।। सा विद्या या विमुक्तये ।।
स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड
"ज्ञानतीर्थ" परिसर, विष्णुपूरी, नांदेड - ४३१६०६ (महाराष्ट्र)
SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY NANDED
"Dnyanteerth", Vishnupuri, Nanded - 431606 Maharashtra State (INDIA)
Established on 17th September 1994 – Recognized by the UGC U/s 2(f) and 12(B), NAAC Re-accredited with 'A' Grade
25 1994 - 2019 SILVER JUBILEE YEAR

ACADEMIC (1-BOARD OF STUDIES) SECTION

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प्रस्तुत विद्यापीठाच्या संकुलातील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील प्रथम वर्षाचे CBCS Pattern नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०१९–२० पासून लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, **दिनांक ०८ जून २०१९ रोजी संपन्न झालेल्या ४४व्या मा. विद्या परिषद बैठकीतील ऐनवेळचा विषय क्र.११/४४–२०१९** च्या ठरावानुसार प्रस्तुत विद्यापीठाच्या **प्रस्तुत विद्यापीठाच्या संकुलातील विज्ञान व तंत्रज्ञान विद्याशाखेतील पदव्युत्तर स्तरावरील प्रथम वर्षाचे** खालील विषयांचे **C.B.C.S. (Choice Based Credit System) Pattern** नुसारचे अभ्यासक्रम शैक्षणिक वर्ष २०१९–२० पासून लागू करण्यात येत आहेत.

1. Botany
2. Certificate Course in Industrial Safety, Health and Environmental Management (SHM)
3. Chemistry
4. Computer Application
5. Computer Network
6. Computer Science
7. Geophysics
8. Mathematics
9. M.C.A.
10. Microbiology
11. Physics
12. Zoology

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.: शैक्षणिक–१/परिपत्रक/संकुले/पदव्युत्तर–सीबीसीएस अभ्यासक्रम/२०१९–२०/**४६५**

दिनांक : ११.०७.२०१९.

स्वाक्षरित/–
उपकुलसचिव
शैक्षणिक (१–अभ्यासमंडळ) विभाग

प्रत माहिती व पुढील कार्यवाहीस्तव :

१) मा. कुलसचिव यांचे कार्यालय, प्रस्तुत विद्यापीठ.
२) मा. संचालक, परीक्षा व मूल्यमापन मंडळ यांचे कार्यालय, प्रस्तुत विद्यापीठ.
३) मा. संचालक, सर्व संबंधित संकुले, विद्यापीठ परिसर, प्रस्तुत विद्यापीठ.
४) साहाय्यक कुलसचिव, पदव्युत्तर विभाग, प्रस्तुत विद्यापीठ.
५) उपकुलसचिव, पात्रता विभाग, प्रस्तुत विद्यापीठ.
६) सिस्टम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ.

Swami RamanandTeerthMarathwada University, Nanded
School of Mathematical Sciences

Two Year M. A. / M. Sc. Degree Program in Mathematics

Revised Syllabi of M. A. / M. Sc. in Mathematics

(Choice Based Credit System)

(To be implemented in the Department of Mathematics, Swami RamanandTeerthMarathwada University, Nanded)

(With effect from Academic Year 2019-2020)

Program Code: SMS-S-MAT-PG

Numeric Code: 20-2-1-01

Title of the Program: M. A. / M. Sc. in Mathematics

1. Preamble: M. A. / M. Sc. Mathematics programme is of minimum 100credits spread over four semesters. The programme emphasizes both theory and applications of Mathematics and is structured to provide knowledge and skills in depth necessary for the employability of students in industry, other organizations, as well as in academics. The program has some unique features such as independent projects, a large number of elective courses, extensive computer training including standard software packages such as LaTeX, SciLab, SageMath, R-software. The department has the academic autonomy and it has been utilized to add the new and need based elective courses. Theindependent project work is one of the important components of this program. The syllabus of the first year (two semesters) covers most of the core courses. In the third semester syllabus there are two core courses and eight elective courses. In the fourth semester syllabus there are two core courses and fourteen elective courses. The syllabus has been framed to have a good balance of theory, methods and applications of Mathematics.
It is possible for the students to study basic courses from other disciplines such as economics, life sciences, computer science and mathematics in place of electives.

2. Introduction: M. A. / M. Sc. Mathematics program has semester pattern andcredit system with variable credits. The program consists of 100 credits. Credits of a course are specified against the title of the course. A course with T in brackets indicates that it is a theory course whereas a course with P in brackets indicates that it is a practical course. Some of the practical courses are linked with a theory course and in such a case, both the courses will have the same number with T and P, indicating a theory and a practical course respectively. A student can enroll for a practical course if the student has enrolled for the corresponding theory course (as indicated) in the same term.

- **Scope:**Mathematics is at the heart of science, engineering and technology, as well as being an indispensable problem-solving and decision-making tool in many other areas of life. Mathematics has got a great importance in the industrial and economic development of a country. M.Sc. in Mathematics is the postgraduate course in Mathematics which enables the candidates to use their mathematical knowledge in different areas. This course has got great scope and there are ample opportunities available for the M.Sc. graduates.

The scope of opportunities is vast and mathematics postgraduates are equipped

with skills and knowledge required for jobs in fields such as finance, education, engineering, science and business, as well as mathematics and mathematical science research.

3. Eligibility: For M. A/ M.Sc. in Mathematics following candidates are eligible.

- B.A./B.Sc. with Mathematics as principal Subject at degree level.

4. Definitions:

Credits:
Credit is a kind of weightage given to the contact hours to teach the prescribed syllabus, which is in a modular form. Normally one credit is allocated to 15 contact hours.

- In each of the courses, credits will be assigned on the basis of the number of lectures / tutorials / laboratory work and other forms of learning required for completing the course contents in maximum 18 week schedule.
- The instructional days as worked out by the UGC for one academic year are 180 working days i.e. 90 days per semester.
- **Mechanics of Credit Calculation:** As per SRTMUN standard, 1Credit= 15 contact hours. Contact hours will include all the modes of teaching like lectures / tutorials / laboratory work / fieldwork or other forms which suits to that particular course. In determining the number of hours of instruction required for a course involving laboratory / field-work, 2 hours of laboratory / field work is generally considered equivalent to 1 hour of lecture.

Credit Point (P):
Credit point is the value obtained by multiplying the grade point (G) by the credit (C): P = G x C.

Grade Point:
Grade point is an integer indicating the numerical *SEMESTER GRADE POINT AVERAGE(SGPA):*

II. Semester Grade Point Average (SGPA) is the value obtained by dividing the sum of credit points (P) earned by a student in various courses taken in a semester by the total number of credits earned by the student in that semester. SGPA shall be rounded off to two decimal places.

II. Cumulative Grade Point Average (CGPA):
'Cumulative Grade Point Average' (CGPA) is the value obtained by dividing the sum of credit points in all the courses earned by a student for the entire programme, by the total number of credits. CGPA shall be rounded off to two decimal places. CGPA indicate an overall letter grade (Cumulative Grade) for the entire programme shall be awarded to a student depending on his/her CGPA.

