties of Gemstones(07 classroom contact hours)

Physical and optical properties of gemstones, grading parameters of gemstones, various shapes and cutting of gemstones, Engraving on stones, drilled stones, Interlink of beauty, rarity, durability and its effect on valuation, Internal and external factors that affects valuation

UNIT:3 Colour and Healing Power(15 classroom contact hours)

The healing power of Gem stones, Tribal concept on Gemstones, Scientific approach of gemstones, Top gemstones with their colours and healing qualities, Science behind different

colours of gemstones and their healing effects, precious gemstones found in tribal areas. Tribal ornaments having gemstones, semi precious stones and their practical identification, organic gemstones, ornament making techniques in both traditional and modern, Ornament design, stones used in fine and fashion jewelers, rare stones collection

UNIT:4 Terminology and nomenclature(15 classroom contact hours)

Terminology and nomenclature of gemstones as per Indian and International markets, weights used in the gem trade, Market system of gems buying and selling, Gems and human race, Career and jobs, Scope in Gemology, Gemology as a tool for tribal development.

Text Books:

1. Colour encyclopedia of Gemstones by Joel. E. Arem
2. The Gemsstones Handbook by Arthur Thomas
3. Precious Stones, Vol-I & II: Max Bauer
4. Gemstones of the World: Walter Schumann
5. Gemology: Cornelius S. Hurlbut& Robert C Kammerling
6. Popular Gemology: Richard M Pearl
7. Dictionary of Gems and Gemology: Robert M Shiplley
8. Gemmolog: Peter G Read
9. Gem: Smiths Onian
10. Stoned: Jewellery,obsession: AjaRaden

SDG Mapping

SDG	Rationale
SDG 4	Education rooted in Indigenous knowledge
SDG 5	Gender roles in traditional gem practices
SDG 10	Empowering Indigenous communities
SDG 12	Sustainable resource use
SDG 15	Protecting natural mineral ecosystems
SDG 17	Partnerships with Indigenous communities

SEMESTER-III			
COURSE CODE	**NAME OF THE COURSE**	**CREDITS**	**L-T-P**
RM50001	Research Methodology	4	3-1-0

RE50003	Research and Publication Ethics	2	2-0-0
CA50005	Computer Application and Data Analysis	4	3-0-1
MT50031	Advanced Numerical Analysis	4	3-0-1
MT50033	Probability and Stochastic Process	4	3-1-0
MT50035	Optimization Theory	4	3-1-0
MT50037	Topology	4	3-1-0
IK50051	Indigenous Knowledge and Intellectual Property Rights	4	3-1-0

Course Code: RM50001

Course Title: Research Methodology

Total Credits: 04 (Credits: Theory-03,Tutorial-01)

Total Lectures: Theory- 45 and Tutorial-30

Course Objectives:

1. To equip students with the foundational principles and advanced techniques of research methodology
2. Enabling them to conduct and evaluate scientific research effectively, with a strong emphasis on ethical practices and innovation.

Course Outcomes:

On the completion of this course students should be able to demonstrate the acquisition of:
CO1: Know the formulation of research problems and plan for their structural study.
CO2: Understand the scope of collection of relevant data and their interpretations
CO3: Apply the use of various statistical analysis for decision making.
CO4: Apply different quantitative methods, statistical techniques and qualitative methods to collect and analyze the data.
CO5: Create the methodologies to build hypotheses and test them with appropriate methods.

Course Outcomes:

CO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	3	2	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	3	3	-	-
CO3	-	3	-	-	-	-	-	-	-	-	-	-	2	3	2	2
CO4	-	-	3	-	-	-	2	-	-	-	-	-	2	3	-	-
CO5	-	-	3	-	-	3	-	-	-	-	-	-	-	2	-	2

Course Inputs:

UNIT- I: Introduction To Research (09 Classroom Contact Hours)

Meaning of Research, Philosophy of Research, Motivation of Research, Importance and Scope of Research, Scientific Research Methods and its Application to Social Phenomenon Introduction to various aspects of research methods, Types of Research.

UNIT- II: Research Design and Data Collection (09 Classroom Contact Hours)

Research Design: Meaning, Need and features of a good design , Types of Research Design , Literature Review and its Importance, Steps in the Process of Research, Write a Research Proposal, Write qualitative research for publication/communication ,Sources and Methods of Data Collection

UNIT- III: Research Problem and Types (09 Classroom Contact Hours)

Research Problem, Research objectives and its Formulation, Fundamental research questions, Research Variables, Measurement and Scaling: Measurement in Research, Measurement Scales, Source of Error in Measurement, Test of sound Measurement: Reliability and Validity. Qualitative Research, Ethnographic Study, Observation, Case Study Method, Interviewing, Schedule, Mail Survey Method, Action Research: PRA and RRA, Focused Group discussion (FGD)

UNIT-IV: Statistics (09 Classroom Contact Hours)

Descriptive Statistics: Frequency Distribution, Relative, Percentage and Cumulative Frequency Distribution, Graph and Diagrams: Two Variables Graphs, Bar Diagrams, Pie Diagram, Pictorial Diagrams. Measures of Central Tendency: Mean, Mode, Median, Measures of Variability: Range, Standard Deviation, Coefficient of Variation, Normal Distribution: Basic Concept only, Standard Scores,Correlation: Correlation Coefficient and its properties, Linear Regression: Regression coefficients, Line of Regressions, Relation between Regression Coefficients and Correlation Coefficient., Rank Correlation Coefficient, Biserial Correlation Coefficient, Coefficient of Determination

UNIT-V: Sampling (09 Classroom Contact Hours)

Sampling: Need for Sampling, Methods of Probability Sampling and Non probability Sampling. Sampling and Non sampling ErrorHypotheses: Concept of Population, Sample, Parameter and Statistic, Concept of Hypothesis, Types of Hypotheses, Formulation of Hypothesis, Procedure of Testing of Hypothesis, Test of Significance, One- tailed and Two-tailed Test, Testing of Single Mean and Difference of Means, Parametric and Non parametric Test, Variable Analysis, Report Writing: Objective, Purpose of Report, Type of Reports, Report Writing Process, Guidelines for Effective Report Writing.

