JAIPUR NATIONAL UNIVERSITY

A venture of The Seedling Group of Educational Institutions

Master of Science - Mathematics
(M.Sc. - Mathematics)

Distance Mode: Starts at Page 2

Online Mode: Starts at Page 71

PROGRAM PROJECT REPORT – M.SC - Mathematics – Distance Mode

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M.SC - Mathematics

1. Program Overview

1.1 Program's Mission and Objectives

The mission of the M.Sc Mathematics program is to provide students with a comprehensive education in advanced mathematical concepts, theories, and methodologies, preparing them for careers in academia, industry, or research. The program aims to cultivate a strong foundation in mathematical principles while promoting intellectual curiosity, creativity, and lifelong learning.

Program Objectives:

1. Advanced Knowledge:To equip students with advanced knowledge and understanding of various branches of mathematics, including but not limited to algebra, analysis, topology, geometry, and applied mathematics.

2. Critical Thinking:To develop students' ability to think critically and analytically about mathematical problems, concepts, and theories, enabling them to formulate and solve complex mathematical problems.

3. Research Skills: To foster research skills in students, including the ability to review literature, formulate research questions, design experiments, collect and analyze data, and draw meaningful conclusions, culminating in a thesis or research project.

4. Communication: To enhance students' communication skills, both written and oral, enabling them to effectively communicate mathematical ideas, results, and conclusions to diverse audiences, including peers, experts, and the general public.

5. Application of Mathematics: To demonstrate the application of mathematical concepts and techniques to real-world problems in various fields, such as physics, engineering, computer science, economics, and finance.

6. Interdisciplinary Perspective: To encourage interdisciplinary collaboration and application of mathematical methods to address problems in other disciplines, fostering innovation and creativity.

7. Ethical Conduct: To instil ethical values and professional integrity in students, emphasizing honesty, rigor, and accountability in their academic and professional endeavours.

8. Professional Development: To provide opportunities for professional development, including seminars, workshops, conferences, and internships, to prepare students for successful careers in academia, industry, or research.

9. Continued Learning: To promote lifelong learning and professional growth among graduates, encouraging them to stay updated with the latest developments in mathematics and related fields through self-directed study, continuing education programs, and participation in professional societies.

By aligning the curriculum, teaching methodologies, and assessment practices with these objectives, the M.Sc Mathematics program aims to produce graduates who are well-equipped to make significant contributions to the advancement of mathematics and its applications in the broader context of society.

1.2 Relevance of the Program with JNU's Vision and Mission

Jaipur National University (JNU) was established in 2007. JNU provides a world-class learning experience, with a highly accomplished faculty, numerous extracurricular activities, and a wide range of academic pursuits. The university fosters holistic development of students.

JNU with its vision to transform the Education Landscape of India and contribute to the maximum to improve the GER of India has plans to launch affordable and flexible education programs. Distance programs is an excellent way to launch affordable and flexible education programs in sync with the vision and mission of the university stated below:

University Vision:

To be a leader in creating unique and exclusive learning opportunities in all disciplines of study that ultimately lead to the advancement of learning and creation of a sustainable society and environment.

University Mission:

- Provide global opportunities of learning through broad and balanced academic programmes.
- Explore and hone the potential of stakeholders, develop their human and intellectual capacities to the fullest.
- Create and maintain excellence with high standard driven activities, universal significance and acknowledgement.
- Inculcate and keep track of the current trends and finest practices in education for constant growth and evolution.

1.3 Nature of Prospective Target Group of Students

The curriculum of M.SC - MATHEMATICS. is designed in such a way that it helps the students to become not only more employable but also encourage them to become entrepreneurs. Primarily the target group of learners will be:

- population living in remote areas where higher education institutes are not easily accessible.
- Learners who could not get admission in the regular mode due to limited intake capacity.
- Learners who are working and who desire to pursue higher education as a means for movement up the ladder.
- Learners who are unable to pursue Higher education due to social, financial and economic compulsions as well as demographic reasons.

1.4 Appropriateness of programs to be conducted in Distance mode to acquire specific skills and competence

The significance of the M.Sc Mathematics program lies in its ability to equip students with advanced mathematical knowledge and analytical skills, making them highly sought after in various industries and sectors. This program provides a deep understanding of mathematical principles, theories, and techniques, which are essential for solving complex problems in fields such as finance, engineering, computer science, and more. Graduates of this program are well-prepared for careers in research, academia, data analysis, cryptography, and numerous other areas where expertise in mathematics is valued. Additionally, the M.Sc Mathematics program contributes to the advancement of knowledge in mathematics and its applications, driving innovation and progress in diverse fields.

2. Procedure for Admission and Curriculum Transaction

The academic programs catered to candidates enrolled in the Distance mode of learning are facilitated by CDOE-JNU, with the backing of various faculties within the University. Eligibility criteria, course structure, detailed curriculum, program duration, and evaluation criteria are subject to approval by the Board of Studies and Academic Council, adhering to UGC guidelines for programs falling under the purview of Distance mode for degree conferment.

Below are the details of the admission procedure, eligibility criteria, fee structure, curriculum, program delivery, information about the Learning Management System (LMS), and assessments and evaluations.

2.1Procedure for Admission

Students who are seeking admission in programs offered by CDOE-JNUneed to apply through https://online.jnujaipur.ac.in/in the courses offered.

2.1.1 Minimum Eligibility Criteria for Admission

The minimum eligibility criteria for admission to the DistanceM.SC - MATHEMATICS program require candidates to hold a Bachelor's degree of a minimum duration of 3 years from a recognized University in any stream, in accordance with UGC and AICTE norms. Additionally, candidates must have secured at least 40% marks in the qualifying examination.

Candidates must also fulfill all documentation requirements as specified on the program's website for admission purposes. Failure to submit proof of eligibility within the stipulated timeframe specified by CDOE-JNU will result in the cancellation of admission. Prospective

candidates are encouraged to carefully review all instructions provided on the website before proceeding with the application process.

2.1.2 Admission Process and Instructions: Learner Communication

The admission process for the students is provided below:

Step	Process	Particulars
Step 1	**Counselling**	Prospective students will receive guidance and counseling for their chosen program from designated and authorized counselors.
Step 2	**Registration on admission portal to get access to My Account.**	They must then complete the application form by providing all necessary details and uploading mandatory documents.
Step 3	**Details of Document upload**	Student Uploads document as follows- <u>Personal Documents</u> Passport-size Photograph Student's Signature Aadhar Card (Back & Front) <u>Academic Documents</u> *UG Student -* 10th Marksheet 12th Marksheet *PG Student -* 10th Marksheet 12th Marksheet UG Marksheet Other Certificates (detailed list of documents is provided in **Annexure II**)
Step 4	**Verification of documents by the Deputy Registrar**	The Deputy Registrar is responsible for verifying all documents uploaded by prospective students on the admission portal. Within a timeframe of 48 hours, the Deputy Registrar will review and either approve or disapprove the eligibility of the prospective student for the chosen program.
Step 5	**Undertaking**	Student will sign Undertaking after Approval in Application.

Step 6	**Payment of fees**	All eligible students, duly approved by the Deputy Registrar, will get fees payment link activated in their My Account for payment. The Fee is payable through any of the following means: (a) UPI (b) Credit/Debit Card (c) Net-banking Note: Cash, bank demand draft and Cheques are not accepted
Step 7	**Enrolment**	After the payment of program fee, the eligible student will get the Enrolment number and access to the LMS within 21 days.
Step 8	**Access to Learning Management System (LMS)**	

General Instructions:

1. Prior to applying for Distance programs, all students are advised to thoroughly read and comprehend the eligibility conditions provided in the student handbook document and outlined on the university website.
2. It is the responsibility of prospective learners to ensure that their educational or qualifying degree has been issued by a recognized university or board only. For learners from Indian higher education institutions, recognition by the regulatory authority of the Government of India is necessary. To verify degrees from recognized boards of education, refer to www.cobse.org.in/. For Polytechnic Diploma, check the respective State Board of Technical Education. Verification of degrees from recognized universities can be done at www.ugc.ac.in/. Foreign prospective learners should verify their institutions at www.aiu.ac.in/.
3. Prospective learners must verify their eligibility on the date of admission and ensure that they have passed the qualifying exams before the commencement of the admission batch.

Upon enrollment, students must register with the Academic Bank of Credits (ABC), a central scheme for depositing credit formulated by the Ministry of Education, Government of India. Creation of an Academic Bank of Credits (ABC) ID is mandatory for all students. (Refer to Annexure V for details).

2.1.3 Program Fee for the Academic Session beginning July 2024

Program fees for students pursuing M.SC - Mathematics offered by CDOE-JNU is mentioned below:

Program	Academic Total Fees (INR)	Exam Fees
M.SC - Mathematics	**40,000**	**1500 per semester**

2.2 Curriculum Transactions

2.2.1 Program Delivery

The curriculum is delivered through Self Learning Materials (SLMs) in the form of e-Contents, supplemented by a variety of learning resources including audio-video aids via the Learning Management System (LMS). Furthermore, the program includes contact hours featuring synchronous live interactive sessions conducted through the LMS, adhering to the current UGC norms for course delivery.

2.2.2 Learning Management System to support Distance mode of Course delivery

The Learning Management System (LMS) is available on URL https://lms.jnujaipur.ac.in/users/login is meticulously developed to offer students a truly global learning experience. With a user-friendly interface, the LMS simplifies the learning process and ensures it meets the highest global standards. Utilizing audio-visual teaching methods, self-learning materials, and evaluation patterns, the platform stands out as unique and aligns seamlessly with both industry requirements and the UGC Guidelines.

Students can engage in uninterrupted learning 24x7 via web and mobile devices, allowing them to progress at their preferred pace. The LMS boasts a simple and intuitive user interface, facilitating easy navigation through the e-learning modules. Designed in accordance with standard norms, all learning tools are easily accessible, ensuring a perfect learning experience for all users.

2.2.3 Course Design

The curriculum is designed by a committee comprising experts from the parent department of the University and Industry experts, keeping in view the needs of the diverse groups of learners.

2.2.4 Academic Calendar for Academic Session beginning July 2024

Sr. No.	Event	Session	Month (Tentative)

1.	Commencement of semester	January	January
		July	July
2.	Enrol learner to Learning Management system	January	Within 21 working days from fee deposit and Eligibility confirmation
		July	
3.	Interactive Live Lectures for query resolution	January	February to May
		July	August to November
4.	Assignment Submission	January	By April
		July	By October
5	Project Report Submission (Wherever applicable during Final semester)	January	Last week of April
		July	Last week of November
6	Term End Examination	January	May onwards
		July	December onwards
7	Result Declaration of End Term Examination	January	By June
		July	By January

3. Instructional Design

3.1 Curriculum Design

The curriculum is meticulously designed by experts in the field of Mathematics, incorporating contemporary topics and fostering environmental awareness. It has received approval from the Board of Studies, the Centre for Internal Quality Assurance (CIQA), and the University Academic Council.

3.2 Program Structure and detailed Syllabus

3.2.1 Program Structure

Semester: I

Course code	Subject Name	Course Category	Hours Per Week			Credits	Evaluation Scheme		Total
			L	T	P		Int	Ext	
DMSMCO101T24	Calculus of variation and special functions	Core	4	0	0	4	30	70	100
DMSMCO102T24	Differential Equations	Core	4	0	0	4	30	70	100
DMSMCO103T24	Real Analysis	Core	4	0	0	4	30	70	100
DMSMCO104T24	C Programming	Core	4	0	0	4	30	70	100
DMSMCO104P24	C Programming Lab	Core	0	0	4	2	30	70	100
DMSMDS101T24	**Industrial Mathematics	DSE	4	0	0	4	30	70	100
DMSMDS102T24	*Hydrodynamics								
DMSMVA101T24	Waste water Treatment	VAC	2	0	0	2	30	70	100
	Select One from list	*GE/OE	2	0	0	2	30	70	100
	Total		**24**	**0**	**4**	**26**			

L: Lecturer, **T**: Tutorial, **P**: Practical **IA:** Internal Assessment, **ETE:** End Term Exam

*Students can obtain credits from MOOC. ** Students can obtain credits from University or from MOOC.

Sr. No	Subject Code	Name of Subject	Name of School
1	DMSMGE101T24	Productivity Tools	SCHOOL OF COMPUTER AND SYSTEM SCIENCES
2	DMSMGE102T24	Understanding Prescription, Doses and doses forms	SCHOOL OF PHARMACEUTICAL SCIENCES
3	DMSMGE103T24	Dining etiquettes	SCHOOL OF HOTEL MANAGEMENT AND CATERING TECHNOLOGY
4	DMSMGE104T24	Basics of Photography	SCHOOL OF MEDIA STUDIES
5	DMSMGE105T24	Mobile App Designing	SCHOOL OF ENGGINEERING AND TECHNOLOGY

Semester: II

Course code	Subject Name	Course Category	Hours Per Week			Credits	Evaluation Scheme		Total
			L	T	P		Int	Ext	
DMSMCO201T24	Numerical and Statistical Techniques	Core	4	0	0	4	30	70	100
DMSMCO202T24	Abstract Algebra	Core	4	0	0	4	30	70	100
DMSMCO203T24	Mathematical Programming	Core	4	0	0	4	30	70	100
DMSMCO204T24	Continuum mechanics	Core	4	0	0	4	30	70	100
DMSMCO201P24	Numerical & Statistical Techniques Lab	Core	0	0	4	2	30	70	100
DMSMDS201T24	Computer Application	DSE	4	0	0	4	30	70	100
DMSMDS202T24	Differential Geometry								
DMSMVA201T24	Biostatistics	VAC	2	0	0	2	30	70	100
	OE		2	0	0	2	30	70	100
	Total		**24**	**0**	**4**	**26**			

L: Lecturer, **T**: Tutorial, **P**: Practical **IA:** Internal Assessment, **ETE:** End Term Exam
Exit Option:-PG Diploma in Mathematics.
Min Credit 52.

Students can choose any one subject from the following list of subjects:

Sr. No	Subject Code	Name of Subject	Name of School
1	DMSMGE201T24	Website Designing	SCHOOL OF COMPUTER AND SYSTEM SCIENCE
2	DMSMGE202T24	Introduction to Epidemiology	SCHOOL OF PHARMACEUTICAL SCIENCES
3	DMSMGE203T24	Basics of Baking	SCHOOL OF HOTEL MANAGEMENT AND CATERING TECHNOLOGY
4	DMSMGE204T24	Videography	SCHOOL OF MEDIA STUDIES
5	DMSMGE205T24	Food Processing & Preservation	SCHOOL OF ENGGINEERING AND TECHNOLOGY

Semester: III

Course code	Subject Name	Course Category	Hours Per Week			Credits	Evaluation Scheme		Total
			L	T	P		Int	Ext	
DMSMCO301T24	Linear Algebra	Core	4	0	0	4	30	70	100
DMSMCO302T24	Mechanics	Core	4	0	0	4	30	70	100
DMSMCO303T24	Integral Transforms	Core	4	0	0	4	30	70	100
DMSMCO304T24	Advance differential equations	Core	4	0	0	4	30	70	100
DMSMCO305P24	Optimization Techniques Simulation Lab	Core	0	0	4	2	30	70	100
DMSMDS301T24	Viscous Fluid Dynamics	DSE	4	0	0	4	30	70	100
DMSMDS302T24	Combinatorics & Graph Theory								
DMSMVA301T24	Research Methodology	VAC	2	0	0	2	30	70	100
	OE		2	0	0	2	30	70	100
	Total		**24**	**0**	**4**	**26**			

L: Lecturer, **T**: Tutorial, **P**: Practical **IA:** Internal Assessment, **ETE:** End Term Exam

*Students can choose any one subject from the following list of subjects:

Sr. No	Subject Code	Name of Subject	Name of School
1	DMSMGE301T24	Basics Computer Networks - Everyone Must Know	SCHOOL OF COMPUTER AND SYSTEM SCIENCES
2	DMSMGE302T24	Public Health Pharmacy	SCHOOL OF PHARMACEUTICAL SCIENCES
3	DMSMGE303T24	Rajasthani and Punjabi cuisine	SCHOOL OF HOTEL MANAGEMENT AND CATERING TECHNOLOGY
4	DMSMGE304T24	Script writing for film	SCHOOL OF MEDIA STUDIES
5	DMSMGE305T24	Solar & Renewable Energy	SCHOOL OF ENGGINEERING AND TECHNOLOGY

Semester: IV

Course code	Subject Name	Course Category	Hours Per Week	Credits	Evaluation Scheme	Total

			L	T	P		Int	Ext	
DMSMCO401T24	Functional Analysis	Core	4	0	0	4	30	70	100
DMSMCO402T24	Integral Equations	Core	4	0	0	4	30	70	100
DMSMCO403T24	Complex Analysis	Core	4	0	0	4	30	70	100
DMSMCO404T24	Number Theory	Core	4	0	0	4	30	70	100
DMSMCO405P24	Dissertation	Core	0	0	12	6	30	70	100
DMSMDS401T24	Difference Equations and Sampling Theory	DSE	4	0	0	4	30	70	100
DMSMDS402T24	Mathematical Statistics								
DMSMVA401T24	Scientific Writing & Academic Integrating	VAC	2	0	0	2	30	70	100
	OE		0	0	2	2	30	70	100
	Total		**22**	**0**	14	30			

L: Lecturer, **T**: Tutorial, **P**: Practical **IA:** Internal Assessment, **ETE:** End Term Exam

Course Completion:-

Master of Science in Mathematics with minimum 108 Credits.

*Students can choose any one subject from the following list of subjects:

Sr. No	Subject Code	Name of Subject	Name Of School
1	DMSMGE401T24	End User Database Management System	SCHOOL OF COMPUTER AND SYSTEM SCIENCES
2	DMSMGE402T24	Social Pharmacy	SCHOOL OF PHARMACEUTICAL SCIENCES
3	DMSMGE403T24	Reception management	SCHOOL OF HOTEL MANAGEMENT AND CATERING TECHNOLOGY
4	DMSMGE404T24	Radio Jockey	SCHOOL OF MEDIA STUDIES
5	DMSMGE405T24	Industrial Safety & Hazard Management.	SCHOOL OF ENGGINEERING AND TECHNOLOGY (SADTM)

3.2.2 Detailed Syllabus of M.SC - MATHEMATICS

Detailed syllabus of M.SC - MATHEMATICS is attached in Annexure-I.

3.3 Duration of the Program

Program	Level	Duration	Maximum duration for completion	Credits
M.SC – MATHEMATIC	Master's Degree	2 years (4 Semesters)	4 Years	108

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3.4 Faculty and Support staff requirements (Refer Regulation Document for all Staff Details)

Academic Staff	Number available to meet the norms
Program Coordinator	1 Member
Course Coordinator	44
Course Mentor	1 Member per batch of 250 students

3.5 Instructional delivery mechanisms

JNU boasts a fully dedicated team of faculty members and staff proficient in delivering lectures through CDOE – JNU. At the commencement of each session, students will receive the academic calendar via the Learning Management System (LMS). The distribution of self-learning material, audio, and video content to students will be facilitated through the LMS via the following delivery channels:

- Self-Learning Material (Hard Copy will be provided to student)
- EBooks
- Study Guide
- Question Bank in Learning Management system - For Practice Test through LMS
- Audio / Video Component in Learning Management System
- Assignments (Submitted through Assignment Response Sheet)
- Personal Contact Program would be conducted at University Campus.
- Live Interactive Sessions would be conducted through the learning management system

3.6 Identification of media-print, audio, or video, online, computer aided

The Learning Management System (LMS) serves as a comprehensive digital platform, offering a multitude of features including recorded faculty video lectures, live sessions, e-content comprising study material, open source materials, and graded assessments.

For each module within a course, there will be one live session conducted by the respective faculty member, focusing on a specific topic. CDOE-JNU has curated study material that is clear and easily comprehensible, complete with concise summaries, self-assessment questions, and case studies.

Access to these course materials is facilitated through:

- Login credentials provided in the welcome email sent by the university
- Students can also log in via the University website at https://lms.jnujaipur.ac.in/

Courseware

Through the Learning Management System (LMS), students will have access to a comprehensive array of course materials mentioned above.

The Dashboard feature of the LMS serves to track and monitor students' learning progress. It includes functionalities such as:

- Monitoring progress in learning
- Comparing progress with peers
- Receiving regular notifications about upcoming Live Sessions, assignments, and examinations

3.7 Student Support Services

Students will have access to support services provided by CDOE-JNU through the Student Relationship Management (SRM) system for queries related to administration and general technical issues. A ticketing system integrated into the LMS will enable learners to connect with the CDOE-JNU technical team for support services, with resolutions handled by the appropriate authority. Notifications will also be sent to the Deputy Registrar to ensure queries are addressed within 24 hours or sooner.

For academic course-related queries, students can raise queries directly with the Course Coordinator, Program Coordinator, and Deputy Director. Queries should be resolved within 48 hours of being raised, with the Program Coordinator responsible for managing and resolving any unresolved matters. The Deputy Director will ensure the timely resolution of academic queries.

In addition to academic excellence, CDOE-JNU prioritizes the holistic development of its students. The department supports various initiatives to broaden students' opportunities and shape them into future leaders.

4. Assessment and Evaluation

4.1 Overview

The evaluation of students' learning will encompass internal assignments, quizzes, learner response sheets, and end-of-term examinations. CDOE-JNU follows a rigorous process in the development of question papers, creation of question and quiz banks, preparation and moderation of assignments, administration of examinations, analysis of answer scripts by qualified academics, and declaration of results. Question papers are meticulously framed to ensure comprehensive coverage of the syllabus.

The evaluation process will include two types of assessments:

Examination Name	Marks Division
Continuous internal assessment	30%
Summative assessment in the form of end-term examination. End-term examination will be held with proctored examination tool technology (follow **Annexure VI** for guidelines and pre-requisites for Proctored Examination)	70%

The examinations are designed to evaluate the knowledge acquired during the study period.

For theory courses, internal evaluation will be conducted through Continuous Internal Assessment (CIA), which includes assignments and quizzes. The internal assessment will contribute a maximum of 30 marks for each course.

At the end of each semester, an end-of-semester examination will be held for each course, lasting two hours.

Guidelines issued by the Regulatory Bodies from time-to-time about conduct of examinations shall be considered and new guidelines if any will be implemented.

4.2 Question Paper Pattern

Exam Time: 2 Hours

Max. Marks: 70

Exam will be comprising of 70 Multiple-Choice Questions (1 Mark Each) – 70 Marks

4.3 Distribution of Marks in Continuous Internal Assessments

The following procedure shall be followed for internal marks for theory courses. Weightage for Assignment is provided below:

Particular	A1 (MCQ Type)	A2 (MCQ Type)
Marks	15	15

Note: Refer to **Annexure VI** and **VII** for reference to the question paper pattern and formats of documents accepted.

Students may re-appear for CIA up to next two semesters and has to follow the same procedure. For the last semester the academic rules shall apply.

4.4 Statistical Method for the Award of Relative Grades

Letter Grade	Grade point	Range of Marks(%)
O (Outstanding)	10	90-100
A+ (Excellent)	9	80-89
A (Very good)	8	70-79
B+ (Good)	7	60-69
B (Above average)	6	50-59
C (Average)	5	40-49
P (Pass)	4	35-39
F (Fail)	0	0-34
Ab (Absent)	0	Absent

Abbreviations:

CO	Core Course	MM	Maximum Marks
DSC	Discipline Specific Course	MO	Marks Obtained
GE	Generic Elective Course	SE	Skill Enhancement
AE	Ability Enhancement	DSE	Discipline Specific Elective

4.4.1 Cumulative Grade Point Average (CGPA) and Semester Grade Point Average

Semester Grade Point Average (SGPA):

It is the summation of product of Credit Points and Grade Points divided by the summation of Credits of all Courses taught in a semester.

SGPA = $\Sigma C_i G_i / \Sigma C$

Where, G is grade and C. is credit for a Course.

Cumulative Grade Point Average (CGPA): $CGPA = \Sigma(C_i \times Si)/\sum c.$

Where, Si is the SGPA of the semester and Ci is the total number of credits in that semester.

The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Note:

- In case of any mistake being detected in the preparation of the Grade Statement at any stage or when it is brought to the notice of the concerned authority the University shall have the right to make necessary corrections.

4.4.2 Cumulative Grade Point Average (CGPA)

CGPA will be used to describe the overall performance of a student in all courses in which letter grades are awarded since his entry into the University or transferred from other University upto the latest semester as per the procedure provided in JNU Academic Regulations. It is the weighted average of the grade points of all the letter grades received by the student from his entry into the University or transferred from other University. Since multiple performance in a course in which the student has already received a grade is possible, whenever through such a process a new grade is obtained, it will replace the earlier one in the calculation of CGPA. On the other hand, if through this process merely a report emerges, this event by itself will not alter the CGPA.

A student's grades, reports, CGPA, etc. at the end of every semester/term will be recorded on a grade card, a copy of which will be issued to him. The grade card will be withheld if a student has not paid his dues or when there is a pending case of breach of discipline or a case of unfair means against him.

The faculty members also responsible for maintaining the complete records of each student's attendance, performance in different components of evaluation. If a scrutiny or statistical analysis becomes necessary, the above records and any other pertinent information should be made available by the faculty member of the course.

4.4.3 Conversion Factor

Formula for Conversion of CGPA to Percentage:

Percentage of marks = CGPA ^{x} 10

4.5 Grade card

All grades and reports and other pertinent information for a semester are given in a grade card which is a complete record of the outcome of what was intended in the original registration. The various grades and reports would be appropriately used to tally the grade card with the original registration.

Chronologically organized information from the grade cards of a student with the necessary explanation constitutes is transcript which is issued at the time the student leaves the University or at an intermediate point on request.

4.5.1 Grade cards and Certification – Student Communication

- The student can get soft copy of grade cards through the University website, the hard copy grade card would be provided only after successfully completion of full program along with degree certificate.
- Once the student completes all the mandated assignments, examinations and projects (if applicable) the final mark sheet/grade card and certificate would be dispatched by the University to the student registered address.
- All pending payments/dues need to be cleared by the student, before the final certification.

- If required, the University may request the mandatory documents from student as submitted during admission time, the students may have to re-submit the same if required during final degree certification.

Students need to apply for degree by filling the degree application form and submit all the required documents and the applicable degree processing application fees as mentioned in this document.

4.5.2Results, grade card and Degree Logistics–Internal Process

- After verification of all data by the Controller of Examination, the results would be published on the CDOE-JNU website.
- Students need to download and save the copy of semester / year wise results.

CDOE-JNU would provide hard copy grade cards and degree certificate at the end of the program to students who have successfully completed the program. Students who successfully completed the program will receive hard copy mark sheet/grade cards and a degree certificate from the University at the end of the program. A provision for On Demand Mark Sheets can be provided wherein student would have to fill the requisition and pay postal charges enabling university to dispatch the hard copy marksheets as requested by the student; prior to completion of the overall program.

5. Requirement of the Laboratory Support and Library Resources

5.1 Laboratory Support

Jaipur National University offers access to state-of-the-art laboratories equipped with the latest tools and resources necessary for research and analytical work. The laboratory support at JNU aims to foster a robust research environment, encouraging students to develop essential skills required for their academic and professional growth.

5.*2 Library Resources*

The Central Library at CDOE-JNU offers a comprehensive range of sections, including reference, circulation, audio-visual, periodical, book-bank, digital library, and reprographic sections. With a collection exceeding 1,00,000 books, the library also provides access to e-journals, online databases such as Scopus and Web of Science, and institutional repositories featuring rare book collections. University has 449 subscriptions of online and offline Journals. Equipped with modern facilities like reading rooms, computer labs, and quiet study areas, the library fosters a conducive

environment for learning and intellectual growth. Additionally, the library frequently organizes workshops, seminars, and exhibitions to enhance academic engagement and promote a culture of continuous learning.

All electronic resources can be accessed seamlessly through the Local Area Network (LAN) on campus, as well as remotely via login credentials. This ensures convenient access to resources for students, faculty, and researchers both on-site and off-site.

6. Cost Estimate of the Program and the Provisions

The Estimate of Cost & Budget could be as follows (all figures on Annual basis) :

Sl. No.	Expenditure Heads	Approx. Amount
1	Program Development (Single Time Investment)	30,00,000 INR
2	Program Delivery (Per Year)	2,00,000 INR
3	Program Maintenance (Per Year)	5,00,000 INR

7. Quality Assurance Mechanism

The quality of a program hinges upon the course curriculum, syllabus, and academic delivery, all of which are meticulously designed to bridge the gap between industry standards and academia. To uphold this standard, the Centre for Internal Quality Assurance (CIQA) and the Academic Council play crucial roles.

The Academic Council is entrusted with ratifying the curriculum and any proposed changes recommended by CIQA to ensure the continual enhancement and maintenance of quality in education at CDOE-JNU.

The Centre for Internal Quality Assurance (CIQA) is tasked with several responsibilities:

(i) Conducting periodic assessments of learning course materials and audio-video tutorials to maintain the quality of learning.

(ii) Soliciting stakeholder feedback and implementing recommended changes to meet the evolving needs of course delivery and industry requirements.

(iii) Evaluating the quality of assignments, quizzes, and end-term assessments and providing suggestions for enhancements to sustain the learning program's standards.

(iv) Ensuring that the learning experience is truly global, aligning with program outcomes and reflecting the vision and mission of JNU.

The Chief Operating Officer (CoE) of the University oversees examinations and the evaluation system to ensure fairness and integrity in the assessment process.

CDOE-JNU is committed to continual improvement, striving to enhance processes, assessments, teaching methodologies, and e-learning materials in line with implementation of the New Education Policy (NEP). The University is dedicated to delivering exceptional education across all learning modes while adhering to NEP, UGC, and other regulatory guidelines, fostering a truly global educational environment.

