# SYLLABUS
# FOR
# Master of Science in Mathematics
## With Specialization
## in
# Indigenous Knowledge, Science and Technology

**Choice Based Credit System (CBCS)**
**With Effect From Academic Session: 2021-2022**

## School of Indigenous Knowledge Science & Technology
## KALINGA INSTITUTE OF SOCIAL SCIENCES (KISS)
## (Deemed to be University)

**Higher Education Campus**
**KISS Campus – 3, Bhubaneswar, Odisha, 751024**
**www.kiss.ac.in**

**M.Sc.(Mathematics)**

**Specialization: Indigenous Knowledge science and Technology**

**CONTENTS**

**M.Sc. With Specialization in Indigenous Knowledge, Science and Technology**

**I. About the School and Programme**

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

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

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

The importance of this School is to disseminate advanced knowledge by providing instructional and research facilities in tribal medicinal systems through phytochemical analysis, geosciences and their impact on the health conditions. The importance of cosmology in their culture, Sutras and sub-sutras of Vedic mathematics, a nutritional component of the food habit of tribes, intellectual property rights to preserve and conserve the biodiversity of indigenous people and advancement in technologies relating to the natural resources of the tribal areas as well as in other branches of learning as it may deem fit.

This could be possible by teaching innovative courses in Indigenous Knowledge and Intellectual Property Rights, Tribal Sports, Nutrition and Health Management, Indigenous People and the Science of Gemology, Indigenous People and the Science of Cosmology and Vedic Mathematics. The courses attempt to examine indigenous knowledge and technology, blending both traditional and modern scientific methods from interdisciplinary and multidisciplinary approaches.

The School of Indigenous Knowledge, Science and Technology constantly endeavors to improve the knowledge and practice content of its academic programme to match the local, regional, national and international standards. KISS Deemed to be University, is the first full-fledged institution in the field of Indigenous Science and Technology in the country.

Prof. Samanta discovered in the last 30 years that the tribals, after all, have a rich reservoir of traditional knowledge and wisdom, bequeathed to them over generations by their forefathers that propelled them to go so uniquely about their livelihood, cater to their health care and lead a self-sustained life.

Having gathered this critical pool of knowledge on tribals by relentlessly interacting with them, KISS is now determined to leverage on that advantage by setting up a regular, organized and permanent framework to ensure that this mine of knowledge and wisdom of yore is explored in depth scientifically, for the lasting benefits of the posterity. The establishment of a School of Indigenous Knowledge, Science and Technology is a step in that direction. This School has introduced four innovative interdisciplinary programmes viz. Physics, Chemistry, Mathematics and Computer Science with specialization in Indigenous Knowledge, Science and Technology in the first phase with the approval of UGC to provide impetus to research in Indigenous Knowledge, Science and Technology with multi disciplinary education facility free of cost. Besides implementing Sustainable Development Goals of the United Nation, the school has been able to bring about the much needed socio-economic changes in the tribal hinterland of Odisha and its neighbouring states.

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

**Vision:**

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

**Mission:**

- Foster all-round development of students through multi-faceted education.
- Focus on Indigenous Science and Technology with the help of innovative courses like Indigenous people and the Science of Cosmology, Vedic Mathematics, Indigenous people and the Science of Gemology, Tribal Sports, Nutrition and Health Management, Indigenous Knowledge and Intellectual Property Rights.

- ❖ Engage with local, national and global communities to get ideas about Indigenous Science and Technological applications for contemporary needs and problems and become successful in life.
- ❖ Manage resources for self employment and create employment for others.

**M. Sc. with specialization in Indigenous Knowledge, Science and Technology**

This programme intends to offer courses that deal with economic poverty alleviation measures through the management of indigenous resources and meet the goals of sustainable development. The programme is inter-disciplinary and it focuses on sustenance of natural/human resources employing traditional methods that are conducive to societal growth and development.

**Process of Revision of Courses through stakeholder inputs:**

The School of Indigenous Knowledge, Science and Technology follows consultative process in the revising of the courses.

Following are the stages of course revision:

(i) Formation of syllabus Revision Committee with members having specialized domain knowledge.

(ii) Consultation with stakeholders comprising alumni, students, employers, etc.

(iii) Approval by all faculty members of the Department

(iv) Approval by Board of Studies (Experts from Outside) and Academic Council

**II. Introduction to CBCS (Choice Based Credit System)**

**Choice Based Credit System:**

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective, skill-based courses. The courses can be evaluated following the grading system. Grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enables the potential employers in assessing the performance of the candidates.

**Definitions**:

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

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

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

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

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

(vi) 'Specialization' means a course to be taken by a student offered in the Programme of the School.

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

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

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

(x) 'SGPA' means 'Semester Grade Point Average' calculated for individual semester and 'CGPA' is 'Cumulative Grade Points Average' calculated for all courses completed by the students at any point of time. CGPA is calculated each year for

both the semesters clubbed together. To benefit the student a formula for conversation of Grand CGPA into percentage marks is given in the Transcript.

## III. M.Sc. With Specialization in Indigenous Knowledge, Science and Technology Programme Details:

As per the structure, there are five to six courses in all semesters. In addition, as per the area of interest, the students are required to choose discipline specific elective, in the beginning of the 4th semester. Under Choice Based Credit System, students will also study 'Open Elective' courses. These courses will be available for students. The programme also offers career advancement and skill enhancement course in each semester as value added courses to equip the students in the competitive market. In the light of augmentation in the field of Indigenous Science and Technology, the overall structure of the course has been changed to widen the scope and depth of the course and inclusion of research paradigms of Indigenous Science and Technology, Chemistry, Physics, Mathematics and Computer Science to facilitate those students aspiring for pursuing research. The course has been designed in line with outcome based approach which requires specification of Course Objectives and Course Learning Outcomes.

This programme structure offers a deep dive into various facet of Indigenous Science and Technology and organizational development by integration of cross-cutting issues relevant to environment and sustainability, human values, professional ethics, into the curriculum through incorporation of relevant topics such as Indigenous Knowledge and Intellectual Property Rights, Tribal Sports, Nutrition and Health Management, Indigenous People and the Science of Gemology, Indigenous People and the Science of Cosmology and Vedic Mathematics. The curriculum seeks to develop managerial knowledge and strategic agility, providing students with a broader skill set and a fresh perspective and to encourage them.

### Programme Educational Objectives (PEOs):

The Objective of this program is to ensure career path of the students. Students can be self employed in the tribal community or elsewhere; or become a social entrepreneur; or can adopt research studies to enhance their skills for sustainable livelihood and become a researcher; they can pursue higher studies; or become a professional for policy making and its execution.

**PEO1:** Aim of this unique program is to enable the students to learn, evaluate and develop analytical ability mainly in the field of science and technology and to ensure preservation of tribal resources. They should be able to highlight the philosophical approach of the tribals towards economic life.

**PEO2:** To explore and innovate scientific knowledge through the application of indigenous knowledge by utilizing the treasured indigenous knowledge of Professors of Practice.

**PEO3:** To collaborate with national and international universities and organizations, especially for undertaking spiritual studies and research on tribal communities

**PEO4:** To provide strong domain knowledge along with skill enhancement through hands-on training. To provide experiential training to students for professional and career readiness to participate in real life projects and develop the right skill-set needed in a competitive market scenario.

**PEO5:** To offer online and offline certificate courses for enrichment and refinement of their skills and computer literacy for attaining global competency.

**PEO6:** To formulate tribal centric development models, publish reports and organize conferences and seminars on issues relating to indigenous science and technology.

**PEO7:** To create ample scope for the researchers in the field of science and technology from a tribal perspective by integrating relevant aspects of indigenous knowledge with traditional subjects like Physics, Chemistry, Mathematics and Computer Science.

**PEO8:** To make proper use of natural resources and indigenous knowledge for sustainable environmental development.

**PEO9:** To equip the students with knowledge in indigenous science and technology and turn them into agents of social transformation in their respective communities.

**PEO10:** To strive for continuous quality enhancement of academic and institutional governance to promote a culture of credibility, transparency and reliability.

**Learning Outcome-based Curriculum Framework (LOCF)**

This Learning Outcome-based Curriculum Framework (LOCF) in M. Sc. (IKST) are as follows:

**1. Introduction**

Postgraduate education in Chemistry in KISS University aims at overall development of the rural and tribal community and sustainable tribal development. The focus is on knowledge and skills that prepare students for further study, employment, and research.

2. In order to achieve the programme goals, following measures shall be adopted:

(i) Reform based on a Learning Outcomes-based Curriculum Framework (LOCF)

(ii) Enriching the quality of teaching and research

(iii) Enlightening learning environment through ICT based hands-on approach to students

(iv) Involving students in discussions, problem-solving, and out of the box thinking

(v) Motivating the students to understand various concepts of chemistry and apply them in real life situations.

The salient features of the Learning Outcome based Curriculum Framework (LOCF) detailed in this syllabus of M. Sc. with specialization in Indiginous Knowledge, Science and Technology (IKST) is as follows:

1) The objectives of this framework are to mentally prepare the students to learn various courses/ subjects in the domain of Chemistry leading to a post graduate degree of KISS Deemed to be University.

2) The learning outcomes for each course have been carefully designed to help students to have experiential learning in various domains of Commerce discipline.

3) Proper care has been taken to include in the course contents the United Nations 2030 Agenda for Sustainable Development Goals and have integrated them in the courses viz., Indigenous People and the Science of Gemology, Indigenous People and the Science of Cosmology and Vedic Mathematics and integrating them in the basis domains integrate courses covering various domains like Physics, Chemistry, Mathematics and Computer Science, Vocational and Life Skills, etc.

4) The core courses have been selected considering the need for studying Chemistry with discipline specific elective and the required theoretical knowledge and practical exposure.

5) In order to achieve the spirit of LOCF under CBCS and to empower the students, large numbers of optional courses under Discipline Specific Elective (DSE) have been included in the structure. This course structure also includes MOOCs, Open Elective Courses and Skill Enhancement Courses. All courses have been developed to encompass domain knowledge and skills, facilitating students to interface with various sections of the society so that they can lead a professional life.

6) Keeping in view the objectives and learning outcomes of each course, proper care has been taken, to provide working knowledge for each unit in the course, so that the students can gain hands-on experience (learning by doing).

7) A Summer Internship of 3 weeks' duration has been included in this structure after the second Semester. This would be followed by submission of a Project Report and a Viva-voce examination.

8) Field Work and Dissertation has been provided in the fourth semester involving application of knowledge in the matter of exploring/analyzing/solving issues in real life situation. The course is designed keeping in view the employability, research, and innovation in the field of Chemistry and Indigenous Science and Technology.

9) The faculty members while delivering a lecture in a classroom situation shall use ICT based teaching learning pedagogy and various interactive teaching and learning techniques like case studies, simulation, role play, presentation, assignment, quiz, group discussions etc., to have continuous learning engagement of the students and effective teaching learning process. Focus is on character building of students, development of holistic personality, their values and ethics, etc., are the prime focus in the teaching learning process so that they become good global citizens.