Recommended Learning Resources

Textbook:

1. "Kothari, C.R. Research Methodology, Methods and Techniques –Wiley Eastern Limited – New Delhi
2. Ahuja, R (2010), Research Methods, Rawat Publication, Jaipur.
3. Sondhi N, Chawla D.(2nd Edition), Research Methodology, Vikas Publication.

Reference Book:

1. "Creswell, John W (2009) Research design: qualitative, quantitative, and mixed methods approaches
2. Creswell, John W (2013) Qualitative inquiry and research design: choosing among five approaches
3. Garett, Henry, E Statistics in Psychology and Education – David Heley and Co.
4. Huberman, A. Michael (2002) Qualitative researcher's companion
5. Maxwell, Joseph (2005) Qualitative research design: an interactive approach
6. W.J. Goode and P. K. Hatt (1952) Methods in Social Research. Mc Graw Hill Co.

SWAYAM Course

Research Methodology - https://onlinecourses.nptel.ac.in/noc24_ge41/preview

SDG Mapping

SDG	Rationale
SDG 4	Research-based higher education
SDG 9	Strengthening scientific research capacity
SDG 12	Responsible consumption in research
SDG 13	Climate-aware scientific inquiry

Course Code: RE50003

Course Title: Research and Publication Ethics

Total Credits: 02 (Credits: Theory-02, Practical-01)

Total Lectures: Theory-30 and Practical-30

Course Objectives:

The objectives of this course are to:

1. This course is focusing on basics of philosophy of science and ethics, research integrity, publication ethics, Hands on sessions are designed to identify research misconduct and predatory publications.

2. Indexing and citation databases, open access publications, research metrics (citation, hi-index, impact factor etc.) and plagiarism tools will be taught in this course.

Course Outcomes: On the completion of this course students should be able to demonstrate the acquisition of:

CO1: Learn about basics of philosophy of science and ethics, research integrity.

CO2: Have awareness about the publication ethics and publication misconducts.

CO3: Learn about the publication related databases and various research related tools.

CO4: Develop knowledge about indexation and citation of publications.

CO5: Learn in and out of research publications.

CO-PO-PSO MAPPING:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO1	3	-	-	-	-	-	-	-	-	-	-	-	2	3	-	-
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	2	-
CO4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	3	-	2	-	-	-	-	-	-	-	-	2	-	2

Course Inputs:

UNIT- I Philosophy and Ethics (7 Classroom Contact Hours)

- Introduction of philosophy: Definition, nature and scope, concept, branches
- Ethics: Definition, moral philosophy, nature of moral judgments and reactions.

UNIT-II Scientific Conduct (7 Classroom Contact Hours)

- Ethics with respect to science and research,
- Intellectual honesty and research Integrity
- Scientific Misconducts: Falsification, Fabrication and Plagiarism (FFP)
- Redundant Publications: duplicate and overlapping publications, salami slicing
- Selective Reporting and misrepresentation of data

UNIT-III Publication Ethics (8 Classroom Contact Hours)

- Publication Ethics: Definition, introduction and importance
- Best practices/standards setting initiatives and guidelines: COPE, WAME etc.
- Conflicts of interest

- Publication misconduct: definition, concepts, problems that lead to unethical behaviour and *vice versa*, types
- Violation of publication ethics, authorship and contributor-ship
- Identification of publication, misconduct, complaints and appeals
- Predatory publishers and journals

Practice

UNIT-IV Open Access Publishing (8 Practical)

- Open access Publications and Initiatives
- SHERPA/RoMEO online resource to check publisher copyright and self-archiving policies
- Software tool to identify predatory publications developed by SPPU
- Journal finder/journal suggestion tools viz. JANE , Elsevier Journal finder, Springer journal suggester, etc.

UNIT-V Publication Misconduct (8 Practical)

A. Group Discussions
   i..Subject specific ethical issues, FFP, authorship
   ii. Conflicts of interest
   iii. Complaints and appeals: examples and fraud from India and Abroad
B. Software tools:
   i.Use of plagiarism software like Turnitin, Urkund and other open source software tools
   ii. Use of Referencing software like Mendeley, Zotero etc

UNIT- VI Data Bases and Research Metrics (7 Practical)

A. Databases
   i. Indexing Databases
   ii. Citation Databases: Web of Science, Scopus etc.
B. Research Metrics

i.Impact factor of journal as per Journal Citation Report, SNIP, SJR, IPP,Cite Score
ii.Metrics: h-index, g index, I 10 index, alt metrics

Textbook:

1. S. B. Kishor, A.S. Kushwaha, Research and Publication Ethics, Das Ganu Prakashan, Nagpur,

2. Y. Sharma., A. Sharma, Textbook of Research and Publication Ethics, Kalyani Publishers.

Reference Books:

1. The students' guide to Research Ethics by Paul Oliver Open University Press, 2003

2. Responsible conduct of Research by Adil E. Shamoo; David B. Resnik Oxford University Press, 2003

3. Anderson B.H., Dursaton, and Poole M.: Thesis and Assignment writing, Wiley Eastern 1997.

Swayam Link- https://onlinecourses.swayam2.ac.in/nou24_ge73/preview

SDG Mapping

SDG	Rationale
SDG 4	Quality research education
SDG 5	Gender-fair authorship
SDG 9	Ethical innovation
SDG 16	Justice, transparency, strong institutions

Course Code: CA50005

Course Title: Computer Application and Data Analysis
Total Credits: 04 (Credits: Theory-03, Practical-01)

Total Lectures: Theory-45 and Practical-30

Course Objectives:

1. Increase knowledge and requisite skills of participants on the use of SPSS
2. enable the students make the most of this powerful software package while allowing them to work independently with SPSS on their own data
3. Provide a solid foundation for advanced data analysis work.
4. Increase proficiency of scholars on the use of Basic computer Applications and SPSS.

Course Outcomes:

CO1: Remember basic computer hardware and software
CO2: Understand MS-office package for organized compiling and presentation and Learn using different analytical and research related software packages
CO3: Apply to formulate and test different hypothese
CO4: Understand the use of SPSS for data analysis and decision making
CO5: Evaluate the applications of programming

CO-PO-PSO Mapping:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	3	-	3
CO2	-	3	-	-	-	-	-	-	-	-	-	-	-	3	2	-
CO3	-	-	3	-	-	-	-	-	-	-	-	-	2	-	-	3

CO4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	-	-	3	-	3	-	-	-	-	-	-	-	2	-	-	2

Course Syllabus

Unit – I: Computer Basic and Computer Fundamental(11 classroom contact hours)

Hardware and Software. Functional units of computer. Operating Systems: Windows, Linux. Data communication and network topology, IP address, Internet, E-mail, and Web pages.

Unit-II: Microsoft word(10 classroom contact hours)

Creating and editing documents, formatting text and paragraph, formatting documents, creating and formatting tables, illustration documents with graphics. Creating a web page, mail merge. Working with charts and diagrams

Unit-III: Microsoft Excel(12 classroom contact hours)

Building and editing worksheets, formatting a worksheet, working with charts, working with formulas and functions, enhancing charts and worksheets Using analysis tools, analyzing data with pivot tables.

Unit-IV Microsoft PowerPoint (08 classroom contact hours)

Creating a presentation with Microsoft PowerPoint, modifying a presentation, inserting objects into presentation, finishing a presentation, enhancing charts, inserting illustration, objects and media clips.

Unit–V: SPSS (06 classroom contact hours)

SPSS, Descriptive Analysis: Mean, Median, Mode, Standard Deviation and Correlation. Regression Analysis, t-test, chi-square test, R- Square test, ANOVA using SPSS

List of Experiments(30 hours)

1. Create and format a **table** in Word with at least 5 rows × 5 columns; apply borders, shading, and sorting.
2. Perform a **Mail Merge**: prepare a personalized invitation letter using an Excel data source (name, address).
3. Build a **student mark sheet** with fields (Name, Roll, Subject Marks). Apply formulas for **Total, Average, Percentage, and Grade**.
4. Format the worksheet (merge cells, adjust column width, borders, number formatting). Apply **conditional formatting** (highlight marks <40 in red).
5. Create different **charts** (bar, pie, line) for student performance or sales data. Enhance charts with titles, legends, and labels.
6. Demonstrate **formulas and functions**:SUM, AVERAGE, MAX, MIN, COUNT, IF
7. Create a **PowerPoint presentation** (minimum 8 slides) on "Emerging Technologies in Computing." Include title slide, content slides, conclusion, and references.

8. Create a **PowerPoint presentation** (minimum 10 slides) on "Emerging Trends in Computer Science." Include:
    1. Slide designs, transitions, and animations
    2. Insert **images, charts, and SmartArt**
    3. Add **audio or video clips**
9. Input a dataset of student scores into SPSS. Perform **Descriptive Statistics**: Mean, Median, Mode, Standard Deviation, and Correlation. Generate graphs (histogram, scatter plot).
10. Using SPSS, perform **Hypothesis Testing**:
    - **t-test** for comparing two groups
    - **Chi-square test** for categorical data
    - **ANOVA** for comparing more than two groups
    - Report **R-square** and regression results with interpretations

Text Books:

1. Hari Shankar Asthana, BrajBhushan, Statistics for Social Sciences (With SPSS Applications, PHI Publication.
2. Jesus Salcedo, Keith Mccormick, SPSS Statistics for Dummies, 3rd Edition (Paperback), Wiley Publication.
3. Sabine Landau and Brian S. Everitt, A Handbook of Statistical Analysis Using SPSS

SDG Mapping

SDG	Rationale
SDG 4	Digital literacy
SDG 9	Data-driven innovation
SDG 10	Equity through unbiased data
SDG 17	Data for partnerships and policy

Course Code: MT50031

Course Title: Advanced Numerical Analysis

Total Credits: 04 (Credits: Theory-03, Practical-01)

Total Lectures: Theory-45 and Practical-30

Course Learning Objectives: Students will be able to articulate and describe:

1. Calculation of error and approximation is a necessity in all real life, industrial and scientific computing

2 Various methods of finding solution of different type of problems such as locating roots of equations

3. Solution of nonlinear equations, systems of linear equations, differential equations,

4. Evaluate approximate eigenavlues by using different methods

Course Outcomes:

After completing this course the students will be able to:

CO1: Remember the concepts of iteration methods based on first degree equations

CO2: Understand Lagrange and Newton interpolations, Finite differences

CO3: Apply the Methods based on Interpolation, Methods based on Finite Differentials

CO4: Analyze the Numerical Solution of system of linear equations

CO-5: Evaluate the problems based on iteration, Lagrange's interpolation, numerical solutions of linear differential equations

CO-PO-PSO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	–	3	–	1	–	–	–	–	–	–	–	–	3	1	1	1	2
CO2	–	3	–	2	–	2	–	–	–	–	–	–	3	2	1	2	2
CO3	–	2	–	3	–	–	–	2	–	–	–	–	2	3	2	2	2
CO4	–	2	–	3	–	–	–	2	1	–	–	–	2	3	2	3	2
CO5	–	2	–	3	–	–	–	–	–	1	–	–	2	3	1	3	1

Course Inputs:.

Unit-I : **Root finding for non-linear equations(11 Classroom Contact Hours)**

Solution of equations in one and two variables: Fixed point iteration method , Acceleration of convergence , Zeros of polynomials and Muller's method , Fixed points for functions of several variables, Newton's method

Unit-II: Interpolations(11 Classroom Contact Hours)

Lagrange and Newton interpolations, Finite differences, Interpolating polynomials using finite differences, Hermite interpolation, Piecewise and Spline interpolation. Approximations. Least

square approximation, Discrete L.S. approximation, Orthogonal polynomials, Chebyshev polynomials and economization, rational approximation.

Unit-III : **Differentiation: Methods based on Interpolation(11 Classroom Contact Hours)**

Methods based on Finite Differentials, Methods based on undetermined coefficients, optimum choice of step length, Interpolation method. Integration: Methods based on Interpolation (Trapezoidal rule, Simpson's rule), Method based on undetermined coefficients (Gausses Legendre Integration method, Lobatto integration method, Radon integration method, Gauss-chebysev Integration method (without derivation), Gauss Laguerre Integration method (without derivation), Gauss-Hermite Integration methods (without derivation), Composite integration methods. Approximation of multiple integrals : product rules , Rules exact for monomials , Radon formula for approximation of integrals in two dimensions .

Unit-IV :**Numerical Solution of system of linear equations(12 Classroom Contact Hours)**

Direct methods, Gauss Elimination methods, Gauss-Jordan Elimination method, Triangularization method, Cholesky method, Iteration methods(Jacobi iteration method, Gauss-Siedel iteration method, Iterative method for A^{-1}) Eigen value problems(Jacobi method for symmetric matrices) Givers Method for symmetric matrices, Rutishauser method for arbitrary matrices). Numerical solution of ordinary dif- ferential equation: Euler Method, Backward Euler method, Mid-point method, Single Step methods (Tayler series method, Rangekutta method(Second order, Fourth order method) .

Numerical Analysis Lab (30 hours)

List of Practical's (using any software)

1. Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + ----------+ 1/ N.
2. To find the absolute value of an integer.
3. Enter 100 integers into an array and sort them in an ascending order.
4. Bisection Method.
5. Newton Raphson Method.
6. Secant Method.
7. Regulai Falsi Method.
8. LU decomposition Method.
9. Gauss-Jacobi Method.
10. SOR Method or Gauss-Siedel Method
11. Lagrange Interpolation or Newton Interpolation.

12. Simpson's rule.

Textbook:

1.M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 6th Ed., New age International Publisher, India, 2007.

Reference Books:

1.Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.

2.C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008

3.Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7th Ed. , PHI Learning Private Limited, 2013.

4.John H. Mathews and Kurtis D. Fink, Numerical Methods using Matlab, 4th Ed.,

SDG Mapping

SDG NO.	SDG Title	Nature of Contribution
SDG 9	Industry, Innovation, and Infrastructure	Supports industrial modeling, algorithm development, and numerical optimization
SDG 4	Quality Education	Strengthens analytical thinking, numerical modeling, and higher-order problem-solving skills
SDG 7	Affordable & Clean Energy	Numerical simulation of energy systems, heat transfer, and optimization problems

Course Code: MT50033

Course Title: Probability & Stochastic Process

Total Credits: 04 (Credits: Theory-03, Tutorial-01)

Total Lectures: Theory-45 and Tutorial -30

Course Objectives: Students will be able to articulate and describe:

1 . Analysis of the outcome a random experiment and numerical probability

2. Sample space, Probability axioms, Conditional probability,

3. Poisson theorem, Interchangeable events and their limiting properties

4. Convergence of a sequence of random variables, Stochastic Processes, Discrete time Markov Chain

Course Outcomes:

After completing this course the students will be able to:

CO1: Remember the concepts of algebra of sets, Fields and Sigma fields

CO2: Understand Conditional probability and probability distribution

CO3: Apply Poisson theorem, Interchangeable events and their limiting properties

CO4: Analyze the convergence of a sequence of random variables

CO5: Evaluate the problems based on Stochastic Processes, Discrete time Markov Chain

CO-PO-PSO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	–	3	–	1	–	–	–	–	–	–	–	–	3	1	1	1	2
CO2	–	3	–	2	–	2	–	–	–	–	–	–	3	2	1	2	2
CO3	–	2	–	3	–	–	–	–	–	–	–	–	2	3	2	2	2
CO4	–	2	–	3	–	–	–	–	1	–	–	–	2	3	2	3	2
CO5	–	2	–	3	–	–	–	–	–	1	–	–	2	3	1	3	1

Course Inputs:.