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Annexure I _Detailed syllabus of M.SC - MATHEMATICSProgram

Semester I

<table>
<tr><td>Subject Name</td><td colspan="3">Calculus of Variation and Special Functions</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To understand why variational problems are important. See several examples of variational problems in physics and other sciences. Appreciate that (and why) some problems have “classical” solutions and some do not be able to prove the existence of solutions to convex variational problems. Know which kinds of problems are not convex and why convexity is often an unrealistic assumption for vector-valued problems. Have an insight into generalised convexity conditions, such a quasi convexity and poly convexity and their applications.Be able to prove existence of solutions to quasi convex/polyconvex variational problems.</td></tr>
<tr><td>Unit I</td><td colspan="3">Calculus of variation – Functionals, Variation of a functional and its properties, Variational problems with fixed boundaries, Euler’s equation, Extremals, Functional dependent on several unknown functions and their first order derivatives.</td></tr>
<tr><td>Unit II</td><td colspan="3">Functionals dependent on higher order derivatives, Functionals dependent on the function of more than one independent variable, Variational problems in parametric form, Direct methods for variational problems, Rayleigh-Ritz method.</td></tr>
<tr><td>Unit III</td><td colspan="3">Gauss hypergeometric function and its properties, Series solution of Gauss hypergeometric equation. Integral representation, Linear and quadratic transformation formulas, Contiguous function relations, Differentiation formulae, Linear relation between the solutions of Gauss hypergeometric equation, Kummer’s confluent hypergeometric function and its properties, Integral representation.</td></tr>
<tr><td>Unit IV</td><td colspan="3">Bessel function Jn(x) , Legendre polynomials and functions Pn(x) and Qn(x).</td></tr>
<tr><td>Course Outcomes</td><td>CO1</td><td>Recall the variational problems. Derive the Euler-Lagrange equations for variational problems, including the case of general variations.</td><td>Remember</td></tr>
<tr><td></td><td>CO2</td><td>Explain the conserved quantities from symmetries, and use them to solve the Euler-Lagrange equations.</td><td>Understand</td></tr>
<tr><td></td><td>CO3</td><td>Apply variational problems with constraints: both algebraic and isoperimetric.</td><td>Apply</td></tr>
<tr><td></td><td>CO4</td><td>Analyze the various applications of the fundamental theorem of Gauss Hypergeometric Function.</td><td>Analyze</td></tr>
</table>

	CO5	Evaluate Bessel, differential equations along with the corresponding recurrence formulas of different functions.	Evaluate
	CO6	Create Legendre differential equations along with the corresponding recurrence formulas of different functions.	Create
	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.	
	Text books (Latest Editions)	1.Calculus of Variation with Applications, A. S. Gupta, Prentice-Hall, India, 2000. 2.Calculus of Variations with Applications, G. M. Ewing, Dover, 2000. 3.Introduction to Calculus of Variations, H. Sagan, Dover, 2010. 4.Variational Calculus and Optimal Control, J. L. Troutman, 2nd edition, Springer Verlag, 2015. 5.Special functions and calculus of variations, PK Banerji, VBL Chaurasia, MA Pathan, Indus valley publications,2010.	
	Online resources	IOP Science Journals, Elsevier Mathematics Journals	

Subject Name	**Differential Equations**
Course Objective	To identify the type of a given differential equation and select and apply the appropriate analytical technique for finding the solution of first order and selected higher order ordinary differential equations.To evaluate first order differential equations including separable, homogeneous, exact, and linear.Show existence and uniqueness of solutions.Create and analyze mathematical models using first order differential equations to solve application problems such as circuits, mixture problems, population modeling, orthogonal trajectories, and slope fields.Solve second order and higher order linear differential equations.
Unit I	Differential Equations: Ordinary Differential Equations of Second Order With Variable Coefficients-Homogeneous Form, Exact Form, Solution When a Part of C.F. is Known, Change of Dependent Variable, Change of Independent Variable, Variation of Parameters, and Solution In Series.
Unit II	Partial differential equations of first order: Lagrange's method and standard forms, Charpit's method, Method of Separation of variables-Application to the solution of wave equation in

<table>
<tr><td></td><td colspan="4">one dimension, Laplace's equation in two dimensions, Diffusion equation in one dimension, Partial differential equations of second order with variable co-efficients- Monge's method.</td></tr>
<tr><td>Unit III</td><td colspan="4">Total Differential equations. Forms and solutions, necessary and sufficient condition, Geometrical Meaning Equation containing three and four variables, total differential equations of second degree.</td></tr>
<tr><td>Unit IV</td><td colspan="4">Series Solution: Radius of convergence, method of differentiation, Cauchy-Euler equation, Solution near a regular singular point (Method of Forbenius) for different cases, Particular integral and the point at infinity. Nonlinear Differential equations.</td></tr>
<tr><td>Course Outcomes</td><td colspan="4"><table>
<tr><td>CO1</td><td>Recall the derivation of differential equation, Linear partial differential.</td><td>Remember</td><td></td></tr>
<tr><td>CO2</td><td>Explain Methods of Solving of Differential equations of first order</td><td>Understand</td><td></td></tr>
<tr><td>CO3</td><td>Apply Lagrange's linear equation, Lagrange's solution of the linear equation.</td><td>Apply</td><td></td></tr>
<tr><td>CO4</td><td>Analyze Geometrical interpretation of Lagrange's linear equation.</td><td>Analyze</td><td></td></tr>
<tr><td>CO5</td><td>Evaluate the linear equations with n independent variables, special types of equations.</td><td>Evaluate</td><td></td></tr>
<tr><td>CO6</td><td>Create the Nonlinear PDE of first order, solve using Charpit's method.</td><td>Create</td><td></td></tr>
</table></td></tr>
<tr><td></td><td>Learner support Material</td><td colspan="3">NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.</td></tr>
<tr><td></td><td>Text books (Latest Editions)</td><td colspan="3">1. "Mathematical Methods"- Potter, M C; Goldberg Jack, Prentice Hall of India Learning Pvt. Ltd, 2016.
2. Ordinary Differential Equations, Simmons, McGraw-Hill; 2nd edition, 2010.
3. Ordinary Differential EquationsLakshmikantham, Deo and Raghavendra, McGraw-Hill, 2000.
4 Introductions to Partial Differential Equations, K, Sankara, Rao, Prentice Hall of India Learning Pvt. Ltd, 2010.</td></tr>
<tr><td></td><td>Online resources</td><td colspan="3">IOP Science Journals, Elsevier Mathematics Journals</td></tr>
</table>

Subject Name	**Real Analysis**
Course Objectives	To studying Bolzano –Weirstrass theorem and Cauchy criteria.Have the knowledge of basic properties of the field of real numbers. Studying the basic topological properties of the real numbers. Have the knowledge of real functions-limits of functions and their properties. Studying the notion of continuous functions and their properties.
Unit I	Review of basic concepts of real numbers: countable and uncountable sets, Real number system, Archimedean property, supremum, infimum and Completeness. Continuity and uniform continuity. Metric spaces and its topology. Weierstras's theorem, Continuity of functions in metric spaces. Compactness and Connectedness. Discontinuities. Monotonic functions
Unit II	Sequences and series, Convergent sequences. Cauchy sequences. Upper and Lower limits. Cauchy's general Principle of convergence. Series of nonnegative terms and convergence tests. Absolute and conditional convergence.
Unit III	Sequences and series of functions. Pointwise and uniform convergence, Cauchy criterion for uniform convergence, Weirstras's M-test, Abel's test and Dirichlet's test for uniform convergence, uniform convergence and continuity, uniform convergence and differentiation, existence of a Power series.
Unit IV	Functions of several variables : linear transformations, derivative in an open subset of Rn, Chain rule, partial derivatives, directional derivatives, the contraction principle, inverse function theorem, Implicit function theorem, Jacobians, extremum problems with constraints, Lagrange's multiplier method.

Course Outcomes				
	CO1	Recall the many properties of the real line and learn to define sequence in terms of functions from to a subset.	Remember	
	CO2	Explain bounded, convergent, divergent, Cauchy and monotonic sequences.	Understand	
	CO3	Apply to calculate their limit superior, limit inferior, and the limit of a bounded sequence.	Apply	
	CO4	Analyze various applications of the fundamental theorem of integral calculus.	Analyze	

	CO5	Evaluate uniform continuity, differentiation, integration and uniform convergence.	Evaluate
	CO6	Create the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.	Create
	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.	
	Text books (Latest Editions)	1. Principles of Mathematical Analysis by W.Rudin, 2010. 2. Mathematical Analysis by T.M.Apostol, Narosa Publishing House, 2000. 3. Theory of Functions of a Real Variable, Volume 1 by I. P. Natanson, Frederick Pub. Co.2015. 4. Real Analysis by H.L. Royden, McMillan Publication Co. Inc. New York, 2016.	
	Online resources	IOP Science Journals, Elsevier Mathematics Journals	

Subject Name	**C Programming**
Course Objectives	The course is designed to provide complete knowledge of C language. Students will be able to develop logics which will help them to create programs, applications in C. Also by learning the basic programming constructs they can easily switch over to any other language in future.
Unit I	Introduction to 'C' programming: Fundamentals, Structure of a C program, Compilation and linking processes.
Unit II	Expressions and Console I/O: Basic Data types, Identifier Names, Variables, Scope, Type qualifiers, Storage class specifier, Constants, Operators, Reading and writing characters, Reading and writing strings.
Unit III	Statements: True and False, Selection statements, Iteration statements, Jump statements, Expression statements, Block statements.
Unit IV	Structure and Union: definition and differences, self-referential structure. File Handling in C: opening and closing a text file, creating a text file, read and write functions.

Course Outcomes	**CO1**	Recall the basics of C programming.	Remember		
	CO2	Explain the sequence of the program and give logical output.	Understand		
	CO3	Apply the uses of pre-processors and various memory models.	Apply		
	CO4	Analyze I/O operations in your C program. Repeat the sequence of instructions and points for a memory location.	Analyze		
	CO5	Evaluate strings in your C program& Store different data types in the same memory.	Evaluate		
	CO6	Create code reusability with functions and pointers. Understand the basics of file handling mechanisms.	Create		
	Learner support Material	NPTL,Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.			
	Text books (Latest Editions)	1"Let us C", Yashavant Kanetkar, BPB, 2015. 2. "Programming in C", Gottfried, Schaum's Series, Tata McGraw-Hill, 2013. 3. "Programming in ANSI C", E. Balagurusamy, TMH, 2000. 4. "The C Programming Language", Kernighan, Ritchie, Prentice Hall of India, 2010.			
	Online resources	Elsevier Computer Science Journals.			

Subject Name	**C Programming Lab**
Course Objectives	The course is oriented to those who want to advance structured and procedural programming understating and to improve C programming skills. The major objective is to provide students with understanding of code organization and functional hierarchical decomposition with using complex data types.
S. No.	Name of the Experiment
1	WAF to display "Hello".
2	WAP and define an algorithm that returns the number of years until a father will have an age double of its son's age.
3	WAP to convert temperature in Fahrenheit or Celsius [Hint: using switch case] $Celsius = (F + 32) * \frac{5}{9}$
4	WAP to calculate Simple Interest on the basis of Principal, rate of interest and number of years given as input by the user using switch statement. HINT : $SI = (P * R * T) / 100$ and $CI = p * [(1 + (R/100))\text{^} N]$.
5	WAP and find the flowchart and algorithm of a program that finds the minimum of three values a, b and c.
6	WAP with the flowchart and associated algorithm that compare two numbers a and b.
7	WAP and work out the algorithm that output the solutions of a 2^{nd} order polynomial

	ax2+bx+c=0, given the parameters a, b and c. Only real solutions will be treated. The cases with 1 or 2 solutions will be separated.
8	WAP and define the flowchart of a program where the user supplies integer values between 1 and 9 and the program returns the sum, average and RMS of the values. The program will exit when 0 is entered. Values outside of the bounds will be discarded.
9	WAP to print the following * 1 * * 2 2 * * * 3 3 3 * * * * 4 4 4 4
10	WAP to generate odd series 1+3+5+7+9+……..
11	WAP to generate even series 2+4+6+8+10+……..
12	WAP to generate power series as 1+4+9+16+25+……
13	WAP to find the factorial of a given number where if the number is lesser than 2 then factorial =1.
14	WAP to generate Fibonacci series as 0,1,1,2,3,5,8,13,…….. [Hint Sum ofd 2 previous terms becomes new terms]
15	WAP to generate sine series. As x-x3/3!+x5/5!-x7/7!+…..
16	WAP to generate cosine series as 1-x2/2!+x4/4!-x6/6!+…
17	WAP to find whether the given number is Armstrong number or not.[153= 13+53+33]
18	WAP to find whether the given number is palindrome no. Or not as 121=121 , 131=131, etc.
19	WAP to find the sum of all the digits of a given number.
20	WAP to calculate the power of a given number.
21	WAP to display the sum of the elements of a linear array.
22	WAP to display the elements in reverse order of an array.
23	WAP to display the sum of rows and columns of a matrix.
24	WAP to find the sum of the diagonals of a matrix.
25	WAP to display the sum & product of two matrixes.
26	WAP to search an element using linear search.
27	WAP to search an element using binary search.
28	WAP to sort an array using selection sort.
29	WAP to compare two inputted strings and store the larger of the two into a new string [Use strcpy and strcmp functions].
30	WAP to swap two numbers using pointers.
31	WAP to display the contents of an array using pointers.
32	WAP to store and display the employee data using structures.
33	WAP to store the student data (roll no, name and marks in 5 subjects) and print his/her result showing his/her percentage as well as grade.
34	WAF to swap two numbers using call by reference.
35	WAF to calculate factorial of a number.
36	WAF to find GCD of two numbers.

37	WA recursive function to display the factorial of a number given as an argument.	
38	WAF that returns the no. of times it had been called upon.[Use static storage class].	
39	WAP to copy the contents of one text file into another.	
40	WAP to create a program that stores the record of three employees. [Use Binary files].	
Course Outcomes	**CO-1**	Write the C code for a given algorithm.
	CO-2	Explain the basic Structure of the C-PROGRAMMING, declaration and usage of variables.
	CO-3	Apply the odd series, even series, power series, Fibonacci series, sine series and cosine series.
	CO-4	Analyses the C programs using operators, conditional and iterative statements to Write C programs.
	CO-5	Assess the programs that perform operations using derived data types.
	CO-6	Build a Program with pointers and arrays, perform pointer arithmetic, and use the pre-processor.

Subject Name	**Industrial Mathematics**
Course Objectives	The objective of the Master's program in Industrial Mathematics is to enable students to acquire the fundamentals of applied mathematics in areas of classical and numerical analysis, differential equations and dynamical systems, and probability and statistics. : Give the student's sufficient knowledge of fundamental principles, methods and a clear perception of the innumerous power of mathematical ideas and tools and knowledge of how to use them by modeling, solving and interpreting. Reflecting the broad nature of the subject and developing mathematical tools for continuing further study in various fields of science.
Unit I	Finite difference schemes for partial differential equations – explicit and implicit schemes .Finite difference schemes for initial and boundary value problems – FTCS, backward Euler and Crank-Nicolson schemes, ADI methods. Application to problems of industry with special reference to Fluid Mechanics.
Unit II	Operational Techniques for Linear Programming Problems, Computational procedure of Simplex method, Two-phase Simplex method, Big-M-method, Duality in linear programming, Duality and Simplex method.
Unit III	Assignment models. Mathematical formulation, Hungarian method. Travelling Salesman problem. Transportation models. Mathematical formulation. Initial basic feasible solution. Degeneracy and unbalanced transportation problems. Advance Game Theory and its applications. Game problems using graphical method.
Unit IV	Queuing models: Basic components of a queuing system, General birth-death equations, steady state solution of Markovian queuing models with single and multiple servers (M/M/1,

	M/M/C M/M/1/k, M/MC/k).			
Course Outcomes	**CO1**	Recall the linear programming problems by different methods. Illustrate the concept of convex set & extreme points.	Remember	
	CO2	Explain the relationships between the primal and dual problems, and to understand sensitivity analysis.	Understand	
	CO3	Apply duality and dual simplex method.	Apply	
	CO4	Analyze transportation model and finding solution of transportation problem.	Analyze	
	CO5	Evaluate assignment problem and method for solving it.	Evaluate	
	CO6	Create linear programming models of real-life situations. Learn about the applications to transportation, assignment in real world.	Create	
	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.		
	Text books (Latest Editions)	1.Numerical Solutions to Partial Differential Equations, G. D. Smith, Oxford University Press, 3rd Edn., 2000. 2. "Mathematical Methods"; Potter, M C; Goldberg Jack, Prentice Hall of India, 2015. 3. Operations Research; S. D. Sharma, Kedar Nath Ram Nath and co, 2016. 4. Operations research; Kanti Swarup, P.K.Gupta and Manmohan, S. Chand & Co, 2017. 5. Operations Research; Hamady Taha, MacMillan Co, 2017.		
	Online resources	IOP Science Journals, Elsevier Mathematics Journals		

Subject Name	**Hydrodynamics**		
Course Objectives	This Course provides Lagrangian and Eulerian methods, Motion in two dimensions, stream function. Use of complex potential for irrotational flow. Circle theorem, uniqueness theorem, and Kinetic energy of an infinite mass of fluid.		
Unit I	Lagrangian and Eulerian methods. Stream lines, Stream tubes, equation of continuity, irrotational and rotational motion, circulation. Euler's dynamical equations, surface conditions. Velocity potential, Bernoulli's theorem.		
Unit II	Motion in two dimensions, stream function. Use of complex potential for irrotational flow. Circle theorem, uniqueness theorem, Kinetic energy of an infinite mass of fluid, constancy of circulation, and flow past a moving cylinder.		
Unit III	Axi-Symmetric fluid motion, Stokes' stream function, flow past a solid of revolution.		
Unit IV	Visocosity, Most general motion of a fluid element, stain quadric, stress quadric. Relation between stress and rate of strain components.		
	CO1	Recall the Lagrangian and Eulerian methods. Stream lines, Stream tubes, equation of continuity, irrotational.	Remember
	CO2	Explain the use of complex potential for irrotational flow.	Understand
	CO3	Apply Euler's dynamical equations and surface conditions.	Apply
	CO4	Analyze the Axi-Symmetric fluid motion, Stokes' stream function.	Analyze
	CO5	Evaluate Kinetic energy of an infinite mass of fluid.	Evaluate
	CO6	Create relation between stress and rate of strain components.	Create
Course Outcomes	On successful completion of this course, students will be able to:Apply knowledge and understanding of the basic concepts, theories, and principles of Hydrodynamics.		
	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.	
	Text books (Latest Editions)	1. Milne-Thomson: Theoretical Hydrodynamics, 2015. 2. G. K. Batchelor: An Introduction to Fluid Dynamics, 2000. 3. N. Curle and H. J. Davies: Modern Fluid Dynamics,Vol. I.,2015. 4 .R. C. Binder: Advanced Fluid Mechanics, 2017.	
	Online resources	IOP Science Journals, Elsevier Mathematics Journals	

Subject Name	**Waste Water Treatment**	
Course Objectives	The ai of this course is to introduce the students to the area of water and waste water treatment. The course will cover water chemistry, characteristics of water & waste water, and design of water and waste water treatment plants.	
Course Details	Characteristics and sources of water, Water Pollution: International Standards of drinking water, water quality parameters COD, BOD, TDS, pH etc., treatment of potable and sewage waste water.	
Course Outcomes	On successful completion of this course, students will be able to:Apply knowledge and understanding of the basic concepts, theories, and principles of Hydrodynamics.	
➢	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
➢	Text books (Latest Editions)	1. Water Chemistry: An Introduction to the Chemistry of Natural and Engineered Systems, Brezonik, P.L.; Arnold, W.A., Oxford University Press. 2011 2. Water Quality and Treatment, 5th edition, R. Letterman, Editor, American Water Works Association, Denver, CO, 1999 3. Metcalf and Eddy, Wastewater Engineering, 4th ed., McGraw Hill Higher Edu., 2002 4. Textbook of Water Supply & Sanitary Engineering: S.K. Husain

Semester II

<table>
<tr><td>Subject Name</td><td colspan="3">Numerical and Statistical Techniques</td></tr>
<tr><td>Course Objectives</td><td colspan="3">The objective is to develop analytical capability and to impart knowledge in Statistical methods. The knowledge of Statistical methods and its applications so as to enable them to apply them for solving real world problems.</td></tr>
<tr><td>Unit I</td><td colspan="3">Floating point Arithmetic: Representation of floating point numbers, Operations, Normalization, Pitfalls of floating point representation, Errors in numerical computation Iterative Methods: Zeros of a single transcendental equation and zeros of polynomial using Bisection Method, Regula-Falsi method, Newton Raphson method, Secant method, Rate of convergence of iterative methods.</td></tr>
<tr><td>Unit II</td><td colspan="3">Simultaneous Linear Equations: Solutions of system of Linear equations, Gauss elimination direct method and pivoting, Ill conditioned system of equations, refinement of solution. Gauss Seidal iterative method, Gauss-Jordan method. Interpolation and approximation: Finite differences, difference tables polynomial interpolation: Newton’s forward and backward formula. Central difference formulae: Gauss forward and backward formula, Stirling’s, Bessel’s, Everett’s formula. Interpolation with unequal intervals: Langrange’s interpolation, Newton divided difference formula.</td></tr>
<tr><td>Unit III</td><td colspan="3">Numerical Differentiation and Integration: Introduction, numerical differentiation, numerical integration, trapezoidal rule, Simpson’s rules, Boole’s rule, Weddle’s rule, Euler- Maclaurin’s formula. Solution of differential equations: Euler’s method, Modified Euler’s method, Picard’s method, Taylor’s method, Runge-Kutta method, Predictor-corrector method, Shooting Method. Difference equations.</td></tr>
<tr><td>Unit IV</td><td colspan="3">Frequency Chart: Different frequency chart like histogram, frequency curve, Pi-chart. Curve fitting, Cubic Spline and Approximation: Method of least squares, fitting of straight lines, polynomials. Time series and forecasting: Moving averages, smoothening of curves, forecasting models and methods. Statistical quality controls methods Testing of Hypothesis: Test of significance, chi-square test, t-test, F-Test.</td></tr>
<tr><td>Course Outcomes</td><td>CO1</td><td>Recall the numerical methods to obtain approximate solutions of mathematical problems.</td><td>Remember</td></tr>
<tr><td></td><td>CO2</td><td>Explain the concepts of finite differences, interpolation, extrapolation, and approximation.</td><td>Understand</td></tr>
<tr><td></td><td>CO3</td><td>Apply the methods to find the accuracy of the numerical solutions.</td><td>Apply</td></tr>
<tr><td></td><td>CO4</td><td>Classify initial and boundary value problems in differential equations using numerical methods.</td><td>Analyse</td></tr>
</table>

	CO5	Evaluate numerical differentiation when routine methods are not applicable.	Evaluate
	CO6	Develop numerical problems in diverse situations in physics, engineering etc.	Create
➢	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.	
➢	Text books (Latest Editions)	1. "Numerical Analysis", Sastry S.S., Prentice Hall of India Learning Pvt. Ltd,2015. 2. "Numerical Methods", Balaguruswamy E, McGraw-Hill Publishing Company, New Delhi, 2000. 3. "Applied Numerical Analysis'' Gerald & Wheatley', Addison-Wesley, 2000. 4. "Numerical Methods for Scientific and Engineering Computation, Jain, Iyengar and Jain, New Age International, 2017.	
➢	Online resources	IOP Science Journals, Elsevier Mathematics Journals.	

Subject Name	**Abstract Algebra**
Course Objectives	Abstract algebra is the study of algebraic structures. The course aims to provide an introduction to some of the most fundamental algebraic structures encountered in algebra and geometry: groups, rings, and fields.
Unit I	Groups, subgroups, Cosets, Lagrange's theorem, cyclic group, normal subgroups, quotient groups, permutation group. Homomorphism, isomorphism theorems and Cayley's theorem.
Unit II	Conjugacy, Class equation, Simple groups. Sylow theorems with applications, Normal and subnormal series, composition series, Jordan holder theorem. Solvable groups, simplicity of An (n > 5).
Unit III	Rings, homomorphisms, ideals, Quotient rings, prime ideals, maximal ideals, Field of quotients of an integral domain, Euclidean rings, unique factorization domains, principal ideal domain.
Unit IV	Polynomial rings, Eisenstenin's criterion of irreducibility, Fields, finite fields, field extensions, Galois Theory.

Course Outcomes	**CO1**	Recall the various algebraic structures.	Remember		
	CO2	Explain the mathematical objects called groups.	Understand		
	CO3	Apply the basic concepts to develop theorems.	Apply		
	CO4	Analyze the significance of the notions of cosets, normal subgroups, and factor groups.	Analyze		
	CO5	Evaluate the fundamental concepts in field theory.	Evaluate		
	CO6	Develop the classification of finite fields.	Create		
	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.			
	Text books (Latest Editions)	1. Topics in algebra by I. N. Herstein. Wiley Eastern Limited, 2015. 2. A first course in Abstract Algebra by John Fraleigh (3rdEdition), Narossa Publishing House, 2000. 3. Basic Abstract Algebra by Bhattacharya, Jain and Nagpal, 2nd Edition, 2010. 4. Algebra by S.Mclane and G.Birkhoff, 2nd Edition, 5. Basic Algebra by N.Jacbson, Hind.Pub.Corp.2017. 6. Contemporary Abstract Algebra, Joseph A. Gallian, Cengage Learning, 2014.			
	Online resources	IOP Science Journals, Elsevier Mathematics Journals.			

Subject Name	**Mathematical Programming**
Course Objectives	To study the basic components of an optimization problem.Formulation of design problems as mathematical programming problems.
Unit I	Nonlinear optimization: basic theory, method of Lagrange multipliers, Karush-Kuhn-Tucker theory, Wolfe's mehod as application of Karush-Kuhn-Tucker condition, convex optimization. Numerical optimization techniques: line search methods, gradient methods, Newton's method. Single variables optimizations. Hassian matrix and its applications.
Unit II	**Project Management:** Historical Development of CPM/PERT, Rules for Drawing Network, CPM: Time estimation and Critical Path in Network, PERT, Probability to complete a Project.
Unit III	Integer programming: Gomory's algorithm for all and mixed integer programming problems, Branch and Bound Algorithms cutting plan algorithm. Dynamic programming: Introduction, Bellman principle of optimality, solution of problems with finite number stages, solution of l.p.p. by dynamic programming. Duality and dual simplex method.

<table>
<tr><td>Unit IV</td><td colspan="4">Game Theory: Two person zero sum game, Game with saddle points, the rule of dominance; Algebric, graphical and linear programming methods for solving mixed strategy games. Sequencing problems: Processing of n jobs through 2 machines, n jobs through 3 machines, 2 jobs through m machines, n jobs through m machines.</td></tr>
<tr><td>Course Outcomes</td><td colspan="4"><table>
<tr><td>CO1</td><td>Recall the concept of linear programming problems.</td><td>Remember</td><td></td></tr>
<tr><td>CO2</td><td>Explain PERT and CPM methods.</td><td>Understand</td><td></td></tr>
<tr><td>CO3</td><td>Apply the basic concepts of Game theory.</td><td>Apply</td><td></td></tr>
<tr><td>CO4</td><td>Analyze the significance of the notions of Duality.</td><td>Analyze</td><td></td></tr>
<tr><td>CO5</td><td>Evaluate dynamic programming.</td><td>Evaluate</td><td></td></tr>
<tr><td>CO6</td><td>Develop the applications of different methods.</td><td>Create</td><td></td></tr>
</table></td></tr>
<tr><td></td><td>Learner support Material</td><td colspan="3">NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.</td></tr>
<tr><td></td><td>Text books (Latest Editions)</td><td colspan="3">1. Operations Research – An Introduction, Handy A Taha – Pearson Education.Operations Research Panneer Selvan Prentice Hall of India,2010.
2. “Operations Research: Theory and Application”, J.K.Sharma, Noida: MacMillan India,2003.
3. “Quantitative Techniques in Management”, N.D.Vohra, New Delhi: Tata McGraw-Hill Publishing Co. Ltd, 2007.
4. “Operations Research”, R.Paneerselvam, New Delhi: Prentice Hall of India, 2008.
5. “Operations Research”, Frederick S.Hillier and Gerald J. Lieberman, New Delhi: Tata McGraw Hill, 2005.</td></tr>
<tr><td></td><td>Online resources</td><td colspan="3">IOP Science Journals, Elsevier Mathematics Journals</td></tr>
</table>

Subject Name	**Continuum Mechanics**
Course Objectives	The purpose of the course is to expose the students to the basic elements of continuum mechanics in a sufficiently rigorous manner. After attending this course, the students should be able to appreciate a wide variety of advanced courses in solid and fluid mechanics.
Unit I	Cartesian Tensors, Index notation and transformation laws of Cartesian tensors. Addition, Subtraction and Multiplication of cartesian tensors, Gradient of a scalar function, Divergence of a vector function and Curl of a vector function using the index notation. e-d identity. Conservative vector field and concept of a scalar potential function. Stokes, Gauss and Green’s theorems.