The comprehensive academic performance of a student in a programme is equivalent of the letter grade.

- **Evaluation System -**

In this section the broad guidelines to be followed in evaluation system and the minimum number of credits to be completed to get a degree are defined.

- The evaluation will be on Continuous Internal Assessment (CIA), End Semester Assessment (ESA). The final results shall be declared after integration of CIA and ESA
- Weightage: 50% for End Semester Assessment (ESA) & 50% for Continuous Internal Assessment (CIA)

The declaration of result is based on the grade point average (GPA) earned towards the end of each semester or the Cumulative Grade Point Average (CGPA) earned towards the end of the program.

a) The Post-graduate degree will be awarded to those students who earn the minimum number of Credits. For the award of degree the student has to acquire minimum number of credits as per the table given below.

Name of the Faculty/course	Total credits	Average credits per semester
M.A./ M.Sc.	100	25

b) One credit will be equivalent to 15 clock hours of teacher-student contact in a semester.
c) Four –credit course of theory will be of four clock hours per week.
d) Two- credit course of practical will be of 4 hours of lab exercise/field.
e) The project / Dissertation will be commencing from Semester III and the final work & report will be completed during Semester IV. The marks & the credits will be allotted in semester IV.
f) There will be no mid-way change allowed from Credit System to Non-credit (external) System or vice versa.
g) In a case, where the PG program duration is of one year, such a program shall consist of minimum 50 credits. Certificate programs shall consist of 25 credits/ semester.
h) Except the credits for practical courses, wherever applicable, a student can register for less number of courses in a semester subject to the condition that such a student will have to complete the degree in a maximum of five, four and two years respectively for three, two and one year programs. This facility will be available subject to the availability of concerned courses in a given semester and with a maximum variation of 25 % credits (in case of fresh credits) per semester.
i) CBCS:
Among the minimum number of credits to be earned by a student to

complete a Post Graduate degree program (100 credits), the student will have to earn minimum 75% credits from the core subjects and the remaining 25 % credits could be earned from the elective/open elective (inter/intra disciplinary) subjects offered within and across the schools. The maximum number of credits offered across the disciplinary should not exceed 10% of total credits for the program.

The distribution of the courses in a Program: The total number of minimum credits to complete the program is different for different programs. Out of these: Core: 75% of total credits of the Program of that particular discipline.
Elective: 25% (including discipline specific subject electives and Open (Generic) Electives). In this the open electives should be of 8 credits in a two year program (average of 4 credits each year). It is mandatory that the open electives shall be of outside the parent school i.e. Inter school 8 open credits can be taken as open elective. This includes Credit Transfer from recognized online courses like SWAYAM/ MOOCS/ NPTEL/Skill oriented courses. Students can opt at most 04 credits per semester and 08 credits per programme from outside the school.
Credit transfer from other Institutes: Depending on the feasibility and availability a maximum of four credits can be completed by the student in any of the national or reputed institutes/organizations/companies/ industries (HOST). For this a student has to complete a minimum number of 15 interactive hours (not necessarily only teaching) with assigned faculty from Host. It may be 3-4 interactive hours in a day and the necessary certificate in this regard shall be issued by HOST faculty. The Director of the school can fix this credit transfer mechanism with mutual consent/understanding form any host institute. After completion of minimum required interactive/teaching hours at the chosen institute the Host has to provide course completion certificate with a grade. The assessment will be made by the concerned faculty of the host and one faculty/Director of the concerned school (Parent) and performance grade and marks will be allotted. The same marks shall be sent to university examination section along with other marks for declaration of the results by the concerned school.

5. **Examination/Evaluation Rules**

The evaluation of the student will be mainly on

1. **Continuous Internal Assessment (CIA) and**
2. **End Semester Assessment (ESA).**

The ratio of CIA and ESA is 50:50

Passing Rules:

The CIA and ESA shall have different passing heads and Minimum passing:- 40% of passing for each subject in each head. To pass the degree program, a

student will have to obtain a minimum aggregate of 40% marks (C+ and above in grade point scale) in each course.

Assessment:

Continuous Internal Assessment (CIA):

CIA aims to assess values, skills and knowledge imbibed by students, internal assessment is to be done by the concerned faculty member, department, school or the centre. **CIA** will be done on a continuous basis during the semester with selected assessment components.

The components selected for CIA may be:

Tests, Quiz, Seminars, Assignments, essay, tutorials,term paper, laboratory work, field work, workshop practice, Comprehensive Viva, Attendance and any other best and innovative assessment practice approved by the School committee. Components of internal evaluation are to have a time frame for completion (by students), and concurrent and continuous evaluation (by faculty members).

The evaluation outcome shall be expressed initially by predetermined marks and latter converted by grades. Minimum Mark for passing in each Paper is 40% for Continuous Internal Assessment **(CIA)**

End Semester Assessment (ESA): This is to be carried out at the end of each semester, and will aimto assess skills and knowledge acquired by the students through classroom instruction, fieldwork, and laboratory work and/or workshop practice. The End Semester Assessment (ESA) is based on written examination. These examinations shall be at the end of each semester.

Integration of CIA and ESA: A student failed in CIA shall have to appear for ESA again in thatparticular paper. In a particular paper if a student failed in internal (CIA), he deemed to be failed in that course and he has to reappear for CIA and ESA irrespective of the marks he got in ESA. If a student passed in CIA and failed in ESA, the student needs to appear for ESA only in his next attempt and the CIA marks shall be carried.

A candidate who does not pass the examination in any course(s) shall be permitted to appear in such failed course(s) in the subsequent examinations to be held in winter/summer season. However the student has to clear the course in the prescribed maximum period for that course.

CIA marks will not change. A student cannot repeat CIA. In case s/he wants to repeat CIA, then s/he can do so only by registering the said course during the semester in which the course is conducted and up to 4 years (2 years program) as the case may be, provided the student was failed in that course. Students who have failed in a course may reappear for the ESA only twice in the subsequent period. If student fail to acquire required Credits within four years from admission period, such student has to acquire Credits with prevailing / revised syllabus at that time. After that, such students will have to seek fresh admission

as per the admission rules prevailing at that time.
A student cannot register for the third/fourth semester, if she/he fails to complete 75% credits of the total credits expected to be ordinarily completed within two semesters.
While marks will be given for all examinations, they will be converted into grades. The semester end grade sheets will have only grades and final grade sheets and transcripts shall have grade points average and total percentage of marks (up to two decimal points).

6. Assessment and Grade point average:

1. The system of evaluation will be as follows: Each CIA and ESA will be evaluated in terms of marks. The marks for CIA and ESA will be added together and then converted into a grade and later a grade point average.
2. Results will be declared for each semester.
3. After the completion of minimum number of credits of a program, a student will get a grade sheet with total grades earned and a grade point average.