Unit-I :**Introduction (09 Classroom Contact Hours)**

Algebra of sets, Fields and Sigma fields, Limits of sequence of subsets, Sigma field generated by a class of subsets, Borel fields. Probability space, continuity of probability measure.

Unit-II :**Random Variables and its properties(09 Classroom Contact Hours)**

Sample space, Probability axioms, Conditional probability, Independence of events. Bayes' theorem, Real and vector valued random variables, Distribution function, Discrete and continuous random variables, Distribution of L.V.S. Marginal and conditional distribution. Independence of random variables.

Unit-III :**Conditional Probability(09 Classroom Contact Hours)**

Poisson theorem, Interchangeable events and their limiting properties, Expectation of a ran- dom variable. Linear properties of expectations. Conditional expectation, Moment generating function. Moment inequalities. Characteristic function and its properties.

Unit-IV : **Convergence theorems of random variables(09 Classroom Contact Hours)**

Convergence of a sequence of random variables, Convergence in distribution, Convergence in probability, Almost sure convergence and Convergence in quadratic mean and their interrela-

tions. Monotone and dominated convergence theorem, Central limit theorem: Lindberg-Levy and Demoivre- Lapalce theorem.

Unit-V: **Introduction to Stochastic Processes(09 Classroom Contact Hours)**

Introduction to Stochastic Processes, Discrete time Markov Chain, Transition Probability Matrices, Recurrent and Transient states , Chapman Kolmogorov Theorems, Long run behavior of Markov Chain , Reducible and Irreducible , Examples- Inventory model, Urn Model, Random walk, Gambler's ruin, Applications to genetics , queueing. Poisson process, Distribution associated with Poisson process (Poisson Exponential, Gamma , Uniform) , Non Homogeneous and compound Poisson process .Continuous time Markov Chains, Pure birth process, Birth and Death process, Kolmogorov Differential Equations.

Textbook:

1.Probability, Statistics and Stochastic Processes for Engineers and Scientists *Aliakbar Montazer Haghighi, Indika Wickramasinghe & Emmanuel A. Appiah*

Reference Books:

1.M.A.Pinsky,S.Karling,"An Introduction to Stocastic Modeling",

2. S. M. Ross, "Introduction to Probability Models"

3. S.M. Ross , "Stochastic Processes"

4. V.K. Rohatgi , A. K .Saleh " An introduction to Probability and Statistics

This syllabus is designed to align with the requirements of UGC NET and GATE, ensuring that students gain both theoretical knowledge and practical skills in big data technologies.

SDG Mapping

SDG NO.	SDG Title	Nature of Contribution
SDG 9	Industry, Innovation, and Infrastructure	Reliability analysis, queuing systems, and stochastic industrial models
SDG 4	Quality Education	Enhances analytical thinking, uncertainty modeling, and higher-order reasoning skills
SDG 3	Good Health & Well-being	Stochastic modeling in epidemiology, disease spread, and healthcare systems

Course Code: MT50035

Course Title: Optimization Theory

Total Credits: 04 (Credits: Theory-03, Tutorial-01)

Total Lectures: Theory-45 and Tutorial -30

Course Learning Objectives: Students will be able to articulate and describe:

1. Basic concepts of Markov process, transition matrix,
2. Basic concepts of Inventory decision, cost associated with inventory
3. Basic concepts of Queuing system, Operating characteristic,
4. The concept of NLPP with constrained optimization

Pedagogy: Lectures, Power Point Presentation, Assignments, Case discussion, Projects and Seminars

Course Outcomes:
After completing this course the students will be able to:

CO1: Remember the concepts of Markov process

CO2: Understand basic concepts of Inventory decision, cost associated with inventory

CO3: Apply the basic concepts of Queuing system, Operating characteristic

CO4: Analyze the concept of NLPP with constrained optimization

CO-5: Evaluate the problems relating to Markov chain and Markov process.

CO-PO-PSO MAPPING

CO/PO	PO 1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	–	3	–	1	–	–	–	–	–	–	–	–	3	1	1	1	2
CO2	–	3	–	2	–	2	–	–	–	–	–	–	3	2	1	2	2
CO3	–	2	–	3	–	2	–	–	–	–	–	–	2	3	2	2	2
CO4	–	2	–	3	–	3	–	–	–	–	–	–	2	3	2	3	2
CO5	–	2	–	3	–	3	–	–	–	–	–	–	2	3	1	3	1

Course Inputs:.

Unit-I : **LPP and Its Duality (12 Classroom Contact Hours)**

:Introduction to LPP, Mathematical formulation, Standard form and canonical form, Graphical solution, Simplex Method including Big-M and two phase method, Degeneracy and Revised simplex method. Dual simplex method with justifications, Duality in Linear Programming, Duality Theorems, Fundamental Theorem of Duality, Transportation and Assignment algorithms

Unit-II : **Game Theory and Dynamic Programming(11 Classroom Contact Hours)**

Game Theory, Two persons zero sum game, Maxmin Minimax principle, Mixed strategy, Graphical solutions, Dominance Property, Arithmetic Method and general solution. Dynamic Programming: Principle of optimality, Reliability of system series, height of projectile, cargo-loading problem, inventory problem.