<table>
<tr><td>Unit II</td><td>Continuum approach, Classification of continuous media, Body forces and surface forces. Components of stress tensor, Force and Moment equations of equilibrium. Transformation l of stress tensor. Stress quadric. Principal stress and principal axes. Stress invariants and stres deviator. Maximum shearing stress, Pain strain Mohr’s Circles for strain.</td></tr>
<tr><td>Unit III</td><td>Lagrangian and Eulerian description of deformation of flow. Comoving derivative, Velocity and Acceleration. Continuity equation. Strain tensors. Linear rotation tensor and rotation vector, Analysis of relative displacements.</td></tr>
<tr><td>Unit IV</td><td>Geometrical meaning of the components of the linear strain tensor, Properties of linear strain tensors. Principal axes, Theory of linear strain. Linear strain components. Rate of strain tensors. The vorticity tensor. Rate of rotation vector and vorticity, Properties of the rate of strain tensor, Rate of cubical dilation.</td></tr>
<tr><td>Course Outcomes</td><td>
<table>
<tr><td>CO1</td><td>Recall the significance of mathematics involved in physical quantities and their uses.</td><td>Remember</td></tr>
<tr><td>CO2</td><td>Explain the Stokes, Gauss, and Green’s theorems.</td><td>Understand</td></tr>
<tr><td>CO3</td><td>Apply Body forces and surface forces.</td><td>Apply</td></tr>
<tr><td>CO4</td><td>Classify the Lagrangian and Euler description of the deformation of flow.</td><td>Analyze</td></tr>
<tr><td>CO5</td><td>Evaluate the concept of stress and strain.</td><td>Evaluate</td></tr>
<tr><td>CO6</td><td>Develop the geometrical meaning of the components of the linear strain tensor.</td><td>Create</td></tr>
</table>
</td></tr>
<tr><td>➢ Learner support Material</td><td>NPTL,Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.</td></tr>
<tr><td>➢ Text books (Latest Editions)</td><td>1. Continuum Mechanics, Anthony james merril spencer,Dover publication,2004.
2. Introduction to Engineering Mechanics A Continuum Approach, Jenn Stroud Rossmann, Clive L. Dym , Taylor and francis group,2010.
3. Inroduction to continuum mechanics for engineers, Ray M. Bowen, dover publication, 2000.
4 First Course in Continuum Mechanics, Y.C.Fung, Prentice Hall, 2017.</td></tr>
<tr><td>➢ Online resources</td><td>IOP Science Journals, Elsevier Mathematics Journals</td></tr>
</table>

Subject Name	**Numerical & Statistical Techniques Lab**
Course Objectives	Learn to develop mathematical models of phenomena involved in various fields and solutions for these models.
S. No.	Name of the Experiment
1.	Write programs in C/C++ to implement Floating Point Representation of the following: a) Addition b) Subtraction c) Multiplication d) Division
2.	Write programs in C/C++ to implement to implement a) Bisection Method b) Newton Raphson Method c) Regula – Falsi Method
3.	Compute the two regression coefficients using the values of actual means of X and Y from the data given below and then work out the values of 'r': X 7 4 8 6 5 Y 6 5 9 8 2
4.	Implement the following : a) Newton's Forward Difference Table b) Newton's Backward Difference Table c) Newton's Central Difference Table d) Newton's Forward Interpolation Formula e) Newton's Backward Interpolation Formula f) Newton's Central Difference Interpolation Formula
5.	Write a program to implement Jacobi's Method.
6.	200 digits were chosen at random from a set of tables. The frequencies of the digits were: Digits 0 1 2 3 4 5 6 7 8 9 Frequencies 18 9 23 21 16 25 22 20 21 15 Use x2 test to assess the correctness of hypothesis that the digits were distributed in equal numbers in the table
7.	Write programs in C/C++ to implement the following: a) Gauss – Seidel Method b) Lagrange's Interpolation c) Trapezoidal Rule d) Simpson's 1/3 Rule e) Simpson's 3/8 Rule f) Euler's Method g) Euler's Modified Method h) Runge – Kutta II Order Method i) Runge – Kutta IV Order Method j) Fitting a Straight Line **Tests:** F – Test, T – Test.
Course Outcomes	**CO-1** Recall the numerical methods to obtain approximate solutions of mathematical problems.

	CO-2	Explain error, source of error and its affect on any numerical computation and also analyzing the efficiency of any numerical algorithm.
	CO-3	Solve system of linear equations numerically using direct and iterative methods.
	CO-4	Analyze the accuracy of common numerical methods.
	CO-5	Evaluate numerical solution of nonlinear equations using Bisection, Newton – Raphson and fixed-point iteration methods.
	CO-6	Create interpolating polynomials with practical exposure.

Subject Name	**Computer Application**
Course Objectives	Improve their computer literacy, their basic understanding of operative systems and a working knowledge of software commonly used in academic and professional environments. Develop criteria to organize and present different type of works in academic and professional environments. Learn how to organize information efficiently in the forms of outlines, charts, etc. by using appropriate software.
Unit I	**Introduction**: Need of and features of Computer, Parts of Computer System: Hardware, Software, Data, Users, The information processing cycle. Evolution of Computer Systems & Generations. **Computer hardware**: Processing Devices, Memory Devices: RAM, ROM, Input and Output Devices (Keyboard, Mouse, Pen, Touch Screens, Bar Code Readers, OCR, Printer, Plotters, VDU, Speakers, etc.), Storage Devices: Magnetic and Optical Storage, **Software**: System software, Application Software, Utility software. Programming languages and language translators.
Unit II	**Data Representation**: Number Systems, Bits and Bytes, Text Codes. Binary/Octal/Hexadecimal Number Systems; Computer Arithmetic. **Data Processing**: The CPU, Machine Cycles, Memory, Factors Affecting Processing Speed, Registers, Memory and Computing Power, Computer's Internal Clock, Bus, Cache Memory.
Unit III	**Secondary Storage Devices**: Sequential access devices; Magnetic tapes: Types, Basic Principles of operation, advantages, Limitations of magnetic Tapes. **Direct access devices**, Magnetic disks: Types, Basic Principles of operation, advantages, Limitations of magnetic disks. **Optical disks**: Types, Basic Principles of operation, advantages, Limitations of optical disks.
Unit IV	**Operating System**: Purpose of Operating Systems, Types of Operating System, User Interface: Graphical User Interfaces, Command Line Interfaces, Running Programs, Sharing Information, Managing Hardware: Processing Interrupts, Working with Device Drivers, Utility Software, Backup Utilities, Antivirus, Firewall, Intrusion Detection, and Screen Savers. Introduction to PC Operating Systems: DOS and windows, UNIX and Linux.

Course Outcomes	**CO1**	Recall the basic concepts of computer hardware and software.	Remember		
	CO2	Explain the data representation and data processing.	Understand		
	CO3	Apply various properties of secondary storage devices.	Apply		
	CO4	Analyze the direct access devices and optical disk.	Analyze		
	CO5	Evaluate factors affecting processing speed.	Evaluate		
	CO6	Create backup DOS and windows, UNIX and Linux.	Create		

	Learner support Material	NPTL,Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books (Latest Editions)	1. "Introduction to Computers", Norton Peter, 6th Ed., TMH, 2001 2. "DOS Guide", Peter Norton's, Prentice Hall of India,2010. 3. "Computer Fundamentals", P. K. Sinha & Priti Sinha , BPB Publications, 2015. 4. "Introduction to Computers", Alex Leon & Mathews Leon, Vikas Publishing House, 2017.
	Online resources	Elsevier Computer Science Journals

Subject Name	**Differential Geometry**
Course Objectives	To understand the Identify situations that requires the use of vector calculus and differential geometry. Solve certain classes of problems related to vector calculus, differential geometry or topology. Understand and write mathematical proofs using formal mathematical reasoning .Present solutions on computer or in a written form.
Unit I	Tensor and their transformation laws, Tensor algebra, Contraction, Quotient law, Reciprocal tensors, Kronecker delta, Symmetric and skew- symmetric tensors, Metric tensor, Riemannian space, Christoffel symbols and their transformation laws, Covariant differentiation of a tensor, Riemannian curvature tensor and its properties, Ricci-tensor.
Unit II	Theory of space curves. Serret-Frenet formulas for curves in space. Parametric representation of curves, Helix , Curvilinear coordinates in E3. Tangent and first curvature vector. Intrinsic equations & differentiation, Parallel vector fields**.**
Unit III	Parametric representation of a surface, Tangent and Normal vector field on a surface, The first and second fundamental tensor. The third fundamental form, Gaussian curvature, Isometry of surfaces, Equation of Gauss, Principal curvature, Normal curvature.

Unit IV	Definition. Differential equation of geodesics. Nature of Geodesics. Canonical equations. Normal property. Geodesic polar coordinate, curvature and torsion.				
Course Outcomes	**CO1**	Recall the vector function to represent space curves and surfaces.	Remember		
	CO2	Explain the Arc Length, Curvature, Torsion and various other quantities.	Understand		
	CO3	Apply the physical and geometrical important concepts related to gradient, divergence and curl of vector field.	Apply		
	CO4	Analyze importance of Green, Gauss and Stokes' theorems in other branches of mathematics.	Analyze		
	CO5	Evaluate integrals of vector valued function over curves, surfaces and domains in two and three-dimensional space.	Evaluate		
	CO6	Create vector and tensor calculus in mechanics, fluid flow, heat flow, electrostatics etc.	Create		
	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.			
	Text books (Latest Editions)	1. Tensor Calculus and Application to Geometry and Mechanics, I. S. Sokolnikoff, 2000, 2. An Introduction to Differential Geometry, T. T. Wilmore, 2010. 3. Differential Geometry, Bary Spain, Arthur L. Besre, Einstein manifolds, Springer Verlag, Berlin, New York, 2000. 4. A course in differential geometry, Klingenberg.W, Springer-verlag, 2017. 5. Lectures on differential geometry, Stenberg S prentice Hall of india, 2015.			
	Online resources	IOP Science Journals, Elsevier Mathematics Journals.			

Subject Name	**Biostatistics**
Course Objectives	Recognize the definition of statistics, its subject and its relation with the other sciences.
Unit I	Graphical Representation by types of data for univariate and bivariate presentation.
Unit II	Measures of Central Tendency and Location – Mean, Median, Mode and Measures of Location Quartiles, Quintiles, Deciles and Percentiles Measures of Dispersion – Range Deviation, Quartile Deviation etc., Mean

	Deviation, Variance.	
Unit III	Standard Deviation, Coefficient of Variation.	
Unit IV	Measures of Central Tendency and Variation for Qualitative Variables Karl Pearson's Coefficients, Correlation and Concepts of Regression.	
Course Outcomes		
➢	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
➢	Text books (Latest Editions)	1. Glover, Thomas and Kevin Mitchell: An Introduction to Biostatistics, 3rd edition. Waveland Press, 2015. **2.** Surender Singh and Deeksha Sharma: Biostatistics and Research Methodology, New Age International (P) Ltd., Publishers, 2020.
➢	Online resources	IOP Science Journals, Elsevier Mathematics Journals.

Semester III

Subject Name	**Linear Algebra**
Course Objectives	To understand the following: How to analyze and solve a linear system of equations; Important characteristics of matrices, such as its four fundamental subspaces, rank, determinant, eigen values and eigenvectors, different factorizations, etc; How to use characteristics of a matrix to solve a linear system of equations or study properties of a linear transformation; Important concepts of vector spaces such as independence, basis, dimensions, orthogonality, etc; Properties of special categories of matrices such as symmetric, positive definite, etc; Some applications of linear algebra in other branches of sciences, engineering, and economics.
Unit I	Vector Spaces, Subspaces, Bases and Dimensions, Linear span, Row space and column space of matrix, Direct Sum, Rank of matrices, Quotient Spaces.
Unit II	Linear transformations, operation with linear mapping, matrix representations of linear transformations, ,the rank and nullity theorem, Change of basis, similarities, transposes of linear transformations; trace and determinant, eigenvalues and eigenvectors, Dual spaces.

Unit III	Characteristic polynomial and minimal polynomial, Diagonalisability, Triangularisable, Caley-Hamilton theorem,, The Adjoint of Linear Transformation, Inner Product Spaces, Orthonormal and Orthogonality, Gram-Schmidt orthogonalization process, Schwartzs inequality, Unitary operators, Self Adjoints and Normal Operators, Polar and Singular Value Decomposition**.**
Unit IV	Canonical and Bilinear Forms: Jordan Forms, The Rational Forms, Bilinear Forms, Quadratic form: Definition and Examples, The matrix of a Bilinear Form, Orthogonality, and Classification of Bilinear Forms.

Course Outcomes			
	CO1	Recall the concepts of vector spaces, subspaces, bases, dimension and their properties.	Remember
	CO2	Explain the linear independence for vectors in Rn , rank and nullity of linear transformation.	Understand
	CO3	Apply the matrix representing a linear under a given basis, and determine how the matrix changes if the basis is changed.	Apply
	CO4	Analyze the characteristic polynomials to compute eigenvalues and eigenvectors.	Analyze
	CO5	Evaluate definite integral as an inner product, orthogonality of vectors and its use in projecting vectors into subspaces and decomposing vectors into components.	Evaluate
	CO6	Create the theory, methods and techniques of the course to solve mathematical problems.	Create

Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
Text books (Latest Editions)	1. Linear algebra by S. Lang, Springer, 2016. 2. Linear Algebra by Bisht and Sahai, Narosa, 2000. 3. Linear Algebra by Hoffman and Kunze, Prentice Hall of India Learning Pvt. Ltd, 2015. 4. Theory and Problems: Linear Algebra, Seymour Lipschutz, McGraw-Hill, 2018.
Online resources	IOP Science Journals, Elsevier Mathematics Journals

Subject	**Mechanics**

Name				
Course Objectives	One of the primary objectives in a mechanics course is to help the student develop this ability to visualize, which is so vital to problem formulation. Indeed, the construction of a meaningful mathematical model is often a more important experience than its solution.			
Unit I	Vector Integration. Line integrals, Surface area and surface integrals, Volume integrals.			
Unit II	Integral Theorems Green's theorem, Gauss divergence theorem, Stoke's theorem.			
Unit III	Curvilinear Coordinates, Orthogonal coordinates, Unit vectors in curvilinear systems, Arc length and volume elements, The gradient, Divergence and curl Special orthogonal coordinate systems.			
Unit IV	Tensor Analysis, Coordinate transformations, Einstein summation convention, Tensors of different ranks Contravariant, Covariant and mixed tensors.			
Course Outcomes	**CO1**	Recall the significance of mathematics involved in physical quantities and their uses	Remember	
	CO2	Explain the necessary conditions for the equilibrium of particles acted upon by various forces and learn the principle of virtual work for a system of coplanar forces acting on a rigid body.	Understand	
	CO3	Apply the centre of gravity of some materialistic systems and discuss the equilibrium of a uniform cable hanging freely under its own weight.	Apply	
	CO4	Analyze the kinematics and kinetics of the rectilinear and planar motions of a particle including the constrained oscillatory motions of particles.	Analyze	
	CO5	Evaluate particle moving under a central force describes a plane curve and know the Kepler's laws of the planetary motions, which were deduced by him long before the mathematical theory given by Newton.	Evaluate	
	CO6	Create the stress developed in beams due to forces applied.	Create	
	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.		
	Text books (Latest Editions)	1. Continuum Mechanics, Anthony james merril spencer,Dover publication,2004. 2. Introduction to Engineering Mechanics A Continuum Approach, Jenn Stroud Rossmann, Clive L. Dym , Taylor and francis group,2010. 3. Inroduction to continuum mechanics for engineers, Ray M.		

		Bowen , dover publication,2010. 4 First Course in Continuum Mechanics, Y.C.Fung, Prentice Hall, 2014.
	Online resources	IOP Science Journals, Elsevier Mathematics Journals

Subject Name	**Integral Transforms**			
Course Objectives	The course is aimed at exposing the students to learn the Laplace transforms and Fourier transforms. To equip with the methods of finding Laplace transform and Fourier Transforms of different functions. To make them familiar with the methods of solving differential equations, partial differential equations, IVP and BVP using Laplace transforms and Fourier transforms.			
Unit I	Laplace transform– Definition and its properties. Rules of manipulation. Laplace transform of derivatives and integrals. Inverse Laplace transform and its properties. Convolution theorem. Solutions of differential equation with the help of Laplace transform.			
Unit II	Fourier transform – Definition and properties of Fourier sine, cosine and complex transforms. Convolution theorem. Inversion theorems. Fourier transform of derivatives.			
Unit III	Mellin transform– Definition and elementary properties. Mellin transforms of derivatives and integrals. Inversion theorem. Convolution theorem.			
Unit IV	Z transforms - Introduction, Properties, and Inverse Z-Transform.			
Course Outcomes	**CO1**	Recall the Capability to solve problems in computer graphics using concepts of linear algebra.	Remember	
	CO2	Explain the various models such as growth and decay models and population models using techniques of differential equations.	Understand	
	CO3	Apply to solve linear system of equations, linear programming problems and network flow problems.	Apply	
	CO4	Analyze linear programming problems	Analyze	
	CO5	Evaluate and solve network flow problems.	Evaluate	
	CO6	Create new solutions using the domain knowledge of mathematics	Create	
	Learner support Material	NPTL,Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.		

	Text books (Latest Editions)	1. Applied Mathematics for Engineers and Physicists by L. A. Pipe (McGraw-Hill),2010 . 2. Introduction to Mathematical Physics by Charlie Harper (Prentice Hall of India),2000 . 3. Higher Engineering Mathematics by B.S. Grewal, Khanna Publications, Delhi,2015. 4. Mathematical Methods for Physicists by George Arfken (Academic Press),2000. 5. Mathematical Methods by Potter and Goldberg (Prentice Hall of India.
	Online resources	IOP Science Journals, Elsevier Mathematics Journals .

Subject Name	**Advance Differential Equations**
Course Objectives	To understand the point of this class is to take your existing knowledge of calculus and apply it towards the construction and solution of mathematical models in the form of differential equations (i.e. equations with derivatives in them). That's it. More precisely, the goal is that by the end of the class you will be able to: understand all of the concepts relating to the order and linearity of ODEs, analytic and computational solution methods for ODEs, and the real-world applications of ODEs.
Unit I	Classification of linear partial differential equation of second order, Canonical forms, Characteristics curve,Cauchy'sproblem of first and second order partial differential equation.
Unit II	General solution of higher order PDEs with constant coefficients, Linear homogeneous boundary value problem, Eigen values and eigen functions, Sturm-Liouville boundary value problems, orthogonality of eigen functions, Lagrange's identity, properties of Eigen functions.
Unit III	Important theorems of sturm Liouville system, Periodic functions.Non-homogeneous boundary value problems, Non-homogeneous Sturm-Liouville boundary value problems (method of eigen function expansion).
Unit IV	Green's Functions: Non-homogeneous Sturm-Liouville boundary value problem (method of Green's function), Procedure of constructing the Green's function and solution of boundary value problem, properties of Green's function, Inhomogeneous boundary conditions, Dirac delta function, Bilinear formula for Green's function, Modified Green's function.

Course Outcomes	**CO1**	Recall the physical systems can be described by differential equations.	Remember
	CO2	Explain the practical importance of solving differential equations.	Understand
	CO3	Apply the differences between initial value and boundary value problems (IVPs and BVPs).	Apply
	CO4	Analyze the importance of establishing the existence and uniqueness of solutions.	Analyze
	CO5	Evaluate an appropriate solution method for a given problem.	Evaluate
	CO6	Create approximate solutions of ODEs using graphical and numerical techniques	Create

	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
➢	Text books (Latest Editions)	1. Theory of Ordinary Differential Equations, E. A. Coddington and N. Levinson, Tata McGraw Hill, 2013. 2. Differential Equations, S. L. Ross, 3rd Edn., Wiley India, 2015. 3. Elements of Partial Differential Equations, I. N. Sneddon, Dover Publications, 2006. 4. Partial Differential Equations, F. John, Springer, 2014.
➢	Online resources	IOP Science Journals, Elsevier Mathematics Journals.

Subject Name	**Optimization Techniques Simulation Lab**	
Course Objectives	Understood the basic concepts, fundamental principles, and various theories in the above mentioned subjects.	
S. No.	Name of the Experiment	
1.	What is Optimization problem solving?	
2.	Development and use of optimization models suitable for computer representation, solution, graphical display and animation.	
3.	Introduction to Mat Lab with its applications.	
4.	Optimization problem-solving techniques.	
5.	Exchanging data between Mat Lab and EXCEL Programming.	
6.	Simulation models in EXCEL and Mat Lab (Simulink).	
7.	Curve fitting using EXCEL and Mat Lab.	
8.	Graphical Problem Solving, Mat Lab and EXCEL.	
Course Outcomes	**CO1**	Recall the Elimination Methods and Interpolation Methods of Unconstrained Optimization
	CO2	Summarize about the concept of OT Simulation.
	CO3	Solve Equality Constraints problems of Constrained Optimization.
	CO4	Analyse and appreciate variety of performance measures for various optimization problems.
	CO5	Evaluate the direct Root Methods of Unconstrained Optimization.
	CO6	Build the basic concepts of mathematics to formulate an optimization problem.

Subject Name	**Viscous Fluid Dynamics**
Course Objectives	To understand students who take this class can expect to develop an appreciation for the properties of Newtonian fluids, study analytical solutions to variety of simplified problems, understand the dynamics of fluid flows and the governing non-dimensional parameters, apply concepts of mass, momentum and energy conservation to flows, grasp

<table>
<tr><td></td><td colspan="4">the basic ideas of turbulence.</td></tr>
<tr><td>Unit I</td><td colspan="4">Viscosity , Analysis of stress and rate of strain, Stoke’s law of friction, Thermal conductivity and generalized law of heat conduction, Equations of state and continuity , Navier- Stokes equations of motion and Equation of energy.</td></tr>
<tr><td>Unit II</td><td colspan="4">Vorticity and circulation, Dynamical similarity, Inspection and dimensional analysis, Buckingham theorem and its application, Non-dimensional parameters and their physical importance : Reynolds number, Froude number, Mach number, Prandtl number, Eckart number, Grashoff number, Brinkmann number, Non – dimensional coefficients : Lift and drag coefficients, Skin friction , Nusselt number, Recovery factor.</td></tr>
<tr><td>Unit III</td><td colspan="4">Exact solutions of Navier – Stokes equations, Velocity distribution for plane couette flow, Plane Poiseuille flow, Generalized plane Couette flow, Hagen- Poiseuille flow, Flow in tubes of uniform cross-sections. Stokes first and second theorem.</td></tr>
<tr><td>Unit IV</td><td colspan="4">Flow between two concentric rotating cylinders. Stagnation point flows : Hiemenz flow, Homann flow, Flow due to a rotating disc.</td></tr>
<tr><td>Course Outcomes</td><td>CO1</td><td>Recall the fundamental properties of fluids, including viscosity, Newtonian and non-Newtonian rheology, and viscoelasticity.</td><td>Remember</td><td></td></tr>
<tr><td></td><td>CO2</td><td>Explain the necessary conditions for the equilibrium of particles acted upon by various forces and learn the principle of virtual work for a system of coplanar forces acting on a rigid body.</td><td>Understand</td><td></td></tr>
<tr><td></td><td>CO3</td><td>Apply microscopic continuum fluid mechanics where flow is governed by the continuity equation and Navier-Stokes equation.</td><td>Apply</td><td></td></tr>
<tr><td></td><td>CO4</td><td>Analyze a problem and arrive at reasonable approximations to put the equations in a more soluble form.</td><td>Analyze</td><td></td></tr>
<tr><td></td><td>CO5</td><td>Evaluate the significance of mathematics involved in physical quantities and their uses.</td><td>Evaluate</td><td></td></tr>
<tr><td></td><td>CO6</td><td>Create the stress developed in beams due to forces applied.</td><td>Create</td><td></td></tr>
<tr><td></td><td colspan="2">Learner support Material</td><td colspan="2">NPTL,Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.</td></tr>
</table>

	Text books (Latest Editions)	1.Viscous Fluid Dynamics J.L. Bansal, Oxford and IBH,2010. 2.Specifications of Viscous Fingering in Mathematical Fluid Dynamics via Bifurcation: A Functional Analytic Approach (English), Bogdan-Vasile Matioc, Suedwestdeutscher Verlag Fuer Hochschulschriften,2000. 3.Boundary Layer Theory, H. Schlichting, K. Gersten, Springer,2010.
	Online resources	IOP Science Journals, Elsevier Mathematics Journals.

Subject Name	**Combinatorics and Graph Theory**			
Course Objectives	The objective of the course is to Explain basic concepts in combinatorial graph theory. Define how graphs serve as models for many standard problems. Discuss the concept of graph, tree, Euler graph, cut set and Combinatorics. See the applications of graphs in science, business and industry			
Unit I	Combinatorics– Counting of sets and multisets. Binomial and multinomial numbers. Unordered selection with repetitions, Selection without repetition. Counting objects and functions. Functions and the Pigeonhole principle. Inclusion and exclusion principle.			
Unit II	Graphs– Basic terminology, Simple graphs, Multi graphs and Weighted graphs. Walk and connectedness. Paths and circuits. Shortest path in weighted graphs, Eulerian paths and circuits. Hamiltonian paths and circuits.			
Unit III	Plannar Graphs– Combinatorial and geometric graphs, Kuratowski's graphs. Euler's formula. Detection of planarity. Geometric dual. Thickness and Crossing number.			
Unit IV	Digraphs– binary relations, Directed graphs and Directed trees, Arborescence, Polish notation method, Tournaments. Counting of Labeled Trees– Cayley's theorem. Counting methods, Polya's theory.			
Course Outcomes	**CO1**	Recall the Functions and the Pigeonhole principle. Inclusion and exclusion principle.	Remember	
	CO2	Explain the Basic terminology, Simple graphs, Multi graphs and Weighted graphs.	Understand	
	CO3	Apply the Pigeonhole principle. Inclusion and exclusion principle.	Apply	

	CO4	Analyze a Shortest path in weighted graphs, Eulerian paths and circuits.	Analyze
	CO5	Evaluate the Thickness and Crossing number.	Evaluate
	CO6	Create a binary relations between Directed graphs and Directed trees.	Create
➢	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.	
➢	Text books (Latest Editions)	1. Elements of Discrete Mathematics by C. L. Liu, McGraw-Hill Book Co, 2015. 2. Discrete mathematical structures by Kolman, Busby and Ross, 4th edition Prentice Hall of India. , 2002. 3. Mathematical Structures for Computer Science by J. L. Gersting, (3rd edition), Computer Science Press, New York, 2010. 4. Discrete Mathematics with Graph Theory by Goodaire and Parmenter, Pearson edition.2nd edition, 2015. 5. Graph Theory with Applications to Engineering and Computer Sciences by N. Deo, Prentice Hall of India, 2010.	
➢	Online resources	IOP Science Journals, Elsevier Mathematics Journals	

Subject Name	**RESEARCH METHODOLOGY**	
Course Objectives	The mission of the course is to impart research skills to the beginners and help improve the quality of Research by the existing researchers. It will enable the Researchers to develop the most appropriate methodology for their Research Studies.	
Module 1	Overview of Research and its Methodologies • Concepts of research, • The need for research, • Types of research, • Steps in conducting research	
Module 2	Literature review • What is literature review? • Why the need for literature review? • How to carry out a literature review?	
Module 3	Selecting and defining a research problem • Problem formulation – why the need for this? • What are the criteria for selecting a problem? • Identifying variables • Evaluating problems • Functions of a hypothesis	
Module 4	Conducting the research • Research activities • Preparations before conducting your research	
Course Outcomes	At the end of this course, the students should be able to: ➢ Understand some basic concepts of research and its methodologies. ➢ Explain what research is and what it is not, and the different definitions of research. ➢ Discuss the criteria of good research and the different types of research. ➢ Know the primary characteristics of quantitative research and qualitative research. ➢ Distinguish a purpose statement, a research question or hypothesis, and a research objective identify appropriate research topics. ➢ Select and define appropriate research problem and parameters.	
➢	Text books (Latest Editions)	1. Garg, B.L., Karadia, R., Agarwal, F. and

		Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers. 2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p. 3. Cohen, L. Lawrence, M., & Morrison, K. (2005). Research Methods in Education (5th edition). Oxford: Oxford University Press.

Semester IV

Subject Name	**Functional Analysis**		
Course Objective	Functional analysis a central pillar of modern analysis, and we will cover its foundations. The main emphasis will be on the study of the properties of bounded linear maps between topological linear spaces of various kinds. This provides the basic tools for the development of such areas as quantum mechanics, harmonic analysis and stochastic calculus. It also has a very close relation to measure and integration theory.		
Unit I	Normed linear spaces. Quotient space of normed linear spaces and its completeness. Banach spaces and examples. Bounded linear transformations. Normed linear space of bounded linear transformations.		
Unit II	Equivalent norms. Basic properties of finite dimensional normed linear spaces and compactness.Reisz Lemma. Multilinear mapping. Open mapping theorem. Closed graph theorem. Uniformboundness theorem.		
Unit III	Continuous linear functionals. Hahn-Banach theorem and its consequences. Embedding andReflexivity of normed spaces. Dual spaces with examples. Inner product spaces. Hilbert space and its properties. Orthogonality and Functionals in Hilbert Spaces.		
Unit IV	Phythagorean theorem, Projection theorem,Orthonormal sets, Bessel's inequality, Complete orthonormal sets, Parseval's identity, Structure of a Hilbert space, Riesz representation theorem, Reflexivity of Hilbert spaces, Adjoint of an operator on a Hilbert space, Self-adjoint, Positive, Normal and Unitary operators and their properties, Projection on a Hilbert space, Invariance, Reducibility, Orthogonal projections.		
Course Outcomes	**CO1**	Recall the research, inquiry and analytical thinking abilities of the students.	Remember
	CO2	Explain the independently use contractions of Banach spaces via fixed point theorems.	Understand
	CO3	Apply the applications in the real world.	Apply
	CO4	Analyze topological-algebraical structures	Analyse
	CO5	Evaluate analytical methods.	Evaluate
	CO6	Create the problems in diverse situations in physics, engineering etc.	Create
	Online resources	IOP Science Journals, Elsevier Mathematics Journals.	