7. Marks/Grade/Grade Point:

i) Table 1: Conversion of marks to grades in credit system

Marks Obtained	Grade	Grade Points
100-90	S	10
89-80	O	09
79-70	A+	08
69-60	A	07
59-55	B+	06
54-45	B	05
44-40	C+	04
39 and Less FC	FC	0 (Fail but Continue)
39 and Less (Internal)	FR	0 (Fail and Repeat the course)

ii) A student who passes the internal tests but fails in Term End Examination of a course shall be given FC grade. Student with FC grade in a course would be granted credit for that course but not the grade for that course and shall have to clear the concerned course within 1.5 year from appearing for first time in the concerned paper, provided the number of courses with FC and FR grades together is 25% or less of the courses of that semester, failing which he/she shall be disqualified for a credit and will have to opt for another credit.

iii) Student who has failed in the internal tests of a course shall be given FR grade and shall have to repeat the concerned course to qualify to appear for term end examination of that course. The grade FC and FR will be taken into consideration while calculating Semester Performance Index (SPI). It shall be replaced only when student clears the course with passing grade within 1.5 year from appearing for first time in the concerned semester.

iv) Grade points earned in each paper shall be calculated as- Grade points obtained (vide Table 1 above) X Credits for the paper.

Maximum grade points that can be earned in a semester are 100.

The Semester Performance Index (SPI) gives weighted performance index of a semester with reference to the credits of a course. The SPI shall be calculated as- SPI = Total Earned Grade Pointes (as given above) for the Semester
Total Credits for the semester

7.5 The total grade point earned in each course shall be calculated as:
Grade point obtained as shown in table -1 **X** Credits for the Course

7.6 SemesterGrade Point Average (SGPA): The performance of the student in a semester is indicated by number called SGPA. It shall be calculated as follows:

$$SGPA = \frac{\sum_{i=1}^{n} c_i p_i}{\sum_{i=1}^{n} c_i}$$

Where C_i = The number of Credits earned in the i^{th} course of a semester for which SGPA is to be calculated.

p_i = Grade point earned in the i^{th} course.

i = 1,2,3,4,……..n represent the number of courses in which a student is registered in the concerned semester.

That is

$$SGPA = \frac{\text{Total earned grade point for the semester}}{\text{Total credits for the semester}}$$

7.7 Final result:

The final marls after assessment will be submitted by the respective schools to the controller of Examination for finalization of the results. Up to date assessment of the overall performance of a student from the time of his / her first registration is obtained by calculating a number is called as Cumulative Grade Point Average (CGPA), which is weighted average of the grade points obtained in all courses registered by the student since he / she entered the department.

$$CGPA = \frac{\sum_{j=1}^{m} c_j p_j}{\sum_{j=1}^{m} c_j}$$

Where C_j= The number of Credits earned in the j^{th} course up to the semester for which CGPA is to be calculated.

p_j = Grade point earned in the j^{th} course.
j = 1, 2, 3, 4…m represent the number of courses in which a student is registered up to the semester for which the CGPA is to be calculated.

- **Final Grade: Table -2**

CGPA	Grade
09.00-10.00	S: Super
08.00-08.99	O : Outstanding
07.50-07.99	A+: Excellent
07.00-07.49	A: Very Good
06.00-06.99	B+: Good
05.00-05.99	B: Satisfactory
04.00 -04.49	C+: Pass
00.00-03.99	F: Fail

7.8 'B+' Grade is equivalent to at least 55% of the marks as per circular No. UGC- 1298/ [4619] UNI- 4 dated December 11, 1999.

7.9 " A" Grade is equivalent to first class

7.10 If the (C) GPA is higher than the indicated upper limit in the three decimal digit, then higher final grade will be awarded (e.g. a student getting (C)GPA of 3.992 may be awarded 'C+' grade).

7.11 For grade improvement a student has to reappear for End Semester Examination (ESE) after the successful completion of the course for a minimum 20 credits in case of Science, Technology, Management and Pharmacy, 20 credits for other faculties and 12 credits in case of one year degree program. These courses will be from the parent Department (core subject). A student can appear only once for the Grade Improvement Program only after the successful completion of UG / PG Degree program and at the end of the next academic year after completion of the Degree and within two years of completion of the Degree.

7.12 The formula for CGPA will be based on Weighted Average. The final CGPA will not be printed unless a student earns minimum 100 credits, 80 credits or 64 credits, as the case may be, from the courses at UG / PG programs.

7.13 If a student failed to obtain a grade other than F in a course then such a course will not betaken into account for calculating CGPA and overall grade. In fact, all the courses in which a student has passed will be taken into account for calculating the CGPA and overall grade.

8. Norms & Procedure for Extra Credit Benefit for NSS or Sports Participation:

The following table shows the grades along with grade point to be given to the students participating in the NSS / Sports activities:

The student should avail the only one benefit neither from NSS or Sport activities.

Maximum addition of Grade point = 0.200

Sr. No.	Event	Specification	Grade point
1	NSS Performance	2 Year regular Programme [240 hrs work + Blood donation + Camp (State / National Level)]	0.200
2	Sports Performance	Intercollegiate : I /II /III	0.150
		Inter- University : I /II /III or Participation	0.200

Swami RamanandTeerthMarathwada University, Nanded
School of Mathematical Sciences

Department of Mathematics

Vision:

The Department of Mathematics aspires to the highest standards of excellence in teaching and research and strives to earn regional recognition for its expertise in the field of Mathematics.

Mission:

- To make sure that the courses are taught at a high standard and meet the needs of those programs
- To provide students a wide spectrum of courses and to offer them a rigorous training that enables them to pursue research /work in jobs that require a high degree of mathematical skills
- To make the students capable of discharging professional, social and economical responsibilities ethically.

M.A. / M.Sc. Mathematics

(2 years program)

Program Educational Objectives:

PEO1: To provide students Mathematical knowledge so that they are able to work as professionals in the subject.
PEO2: To prepare them to go for higher studies and pursue research
PEO3: To train students to handle the problems faced by industry through Mathematical knowledge and scientific computational techniques.
PEO4: To introduce the fundamentals of Mathematics to strengthen the students' logical and analytical ability.

PROGRAMME OUTCOMES (PO):

After the completion of the program, students will able to:

PO1: Pursue research in reputed institutions and solve the existing mathematical problems using the knowledge of pure and applied mathematics.

PO2: Acquire the **s**trong foundation of basic concepts which will benefit them to become good academicians.

PO3: Apply the concept of mathematical tools to address real life problems

PO4: Gain the knowledge of software which will be useful in Research and Industry

PO5: Qualify various competitive exams like CSIR-UGC NET, SET, GATE, MPSC, UPSC, etc

PROGRAM SPECIFIC OUTCOMES (PSO):

PSO 1: To imbibe problem-solving and computational skills

PSO 2: To understand the motivation behind the statements and proofs

PSO 3: To enhance self learning and improve own performance.

PSO 4: To inculcate abstract mathematical thinking.