**Programme Outcomes (POs):**

The expected attributes for a post graduate in Chemistry shall be expert disciplinary knowledge with communication skills, critical thinking, problem solving, research related skills, digital literacy, self directed lifelong learning with high social commitment and ethical awareness.

| | **Attributes** | **Description** |
|---|---|---|
| **PO1** | **Disciplinary Knowledge** | Capability of executing comprehensive knowledge including the '2030 Agenda for Sustainable Development' of United Nations and understanding of discipline that form part of Chemistry. |

| | | |
|---|---|---|
| **PO2** | **Communication skills** | Ability to speak, read, write, listen and understand clearly in person or through electronic media and make meaning of the world by connecting people, ideas, books, media and technology. |
| **PO3** | **Critical Thinking** | ➢ Ability to engage in reflective and independent thinking by understanding the concepts in every area of Chemistry with Indigenous Science and Technology; and take informed actions after identifying the assumptions that frame their thinking and actions, checking out the degree to which these assumptions are accurate and valid and looking at ideas and decisions from different perspectives.<br>➢ Ability to examine the results and apply them to various problems appearing in different branches of Chemistry with Indigenous Science and Technology**.** |
| **PO4** | **Problem solving** | ➢ Ability to address scientific problems and offer a solution for the same. |
| **PO5** | **Analytical Reasoning** | ➢ Capabilities to analyze synthesize data and derive inferences for valid conclusions.<br>➢ Ability to deduce the relationship between innovation in chemical and sociological and cultural processes (the importance of applications such as drugs, fertilizers, and polymers).<br>➢ Capabilities to analyze the impact of chemical technology on the overall development of tribal society. |

| | | |
|---|---|---|
| **PO6** | **Research Related Skills** | ➢ Ability to search for, locate, extract, organise, evaluate, and use or present information which has relevance with different Scientific issues.<br>➢ Ability to identify the research gaps and developments in various branches of Chemistry and Indigenous Science. |
| **PO7** | **Cooperation/Teamwork** | Convey ideas and information effectively to a range of audiences for a variety of purposes and contribute in a positive and collaborative manner to achieving common goals. |
| **PO8** | **Reflective Thinking** | Ability to understand what to do, why to do, why that is important to do and understanding consequences of such actions. |
| **PO9** | **Information/Digital Literacy** | Capability to use various technical ICT tools (Data analytics) for exploring, analysing, and using the information for different purposes. |
| **PO10** | **Self-directed** | Capability to work independently in diverse projects and ensure detailed study of various facets of Indigenous knowledge relating to tribal resources. |
| **PO11** | **Behavioral Skills** | Improve the verbal and non-verbal communication skills and acquire leadership skill and team work capabilities through participation. |
| **PO12** | **Leadership Readiness/Qualities** | Students are expected to have the qualities like high integrity, accountable for actions, sense of empathy, humanity, resilience, positivity, influencing and a vision. They are expected to engage in professional behaviour and have the potential to be an entrepreneur and take leadership roles in their chosen occupations or careers and communities. |
| **PO13** | **Application Skills/Professional Skills** | ➢ Students are expected to exhibit skills that would demonstrate what they are capable of contributing to their job role and fulfil duties of the position they would seek.<br>➢ Ability to achieve professional integrity and professional behavior, as well as the skills and attitudes necessary to plan for |

| | | |
|---|---|---|
| | | one's career and to stay current in this dynamic world. |
| **PO14** | **Experiential Learning/ Employability** | Students would seek hands-on learning to perform in the real world by acquiring knowledge, skills and attitude, so that they will be able to present them effectively to their employers. |
| **PO15** | **Environment Awareness and Sustainability** | Able to understand the issues of environment trends and would endeavour for their lasting solutions. |

**Qualification Descriptors:**

Further, qualification descriptors of each post graduate shall be to demonstrate extensive and coherent knowledge of commerce and its applications in real business world; understanding of various concepts and theories providing strong foundation in domain knowledge; demonstrate educational skills in areas of Marketing, Finance, Accounting, Human Resource Management, Tax, Economics, Information Technology, Banking and Insurance and other branches of commerce. They are expected to acquire various soft skills like effective communication and organising ability, become analytical to manage complex business situation as well as life situations; apply knowledge, understanding, skills to identify the difficult / unsolved problems in rapidly changing environment and to collect the required information from possible range of sources and try to analyse and assess these problems using appropriate methodology; fulfill one's learning requirements to provide an insight of research in commerce stream and interdisciplinary areas while seeking research pursuits; good value systems leading to high ethical and moral conduct in society at large.

**Programme Specific Outcomes:**

**PSO1:** Students would be able to recall facts and understand the basic concepts of Chemistry like Medicinal Chemistry, Industrial Chemistry, Bio-inorganic & Supra Molecular Chemistry, Environmental Chemistry, Chemical Technology and Society, Chemistry of Polymers and Fibres, Disaster Management and Indigenous Knowledge and Intellectual Property Rights. This

program also applies and explains the ideas or concepts of those basics of Indigenous knowledge and management of resources.

**PSO2:** Interpret and analyse the information in emerging situations, execute and solve issues in the real field and demonstrate in their career.

**PSO3:** Connect among the areas of scientific experiments and evaluate those ideas in real life situations with focus on life-cycle assessment approach.

**PSO4:** Students would be able to justify their stand, appraise, negotiate, defend, support others views in their professional career.

**PSO5:** To juxtapose as well as synthesize the established western as well as indigenous systems of scientific knowledge and work out modes of technological applications for contemporary needs and problems. Additionally, to develop entrepreneurial skills among students to achieve the objectives outlined.

**Programme Credit Scheme:**

M.Sc. with Specialization in Indigenous Knowledge, science and Technology programme is a two-year course divided into four-semesters. The course is of 110 Credits and for the award of degree a student will be required to complete the credits as per the University norm.

**Course Credit Scheme**

| Semester | Core Courses | | Specialization focus on Indigenous Knowledge, Science and Technologyi00 | | Core Elective | | *Massive Open Online Courses* (MOOCs) /Open Elective | | Skill Enhancement Course | | Grand Total Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. Of Papers | Total Credits | No. Of Papers | Total Credits | No. Of Papers | Total Credits | No. Of Papers | Total Credits | No. Of Papers | Total Credit | |
| I | 4 | 16 | 1 | 4 | - | - | - | - | 1 | 4 | 24 |
| II | 5 | 20 | 1 | 4 | - | - | | | 1 | 4 | 28 |
| III | 2 | 10 | 2 | 8 | 2 | 8 | 1 | 2 | 1 | 2 | 30 |
| IV | 2 | 8 | 1 | 4 | 2 | 8 | 1 | 2 | | | 28 |
| Total Credits for the Course | 10 | 54 | 6 | 20 | 4 | 16 | 2 | 4 | 3 | 10 | 110 |

**Selection of Discipline Specific Elective Courses:**

The available discipline specific electives are to be selected at the commencement of the III Semester.

1) For a functional area, wherever available a student may opt for Discipline Specific Elective Course in III semester Group comprising of four courses.

2) The discipline specific elective groups in the Semester III and IV will remain the same as the ones selected in Semester III, once a group has been selected, no change in selected groups will be allowed later.

**Selection of Open Elective Courses:**

1) Options for Open Elective Courses/MOOC will be floated according to availability of faculty and minimum number of students.

2) Open Elective Courses as placed in Semester III and IV would be announced at the beginning of the Semester III and IV, accordingly students will be asked to select that time.

**Selection of Value Added Courses:**

Students can choose value added courses as per their interest.

**Eligibility for Admissions with No. of Seats:**

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

**EXAMINATION AND ASSESSMENT**

**Scheme of Examinations**

Each course in the program tests and evaluate students on the basis of minimum five components viz. Quiz, Assignment and presentation, class participation, midterm exam and End Term Exams to know the students understanding, recalling concepts, analyzing and evaluating, applying in real life situations and to be creative with new ideas in the concerned subjects.

1. English shall be the medium of instruction and examination.

2. Mid Semester and End Semester Examinations shall be conducted at the end of each Semester as per the Academic Calendar notified by the KISS Deemed to be University and other components during the course to ensure continuous teaching learning process.

3. The system of evaluation shall be as follows:

    3.1 Each paper will carry 100 weightage (marks), of which 50 weightage (marks) shall be reserved for internal assessment based on a combination of tutorials, classroom participation, assignment, seminar, term papers, tests, and attendance. The weightage given to each of these components in a combination shall be decided and

announced at the beginning of the semester by the Department in consultation with the faculties.

3.2 The remaining 50 weightage (marks) in each paper shall be awarded on the basis of a written examination at the end of each semester. The duration of written examination for each paper shall be three hours.

**Criteria for weightage (marks) and examination hours for M.Sc. with Specialization in Indigenous Knowledge, Science and Technology**

| | **Weightage** | **Time** |
|---|---|---|
| ➢ Mid-Semester (Internal) | 25 | 1:30hrs |
| ➢ Assignment and Presentation | 20 | - |
| ➢ Attendance | 05 | - |
| ➢ End Semester | 50 | 3:00hrs |

**QUESTION PATTERN**

**MID SEMESTER**

- Five questions of one Weightage each(all questions are compulsory)
- Two question of five Weightage (out of three questions)
- One question of ten Weightage (out of two questions)
- Total 50 Weightage for mid semester examination including Assignment, presentation and attendance

**END SEMESTER**

- Ten questions of one Weightage each(all questions are compulsory)
- Four questions of five Weightage each(out of six questions)
- Two questions of ten Weightage each(out of four questions)
- Total 50 Weightage for theory portion**.**

4. Examinations for courses shall be conducted only in the respective odd and even Semesters as per the Scheme of Examinations. Regular as well as ex-students shall be permitted to appear/reappear/improve in courses of Odd Semesters only at the end of Odd Semester and courses of Even Semesters only at the end of Even Semesters.

5. Use of simple calculator is allowed.

**Note: Submission of Record Note Books for practical examinations**

Candidates appearing for practical examinations should submit bonafide Record Note Books prescribed for practical examinations, otherwise the candidates shall not be permitted to appear for the practical examinations.

**Pass Percentage and Promotion Criteria**

a. The minimum weightage required to pass any paper in a semester shall be 40% in

each paper and 50% in aggregate of a semester.

However, a candidate who has secured the minimum weightage to pass in each paper but has not secured the minimum weightage to pass in aggregate may reappear in any of the paper/s of his choice in the concerned semester in order to be able to secure the minimum weightage prescribed to pass the semester in aggregate.

b. A student who has to reappear in a paper prescribed for Semester I/III may do so only in the odd Semester examinations to be held as per academic calendar. A student who has to reappear in a paper prescribed for Semester II/IV may do so only in the even Semester examinations to be held as per academic calendar.

**System of Evaluation:**

**1. A seven point grading system on a 10 point scale is followed for grading in the examinations. The details are given in a table below:**

| Qualification | Grade | Score on 100 | Point |
|---|---|---|---|
| Outstanding | O | 90 to 100 | 10 |
| Excellent | E | 80 to 89 | 9 |
| Very good | A | 70 to 79 | 8 |
| Good | B | 60 to 69 | 7 |
| Fair | C | 50 to 59 | 6 |
| Below Average | D | 40 to 49 | 5 |
| Failed | F | Below 40 | 2 |

2. CREDIT POINT=CREDIT XPOINT for each course item.
3. CREDIT INDEX (CI)= Σ CREDIT POINT of all course items in a semester.
4. Semester Grade Point Average
   SGPA= CI / Σ CREDITS (for a semester)

5. Cumulative Grade Point Average
   CGPA = [Σ CI of all previous semesters up to current semester]

   [Σ CREDITS of all previous semesters including the current semester]

6. The degree is awarded with CGPA 6.0 or above and having no back log (F- Fail or I- Incomplete grade) on any other subject items (s) and

The School will follow the guidelines for examination provide by University from time to time.

**Span Period**

No student shall be admitted as a candidate for the examination for any of the

Parts/Semesters after the lapse of four years from the date of admission to the Semester-I of the M. Sc. with Specialization in Indigenous Knowledge, Science and Technology.

**Attendance Requirement**

Attendance in Lecturer, tutorials, seminars etc. arranged by the School from time to time, is mandatory according to the Internal Assessment requirement as per University rules.

| **The marks for attendance shall be as follows** | | |
|---|---|---|
| (i) | For 75% | 1 Marks |
| (ii) | More than 75% but less than 80% | 2 Marks |
| (iii) | 80% or more but less than 85% | 3 Marks |
| (iv) | 85% or more but less than 90% | 4 Marks |
| (v) | 90% and above | 5 Marks |

## Course Structure of the Post Graduate Programme

## M.Sc with Specialization in Indigenous Knowledge, Science and Technology

**SEMESTER-I**

| **Paper Code** | **Paper Name** | **Weekly Contact** | | | **Credits** |
|---|---|---|---|---|---|
| | | **L** | **T** | **P** | |
| MT- 4001 | Abstract Algebra | 3 | 1 | 0 | 4 |
| MT- 4003 | Real Analysis | 3 | 1 | 0 | 4 |
| MT- 4005 | Ordinary Differential Equations | 3 | 1 | 0 | 4 |
| MT- 4007 | Programming in $C/C^{++}$ | 3 | 0 | 2 | 4 |
| MT- 4009 | Discrete Mathematics | 3 | 1 | 0 | 4 |
| Special Paper | | | | | |
| IK- 4051 | Indigenous People and the Science of Cosmology | 0 | 0 | 8 | 4 |
| | | | | | **TOTAL = 24 Credits** |

**SEMESTER-II**

| **Paper Code** | **Paper Name** | **Weekly Contact** | | | **Credits** |
|---|---|---|---|---|---|
| | | **L** | **T** | **P** | |
| MT- 4002 | Operations Research | 3 | 1 | 0 | 4 |
| MT- 4004 | Complex Analysis | 3 | 1 | 0 | 4 |
| MT- 4006 | Probability and Stochastic Process | 3 | 1 | 0 | 4 |
| MT- 4008 | Linear Algebra | 3 | 1 | 0 | 4 |

| | | | | | |
|---|---|---|---|---|---|
| MT - 4010 | Graph Theory | 3 | 1 | 0 | 4 |
| Special Papers | | | | | |
| IK - 4052 | Vedic Mathematics | 3 | 1 | 0 | 4 |
| IK- 4054 | Theme based Movies and Museum visit to Preserve and Promote Tribal Culture through Documentation | 3 | 1 | 0 | 4 |
| | | | | **TOTAL = 28 Credits** | |