<table>
<tr><td>Subject Name</td><td colspan="4">Integral Equations</td></tr>
<tr><td>Course Objective</td><td colspan="4">The objective of the course module is to study Integral Equations and to know that what is the relationship between the integral equations and ordinary differential equations and how solved the linear and non linear integral equations by different methods with some problems which give rise to Integral Equations. Integral equations are important in many applications.</td></tr>
<tr><td>Unit I</td><td colspan="4">Linear integral equations– Definition and classification, Conversion of initial and boundary value problems to an integral equation, Eigen values and Eigen functions, Solution of homogeneous and general Fredholm integral equations of second kind with separable kernels.</td></tr>
<tr><td>Unit II</td><td colspan="4">Solution of Fredholm and Volterra integral equations of second kind by methods of successive substitutions and successive approximations, Resolvent kernel and its results, Conditions of uniform convergence and uniqueness of series solution.</td></tr>
<tr><td>Unit III</td><td colspan="4">Integral equations with symmetric kernels– Orthogonal system of functions, Fundamental properties of eigen values and eigen functions for symmetric kernels, Expansion in eigen functions and bilinear form, Hilbert-Schmidt theorem, Solution of Fredholm integral equations of second kind by using Hilbert-Schmidt theorem.</td></tr>
<tr><td>Unit IV</td><td colspan="4">Solution of Volterra integral equations of second kind with convolution type kernels by LaplaceTransform, Solution of singular integral equations by Fourier transform, Classical Fredholm theory– Fredholm theorems, Solution of Fredholm integral equation of second kind by using Fredholm first theorem .</td></tr>
<tr><td>Course Outcome</td><td>CO1</td><td>Recall various algebraic structures.</td><td>Remember</td><td></td></tr>
<tr><td></td><td>CO2</td><td>Explain the concept of integral equations.</td><td>Understand</td><td></td></tr>
<tr><td></td><td>CO3</td><td>Apply the basic concepts to develop theorems.</td><td>Apply</td><td></td></tr>
<tr><td></td><td>CO4</td><td>Analyze the significance of the notions of integral equations.</td><td>Analyze</td><td></td></tr>
<tr><td></td><td>CO5</td><td>Evaluate the fundamental concepts of integral equations.</td><td>Evaluate</td><td></td></tr>
<tr><td></td><td>CO6</td><td>Create Different methods to solve integral equations</td><td>Create</td><td></td></tr>
<tr><td></td><td colspan="2">Learner support Material</td><td colspan="2">NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.</td></tr>
<tr><td></td><td colspan="2">Text books (Latest Editions)</td><td colspan="2">1.Integral Equations, F.G Tricomi, Dover Publications Inc. New York, 2014.
2.Integral Equations: A Practical Treatment from Spectral Theory to Applications, D. Porter and D.S.G. Stirling, Cambridge University Press, 2015.</td></tr>
</table>

		3.Singular Integral Equations, N.I. Muskhelishvili, Dover Publications Inc., New York, 2008., J.B. Conway, Springer, 2010.
	Online resources	IOP Science Journals, Elsevier Mathematics Journals.

Subject Name	**Complex Analysis**				
Course Objective	The objective of this course is to introduce the fundamental ideas of the functions of complex variables and developing a clear understanding of the fundamental concepts of Complex Analysis such as analytic functions, complex integrals.				
Unit I	Functions of a complex Variable, Differentiability and analyticity, Cauchy Riemann Equations, Harmonic functions, Existence of Harmonic conjugate, Power series as an analytic function, properties of line integrals, Goursat Theorem, Cauchy theorem, consequence of simply connectivity, index of a closed curve .				
Unit II	Cauchy's integral formula, Morera's theorem, Liouville's theorem, Fundamental theorem of Algebra,Taylor's theorem, Laurent series, Power series and its radius of convergence.				
Unit III	Zeros of Analytic functions, singularities, classification of singularities,Maximum modulus theorem, Minimum modulus theorem, Hadamard three circle theorem, Schwarz's Lemma, Rouche's theorem.				
Unit IV	Calculation of residues, Residue theorem and its applications in evaluating real integrals,Conformal mappings, critical points. Bilinear transformation, their properties and classification, cross ratio, preservance of cross ratio under bilinear transformation, preservance of circle and straight line under bilinear transformation, fixed point bilinear transformation, normal form of a bilinear transformation.				
Course Outcome	**CO1**	Recall the fundamental concepts of complex analysis.	Remember		
	CO2	Explain the accurate and efficient use of complex analysis Techniques.	Understand		
	CO3	Apply problem-solving techniques using complex analysis.	Apply		
	CO4	Analyze the significance of the notions of Complex plane.	Analyze		
	CO5	Evaluate different problems of complex physics.	Evaluate		
	CO6	Create the applications of different methods.	Create		
	Learner support Material	NPTL,Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.			

	Text books (Latest Editions)	1. Complex Analysis (Third edition) by L. V. Ahlfors, McGraw-Hill Book Company, 2015. 2. Complex Analysis by J. B. Conway, Narosa Publishing House,2010. 3. Complex Analysis by Serg Lang, Addison Wesley,2015. 4. Foundations of Complex analysis (Second Edition), S. Ponnusamy, Narosa Publishing House,2010. 5. Complex variables and Applications by Ruel V. Churchill,2015 .
	Online resources	IOP Science Journals, Elsevier Mathematics Journals.

Subject Name	**Number Theory**			
Course Objective	To present a rigorous development of Number Theory using axioms, definitions, examples, theorems and their proofs.			
Unit I	Divisibility, G.C.D and L.C.M., Primes, Fermat numbers, congruences and residues, theorems Euler, Fermat and Wilson, solutions of congruences, linear congruences, Chinese remainder theorem.			
Unit II	Arithmetical functions $\varphi(n)$, $\mu(n)$ and $d(n)$and $\sigma(n)$, Moebius inversion formula, congruences o higher degree, congruences of prime power modulli and prime modulus, power residue.			
Unit III	Quadratic residue, Legendre symbols, lemma of Guass and reciprocity law. Jacobi symbols, Farey series, rational approximation, Hurwitz theorem, irrational numbers, irrationality of e and π, Representation of the real numbers by decimals.			
Unit IV	Finite continued fractions, simple continued fractions, infinite simple continued fractions, periodic continued fractions, approximation by convergence, best possible approximation, Pell's equations, Lagrange four sphere theorem.			
Course Outcomes	**CO1**	Recall the Mathematical concepts and principles to perform symbolic computations.	Remember	
	CO2	Explain the technology appropriately to investigate and solve mathematical and statistical problems.	Understand	
	CO3	Apply proofs effectively in both written and oral forms.	Apply	
	CO4	Analyze the ability to learn number theory concepts.	Analyze	
	CO5	Evaluate different problems of number theory.	Evaluate	

	CO6	Create the applications of different methods.	Create
	Learner support Material	NPTL,Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.	
	Text books (Latest Editions)	1. Theory of Numbers, G H Hardy and E M Wright, Oxford Science Publications, 2003. 2. Introduction to the Theory of Numbers, I Niven and H S Zuckerman, John Wiley & Sons,2016. 3. Elementary Number Theory, D M Burton, Tata McGraw Hill Publishing House, 2006. 4. Higher Arithmetic, H. Davenport, Cambridge University Press, 2000. 5. Introduction to Analytic Number Theory, T.M. Apostal, Narosa Publishing House,2015.	
	Online resources	IOP Science Journals, Elsevier Mathematics Journals.	

Subject Name	**Dissertation**	
Course Objective	Students will be able to read and identify mathematical and computational methods in order to solve problems and present. Provide Strong foundation and inculcate ample knowledge on topics in pure and applied mathematics, empowering the students to pursue higher degrees.	
Area of Dissertation	Fluid Dynamics	
	Integral Transform	
	Numerical Methods.	
Course Outcome		
➢	Learner support Material	E-library, E-books, online PDF material etc.
➢	Text books (Latest Editions)	1. Viscous Fluid Dynamics J.L. Bansal,, Oxford and IBH,2010. 2. Higher Engineering Mathematics by B.S. Grewal, Khanna Publications, Delhi 2015.
➢	Online resources	IOP Science Journals, Elsevier Mathematics Journals.

<table>
<tr><td>Subject Name</td><td colspan="4">Difference Equations and Sampling Theory</td></tr>
<tr><td>Course Objectives</td><td colspan="4">1. To build an understanding of the fundamental concepts of Mathematics.
2.To introduce the student to formulate and analyze mathematical and statistical problems, precisely define the key terms, and draw clear and reasonable
Conclusions.</td></tr>
<tr><td>Unit I</td><td colspan="4">Introduction, Difference Calculus – The difference operator, Summation, Generating functions and approximate summation. Linear Difference Equations - First order equations. General results for linear equations.</td></tr>
<tr><td>Unit II</td><td colspan="4">Equations with constant coefficients. Applications. Equations with variable coefficients. Stability Theory - Initial value problems for linear systems. Stability of linear systems.</td></tr>
<tr><td>Unit III</td><td colspan="4">Sample space, Events, Algebra of events, Baye’s Rule, Bernoulli Trials. Probability Distribution and probability Densities:</td></tr>
<tr><td>Unit IV</td><td colspan="4">Bernoulli, Binomial, Poisson, Normal, Rectangular and exponential distributions and their PDFs. Moments and MGFs for above distributions.</td></tr>
<tr><td>Course Outcome</td><td colspan="4"><table>
<tr><td>CO1</td><td>Recall the significance of Difference Equations</td><td>Remember</td><td></td></tr>
<tr><td>CO2</td><td>Explain the Sampling Theory.</td><td>Understand</td><td></td></tr>
<tr><td>CO3</td><td>Apply the importance of mathematics and its techniques to solve real life problems</td><td>Apply</td><td></td></tr>
<tr><td>CO4</td><td>Analyze the limitations of such techniques and the validity of the results.</td><td>Analyze</td><td></td></tr>
<tr><td>CO5</td><td>Evaluate the application of Difference equations in Numerical methods.</td><td>Evaluate</td><td></td></tr>
<tr><td>CO6</td><td>Create the geometrical meaning of the Difference equations</td><td>Create</td><td></td></tr>
</table></td></tr>
<tr><td></td><td>Learner support Material</td><td colspan="3">NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.</td></tr>
<tr><td></td><td>Text books (Latest Editions)</td><td colspan="3">1.“Mathematical Methods”-Potter, M C; Goldberg Jack, PHI,2010
2.Probability and Statistics” – Schaum’s Series – McGraw Hill,2015.
3.Walter G. Kelley and Allan C. Peterson- Difference Equations. An Introduction with Applications, Academic Press Inc., Harcourt Brace Joranovich Publishers, 2014.
4. Calvin Ahlbrandt and Allan C. Peterson. Discrete Hamiltonian Systems, Difference Equations, Continued Fractions and Riccatti Equations. Kluwer, Boston, 2015.</td></tr>
<tr><td></td><td>Online resources</td><td colspan="3">IOP Science Journals, Elsevier Mathematics Journals.</td></tr>
</table>

<table>
<tr><td>Subject Name</td><td colspan="4">Mathematical Statistics</td></tr>
<tr><td>Course Objective</td><td colspan="4">The objective of this course is to provide an understanding for the graduate business student on statistical concepts to include measurements of location and dispersion, probability, probability distributions, sampling, estimation, hypothesis testing, regression, and correlation analysis, multiple regression and business/economic forecasting.</td></tr>
<tr><td>Unit I</td><td colspan="4">Probability Theory: Three definitions of probability (Mathematical, Empirical & axiomatic). Dependent, independent and compound events. Addition and multiplication theorems of probability, conditional probability. Binomial and multinomial theorems of probability, Baye’s theorem, Mathematical expectation and its properties, Moment generating functions (m.g.f.) and cumulants.</td></tr>
<tr><td>Unit II</td><td colspan="4">Discrete distribution– Binomial & Poisson distributions and their properties.
Continuous distribution: – Distribution function, Probability density function (Pdf), Cauchy’s distribution, rectangular distribution, exponential distribution, Beta, Gamma Normal distributions and their properties.
Fitting of the Curves by method of least square – Straight line, parabola and exponential curves.</td></tr>
<tr><td>Unit III</td><td colspan="4">Correlation and Regression: Bivariate population, Meaning of correlation & regression. Coefficient of Correlation, rank correlation, lines of regression. Properties of regression coefficients, Partial and multiple correlation and their simple Properties.</td></tr>
<tr><td>Unit IV</td><td colspan="4">Types of population, Parameters & Statistics, Null Hypothesis, Level of Significance, critical region. Procedure for testing Hypothesis. Type I & Type II error, Chi Square - distribution and its properties.</td></tr>
<tr><td>Course Outcome</td><td>CO1</td><td>Recall the dependent, independent, compound events, addition and multiplication theorems of probability.</td><td>Remember</td><td></td></tr>
<tr><td></td><td>CO2</td><td>Explain the Binomial & Poisson distributions and their properties.</td><td>Understand</td><td></td></tr>
<tr><td></td><td>CO3</td><td>Apply the Fitting of the Curves by method of least square.</td><td>Apply</td><td></td></tr>
<tr><td></td><td>CO4</td><td>Analyze the Parameters & Statistics, Null Hypothesis, Level of Significance and critical region.</td><td>Analyze</td><td></td></tr>
<tr><td></td><td>CO5</td><td>Evaluate the Coefficient of Correlation, rank of correlation and lines of regression.</td><td>Evaluate</td><td></td></tr>
<tr><td></td><td>CO6</td><td>Create the Procedure for testing Hypothesis.</td><td>Create</td><td></td></tr>
<tr><td></td><td colspan="2">Learner support Material</td><td colspan="2">NPTL,Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.</td></tr>
</table>

	Text books (Latest Editions)	1. A.M. Goon, M. K. Gupta and B. Dasgupta, Fundamentals of Statistics, Vol I and II, World Press, 2005. 2. J. D. Gibbons, Non-parametric Statistical Inference, McGraw-Hill Inc, 2015. 3. R. V. Hogg, J. McKean and A. Craig, Introduction to Mathematical Statistics, 7th Edition, Pearson, 2012.
	Online resources	IOP Science Journals, Elsevier Mathematics Journals.

Subject Name	**SCIENTIFIC WRITING AND ACADEMIC INTEGRITY**
Course Objective	In this course, participants will learn about the different types of scientific articles and know how to write an original research article by describing their original scientific research while maintaining academic integrity.
Unit I	**Probability Theory:** Three definitions of probability (Mathematical, Empirical & axiomatic). Dependent, independent and compound events. Addition and multiplication theorems of probability, conditional probability. Binomial and multinomial theorems of probability, Baye's theorem, Mathematical expectation and its properties, Moment generating functions (m.g.f.) and cumulants.
Unit II	Discrete distribution– Binomial & Poisson distributions and their properties. Continuous distribution: – Distribution function, Probability density function (Pdf), Cauchy's distribution, rectangular distribution, exponential distribution, Beta, Gamma Normal distributions and their properties. Fitting of the Curves by method of least square – Straight line, parabola and exponential curves.
Unit III	**Correlation and Regression**: Bivariate population, Meaning of correlation & regression. Coefficient of Correlation, rank correlation, lines of regression. Properties of regression coefficients, Partial and multiple correlation and their simple Properties.
Unit IV	Types of population, Parameters & Statistics, Null Hypothesis, Level of Significance, critical region. Procedure for testing Hypothesis. Type I & Type II error, Chi Square - distribution and its properties.
Course Outcome	Upon completion of this course students will be able to: ❖ Describe and utilize writing resources available. ❖ Create scientific documents using their improved scientific writing skills. ❖ Exercise accepted methods for literature discussion, citing and quoting to written scientific documents, while avoiding plagiarism. ❖ Apply electronic resources, including EndNote and iThenticate, to written scientific documents.

	❖ Write a good, solid draft of the specific aims and background related to their Master's Thesis, PhD research proposal and other academic work. ❖ Understand the academic misconduct, conflict of interest and academic cheating.	
➢	Text books (Latest Editions)	1. Communicating science effectively: a research agenda, Washington, DC: the National Academies Press, 2017. 2. Communicate science papers, presentations, and posters effectively: papers, posters, and presentations, London: Academic Press, an imprint of Elsevier, 2015. 3. Systematic approaches to a successful literature review, Los Angeles: Sage, 2016, second edition. 4. Doing a systematic review: a student's guide, London SAGE, 2017, second edition. 5. Handbook of Academic Integrity (Bretag, Tracey (Ed.)), 2016, Springer Singapore.

Annexure II- Mandatory Documents for Admission

To be uploaded on the Admission Portal by the Prospective students

Admission Documents	Format (Jpeg/PNG/PDF)	Documents Size
Duly filled application form with student signature	Digital signature/Student signature JPEG/PNG	20 KB
Colour scan copy of all year/semester mark sheet/grade cards (for PG programs only) or consolidated mark sheet/grade cards also accepted.	PDF/JPEG	500 KB
Colour scan copy of 10th std. Mark sheet/grade card	PDF/JPEG	
Colour scan copy of 12th std./ Three-Year Polytechnic Diploma Mark sheet/grade card	PDF/JPEG	
Colour scan copy of passport size photograph	JPEG or PNG Format	50 KB
Colour scan copy of Govt. Photo id proof, Aadhar card is mandatory. (Other options: Voter's id, Driving License, Passport etc.)	PDF/JPEG	100 KB
In case of name change, Gazette notification documents for name changes For married women – marriage certificate would be accepted – provided previous maiden name is clearly mentioned in the same. In case of deferred Father name or mother name in such cases without a Gazette notification document.	PDF	500 KB
Fees submission transaction details or receipt as per University policy for respective Distance programs	PDF/JPEG	500 KB
Digitally Signed undertaking as per the process; where applicable	PDF	500 KB

Students can also visit the University website for the said information.

Annexure III- Academic Bank of Credit Id Creation Process

All enrolled students, particularly those of Indian nationality, are required to register with ABC (Academic Bank of Credits), a central scheme established by the Ministry of Education, Government of India, for depositing credit. ABC ID creation is mandatory for all students, ensuring their participation in this scheme.

The ABC Id can be created by students themselves using Digi-locker, UMANG application, ABC portal or Academic Institution Portal. The process for which is provided below.

Process	• Students can register by logging in at www.abc.digilocker.gov.in • Click on My Account → Login as Student • Click on "Sign up with DigiLocker" → Enter valid mobile number → An OTP is sent at the phone number via SMS → Enter the OTP and click on "Continue" button → Enter Security PIN set created during Sign Up and click "Submit" Button • You will be prompted with ABC student account creation window
Documents and proofs required	• Aadhaar Card is mandatory for ABC Id creation • Learners Name • Date of Birth • Gender • Enrolment Number • Requirements by Academic Institution: • Mobile Number

The University will extend support to the students to create ABC ID. The documents required will remain the same as stated above.

Annexure IV – Continuous Internal Assessment Pattern

Particular	A1 (Objective Type)	A2 (Objective Type)
Marks	15	15

Question Pattern for the CIA Components
A-1 1.There will be 15 Objective type Multiple Choice Questions (MCQs), each carrying mark1 mark 2. The time for the A-1 assignment will be 30 mins 3. All questions are compulsory 4. There will be NO NEGATIVE MARKING for the wrong answers. **A-2** 1. There will be 15 Objective type Multiple Choice Questions (MCQs), each carrying mark1 mark 2. The time for the A-1 assignment will be 30 mins 3. All questions are compulsory 4. There will be NO NEGATIVE MARKING for the wrong answers.

Annexure V– End-term Examination Pattern

JNU

Centre for Distance and Online Education

End Term Examination

[PROGRAM NAME]

[COURSE NAME][COURSE CODE]

Time : 2 Hours	Max. Marks : 70
Note for students: The paper will comprises of 70 compulsory objective questions of 1 mark each.	
Answer all the questions. Each question carries one mark.	
Q. No. 1 to Q. No. 70 - Objective questions with four multiple choices.	

JAIPUR NATIONAL UNIVERSITY

A venture of The Seedling Group of Educational Institutions

Master of Science - Mathematics
(M.Sc. - Mathematics)
Online Mode

PROGRAM PROJECT REPORT – M.Sc. - Mathematics – Online Mode

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M.SC - MATHEMATICS – Online Mode

1. Program Overview

1.1 Program's Mission and Objectives

The mission of the M.Sc Mathematics program is to provide students with a comprehensive education in advanced mathematical concepts, theories, and methodologies, preparing them for careers in academia, industry, or research. The program aims to cultivate a strong foundation in mathematical principles while promoting intellectual curiosity, creativity, and lifelong learning.

Program Objectives:

1. Advanced Knowledge: To equip students with advanced knowledge and understanding of various branches of mathematics, including but not limited to algebra, analysis, topology, geometry, and applied mathematics.

2. Critical Thinking: To develop students' ability to think critically and analytically about mathematical problems, concepts, and theories, enabling them to formulate and solve complex mathematical problems.

3. Research Skills: To foster research skills in students, including the ability to review literature, formulate research questions, design experiments, collect and analyze data, and draw meaningful conclusions, culminating in a thesis or research project.

4. Communication: To enhance students' communication skills, both written and oral, enabling them to effectively communicate mathematical ideas, results, and conclusions to diverse audiences, including peers, experts, and the general public.

5. Application of Mathematics: To demonstrate the application of mathematical concepts and techniques to real-world problems in various fields, such as physics, engineering, computer science, economics, and finance.

6. Interdisciplinary Perspective: To encourage interdisciplinary collaboration and application of mathematical methods to address problems in other disciplines, fostering innovation and creativity.

7. Ethical Conduct: To instil ethical values and professional integrity in students, emphasizing honesty, rigor, and accountability in their academic and professional endeavours.

8. Professional Development: To provide opportunities for professional development, including seminars, workshops, conferences, and internships, to prepare students for successful careers in academia, industry, or research.

9. Continued Learning: To promote lifelong learning and professional growth among graduates, encouraging them to stay updated with the latest developments in mathematics and related fields through self-directed study, continuing education programs, and participation in professional societies.

By aligning the curriculum, teaching methodologies, and assessment practices with these objectives, the M.Sc Mathematics program aims to produce graduates who are well-equipped to make significant contributions to the advancement of mathematics and its applications in the broader context of society.

1.2 Relevance of the Program with JNU's Vision and Mission

Jaipur National University (JNU) was established in 2007. JNU provides a world-class learning experience, with a highly accomplished faculty, numerous extracurricular activities, and a wide range of academic pursuits. The university fosters holistic development of students.

JNU with its vision to transform the Education Landscape of India and contribute to the maximum to improve the GER of India has plans to launch affordable and flexible education programs. Online programs are an excellent way to launch affordable and flexible education programs in sync with the vision and mission of the university stated below:

University Vision:

To be a leader in creating unique and exclusive learning opportunities in all disciplines of study that ultimately lead to the advancement of learning and creation of a sustainable society and environment.

University Mission:

- Provide global opportunities of learning through broad and balanced academic programmes.
- Explore and hone the potential of stakeholders, develop their human and intellectual capacities to the fullest.
- Create and maintain excellence with high standard driven activities, universal significance and acknowledgement.
- Inculcate and keep track of the current trends and finest practices in education for constant growing and evolving.

1.3 Nature of Prospective Target Group of Students

The curriculum of the M.Sc Mathematics program is meticulously crafted to enhance not only the employability of students but also to inspire entrepreneurial ventures. The primary target audience includes:

- Individuals of all ages residing in remote regions with limited access to higher education institutions.
- Learners who were unable to secure admission in traditional programs due to restricted intake capacities.
- Working professionals aspiring to advance their careers through higher education.
- Individuals unable to pursue further education due to socio-economic constraints or demographic factors.

By catering to these diverse groups, the program aims to democratize access to advanced mathematical education, empowering individuals from all backgrounds to enhance their skills, explore entrepreneurial opportunities, and contribute meaningfully to society and the economy

1.4 Appropriateness of programs to be conducted in online mode to acquire specific skills and competence

The significance of the M.Sc Mathematics program lies in its ability to equip students with advanced mathematical knowledge and analytical skills, making them highly sought after in

various industries and sectors. This program provides a deep understanding of mathematical principles, theories, and techniques, which are essential for solving complex problems in fields such as finance, engineering, computer science, and more. Graduates of this program are well-prepared for careers in research, academia, data analysis, cryptography, and numerous other areas where expertise in mathematics is valued. Additionally, the M.Sc Mathematics program contributes to the advancement of knowledge in mathematics and its applications, driving innovation and progress in diverse fields.

2. Procedure for Admission and Curriculum Transaction

The academic programs catered to candidates enrolled in the online mode of learning are facilitated by CDOE-JNU, with the backing of various faculties within the University. Eligibility criteria, course structure, detailed curriculum, program duration, and evaluation criteria are subject to approval by the Board of Studies and Academic Council, adhering to UGC guidelines for programs falling under the purview of online mode for degree conferment.

Below are the details of the admission procedure, eligibility criteria, fee structure, curriculum, program delivery, information about the Learning Management System (LMS), and assessments and evaluations.

2.1Procedure for Admission

Students who are seeking admission in programs offered by CDOE-JNU need to apply through https://online.jnujaipur.ac.in/ in the courses offered.

2.1.1 Minimum Eligibility Criteria for Admission

The minimum eligibility criteria for admission to the Online M.SC - Mathematics program require candidates to hold a Bachelor's degree of a minimum duration of 3 years from a recognized University in any stream, in accordance with UGC and AICTE norms. Additionally, candidates must have secured at least 40% marks in the qualifying examination.

Candidates must also fulfill all documentation requirements as specified on the program's website for admission purposes. Failure to submit proof of eligibility within the stipulated timeframe specified by CDOE-JNU will result in the cancellation of admission. Prospective candidates are encouraged to carefully review all instructions provided on the website before proceeding with the application process.

2.1.2 Online Admission Process and Instructions: Learner Communication

The online admission process for the students is provided below:

Step	Process	Particulars
Step 1	**Counselling**	Prospective students will receive guidance and counseling for their chosen program from designated and authorized counselors.
Step 2	**Registration on admission portal to get access to My Account.**	They must then complete the application form by providing all necessary details and uploading mandatory documents.
Step 3	**Details of Document upload**	Student Uploads document as follows- <u>Personal Documents</u> Passport-size Photograph Student's Signature Aadhar Card (Back & Front) Passport (For International Student) <u>Academic Documents</u> *UG Student -* 10th Marksheet 12th Marksheet *PG Student -* 10th Marksheet 12th Marksheet UG Marksheet Other Certificates (detailed list of documents is provided in **Annexure II**)
Step 4	**Verification of documents by the Deputy Registrar**	The Deputy Registrar is responsible for verifying all documents uploaded by prospective students on the admission portal. Within a timeframe of 48 hours, the Deputy Registrar will review and either approve ordisapprove the eligibility of the prospective student for the chosen program.
Step 5	**Undertaking**	Student will sign Undertaking after Approval in Application.
Step 6	**Payment of fees**	All eligible students, duly approved by the Deputy Registrar, will get fees payment link activated in their

		My Account for payment. The Fee is payable through any of the following means: (a) UPI (b) Credit/Debit Card (c) Net-banking Note: Cash, bank demand draft and Cheques are not accepted
Step 7	**Enrolment**	After the payment of program fee, the eligible student will get the Enrolment number and access to the LMS within 21 days.
Step 8	**Access to Learning Management System (LMS)**	

General Instructions:

1. Prior to applying for online programs, all students are advised to thoroughly read and comprehend the eligibility conditions provided in the student handbook document and outlined on the university website.
2. It is the responsibility of prospective learners to ensure that their educational or qualifying degree has been issued by a recognized university or board only. For learners from Indian higher education institutions, recognition by the regulatory authority of the Government of India is necessary. To verify degrees from recognized boards of education, refer to www.cobse.org.in/. For Polytechnic Diploma, check the respective State Board of Technical Education. Verification of degrees from recognized universities can be done at www.ugc.ac.in/. Foreign prospective learners should verify their institutions at www.aiu.ac.in/.
3. Prospective learners must verify their eligibility on the date of admission and ensure that they have passed the qualifying exams before the commencement of the admission batch.

Upon enrollment, students must register with the Academic Bank of Credits (ABC), a central scheme for depositing credit formulated by the Ministry of Education, Government of India. Creation of an Academic Bank of Credits (ABC) ID is mandatory for all students. (Refer to Annexure V for details).

2.1.3 Program Fee for the Academic Session beginning July 2024

Program fees for students pursuing M.SC - Mathematics offered by CDOE-JNU is mentioned below:

Program	Academic Total Fees (INR)	Exam Fees
M.Sc – Mathematics	**60,000**	**1500 per Semester**

2.1.4 Financial Assistance Policy

Students will make fee payments through the online mode available on the university website. Additionally, the University has collaborated with a third-party Non-Banking Financial Company (NBFC) to offer financial assistance to individuals who require it.

2.2 Curriculum Transactions

2.2.1 Program Delivery

The curriculum is delivered through Self Learning Materials (SLMs) in the form of e-Contents, supplemented by a variety of learning resources including audio-video aids via the Learning Management System (LMS), following the four-quadrant approach. Furthermore, the program includes online contact hours featuring discussion forums and synchronous live interactive sessions conducted through the LMS, adhering to the current UGC norms for course delivery.

2.2.2 Learning Management System to support online mode of Course delivery

The Learning Management System (LMS) is available on URL https://lms.jnujaipur.ac.in/is meticulously developed to offer students a truly global learning experience. With a user-friendly interface, the LMS simplifies the learning process and ensures it meets the highest global standards. Utilizing audio-visual teaching methods, self-learning materials, discussion forums, and evaluation patterns, the platform stands out as unique and aligns seamlessly with both industry requirements and the UGC Guidelines' four-quadrant approach.

Students can engage in uninterrupted learning 24x7 via web and mobile devices, allowing them to progress at their preferred pace. The LMS boasts a simple and intuitive user interface, facilitating easy navigation through the e-learning modules. Designed in accordance with standard norms, all learning tools are easily accessible, ensuring a perfect learning experience for all users.

2.2.3 Course Design

The Course content is designed as per the 4-quadrant approach as detailed below to facilitate seamless delivery and learning experience

Quadrant-I i.e., e-Tutorial, that contains – Faculty led Video and Audio Contents, Simulations, video demonstrations, Virtual Labs

Quadrant-II i.e., e-Content that contains – Portable Document Format or e-Books or Illustration, video demonstrations, documents as required.

Quadrant-III i.e., Discussion forums to raise and clarify doubts on real time basis by the Course Coordinator and his team.

Quadrant-IV i.e. Self-Assessment, that contains MCQs, Problems, Quizzes, Assignments with solutions and Discussion forum topics.

2.2.4 Academic Calendar for Academic Session beginning July 2024

Sr. No.	**Event**	**Session**	**Month (Tentative)**
1.	Commencement of semester	January	January
		July	July
2.	Enrol learner to Learning Management system	January	Within 21 working days from fee deposit and Eligibility confirmation
		July	
3.	Interactive Live Lectures for query resolution	January	February to May
		July	August to November
4.	Assignment Submission	January	By April
		July	By October
5	Project Report Submission (Wherever applicable during Final semester)	January	Last week of April
		July	Last week of November
6	Term End Examination	January	May onwards
		July	December onwards
7	Result Declaration of End Term Examination	January	By June
		July	By January

3. Instructional Design

3.1 Curriculum Design

The curriculum is meticulously designed by experts in the field of Mathematics, incorporating contemporary topics and fostering environmental awareness. It has received approval from the Board of Studies, the Centre for Internal Quality Assurance (CIQA), and the University Academic Council.