Unit-III : Queuing Theory(11 Classroom Contact Hours)

Queuing system, Operating characteristic, probability distribution, Classification of queuing models, Transient and Steady state, Poisson and Non-Poisson Queuing 35 System, Cost model in queuing, Queuing control, Queuing Theory and Inventory control.

Unit-IV: Non Linear Programming Problem(11 Classroom Contact Hours)

Formulation of Non Linear programming, Constrained optimization. with equal- ity constraint and inequality constraint, Saddle point and NLLP. Graphical solution, Kuhn- Tucker conditions, Quadratic Programming,Wolfes' and Beales' method.

Textbook:

1. Optimization Theory for Engineering – *S.S. Rao*
2. **Operations Research: An Introduction** – *Taha H.A.*

Reference Books:

1.. Kambo.,NS : Mathemetical Pro.gramming Tech., Affiliated East- West press,1991.

2. Hadley, G. , Linear Programming, Narosa, 1987.

SDG Mapping

SDG NO.	SDG Title	Nature of Contribution
SDG 9	Industry, Innovation, and Infrastructure	Optimization for industrial processes, logistics, supply chain, and infrastructure planning
SDG 4	Quality Education	Enhances analytical, problem-solving, and modeling skills through optimization techniques
SDG 7	Affordable & Clean Energy	Optimization of energy systems, resource allocation, and efficiency improvements

Course Code: MT50037

Course Title: Topology

Total Credits: 04 (Credits: Theory-03, Tutorial-01)

Total Lectures: Theory-45 and Tutorial -30

Course Learning Objectives: Students will be able to articulate and describe:

1. The basics of Topological spaces, Basis of topology,
2. Basic concepts Connectedness,
3. Understanding Limit point compactness, sequential compactness
4. Countability axioms Separation axioms
5. Tychonoff Theorem, Homotopy

Course Outcomes:
After completing this course the students will be able to:

CO1: Remember the concepts of topological spaces, Basis of topology,

CO2: Understand Concept Of Connectedness

CO3: Apply limit point compactness, sequential compactness,

CO4: Analyze countability axioms Separation axioms

CO-5: Evaluate the problems relating to topological spaces and connectedness

CO-PO-PSO MAPPING

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	–	3	–	1	–	–	–	–	–	–	–	–	3	1	1	1	2
CO2	–	3	–	2	–	2	–	–	–	–	–	–	3	2	1	2	2
CO3	–	2	–	3	–	2	–	–	–	–	–	–	2	3	2	2	2
CO4	–	2	–	3	–	3	–	–	–	–	–	–	2	3	2	3	2
CO5	–	2	–	3	–	3	–	–	–	–	–	–	2	3	1	3	1

Course Inputs:.

Unit-I :**Introduction to Topological spaces(10 Classroom Contact Hours)**

Metric space, open sets, closed sets, limit points, compactness and connectedness, Topological spaces, Basis of topology, Order topology, Product topology, Subspace topology Examples, Bases, Sub bases, , , Continuous functions. Quotient topology.

Unit-II: **Connectedness and compactness(09 Classroom Contact Hours)**

Connectedness, Local connectedness, Path-connectedness, compact Spaces, compactness in metric spaces, locally compacts spaces, compact open topology

Unit-III:Point set topology(09 Classroom Contact Hours)

Limit point compactness, sequential compactness and their equivalence in metric spaces, local compactness and one point compactification**.**

Unit-IV : **Countability axioms(09 Classroom Contact Hours)**

Separation axioms Regular & completely regular space, normal spaces, Urysohn Lemma, Urysohn metrization theorem

Unit-V :**Some important theorems(08 Classroom Contact Hours)**

Tychonoff Theorem, Homotopy, Homotopy equivalences, path homotopy Fundamental Group, covering space fundamental Group of S1.

Recommended Learning Resources

Textbook:

1.J.R. Munkres-Topology - A First Course in Topology, Pearson; 2 edition, 2000.

Reference Books:

1.. Dugundji - Topology, McGraw-Hill Inc.,US (1 April 1988)

2. Hu- Elements of General Topology, Holden-Day, 1964

SDG Mapping

SDG NO.	SDG Title	Nature of Contribution
SDG 9	Industry, Innovation, and Infrastructure	Applications of topology in networks, data structures, and algorithm design
SDG 4	Quality Education	Enhances logical reasoning, abstract thinking, and advanced mathematical skills
SDG 8	Decent Work & Economic Growth	Analytical and problem-solving skills applicable in research, data science, and technology

Course Code: IK50051
Course Title: Indigenous Knowledge and Intellectual Property Rights
Total Credits: 04 (Credits: Theory-03, Practical-01)
Total Lectures: Theory- 45 and Practical-30

Course Objectives: Students will be able to articulate and describe:

1. Intellectual Property Rights: Concept and meaning.

2. Indian Patent Law (a) The Patents Acts
3. Copyright, Neighbouring Rights and Industrial Designs. Introduction to Copyright

4.Geographical Indications: Concept of Appellations of Origin.

Course Outcomes:

Upon successful completion of this course, students should be able to:

CO1. Remember Intellectual Property Rights.
CO2. Understand the Indian Patent Law and related Patents Acts
CO3. Apply the Copyright, Neighbouring Rights and Industrial Designs.
CO4. Analyze the Geographical Indications
CO5:Evaluate the examples relating to industrial designs and patent acts.