## SEMESTER-III

| Paper Code | Paper Name | Weekly Contact | | | Credit |
|---|---|---|---|---|---|
| | | L | T | P | |
| MT- 5001 | Partial Differential Equations and Transforms | 3 | 1 | 0 | 4 |
| MT-5003 | Numerical Analysis | 3 | 1 | 0 | 4 |
| MT- 5093 | Numerical Analysis(Lab) | 0 | 0 | 4 | 2 |
| MO-5021 | MOOCs (Choose any course from the following sources)<br><br>**NPTEL Online Courses**<br>**URL:** https://nptel.ac.in/course.html<br>**Swayam courses**<br>**URL:** https://swayam.gov.in/explorer<br>**MOOC Courses**<br>**URL:** https://www.mooc.org/#course-categories<br>KIIT LMS | 2 | 0 | 0 | 2 |
| Elective Papers(Choose any Two) | | | | | |
| MT-5031 | Functional Analysis | 3 | 1 | 0 | 4 |
| MT- 5033 | Mathematical Methods | 3 | 1 | 0 | 4 |
| MT- 5035 | Optimization Theory | 3 | 1 | 0 | 4 |
| MT- 5037 | Operator Theory | 3 | 1 | 0 | 4 |
| MT-5039 | Number theory and Cryptography | 3 | 1 | 0 | 4 |
| Special Papers | | | | | |
| IK-5051 | Indigenous People and the Science of Gemology | 3 | 1 | 0 | 4 |
| IK -5053 | Tribal Sports, Nutrition and Health Management | 3 | 1 | 0 | 4 |
| IP-5081 | Internship | 1 | 0 | 2 | 2 |
| | | | | **TOTAL = 30 Credits** | |

## SEMESTER-IV

| Paper Code | Paper Name | Weekly Contact | | | Credit |
|---|---|---|---|---|---|
| | | L | T | P | |
| MT-5002 | Analytic Number Theory | 3 | 1 | 0 | 4 |
| MT-5004 | Topology | 3 | 1 | 0 | 4 |
| MT-5082 | Dissertation | 0 | 0 | 12 | 6 |
| Elective Papers(Choose any Two) | | | | | |
| MT-5032 | Differential Geometry | 3 | 1 | 0 | 4 |
| MT-5034 | Advanced Analysis | 3 | 1 | 0 | 4 |

| | | | | | |
|---|---|---|---|---|---|
| MT-5036 | Fluid Dynamics | 3 | 1 | 0 | 4 |
| MT-5038 | Matrix Transformations and Sequence Spaces | 3 | 1 | 0 | 4 |
| MT-5040 | Stochastic Calculus | 3 | 1 | 0 | 4 |
| Special Paper | | | | | |
| IK-5052 | Indigenous Knowledge and Intellectual Property Rights | 3 | 1 | 0 | 4 |
| Open Electives(Choose any one) | | | | | |
| MT-5006 | Fuzzy sets and their applications | 2 | 0 | 0 | 2 |
| MT-5008 | Data Structure. | 2 | 0 | 0 | 2 |
| | | | | **TOTAL = 28 Credits** | |

**GRAND TOTAL CREDITS = 110**

*** One Credit = 1 hour for Theory classes**

*** One Credit = 2 hours for Practical classes**

## PROGRAMME LEARNING OUTCOMES : SEMESTER-I

| Sl. No. | Programme Outcomes | MT-4001 | MT-4003 | MT-4005 | MT-4007 | MT-4009 | IK-4051 |
|---|---|---|---|---|---|---|---|
| 1 | Disciplinary knowledge | √ | √ | √ | √ | √ | √ |
| 2 | Communication skills | √ | | | | √ | √ |
| 3 | Critical thinking | √ | √ | √ | | √ | √ |
| 4 | Problem Solving | √ | √ | √ | √ | √ | √ |
| 5 | Analytical Reasoning | √ | √ | √ | √ | √ | √ |
| 6 | Research related skills | √ | | | | √ | √ |
| 7 | Cooperation/Teamwork | √ | √ | √ | | √ | √ |
| 8 | Reflective Thinking | | √ | √ | √ | | |
| 9 | Information/Digital Literacy | √ | √ | √ | √ | √ | √ |
| 10 | Self-directed | √ | √ | √ | | √ | √ |
| 11 | Behavioral Skills | √ | √ | √ | | √ | √ |
| 12 | Leadership Readiness/Qualities | √ | √ | √ | √ | √ | √ |
| 13 | Application Skills / Professional Skills | √ | √ | √ | √ | √ | √ |
| 14 | Experiential Learning / Employability | √ | √ | √ | √ | √ | √ |
| 15 | Environment Awareness and | √ | √ | √ | √ | √ | √ |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Sustainability | | | | | | |

## PROGRAMME LEARNING OUTCOMES : SEMESTER-II

| Sl. No. | Programme Outcomes | MT-4002 | MT-4004 | MT-4006 | MT-4008 | MT-4010 | IK-4052 | IK-4054 |
|---|---|---|---|---|---|---|---|---|
| 1 | Disciplinary knowledge | √ | √ | √ | √ | √ | √ | √ |
| 2 | Communication skills | √ | √ | √ | √ | √ | | √ |
| 3 | Critical thinking | √ | √ | √ | √ | √ | √ | |
| 4 | Problem Solving | √ | √ | √ | √ | √ | √ | √ |
| 5 | Analytical Reasoning | √ | √ | √ | √ | √ | √ | √ |
| 6 | Research related skills | √ | | | √ | √ | √ | √ |
| 7 | Cooperation/Teamwork | √ | √ | √ | √ | √ | | √ |
| 8 | Reflective Thinking | √ | √ | √ | √ | √ | | √ |
| 9 | Information/Digital Literacy | √ | √ | √ | √ | √ | √ | √ |
| 10 | Self-directed | √ | | | √ | √ | √ | √ |
| 11 | Behavioral Skills | √ | √ | √ | √ | √ | √ | √ |
| 12 | Leadership Readiness/Qualities | √ | √ | √ | √ | √ | √ | √ |
| 13 | Application Skills / Professional Skills | √ | √ | √ | √ | √ | √ | √ |
| 14 | Experiential Learning / Employability | √ | √ | √ | √ | √ | | √ |
| 15 | Environment Awareness and Sustainability | √ | √ | √ | | √ | √ | √ |

## PROGRAMME LEARNING OUTCOMES : SEMESTER-III

| Sl. No. | Programme Outcomes | MT-5001 | MT-5003 | MT-5021 | MT-5031 | MT-5033 | MT-5035 | MT-5037 | IK-5051 | IK-5053 | IK-5081 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Disciplinary knowledge | √ | √ | √ | √ | √ | √ | √ | | √ | √ |
| 2 | Communication skills | | | √ | √ | √ | √ | | √ | √ | √ |
| 3 | Critical thinking | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | Problem Solving | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 5 | Analytical Reasoning | √ | √ | √ | √ | √ | √ | √ | | | √ |
| 6 | Research related skills | √ | √ | √ | √ | √ | √ | | √ | | |
| 7 | Cooperation/Teamwork | √ | √ | √ | √ | | √ | √ | | | √ |
| 8 | Reflective Thinking | | √ | √ | | √ | √ | | | | |
| 9 | Information/Digital Literacy | √ | √ | √ | √ | √ | √ | √ | | | √ |
| 10 | Self-directed | √ | √ | √ | √ | √ | | | √ | √ | |
| 11 | Behavioral Skills | √ | √ | √ | √ | √ | | | √ | | √ |
| 12 | Leadership Readiness/Qualities | √ | √ | √ | √ | √ | √ | √ | √ | √ | |
| 13 | Application Skills / Professional Skills | √ | √ | √ | √ | √ | √ | √ | √ | √ | |
| 14 | Experiential Learning / Employability | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 15 | Environment Awareness and Sustainability | √ | √ | | | | | √ | √ | √ | |

## PROGRAMME LEARNING OUTCOMES: SEMESTER-IV

| Sl. No. | Programme Outcomes | MT-5002 | MT-5004 | MT-5092 | MT-5032 | MT-5034 | MT-5036 | MT-5038 | IK-5052 | MT-5006 | MT-5008 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Disciplinary knowledge | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 2 | Communication skills | √ | √ | √ | | √ | √ | √ | √ | √ | √ |
| 3 | Critical thinking | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 4 | Problem Solving | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 5 | Analytical Reasoning | √ | √ | √ | √ | √ | √ | | | | √ |
| 6 | Research related skills | | √ | | √ | | √ | √ | √ | √ | |
| 7 | Cooperation/Teamwork | √ | √ | √ | √ | | √ | √ | √ | √ | |
| 8 | Reflective Thinking | | √ | √ | √ | | √ | | | | |
| 9 | Information/Digital Literacy | √ | √ | √ | √ | √ | √ | √ | √ | √ | √ |
| 10 | Self-directed | | √ | √ | √ | √ | √ | √ | √ | √ | |
| 11 | Behavioral Skills | | √ | √ | | √ | √ | √ | √ | √ | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | Leadership Readiness/Qualities | √ | √ | √ | √ | | √ | √ | √ | √ | |
| 13 | Application Skills / Professional Skills | √ | √ | √ | √ | | √ | √ | √ | √ | |
| 14 | Experiential Learning / Employability | √ | √ | √ | √ | √ | √ | √ | √ | √ | |
| 15 | Environment Awareness and Sustainability | √ | | | √ | √ | √ | | | | |

**Semester-I**

**Course Code: MT-4001**

**Course Title: Abstract Algebra (Credit – 4)**

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

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

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

3. Algebraic structures like field and its properties

4. Some important results with their applications.

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

**Course Inputs**:

**Unit - I :**Groups, Subgroups, Permutation group, Dihedral group, Cayley's Theorem, Direct product of groups, cyclic group, Normal subgroup, Quotient group, Homomorphism, Isomorphism.

**Unit-II :** Finitely generated Abelian group, free abelian groups, Commutator group, and Simple group, Series of groups, Group action on a set, Sylow's theorems and applications.

**Unit - III :**Ring, Integral domain, Characteristic of an Integral domain, Homomorphism, Isomorphism, Ideals, Maximal ideal, Prime ideal, Quotient rings.

**Unit - IV :**Euclidean rings, Gaussian integers, Polynomial rings, Principal ideal domain, unique factorization domain, Modules, Sub modules, Quotient modules, Direct Sums.

**Unit-V:**The elements of Galois Theory, Solvability by Radicals, Galois groups over the Rationals .

Extension of Fields, Transcendence of e, Roots of polynomials, construction with straightedge & compass, more about roots.

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

**CO1: U**nderstand the concepts, nature and significance of different algebraic structures

**CO2:** understand Parameters defining group, ring and field theory

**CO3:** Analyse some important results like Sylow Theorems

**CO-4:** Apply Some results on roots of polynomials

**Suggested Readings:**


1. Topics in Algebra, I.N. Herstein, Wiley India Pvt. Ltd, 2nd Edition, 2006.
1. Contemporary Abstract Algebra, Joseph A. Gillian, Cengage Learning, 9th Edition, 2017.
2. Topics in Algebra, S. Nanda, Allied Publishers, New Delhi.
3. A First Course on Abstract Algebra, John B. Fraleigh, 7th Edition, 2008.


**Note: Latest edition of the text books should be used.**

**Course Code: MT-4003**

**Course Title:Real Analysis (Credit – 4)**

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

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

2. continuity, uniform continuity and uniform convergence

3. Functions of several variables, Riemann integrals

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

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

**Course Inputs:**

**Unit – I:** Metric spaces, open sets, closed sets, sequence and series of functions, Uniform convergence , Sequences of real numbers, Cauchy sequence, completeness, Bolzano Weierstrass theorem, Heine Borel's theorem, Series, convergence, tests of convergence

**Unit – II :**Continuous functions, Definition and general properties, Uniform continuity, power series, uniform convergence, Weierstrass M Test, Weierstrass approximation theorem, Functions of bounded variation, Differentiation, properties , Mean value theorems, Taylor's theorem

**Unit –III:** Functions of several variables, Differentiation in Rn, Partial derivatives, Directional derivatives, Jacobians, Contraction mapping principle, inverse function theorem, implicit function theorem, Riemann integrals, Properties and techniques, Riemann Stieltjes Integrals, properties and techniques, Improper Integrals, multiple integrals

**Unit –IV :** Lebesgue measure on the line, Outer measure, measurable sets, Properties of measurable sets, non measurable sets, measurable functions, simple functions, Lebesgue integration of simple and measurable functions, convergence theorems

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

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

**CO1:** Understand the concepts, nature and significance of Metric spaces

**CO2:** Understand Parameters defining Reimann integral, Lebesgue measure

**CO3:** Analyse some important results on uniform continuity and uniform convergence

**CO-4:** Analyse some results on The $L_P$ spaces,

**Suggested Readings:**


1. Principles of Mathematical Analysis, Walter Rudin, Mc Graw Hill, 3rd edition, 1976.
2. S. Nanda and V.P Saxena, Real Analysis, Allied Publishers Pvt. Ltd. New Delhi 1999.
3. G.De. Brra – Measure theory and integration (willey Eastern Ltd.),

**4 .**Real Analysis, H.L. Royden, Prentice Hall of India, New Delhi, 3rd Edition, 1988


**Note: Latest edition of the text books should be used**

**Course Code: MT-4005**

**Course Title:Ordinary Differential Equations (Credit – 4)**

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

1 . Second order Linear Differential Equations.