3.2 Program Structure and detailed Syllabus

3.2.1 Program Structure

Semester: I

Course code	Subject Name	Course Category	Hours Per Week			Credits	Evaluation Scheme		Total
			L	T	P		Int	Ext	
OMSMCO101T24	Calculus of variation and special functions	Core	4	0	0	4	30	70	100
OMSMCO102T24	Differential Equations	Core	4	0	0	4	30	70	100
OMSMCO103T24	Real Analysis	Core	4	0	0	4	30	70	100
OMSMCO104T24	C Programming	Core	4	0	0	4	30	70	100
OMSMCO104P24	C Programming Lab	Core	0	0	4	2	30	70	100
OMSMDS101T24	**Industrial Mathematics	DSE	4	0	0	4	30	70	100
OMSMDS102T24	*Hydrodynamics								
OMSMVA101T24	Waste water Treatment	VAC	2	0	0	2	30	70	100
		GE/OE*	2	0	0	2	30	70	100
		Total	**24**	**0**	**4**	**26**			

L: Lecturer, **T**: Tutorial, **P**: Practical **IA:** Internal Assessment, **ETE:** End Term Exam
*Students can obtain credits from MOOC. ** Students can obtain credits from University or from MOOC.
Students can choose any one subject from the following list of subjects:

Sr. No	Subject Code	Name of Subject	Name of School

1	OMSMGE101T24	Productivity Tools	SCHOOL OF COMPUTER AND SYSTEM SCIENCES
2	OMSMGE102T24	Understanding Prescription, Doses and doses forms	SCHOOL OF PHARMACEUTICAL SCIENCES
3	OMSMGE103T24	Dining etiquettes	SCHOOL OF HOTEL MANAGEMENT AND CATERING TECHNOLOGY
4	OMSMGE104T24	Basics of Photography	SCHOOL OF MEDIA STUDIES
5	OMSMGE105T24	Mobile App Designing	SCHOOL OF ENGGINEERING AND TECHNOLOGY

Semester: II

Course code	Subject Name	Course Category	Hours Per Week			Credits	Evaluation Scheme		Total
			L	T	P		Int	Ext	
OMSMCO201T24	Numerical and Statistical Techniques	Core	4	0	0	4	30	70	100
OMSMCO202T24	Abstract Algebra	Core	4	0	0	4	30	70	100
OMSMCO203T24	Mathematical Programming	Core	4	0	0	4	30	70	100
OMSMCO204T24	Continuum mechanics	Core	4	0	0	4	30	70	100
OMSMCO201P24	Numerical & Statistical Techniques Lab	Core	0	0	4	2	30	70	100
OMSMDS201T24	Computer Application	DSE	4	0	0	4	30	70	100
OMSMDS202T24	Differential Geometry								
OMSMVA201T24	Biostatistics	VAC	2	0	0	2	30	70	100
	OE*		2	0	0	2	30	70	100
	Total		**24**	**0**	**4**	**26**			

L: Lecturer, **T**: Tutorial, **P**: Practical **IA:** Internal Assessment, **ETE:** End Term Exam
Exit Option:-PG Diploma in Mathematics.
Min Credit 52.

*Students can choose any one subject from the following list of subjects:

Sr. No	Subject Code	Name of Subject	Name of School
1	OMSMGE201T24	Website Designing	SCHOOL OF COMPUTER AND SYSTEM SCIENCE
2		Introduction to	SCHOOL OF PHARMACEUTICAL SCIENCES

	OMSMGE202T24	Epidemiology	
3	OMSMGE203T24	Basics of Baking	SCHOOL OF HOTEL MANAGEMENT AND CATERING TECHNOLOGY
4	OMSMGE204T24	Videography	SCHOOL OF MEDIA STUDIES
5	OMSMGE205T24	Food Processing & Preservation	SCHOOL OF ENGGINEERING AND TECHNOLOGY

Semester: III

Course code	Subject Name	Course Category	Hours Per Week			Credits	Evaluation Scheme	
			L	T	P		Int	Ext
OMSMCO301T24	Linear Algebra	Core	4	0	0	4	30	70
OMSMCO302T24	Mechanics	Core	4	0	0	4	30	70
OMSMCO303T24	Integral Transforms	Core	4	0	0	4	30	70
OMSMCO304T24	Advance differential equations	Core	4	0	0	4	30	70
OMSMCO305P24	Optimization Techniques Simulation Lab	Core	0	0	4	2	30	70
OMSMDS301T24	Viscous Fluid Dynamics	DSE	4	0	0	4	30	70
OMSMDS302T24	Combinatorics & Graph Theory							
OMSMVA301T24	Research Methodology	VAC	2	0	0	2	30	70
	OE*		2	0	0	2	30	70
	Total		**24**	**0**	**4**	**26**		

L: Lecturer, **T**: Tutorial, **P**: Practical **IA:** Internal Assessment, **ETE:** End Term Exam

*Students can choose any one subject from the following list of subjects:

Sr. No	Subject Code	Name of Subject	Name of School
1	OMSMGE301T24	Basics Computer Networks - Everyone Must Know	SCHOOL OF COMPUTER AND SYSTEM SCIENCES
2	OMSMGE302T24	Public Health Pharmacy	SCHOOL OF PHARMACEUTICAL SCIENCES

3	OMSMGE303T24	Rajasthani and Punjabi cuisine	SCHOOL OF HOTEL MANAGEMENT AND CATERING TECHNOLOGY
4	OMSMGE304T24	Script writing for film	SCHOOL OF MEDIA STUDIES
5	OMSMGE305T24	Solar & Renewable Energy	SCHOOL OF ENGGINEERING AND TECHNOLOGY

Semester: IV

Course code	Subject Name	Course Category	Hours Per Week			Credits	Evaluation Scheme		Total
			L	T	P		Int	Ext	
OMSMCO401T24	Functional Analysis	Core	4	0	0	4	30	70	100
OMSMCO402T24	Integral Equations	Core	4	0	0	4	30	70	100
OMSMCO403T24	Complex Analysis	Core	4	0	0	4	30	70	100
OMSMCO404T24	Number Theory	Core	4	0	0	4	30	70	100
OMSMCO405P24	Dissertation	Core	0	0	12	6	30	70	100
OMSMDS401T24	Difference Equations and Sampling Theory	DSE	4	0	0	4	30	70	100
OMSMDS402T24	Mathematical Statistics								
OMSMVA401T24	Scientific Writing & Academic Integrating	VAC	2	0	0	2	30	70	100
	OE*		0	0	2	2	30	70	100
	Total		**22**	**0**	14	30			

L: Lecturer, **T**: Tutorial, **P**: Practical **IA:** Internal Assessment, **ETE:** End Term Exam

Course Completion:-

Master of Science in Mathematics with minimum 108 Credits.

*Students can choose any one subject from the following list of subjects:

Sr. No	Subject Code	Name of Subject	Name Of School
1	OMSMGE401T24	End User Database Management System	SCHOOL OF COMPUTER AND SYSTEM SCIENCES
2	OMSMGE402T24	Social Pharmacy	SCHOOL OF PHARMACEUTICAL SCIENCES

3	OMSMGE403T24	Reception management	SCHOOL OF HOTEL MANAGEMENT AND CATERING TECHNOLOGY
4	OMSMGE404T24	Radio Jockey	SCHOOL OF MEDIA STUDIES
5	OMSMGE405T24	Industrial Safety & Hazard Management.	SCHOOL OF ENGGINEERING AND TECHNOLOGY (SADTM)

3.4.2 Detailed Syllabus of M.SC - MATHEMATICS

Detailed syllabus of M.SC - MATHEMATICS is attached in Annexure-I.

3.5 Duration of the Program

Program	Level	Duration	Maximum duration for completion	Credits
M.SC – MATHEMATICS	Master's Degree	2 years (4 Semesters)	4 Years	108

3.6 Faculty and Support staff requirements (Refer Regulation Document for all Staff Details)

3.4.1Director

The selected candidate will assume the role of a permanent, full-time Professor, bringing expertise in overseeing and coordinating online and distance learning initiatives throughout their career. They will spearhead the CDOE-JNU department, ensuring seamless coordination among faculty, the technology department, and staff. This individual will hold responsibilities encompassing both academic and administrative realms.

KRA

1. Oversee the operations of CDOE-JNU and the Learning Management System (LMS), in addition to supervising relevant staff members.
2. Foster collaboration among various faculties and supervisors to ensure the implementation of suitable pedagogical approaches and delivery of high-quality educational content.
3. Continuously assess the strengths and weaknesses of the program, offering appropriate solutions and enhancements as needed.

3.4.2 Deputy Director

The candidate is required to hold the position of Associate Professor in accordance with UGC Regulations 2018. Proficiency in Learning Management Systems (LMS) is essential, along with technical proficiency to facilitate and contribute to module development.

KRA:-

1. Collaborate with the Technical Manager to provide information manuals and documents to CDOE team members.
2. Develop the academic calendar for the academic sessions.
3. Review the timetable for live classes and interactive sessions, offering recommendations to the Program Coordinator as needed.
4. Approve the Content Matrix for each program, ensuring compliance with UGC guidelines.
5. Participate in syllabus design and updates in consultation with the Board of Studies and Academic Council of JNU to meet industry requirements.
6. Ensure academic planning, conduct academic audits, and implement academic policies.
7. Incorporate and implement changes in academic delivery as per UGC amendments.
8. Approve e-content and e-tutorials, forwarding them to the Technical Manager for upload on the LMS.
9. Monitor faculty members' live classes and interactive sessions, coordinating with the Program Coordinator to record attendance.
10. Maintain records of learner dropouts, actively minimizing dropout rates through student follow-up and support.
11. Issue academic notifications for lectures, events, content uploads, and examinations regularly.
12. Ensure adherence to the four-quadrant approach in academic practices.
13. Propose schedules for continuous internal assessments and end-term examinations, approving them for circulation.
14. Supply approved schedules to the Technical Manager for upload on the LMS.

15. Review reports on student performance and attendance in assessments periodically.
16. Ensure timely submission of internal assessment marks to the Controller of Examinations (CoE) and upload them as per schedule.
17. Monitor submission of examination forms and payment of examination fees by students within deadlines, communicating with the CoE as necessary.
18. Coordinate with the CoE for all examination-related matters at CDOE-JNU.
19. Arrange provision for industrial interface and provide assistance to students, coordinating with the Program Coordinator.
20. Organize orientation, Faculty Development Programs (FDP), and training programs for CDOE-JNU team members periodically.
21. Fulfill any other assigned functions as part of relevant committees or teams to ensure smooth functioning of CDOE-JNU.

3.4.3 Assistant Director

The candidate must hold the position of Associate Professor as per UGC Regulations 2018 and possess prior experience in overseeing online education programs.

KRA:-

1. Coordinate with different departments that offer online programs.
2. Aid the Deputy Director in fulfilling daily responsibilities associated with the Online Program.
3. Ensure that courses are conducted according to schedule and without any errors.
4. Ensure timely completion of assigned tasks as directed by the Deputy Director.

3.4.4 Program Coordinator

Each program will require the appointment of a Program Coordinator. Eligible candidates for this role must meet the qualifications outlined in the UGC Regulations 2018 for either Associate Professor or Assistant Professor.

KRA

1. Prepare the timetable for live classes and interactive sessions, ensuring accessibility for

both students and faculty, with approval from the Deputy Director.

2. Schedule or reschedule classes as needed.
3. Ensure course content aligns with the Content Matrix, coordinating with faculties and academic partners.
4. Develop a subject allocation plan in consultation with faculty members, seeking approval from the Deputy Director.
5. Maintain faculty attendance records and ensure regular participation in live classes and interactive sessions, reporting to the Deputy Director.
6. Ensure instructional delivery adheres to the Content Matrix and UGC regulations.
7. Review the quality and plagiarism of e-content and e-tutorials, coordinating with the Course Coordinator and submitting for approval to the Deputy Director.
8. Ensure timely availability of e-content, e-tutorials, and events on the LMS.
9. Assist the Deputy Director in uploading e-content and e-tutorials on the LMS in coordination with technical departments.
10. Provide technical support to faculty and students throughout the course duration.
11. Schedule and deliver live lectures punctually and without technical issues.
12. Monitor student attendance in live classes and interactive sessions, maintaining accurate records.
13. Ensure scheduled lectures are completed on time and utilize the allocated credit hours.
14. Schedule sessions with Visiting Faculty, subject to approval from the Director.
15. Coordinate with the Deputy Director for soft skill and value-added certificate programs to enhance students' career prospects.
16. Coordinate academic activities such as Discussion Forums with Course Coordinators.
17. Pace and plan continuous internal assessments, ensuring technical feasibility and effective communication.
18. Ensure assessment contents align with Quadrant-IV and are uploaded on the LMS by faculty.
19. Allocate faculty for student project work, establish completion timelines, communicate dissertation preparation guidelines, ensure plagiarism checks, and monitor topic diversity.

20. Ensure timely thesis submission and schedule viva-voce examinations for students.
21. Submit online program question papers within deadlines and communicate with the Controller of Examinations.
22. Monitor faculty evaluation and uploading of marks on the LMS.
23. Ensure timely completion of evaluations for publishing results within planned timelines, consulting with the Controller of Examinations.

3.4.5 Course Coordinator

Each course will require the appointment of a Course Coordinator possessing subject expertise and industry knowledge necessary for academic delivery. Eligible candidates for this role must meet the qualifications and experience outlined in the UGC Regulations 2018 for Professor, Associate Professor, or Assistant Professor.

KRA

1. Familiarize oneself with the LMS operations before the session begins.
2. Prepare thoroughly for daily sessions, engaging students for the entire allocated time and fostering effective communication.
3. Organize Discussion Forums for clearing doubts and promptly respond to student queries via chat, email, phone, video, or other synchronous tools, adhering to university policies and SRM directives.
4. Provide regular feedback to students on discussion board activities, assignments, tests, etc.
5. Conduct plagiarism checks on all e-tutorials and e-content according to UGC's four-quadrant framework, reporting findings to the Program Coordinator.
6. Schedule regular assessments of course modules using the LMS platform.
7. Ensure assessments are conducted with integrity, reporting any instances of academic misconduct to the Program Coordinator.

3.4.6 Course Mentor

For each batch of 250 students, the appointment of one Course Mentor is required. Eligible candidates for this role must meet the qualifications and experience outlined in the UGC Regulations 2018 for Assistant Professor.

KRA

1. Assist the Program Coordinator and Course Coordinator in sharing academic knowledge and resolving procedural queries as requested by students.
2. Supervise teacher-student interaction groups.
3. Aid the Course Coordinator in organizing and actively participating in discussion forums.
4. Develop mechanisms to improve learners' learning experiences through open dialogues, counseling, etc.
5. Ensure resolution of non-academic queries.

3.4.7 Examinations

Deputy Controller of Examination (Dy. CoE)

The Deputy Controller of Examinations (Dy. CoE) is responsible for overseeing and executing all functions related to the entire examination process.

KRA

1. Verify that students at CDOE-JNU meet examination eligibility criteria, in coordination with the Dy. Director.
2. Ensure students submit examination forms and pay fees within deadlines, in coordination with the Dy. Registrar and student cell.
3. Issue admit cards to compliant students at least 3 days before end-term examinations, coordinating with the academic team.
4. Prepare and release the Examination Time-Table.
5. Appoint qualified faculty examiners for online student assessments, whether internal or external.

6. Ensure timely receipt of question papers for online programs, adhering to guidelines, in coordination with the Dy. Director.
7. Ensure faculty examiners receive appropriate payment for paper checking fees, as per CDOE-JNU norms.
8. Ensure timely declaration of results and issuance of grade cards to students, in coordination with the given time-frame.
9. Disseminate notifications, guidelines, and regulations to promote awareness of examination policies and procedures among students and faculty members at CDOE-JNU.
10. Coordinate with CDOE-JNU for all matters concerning result declaration and grade-card issuance.

3.4.8 Technical Support Team

1. *Technical Manager* (Operations)– One Technical Manager is to be appointed.

   KRA

   a) Upload academic content for delivery after approval from the Dy. Director.

   b) Develop e-tutorials and e-contents in alignment with the four-quadrants approach, UGC plagiarism guidelines, and branding guidelines of CDOE-JNU.

   c) Collaborate with other Technical Managers, ERP, and LMS providers for ongoing maintenance and issue resolution.

2. *Technical Associate* (Audio-Video recording and editing)– One Technical Associate is to be appointed.

   KRA

   a) a) Record, edit, and execute tasks related to creating audio-video content for CDOE-JNU.

   b) b) Implement changes and develop audio-video content as directed by the Technical Manager and Director.

3.4.9 Administrative StaffStrength

The strength of the administrative staff shall constitute of:

1. *Deputy Registrar* – One individual is to be appointed with minimum Master's degree qualification and five years of experience as an Assistant Registrar or an equivalent position. The individual should have expertise in adequate technology.

KRA

i. Coordinate with the Admissions teams to ensure smooth functioning of the admission process at CDOE-JNU.

ii. Ensure that Academic Bank of Credit (ABC) IDs are generated for all students after enrollment numbers are issued.

iii. Approve and ensure regular notifications related to administration are sent to faculty and staff.

iv. Conduct official correspondence with regulatory bodies, the Registrar's Office, and other stakeholders on behalf of CDOE-JNU.

v. Approve and ensure regular administration-related notifications are sent to students.

vi. Maintain records of student enrollment, including all necessary documents such as bonafide letters and NOCs.

vii. Collect fees from students when applicable.

viii. Conduct official correspondence with regulatory bodies, the Registrar's Office, and stakeholders as needed.

ix. Ensure scholarship facilities are provided to students based on criteria set by JNU and other funding agencies.

x. Ensure compliance with statutory regulations as per UGC, AICTE, and other regulatory bodies.

xi. Organize induction and training programs for new recruits and staff members at CDOE-JNU.

xii. Determine the need for recruiting staff members at various positions within the CDOE-JNU department.

xiii. Determine employee salaries based on university criteria and communicate this information to the JNU accounts department.

xiv. Ensure all required documents are submitted by employees for performance appraisals and communicate this to the Registrar's office.

xv. Organize events for effective employee engagement as deemed necessary.

xvi. Efficiently address employee grievances at CDOE-JNU.

xvii. Oversee the grievance redressal process for students.

xviii. Manage and oversee other duties related to the examinations, admissions, and technical departments.

2. Student Relationship Manager (SRM)

CDOE-JNU will appoint two Student Relationship Managers (SRM), each with a minimum qualification of an undergraduate degree and at least two years of relevant experience in managing student relationships within an academic institution. Candidates should possess excellent communication skills and demonstrate the ability to collaborate effectively in teams.

KRA

1. Establish and maintain relationships with prospective learners and their parents/guardians.
2. Assist learners in understanding the various courses offered and highlight their selling points.
3. Identify opportunities and weaknesses in the SRM systems and implement necessary changes.
4. Gather feedback and efficiently resolve complaints throughout the program duration.
5. Fulfill any other duties as required.

3.5 Instructional delivery mechanisms

JNU boasts a fully dedicated team of faculty members and staff proficient in delivering online lectures through CDOE – JNU. At the commencement of each session, students will receive the academic calendar via the Learning Management System (LMS). The distribution of self-learning material, audio, and video content to students will be facilitated through the LMS via the following delivery channels:

3.5.1 Four Quadrants and Academic Delivery

No. of Credits	Duration	Live Sessions	Quadrant – I e-Tutorial		Quadrant – II e-Content	Quadrant – III Discussion Forum	Quadrant – IV Assessment
			(Recorded Lecture)	Open Source Videos	e-Content(E-book/ PDF & PPT)	Live Session (2hrs/week)	CIA
2	6 weeks	6 (1/week)	6 hrs	4 hrs	• PPT and E-book/PDF • Reading time should be mentioned for each file	Forum Topics – For raising of doubts and clarifying the same on real time basis by the Course Coordinator or his team	Multiple Choice Questions, Fill in the blanks, Practice Questions.
Total Hours= 60		**6 hrs**	**10 Hrs**		**10 Hrs**	**12 hrs**	**22 Hrs**
3	9 weeks	9 (1 session/week)	9	6	• PPT and E-book/PDF Reading time should be mentioned for each file	-same-	-same-
Total Hours = 90		**9 Hrs**	**15 Hrs**		**15 Hours**	**18 hrs**	**33 Hrs**
4	12 weeks	12 (1 session/week)	12	8	• PPT and E-book/PDF Reading time should be mentioned for each file	-same-	-same-
Total Hours = 120		**12 Hrs**	**20 Hrs**		**20 Hours**	**24 hrs**	**44 Hrs**

*Proportionate Credit wise allocation would be done.

3.6 Identification of media-print, audio, or video, online, computer aided

The Learning Management System (LMS) serves as a comprehensive digital platform, offering a multitude of features including recorded faculty video lectures, real-time discussion forums, live sessions, e-content comprising study material, open source materials, and graded assessments. For each module within a course, there will be one live session conducted by the respective faculty member, focusing on a specific topic. CDOE-JNU has curated study material that is clear

and easily comprehensible, complete with concise summaries, self-assessment questions, and case studies.

Access to these course materials is facilitated through:

- Login credentials provided in the welcome email sent by the university
- Students can also log in via the University website at https://lms.jnujaipur.ac.in/ .

Online Courseware

Through the Learning Management System (LMS), students will have access to a comprehensive array of course materials, including:

- e-Books (Self Learning Materials)
- Study Guides (PowerPoint presentations)
- Tutorial Videos
- Live Interactive Online Sessions
- Frequently Asked Questions (FAQs) and Misconceptions
- Web Resources for Research Purposes
- Practice Assignments
- Online Discussion Forums
- Enriching Content such as gamified elements and Value Added Content
- The LMS is organized with semester/year-wise buckets for subjects and specializations of the respective programs as enrolled.

The Dashboard feature of the LMS serves to track and monitor students' learning progress. It includes functionalities such as:

- Monitoring progress in learning
- Receiving regular notifications about upcoming webinars, virtual classes, assignments, discussion forum participations, and examinations
- Providing a platform for raising queries, which can be addressed by course coordinators, mentors, and faculty members. may be answered and conveyed by the course coordinators mentors and faculty.

3.7 Student Support Services

Students will have access to support services provided by CDOE-JNU through the Student Relationship Management (SRM) system for queries related to administration and general technical

issues. A ticketing system integrated into the LMS will enable learners to connect with the CDOE-JNU technical team for support services, with resolutions handled by the appropriate authority. Notifications will also be sent to the Deputy Registrar to ensure queries are addressed within 24 hours or sooner.

For academic course-related queries, students can raise queries directly through an open discussion forum, which will notify the Course Coordinator, Program Coordinator, and Deputy Director. Queries should be resolved within 48 hours of being raised, with the Program Coordinator responsible for managing and resolving any unresolved matters. The Deputy Director will ensure the timely resolution of academic queries.

In addition to academic excellence, CDOE-JNU prioritizes the holistic development of its students. The department supports various initiatives to broaden students' opportunities and shape them into future leaders.

4. Assessment and Evaluation

4.1 Overview

The evaluation of students' learning will encompass internal assignments, quizzes, learner response sheets, and end-of-term examinations. CDOE-JNU follows a rigorous process in the development of question papers, creation of question and quiz banks, preparation and moderation of assignments, administration of examinations, analysis of answer scripts by qualified academics, and declaration of results. Question papers are meticulously framed to ensure comprehensive coverage of the syllabus.

The evaluation process will include two types of assessments:

Examination Name	Marks Division
Continuous internal assessment	30%
Summative assessment in the form of end-term examination. End-term examination will be held with proctored examination tool technology (follow **Annexure V** for guidelines and pre-requisites for Proctored Examination)	70%

The examinations are designed to evaluate the knowledge acquired during the study period.

For theory courses, internal evaluation will be conducted through Continuous Internal Assessment (CIA), which includes assignments and quizzes. The internal assessment will contribute a maximum of 30 marks for each course.

At the end of each semester, an end-of-semester online examination will be held for each course, lasting two hours.

Guidelines issued by the Regulatory Bodies from time-to-time about conduct of examinations shall be considered and new guidelines if any will be implemented.

4.2 Question Paper Pattern

Online Exam Time: 2 Hours

Max. Marks: 70

Exam will be comprising of 70 Multiple-Choice Questions (1 Mark Each) – 70 Marks

4.3 Distribution of Marks in Continuous Internal Assessments

The following procedure shall be followed for internal marks for theory courses. Weightage for Assignment is provided below:

Particular	A1 (MCQ Type)	A2 (MCQ Type)
Marks	15	15

Note: Refer to **Annexure VI** and **VII** for reference to the question paper pattern and formats of documents accepted.

Students may re-appear for CIA up to next two semesters and has to follow the same procedure. For the last semester the academic rules shall apply.

4.4 Statistical Method for the Award of Relative Grades

Letter Grade	Grade point	Range of Marks(%)
O (Outstanding)	10	90-100
A+ (Excellent)	9	80-89

A (Very good)	8	70-79
B+ (Good)	7	60-69
B (Above average)	6	50-59
C (Average)	5	40-49
p (Pass)	4	35-39
F (Fail)	0	0-34
Ab (Absent)	0	Absent

Abbreviations:

CO	Core Course	MM	Maximum Marks
DSC	Discipline Specific Course	MO	Marks Obtained
GE	Generic Elective Course	SE	Skill Enhancement
AE	Ability Enhancement	DSE	Discipline Specific Elective

4.4.1 Cumulative Grade Point Average (CGPA) and Semester Grade Point Average

Semester Grade Point Average (SGPA):

It is the summation of product of Credit Points and Grade Points divided by the summation of Credits of all Courses taught in a semester.

SGPA = $\Sigma C.G. / \Sigma C$

Where, G is grade and C. is credit for a Course.

Cumulative Grade Point Average (CGPA): $CGPA = \Sigma(C_i \times Si)/\sum c.$

Where, Si is the SGPA of the semester and Ci is the total number of credits in that semester.

The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Note:

- In case of any mistake being detected in the preparation of the Grade Statement at any stage or when it is brought to the notice of the concerned authority the University shall have the right to make necessary corrections.

4.4.2 Cumulative Grade Point Average (CGPA)

CGPA will be used to describe the overall performance of a student in all courses in which letter grades are awarded since his entry into the University or transferred from other University upto the latest semester as per the procedure provided in JNU Academic Regulations. It is the weighted average of the grade points of all the letter grades received by the student from his entry into the University or transferred from other University. Since multiple performance in a course in which the student has already received a grade is possible, whenever through such a process a new grade is obtained, it will replace the earlier one in the calculation of CGPA. On the other hand, if through this process merely a report emerges, this event by itself will not alter the CGPA.

A student's grades, reports, CGPA, etc. at the end of every semester/term will be recorded on a grade card, a copy of which will be issued to him. The grade card will be withheld if a student has not paid his dues or when there is a pending case of breach of discipline or a case of unfair means against him.

The faculty members also responsible for maintaining the complete records of each student's attendance, performance in different components of evaluation. If a scrutiny or statistical analysis becomes necessary, the above records and any other pertinent information should be made available by the faculty member of the course.

4.4.3 Conversion Factor

Formula for Conversion of CGPA to Percentage:

Percentage of marks = CGPA ^{x} 10

4.5 Grade card

All grades and reports and other pertinent information for a semester are given in a grade card which is a complete record of the outcome of what was intended in the original registration. The various grades and reports would be appropriately used to tally the grade card with the original registration.

Chronologically organized information from the grade cards of a student with the necessary explanation constitutes is transcript which is issued at the time the student leaves the University or at an intermediate point on request.

4.5.1 Grade cards and Certification – Student Communication

- The student can get soft copy of grade cards through the University website, the hard copy grade card would be provided only after successfully completion of full program along with degree certificate.
- Once the student completes all the mandated assignments, examinations and projects (if applicable) the final mark sheet/grade card and certificate would be dispatched by the University to the student registered address.
- All pending payments/dues need to be cleared by the student, before the final certification.
- If required, the University may request the mandatory documents from student as submitted during admission time, the students may have to re-submit the same if required during final degree certification.
- Students need to apply for degree by filling the degree application form and submit all the required documents and the applicable degree processing application fees as mentioned in this document.

4.5.2 Online Results, grade card and Degree Logistics–Internal Process

- After verification of all data by the Controller of Examination, the results would be published on the CDOE-JNU website.
- Students need to download and save the copy of semester / year wise results.

CDOE-JNU would provide hard copy grade cards and degree certificate at the end of the program to students who have successfully completed the program. Students who successfully completed the program will receive hard copy mark sheet/grade cards and a degree certificate from the University at the end of the program. A provision for On Demand Mark Sheets can be provided wherein student would have to fill the requisition and pay postal charges enabling university to dispatch the hard copy marksheets as requested by the student; prior to completion of the overall program.

5. Requirement of the Laboratory Support and Library Resources

5.1 Laboratory Support

Jaipur National University offers access to state-of-the-art laboratories equipped with the latest tools and resources necessary for research and analytical work. The laboratory support at JNU aims

to foster a robust research environment, encouraging students to develop essential skills required for their academic and professional growth.

5.*2 Library Resources*

The Central Library at CDOE-JNU offers a comprehensive range of sections, including reference, circulation, audio-visual, periodical, book-bank, digital library, and reprographic sections. With a collection exceeding 1,00,000 books, the library also provides access to e-journals, online databases such as Scopus and Web of Science, and institutional repositories featuring rare book collections. University has 449 subscriptions of online and offline Journals. Equipped with modern facilities like reading rooms, computer labs, and quiet study areas, the library fosters a conducive environment for learning and intellectual growth. Additionally, the library frequently organizes workshops, seminars, and exhibitions to enhance academic engagement and promote a culture of continuous learning.

All electronic resources can be accessed seamlessly through the Local Area Network (LAN) on campus, as well as remotely via login credentials. This ensures convenient access to resources for students, faculty, and researchers both on-site and off-site.