Structure of the program: M.A./ M.Sc. Mathematics

SEMESTER-I

Course. No.	Course	Course Title	Theory/ Practical Paper	No. of Credits	Marks@ 25/Credit	Internal Component (50%)	Semester End Component (50%)	Grand Total
MATHC-101	Core I	Group Theory	**L/T**	**4**	**100**	**50**	**50**	**100**
MATHC-102	Core II	Real Analysis	**L/T**	**4**	**100**	**50**	**50**	**100**
MATHC-103	Core III	Complex Analysis	**L/T**	**4**	**100**	**50**	**50**	**100**
MATHC-104	Core IV	Ordinary Differential Equations	**L/T**	**4**	**100**	**50**	**50**	**100**
Elective (Intra/ Inter) (4 credits)	Choose any one	MATHE-105 Advanced Discrete Mathematics	**L/T**	**4**	**100**	**50**	**50**	**100**
		MATHE-106 Probability and Statistics	**L/T**	**4**	**100**	**50**	**50**	**100**
		One course from any campus school or online courses offered by Swayam, NPTEL, etc	**L/T**	**4**	**100**	**50**	**50**	**100**
MATHP-107	Practical I	Latex Typesetting	**p**	**3**	**75**	**25**	**50**	**75**
Elective (Intra/ Inter) (2 credits)	Choose any one	MATHOE-01 R Computing-1 (Intra/inter)	**L/T**	**2**	**50**	**25**	**25**	**50**
		One course from any campus school or online courses offered by Swayam, NPTEL, etc	**L/T**	**2**	**50**	**25**	**25**	**50**
		Total						**625**

Courses offered for other campus schools:

1. Advanced Discrete Mathematics (4 credits)
2. Probability and Statistics (4 credits)
3. R Computing-1 (2 credits)
4. Mathematical Software-I (2 credits)

SEMESTER-II

Sr. No.	Course	Course Title	Theory/ Practical Paper	No. of Credits	Marks@ 25/Credit	Internal Component (50%)	Semester End Component (50%)	Grand Total
MATHC-201	Core I	Linear Algebra	**L/T**	**4**	**100**	**50**	**50**	**100**
MATHC-202	Core II	Measure and Integration	**L/T**	**4**	**100**	**50**	**50**	**100**
MATHC-203	Core III	Topology	**L/T**	**4**	**100**	**50**	**50**	**100**
MATHC-204	Core IV	Partial Differential Equations	**L/T**	**4**	**100**	**50**	**50**	**100**
Elective (Intra/ Inter) (4 credits)	Choose any one	MATHE-205 Elementary Number Theory	**L/T**	**4**	**100**	**50**	**50**	**100**
		MATHE-206 Graph Theory	**L/T**	**4**	**100**	**50**	**50**	**100**
		One course from any campus school or online courses offered by Swayam, NPTEL, etc	**L/T**	**4**	**100**	**50**	**50**	**100**
MATHP-207	Practical II	Introduction to Scilab	**p**	**3**	**75**	**25**	**50**	**75**
Elective (Intra/ Inter) (2 credits)	Choose any one which is not taken in first semester	MATHOE-02 R Computing-2 (Intra/inter)	**L/T**	**2**	**50**	**25**	**25**	**50**
		One course from any campus school or online courses offered by Swayam, NPTEL, etc	**L/T**	**2**	**50**	**25**	**25**	**50**
		Total						**625**

Courses offered for other campus schools:

1. Elementary Number Theory (4 credits)
2. Graph Theory (4 credits)
3. R Computing-2 (2 credits)
4. Mathematical Software-II (2 credits)

M.Sc. (Mathematics)-II year (CBCS Pattern)

SEMESTER-III

Course. No.	Course	Course Title	Theory/ Practical Paper	No. of Credits	Marks@ 25/Credit	Internal Component (50%)	Semester End Component (50%)	Grand Total
MATHC-301	Core I	Rings and Modules	L/T	4	100	50	50	100
MATHC-302	Core II	Functional Analysis	L/T	4	100	50	50	100
Elective Group III (MATHE 303 to MATHE 311- any three)								
Choose any three (4 credits)	MATHE-303	Fractional Calculus	L/T	4	100	50	50	100
	MATHE-304	Operations Research-I	L/T	4	100	50	50	100
	MATHE-305	Analytic Number Theory	L/T	4	100	50	50	100
	MATHE-306	Numerical Analysis	L/T	4	100	50	50	100
	MATHE-307	Coding Theory	L/T	4	100	50	50	100
	MATHE-308	Riemannian Geometry	L/T	4	100	50	50	100
	MATHE-309	Algebraic Topology	L/T	4	100	50	50	100
	MATHE-310	Representation Theory of Finite Groups	L/T	4	100	50	50	100
	MATHE-311	Difference Equations	L/T	4	100	50	50	100
	one course from any campus school or online courses offered by Swayam, NPTEL, etc		L/T	4	100	50	50	100
MATHP-312	Practical III	Introduction to SageMath	p	3	75	25	50	75
Elective (Intra/ Inter) (2 credits)	Choose any one which is not taken in first year	MATHOE-03 R Computing-1 (Intra/inter)	L/T	2	50	25	25	50
		One course from any campus school or online courses offered by Swayam, NPTEL, etc	L/T	2	50	25	25	50
		Total						**625**

Courses offered for other campus schools:

1. Coding Theory (4 credits)
2. Operations Research-I (4 credits)
3. Numerical Analysis (4 credits)
4. Mathematical Software-III (2 credits)

SEMESTER-IV

Course. No.	Course	Course Title	Theory/ Practical Paper	No. of Credits	Marks@ 25/Credit	Internal Component (50%)	Semester End Component (50%)	Grand Total
MATHC-401	Core I	Galois Theory	**L/T**	**4**	**100**	**50**	**50**	**100**
MATHC-402	Core II	Integral Equations and transforms	**L/T**	**4**	**100**	**50**	**50**	**100**
Elective Group III (MATHE 403 to MATHE 410- any three)								
Choose any three (4 credits)	MATHE-403	Lie Groups and Lie Algebra	**L/T**	**4**	**100**	**50**	**50**	**100**
	MATHE-404	Algorithms and their analysis.	**L/T**	**4**	**100**	**50**	**50**	**100**
	MATHE-405	Algebraic Geometry	**L/T**	**4**	**100**	**50**	**50**	**100**
	MATHE-406	Classical Mechanics	**L/T**	**4**	**100**	**50**	**50**	**100**
	MATHE-407	Theory of Relativity	**L/T**	**4**	**100**	**50**	**50**	**100**
	MATHE-408	Cryptography	**L/T**	**4**	**100**	**50**	**50**	**100**
	MATHE-409	Algebraic Number Theory	**L/T**	**4**	**100**	**50**	**50**	**100**
	MATHE-410	Operations Research-II	**L/T**	**4**	**100**	**50**	**50**	**100**
	MATHE-411	Multivariate Calculus	**L/T**	**4**	**100**	**50**	**50**	**100**
	MATHE-412	Commutative Algebra	**L/T**	**4**	**100**	**50**	**50**	**100**
	one course from any campus school or online courses offered by Swayam, NPTEL, etc		**L/T**	**4**	**100**	**50**	**50**	**100**
MATHC-413	Core Project	Project Work	**p**	**4**	**100**	**50**	**50**	**100**
MATHC-414	Seminar	Seminar	**L/T/P**	**1**	**25**	**--**	**25**	**25**
		Total						**625**