2. Oscillations of second Order Equations

3. Existence and Uniqueness of Solutions

**4.**. System of Linear Differential Equations

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

**Course Inputs:**

**Unit- I** : Second order Linear Differential Equations*:-* General solution, Using a known solution to find the other, Homogeneous equations with constant coefficients, Inverse operator method, Method of variation of parameters, Power series solution and special functions.

**Unit II** : Oscillations of second Order Equations*:* Fundamental Results, Sturm's Comparison theorem, Hille-wintner theorem, Oscillations of $x''+a(t)x=0$.

Boundary Value Problems*:* Introduction, Strum Liouville Problem, Green's functions, Picard's theorem.

**Unit III**: Existence and Uniqueness of Solutions*:* Successive approximations, Picard's Theorem, Non Uniqueness of solutions, Continuation and dependence on initial conditions, Existence of solutions in the large, Existence and uniqueness of solution of systems.

**Unit- IV: System** of Linear Differential Equations*:* System of first order equations, Existence and Uniqueness theorems, Fundamental Matrix, Homogeneous and Non Homogeneous linear systems with constant Co-efficient, linear system with periodic Co-efficient.

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

**CO1:** Learn and understand the concepts, nature and significance of Differential equations

**CO2:** Understand Parameters defining ordinary differential equations and its solutions

**CO3:** Analyse existence and uniqueness of solutions of differential equation

**CO-4:**Solve system of differential equations,

**Suggested Readings:**

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

2. S. G. Deo and V. Raghavendra, Ordinary Differential Equations and stability theory, TATA Mc Graw Hill Ltd, 1980. Chapter 2 (Quick Review ) 4,5,6,7.
3. G. Birkhoff and G. C. Rota-Ordinary Differential Equations-John Wiley and Sons, N.Y., 1989.
4. Coddington and Levinson, Theory of Ordinary Differential Equations, Krieger Pub Co (June 1984)
5. Tyn-Myint-U Ordinary Differential Equations, Elsevier North-Holland, 1987.

**Note: Latest edition of the text books should be used**

**Course Code: MT-4007**

**Course Title: Programming in c/c$^{++}$ (Credit – 4)**

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

1 .Computer fundamentals, programming language C.

2. Basic concepts of computer programming and developer tools

3. Developer tools and to present the syntax and semantics of the "C" language as well as data types

**4.**. Basics about the concepts of Object oriented program, Basics in C++ programming, Constructors and destructors

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

**Course Inputs:**

**UNIT-I :**Fundamentals, Introduction to C, Data Type, Arrays, Computer Fundamentals, Evolution of Programming Languages, Structure of C program, writing a Simple C program, identifiers, basic data types, storage classes, Constants, variables, different types of operators, precedence of operators. Input-output statements, statements and blocks, if and switch statements, loops- while, do-while and for statements, break, continue. Arrays- concepts, declaration, definition, accessing elements, storing elements, multi-dimensional arrays, Strings

**UNIT-II :**Structure Pointers, Functions, C-Pre-processors Structures: declaration, definition and initialization of structures, accessing structures, nested structures, arrays of structures, self referential structures, unions. Pointers: concepts, initialization of pointer variables, concept of arrays and pointer, pointers of pointer, Character pointers, pointers to structures. Functions:

basics, different types parameter passing, user defined functions, standard library functions, recursive functions, structures and functions. C-pre-processor and header files.

**UNIT-III :** Concept of Opps, Introduction to C++, Class and Objects, Principle of Object Oriented Programming language, Procedural vs Object Oriented Programming, Elements of Object Oriented Programming: Objects, Classes, Encapsulation and Data Hiding, Data Abstraction, Inheritance and reusability, Polymorphism, message passing. Introductions to C++: Basic I/Os (Cin, Cout), Literals, Constant Qualifiers, Keywords, Conditional statements, loops, structures, union, functions and types of parameters passing, inline functions, static members. Objects and Classes: Access Specifies (Private, Public, Protected), Defining class Member, Use of scope resolution operators to define member functions outside the class, static member functions.

**UNIT-IV :** Friend Function, Function Overloading, Constructors & Destructors, Operator Overloading, Inheritance Friend Function: Basics and examples Function Overloading: Basic and example Constructors and Destructors: Basic, Types (parameterized constructors, copy constructors, multiple constructors etc), Destructor. Operator Overloading: Basics, types of operator can be used for overloading, examples. In- heritance: Basics, types of inheritance, different types of data derivation, examples

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

**CO1:** Learn and understand the Computer Fundamentals, Evolution of Programming Languages, Structure of C program

**CO2:** Understand Structure Pointers, Functions, C-Pre-processors Structures

**CO3:** Analyze the Concept of Opps, Introduction to C++, Class and Objects, Principle of Object Oriented Programming language

**CO-4:** Understand the Basics and examples Function Overloading,

**Suggested Readings:**

1. E. Balaguruswamy, The C Programming Language, TMH.
2. E. Balaguruswamy, The C++ Programming Language, TMH.
3. B.W. Kernighan, Dennis M. Ritchie, The C Programming Language, PHI/Pearson Education, 2 edition (1990)
5. Bjarne Stroustrup,The C++ Programming Languages, Addison-Wesley

Professional, 4th ed., 2013**.**

**PROGRAMMING LAB-**

The candidates should be able to do the following Programmes by using C Languages.

1. Write a program to find the solutions of a Quadratic equation.
2. Write a program to find the addition of two matrices.
3. Write a program to find the Fibonacci series.
4. Write a program to find the GCD and LCM of two numbers.
5. Write a program to test a number is prime or not.
6. Write a program to find the transpose of a matrix.
7. Write a program to find the area of a circle.
8. Write a program to find the area of an ellipse.
9. Write a program to arrange some numbers in ascending order.
10. Write a program to multiply two matrices.
11. Write a program to find the sum of diagonal elements of a matrix.
12. Write a program to find the Factorial of a number.
13. Write a program to find the Surface area of a sphere.
14. Write a program to find the sum of digits of a number.
15. Write a program to find the Volume of a Cone.
16. Write a program to find the Volume of a Sphere.
17. Write a program to check a number is a palindrome or not.
18. Write a program to find Surface area of a Prism.
19. Write a program to calculate the Product of two complex numbers.
20. Write a program to find the Exponential series.
21. Write a program to find the Pascal Triangle.
22. Write a program to find the Sine series and Cosine series.
23. Write a program to find all factors of a number.

**Note: Latest edition of the text books should be used**

**Course Code: MT-4007**

**Course Title:Discrete Mathematics (Credit – 4)**

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

1 . The concept of set, relation, poset and different principles

2. Basic concepts of Boolean algebra and graphs, tree and lattice

3. Basic concepts of Combinatorics

**4.**. Basics about Network flows, Graphs as a model of commodities

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

**Course Inputs:**

**Unit – I :**Set and Relation: Review of Basic Set Operations; Relations: Types of relations, operations of relations, Special Properties of Binary Relations, Equivalence Relations, Ordering Relations, Lattices, POSETS; Directed Graphs and Adjacency Matrices, Topological Sorting, Propositional Logic: language of propositional logic, truth table, natural deduction, predicate logic: language of predicate logic, Logical inference with Quantifiers. Proof techniques: Introduction to different standard proof techniques.

**Unit – II :** Combinatory: Counting techniques: Pigeon Hole principle, inclusion exclusion principle, Generating Functions of Sequences, Calculating Coefficients of Generating Functions, Recurrence Relations, Solving Recurrence Relations by Substitution and Generating Functions, The Method of Characteristic Roots, Solutions of Inhomogeneous Recurrence Relations

**Unit – III:** Boolean Algebras, Boolean Functions, Switching Mechanisms, Minimization of Boolean Functions, Applications to Digital Computer Design;

**Unit – IV:** Graphs: Basic Concepts, Isomorphism's and Sub graphs, Trees and Their Properties, Spanning Trees, Directed Trees, Binary Trees, Planar Graphs, Euler's Formula ,Euler Circuits, Hamiltonian Graphs, Chromatic Numbers, The Four-Color Problem,

**Unit – V: Network** flows, Graphs as a model of commodities, flows, Maximal flows and minimal cuts, The Max Flow-Min Cut Theorem, Matching and Hall's Marriage Theorem

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

**CO1:** Learn and understand the Basics of Set and Relation, Basic Set Operations, Relations

**CO2:** Understand Combinatorics

**CO3:** Concept of Boolean Algebras, Boolean Functions

**CO-4:** Basics of Graphs,Basic Concepts, Isomorphism's and Sub graphs,

CO-5: Basics of Network flows

**Suggested Readings:**

**1.** J.L. Mott, A. Kendel and T.P. Baker: Discrete mathematics for computer scientists, and mathematicians

**Note: Latest edition of the text books should be used**

**Course Code: IK-4051**

**Course Title: Indigenous People and the Science of Cosmology (Credit – 4)**

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

1 . The origin of cosmic rays, General relativity and physical cosmology

2. Basic concepts of Tribal Perspective on Modern Physics and Cosmology

3. Cosmology a history of Universe, Epistemic value of cosmology

**4.**. Mass-radius-density data for Astronomical object

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

**Course Inputs**:.

**Unit – I: Cosmology: A mythological view**

What is cosmology, stellar dynamics and evolution, Galaxy formation and evolution, origin of cosmic rays, General relativity and physical cosmology, string cosmology, Introduction of Mythology, Contemporary approaches to classical and Indian mythology, Significance of river and religion in cosmology , Mythology of prominent rivers of India.

**Unit-II: Cosmology: A Tribal Perspective**

Tribal Perspective on Modern Physics and Cosmology: Classical reality and philosophy, Classical Physics, Understanding Indigenous Science and Indigenous Knowledge: Cataloging Indigenous Knowledge, Knowledge on Modern Physics and Tribal metaphysics. Cosmology and Indigenous World. Allowing Tribal concepts to enrich science.

**Unit-III: Cosmology: A Scientific View**

Fundamental Observation: Cosmology a history of Universe, Epistemic value of cosmology, Explanatory value of Cosmology, A brief history of time: From Big Bang to Black holes.

Newton verses Einstein ;The way of Newton, The special way of Einstein, The general way of Einstein. Describing Curvature. The Robertson-Walker Metric, Proper distance.

**Unit-IV: Astronomy and Astrophysics**

Solar System: The Sun, Solar Eclipses, Planets, Natural Satellites in Solar System, Selected Comets, Selected Asteroids. Star: 50 visually brightest stars, Pulsars, Galaxies, Properties of Milky way Galaxy.

The Universe: Mass-radius-density data for Astronomical object, Radio Astronomy, Microwave background, selected discrete radio Sources, Radio spectra. IR Astronomy, Planetary Nebula, Emission from Galaxies.

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

**CO1**: Understand the theoretical basis for our modern cosmological view of the universe.

**CO2**: Apply the knowledge on Modern Physics and Tribal metaphysics and can able to bring tribal concepts to enrich science.

**CO3**: Understand the epistemic value and explanatory value of cosmology with a brief history of time: From Big Bang to Black holes.

**CO4**: Remember how the universe formed and the stars, planets, black holes, dark matter and galaxies that exist within it.

**Suggested Readings:**


1. A brief History of Time by Stephen Hawking
2. Cosmos by Carl Sagan
3. The Elegant Universe by Brian Greene
4. Gravitation and Cosmology by S Weinberg
5. Introduction to Cosmology by J.V Narlikar
6. An Introduction to Mathematical Cosmology by J.N Islam
7. Cosmological Physics by J.A Peacock
8. Modern Cosmology by Dodelson
9. Introduction to Cosmology by Barbara Ryden


**Note: Latest edition of the text books should be used**

## Semester-II

**Course Code:MT-4002**

**Course Title: Operations Research (Credit – 4)**

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

1 .To solve the industrial problems to students with various methods of solving Linear Programming Problems

2. Dual simplex method with justifications and its applications

3. Sensitivity Analysis, variation in cost and requirement vectors

**4.**. Game Theory, Two persons zero sum game

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

**Course Inputs:**.

**Unit-I** :Introduction to LPP, Mathematical formulation, Standard form and canonical form, Graphical solution, Simplex Method including Big-M and two phase method, Degeneracy and Revised simplex method.

**Unit-II** :Dual simplex method with justifications, Duality in Linear Programming, Duality Theorems, Fundamental Theorem of Duality, Transportation and Assignment algorithms.

**Unit-III** :Introduction to Sensitivity Analysis, variation in cost and requirement vectors, coefficient matrix and applications, Parametric Programming Problems.