6. Cost Estimate of the Program and the Provisions

The Estimate of Cost & Budget could be as follows (all figures on Annual basis) :

Sl. No.	Expenditure Heads	Approx. Amount
1	Program Development (Single Time Investment)	40,00,000 INR
2	Program Delivery (Per Year)	7,00,000 INR
3	Program Maintenance (Per Year)	25,00,000 INR

7. Quality Assurance Mechanism

The quality of a program hinges upon the course curriculum, syllabus, and academic delivery, all of which are meticulously designed to bridge the gap between industry standards and academia. To uphold this standard, the Centre for Internal Quality Assurance (CIQA) and the Academic Council play crucial roles.

The Academic Council is entrusted with ratifying the curriculum and any proposed changes recommended by CIQA to ensure the continual enhancement and maintenance of quality in online education at CDOE-JNU.

The Centre for Internal Quality Assurance (CIQA) is tasked with several responsibilities:

(i) Conducting periodic assessments of online learning course materials and audio-video tutorials to maintain the quality of learning.

(ii) Soliciting stakeholder feedback and implementing recommended changes to meet the evolving needs of course delivery and industry requirements.

(iii) Evaluating the quality of assignments, quizzes, and end-term assessments and providing suggestions for enhancements to sustain the learning program's standards.

(iv) Ensuring that the learning experience is truly global, aligning with program outcomes and reflecting the vision and mission of JNU.

The Chief Operating Officer (CoE) of the University oversees examinations and the evaluation system to ensure fairness and integrity in the assessment process.

CDOE-JNU is committed to continual improvement, striving to enhance processes, assessments, teaching methodologies, and e-learning materials in line with the four-quadrant approach and the implementation of the New Education Policy (NEP). The University is dedicated to delivering exceptional education across all learning modes while adhering to NEP, UGC, and other regulatory guidelines, fostering a truly global educational environment.

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Annexure I _Detailed syllabus of M.SC - Mathematics Program

Semester I

<table>
<tr><td>Subject Name</td><td colspan="3">Calculus of Variation and Special Functions</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To understand why variational problems are important. See several examples of variational problems in physics and other sciences. Appreciate that (and why) some problems have “classical” solutions and some do not be able to prove the existence of solutions to convex variational problems. Know which kinds of problems are not convex and why convexity is often an unrealistic assumption for vector-valued problems. Have an insight into generalised convexity conditions, such a quasi convexity and poly convexity and their applications.Be able to prove existence of solutions to quasi convex/polyconvex variational problems.</td></tr>
<tr><td>Unit I</td><td colspan="3">Calculus of variation – Functionals, Variation of a functional and its properties, Variational problems with fixed boundaries, Euler’s equation, Extremals, Functional dependent on several unknown functions and their first order derivatives.</td></tr>
<tr><td>Unit II</td><td colspan="3">Functionals dependent on higher order derivatives, Functionals dependent on the function of more than one independent variable, Variational problems in parametric form, Direct methods for variational problems, Rayleigh-Ritz method.</td></tr>
<tr><td>Unit III</td><td colspan="3">Gauss hypergeometric function and its properties, Series solution of Gauss hypergeometric equation. Integral representation, Linear and quadratic transformation formulas, Contiguous function relations, Differentiation formulae, Linear relation between the solutions of Gauss hypergeometric equation, Kummer’s confluent hypergeometric function and its properties, Integral representation.</td></tr>
<tr><td>Unit IV</td><td colspan="3">Bessel function Jn(x) , Legendre polynomials and functions Pn(x) and Qn(x).</td></tr>
<tr><td>Course Outcomes</td><td>CO1</td><td>Recall the variational problems. Derive the Euler-Lagrange equations for variational problems, including the case of general variations.</td><td>Remember</td></tr>
<tr><td></td><td>CO2</td><td>Explain the conserved quantities from symmetries, and use them to solve the Euler-Lagrange equations.</td><td>Understand</td></tr>
<tr><td></td><td>CO3</td><td>Apply variational problems with constraints: both algebraic and isoperimetric.</td><td>Apply</td></tr>
</table>

	CO4	Analyze the various applications of the fundamental theorem of Gauss Hypergeometric Function.	Analyze	
	CO5	Evaluate Bessel, differential equations along with the corresponding recurrence formulas of different functions.	Evaluate	
	CO6	Create Legendre differential equations along with the corresponding recurrence formulas of different functions.	Create	
	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.		
	Text books (Latest Editions)	1.Calculus of Variation with Applications, A. S. Gupta, Prentice-Hall, India, 2000. 2.Calculus of Variations with Applications, G. M. Ewing, Dover, 2000. 3.Introduction to Calculus of Variations, H. Sagan, Dover, 2010. 4.Variational Calculus and Optimal Control, J. L. Troutman, 2nd edition, Springer Verlag, 2015. 5.Special functions and calculus of variations, PK Banerji, VBL Chaurasia, MA Pathan, Indus valley publications,2010.		
	Online resources	IOP Science Journals, Elsevier Mathematics Journals		

Subject Name	**Differential Equations**
Course Objective	To identify the type of a given differential equation and select and apply the appropriate analytical technique for finding the solution of first order and selected higher order ordinary differential equations.To evaluate first order differential equations including separable, homogeneous, exact, and linear.Show existence and uniqueness of solutions.Create and analyze mathematical models using first order differential equations to solve application problems such as circuits, mixture problems, population modeling, orthogonal trajectories, and slope fields.Solve second order and higher order linear differential equations.
Unit I	Differential Equations: Ordinary Differential Equations of Second Order With Variable Coefficients-Homogeneous Form, Exact Form, Solution When a Part of C.F. is Known, Change of Dependent Variable, Change of Independent Variable, Variation of Parameters, and Solution In Series.

<table>
<tr><td></td><td colspan="4"></td></tr>
<tr><td>Unit II</td><td colspan="4">Partial differential equations of first order: Lagrange’s method and standard forms, Charpit’s method, Method of Separation of variables-Application to the solution of wave equation in one dimension, Laplace’s equation in two dimensions, Diffusion equation in one dimension, Partial differential equations of second order with variable co-efficients- Monge’s method.</td></tr>
<tr><td>Unit III</td><td colspan="4">Total Differential equations. Forms and solutions, necessary and sufficient condition, Geometrical Meaning Equation containing three and four variables, total differential equations of second degree.</td></tr>
<tr><td>Unit IV</td><td colspan="4">Series Solution: Radius of convergence, method of differentiation, Cauchy-Euler equation, Solution near a regular singular point (Method of Forbenius) for different cases, Particular integral and the point at infinity. Nonlinear Differential equations.</td></tr>
<tr><td>Course Outcomes</td><td colspan="4"><table>
<tr><td>CO1</td><td>Recall the derivation of differential equation, Linear partial differential.</td><td>Remember</td><td></td></tr>
<tr><td>CO2</td><td>Explain Methods of Solving of Differential equations of first order</td><td>Understand</td><td></td></tr>
<tr><td>CO3</td><td>Apply Lagrange’s linear equation, Lagrange’s solution of the linear equation.</td><td>Apply</td><td></td></tr>
<tr><td>CO4</td><td>Analyze Geometrical interpretation of Lagrange’s linear equation.</td><td>Analyze</td><td></td></tr>
<tr><td>CO5</td><td>Evaluate the linear equations with n independent variables, special types of equations.</td><td>Evaluate</td><td></td></tr>
<tr><td>CO6</td><td>Create the Nonlinear PDE of first order, solve using Charpit’s method.</td><td>Create</td><td></td></tr>
</table></td></tr>
<tr><td></td><td colspan="2">Learner support Material</td><td colspan="2">NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.</td></tr>
<tr><td></td><td colspan="2">Text books (Latest Editions)</td><td colspan="2">1. “Mathematical Methods”- Potter, M C; Goldberg Jack, Prentice Hall of India Learning Pvt. Ltd, 2016.
2. Ordinary Differential Equations, Simmons, McGraw-Hill; 2nd edition, 2010.
3. Ordinary Differential EquationsLakshmikantham, Deo and Raghavendra, McGraw-Hill, 2000.
4 Introductions to Partial Differential Equations, K, Sankara, Rao, Prentice Hall of India Learning Pvt. Ltd, 2010.</td></tr>
<tr><td></td><td colspan="2">Online resources</td><td colspan="2">IOP Science Journals, Elsevier Mathematics Journals</td></tr>
</table>

Subject Name	**Real Analysis**
Course Objectives	To studying Bolzano –Weirstrass theorem and Cauchy criteria.Have the knowledge of basic properties of the field of real numbers. Studying the basic topological properties of the real numbers. Have the knowledge of real functions-limits of functions and their properties. Studying the notion of continuous functions and their properties.
Unit I	Review of basic concepts of real numbers: countable and uncountable sets, Real number system, Archimedean property, supremum, infimum and Completeness. Continuity and uniform continuity. Metric spaces and its topology. Weierstras's theorem, Continuity of functions in metric spaces. Compactness and Connectedness. Discontinuities. Monotonic functions
Unit II	Sequences and series, Convergent sequences. Cauchy sequences. Upper and Lower limits. Cauchy's general Principle of convergence. Series of nonnegative terms and convergence tests. Absolute and conditional convergence.
Unit III	Sequences and series of functions. Pointwise and uniform convergence, Cauchy criterion for uniform convergence, Weirstras's M-test, Abel's test and Dirichlet's test for uniform convergence, uniform convergence and continuity, uniform convergence and differentiation, existence of a Power series.
Unit IV	Functions of several variables : linear transformations, derivative in an open subset of Rn, Chain rule, partial derivatives, directional derivatives, the contraction principle, inverse function theorem, Implicit function theorem, Jacobians, extremum problems with constraints, Lagrange's multiplier method.
Course Outcomes	**CO1** Recall the many properties of the real line and learn to define sequence in terms of functions from to a subset. — Remember
	CO2 Explain bounded, convergent, divergent, Cauchy and monotonic sequences. — Understand
	CO3 Apply to calculate their limit superior, limit inferior, and the limit of a bounded sequence. — Apply

	CO4	Analyze various applications of the fundamental theorem of integral calculus.	Analyze	
	CO5	Evaluate uniform continuity, differentiation, integration and uniform convergence.	Evaluate	
	CO6	Create the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.	Create	

	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books (Latest Editions)	1. Principles of Mathematical Analysis by W.Rudin, 2010. 2. Mathematical Analysis by T.M.Apostol, Narosa Publishing House, 2000. 3. Theory of Functions of a Real Variable, Volume 1 by I. P. Natanson, Frederick Pub. Co.2015. 4. Real Analysis by H.L. Royden, McMillan Publication Co. Inc. New York, 2016.
	Online resources	IOP Science Journals, Elsevier Mathematics Journals

Subject Name	**C Programming**
Course Objectives	The course is designed to provide complete knowledge of C language. Students will be able to develop logics which will help them to create programs, applications in C. Also by learning the basic programming constructs they can easily switch over to any other language in future.
Unit I	Introduction to 'C' programming: Fundamentals, Structure of a C program, Compilation and linking processes.
Unit II	Expressions and Console I/O: Basic Data types, Identifier Names, Variables, Scope, Type qualifiers, Storage class specifier, Constants, Operators, Reading and writing characters, Reading and writing strings.
Unit III	Statements: True and False, Selection statements, Iteration statements, Jump statements, Expression statements, Block statements.
Unit IV	Structure and Union: definition and differences, self-referential structure. File Handling in C: opening and closing a text file, creating a text file, read and write functions.

Course Outcomes	**CO1**	Recall the basics of C programming.	Remember	
	CO2	Explain the sequence of the program and give logical output.	Understand	
	CO3	Apply the uses of pre-processors and various memory models.	Apply	
	CO4	Analyze I/O operations in your C program. Repeat the sequence of instructions and points for a memory location.	Analyze	
	CO5	Evaluate strings in your C program& Store different data types in the same memory.	Evaluate	
	CO6	Create code reusability with functions and pointers. Understand the basics of file handling mechanisms.	Create	

	Learner support Material	NPTL,Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books (Latest Editions)	1"Let us C", Yashavant Kanetkar, BPB, 2015. 2. "Programming in C", Gottfried, Schaum's Series, Tata McGraw-Hill, 2013. 3. "Programming in ANSI C", E. Balagurusamy, TMH, 2000. 4. "The C Programming Language", Kernighan, Ritchie, Prentice Hall of India, 2010.
	Online resources	Elsevier Computer Science Journals.

Subject Name	**C Programming Lab**
Course Objectives	The course is oriented to those who want to advance structured and procedural programming understating and to improve C programming skills. The major objective is to provide students with understanding of code organization and functional hierarchical decomposition with using complex data types.
S. No.	Name of the Experiment
1	WAF to display "Hello".
2	WAP and define an algorithm that returns the number of years until a father will have an age double of its son's age.
3	WAP to convert temperature in Fahrenheit or Celsius [Hint: using switch case] $Celsius = (F + 32) * \frac{5}{9}$
4	WAP to calculate Simple Interest on the basis of Principal, rate of interest and number of years given as input by the user using switch statement. HINT : $SI = (P * R * T) / 100$ and $CI = p * [(1 + (R/100))\text{^} N]$.
5	WAP and find the flowchart and algorithm of a program that finds the minimum of three values a, b and c.
6	WAP with the flowchart and associated algorithm that compare two numbers a and b.

7	WAP and work out the algorithm that output the solutions of a 2nd order polynomial ax2+bx+c=0, given the parameters a, b and c. Only real solutions will be treated. The cases with 1 or 2 solutions will be separated.
8	WAP and define the flowchart of a program where the user supplies integer values between 1 and 9 and the program returns the sum, average and RMS of the values. The program will exit when 0 is entered. Values outside of the bounds will be discarded.
9	WAP to print the following * 1 * * 2 2 * * * 3 3 3 * * * * 4 4 4 4
10	WAP to generate odd series 1+3+5+7+9+……..
11	WAP to generate even series 2+4+6+8+10+……..
12	WAP to generate power series as 1+4+9+16+25+……
13	WAP to find the factorial of a given number where if the number is lesser than 2 then factorial =1.
14	WAP to generate Fibonacci series as 0,1,1,2,3,5,8,13,…….. [Hint Sum ofd 2 previous terms becomes new terms]
15	WAP to generate sine series. As x-x3/3!+x5/5!-x7/7!+…..
16	WAP to generate cosine series as 1-x2/2!+x4/4!-x6/6!+…
17	WAP to find whether the given number is Armstrong number or not.[153= 13+53+33]
18	WAP to find whether the given number is palindrome no. Or not as 121=121 , 131=131, etc.
19	WAP to find the sum of all the digits of a given number.
20	WAP to calculate the power of a given number.
21	WAP to display the sum of the elements of a linear array.
22	WAP to display the elements in reverse order of an array.
23	WAP to display the sum of rows and columns of a matrix.
24	WAP to find the sum of the diagonals of a matrix.
25	WAP to display the sum & product of two matrixes.
26	WAP to search an element using linear search.
27	WAP to search an element using binary search.
28	WAP to sort an array using selection sort.
29	WAP to compare two inputted strings and store the larger of the two into a new string [Use strcpy and strcmp functions].
30	WAP to swap two numbers using pointers.
31	WAP to display the contents of an array using pointers.
32	WAP to store and display the employee data using structures.
33	WAP to store the student data (roll no, name and marks in 5 subjects) and print his/her result showing his/her percentage as well as grade.
34	WAF to swap two numbers using call by reference.
35	WAF to calculate factorial of a number.

36	WAF to find GCD of two numbers.	
37	WA recursive function to display the factorial of a number given as an argument.	
38	WAF that returns the no. of times it had been called upon.[Use static storage class].	
39	WAP to copy the contents of one text file into another.	
40	WAP to create a program that stores the record of three employees. [Use Binary files].	
Course Outcomes	**CO-1**	Write the C code for a given algorithm.
	CO-2	Explain the basic Structure of the C-PROGRAMMING, declaration and usage of variables.
	CO-3	Apply the odd series, even series, power series, Fibonacci series, sine series and cosine series.
	CO-4	Analyses the C programs using operators, conditional and iterative statements to Write C programs.
	CO-5	Assess the programs that perform operations using derived data types.
	CO-6	Build a Program with pointers and arrays, perform pointer arithmetic, and use the pre-processor.

Subject Name	**Industrial Mathematics**
Course Objectives	The objective of the Master's program in Industrial Mathematics is to enable students to acquire the fundamentals of applied mathematics in areas of classical and numerical analysis, differential equations and dynamical systems, and probability and statistics. : Give the student's sufficient knowledge of fundamental principles, methods and a clear perception of the innumerous power of mathematical ideas and tools and knowledge of how to use them by modeling, solving and interpreting. Reflecting the broad nature of the subject and developing mathematical tools for continuing further study in various fields of science.
Unit I	Finite difference schemes for partial differential equations – explicit and implicit schemes .Finite difference schemes for initial and boundary value problems – FTCS, backward Euler and Crank-Nicolson schemes, ADI methods. Application to problems of industry with special reference to Fluid Mechanics.
Unit II	Operational Techniques for Linear Programming Problems, Computational procedure of Simplex method, Two-phase Simplex method, Big-M-method, Duality in linear programming, Duality and Simplex method.
Unit III	Assignment models. Mathematical formulation, Hungarian method. Travelling Salesman problem. Transportation models. Mathematical formulation. Initial basic feasible solution. Degeneracy and unbalanced transportation problems. Advance Game Theory and its applications. Game problems using graphical method.
Unit IV	Queuing models: Basic components of a queuing system, General birth-death equations,

<table>
<tr><td></td><td colspan="4">steady state solution of Markovian queuing models with single and multiple servers (M/M/1, M/M/C M/M/1/k, M/MC/k).</td></tr>
<tr><td>Course Outcomes</td><td colspan="4"><table>
<tr><td>CO1</td><td>Recall the linear programming problems by different methods. Illustrate the concept of convex set & extreme points.</td><td>Remember</td><td></td></tr>
<tr><td>CO2</td><td>Explain the relationships between the primal and dual problems, and to understand sensitivity analysis.</td><td>Understand</td><td></td></tr>
<tr><td>CO3</td><td>Apply duality and dual simplex method.</td><td>Apply</td><td></td></tr>
<tr><td>CO4</td><td>Analyze transportation model and finding solution of transportation problem.</td><td>Analyze</td><td></td></tr>
<tr><td>CO5</td><td>Evaluate assignment problem and method for solving it.</td><td>Evaluate</td><td></td></tr>
<tr><td>CO6</td><td>Create linear programming models of real-life situations. Learn about the applications to transportation, assignment in real world.</td><td>Create</td><td></td></tr>
</table></td></tr>
<tr><td></td><td colspan="2">Learner support Material</td><td>NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.</td></tr>
<tr><td></td><td colspan="2">Text books (Latest Editions)</td><td>1.Numerical Solutions to Partial Differential Equations, G. D. Smith, Oxford University Press, 3rd Edn., 2000.
2. “Mathematical Methods”; Potter, M C; Goldberg Jack, Prentice Hall of India, 2015.
3. Operations Research; S. D. Sharma, Kedar Nath Ram Nath and co, 2016.
4. Operations research; Kanti Swarup, P.K.Gupta and Manmohan, S. Chand & Co, 2017.
5. Operations Research; Hamady Taha, MacMillan Co, 2017.</td></tr>
<tr><td></td><td colspan="2">Online resources</td><td>IOP Science Journals, Elsevier Mathematics Journals</td></tr>
</table>

Subject Name	**Hydrodynamics**	
Course Objectives	This Course provides Lagrangian and Eulerian methods, Motion in two dimensions, stream function. Use of complex potential for irrotational flow. Circle theorem, uniqueness theorem, and Kinetic energy of an infinite mass of fluid.	
Unit I	Lagrangian and Eulerian methods. Stream lines, Stream tubes, equation of continuity, irrotational and rotational motion, circulation. Euler's dynamical equations, surface conditions. Velocity potential, Bernoulli's theorem.	
Unit II	Motion in two dimensions, stream function. Use of complex potential for irrotational flow. Circle theorem, uniqueness theorem, Kinetic energy of an infinite mass of fluid, constancy of circulation, and flow past a moving cylinder.	
Unit III	Axi-Symmetric fluid motion, Stokes' stream function, flow past a solid of revolution.	
Unit IV	Visocosity, Most general motion of a fluid element, stain quadric, stress quadric. Relation between stress and rate of strain components.	
	CO1 Recall the Lagrangian and Eulerian methods. Stream lines, Stream tubes, equation of continuity, irrotational. — Remember	
	CO2 Explain the use of complex potential for irrotational flow. — Understand	
	CO3 Apply Euler's dynamical equations and surface conditions. — Apply	
	CO4 Analyze the Axi-Symmetric fluid motion, Stokes' stream function. — Analyze	
	CO5 Evaluate Kinetic energy of an infinite mass of fluid. — Evaluate	
	CO6 Create relation between stress and rate of strain components. — Create	
Course Outcomes	On successful completion of this course, students will be able to:Apply knowledge and understanding of the basic concepts, theories, and principles of Hydrodynamics.	
	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books (Latest Editions)	1. Milne-Thomson: Theoretical Hydrodynamics, 2015. 2. G. K. Batchelor: An Introduction to Fluid Dynamics, 2000. 3. N. Curle and H. J. Davies: Modern Fluid Dynamics,Vol. I.,2015.

		4 .R. C. Binder: Advanced Fluid Mechanics, 2017.
	Online resources	IOP Science Journals, Elsevier Mathematics Journals

Subject Name	**Waste Water Treatment**	
Course Objectives	The ai of this course is to introduce the students to the area of water and waste water treatment. The course will cover water chemistry, characteristics of water & waste water, and design of water and waste water treatment plants.	
Course Details	Characteristics and sources of water, Water Pollution: International Standards of drinking water, water quality parameters COD, BOD, TDS, pH etc., treatment of potable and sewage waste water.	
Course Outcomes	On successful completion of this course, students will be able to:Apply knowledge and understanding of the basic concepts, theories, and principles of Hydrodynamics.	
➢	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
➢	Text books (Latest Editions)	5. Water Chemistry: An Introduction to the Chemistry of Natural and Engineered Systems, Brezonik, P.L.; Arnold, W.A., Oxford University Press. 2011 6. Water Quality and Treatment, 5th edition, R. Letterman, Editor, American Water Works Association, Denver, CO, 1999 7. Metcalf and Eddy, Wastewater Engineering, 4th ed., McGraw Hill Higher Edu., 2002 8. Textbook of Water Supply & Sanitary Engineering: S.K. Husain

Semester II

Subject Name	**Numerical and Statistical Techniques**
Course Objectives	The objective is to develop analytical capability and to impart knowledge in Statistical methods. The knowledge of Statistical methods and its applications so as to enable them to apply them for solving real world problems.
Unit I	**Floating point Arithmetic**: Representation of floating point numbers, Operations, Normalization, Pitfalls of floating point representation, Errors in numerical computation **Iterative Methods:** Zeros of a single transcendental equation and zeros of polynomial using Bisection Method, Regula-Falsi method, Newton Raphson method, Secant method, Rate of convergence of iterative methods.

<table>
<tr><td>Unit II</td><td colspan="3">Simultaneous Linear Equations: Solutions of system of Linear equations, Gauss elimination direct method and pivoting, Ill conditioned system of equations, refinement of solution. Gauss Seidal iterative method, Gauss-Jordan method. Interpolation and approximation: Finite differences, difference tables polynomial interpolation: Newton’s forward and backward formula. Central difference formulae: Gauss forward and backward formula, Stirling’s, Bessel’s, Everett’s formula. Interpolation with unequal intervals: Langrange’s interpolation, Newton divided difference formula.</td></tr>
<tr><td>Unit III</td><td colspan="3">Numerical Differentiation and Integration: Introduction, numerical differentiation, numerical integration, trapezoidal rule, Simpson’s rules, Boole’s rule, Weddle’s rule, Euler- Maclaurin’s formula. Solution of differential equations: Euler’s method, Modified Euler’s method, Picard’s method, Taylor’s method, Runge-Kutta method, Predictor-corrector method, Shooting Method. Difference equations.</td></tr>
<tr><td>Unit IV</td><td colspan="3">Frequency Chart: Different frequency chart like histogram, frequency curve, Pi-chart. Curve fitting, Cubic Spline and Approximation: Method of least squares, fitting of straight lines, polynomials. Time series and forecasting: Moving averages, smoothening of curves, forecasting models and methods. Statistical quality controls methods Testing of Hypothesis: Test of significance, chi-square test, t-test, F-Test.</td></tr>
<tr><td>Course Outcomes</td><td>CO1</td><td>Recall the numerical methods to obtain approximate solutions of mathematical problems.</td><td>Remember</td></tr>
<tr><td></td><td>CO2</td><td>Explain the concepts of finite differences, interpolation, extrapolation, and approximation.</td><td>Understand</td></tr>
<tr><td></td><td>CO3</td><td>Apply the methods to find the accuracy of the numerical solutions.</td><td>Apply</td></tr>
<tr><td></td><td>CO4</td><td>Classify initial and boundary value problems in differential equations using numerical methods.</td><td>Analyse</td></tr>
<tr><td></td><td>CO5</td><td>Evaluate numerical differentiation when routine methods are not applicable.</td><td>Evaluate</td></tr>
<tr><td></td><td>CO6</td><td>Develop numerical problems in diverse situations in physics, engineering etc.</td><td>Create</td></tr>
<tr><td>➢</td><td colspan="2">Learner support Material</td><td>NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.</td></tr>
<tr><td>➢</td><td colspan="2">Text books (Latest Editions)</td><td>1. “Numerical Analysis”, Sastry S.S., Prentice Hall of India Learning Pvt. Ltd,2015.
2. “Numerical Methods”, Balaguruswamy E, McGraw-Hill Publishing Company, New Delhi, 2000.
3. “Applied Numerical Analysis’’ Gerald & Wheatley’, Addison-Wesley, 2000.</td></tr>
</table>

		4. "Numerical Methods for Scientific and Engineering Computation, Jain, Iyengar and Jain, New Age International, 2017.
➢	Online resources	IOP Science Journals, Elsevier Mathematics Journals.

Subject Name	**Abstract Algebra**			
Course Objectives	Abstract algebra is the study of algebraic structures. The course aims to provide an introduction to some of the most fundamental algebraic structures encountered in algebra and geometry: groups, rings, and fields.			
Unit I	Groups, subgroups, Cosets, Lagrange's theorem, cyclic group, normal subgroups, quotient groups, permutation group. Homomorphism, isomorphism theorems and Cayley's theorem.			
Unit II	Conjugacy, Class equation, Simple groups. Sylow theorems with applications, Normal and subnormal series, composition series, Jordan holder theorem. Solvable groups, simplicity of An (n > 5).			
Unit III	Rings, homomorphisms, ideals, Quotient rings, prime ideals, maximal ideals, Field of quotients of an integral domain, Euclidean rings, unique factorization domains, principal ideal domain.			
Unit IV	Polynomial rings, Eisenstenin's criterion of irreducibility, Fields, finite fields, field extensions, Galois Theory.			
Course Outcomes	**CO1**	Recall the various algebraic structures.	Remember	
	CO2	Explain the mathematical objects called groups.	Understand	
	CO3	Apply the basic concepts to develop theorems.	Apply	
	CO4	Analyze the significance of the notions of cosets, normal subgroups, and factor groups.	Analyze	
	CO5	Evaluate the fundamental concepts in field theory.	Evaluate	
	CO6	Develop the classification of finite fields.	Create	
	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.		
	Text books (Latest Editions)	1. Topics in algebra by I. N. Herstein. Wiley Eastern Limited, 2015. 2. A first course in Abstract Algebra by John Fraleigh (3rdEdition), Narossa Publishing House, 2000. 3. Basic Abstract Algebra by Bhattacharya, Jain and Nagpal, 2nd Edition, 2010.		

		4. Algebra by S.Mclane and G.Birkhoff, 2nd Edition, 5. Basic Algebra by N.Jacbson, Hind.Pub.Corp.2017. 6. Contemporary Abstract Algebra, Joseph A. Gallian, Cengage Learning, 2014.
	Online resources	IOP Science Journals, Elsevier Mathematics Journals.