UNIT:1

Introduction to Intellectual Property Rights: Concept and meaning.
Theories of Property - An Overview, Intellectual Property as an Instrument of Development
Introduction to Patent Law (a) Paris Convention (b) Patent Cooperation Treaty (c) WTO- TRIPS (d) Harmon

UNIT:2

Indian Patent Law (a) The Patents Act, 1970 (b) Amendments to the Patents Act (c) Patentable Subject Matter, Patentability Criteria (d) Procedure for Filing Patent Applications, Patent Granting Procedure (e) Revocation, Patent Infringement and Remedies (f) Relevant Provisions of the Biological Diversity Act, 2002 (g) Access and Benefit Sharing Issuesisation of CBD and TRIPs

UNIT:3

Copyright, Neighbouring Rights and Industrial Designs. Introduction to Copyright.

Indian Copyright Law: (a) The Copyright Act, 1957 with its amendments (b) Copyright works (c) Ownership, transfer and duration of Copyright (d) Renewal and Termination of Copyright (e) Neighbouring Rights (f) Infringement of copyrights and remedies

Industrial Designs (a) Need for Protection of Industrial Designs (b) Subject Matter of Protection and Requirements (c) The Designs Act, 2000 (d) Procedure for obtaining Design Protection (e) Revocation, Infringement and Remedies

UNIT:4

Geographical Indications, Layout designs of Integrated Circuits and Protection of Plant Varieties and Farmers' Rights.

Geographical Indications: Concept of Appellations of Origin, Indication of Source and Geographical Indication, The Geographical Indications of Goods, Infringement, Penalties and Remedies.

Layout-Designs of Integrated Circuits: Conditions and Procedure for Registration, Duration and Effect of Registration, Assignment and Transmission

The Protection of Plant Varieties and Farmers' Rights: The Protection of Plant Varieties and Farmer's Rights Act, 2001., Protection of Plant Varieties and Farmers' Rights, Registration of Plant Varieties and Essentially derived variety, Duration, Effect of Registration and Benefit Sharing, Farmers' Rights, Plant Varieties Protection Appellate Tribunal, Infringement, Offences, Penalties and Procedure

Text Books:

1. Arai, Hisamitsu. "Intellectual Property Policies for the Twenty-First Century: The Japanese Experience in Wealth Creation", WIPO Publication Number 834 (E). 2000. wipo.int
2. Bettig, R. V. (1996). Critical Perspectives on the History and Philosophy of Copyright. In R. V. Bettig, Copyrighting Culture: The Political Economy of Intellectual Property. (pp. 9–32). Boulder, CO: Westview Press.
3. Boldrin, Michele and David K. Levine. "Against Intellectual Monopoly", 2008. dkleving.com
4. Branstetter, Lee, Raymond Fishman and C. Fritz Foley. "Do Stronger Intellectual Property Rights Increase International Technology Transfer? Empirical Evidence from US Firm-Level Data". NBER Working Paper 11516. July 2005. weblog.ipcentral.info
5. Burk, Dan L. and Mark A. Lemley (2009). The Patent Crisis and How the Courts Can Solve It. University of Chicago Press. ISBN 978-0-226-08061-1.
6. Connell, Shaun. "Intellectual Ownership". October 2007. rebithofffreedom.org
7. De George, Richard T. "14. Intellectual Property Rights." In The Oxford Handbook of Business Ethics, by George G. Brenkert and Tom L. Beauchamp, 1:408-439. 1st ed. Oxford, England: Oxford University Press, n.d.
8. Farah, Paolo and Cima, Elena. "China's Participation in the World Trade Organization: Trade in Goods, Services, Intellectual Property Rights and Transparency Issues" in Aurelio Lopez-Tarruella Martinez (ed.), El comercio con China. Oportunida desempresariales, in certidumbresjurídicas, Tirant lo Blanch, Valencia (Spain) 2010, pp. 85–121. ISBN 978-84-8456-981-7. Available at SSRN.com
9. Farah, Paolo Davide, Tremolada Riccardo, Desirability of Commodification of Intangible Cultural Heritage: The Unsatisfying Role of IPRs, in TRANSNATIONAL DISPUTE MANAGEMENT, Special Issues "The New Frontiers of Cultural Law: Intangible Heritage Disputes", Volume 11, Issue 2, March 2014, ISSN 1875-4120Available at SSRN.com
10. Farah, Paolo Davide, Tremolada Riccardo, Intellectual Property Rights, Human Rights and Intangible Cultural Heritage, Journal of Intellectual Property Law, Issue 2, Part I, June 2014, ISSN 0035-614X, Giuffre, pp. 21–47. Available at SSRN.com

CO-PO-PSO MAPPING

CO/PO	PO 1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	–	3	–	1	–	–	–	–	–	–	–	–	–	–	–	–	2
CO2	–	3	–	2	–	2	–	–	–	–	–	–	–	–	–	–	2
CO3	–	2	–	3	–	2	–	–	–	–	–	–	–	–	–	–	2
CO4	–	2	–	3	–	3	–	–	–	–	–	–	–	–	–	–	2
CO5	–	2	–	3	–	3	–	–	–	–	–	–	–	–	–	–	1

SDG Mapping

SDG	Rationale
SDG 4	Education rooted in Indigenous knowledge
SDG 5	Gender roles in knowledge transmission
SDG 10	Empowering Indigenous communities
SDG 12	Sustainable resource use
SDG 15	Biodiversity and ecosystem protection
SDG 16	Justice and rights protection
SDG 17	Partnerships with Indigenous communities

Course Code: RT50082
Course Title: Research Thesis
(Credit-20)
Full Marks: 500 marks

Course objectives: The aim of this course is to provide a comprehensive understanding the nature of Anthropological research and make students acquainted with various types of data collection. This course also aims to able the students to make data analysis and writing report.