**Unit-IV** :Game Theory, Two persons zero sum game, Maxmin Minimax principle, Mixed strategy, Graphical solutions, Dominance Property, Arithmetic Method and general solution.

**Unit- V :** Dynamic Programming: Principle of optimality, Reliability of system series, height of projectile, cargo-loading problem, inventory problem.

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

**CO1:** Learn and understand Mathematical formulation of LPP and methods of solving with examples

**CO2:** Understand Dual simplex method and method of solving

**CO3:** Basics of Sensitivity Analysis

CO4: Basics of Game theory with examples

CO5: Basics of Dynamic Programming with examples

**Suggested Readings:**

1. N. S. Kambo (1991 ) : Mathematical Programming Tech., Affiliated East- West press.

2. G. Hadley (1987): Linear Programming

3. H. A. Taha (l992) :.Operations Research, 5th Ed. (McMillan)

4. P. Rama Murty, Operations Research, New Age International, 2nd Edition (2007).

5. F. S. Hillier, G. J. Lieberman, Introduction to Operations Research, McGraw-Hill International, 9th Edition.

6. K. Swarup, Operations Research, Sultan Chand & Sons, 12th Edition.

**Note: Latest edition of the text books should be used**

**Course Code: MT-4004**

**Course Title: Complex Analysis (Credit – 4)**

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

1 . The theories for functions of a complex variable

2. Complex line integrals and Cauchy's theorem

3. Singularities and residues

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

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

**Course Inputs:**.

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

**Unit-II** :Complex line integrals and Cauchy's theorem, Cauchy's integral formula, The index of a closed curve, Cauchy's theorem for rectangle, Cauchy's theorem for disc, General form of Cauchy's theorem, Harmonic functions, Fundamental theorem of algebra, Morera's theorem, Open map- ping theorem a Zeros of complex functions.

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

**Unit-IV** :Normal families, Arzela's theorem, Product developments, Hadamard's theorem Riemann zeta functions, Riemann mapping theorem and Weriestrass' theorem.

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

**CO1:** Learn and understand complex number system and analytic functions

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

**CO3:** Basics of Singularities and residues

CO4: The applications of the calculus of residues in the evaluation of integrals.

**Suggested Readings:**

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

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

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

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

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

**Note: Latest edition of the text books should be used**

**Course Code: MT-4006**

**Course Title: Probability & Stochastic Process (Credit – 4)**

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

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

2. Sample space, Probability axioms, Conditional probability,

3. Poisson theorem, Interchangeable events and their limiting properties

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

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

**Course Inputs:**.

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

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

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

**Unit-IV** :Convergence of a sequence of random variables, Convergence in distribution, Convergence in probability, Almost sure convergence and Convergence in quadratic mean and their interrela- tions. Monotone and dominated convergence theorem, Central limit theorem: Lindberg-Levy and Demoivre- Lapalce theorem.

**Unit-V**: Introduction to Stochastic Processes, Discrete time Markov Chain, Transition Probability Matrices, Recurrent and Transient states , Chapman Kolmogorov Theorems, Long run behavior of Markov Chain , Reducible and Irreducible , Examples- Inventory model, Urn Model, Random walk, Gambler's ruin, Applications to genetics , queueing. Poisson process, Distribution associated with Poisson process (Poisson Exponential, Gamma , Uniform ) , Non

Homogeneous and compound Poisson process .Continuous time Markov Chains, Pure birth process, Birth and Death process, Kolmogorov Differential Equations.

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

**CO1:** Learn and understand Algebra of sets, Fields and Sigma fields

**CO2:** Understand Conditional probability and probability distribution

**CO3:** Understand Poisson theorem, Interchangeable events and their limiting properties

CO4: Understand Convergence of a sequence of random variables

CO5: Understand Stochastic Processes, Discrete time Markov Chain

**Suggested Readings:**

1.M.A.Pinsky,S.Karling,"An Introduction to Stocastic Modeling",
2. S.M.Ross, "Introduction to Probability Models"

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

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

**Note: Latest edition of the text books should be used**

**Course Code:MT-4008**

**Course Title: Linear Algebra (Credit – 4)**

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

1 . The concept of Vector Spaces, Subspaces

2. Solution of System of Linear equations

3. Concept of eigen values and Eigen vectors

**4.** Different canonical forms with examples

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

**Course Inputs:**.

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

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

**Unit - III** : Canonical forms .Canonical Forms: Diagonal forms, triangular forms, Jordan form, Quadratic form, Inner Product spaces, Nilpotent transforms, Index of nilpotent, A decomposition of V. Jordan form, Rational canonical form.

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

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

**CO1:** Learn and understand the concept of Vector Spaces, Subspaces

**CO2:** Understand System of Linear equations, Characteristic roots

**CO3:**Understand Diagonal forms, triangular forms, Jordan form, Quadratic form

CO4: Understand Euclidean space, unitary space

**Suggested Readings:**

1. A. Ramachandra Rao and P. Bhimsankaram. Linear Algebra, Hindustan Book Agency; 2nd Revised edition edition (15 May 2000.

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

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

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

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

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

**Note: Latest edition of the text books should be used**

**Course Code: MT-4010**

**Course Title: Graph Theory (Credit – 4)**

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

1 . The concept of model networking problems in physical and biological sciences

2. Application to social media, linguistics, chemical bonds, computational neuro science, market and financial analysis, communication system, data organisation, flows and links

3. Concept of Graphs and Digraphs, Trees

**4.** Concept of Eulerian Graphs, Planar Graphs

5. Concept of Matching and Factorizations

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

**Course Inputs:**.

**Unit – I: Introduction** to Graphs and Digraphs: Definitions of some basic terms, representation of graphs, Degree Sequence, characterization of graphical sequence; Graph and Matrices

**Unit – II:** Trees: Characterizations, Minimum Spanning Trees, counting of trees; Paths and distance in Graphs: Basic Definitions, center and median of Graphs, activity digraphs and critical paths

**Unit – III :** Eulerian Graphs: Characterization, Chinese postman problem; Hamiltonian Graphs: Necessary conditions, sufficient conditions,

**Unit – IV :**Planar Graphs: Properties, Characterization; Graph Coloring: vertex coloring, chromatic polynomials, edge coloring, planar graph coloring, total coloring

**Unit – V :**Matching and Factorizations: maximum matching in bipartite graphs, maximum matching in general graphs, Hall's marriage theorem, factorization Networks: The Max-flow min-cut theorem, max-flow algorithm, connectivity and edge connectivity, Menger's theorem.

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

**CO1:** Learn and understand the concept of Graphs and Digraphs

**CO2:** Understand concept of Trees

**CO3:** Understand concept of Eulerian Graphs

CO4: Understand concept of Planar Graphs

CO5: Understand the concept of Matching and Factorizations

**Suggested Readings:**


1. D.B. West, Introduction to Graph Theory,2nd Edition,2002.
2. John Clark and D.A .Holton A First Look at Graph Theory , World Scientific and Allied Publisher


**Note: Latest edition of the text books should be used**

**Course Code: IK– 4052**

**Course Title: Vedic Mathematics (Credit – 4)**

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

1. Mathematics in Vedas, different sutras and sub sutras
2. Knowledge on Arithmetic progression in Ancient India and different techniques
3. **:** Mathematical numbers in Indian Tradition and different types of problems relating to Vedic sutras
4. Mathematical Concept in Tribal Tradition

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

**Course Inputs:**.

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

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

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

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

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

CO1: Correlate the modern mathematics in Vedas, different sutras and sub sutras.

CO2: Recognizing the basic Concepts of Ancient Arithmetic, development and their uses.

CO3: Implement the techniques of simple equations, quadratic equations, cubic equation, biquadrate equation, simultaneous equation in mathematics.

CO4: Apply Vedic sutras in factorization, H.C.F, partial fractions, differential calculus in mathematics.

CO5: Analyze the mathematical Concept in Tribal Tradition: Ethno mathematics: development and meaning of "ethno mathematics", Numerals and naming systems, Mathematics in folk art, Informal mathematics.

**Suggested Readings:**

1. Vedic Mathematics space book by S,.JK. Cosmic Kapoor- 2005
2. Vedic Arithmetic and Development of basic concepts Dr. K.P. Chamola – 2006 Arithmetic

**Note: Latest edition of the text books should be used**

**Course Code: IK-4054**

**Course Title:** Theme based movies and Museum visit to preserve and promote Tribal Culture through documentation **(Credit – 4)**

**Course Learning Objectives**:

The objective of this course is to preserve and promote Tribal Culture through documentation.

**Pedagogy:** Visit to different Museums

**Course Learning Outcomes:** After visiting different Museums, the students will be able to:

**CO1:** Learn rather than teaching

**CO2:** Document their culture.

**CO3:** Preserve their culture

**CO4:** Promote their culture

**Note: Latest edition of the text books should be used.**

## Semester-III

**Course Code: MT-5001**

**Course Title:Partial Differential Equations and Transforms (Credit – 4)**

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

1. Basic methods for solving Partial Differential Equations first order and second order

2 Charpit's Method, Jacobi Method

3.Methods to solve wave equation, heat equation

**4.** Classification of Partial Differential Equation and boundary value problems.

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

**Course Inputs:**.

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

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

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

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

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

**CO1:** Analyse and understand first order Partial differential equations, Semi-linear and quasi-linear equations

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

**CO3:** Understand Linear Second order partial Differential Equations

CO4: Understand Laplace equation , Boundary value problems

**Suggested Readings:**

1. Ian Sneddon, Elements of Partial Differential Equations, International Students Edition.
2. Phoolan Prasad and Renuka Ravindran, Partial Differential Equations, New Age International, 1985.
3. F. John - Partial Differential Equations, Springer-Verlag, New York, 1978.
4. Tyn-Myint-U - Partial Differential Equations North Holland Publication.

**Note: Latest edition of the text books should be used**

**Course Code: MT-5003**

**Course Title: Numerical Analysis (Credit – 4)**

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

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

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

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

4. Evaluate approximate eigenavlues by using different methods.

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

**Course Inputs:**.

**Unit-I** :Errors: Root finding for non-linear equations: Bisection method, Iteration methods based on first degree equations( Secant method, Regula-Falsi method, Newton Raphson method), Iteration methods based on second degree equation(Muller method, Chebysev method), Rate of convergence , Iteration methods.

**Unit-II** :Interpolations: Lagrange and Newton interpolations, Finite differences, Interpolating polynomials using finite differences, Hermite interpolation, Piecewise and Spline interpolation. Approximations.

**Unit-III** : Differentiation: Methods based on Interpolation, Methods based on Finite Differentials, Methods based on undetermined coefficients, optimum choice of step length, Interpolation method. Integration: Methods based on Interpolation (Trapezoidal rule, Simpson's rule), Method based on undetermined coefficients (Gausses Legendre Integration method, Lobatto integration method, Radon integration method, Gauss-chebysev Integration method (without derivation), Gauss Laguerre Integration method (without derivation), Gauss-Hermite Integration methods (without derivation), Composite integration methods.

**Unit-IV** :Numerical Solution of system of linear equations: Direct methods, Gauss Elimination methods, Gauss-Jordan Elimination method, Triangularization method, Cholesky method, Iteration methods(Jacobi iteration method, Gauss-Siedel iteration method, Iterative method for *A-1*) Eigen value problems(Jacobi method for symmetric matrices) Givers Method for symmetric matrices, Rutishauser method for arbitrary matrices). Numerical solution of ordinary differential equation: Euler Method, Backward Euler method, Mid-point method, Single Step methods (Tayler series method, Rangekutta method(Second order, Fourth order method) .

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

**CO1:** Analyse and understand Iteration methods based on first degree equations

**CO2:** Understand Lagrange and Newton interpolations, Finite differences

**CO3:** Understand Methods based on Interpolation, Methods based on Finite Differentials

CO4: Understand Numerical Solution of system of linear equations

**Course Code: MT-5093**

**Course Title: Numerical Analysis Lab (credit-2)**

**List of Practical's (using any software)**

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

**Suggested Readings:**

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

2.M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and

Engineering Computation, 6th Ed., New age International Publisher, India, 2007.

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

4.Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7th Ed.

, PHI Learning Private Limited, 2013.

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

PHI Learning Private Limited, 2012.

**Note: Latest edition of the**

**Course Code: MO-5021**

**Course Title: MOOCs (Credit 2)**

**Course Learning Objectives:**

MOOCs integrate social networking, accessible online resources, and are facilitated by leading practitioners in the field of study. Most significantly, MOOCs build on the engagement of learners who self-organize their participation according to learning goals, prior knowledge and skills, and common interests. Also helps the student how to self learning directed at the unprecedented situation.