Courses offered for other campus schools:

1. Cryptography (4 credits)
2. Operations Research-II
3. Algorithms and their analysis (4 credits)

NOTE:

- Each semester will have five Theory papers and each theory paper will be of 100 Marks [50 External Exam+ 50 Internal Exam (02 tests each of 15 Marks+20 Marks for class performance)].
- Each Practical course will be of 75 marks [50 External Exam + 25 Internal Exam (1 test of 15 marks+ 10 marks for record and class performance)].
- Project course will be of 100 marks
- Each Seminar course will be of 25 marks [External].
- All the Practicals and Seminar courses are compulsory to all the students.
- Each semester is of 625 marks.
- Total marks for I sem+ II sem+ III sem + IV sem = 2500.
- Total degree is of 2500 Marks, converted in the form of 100 credits CBCS system.
- One credit is of 25 marks.
- Minimum 40% Marks are required for passing in each of the above head i.e. separate passing in External Exam and that in Internal Exam.
- Project/ Practical will be evaluated by one external examiner and one internal examiner.
- Project work will be commencing from Semester III and the final work & report will be completed during Semester IV. The marks & the credits will be allotted in semester IV.
- Students can opt at most 04 credits per semester and 08 credits per programme from outside the school.
- Maximum no of periods per paper is 60.

M.Sc. Mathematics Syllabus

Semester-I

MATHC- 101: Group Theory

Course Objective:
To introduce the concepts and to develop working knowledge on Groups, so that strong foundation for subsequent algebra courses can be developed.

Course Outcomes:
Upon successful completion of this course, students will able to
CO1: Verify group properties, study cyclic groups.
CO2: Decide whether given two groups are isomorphic or not.
CO3: Understand solvability of groups.
CO4:Gain command over Sylow theorems and thereby simplicity of groups.

Prerequisites: Introduction to Groups, Definition and Examples, Elementary properties of Groups, Finite Groups and Subgroups, Subgroup Tests, Examples of Subgroups).
Unit I: Cyclic Groups, Properties of Cyclic Groups, Classification of Subgroups of Cyclic Groups, Permutation Groups, Definition and Notation, Cycle Notation, Properties of Permutations, A Check-Digit Scheme Based on D5. (12L+3T)
Unit II: Isomorphisms, Definition and Examples, Cayley's Theorem, Properties of Isomorphisms, Automorphisms, Cosets and Lagrange's Theorem, An Application of Cosets to Permutaion Groups, External direct products, Normal Subgroups, Factor Groups, Application of Factor Groups. (12L+3T)
Unit III: Conjugacy and G-sets: Group action, G-set and examples, orbit of an element and their properties, Conjugates. Normal series, Solvable groups and Nilpotent groups. (12L+3T)
Unit IV: Internal Direct Product, Group Homomorphisms and their properties, The First Isomorphism Theorem, The Fundamental Theorem, Isomorphism Classes of Abelian Groups, Proof of Fundamental Theorem, The Class Equation, The Sylow Theorem. (12L+3T)

Text Books:

1. J. A. Gallian, Contemporary Abstract Algebra, Fourth edition, Narosa Publishing House.
Scope: For Unit –I, II, and IV : Chapter 4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,24.
2. P. B. Bhattacharyya, S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra (2e), Cambridge Univ. Press, Indian Edition, 1997.
Scope: For Unit-III: Articles 5.4, 6.1, 6.2 and 6.3.

Reference Books:
1. D. S. Dummit and R. M. Foote, Abstract Algebra, 2nd Ed., John Wiley, 2002.
2. M. Artin, Algebra, Prentice-Hall of India Pvt. Ltd.
3. I.N. Herstein, Topics in Algebra, Macmillan, Indian Edition.
4. J. B. Fraleigh, Abstract Algebra, 5th Edition.
5. I.S. Luthar, I. B. S. Passi, Algebra, Vol. 1, Groups, Narosa Publishing House.
6. N. Gopalakrishnan, University Algebra, New Age International.

MATHC-102: Real Analysis

Course Objective(s): To learn the concepts of basic topological objects such as open sets, closed sets, compact sets and the concept of sequence of functions, Arzela - Ascoli Theorem

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Attain mastery in Archimedean property, LUB axioms, and Sequence of real numbers

CO2: Acquire the knowledge of Open, closed, and connected sets and continuous functions

CO3: Study Compact metric space , Uniform Continuity, Continuous functions on Compact domains

CO4: Study in detail sequence of functions, Arzela - Ascoli Theorem

Unit-I: Real Number System, LUB axiom, Archemedian property. Equivalent Sets, countable and uncountable sets, Sequences of real numbers, convergent sequence, subsequence, monotonic sequence, Cauchy sequence, limsup, liminf. Metric spaces, Limits in Metric spaces. (12L+3T)

Unit-II: Open sets, closed sets, The Relative Metric, Continuous Functions, Homeomorphisms, The Space of Continuous Functions, Connected sets, Totally Bounded Sets, Complete Metric Spaces, Fixed Points, Completions. (12L+3T)

Unit-III: Compact Metric Spaces, Uniform Continuity, Continuous functions on Compact domains, Equivalent Metrics, Discontinuous Functions, Baire Category Theorem. (12L+3T)

Unit-IV: Sequence of functions, point wise and uniform convergence, Interchanging limits, The space of Bounded Functions, The Weierstrass theorem, equicontinuous family of functions, Arzela - Ascoli Theorem. (12L+3T)

Text Book: N.L. Carothers, Real Analysis, Cambridge University Press.

Scope: Chapters 1 to 11.

REFERENCES:

1. Ajit Kumar and S. Kumaresan, Basics of Real Analysis, CRC Press.
2. W. Rudin, Principles of Mathematical Analysis.
3. C. C. Pugh, Real Mathematical Analysis.
4. S. Kumaresan, Topology of Metric Spaces, Narosa Publishing House.
5. T. M. Apostol, Mathematical Analysis, Narosa Publishing House.
6. Sudhir R. Ghorpade and Balmohan V. Limaye, A Course in Calculus and Real Analysis, Springer Publications.

MATHC 103 - Complex Analysis

Course Objectives:

This course is aimed to provide an introduction to the theories for functions of a complex Variable. Some of the objectives of the course is to study and understand the topics like Cauchy–Riemann Equations, Cauchy Integral Formula and its applications, Poles and residues, Mobius Transformation.