Field Work and Report Writing [600 Lab Contact Hours]

Field Work: Each student shall have to undergo training for learning and use of different techniques of scientific data collection during 30 days of fieldwork under the supervision of a teacher, as nominated by the head of the Programme, in a tribal/rural area. The Programme shall announce the exact date of commencement of fieldwork. Student failing to complete the fieldwork in a particular year can only clear the paper by completing fieldwork next year.

Dissertation is to be prepared by the student under the supervision of the concerned teacher. The student is required to submit the dissertation through the supervising teacher to the Head of the Programme for its evaluation at least fifteen days in advance of the date notified for examination. The dissertation shall be evaluated by an external examiner in consultation with the internal examiner (the supervising teacher). The candidate shall be awarded grade both by the internal and external examiners on the basis of his/her dissertation, seminar presentation and viva voice.

SL No	Mode of Evaluation	Credits
1	Selection of Research Topic and Synopsis Presentation	4
2	Literature Review and Preparation of Research Tools (Questionnaires and schedule)	4
3	Fieldwork and Data Collection	4
4	Data Analysis and Report Writing	4
5	Seminar Presentation and Viva voce test on dissertation	4
	TOTAL	20

The Dissertation has to be submitted by the student positively before the end semester examination.

Course Learning Outcomes:

CO 1: The students who successfully complete this course will understand the nature of anthropological research and develop their skills in various types of data collection, interpretation and presentation.
CO 2: After this course the students also able to explore different problems areas of human society, acquire skills in fieldwork, data analysis and report writing.
CO 3: This course will help the students to interpret both biological and social issues faced by the human societies.
CO 4: The students through this paper assess the data presentation and documentation in an effective way.
CO 5: Develop the capability of academic writing and publication of research findings.
Course Outcomes - Programme Outcomes Mapping of Paper RT50082

Course Outcomes ↓ / Program Outcomes →	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	2	3	2	3	2	3	1	3	3	3
CO2	2	3	2	3	3	3	2	3	3	3
CO3	2	3	2	3	2	2	1	3	2	2
CO4	2	3	3	2	2	3	1	3	3	3
CO5	2	3	3	3	2	3	1	3	3	3
Average	2.0	3.0	2.4	2.8	2.2	2.8	1.2	3.0	2.8	2.8

1 = Weakly Mapped (Low), 2 = Moderately Mapped (Medium),

3 = Strongly Mapped (High), "–" = There is No correlation

Suggested Readings:

1.Ahuja, Ram (2010), *Research Methods*. Jaipur: Rawat Publication.

2.Bauer M.W. & G. Gaskell (eds.). (2000). *Qualitative Research with Text, Image and Sound: 3.A Practical Handbook*. London, Sage Publications.

4.Bryman A. (1988). *Quantity and Quality in Social Research*. London, Unwin Hyman Ltd.

5.Bryman, A. (2001). *Surveying the Social World*, Buckingham. Philadelphia, Open University Press.

6.Denzin, N.K. & Y.S. Lincoln. (eds.). (2000). *Handbook of Qualitative Research*. New York, Sage.

7.Flick, U. (2009).*An Introduction to Qualitative Research* (4th Edition). London, Sage Publications.

8.Giddens, A. (1993). *New Rules of sociological Method* (2nd Edition).Stanford, California, Stanford University Press.

9.Grbich, C. (2004). *New Approaches in Social Research*. London, Sage Publications.

Gupta, C.B and Gupta, V. *An Introduction to Statistical Methods*, New Delhi: Vikas Publishing House PVT Ltd.

10.Huberman, A.M. & M.B. Miles.(2002). *The Qualitative Researcher's Companion*. New York, Sage Publications.

11.Kothari, C. R. *Research Methodology*, Methods and Techniques –Wiley Eastern Limited – New Delhi

12.Silverman, D. (ed.). (2011) *Qualitative Research* (3rd Edition).London, Sage Publications.

13.University of Chicago (2010). *The Chicago Manual of Style* (sixteenth ed.). Chicago: Univ. of Chicago Press.

14.W.J. Goode and P. K. Hatt (1952) *Methods in Social Research*. McGraw Hill Co.

Young, P.V. 1956. *Scientific Social Surveys and Research*. London: Prentice-Hall

SDGs Mapping of this course

SDG No.	SDG Title	Nature of Contribution
SDG 4	Quality Education	Develops research skills, fieldwork competence, and academic writing, promoting quality higher education
SDG 5	Gender Equality	Encourages gender-sensitive research design and inclusive data collection practices
SDG 8	Decent Work and Economic Growth	Enhances employability through research, analytical, and reporting skills
SDG 9	Industry, Innovation and Infrastructure	Promotes innovation through data analysis, research tools, and methodological applications
SDG 10	Reduced Inequalities	Supports research on marginalized communities and social disparities
SDG 12	Responsible Consumption and Production	Emphasizes ethical use of data, responsible research practices, and sustainability
SDG 16	Peace, Justice and Strong Institutions	Highlights research ethics, transparency, accountability, and evidence-based policy support
SDG 17	Partnerships for the Goals	Encourages collaborative and interdisciplinary research across institutions and communities

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