Subject Name	**Mathematical Programming**				
Course Objectives	To study the basic components of an optimization problem.Formulation of design problems as mathematical programming problems.				
Unit I	Nonlinear optimization: basic theory, method of Lagrange multipliers, Karush-Kuhn-Tucker theory, Wolfe's mehod as application of Karush-Kuhn-Tucker condition, convex optimization. Numerical optimization techniques: line search methods, gradient methods, Newton's method. Single variables optimizations. Hassian matrix and its applications.				
Unit II	**Project Management:** Historical Development of CPM/PERT, Rules for Drawing Network, CPM: Time estimation and Critical Path in Network, PERT, Probability to complete a Project.				
Unit III	Integer programming: Gomory's algorithm for all and mixed integer programming problems, Branch and Bound Algorithms cutting plan algorithm. Dynamic programming: Introduction, Bellman principle of optimality, solution of problems with finite number stages, solution of l.p.p. by dynamic programming. Duality and dual simplex method.				
Unit IV	Game Theory: Two person zero sum game, Game with saddle points, the rule of dominance; Algebric, graphical and linear programming methods for solving mixed strategy games. Sequencing problems: Processing of n jobs through 2 machines, n jobs through 3 machines, 2 jobs through m machines, n jobs through m machines.				
Course Outcomes	**CO1**	Recall the concept of linear programming problems.	Remember		
	CO2	Explain PERT and CPM methods.	Understand		
	CO3	Apply the basic concepts of Game theory.	Apply		
	CO4	Analyze the significance of the notions of Duality.	Analyze		
	CO5	Evaluate dynamic programming.	Evaluate		
	CO6	Develop the applications of different methods.	Create		
	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.			
	Text books (Latest	1. Operations Research – An Introduction, Handy A Taha –			

	Editions)	Pearson Education.Operations Research Panneer Selvan Prentice Hall of India,2010. 2. "Operations Research: Theory and Application", J.K.Sharma, Noida: MacMillan India,2003. 3. "Quantitative Techniques in Management", N.D.Vohra, New Delhi: Tata McGraw-Hill Publishing Co. Ltd, 2007. 4. "Operations Research", R.Paneerselvam, New Delhi: Prentice Hall of India, 2008. 5. "Operations Research", Frederick S.Hillier and Gerald J. Lieberman, New Delhi: Tata McGraw Hill, 2005.
	Online resources	IOP Science Journals, Elsevier Mathematics Journals

Subject Name	**Continuum Mechanics**
Course Objectives	The purpose of the course is to expose the students to the basic elements of continuum mechanics in a sufficiently rigorous manner. After attending this course, the students should be able to appreciate a wide variety of advanced courses in solid and fluid mechanics.
Unit I	Cartesian Tensors, Index notation and transformation laws of Cartesian tensors. Addition, Subtraction and Multiplication of cartesian tensors, Gradient of a scalar function, Divergence of a vector function and Curl of a vector function using the index notation. e-d identity. Conservative vector field and concept of a scalar potential function. Stokes, Gauss and Green's theorems.
Unit II	Continuum approach, Classification of continuous media, Body forces and surface forces. Components of stress tensor, Force and Moment equations of equilibrium. Transformation l of stress tensor. Stress quadric. Principal stress and principal axes. Stress invariants and stre deviator. Maximum shearing stress, Pain strain Mohr's Circles for strain.
Unit III	Lagrangian and Eulerian description of deformation of flow. Comoving derivative, Velocity and Acceleration. Continuity equation. Strain tensors. Linear rotation tensor and rotation vector, Analysis of relative displacements.
Unit IV	Geometrical meaning of the components of the linear strain tensor, Properties of linear strain tensors. Principal axes, Theory of linear strain. Linear strain components. Rate of strain tensors. The vorticity tensor. Rate of rotation vector and vorticity, Properties of the rate of strain tensor, Rate of cubical dilation.
Course Outcomes	**CO1** Recall the significance of mathematics involved in physical quantities and their uses. — Remember **CO2** Explain the Stokes, Gauss, and Green's theorems. — Understand

	CO3	Apply Body forces and surface forces.	Apply
	CO4	Classify the Lagrangian and Euler description of the deformation of flow.	Analyze
	CO5	Evaluate the concept of stress and strain.	Evaluate
	CO6	Develop the geometrical meaning of the components of the linear strain tensor.	Create

➢	Learner support Material	NPTL,Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
➢	Text books (Latest Editions)	1. Continuum Mechanics, Anthony james merril spencer,Dover publication,2004. 2. Introduction to Engineering Mechanics A Continuum Approach, Jenn Stroud Rossmann, Clive L. Dym , Taylor and francis group,2010. 3. Inroduction to continuum mechanics for engineers, Ray M. Bowen, dover publication, 2000. 4 First Course in Continuum Mechanics, Y.C.Fung, Prentice Hall, 2017.
➢	Online resources	IOP Science Journals, Elsevier Mathematics Journals

Subject Name	**Numerical & Statistical Techniques Lab**
Course Objectives	Learn to develop mathematical models of phenomena involved in various fields and solutions for these models.
S. No.	Name of the Experiment
1.	Write programs in C/C++ to implement Floating Point Representation of the following: a) Addition b) Subtraction c) Multiplication d) Division
2.	Write programs in C/C++ to implement to implement a) Bisection Method b) Newton Raphson Method c) Regula – Falsi Method
3.	Compute the two regression coefficients using the values of actual means of X and Y from the data given below and then work out the values of 'r': X 7 4 8 6 5 Y 6 5 9 8 2
4.	Implement the following : a) Newton's Forward Difference Table b) Newton's Backward Difference Table c) Newton's Central Difference Table d) Newton's Forward Interpolation Formula e) Newton's Backward Interpolation Formula f) Newton's Central Difference Interpolation Formula
5.	Write a program to implement Jacobi's Method.
6.	200 digits were chosen at random from a set of tables. The frequencies of the digits were: Digits 0 1 2 3 4 5 6 7 8 9 Frequencies 18 9 23 21 16 25 22 20 21 15 Use x2 test to assess the correctness of hypothesis that the digits were distributed in equal numbers in the table
7.	Write programs in C/C++ to implement the following: a) Gauss – Seidel Method b) Lagrange's Interpolation c) Trapezoidal Rule d) Simpson's 1/3 Rule e) Simpson's 3/8 Rule f) Euler's Method g) Euler's Modified Method h) Runge – Kutta II Order Method i) Runge – Kutta IV Order Method j) Fitting a Straight Line **Tests:** F – Test, T – Test.
Course	**CO-1** Recall the numerical methods to obtain approximate solutions of

Outcomes		mathematical problems.
	CO-2	Explain error, source of error and its affect on any numerical computation and also analyzing the efficiency of any numerical algorithm.
	CO-3	Solve system of linear equations numerically using direct and iterative methods.
	CO-4	Analyze the accuracy of common numerical methods.
	CO-5	Evaluate numerical solution of nonlinear equations using Bisection, Newton – Raphson and fixed-point iteration methods.
	CO-6	Create interpolating polynomials with practical exposure.

Subject Name	**Computer Application**
Course Objectives	Improve their computer literacy, their basic understanding of operative systems and a working knowledge of software commonly used in academic and professional environments. Develop criteria to organize and present different type of works in academic and professional environments. Learn how to organize information efficiently in the forms of outlines, charts, etc. by using appropriate software.
Unit I	**Introduction**: Need of and features of Computer, Parts of Computer System: Hardware, Software, Data, Users, The information processing cycle. Evolution of Computer Systems & Generations. **Computer hardware**: Processing Devices, Memory Devices: RAM, ROM, Input and Output Devices (Keyboard, Mouse, Pen, Touch Screens, Bar Code Readers, OCR, Printer, Plotters, VDU, Speakers, etc.), Storage Devices: Magnetic and Optical Storage, **Software**: System software, Application Software, Utility software. Programming languages and language translators.
Unit II	**Data Representation**: Number Systems, Bits and Bytes, Text Codes. Binary/Octal/Hexadecimal Number Systems; Computer Arithmetic. **Data Processing**: The CPU, Machine Cycles, Memory, Factors Affecting Processing Speed, Registers, Memory and Computing Power, Computer's Internal Clock, Bus, Cache Memory.
Unit III	**Secondary Storage Devices**: Sequential access devices; Magnetic tapes: Types, Basic Principles of operation, advantages, Limitations of magnetic Tapes. **Direct access devices**, Magnetic disks: Types, Basic Principles of operation, advantages, Limitations of magnetic disks. **Optical disks**: Types, Basic Principles of operation, advantages, Limitations of optical disks.
Unit IV	**Operating System**: Purpose of Operating Systems, Types of Operating System, User Interface: Graphical User Interfaces, Command Line Interfaces, Running Programs, Sharing Information, Managing Hardware: Processing Interrupts, Working with Device Drivers, Utility Software, Backup Utilities, Antivirus, Firewall, Intrusion Detection, and Screen Savers. Introduction to PC Operating Systems: DOS and windows, UNIX and Linux.

Course Outcomes	**CO1**	Recall the basic concepts of computer hardware and software.	Remember	
	CO2	Explain the data representation and data processing.	Understand	
	CO3	Apply various properties of secondary storage devices.	Apply	
	CO4	Analyze the direct access devices and optical disk.	Analyze	
	CO5	Evaluate factors affecting processing speed.	Evaluate	
	CO6	Create backup DOS and windows, UNIX and Linux.	Create	
	Learner support Material	NPTL,Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.		
	Text books (Latest Editions)	1. "Introduction to Computers", Norton Peter, 6th Ed., TMH, 2001 2. "DOS Guide", Peter Norton's, Prentice Hall of India,2010. 3. "Computer Fundamentals", P. K. Sinha & Priti Sinha , BPB Publications, 2015. 4. "Introduction to Computers", Alex Leon & Mathews Leon, Vikas Publishing House, 2017.		
	Online resources	Elsevier Computer Science Journals		

Subject Name	**Differential Geometry**
Course Objectives	To understand the Identify situations that requires the use of vector calculus and differential geometry. Solve certain classes of problems related to vector calculus, differential geometry or topology. Understand and write mathematical proofs using formal mathematical reasoning .Present solutions on computer or in a written form.
Unit I	Tensor and their transformation laws, Tensor algebra, Contraction, Quotient law, Reciprocal tensors, Kronecker delta, Symmetric and skew- symmetric tensors, Metric tensor, Riemannian space, Christoffel symbols and their transformation laws, Covariant differentiation of a tensor, Riemannian curvature tensor and its properties, Ricci-tensor.
Unit II	Theory of space curves. Serret-Frenet formulas for curves in space. Parametric representation of curves, Helix , Curvilinear coordinates in E3. Tangent and first curvature vector. Intrinsic equations & differentiation, Parallel vector fields**.**
Unit III	Parametric representation of a surface, Tangent and Normal vector field on a surface, The first and second fundamental tensor. The third fundamental form, Gaussian curvature, Isometry of surfaces, Equation of Gauss, Principal curvature, Normal curvature.

<table>
<tr><td>Unit IV</td><td colspan="4">Definition. Differential equation of geodesics. Nature of Geodesics. Canonical equations. Normal property. Geodesic polar coordinate, curvature and torsion.</td></tr>
<tr><td>Course Outcomes</td><td colspan="4"><table>
<tr><td>CO1</td><td>Recall the vector function to represent space curves and surfaces.</td><td>Remember</td><td></td></tr>
<tr><td>CO2</td><td>Explain the Arc Length, Curvature, Torsion and various other quantities.</td><td>Understand</td><td></td></tr>
<tr><td>CO3</td><td>Apply the physical and geometrical important concepts related to gradient, divergence and curl of vector field.</td><td>Apply</td><td></td></tr>
<tr><td>CO4</td><td>Analyze importance of Green, Gauss and Stokes' theorems in other branches of mathematics.</td><td>Analyze</td><td></td></tr>
<tr><td>CO5</td><td>Evaluate integrals of vector valued function over curves, surfaces and domains in two and three-dimensional space.</td><td>Evaluate</td><td></td></tr>
<tr><td>CO6</td><td>Create vector and tensor calculus in mechanics, fluid flow, heat flow, electrostatics etc.</td><td>Create</td><td></td></tr>
</table></td></tr>
<tr><td></td><td>Learner support Material</td><td colspan="3">NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.</td></tr>
<tr><td></td><td>Text books (Latest Editions)</td><td colspan="3">1. Tensor Calculus and Application to Geometry and Mechanics, I. S. Sokolnikoff, 2000,
2. An Introduction to Differential Geometry, T. T. Wilmore, 2010.
3. Differential Geometry, Bary Spain, Arthur L. Besre, Einstein manifolds, Springer
Verlag, Berlin, New York, 2000.
4. A course in differential geometry, Klingenberg.W, Springer-verlag, 2017.
5. Lectures on differential geometry, Stenberg S prentice Hall of india, 2015.</td></tr>
<tr><td></td><td>Online resources</td><td colspan="3">IOP Science Journals, Elsevier Mathematics Journals.</td></tr>
</table>

Subject Name	**Biostatistics**
Course Objectives	Recognize the definition of statistics, its subject and its relation with the other sciences.
Unit I	Graphical Representation by types of data for univariate and bivariate presentation.
Unit II	Measures of Central Tendency and Location – Mean, Median, Mode and Measures of Location Quartiles, Quintiles, Deciles and Percentiles Measures of Dispersion – Range Deviation, Quartile Deviation etc., Mean

	Deviation, Variance.	
Unit III	Standard Deviation, Coefficient of Variation.	
Unit IV	Measures of Central Tendency and Variation for Qualitative Variables Karl Pearson's Coefficients, Correlation and Concepts of Regression.	
Course Outcomes		
➢	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
➢	Text books (Latest Editions)	1. Glover, Thomas and Kevin Mitchell: An Introduction to Biostatistics, 3rd edition. Waveland Press, 2015. **2.** Surender Singh and Deeksha Sharma: Biostatistics and Research Methodology, New Age International (P) Ltd., Publishers, 2020.
➢	Online resources	IOP Science Journals, Elsevier Mathematics Journals.

Semester III

Subject Name	**Linear Algebra**
Course Objectives	To understand the following: How to analyze and solve a linear system of equations; Important characteristics of matrices, such as its four fundamental subspaces, rank, determinant, eigen values and eigenvectors, different factorizations, etc; How to use characteristics of a matrix to solve a linear system of equations or study properties of a linear transformation; Important concepts of vector spaces such as independence, basis, dimensions, orthogonality, etc; Properties of special categories of matrices such as symmetric, positive definite, etc; Some applications of linear algebra in other branches of sciences, engineering, and economics.
Unit I	Vector Spaces, Subspaces, Bases and Dimensions, Linear span, Row space and column space of matrix, Direct Sum, Rank of matrices, Quotient Spaces.
Unit II	Linear transformations, operation with linear mapping, matrix representations of linear transformations, ,the rank and nullity theorem, Change of basis, similarities, transposes of linear transformations; trace and determinant, eigenvalues and eigenvectors, Dual spaces.

Unit III	Characteristic polynomial and minimal polynomial, Diagonalisability, Triangularisable, Caley-Hamilton theorem,, The Adjoint of Linear Transformation, Inner Product Spaces, Orthonormal and Orthogonality, Gram-Schmidt orthogonalization process, Schwartzs inequality, Unitary operators, Self Adjoints and Normal Operators, Polar and Singular Value Decomposition**.**
Unit IV	Canonical and Bilinear Forms: Jordan Forms, The Rational Forms, Bilinear Forms, Quadratic form: Definition and Examples, The matrix of a Bilinear Form, Orthogonality, and Classification of Bilinear Forms.

Course Outcomes			
	CO1	Recall the concepts of vector spaces, subspaces, bases, dimension and their properties.	Remember
	CO2	Explain the linear independence for vectors in Rn , rank and nullity of linear transformation.	Understand
	CO3	Apply the matrix representing a linear under a given basis, and determine how the matrix changes if the basis is changed.	Apply
	CO4	Analyze the characteristic polynomials to compute eigenvalues and eigenvectors.	Analyze
	CO5	Evaluate definite integral as an inner product, orthogonality of vectors and its use in projecting vectors into subspaces and decomposing vectors into components.	Evaluate
	CO6	Create the theory, methods and techniques of the course to solve mathematical problems.	Create

Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
Text books (Latest Editions)	1. Linear algebra by S. Lang, Springer, 2016. 2. Linear Algebra by Bisht and Sahai, Narosa, 2000. 3. Linear Algebra by Hoffman and Kunze, Prentice Hall of India Learning Pvt. Ltd, 2015. 4. Theory and Problems: Linear Algebra, Seymour Lipschutz, McGraw-Hill, 2018.
Online resources	IOP Science Journals, Elsevier Mathematics Journals

<table>
<tr><td>Subject Name</td><td colspan="4">Mechanics</td></tr>
<tr><td>Course Objectives</td><td colspan="4">One of the primary objectives in a mechanics course is to help the student develop this ability to visualize, which is so vital to problem formulation. Indeed, the construction of a meaningful mathematical model is often a more important experience than its solution.</td></tr>
<tr><td>Unit I</td><td colspan="4">Vector Integration. Line integrals, Surface area and surface integrals, Volume integrals.</td></tr>
<tr><td>Unit II</td><td colspan="4">Integral Theorems Green’s theorem, Gauss divergence theorem, Stoke’s theorem.</td></tr>
<tr><td>Unit III</td><td colspan="4">Curvilinear Coordinates, Orthogonal coordinates, Unit vectors in curvilinear systems, Arc length and volume elements, The gradient, Divergence and curl Special orthogonal coordinate systems.</td></tr>
<tr><td>Unit IV</td><td colspan="4">Tensor Analysis, Coordinate transformations, Einstein summation convention, Tensors of different ranks Contravariant, Covariant and mixed tensors.</td></tr>
<tr><td>Course Outcomes</td><td>CO1</td><td>Recall the significance of mathematics involved in physical quantities and their uses</td><td>Remember</td><td></td></tr>
<tr><td></td><td>CO2</td><td>Explain the necessary conditions for the equilibrium of particles acted upon by various forces and learn the principle of virtual work for a system of coplanar forces acting on a rigid body.</td><td>Understand</td><td></td></tr>
<tr><td></td><td>CO3</td><td>Apply the centre of gravity of some materialistic systems and discuss the equilibrium of a uniform cable hanging freely under its own weight.</td><td>Apply</td><td></td></tr>
<tr><td></td><td>CO4</td><td>Analyze the kinematics and kinetics of the rectilinear and planar motions of a particle including the constrained oscillatory motions of particles.</td><td>Analyze</td><td></td></tr>
<tr><td></td><td>CO5</td><td>Evaluate particle moving under a central force describes a plane curve and know the Kepler’s laws of the planetary motions, which were deduced by him long before the mathematical theory given by Newton.</td><td>Evaluate</td><td></td></tr>
<tr><td></td><td>CO6</td><td>Create the stress developed in beams due to forces applied.</td><td>Create</td><td></td></tr>
<tr><td></td><td colspan="2">Learner support Material</td><td colspan="2">NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.</td></tr>
<tr><td></td><td colspan="2">Text books (Latest Editions)</td><td colspan="2">1. Continuum Mechanics, Anthony james merril spencer,Dover publication,2004.
2. Introduction to Engineering Mechanics A Continuum Approach, Jenn Stroud Rossmann, Clive L. Dym , Taylor and francis group,2010.</td></tr>
</table>

		3. Inroduction to continuum mechanics for engineers, Ray M. Bowen , dover publication,2010. 4 First Course in Continuum Mechanics, Y.C.Fung, Prentice Hall, 2014.
	Online resources	IOP Science Journals, Elsevier Mathematics Journals

Subject Name	**Integral Transforms**
Course Objectives	The course is aimed at exposing the students to learn the Laplace transforms and Fourier transforms. To equip with the methods of finding Laplace transform and Fourier Transforms of different functions. To make them familiar with the methods of solving differential equations, partial differential equations, IVP and BVP using Laplace transforms and Fourier transforms.
Unit I	Laplace transform– Definition and its properties. Rules of manipulation. Laplace transform of derivatives and integrals. Inverse Laplace transform and its properties. Convolution theorem. Solutions of differential equation with the help of Laplace transform.
Unit II	Fourier transform – Definition and properties of Fourier sine, cosine and complex transforms. Convolution theorem. Inversion theorems. Fourier transform of derivatives.
Unit III	Mellin transform– Definition and elementary properties. Mellin transforms of derivatives and integrals. Inversion theorem. Convolution theorem.
Unit IV	Z transforms - Introduction, Properties, and Inverse Z-Transform.

Course Outcomes				
	CO1	Recall the Capability to solve problems in computer graphics using concepts of linear algebra.	Remember	
	CO2	Explain the various models such as growth and decay models and population models using techniques of differential equations.	Understand	
	CO3	Apply to solve linear system of equations, linear programming problems and network flow problems.	Apply	
	CO4	Analyze linear programming problems	Analyze	
	CO5	Evaluate and solve network flow problems.	Evaluate	
	CO6	Create new solutions using the domain knowledge of mathematics	Create	

❯	Learner support Material	NPTL,Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
❯	Text books (Latest Editions)	1. Applied Mathematics for Engineers and Physicists by L. A. Pipe (McGraw-Hill),2010 . 2. Introduction to Mathematical Physics by Charlie Harper (Prentice Hall of India),2000 . 3. Higher Engineering Mathematics by B.S. Grewal, Khanna Publications, Delhi,2015. 4. Mathematical Methods for Physicists by George Arfken (Academic Press),2000. 5. Mathematical Methods by Potter and Goldberg (Prentice Hall of India.
❯	Online resources	IOP Science Journals, Elsevier Mathematics Journals .

Subject Name	**Advance Differential Equations**
Course Objectives	To understand the point of this class is to take your existing knowledge of calculus and apply it towards the construction and solution of mathematical models in the form of differential equations (i.e. equations with derivatives in them). That's it. More precisely, the goal is that by the end of the class you will be able to: understand all of the concepts relating to the order and linearity of ODEs, analytic and computational solution methods for ODEs, and the real-world applications of ODEs.
Unit I	Classification of linear partial differential equation of second order, Canonical forms, Characteristics curve,Cauchy'sproblem of first and second order partial differential equation.
Unit II	General solution of higher order PDEs with constant coefficients, Linear homogeneous boundary value problem, Eigen values and eigen functions, Sturm-Liouville boundary value problems, orthogonality of eigen functions, Lagrange's identity, properties of Eigen functions.
Unit III	Important theorems of sturm Liouville system, Periodic functions.Non-homogeneous boundary value problems, Non-homogeneous Sturm-Liouville boundary value problems (method of eigen function expansion).
Unit IV	Green's Functions: Non-homogeneous Sturm-Liouville boundary value problem (method of Green's function), Procedure of constructing the Green's function and solution of boundary value problem, properties of Green's function, Inhomogeneous boundary conditions, Dirac delta function, Bilinear formula for Green's function, Modified Green's function.

Course Outcomes	**CO1**	Recall the physical systems can be described by differential equations.	Remember
	CO2	Explain the practical importance of solving differential equations.	Understand
	CO3	Apply the differences between initial value and boundary value problems (IVPs and BVPs).	Apply
	CO4	Analyze the importance of establishing the existence and uniqueness of solutions.	Analyze
	CO5	Evaluate an appropriate solution method for a given problem.	Evaluate
	CO6	Create approximate solutions of ODEs using graphical and numerical techniques	Create

	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
➢	Text books (Latest Editions)	5. Theory of Ordinary Differential Equations, E. A. Coddington and N. Levinson, Tata McGraw Hill, 2013. 6. Differential Equations, S. L. Ross, 3rd Edn., Wiley India, 2015. 7. Elements of Partial Differential Equations, I. N. Sneddon, Dover Publications, 2006. 8. Partial Differential Equations, F. John, Springer, 2014.
➢	Online resources	IOP Science Journals, Elsevier Mathematics Journals.

Subject Name	**Optimization Techniques Simulation Lab**	
Course Objectives	Understood the basic concepts, fundamental principles, and various theories in the above mentioned subjects.	
S. No.	Name of the Experiment	
1.	What is Optimization problem solving?	
2.	Development and use of optimization models suitable for computer representation, solution, graphical display and animation.	
3.	Introduction to Mat Lab with its applications.	
4.	Optimization problem-solving techniques.	
5.	Exchanging data between Mat Lab and EXCEL Programming.	
6.	Simulation models in EXCEL and Mat Lab (Simulink).	
7.	Curve fitting using EXCEL and Mat Lab.	
8.	Graphical Problem Solving, Mat Lab and EXCEL.	
Course Outcomes	**CO1**	Recall the Elimination Methods and Interpolation Methods of Unconstrained Optimization
	CO2	Summarize about the concept of OT Simulation.
	CO3	Solve Equality Constraints problems of Constrained Optimization.
	CO4	Analyse and appreciate variety of performance measures for various optimization problems.
	CO5	Evaluate the direct Root Methods of Unconstrained Optimization.
	CO6	Build the basic concepts of mathematics to formulate an optimization problem.

Subject Name	**Viscous Fluid Dynamics**
Course Objectives	To understand students who take this class can expect to develop an appreciation for the properties of Newtonian fluids, study analytical solutions to variety of simplified problems, understand the dynamics of fluid flows and the governing non-dimensional

	parameters, apply concepts of mass, momentum and energy conservation to flows, grasp the basic ideas of turbulence.				
Unit I	Viscosity , Analysis of stress and rate of strain, Stoke's law of friction, Thermal conductivity and generalized law of heat conduction, Equations of state and continuity , Navier- Stokes equations of motion and Equation of energy.				
Unit II	Vorticity and circulation, Dynamical similarity, Inspection and dimensional analysis, Buckingham theorem and its application, Non-dimensional parameters and their physical importance : Reynolds number, Froude number, Mach number, Prandtl number, Eckart number, Grashoff number, Brinkmann number, Non – dimensional coefficients : Lift and drag coefficients, Skin friction , Nusselt number, Recovery factor.				
Unit III	Exact solutions of Navier – Stokes equations, Velocity distribution for plane couette flow, Plane Poiseuille flow, Generalized plane Couette flow, Hagen- Poiseuille flow, Flow in tubes of uniform cross-sections. Stokes first and second theorem.				
Unit IV	Flow between two concentric rotating cylinders. Stagnation point flows : Hiemenz flow, Homann flow, Flow due to a rotating disc.				
Course Outcomes	**CO1**	Recall the fundamental properties of fluids, including viscosity, Newtonian and non-Newtonian rheology, and viscoelasticity.	Remember		
	CO2	Explain the necessary conditions for the equilibrium of particles acted upon by various forces and learn the principle of virtual work for a system of coplanar forces acting on a rigid body.	Understand		
	CO3	Apply microscopic continuum fluid mechanics where flow is governed by the continuity equation and Navier-Stokes equation.	Apply		
	CO4	Analyze a problem and arrive at reasonable approximations to put the equations in a more soluble form.	Analyze		
	CO5	Evaluate the significance of mathematics involved in physical quantities and their uses.	Evaluate		
	CO6	Create the stress developed in beams due to forces applied.	Create		
	Learner support Material	NPTL,Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.			

	Text books (Latest Editions)	1.Viscous Fluid Dynamics J.L. Bansal, Oxford and IBH,2010. 2.Specifications of Viscous Fingering in Mathematical Fluid Dynamics via Bifurcation: A Functional Analytic Approach (English), Bogdan-Vasile Matioc, Suedwestdeutscher Verlag Fuer Hochschulschriften,2000. 3.Boundary Layer Theory, H. Schlichting, K. Gersten, Springer,2010.
	Online resources	IOP Science Journals, Elsevier Mathematics Journals.

Subject Name	**Combinatorics and Graph Theory**			
Course Objectives	The objective of the course is to Explain basic concepts in combinatorial graph theory. Define how graphs serve as models for many standard problems. Discuss the concept of graph, tree, Euler graph, cut set and Combinatorics. See the applications of graphs in science, business and industry			
Unit I	Combinatorics– Counting of sets and multisets. Binomial and multinomial numbers. Unordered selection with repetitions, Selection without repetition. Counting objects and functions. Functions and the Pigeonhole principle. Inclusion and exclusion principle.			
Unit II	Graphs– Basic terminology, Simple graphs, Multi graphs and Weighted graphs. Walk and connectedness. Paths and circuits. Shortest path in weighted graphs, Eulerian paths and circuits. Hamiltonian paths and circuits.			
Unit III	Plannar Graphs– Combinatorial and geometric graphs, Kuratowski's graphs. Euler's formula. Detection of planarity. Geometric dual. Thickness and Crossing number.			
Unit IV	Digraphs– binary relations, Directed graphs and Directed trees, Arborescence, Polish notation method, Tournaments. Counting of Labeled Trees– Cayley's theorem. Counting methods, Polya's theory.			
Course Outcomes	**CO1**	Recall the Functions and the Pigeonhole principle. Inclusion and exclusion principle.	Remember	
	CO2	Explain the Basic terminology, Simple graphs, Multi graphs and Weighted graphs.	Understand	
	CO3	Apply the Pigeonhole principle. Inclusion and exclusion principle.	Apply	

	CO4	Analyze a Shortest path in weighted graphs, Eulerian paths and circuits.	Analyze
	CO5	Evaluate the Thickness and Crossing number.	Evaluate
	CO6	Create a binary relations between Directed graphs and Directed trees.	Create
➢	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.	
➢	Text books (Latest Editions)	1. Elements of Discrete Mathematics by C. L. Liu, McGraw-Hill Book Co, 2015. 2. Discrete mathematical structures by Kolman, Busby and Ross, 4th edition Prentice Hall of India. , 2002. 3. Mathematical Structures for Computer Science by J. L. Gersting, (3rd edition), Computer Science Press, New York, 2010. 4. Discrete Mathematics with Graph Theory by Goodaire and Parmenter, Pearson edition.2nd edition, 2015. 5. Graph Theory with Applications to Engineering and Computer Sciences by N. Deo, Prentice Hall of India, 2010.	
➢	Online resources	IOP Science Journals, Elsevier Mathematics Journals	

Subject Name	**RESEARCH METHODOLOGY**	
Course Objectives	The mission of the course is to impart research skills to the beginners and help improve the quality of Research by the existing researchers. It will enable the Researchers to develop the most appropriate methodology for their Research Studies.	
Module 1	Overview of Research and its Methodologies • Concepts of research, • The need for research, • Types of research, • Steps in conducting research	
Module 2	Literature review • What is literature review? • Why the need for literature review? • How to carry out a literature review?	
Module 3	Selecting and defining a research problem • Problem formulation – why the need for this? • What are the criteria for selecting a problem? • Identifying variables • Evaluating problems • Functions of a hypothesis	
Module 4	Conducting the research • Research activities • Preparations before conducting your research	
Course Outcomes	At the end of this course, the students should be able to: ➢ Understand some basic concepts of research and its methodologies. ➢ Explain what research is and what it is not, and the different definitions of research. ➢ Discuss the criteria of good research and the different types of research. ➢ Know the primary characteristics of quantitative research and qualitative research. ➢ Distinguish a purpose statement, a research question or hypothesis, and a research objective identify appropriate research topics. ➢ Select and define appropriate research problem and parameters.	
➢	Text books (Latest Editions)	4. Garg, B.L., Karadia, R., Agarwal, F. and

		Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers. 5. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p. 6. Cohen, L. Lawrence, M., & Morrison, K. (2005). Research Methods in Education (5th edition). Oxford: Oxford University Press.