Course Outcomes:

Upon successful completion, students will have the knowledge and skills to:

CO1: Explain the concepts of C-R Equations, Analytic Functions, and Elementary Functions.
CO2: Construct the proofs of Cauchy Integral Formula, Liouvellis Theorem, and solve problems related to Taylor and Laurent series.
CO3: Identify different types of singularities, zeros of analytic function, Evaluate improper integrals and apply the Rouche'stheorem to solve the problems.
CO4: Understand Mobius Transformation and mappings of regions under some special transoframtions.
Pre requisites: Sums and Products of complex numbers, Basic Algebraic Properties, Vectors and Moduli, Complex Conjugates, Exponential Form, Products and Powers in Exponential Form, Arguments of Products and Quotients, Roots of Complex Numbers, regions in the complex plane.
Unit I: Functions of a Complex Variable, Mappings, Limits, Theorems on Limits, Limits Involving the Point at Infinity, Continuity, Derivatives, Cauchy–Riemann Equations, Sufficient Conditions for Differentiability, Polar Coordinates, Analytic Functions, Harmonic Functions, Uniquely Determined Analytic Functions, Reflection Principle, The Exponential Function, The Logarithmic Function, Branches and Derivatives of Logarithms, Complex Exponents, Trigonometric Functions, Hyperbolic Functions, Inverse Trigonometric and Hyperbolic Functions. **(12L +3T)**
Unit II: Derivatives of Functions, Definite Integrals of Functions, Contour Integrals, Branch Cuts,Upper Bounds for Moduli of Contour Integrals, Antiderivatives, Cauchy–Goursat Theorem, Simply Connected Domains, Cauchy Integral Formula, Liouville's Theorem and the Fundamental Theorem of Algebra, Maximum Modulus Principle, Convergence of Sequences and series, Taylor Series, Laurent Series, Absolute and Uniform Convergence of Power Series**.** **(12L +3T)**
Unit III: Isolated Singular Points, Residues,Cauchy's Residue Theorem,Residue at Infinity, The Three Types of Isolated Singular Points, Residues at Poles,Zeros of Analytic Functions, Zeros and Poles, Behaviour of functions near isolated singular points, Evaluation of Improper Integrals, Jordan's Lemma, Definite Integrals Involving Sines and Cosines, Argument Principle, Rouch´e's Theorem. **(12L +3T)**
Unit IV: Linear Transformations, The Transformation w = 1/z, Mappings by 1/z, Linear Fractional Transformations, An Implicit Form, Mappings of the Upper Half Plane, The Transformation w = sin z, Mappings by z2 and Branches of z1/2 . (12L +3T)

Textbook:
R.V.Churchill and J.W.Brown, Complex Variables and Applications (eighth edition), McGraw Hill Publication
Scope : Prerequisites- Chapter 1
Unit 1 – Chapter 2 and 3
Unit 2 - Chapter 4(excluding multiply connected domains) and Chapter 5(excluding continuity of sums of power series, integration and differentiation of power series, multiplication and division of power series)
Unit 3 - Chapter 6 and Chapter 7(excluding improper integral from Fourier Analysis, indented paths, integration along branch cuts, inverse Laplace transforms)
Unit 4 – Chapter 8 (excluding square roots of polynomials, Riemann surfaces)
References:
1) Foundation of Complex Analysis- S.Ponnusamy, Narosa Publication, Second Edition.
2) Functions of one Complex Variable - John B. Convey, Narosa Publishing House.
3) Complex Analysis - L. V. Ahlfors, McGraw Hill.
4) Functions of Complex Variables - H.Silverman
5) Complex Analysis - T.W.Gamelin, Springer Publications.

MATHC-104: Ordinary Differential Equations

Course Objectives: The aim of the course is to introduce various methods to solve first order differential equations. Also to study qualitative properties such as existence and uniquesness of their solutions.

Course Outcomes:

On successful completion of this course, the student will be able to:
CO1: Solve first order differential equations.
CO2: Identify and solve homogeneous and non homogeneous differential equations with variable coefficients.
CO3: Study the existence and uniqueness of solutions
CO4: Analyse system of differential equations

Unit I: Linear equations of first order, The second order homogeneous equation, initial value problems, Linear dependence and independence, A formula for the Wronskian, The homogeneous equation of order n, The non-homogeneous equation of order n, special method for solving non-homogeneous equation. **(12L +3T)**
Unit II: Linear equations with variable coefficients, Initial value problem, solution of the homogeneous equation, Wronskian and linear independence, reduction of order of a homogeneous equation, Non-homogeneous equation, Homogeneous equations with analytic coefficients, The Legendre equation, The Euler equation, second order equation with regular singular points, The Bessel equation. **(12L +3T)**
Unit III: Equations with variables separated, exact equation, The method of successive approximations, The Lipschitz condition, convergence of successive approximations, Non-local existence of solutions, approximations to and uniqueness of the solutions. **(12L +3T)**

Unit IV: Some special equation, complex n-dimensional space, system as vector equations, existence and uniqueness of solution to systems, existence and uniqueness of solution for linear systems, equations of order n. **(12L +3T)**

Textbook:-
E. A. Coddington, An Introduction to Ordinary Differential Equation, Prentice-Hall of India Pvt. Ltd., New Delhi.
Scope: chapter 1 to 6

References :-
1] G. F. Simmons, Differential Equations with Applications and Historical Notes, (2nd edition) McGraw Hill Book Co.
2] G.Birkhoff and G.C.Rota, Ordinary Differential Equations, John Wiley and Sons.

MATHE - 105: Advanced Discrete Mathematics

Course Objectives:

The mission of the course is to study objects that are of discrete nature. Understand the application in real life communication models, computer sciences, electronic circuits .

Course Outcomes:

On successful completion of this course, the student will be able to:

CO1: Understand Formal Logic, Prepositional Logic, Semi groups and Monoids, Congruence relation
CO2: Study Complemented and Distributive Lattices.
CO3: Analyse Boolean Algebras
CO4: Apply Boolean algebra to switching theory

Unit I: Formal Logic: Statements, Symbolic Representation and Tautologies, Quantifiers, Predicates and validity, PrepositionalLogic. Semi groups and Monoids: Definitions and example of Semigroups and Monoids (including those pertaining to concatenation operations) Homomorphism of semigroups and monoids, Congruence relation and quotient semigroups, Subsemigroup and submonoids, Direct product, Basic Homomorphism Theorem. **(12L+3T)**
Unit II: Lattices: Lattices as partially ordered sets, their properties. Lattices as algebraic systems.Sublattices, Direct products and Homomorphisms, Some special lattices e. g. complete.Complemented and Distributive Lattices. **(12L+3T)**
Unit III: Boolean Algebras: Boolean Algebras as Lattices, Various Boolean Identities, The switching Algebra. Example, subalgebras, Direct Products and Homomorphisms, Join-irreducible elements. Atoms and Minterms, Boolean forms and their equivalence, Minterm Boolean forms, Sum of Products, Canonical forms. **(12L+3T)**
Unit IV: Minimization of Boolean functions, Applications of Boolean Algebra to Switching Theory (using AND, OR and NOT gates) The Karnaugh Map method. **(12L+3T)**

Reference Books:

1. J. P. Trembley and Manohar, Discrete Mathematical Structures with applications to Computer Science, McGraw-HillBookCo.1997.
2. Seymour Lipschutz, Finite Mathematics(International edition1983), McGraw-Hill Book
3. S.Wiitala, Discrete Mathematics-A Unified Approach, McGraw-Hill Book Co. New York.
4. J. L. Gersting, Mathematical Structures for Computer Science, (3rdedition).