**Course Inputs:**

Available in the MOOC platform

**Course Learning Outcomes:** After finishing this course the student will be able to:

**CO1:** Identify the pedagogical and technological considerations for developing your low-cost MOOC

**CO2:** Prepare content in a variety of formats for your MOOC

**CO3:** Produce a project plan to develop your MOOC

**CO3:** Assess various technological tools and platforms to develop and host your MOOC

MOOCs (Choose any course from the following sources)

**e-PG-Pathshala**

**NMEICT/any other Government Initiatives**

**NPTEL Online Courses**
**URL:** https://nptel.ac.in/course.html
**Swayam courses**
**URL:** https://swayam.gov.in/explorer
**MOOC Courses**
**URL:** https://www.mooc.org/#course-categories
**KIIT LMS**

**Institutional LMS**

**Open Elective Course :** Open Elective Course to be opted by students of other programmes is to allow them to learn courses other than their own courses of the program to which they belong, for enrichment of their knowledge in multidisciplinary areas.

# ELECTIVE PAPERS

**Course Code: MT-5031**

**Course Title: Functional Analysis (Credit-4)**

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

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

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

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

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

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

**Course Inputs:**.

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

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

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

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

**UNIT V** : **Fixed Point Theorems:** Riesz theorem; Hilbert adjoint operator and its basic properties; basic properties of self adjoint, unitary and normal operators, Banach fixed point theorem.

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

**CO1:** Learn and understand definition, examples and basic properties of normed spaces

**CO2:** Understand definition and basic properties of bounded linear operators

**CO3:** Understand Definition and basic properties of Inner product spaces

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

**CO5:** Understand the concepts of different fixed point theorems

**Suggested Readings:**


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


**Note: Latest edition of the text books should be used**

**Course Code: MT-5033**

**Course Title: Mathematical Methods (Credit-4)**

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

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

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

**Course Inputs:**.

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

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

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

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

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

**CO1:** Learn and understand concept of Laplace transforms and its application to PDE

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

**CO3:** Understand basic concepts of Fredholm Integral Equations and its properties

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

**Suggested Readings:**

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

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

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

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

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

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

**Note: Latest edition of the text books should be used.**

**Course Code: MT-5035**

**Course Title: Optimization Theory (Credit-4)**

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

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

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

**Course Inputs:**.

**Unit-I** :Markov process, transition matrix, transition diagram, construction of transition matrix, n- step transition prob. Equilibrium condition, Markov analysis algorithm, Nerwork Scheduling by PERT/CPM.

**Unit-II** :Inventory decision, cost associated with inventory, Factors affecting inventories, EOQ, Deterministic inventories with no shortage and with shortage, inventory with uncertain demand, System of inventory control, Probabilistic inventory problems.

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

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

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

**CO1:** Learn and understand concept of Markov process

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

**CO3:** Understand basic concepts of Queuing system, Operating characteristic

CO4: Understand the concept of NLPP with constrained optimization

**Suggested Readings:**

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

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

**Note: Latest edition of the text books should be used.**

**Course Code: MT-5037**

**Course Title: Operator Theory (Credit-4)**

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

1. Basic operator theoretic methods as a second course to functional analysis.
2. Basic concepts of Banach Algebra
3. Basic concepts of Spectral Theorem, Eigen Values of Normal Operators
4. The concept of Unbounded Operators

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

**Course Inputs:**.

**Unit- I** : Banach Algebra : Introduction , Complex homomorphism Basic properties of spectra, Com- mutative Banach Algebra : Ideals, Gelfand transform, Involution, Bounded operator.

**Unit-II** : Bounded Operator : Invertibility of bounded operator, Adjoints, Spectrum of bounded op- erator, Fundamentals of spectral Theory, Self adjoint operators, 34 Normal, Unitary operators, Projection Operator, introduction to complex measure, Resolution of the Identity

**Unit- III** : Spectral Theorem, Eigen Values of Normal Operators, Positive Operators, Square root of Positive operators, Partial Isometry, Invariant of Spaces, Compact and Fredholm Operators, Integral Operators.

**Unit- IV** :Unbounded Operators : Introduction, Closed Operators, Graphs and Symmetric Operators, Cayley transform, Deficiency Indices, Resolution of Identity, Spectral Theorem of normal Op- erators, Semi group of Operators.

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

**CO1:** Learn and understand concept of Banach Algebra

**CO2:** Understand basic concepts of Bounded Operator

**CO3:** Understand basic concepts of Spectral Theorem, Eigen Values of Normal Operators

CO4: Understand the concept of Unbounded Operators

**Suggested Readings:**

1. Walter Rudin, Functional Analysis, Tata McGraw Hill, 2010.
2. Walter Rudin, Real and Complex Analysis, Tata McGraw Hill, 2010.
3. R.G. Douglas, Banach Algebra Techniques in Operator Theory, Springer,1997.
4. Gohberg and Goldberg Basic Operator Theory, 2001.
5. M. Schecter, Principle of Functional Analysis, American Mathematical society, 2002.
6. Akhietzer and Glazeman Theory of Linear Operator, Vol I, II ,Pitman Publishing House,1981.
7. Donford and Schwarz, Linear Operator, vol. 1. 2. 3., 1988.
8. Weidman J, Linear Operators on Hilbert Spaces, Springer, 1980.

**Note: Latest edition of the text books should be used.**

**Course Code: MT-5039**

**Course Title: Number Theory and Cryptography (Credit-4)**

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

1. Basic operator fundamental concepts of number theory and cryptography.
2. Basic concepts of standard algorithms used to provide confidentiality, integrity and authenticity
3. Basic concepts of various key distribution and management schemes
4. How to deploy encryption techniques to secure data.

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

**Course Inputs:**.

**Unit-I:** The division algorithm. The greatest common divisor. The Euclidean algorithm. Diophantine equations (sums of two squares, the Brahmagupta-Bhaskar equation, Fermat's last

theorem) The fundamental theorem of arithmetic. Basic properties of congruence. Linear congruence and Chinese remainder theorem. Fermat's little theorem and Pseudoprimes, Wilson's theorem

**Unit II.:** The sum and number of divisors. The Mobius inversion formula. The greatest integer function. Euler's phi function and its properties. Euler's Theorem, Fermat's little theorem as a corollary of Euler's theorem.

**Unit III. :**Classical Cryptosystems: Shift cipher, Affine cipher, Substitution cipher, Vigenere cipher, Hill cipher. Public Key cryptography: One way function, Trap door functions, Concept of public key cryptography. RSA scheme.

**Unit IV.:**Primality testing and factoring: Pseudoprimes and Carmichael numbers. Strong Pseudoprimes and Probabilistic primality testing. Primitive roots(order of an integer modulo n, primitive roots for primes). Quadratic reciprocity law, Discrete logarithm. Primality ElGamal system. Signature schemes

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

**CO1:** Learn and understand concept of Euclidean algorithm
**CO2:** Understand basic concepts of Euler's phi function and its properties
**CO3:** Understand basic concepts of Classical Cryptosystems

CO4: Understand the concept of Primality testing and factoring

**Suggested Readings:**


1. David Burton, Elementary Number Theory, 7th edition, McGraw Hill Education, 2012.
2. R Kumanduri and C Romero, Number Theory with Computer Applications, Prentice Hall, New Jersey, 1998.
3. N. Koblitz, A course in Number Theory and Cryptography, 2nd edition, SpringerVerlag, 1994.
4. Thomas Koshy, Elementary Number Theory with Applications, 2nd edition, Elsevier, 2007.


**Note: Latest edition of the text books should be used.**

**Course Code:IK-5051**

**Course Title: Indigenous People and the Science of Gemology (Credit-4)**

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

1. Basic concepts of world of Gemstones.
2. Basic concepts of Physical and optical properties of gemstones
3. Basic concepts of Colour and Healing Power
4. Basic terminology and nomenclature of gemstones as per Indian and International markets .

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

**Course Inputs:**.

**Unit-I: Introduction to the world of Gemstones**

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

**Unit-II: Properties of Gemstones**

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

**Unit-III: Colour and Healing Power**

The healing power of Gem stones, Tribal concept on Gemstones, Scientific approach of gemstones, Top gemstones with their colours and healing qualities, Science behind different colours of gemstones and their healing effects, precious gemstones found in tribal areas. Tribal ornaments having gemstones, semi precious stones and their practical identification, organic gemstones, ornament making techniques in both traditional and modern, Ornament design, stones used in fine and fashion jewelers, rare stones collection.

**Unit-IV: Terminology and nomenclature**

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

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

CO1: Acquire skills on gems mineralogy and genesis.

CO2: Acquire skills to identify and characterize different gem stones by means of physical and optical techniques.

CO3: Remember the physical and optical properties of gemstones and can able to apply their knowledge for grading and engraving.

CO4: Explain the science behind different colours of gemstones and their healing effects.

**Suggested Readings:**


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


**Note: Latest edition of the text books should be used.**

**Course Code: IK-5053**

**Course Title: Tribal Sports, Nutrition and Health Management (Credit-2)**

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

1. To learn about energy expenditure during exercise,

2. Basic concepts of the proper dietary needs for training and basic nutritional concepts

**3.** Understanding of exercise physiology and learn how to create a nutritional fitness plan for each sport

4. Nutrition – Daily calorie intake and expenditure.

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

**Course Inputs:**.

**Unit – I: Introduction to Sports Nutrition**

Meaning and Definition of Sports Nutrition o Basic Nutrition guidelines Role of nutrition in sports, Factor to consider for developing nutrition plan

**Unit – II: Nutrients**

Ingestion to energy metabolism: Carbohydrates, Protein, Fat – Meaning, classification and its function, Role of carbohydrates, Fat and protein during exercise Vitamins and Nutrition:

Vitamins, Minerals, Water – Meaning, classification and its function Role of hydration during exercise, water balance. Nutrition – daily caloric requirement and expenditure.

**Unit – III: Nutrition and Health Management**

Meaning of weight management Concept of weight management in modern era Factor affecting weight management and values of weight management, Concept of BMI (Body mass index), Obesity and its hazard, Myth of Spot reduction, Dieting versus exercise for weight control, Common Myths about Weight Loss, Obesity – Definition, meaning and types of obesity, Health Risks Associated with Obesity, Obesity - Causes and Solutions for Overcoming Obesity.

**Unit – IV: Steps of planning of Health Management**

Nutrition – Daily calorie intake and expenditure, Determination of desirable body health Balanced diet for Tribal Children, Maintaining a Healthy Lifestyle, Health management program for sporty child, Role of diet and exercise in health management, Design diet plan and exercise schedule for weight gain and loss

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

CO1: Examine the role of nutrition in sports and health management.

CO2: Evaluate and utilize the role of carbohydrates, fat and protein in sports.

CO4: Create a culture that embraces professionslism, ethics and change, and inspires innovation, productivity and teamwork.

CO5: Evaluate and utilize the key components of the health care system and health system globally to deliver excellent integrative health services.

CO6: Develop appropriate professional behaviors and leadership skills for careers in health care.

**Suggested Readings:**

1. "Environmental Engineering" by Peavy, H. S., Rowe, D. R., Tchobanoglous, G.McGraw Hills, New York, 2013.

2. "Physicochemical processes for water quality control" by Weber, W.J. John Wileyand sons, Newyork, 2003.

**Note: Latest edition of the text books should be used.**

**Course Code: IP-5081**

**Course Title: Internship Programme (Credit – 2)**

**Course Learning Objectives:**

To enable students to acquire practical knowledge and to act professionally in this area. This is meant to provide a scope to the students to apply theoretical knowledge in the real world, explore further in-depth knowledge in Indigenous Knowledge, Science and Technology.

**Course Learning Outcomes:**

1. The students will have working knowledge in the real world and operate.
2. Develop an understanding of the importance and scope of industry interface.
3. Understand the changing micro and macro environment of organizations and importance of industry research and forecasting.
4. Develop an understanding of the competitive strategies for industry.
5. Establish a link between academic programme and industry as a strategic tool for staying ahead in a competitive market.

Preamble:

The Summer Internship is a fully practical oriented course which has been designed to give students in depth knowledge about. Summer Internship is designed at the end of first year, where in student would have studied the courses in science and technology and will have more scope to apply knowledge. In this subject, wherein he will be encouraged to explore concepts already dealt in the class and understand its application in the field. The student while carrying summer internship training Project is more focused and would be getting continuous guidance from the external as well as internal experts. The following note presents the broad guidelines of the Project.

**PROCESS / GUIDELINES:**

1) The student will be required to undergo a field placement for a total duration of 3-4 weeks in their chosen area of interest. Or institute will depute the students to various organizations looking at their area of interest.

2) In case the student makes the choice of the organization, it has to be made in consultation with the Institute. The Institute for this purpose should assign an internal faculty member who will act as the mentor throughout the Project. The assignment of mentor and choice of project should be made.

3) The study conducted by the student will be a full-time effort.

4) The proposal for the Summer Project or title of the project should be submitted to the Institute, which will ensure the registration of students for Project.

Students should prepare these proposals in consultation with the Internal and External Guide.