Semester IV

Subject Name	**Functional Analysis**		
Course Objective	Functional analysis a central pillar of modern analysis, and we will cover its foundations. The main emphasis will be on the study of the properties of bounded linear maps between topological linear spaces of various kinds. This provides the basic tools for the development of such areas as quantum mechanics, harmonic analysis and stochastic calculus. It also has a very close relation to measure and integration theory.		
Unit I	Normed linear spaces. Quotient space of normed linear spaces and its completeness. Banach spaces and examples. Bounded linear transformations. Normed linear space of bounded linear transformations.		
Unit II	Equivalent norms. Basic properties of finite dimensional normed linear spaces and compactness.Reisz Lemma. Multilinear mapping. Open mapping theorem. Closed graph theorem. Uniformboundness theorem.		
Unit III	Continuous linear functionals. Hahn-Banach theorem and its consequences. Embedding andReflexivity of normed spaces. Dual spaces with examples. Inner product spaces. Hilbert space and its properties. Orthogonality and Functionals in Hilbert Spaces.		
Unit IV	Phythagorean theorem, Projection theorem,Orthonormal sets, Bessel's inequality, Complete orthonormal sets, Parseval's identity, Structure of a Hilbert space, Riesz representation theorem, Reflexivity of Hilbert spaces, Adjoint of an operator on a Hilbert space, Self-adjoint, Positive, Normal and Unitary operators and their properties, Projection on a Hilbert space, Invariance, Reducibility, Orthogonal projections.		
Course Outcomes	**CO1**	Recall the research, inquiry and analytical thinking abilities of the students.	Remember
	CO2	Explain the independently use contractions of Banach spaces via fixed point theorems.	Understand
	CO3	Apply the applications in the real world.	Apply
	CO4	Analyze topological-algebraical structures	Analyse
	CO5	Evaluate analytical methods.	Evaluate
	CO6	Create the problems in diverse situations in physics, engineering etc.	Create
	Online resources	IOP Science Journals, Elsevier Mathematics Journals.	

<table>
<tr><td>Subject Name</td><td colspan="5">Integral Equations</td></tr>
<tr><td>Course Objective</td><td colspan="5">The objective of the course module is to study Integral Equations and to know that what is the relationship between the integral equations and ordinary differential equations and how solved the linear and non linear integral equations by different methods with some problems which give rise to Integral Equations. Integral equations are important in many applications.</td></tr>
<tr><td>Unit I</td><td colspan="5">Linear integral equations– Definition and classification, Conversion of initial and boundary value problems to an integral equation, Eigen values and Eigen functions, Solution of homogeneous and general Fredholm integral equations of second kind with separable kernels.</td></tr>
<tr><td>Unit II</td><td colspan="5">Solution of Fredholm and Volterra integral equations of second kind by methods of successive substitutions and successive approximations, Resolvent kernel and its results, Conditions of uniform convergence and uniqueness of series solution.</td></tr>
<tr><td>Unit III</td><td colspan="5">Integral equations with symmetric kernels– Orthogonal system of functions, Fundamental properties of eigen values and eigen functions for symmetric kernels, Expansion in eigen functions and bilinear form, Hilbert-Schmidt theorem, Solution of Fredholm integral equations of second kind by using Hilbert-Schmidt theorem.</td></tr>
<tr><td>Unit IV</td><td colspan="5">Solution of Volterra integral equations of second kind with convolution type kernels by LaplaceTransform, Solution of singular integral equations by Fourier transform, Classical Fredholm theory– Fredholm theorems, Solution of Fredholm integral equation of second kind by using Fredholm first theorem .</td></tr>
<tr><td>Course Outcome</td><td>CO1</td><td colspan="2">Recall various algebraic structures.</td><td>Remember</td><td></td></tr>
<tr><td></td><td>CO2</td><td colspan="2">Explain the concept of integral equations.</td><td>Understand</td><td></td></tr>
<tr><td></td><td>CO3</td><td colspan="2">Apply the basic concepts to develop theorems.</td><td>Apply</td><td></td></tr>
<tr><td></td><td>CO4</td><td colspan="2">Analyze the significance of the notions of integral equations.</td><td>Analyze</td><td></td></tr>
<tr><td></td><td>CO5</td><td colspan="2">Evaluate the fundamental concepts of integral equations.</td><td>Evaluate</td><td></td></tr>
<tr><td></td><td>CO6</td><td colspan="2">Create Different methods to solve integral equations</td><td>Create</td><td></td></tr>
<tr><td></td><td colspan="2">Learner support Material</td><td colspan="3">NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.</td></tr>
<tr><td></td><td colspan="2">Text books (Latest Editions)</td><td colspan="3">1.Integral Equations, F.G Tricomi, Dover Publications Inc. New York, 2014.
2.Integral Equations: A Practical Treatment from Spectral Theory to Applications, D. Porter and D.S.G. Stirling, Cambridge University Press, 2015.
3.Singular Integral Equations, N.I. Muskhelishvili, Dover Publications Inc., New York, 2008., J.B. Conway, Springer, 2010.</td></tr>
<tr><td></td><td colspan="2">Online resources</td><td colspan="3">IOP Science Journals, Elsevier Mathematics Journals.</td></tr>
</table>

Subject Name	**Complex Analysis**		
Course Objective	The objective of this course is to introduce the fundamental ideas of the functions of complex variables and developing a clear understanding of the fundamental concepts of Complex Analysis such as analytic functions, complex integrals.		
Unit I	Functions of a complex Variable, Differentiability and analyticity, Cauchy Riemann Equations, Harmonic functions, Existence of Harmonic conjugate, Power series as an analytic function, properties of line integrals, Goursat Theorem, Cauchy theorem, consequence of simply connectivity, index of a closed curve .		
Unit II	Cauchy's integral formula, Morera's theorem, Liouville's theorem, Fundamental theorem of Algebra,Taylor's theorem, Laurent series, Power series and its radius of convergence.		
Unit III	Zeros of Analytic functions, singularities, classification of singularities,Maximum modulus theorem, Minimum modulus theorem, Hadamard three circle theorem, Schwarz's Lemma, Rouche's theorem.		
Unit IV	Calculation of residues, Residue theorem and its applications in evaluating real integrals,Conformal mappings, critical points. Bilinear transformation, their properties and classification, cross ratio, preservance of cross ratio under bilinear transformation, preservance of circle and straight line under bilinear transformation, fixed point bilinear transformation, normal form of a bilinear transformation.		
Course Outcome	**CO1**	Recall the fundamental concepts of complex analysis.	Remember
	CO2	Explain the accurate and efficient use of complex analysis Techniques.	Understand
	CO3	Apply problem-solving techniques using complex analysis.	Apply
	CO4	Analyze the significance of the notions of Complex plane.	Analyze
	CO5	Evaluate different problems of complex physics.	Evaluate
	CO6	Create the applications of different methods.	Create
	Learner support Material	NPTL,Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.	

	Text books (Latest Editions)	1. Complex Analysis (Third edition) by L. V. Ahlfors, McGraw-Hill Book Company, 2015. 2. Complex Analysis by J. B. Conway, Narosa Publishing House,2010. 3. Complex Analysis by Serg Lang, Addison Wesley,2015. 4. Foundations of Complex analysis (Second Edition), S. Ponnusamy, Narosa Publishing House,2010. 5. Complex variables and Applications by Ruel V. Churchill,2015 .
	Online resources	IOP Science Journals, Elsevier Mathematics Journals.

Subject Name	**Number Theory**			
Course Objective	To present a rigorous development of Number Theory using axioms, definitions, examples, theorems and their proofs.			
Unit I	Divisibility, G.C.D and L.C.M., Primes, Fermat numbers, congruences and residues, theorems Euler, Fermat and Wilson, solutions of congruences, linear congruences, Chinese remainder theorem.			
Unit II	Arithmetical functions $\varphi(n)$, $\mu(n)$ and $d(n)$and $\sigma(n)$, Moebius inversion formula, congruences o higher degree, congruences of prime power modulli and prime modulus, power residue.			
Unit III	Quadratic residue, Legendre symbols, lemma of Guass and reciprocity law. Jacobi symbols, Farey series, rational approximation, Hurwitz theorem, irrational numbers, irrationality of e and π, Representation of the real numbers by decimals.			
Unit IV	Finite continued fractions, simple continued fractions, infinite simple continued fractions, periodic continued fractions, approximation by convergence, best possible approximation, Pell's equations, Lagrange four sphere theorem.			
Course Outcomes	**CO1**	Recall the Mathematical concepts and principles to perform symbolic computations.	Remember	
	CO2	Explain the technology appropriately to investigate and solve mathematical and statistical problems.	Understand	
	CO3	Apply proofs effectively in both written and oral forms.	Apply	
	CO4	Analyze the ability to learn number theory concepts.	Analyze	
	CO5	Evaluate different problems of number theory.	Evaluate	

	CO6	Create the applications of different methods.	Create
	Learner support Material	NPTL,Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.	
	Text books (Latest Editions)	1. Theory of Numbers, G H Hardy and E M Wright, Oxford Science Publications, 2003. 2. Introduction to the Theory of Numbers, I Niven and H S Zuckerman, John Wiley & Sons,2016. 3. Elementary Number Theory, D M Burton, Tata McGraw Hill Publishing House, 2006. 4. Higher Arithmetic, H. Davenport, Cambridge University Press, 2000. 5. Introduction to Analytic Number Theory, T.M. Apostal, Narosa Publishing House,2015.	
	Online resources	IOP Science Journals, Elsevier Mathematics Journals.	

Subject Name	**Dissertation**	
Course Objective	Students will be able to read and identify mathematical and computational methods in order to solve problems and present. Provide Strong foundation and inculcate ample knowledge on topics in pure and applied mathematics, empowering the students to pursue higher degrees.	
Area of Dissertation	Fluid Dynamics	
	Integral Transform	
	Numerical Methods.	
Course Outcome		
➢	Learner support Material	E-library, E-books, online PDF material etc.
➢	Text books (Latest Editions)	1. Viscous Fluid Dynamics J.L. Bansal,, Oxford and IBH,2010. 2. Higher Engineering Mathematics by B.S. Grewal, Khanna Publications, Delhi 2015.
➢	Online resources	IOP Science Journals, Elsevier Mathematics Journals.

Subject	**Difference Equations and Sampling Theory**

Name	
Course Objectives	1. To build an understanding of the fundamental concepts of Mathematics. 2.To introduce the student to formulate and analyze mathematical and statistical problems, precisely define the key terms, and draw clear and reasonable Conclusions.
Unit I	Introduction, Difference Calculus – The difference operator, Summation, Generating functions and approximate summation. Linear Difference Equations - First order equations. General results for linear equations.
Unit II	Equations with constant coefficients. Applications. Equations with variable coefficients. Stability Theory - Initial value problems for linear systems. Stability of linear systems.
Unit III	Sample space, Events, Algebra of events, Baye's Rule, Bernoulli Trials. Probability Distribution and probability Densities:
Unit IV	Bernoulli, Binomial, Poisson, Normal, Rectangular and exponential distributions and their PDFs. Moments and MGFs for above distributions.

Course Outcome			
	CO1	Recall the significance of Difference Equations	Remember
	CO2	Explain the Sampling Theory.	Understand
	CO3	Apply the importance of mathematics and its techniques to solve real life problems	Apply
	CO4	Analyze the limitations of such techniques and the validity of the results.	Analyze
	CO5	Evaluate the application of Difference equations in Numerical methods.	Evaluate
	CO6	Create the geometrical meaning of the Difference equations	Create

	Learner support Material	NPTL, Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.
	Text books (Latest Editions)	1."Mathematical Methods"-Potter, M C; Goldberg Jack, PHI,2010 2.Probability and Statist**ics" – Schaum's Series** – McGraw Hill,2015. 3.Walter G. Kelley and Allan C. Peterson- Difference Equations. An Introduction with Applications, Academic Press Inc., Harcourt Brace Joranovich Publishers, 2014. 4. Calvin Ahlbrandt and Allan C. Peterson. Discrete Hamiltonian Systems, Difference Equations, Continued Fractions and Riccatti Equations. Kluwer, Boston, 2015.
	Online resources	IOP Science Journals, Elsevier Mathematics Journals.

Subject	**Mathematical Statistics**

<table>
<tr><td>Name</td><td colspan="5"></td></tr>
<tr><td>Course Objective</td><td colspan="5">The objective of this course is to provide an understanding for the graduate business student on statistical concepts to include measurements of location and dispersion, probability, probability distributions, sampling, estimation, hypothesis testing, regression, and correlation analysis, multiple regression and business/economic forecasting.</td></tr>
<tr><td>Unit I</td><td colspan="5">Probability Theory: Three definitions of probability (Mathematical, Empirical & axiomatic). Dependent, independent and compound events. Addition and multiplication theorems of probability, conditional probability. Binomial and multinomial theorems of probability, Baye’s theorem, Mathematical expectation and its properties, Moment generating functions (m.g.f.) and cumulants.</td></tr>
<tr><td>Unit II</td><td colspan="5">Discrete distribution– Binomial & Poisson distributions and their properties.
Continuous distribution: – Distribution function, Probability density function (Pdf), Cauchy’s distribution, rectangular distribution, exponential distribution, Beta, Gamma Normal distributions and their properties.
Fitting of the Curves by method of least square – Straight line, parabola and exponential curves.</td></tr>
<tr><td>Unit III</td><td colspan="5">Correlation and Regression: Bivariate population, Meaning of correlation & regression. Coefficient of Correlation, rank correlation, lines of regression. Properties of regression coefficients, Partial and multiple correlation and their simple Properties.</td></tr>
<tr><td>Unit IV</td><td colspan="5">Types of population, Parameters & Statistics, Null Hypothesis, Level of Significance, critical region. Procedure for testing Hypothesis. Type I & Type II error, Chi Square - distribution and its properties.</td></tr>
<tr><td>Course Outcome</td><td>CO1</td><td>Recall the dependent, independent, compound events, addition and multiplication theorems of probability.</td><td>Remember</td><td></td><td></td></tr>
<tr><td></td><td>CO2</td><td>Explain the Binomial & Poisson distributions and their properties.</td><td>Understand</td><td></td><td></td></tr>
<tr><td></td><td>CO3</td><td>Apply the Fitting of the Curves by method of least square.</td><td>Apply</td><td></td><td></td></tr>
<tr><td></td><td>CO4</td><td>Analyze the Parameters & Statistics, Null Hypothesis, Level of Significance and critical region.</td><td>Analyze</td><td></td><td></td></tr>
<tr><td></td><td>CO5</td><td>Evaluate the Coefficient of Correlation, rank of correlation and lines of regression.</td><td>Evaluate</td><td></td><td></td></tr>
<tr><td></td><td>CO6</td><td>Create the Procedure for testing Hypothesis.</td><td>Create</td><td></td><td></td></tr>
<tr><td></td><td colspan="2">Learner support Material</td><td colspan="3">NPTL,Swayam(https://swayam.gov.in), E-library, E-books, online PDF material etc.</td></tr>
<tr><td></td><td colspan="2">Text books (Latest</td><td colspan="3">1. A.M. Goon, M. K. Gupta and B. Dasgupta, Fundamentals of</td></tr>
</table>

	Editions)	Statistics, Vol I and II, World Press, 2005. 2. J. D. Gibbons, Non-parametric Statistical Inference, McGraw-Hill Inc, 2015. 3. R. V. Hogg, J. McKean and A. Craig, Introduction to Mathematical Statistics, 7th Edition, Pearson, 2012.
	Online resources	IOP Science Journals, Elsevier Mathematics Journals.

Subject Name	**SCIENTIFIC WRITING AND ACADEMIC INTEGRITY**
Course Objective	In this course, participants will learn about the different types of scientific articles and know how to write an original research article by describing their original scientific research while maintaining academic integrity.
Unit I	**Probability Theory:** Three definitions of probability (Mathematical, Empirical & axiomatic). Dependent, independent and compound events. Addition and multiplication theorems of probability, conditional probability. Binomial and multinomial theorems of probability, Baye's theorem, Mathematical expectation and its properties, Moment generating functions (m.g.f.) and cumulants.
Unit II	Discrete distribution– Binomial & Poisson distributions and their properties. Continuous distribution: – Distribution function, Probability density function (Pdf), Cauchy's distribution, rectangular distribution, exponential distribution, Beta, Gamma Normal distributions and their properties. Fitting of the Curves by method of least square – Straight line, parabola and exponential curves.
Unit III	**Correlation and Regression**: Bivariate population, Meaning of correlation & regression. Coefficient of Correlation, rank correlation, lines of regression. Properties of regression coefficients, Partial and multiple correlation and their simple Properties.
Unit IV	Types of population, Parameters & Statistics, Null Hypothesis, Level of Significance, critical region. Procedure for testing Hypothesis. Type I & Type II error, Chi Square - distribution and its properties.
Course Outcome	Upon completion of this course students will be able to: ❖ Describe and utilize writing resources available. ❖ Create scientific documents using their improved scientific writing skills. ❖ Exercise accepted methods for literature discussion, citing and quoting to written scientific documents, while avoiding plagiarism. ❖ Apply electronic resources, including EndNote and iThenticate, to written scientific documents. ❖ Write a good, solid draft of the specific aims and background related to their

	Master's Thesis, PhD research proposal and other academic work. ❖ Understand the academic misconduct, conflict of interest and academic cheating.	
➢	Text books (Latest Editions)	1. Communicating science effectively: a research agenda, Washington, DC: the National Academies Press, 2017. 2. Communicate science papers, presentations, and posters effectively: papers, posters, and presentations, London: Academic Press, an imprint of Elsevier, 2015. 3. Systematic approaches to a successful literature review, Los Angeles: Sage, 2016, second edition. 4. Doing a systematic review: a student's guide, London SAGE, 2017, second edition. 5. Handbook of Academic Integrity (Bretag, Tracey (Ed.)), 2016, Springer Singapore.

Annexure II- Mandatory Documents for Admission

To be uploaded on the Online Admission Portal by the Prospective students

Admission Documents	Format (Jpeg/PNG/PDF)	Documents Size
Duly filled online application form with student signature	Digital signature/Student signature JPEG/PNG	20 KB
Colour scan copy of all year/semester mark sheet/grade cards (for PG programs only) or consolidated mark sheet/grade cards also accepted.	PDF/JPEG	500 KB
Colour scan copy of 10th std. Mark sheet/grade card	PDF/JPEG	
Colour scan copy of 12th std./ Three-Year Polytechnic Diploma Mark sheet/grade card	PDF/JPEG	
Colour scan copy of passport size photograph	JPEG or PNG Format	50 KB
Colour scan copy of Govt. Photo id proof, Aadhar card is mandatory. (Other options: Voter's id, Driving License, Passport etc.)	PDF/JPEG	100 KB
In case of name change, Gazette notification documents for name changes For married women – marriage certificate would be accepted – provided previous maiden name is clearly mentioned in the same. In case of deferred Father name or mother name in such cases without a Gazette notification document.	PDF	500 KB
If foreign student: colour scan copy of passport	PDF/JPEG	500 KB
Fees submission transaction details or receipt as per University policy for respective online programs	PDF/JPEG	500 KB
Digitally Signed undertaking as per the process; where applicable	PDF	500 KB

Students can also visit the University website for the said information.

Annexure III- Content uploading protocol: Internal Process

The step-by-step breakdown of the process is as follows:

1) **Organizing Academic Content:**

- Create a separate sub-folder for each module of a subject within the Course Folder named after the Course Code.
- Each module sub-folder should contain PDFs (e-books, practical assignments, plagiarism reports, etc.), 1 PowerPoint presentation (ppt), and 1 recorded lecture video.
- Compile all module study material PDFs into one combined PDF for each subject for plagiarism check.

2) **Google Drive Link Creation and Sharing:**

- Create a Google Drive link for content sharing.
- Upload the folders onto the drive.
- Share the drive link with the Deputy Director and Program Coordinator for review.

3) **Review Process:** Program Coordinator will provide suggestions and reviews.

4) **Revised Content Sharing:** After revisions, follow Step 1 and Step 2 again, but rename the files to indicate corrections (e.g., MBM101_corrected).

5) **Final Approval:** Deputy Director communicates final approval to upload the contents on LMS to the Technical Manager.

6) **Content Upload on LMS:** Once approved, Program Coordinator ensures the contents are uploaded under the correct subject name and program on the LMS.

7) **Student Notification:** Notify students of the availability of approved content on the LMS.

This process ensures organized content creation, thorough review, and proper dissemination to students via the Learning Management System.

Annexure IV- Academic Bank of Credit Id Creation Process

All enrolled students, particularly those of Indian nationality, are required to register with ABC (Academic Bank of Credits), a central scheme established by the Ministry of Education,

Government of India, for depositing credit. ABC ID creation is mandatory for all students, ensuring their participation in this scheme.

The ABC Id can be created by students themselves using Digi-locker, UMANG application, ABC portal or Academic Institution Portal. The process for which is provided below.

Process	• Students can register by logging in at www.abc.digilocker.gov.in • Click on My Account → Login as Student • Click on "Sign up with DigiLocker" → Enter valid mobile number → An OTP is sent at the phone number via SMS → Enter the OTP and click on "Continue" button → Enter Security PIN set created during Sign Up and click "Submit" Button • You will be prompted with ABC student account creation window
Documents and proofs required	• Aadhaar Card is mandatory for ABC Id creation • Learners Name • Date of Birth • Gender • Enrolment Number • Requirements by Academic Institution: • Mobile Number

The University will extend support to the students to create ABC ID. The documents required will remain the same as stated above.

Annexure V - Guidelines and Pre-requisites for Proctored Examination

the minimum hardware, software, and connectivity requirements for taking exams through the Online Proctored Examination Platform are mentioned below:

TYPE	MINIMUM	RECOMMENDED
Internet Connection	Wifi Connection	Wired Connection
PC Users	Windows 8 (Windows 10 S mode is not supported)	Windows 10 (10 S mode is not supported)
Mac Users	MacOS 10.13 (Oldest Still Maintained Version)	MacOS 10.15
CPU	more than 2 core CPU less than 85% CPU Usage	more than 4 core CPU less than 50% CPU Usage
Webcam	640x480 resolution	1280x720 resolution
Internet Download Speed	1 Mbps	12 Mbps
Internet Upload Speed	1 Mbps	3 Mbps
RAM	4 GB less than 90% Ram Usage	16 GB less than 70% Usage
Connectivity Ports	1935, 843, 80, 443, 61613, UDP/TCP	1935, 843, 80, 443, 61613, UDP/TCP
Screen Resolution	1366 x 768	1920 x 1080 and above
Chromebook Users (Only for Automated Proctoring. Is not Supported for Live Proctoring)	Chrome device is running the latest version of Chrome OS.	Chrome device is running the latest version of Chrome OS.

1) Additional Requirements:

- A functioning microphone (some web cameras have them built-in); the microphone should not be part of headphones.
- Headphones are generally not permitted; check with your testing organization to determine if headphones are allowed.

- A compatible browser: Google Chrome (preferred) or Mozilla Firefox.
- Webcam and microphone (built-in or external) – test your webcam at https://webcamtests.com/.
- Connection to a network with sufficient internet speed: at least 1 Mbps download speed and 1 Mbps upload – test internet speed at www.speedtest.net.

2) **Not Supported:**

- Microsoft Edge browser.
- Google Chromebooks (for Live Proctoring only).
- Tablets (Nexus, iPad, Tab, Note, etc.).
- Smartphones.
- Linux operating systems.
- Windows 10 in S mode or Surface RT.
- Connecting from within a virtual machine. You will be asked to reconnect using your host operating system to take your exam.
- Apple Boot Camp.
- Remote Access Software.
- Inactive Version of Windows and Test Builds/Test Mode.

3) **Pop-up Blocker:**
Pop-up blockers must be either off or disabled. Disable your pop-up blocker as follows:

    - Open Chrome on your computer.
    - Click on the icon with three vertical dots.
    - Click More, then Settings on the top right.
    - Go to Privacy and security and click Site settings.
    - Click Pop-ups and redirects.
    - Turn the setting to Allowed at the top.

Important: The Institute regularly takes actions to optimize its examination system, and hence please note that the above-mentioned hardware, software, equipment, and connectivity requirements might change at the Institute's discretion. All students will need to 100% comply with any such changed specifications announced by the Institute.

General Instructions

For Proctored Online Examinations, the timing will strictly adhere to the communicated timetable schedule in Indian Standard Time (IST), including for candidates taking the exam outside India.

Candidates can take exams on devices such as laptops or desktops. Ensure that the device is fully charged well in advance to last for at least 2 hours. It should also have continuous internet connectivity. Avoid sharing the phone's hotspot with any other device during the examination.

To ensure a smooth examination attempt, students are advised to:

a) Sit in a closed room with adequate lighting for the camera to detect them. Face the light during the examination and avoid sitting near or against a window.

b) Ensure a noise-free environment during the examination to avoid detection and capture as deviation.

c) Position the device so that the front camera captures the student's face properly, and they can sit comfortably for one hour without moving the device.

d) If using a Wi-Fi router, sit near the router/modem to prevent any signal-related issues.

Students must log in to the portal 30 minutes before the start of the examination compulsorily. This ensures sufficient time for any technical checks or troubleshooting before the exam begins.

- During the online examination, the following activities are strictly prohibited:
  a) Having any other person present in the room where the student is taking the examination.
  b) Moving from one place to another during the examination.
- You are not allowed to refer to any textbooks or any other material during the notified examination time.

- You are permitted to use rough paper and pen/pencil for solving analytical questions only and can use permitted scientific calculators. Before using rough papers and calculators, kindly show them in your PC/Mobile camera and then proceed.

- Once logged into the system with your Username and Password, please allow camera, location access, and audio device access when prompted. Failure to grant access to any of these may prevent you from appearing for the examination, or the remote proctor may disable your examination.

- In case of network disconnection or power failure during the examination, wait for internet connectivity to restore (do so as quickly as possible) and resume the test within 2 minutes by clicking on the "Resume" button. If unable to reconnect after 2 minutes, contact the administration for appropriate solutions to continue the test.

- It is advised to use the same laptop/desktop for both the mock examination and the final online examination.

- A helpdesk number will be provided to troubleshoot technical issues during the examination process. Students can contact this number for assistance in such cases.

2. Examination Rules

• Every student will need to log in through a secure ID and password on the online examination platform on the day of the examination. The time schedule, URL, User ID, and password will be provided in the LMS portal and will also be sent to the registered email ID or via SMS to the registered mobile phone.

- At the beginning of each session, the student undergoes identity verification at 2 levels:
    - Level 1: Capture of facial photo. During the examination, the student is required to click and upload their photograph in the system. The system constantly monitors the picture of the student taking the examination with the facial photo captured initially for any mismatch. In case of any mismatch, the system will capture the anomaly, and a notification to the student/live proctor will be instantly displayed.
    - Level 2: Student must display College ID/Government-authorized ID proof at the beginning of the examination.
- Only 2 attempts will be allowed for every student for every session of the day for a test. After two attempts, the student will not be able to take the test again for the respective session of the day.
- The student should ensure that they click on the "Submit" button available on the right top position of the screen before logging out of the exam.
- The Online Examination system will issue regular warnings for any deviations from the specified norms on the screen of your device. The maximum number of warnings will be 10, after which the test will be terminated.
- If a student violates any rules during the examination or tries to adopt any unfair means, the system will automatically collect data based on the following deviations and alert the student, immediately alerting the online live proctor:

    - Focus changed to a different window: student tabs out of the examination-taking window.
    - Browser not supported: Student is using an older browser version or a non-compatible browser.
    - Webcam is disabled: Student's webcam is disabled.

- Face is not visible in the camera: Student is not looking into the camera.
- Several faces in front of the camera: There are other people along with the examination taker.
- Face does not match the profile: Student taking the examination is not the same person whose photo was captured before starting the examination and the photo of the student as available in the University database.
- Microphone muted or its volume is low: Student has muted the microphone.
- Conversation or noise in the background: System has captured background noise.
- Screen activities are not shared: student has stopped screen share activity. Sharing of the screen is not necessary for the users of smartphones.
- Second display is used: Additional display like an extended monitor has been connected.
- Full-screen mode is disabled: student has disabled full-screen mode.

3. Examination code of conduct and Malpractices

• Students are not permitted to leave their seat during the examination.
• Consultation with others for information during the examination is strictly prohibited.
• The system utilizes Artificial Intelligence to monitor and record facial expressions, eye movements, and other activities.
• Engagement in suspicious or objectionable activities detected by the system will result in disciplinary action as per University regulations.
• Regular warnings will be issued on the device screen, recorded in the examination system, affecting the overall credibility score, potentially leading to examination cancellation.
• Taking photos, recording videos, or engaging in suspicious activities during the examination will be recorded and treated as malpractice.
• Use of headphones, noise cancellation devices, or Bluetooth devices during the examination is prohibited.
• Manual proctors (invigilators) will monitor students throughout the examination duration.
• Referring to textbooks or consulting others for information during the examination is not allowed.
• Taking photos, screenshots, audio recording, or video recording of the examination and sharing it with others is considered malpractice.
• Use of headphones, noise cancellation devices, or Bluetooth devices during the examination is prohibited.
• Attempting to navigate away from the main screen will automatically terminate the examination.
• While using a laptop or desktop, refrain from using the keyboard except for communicating with the proctor; only use the mouse to answer questions.
• Starting the examination from multiple devices simultaneously is not allowed; however, changing devices due to technical faults is permitted.

• Students must remain in their place for the duration of the examination.
• Ensure no light source is behind your face.
• Avoid covering your face with hair, clothing (mask), hands, or any other object.
• Do not use headphones, earbuds, or any listening equipment.
• Eliminate background noise, voices, music, or television.
• Do not wear sunglasses during the examination.
• Do not allow any other individuals into the room.
• Avoid communication with any person during the examination.
• Do not have any programs or applications running that utilize the webcam, microphone, or screen-share features.
• Refrain from taking photos, screenshots, audio recording, or video recording of the examination and sharing it with others, as it will be considered malpractice.

Annexure VI – Continuous Internal Assessment Pattern

Particular	A1 (Objective Type)	A2 (Objective Type)
Marks	15	15

Question Pattern for the CIA Components
A-1 1.There will be 15 Objective type Multiple Choice Questions (MCQs), each carrying mark1 mark 2. The time for the A-1 assignment will be 30 mins 3. All questions are compulsory 4. There will be NO NEGATIVE MARKING for the wrong answers. **A-2** 1. There will be 15 Objective type Multiple Choice Questions (MCQs), each carrying mark1 mark 2. The time for the A-1 assignment will be 30 mins 3. All questions are compulsory 4. There will be NO NEGATIVE MARKING for the wrong answers.

Annexure VII – End-term Examination Pattern

JNU

Centre for Distance and Online Education

End Term Examination

[PROGRAM NAME]

[COURSE NAME][COURSE CODE]

Time : 2 Hours	Max. Marks : 70
Note for students: The paper will comprises of 70 compulsory objective questions of 1 mark each.	
Answer all the questions. Each question carries one mark.	
Q. No. 1 to Q. No. 70 - Objective questions with four multiple choices.	