MATHE-106: Introduction to Probability

Course Objectives:

The focus of this course is to study the concepts like Axioms of Probability, Conditional probability, Random Variables, Distribution functions, types of random variables with examples and their properties, inequalities, modes of convergences, Law of Large Numbers.

Course Outcomes:

Upon successful completion, students will have the knowledge and skills to:

CO1: Solve the problems using Baye's formula and identify independent events.
CO2: Able to identify the correct distribution to the real life problem
CO3: Explain joint distributions and derive the marginal distributions. Find the expectation, variance, MGF of random variables.
CO4: Apply inequalities and law of large numbers to solve real life problems

Unit I: Sets and classes, limit of a sequence of sets, fields, sigma-fields, monotone classes. Sample Space and Events, Axioms of Probability, Sample Spaces Having Equally Likely Outcomes, Conditional Probabilities, Bayes Formula, Independent Events. **(12L+3T)**
Unit II: Random Variables, Distribution Functions, Discrete Random Variables, Expected Value, Expectation of a Function of a Random Variable, Variance, Discrete distributions: uniform, binomial, geometric, negative binomial, hyper geometric, Poisson. Continuous distributions: uniform, exponential, gamma, Weibull, beta, normal, Cauchy. **(12L+3T)**
Unit III: Joint Distribution Functions, Independent Random Variables, Sums of Independent Random Variables, Conditional Distributions: Discrete Case and Continuous Case, Joint Probability Distribution of Functions of Random Variables. Expectation of Sums of Random Variables, Covariance, Variance of Sums, and Correlations, Conditional Expectation, Moment Generating Functions, Joint Moment Generating Functions.**(12L+3T)**
Unit IV: Problems on Chebyshev's and other inequalities, Modes of Convergence, Weak Law of Large Numbers, Strong Law of Large Numbers, Central Limit Theorem. **(12L+3T)**
Text Books:

[1] Sheldon Ross, A First Course in Probability, PRENTICE HALL India.

[2] VIJAY K. ROHATGI, A. K. MD. EHSANES SALEH, An Introduction to Probability and Statistics, second edition, Wiley series.

Reference Books:

1. Murray R. Speigel, Schaum's Outline of Probability and Statistics.
2. J.S. Milton & J.C. Arnold, Introduction to Probability and Statistics.
3. H.J. Larson , Introduction to Probability Theory and Statistical Inference.
4. S.M. Ross , Introduction to Probability and Statistics for Engineers and Scientists.
5. P. Halmos , Measure Theory (for algebra of sets)
6. Feller, W., Introduction to Probability Theory and its Applications, 3rd Ed., Wiley Eastern, 1978.
7. PrakashRao, B.L.S., A First Course in Probability and Statistics, World Scientific, 2009.

MATHC-107: LaTeX Typesetting

Course Objectives:

The objective of this course is to introduce latex for research paper preparation, project, book etc and beamer for beautiful presentations.

Course Outcomes:

Upon successful completion, students will have the knowledge and skills to:

CO1: Install Latex and execute small documents
CO2: Typeset any type of document which involve more math
CO3: Prepare presentation using beamer class and create handouts from it.

Unit I: Introduction to LaTeX, Installation of LaTeX, Layout Design, LaTeX input files, Input file structure, document classes, packages, environments, page styles, Typesetting texts, Fancy Header, tables.

Unit II: Inline math formulas and displayed equations,Math symbols and fonts, Delimeters, matrices, arrays, Typesetting Mathematical formulae: fractions, Integrals, sums, products, etc. Producing Mathematical Graphics.

Unit III: Document classes for paper writing, thesis, books, etc. Table of contents, index, bibliography management, hypertext, pdfpages, geometry, fancy header and footer, Verbatim, itemize, enumerate, boxes, equation number. Beamer class, beamer theme, frames, slides, pause, overlay, transparent, handouts and presentation mode.

Reference Books:

1. LATEX Tutorials A Primer, Indian TEX Users Group, Trivandrum, India, 2003 September.
2. Learning LATEX by Doing, Andre Heck, 2002.
3. Latex beginners guide, Stefan Kottiwitz
4. The Latex companion, M. Carter, B.vanBrunt, second edition, Addison wisely, Pearson Education.

Semester-II

MATHC -201: Linear Algebra

Course Objective:

This course is aimed to provide an introduction to the theories, concepts and to develop working knowledge of vector spaces, linear transformations and canonical forms.

Course Outcomes:

Upon successful completion of this course, students will able to
CO1: Assimilate the concept of linear dependence, basis etc.
CO2: Analyse properties of linear transformations, their matrices etc.
CO3: Study eigen value, eigen vectors of linear transformation.
CO4: Understand geometric properties via study of inner product spaces. Develop knowledge of canonical forms.

Pre-requisites: Basic theory of fields, Field extension, Examples, matrices, determinants, polynomials. Elementary Matrix Operations and elementary matrices, the rank of a matrix, System of linear equations-Theoretical Aspects, System of linear equations-Computational Aspects.

Unit I: Vector spaces: Introduction, Vector spaces, subspaces, Linear combinations and system of linear equations, linear dependence and independence, Bases and dimension, Maximal Linear Independent Subsets. **(12L+3T)**

Unit II: Linear Transformations and Matrices: Linear Transformations, Null spaces, and ranges, the matrix representation of a linear transformation, Composition of linear transformations, Invertibility and Isomorphisms, The change of Coordinate matrix, Dual spaces, and Homogeneous linear Differential equations with constant coefficients. **(12L+3T)**

Unit III: Diagonalization: Eigen values and eigen vectors, Diagonalizabity, Invariant Subspaces and the Cayley-Hamilton Theorem. **(12L+3T)**

Unit IV: Inner Product Spaces: Inner products and Norms, The Gram-Schmidt orthogonalization process and orthogonal complements, the adjoint of a linear operator, Normal and self-adjoint operators, Unitary and orthogonal operators and their matrices, orthogonal projections and the spectral theorem, Quadratic forms. Jordan Canonical form I, Jordan Canonical form II, The minimal polynomial, Rational Canonical form. **(12L+3T)**

Text Book:S.H.Friedberg, A.J.Insel, L.E.Spence: Linear Algebra, Prentice-Hall International, Inc., 3rd Edition.

Scope: Ch 1: Art.1.1 to 1.7, Ch 2:Art. 2.1 to 2.7, Ch 3:Art 3.1 to 3.4, Ch 5: Art 5.1,5.2,5.4, Ch 6:Art 6.1 to 6.7, Ch 7 : Art 7.1 to 7.4 .

Reference Books:

1. VivekSahai, VikasBist, Linear Algebra, Narosa Publishing House, 2nd Edition.
2. I. N. Herstein, Topics in Algebr, Macmillan, Indian Edition.