5) Students should send Joining Report on the first day of the joining which should be duly signed by the external guide.

6) Student should also send weekly reports every week keeping posted about the work –in – progress regarding project to the institute.

7) The format for the proposal or deciding about project title is as given below:

- Title of the study
- Need for the study (Stress on Need for study-current trends in the area)
- A review of earlier research studies conducted
- Objectives of the study
- Methodology
- Proposed outcomes and benefits of the study

8) The project should complete in time. Late submissions should not be entertained. A soft copy of all reports is to be submitted to Department on or before the submission date.

9) There shall be 2 copies of project reports along with soft copy to be submitted by each student to the School.

10) There will be a project viva-voice conducted by the University.

Deliverables:

The students are required to deliver the following Deliverables.

1) Joining Report and deciding project title/ proposal

2) Submission of project report (Soft copy + Hard copy- 2no.s /Project)

3) Presentation (for organization and the Institute)

4) Presentation for Viva-voce examination to be conducted by the University.

5) Student to present 1 copy to the organization and get the Certificate.

Format for Project Reports

The format for the Major Concurrent Project reports should be in the following manner.

- Executive Summary
- About the organization – Brief
- Certificate of Completion
- Introduction of the study
- Objectives
- Analysis and Findings
- Discussion
- **Conclusion**
- **References**

In certain cases, students may change the format in consultation with his mentor and the External Guide. Enough care should be taken that the Project report focuses the study undertaken by the student and its findings. The report should contain minimum 25 pages with the following styles:

i) A-4 size paper (Executive Bond)

ii) MS Word style with Times New Roman Font

iii) Font size -12 for Text and 14 for headings

iv) Paper settings with 1-inch margins on all the four sides.

**text books should be used**

# Semester-IV

**Course Code:MT-5002**

**Course Title:** Analytic Number Theory**(Credit-4)**

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

1. The basics of Analytic Number Theory, Arithmetic Function,

2. Basic concepts of Distribution of Prime Number, Riemann Zeta function and work of Ramanujam

**3.** Understanding Brief sketch of an elementary proof of the prime number theorem

4. The Riemann zeta function and the L-function

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

**Course Inputs:**.

**UNIT-I :** Arithmetical Functions and Dirichlet Multiplications: The arithmetical functions and their relations, The Dirichlet product of arithmetical functions, Dirichlet inverses and Mobius inversion formula, Multiplicative functions, The Bell series of an arithmetical function and Dirichlet multiplications, Derivatives of arithmetical functions, The Selberg identity, The big oh notation, Euler's summation formula, Some elementary asymptotic formulas.

**UNIT-II :** Averages of arithmetical functions: The average order of divisor functions, The average order of Euler totient function, The average order of Mobious and Mangoldt functions, The partial sums of a Dirichlet product, Applications to the Mobius and Mangoldt functions. Some elementary theorems on distribution of prime numbers: Chebyshev's functions and their relations with $(x)$ (The number of primes less than or equal to $x$), Some equivalent forms of the prime number theorem, Shapiro Tauberian theorem, The partial sums of the Mobius function.

**Unit-III:** Brief sketch of an elementary proof of the prime number theorem, Functions periodic modulo k, Existence of finite Fourier series for periodic arithmetical functions, Ramanujan's sum and generalizations, The half-plane of absolute convergence of a Dirichlet series, Euler products, Analytic properties of Dirichlet series, Mean value formulas for Dirichlet series, An integral formulas for the coefficients and the partial sums of a Dirichlet series

**Unit-IV:** The Riemann zeta function and the L-function: Properties of the gamma function, Integral representation for the Hurwitz zeta function, Analytic continuation of the Hurwitz zeta function, Analytic continuation of the Riemann zeta function and the L-function, The functional equation for the Riemann zeta function, Properties of Bernoulli numbers and Bernoulli polynomials.

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

**CO1:** Analyse and understand Arithmetical Functions and Dirichlet Multiplications

**CO2:** Understand Averages of arithmetical functions

**CO3:** Understand Brief sketch of an elementary proof of the prime number theorem,

CO4: Understand The Riemann zeta function and the L-function

**Suggested Readings:**

1. Introduction to Analytic Number Theory, T. M. Apostol, Springer-Verlag, New York, 1976.

2. Analytic Number Theory: Exploring the Anatomy of Integers, Jean-Marie De Koninck, Florian Luca, American Mathematical Society, 2012

3. A Primer of Analytic Number Theory: From Pythagoras to Riemann, Jeffrey Stopple, Cambridge University Press, 2003.

**Note: Latest edition of the text books should be used.**

**Course Code: MT-5004**

**Course Title: Topology (Credit-4)**

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

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

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

**Course Inputs:**.

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

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

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

**Unit-IV** : Countability axioms Separation axioms Regular & completely regular space, normal spaces, Urysohn Lemma, Urysohn metrization theorem

**Unit-V** :Tychonoff Theorem, Homotopy, Homotopy equivalences, path homotopy Fundamental Group, covering space fundamental Group of S1.

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

**CO1:** Learn and understand Topological spaces, Basis of topology,

**CO2:** Understand Concept Of Connectedness

**CO3:** Understand Limit point compactness, sequential compactness,

CO4: Understand Countability axioms Separation axioms

**Suggested Readings:**

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

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

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

**Note: Latest edition of the text books should be used.**

**Course Code: MT-5082**

**Course Title: Dissertation (Credit-6)**

Dissertation is to be prepared by the students under the supervision of the concerned teacher. The student is required to submit the dissertation through the supervising teacher to the Head of the Department for its evaluation at least 15 days in advance of the date notified for examination.

The dissertation shall be evaluated by an external examiner in consultation with the internal examiner(supervising teacher). The candidate shall be awarded grade both by the internal and external examiners on the basis of his/her dissertation, seminar presentation and viva-voce.

# ELECTIVE PAPERS

**Course Code: MT-5032**

**Course Title: Differential Geometry (Credit-4)**

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

1. The basics of calculus in Rn, local theory of curves and surfaces
2. Basic concepts of Differential manifolds, Submanifolds
3. Understanding Dual space, tensor of type(r.s), Operations with tensors
4. Riemann Curvature tensor and properties

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

**Course Inputs:**.

**Unit-I** : Review of calculus in Rn ,Inverse and implicit function theorem, Rank theorem. Review of local theory of curves and surfaces, Serret Frenet formula, First fundamental forms, second fundamental form, Normal curvature, Geodesic curvature, Gauss formula, , Weiengarten map, principal curvatures, Gaussian curvature, mean curvature , motivation of global theory, Gauss Bonnet formulae.

**Unit-II** :Introduction to Manifolds, Differential manifolds, Examples, Submanifolds, Tangent vector and tangent space at a point of the manifold, cotangent spaces, vector fields, Lie bracket, Lie algebra, Definition and example of Lie groups, Integration on manifolds, Stoke's theorem,

**Unit-III** :Multi linear Algebra: Dual space, tensor of type(r.s), Operations with tensors, contractions, quotient law of tensors, metric tensor, associated tensors, symmetric and antisymmetric tensors, Exterior forms, Wedge product , Exterior Algebra, Exterior derivative, Exact forms, Closed forms.

**Unit-IV** :Affine connection of manifolds, parallel transport, Intrinsic derivative, covariant derivative, curvature tensor, Riemannian metric, Riemannian manifold, Fundamental theorem of

Riemannian Geometry, Levi Civita Connection, Riemann Curvature tensor and properties, Bianchi identities, Scalar curvature, applications to relativity.

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

**CO1:** Learn and understand calculus in Rn, local theory of curves and surfaces
**CO2:** Understand concepts of Differential manifolds, Submanifolds
**CO3:** Understand Dual space, tensor of type(r.s), Operations with tensors
CO4: Understand Riemann Curvature tensor and properties

**Suggested Readings:**

1. Wilmore- Differential and Riemannian geometry, Oxford University Press, 1996.
2. A. Pressley, Elementary differential geometry, Springer international edition, 2014
3. U.C De & A.A Shaikh, Differential Geometry of Manifolds, Narosa, 2009.
4. Warner-Foundations of differential geometry and Lie groups Springer, 1983.
5. Boothby - An introduction to differential and Riemannian geometry, Acade

**Note: Latest edition of the text books should be used.**

**Course Code: MT-5034**

**Course Title: Advanced Analysis (Credit-4)**

**Course Learning Objectives:** Students will be able to articulate and describe:
1. Some vital parts of analysis such as Integration of vector valued functions
2. Basic concepts of Fourier series, Riemann integral and types of measures
**3.** Understanding Measureable Sets and Lebesgue measure,
4. The Rieman Integral, The Lebesgue integral of a bounded function
**Pedagogy:** Lectures, Power Point Presentation, Assignments, Case discussion, Projects and Seminars
**Course Inputs:**.

**Unit-1:** Integration of vector valued functions, rectifiable curves, equi-continuous families of function. The stone Weierstrass theorem , Fourier Series, Orthogonal and Orthonormal system of functions

**Unit-II:** Bersets inequality, Dirichlet-kernel, point wise convergence of Fourier series ,Approximation theorems, Parseval's theorem**.** Harmonic function, Basic properties of harmonic functions, harmonic functions on a disk.

**Unit-III:** Dirchlet problem, Green's function, Entire functions, Jensons Formula, Genus and order of an entire function, Hadmard factorization theorem .Outer measure, Lebesgue Measure, Measureable Sets and Lebesgue measure, Non measurable sets, Measureable functions

**Unit-IV:** The Rieman Integral, The Lebesgue integral of a bounded function , The general Lebesgue integral,Measure spaces, Measureable functions, Integration, General convergence theorems

**Unit-V:** Signed measures, The Lp-spaces, Outer measure and measurability , The extension theorem The Lebesgue Stieltjes integral, Product measures.

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

**CO1:** Learn and understand Integration of vector valued functions
**CO2:** Understand concepts of Fourier series, Riemann integral and types of measures
**CO3:** Understand Basic properties of harmonic functions, harmonic functions on a disk.

CO4: Understand The Rieman Integral, The Lebesgue integral of a bounded function

**Suggested Readings:**

1.Principles of Mathematical Analysis –W.Rudin 3rd edition

2.D. Smith, M. Eggen and R. ST. Andre, A transition to Advanced Mathematics, (Brooks Cole, 2004)

3. Seymour Lipschutz, Set Theory and Related Topics, (McGraw Hill, 1964)

4. Frankel, A. Abstract Set theory, (North Holland Publishing Co., 1961)

5. Royden, H. L. Real Analysis, (Prentice Hall, 1988)

6. Suppes, P. Axiomatic Set Theory, (Dover Publications Inc.,May 1973)

7. Halmos, P. R. Naive Set Theory, (Springer, 1974)

8. Halmos, P. R. Measure Theory, (Springer, 1974)

9. Rudin, W. Real and Complex Analysis, (McGraw-Hill Higher Education, 1987)

**Note: Latest edition of the text books should be used.**

**Course Code:MT-5036**

**Course Title: Fluid Dynamics (Credit-4)**

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

1. Kinematics of Fluids, Methods describing Fluid motion
2. Fundamental equations of the flow of viscous compressible fluids
3. The equation of state. Fundamental equations of continuity
4. Basic equations and concepts of flow.

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

**Course Inputs:**.

**Unit-I :** Kinematics of Fluids, Methods describing Fluid motion. Lagarangian and Eulerian Methods. Translation Rotation and Rate of Deformation. Streamlines, Pathlines and Streaklines. The Material derivative and Acceleration Vorticity in Polar and Orthogonal Curvilinear Coordinates.

**Unit-II :** Fundamental equations of the flow of viscous compressible fluids, Equations of continuity, motion and energy is Cartesian coordinate systems.

**Unit-III :** The equation of state. Fundamental equations of continuity, motion and energy in Cylindrical and Spherical coordinates.

**Unit-IV:** 2-D and 3-D in viscid incompressible flow. Basic equations and concepts of flow. Circulation theorems, Velocity potential, Rotational and Irrotational flows. Integration of the equations of motion. Bernoulli's Equation, The momentum theorem and the moment of momentum theorem. Laplace's equations in different coordinate systems. Stream function in 2-D motion.

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

**CO1:** Learn and understand Kinematics of Fluids, Methods describing Fluid motion
**CO2:** Understand Fundamental equations of the flow of viscous compressible fluids
**CO3:** Understand The equation of state. Fundamental equations of continuity
CO4: Understand The Rieman Integral, The Lebesgue integral of a bounded function

**Suggested Readings:**

1. Foundations of Fluid Mechanics by S. W. Yuan, Publisher Prentice-Hall of India. Chapters : 3, 5 (5.1 to 5.6), 7 (7.1 to 7.9

2. Foundations of fluid Mechanics by S.W.Yuan ,Publisher prentice-Hall of India.

Chapters:3,5(5.1 to5.5),7(7.1 to 7.9**).**

**Note: Latest edition of the text books should be used.**

**Course Code:MT-5038**

**Course Title: Matrix Transformations and Sequence Spaces (Credit-4)**

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

1. Limitation methods, Examples of Limitation Methods
2. Some particular Limitation Matrices
3. Bounded sequence, Uniformly limitabie sequence
4. Matrix and linear transformations.

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

**Course Inputs:**.

**Unit-I:** Limitation Methods : Limitation methods, Examples of Limitation Methods, Matrix Limitation Methods, Norlund and Riesz Musos ,Scbur Matrices: Consistency of Matrix Methods

**Unit-II :**Some particular Limitation Matrices: Norlund Mean, Cesaro and Holder Matrices. Hausdorff Methods, Abels method, Tauberin Theorem, Banach Limits, Strongly Regular Matrices, Counting function. Some Matrices of a special Type, A universal Tauberian Theorem.

**Unit-III:** Bounded sequence, Uniformlylimitabie sequence, Intersection of Bounded Convergence Fluids. Set of Matrices, Bounds on Limits of sequences, Matrix Norms, Pairs of consistent matrices

**Unit-IV :**Matrix and linear transformations Algebras of matrices, Summability, Tauberian theorems.

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

**CO1:** Analyse and understand Limitation methods, Examples of Limitation Methods

**CO2:** Understand Some particular Limitation Matrices

**CO3:** Understand Bounded sequence, Uniformly limitable sequence

CO4: Understand Matrix and linear transformations.

**Suggested Readings:**

1. Regular Matrix Transformation by G. N. Peterson McGraw-Hill Publishing Company. Chapters: 1, 2, 3,4

2. Elements of Functional Analysis by I. J. Maddox, Cambridge University Press, Chapter: 7

**Note: Latest edition of the text books should be used.**

**Course Code:MT-5040**

**Course Title: Stochastic Calculus (Credit-4)**

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

1. Preliminaries from Calculus, Concepts of Probability Theory
2. Ito Integration, Stochastic differential equations,
3. Martingales, Calculus for semi martingales
4. Applications in Finance

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

**Course Inputs:**.

**Unit I: Preliminaries** from Calculus, Concepts of Probability Theory, Brownian motion.

**Unit II: Ito** Integration, Stochastic differential equations, Diffusion processes.

**Unit III: Martingales**, Calculus for semi martingales, Pure jump processes.

**Unit IV:** Applications in Finance ( Stoke, Bond, Rate , Currency). Applications in Biology (Branching diffusion). Applications in Engineering and Physics (Filtering, Random oscillation).

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

**CO1:** Learn and understand Preliminaries from Calculus, Concepts of Probability Theory

**CO2:** Understand Ito Integration, Stochastic differential equations

**CO3:** Understand Martingales, Calculus for semi martingales

CO4: Understand Applications in Finance

**Suggested Readings:**

1. Klebaner, F.C.(2012). Introduction to Stochastic Calculus with applications.
World Scientific Publishing Company.
2. Bald, P.(2017). Stochastic Calculus: An Introduction Through Theory and Exercises.
3. Durrett, R.(2018).Stochastic Calculus: A practical introduction. CRC Press.

4. Karatzas , I. & Shreve, S.(2014). Brownian motion and Stochastic Calculus(Vol-113). Springer.
5. Rao, B. V.(2018). Introduction to Stochastic Calculus. Springer.
6. Shreve , S. E.(2004). Stochastic Calculus for Finance II: Continuous-time models(Vol-11).Springer Science and Business Media.

**Note: Latest edition of the text books should be used.**

**Course Code: IK - 5052**

**Course Title: Indigenous Knowledge and Intellectual Property Rights (Credit-4)**

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

1. Intellectual Property Rights: Concept and meaning.
2. Indian Patent Law (a) The Patents Acts
3. Copyright, Neighbouring Rights and Industrial Designs.Introduction to Copyright
4. Geographical Indications: Concept of Appellations of Origin

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

**Course Inputs:**.

**Unit – I:** Introduction to Intellectual Property Rights: Concept and meaning.

Theories of Property - An Overview, Intellectual Property as an Instrument of Development. Introduction to Patent Law (a) Paris Convention (b) Patent Cooperation Treaty (c) WTO- TRIPS (d) Harmonisation of CBD and TRIPs

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

**Unit – III:** Copyright, Neighbouring Rights and Industrial Designs.Introduction to Copyright. Indian Copyright Law: (a) The Copyright Act, 1957 with its amendments (b) Copyright works (c) Ownership, transfer and duration of Copyright (d) Renewal and Termination of Copyright (e) Neighbouring Rights (f) Infringement of copyrights and remedies

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

**Unit – IV:** Geographical Indications, Layout designs of Integrated Circuits and Protection of Plant Varieties and Farmers' Rights.

Geographical Indications: Concept of Appellations of Origin, Indication of Source and Geographical Indication, The Geographical Indications of Goods, Infringement, Penalties and Remedies. Layout-Designs of Integrated Circuits: Conditions and Procedure for Registration, Duration and Effect of Registration, Assignment and Transmission

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

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

CO1: Have an in-depth understanding of the fundamental legal principles relating to confidential information, copyright, patents, designs, trademarks and unfair competition.

CO2: Understand the current and emerging issues relating to the intellectual property protection.

CO3: Anticipate and subject to critical analysis arguments relating to the development and reform of intellectual property right institutions and their likely impact on creativity and innovation.

CO4: Acquire knowledge about layout designs of Integrated Circuits and Protection of Plant Varieties and Farmers' Rights.

**Suggested Readings:**

1. Arai, Hisamitsu. "Intellectual Property Policies for the Twenty-First Century: The Japanese Experience in Wealth Creation", WIPO Publication Number 834 (E). 2000. wipo.int

2. Bettig, R. V. (1996). Critical Perspectives on the History and Philosophy of Copyright. In R. V. Bettig, Copyrighting Culture: The Political Economy of Intellectual Property. (pp. 9–32). Boulder, CO: Westview Press.

3. Boldrin, Michele and David K. Levine. "Against Intellectual Monopoly", 2008. dkleving.com

4. Branstetter, Lee, Raymond Fishman and C. Fritz Foley. "Do Stronger Intellectual Property Rights Increase International Technology Transfer? Empirical Evidence from US Firm-Level Data". NBER Working Paper 11516. July 2005. weblog.ipcentral.info

5. Burk, Dan L. and Mark A. Lemley (2009). The Patent Crisis and How the Courts Can Solve It. University of Chicago Press. ISBN 978-0-226-08061-1.
6. Connell, Shaun. "Intellectual Ownership". October 2007. rebithofffreedom.org
7. De George, Richard T. "14. Intellectual Property Rights." In The Oxford Handbook of Business Ethics, by George G. Brenkert and Tom L. Beauchamp, 1:408-439. 1st ed. Oxford, England: Oxford University Press, n.d.
8. Farah, Paolo and Cima, Elena. "China's Participation in the World Trade Organization: Trade in Goods, Services, Intellectual Property Rights and Transparency Issues" in Aurelio Lopez-Tarruella Martinez (ed.), El comercio con China. Oportunidades empresariales, incertidumbres jurídicas, Tirant lo Blanch, Valencia (Spain) 2010, pp. 85–121. ISBN 978-84-8456-981-7. Available at SSRN.com
9. Farah, Paolo Davide, Tremolada Riccardo, Desirability of Commodification of Intangible Cultural Heritage: The Unsatisfying Role of IPRs, in TRANSNATIONAL DISPUTE MANAGEMENT, Special Issues "The New Frontiers of Cultural Law: Intangible Heritage Disputes", Volume 11, Issue 2, March 2014, ISSN 1875-4120Available at SSRN.com
10.Farah, Paolo Davide, Tremolada Riccardo, Intellectual Property Rights, Human Rights and Intangible Cultural Heritage, Journal of Intellectual Property Law, Issue 2, Part I, June 2014, ISSN 0035-614X, Giuffre, pp. 21–47. Available at SSRN.com

**Note: Latest edition of the text books should be used.**

**Course Code: MT-5006**

**Course Title: Fuzzy sets and their applications (Credit-2)**

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

1. Basic concept of fuzzy sets and their representation.
2. **:** Fuzzy Graphs- Fuzzy relations on fuzzy sets
3. Possibility Theory-Fuzzy measures,
4. Fuzzy Control-Fuzzy controllers.

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

**Course Inputs:**.

**Unit-I** : Basic concept of fuzzy sets, fuzzy sets and their representation. Types of fuzzy sets. Convex fuzzy sets. Basic operations on fuzzy sets geometric interpretation of fuzzy sets.

Cartesian products. Image and inverse image of fuzzy sets. Fuzzy relations. Fuzzy numbers. Elements of fuzzy arithmetic. Composition of fuzzy relations.

**Unit-II :** Fuzzy Relations Fuzzy Graphs- Fuzzy relations on fuzzy sets. Composition of fuzzy relations. Fuzzy relation equations. Fuzzy graphs. Similarity relation. Fuzzy logic and fuzzy proposition, fuzzy equivalence relations, fuzzy ordering relations. Projections and cylindrical extensions. Fuzzy Numbers, fuzzification in Integrations,

**Unit-III :**Possibility Theory-Fuzzy measures, Evidence theory. Possibility Theory-Fuzzy sets. Fuzzy quantifiers, linguistic variables, Multi valued logics and Fuzzy propositions. Fuzzy rule-based models for function approximation. Types of fuzzy rule-based models. Fuzzy mapping rules and fuzzy implication rules. Fuzzy quantifiers. Baye's theorem for fuzzy events. The compositional rule of inference.

**Unit-IV :** An introduction to Fuzzy Control-Fuzzy controllers. Fuzzy rule base. Fuzzy inference engine. Fuzzification. Defuzzification and the various defuzzification methods. Decision making in Fuzzy Environment, Individual decision making, multi-person decision making. Multicriteria decision making. Multistage decision making. Fuzzy ranking methods, Fuzzy linear programming.

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

**CO1:** Learn and understand fuzzy sets and their representation.
**CO2:** Understand Fuzzy Graphs- Fuzzy relations on fuzzy sets
**CO3:** Possibility Theory-Fuzzy measures,
CO4: Understand Geographical Indications: Concept of Appellations of Origin

**Suggested Readings:**

1. Kwang H. Lee, First Course on Fuzzy Theory and Applications, Springer International Edition. 2005.

2. Chander Mohan, An Introduction to Fuzzy Set Theory and Fuzzy Logic, Anshan Publishers.

3. Wang, Zhenyuan, Rong Yang, and Kwong-Sak Leung. Nonlinear Integrals andTheir Applicationsin Data Mining. Singapore: World Scientific Publishing Company, 2010.

4. J. Yen and R. Lingari: Fuzzy Logic: Intelligence, control and Information, Pearson Education,2003.

5. G.J. Klir and B. Yuan: Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice-Hall of india.

6. H.J. Zimmermann, Fuzzy Set theory and its Applications, Kluwer Academic Publ, 2001.

**Note: Latest edition of the text books should be used.**

**Course Code: MT-5008**

**Course Title: DATA STRUCTURE (Credit-2)**

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

1. What are data structures, Java Refresher,
2. Abstract Data Types (ADTs),
3. Binary Trees, The Search Tree AD Binary Search Trees
4. Priority Quest, Models, Simple Implementations

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

**Course Inputs:**

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**Unit-I** :What are data structures, Java Refresher, JAVA refresher and generics, Analysis Tools and Techniques, Algorithm Analysis, Mathematical Background, Model, Running Time Calculations

**Unit-II** :Abstract Data Types (ADTs), vector and list in the STL, Linked lists and Iterators, Stacks and Queues, The Stack ADT, The Queue ADT

**Unit-III** :Binary Trees, The Search Tree AD Binary Search Trees, AVL Trees, Splay Trees, B-Trees, Hash Function, Separate Chaining, Hash Tables Without Linked Lists, Rehashing

**Unit-IV** :Priority Quest, Models, Simple Implementations, Binary Heap, Applications of Priority Queues, d-Heaps, Sorting, Graph

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

**CO1:** Learn and understand what are data structures, Java Refresher,

**CO2:** Understand Abstract Data Types (ADTs),

**CO3:** Understand Binary Trees, The Search Tree AD Binary Search Trees,

CO4: Understand Priority Quest, Models, Simple Implementations

**Suggested Readings:**

1. M. A. Weiss. Data Structures and Algorithm Analysis in C++ (3rd edition), by Addison-Wesley

2. Alfred V. Aho, Jeffrey D. Ullman, John E. Hopcroft. Data Structures and Algorithms. Addison Wesley, 1983.

3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein. Introduction to Algorithms. McGraw-Hill, 2001.

4. Donald E. Knuth. The Art of Computer Programming, Volumes 1-3. Addison-Wesley Professional, 1998.

**Note: Latest edition of the text books should be used.**

**THANK YOU**