3. S.Lang, Introduction to Linear algebra, Springer International Edition,2nd Edition.
4. K.Hoffman,R.Kunze, Linear Algebra. Prentice Hall of India.
5. S. Kumaresan, Linear Algebra: A geometric approach, Prentice Hall India Learning Private Limited; New title edition (2000).

MATHC-202: Measure and Integration

Course Objectives:

This course will help to learn basic elements of measure theory such as measurable sets, functions, Lebesgue integration and differentiation. Also understand the concepts of abstract measure theory with the help of classical Banach spaces .

Course Outcome(s):

After completing this course, the student will be able to:

CO1: Gain knowledge of measurable sets and measurable functions

CO2: Acquire mastery on Lebesgue Integral

CO3: Study Differentiation and integration concepts

CO4: Learn Classical Banach spaces and approximation in Lp Spaces

Pre-requisites: Algebra of sets, The axiom of choice and infinite direct products, Open and closed sets of real numbers, continuous functions, Borel sets.

Unit I: Lebesgue measure: Introduction, outer measure, measurable sets and Lebesgue measure, a non measurable set, Measurable functions, Littlewood's three principles. **(12L+3T)**

Unit II: The Lebesgue integral:The Riemann integral, The Lebesgue integral of a bounded function over a set of finite measure, The integral of a nonnegative function, The general Lebesgue integral, convergence in measure. **(12L+3T)**

Unit III: Differentiation and integration:Differentiation of monotone functions, functions of bounded variation, differentiation of an integral, absolute continuity, convex functions. **(12L+3T)**

Unit IV: Classical Banach spaces:The Lp spaces, The Minkowski and Holder inequalities, convergence and completeness. Approximation in Lp .**(12L+3T)**

Text Book: -H. L. Royden: Real Analysis, 3rd Edition, PHI Learning Private Ltd.

Reference Books:

1 N.L. Carothers, “Real Analysis”, Cambridge university press.
2 P.R. Halmos: Measure theory, Narosa Publishing House.
3 InderK.Rana : An Introduction to measure and Integration. Norosa publishing House, Delhi : 1997.
4 G. de. Barra; Measure theory and Integration, Woodhead Publishing, July 2003.
5 P.K. Jain and V.P Gupta : Lebesgue measure and Integrtion , New age international (P) ltd publishing, New Delhi (Reprint 2000.)

MATHC-203: Topology

Course Objectives:

The goal of the course is to provide in depth knowledge of this fundamental core course in mathematics to show various techniques from analysis , set theory , logic that are used in topological spaces to obtain their properties , to demonstrate application in physics.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Understand basics of Topological Spaces
CO2: Study Connected Spaces, Limit Point Compactness, Local Compactness.
CO3: Achieve the zenith in treating Countable Axioms, Separable, Regular and Normal spaces.
CO4: Understand theorems like The Urysohn's Lemma, Urysohn'sMetrization Theorem.

Unit I: Topological Spaces, Basis for Topology, The Order Topology, The product Topology, The Subspace Topology , Closed Sets and Limit Points , Continuous functions, The Metric Topology. **(12L+3T)**

Unit II: Connected Spaces, Connected Subspace on Real Line. Compact Spaces, Compact Subspace on the Real Line, Components and Local Connectedness, Limit Point Compactness, Local Compactness. **(12L+3T)**

Unit III: Countable Axioms: First countable, Second Countable, Separable, Lindelof, Separation Axioms: Regular and Normal spaces. **(12L+3T)**

Unit IV: The Urysohn's Lemma, The UrysohanMetrization Theorem and the Tychonoff Theorem. **(12L+3T)**

Text Book:

James R. Munkres: Topology, A first course, Prentice Hall of India. Pvt. Ltd. New Delhi-2000.

Scope:-

Chapter 2: Articles 12 to 21

Chapter 3: Articles 23, 24, 25, 26, 27, 28, 29

Chapter 4: Articles 30 to 34.

Chapter 5: Article 37

Reference Books:

1. J. DugundjiAllya and Bacon, Topology, (1966) reprinted: Prentice Hall of India.
2. W. J. Pervin: Foundations of general topology, academic press Inc. N.Y. Hi] S. T.Hu: Elements of general topology. Holden day Inc. 1965.
3. Stephen Willard, General Topology, Addison-Wesley Publishing Company, 1970
4. Sheldon W. Davis, Topology (The Walter Rudin Student Series in Advanced Mathematics), TATA McGraw-Hill.2006.

5. Sidney A Morris, Topology without Tears, 2011 Version.
6. S. Kumaresan, Topology of metric spaces, 2nd edition, Narosa, 2011.

MATHC-204: Partial Differential Equations

Course Objectives:

This course aims to introduce classification of partial differential equations and to learn various methods to solve them.

Course Outcomes:

After successful completion of this course, the students will be able to:
CO1: Find solutions of partial differential equations and determine the existence, uniqueness of solution of partial differential equations.
CO2: Classify partial differential equations.
CO3: Find Fourier sine series, Fourier cosine series, Fourier series expansion of various functions like even, odd, periodic, piecewise continuous functions.
CO4: Understand convergence of Fourier series.

Unit I: First order PDE, classification of integrals, Linear equations of first order, Pfaffian differential equations, compatible systems, Charpit's method, Jacobi's method. **(12L+3T)**
Unit II: Classification of second order PDE, one dimensional wave equation, Laplace equation, Theory of Green's function for Laplace equation, Heat conduction problem, Duhamel's principle. **(12L+3T)**
Unit III: Fourier Series: Piecewise Continuous Functions, Fourier Cosine Series, Fourier Sine Series, Fourier series, adaptations to other intervals. **(12L+3T)**
Unit IV: Convergence of Fourier Series: One-Sided Derivatives, A Property of Fourier Coefficients, Two lemmas, A Fourier Theorem, Discussion of the theorem and its corollary, convergence on other intervals, A Lemma, Absolute and Uniform Convergence of Fourier Series, Differentiation of Fourier Series, Integration of Fourier Series. **(12L+3T)**

Text books:

1) T. Amarnath: An elementary course in PDE (2nd edition), Narosa Publishing House.

Scope:
Unit 1 :- Chapter 1(1.1 to 1.8)
Unit 2 :- Chapter 2(2.1 to 2.6)

2) R.V. Churchill and J. Brown.: Fourier Series and Boundary Value Problems, 7th edition, McGraw-Hill Book Company.

References:

1) W.E.Williams:"Partial Differential Equations",Claredon Press Oxford.

2) E.T.Copson:"Partial Differential Equations", Cambridge University Press

3) I.N.Sneddon:"Elements of Partial Differential Equation", McGraw Hill Co

MATHE-205: Elementary Number Theory

Course Objectives:

The aim of the course is to provide foundation and thorough understanding of Divisibility properties, Number theoretic functions and their properties, Linear Congruences, Diophantine Equations, quadratic Congruences etc.

Course Outcomes:

After successful completion of this course, the students will be able to:
CO1: Tackle Division Algorithm, The Euclidean Algorithm, Fundamental Theorem of Arithmetic.
CO2: Handle Theory of Congruences: Chinese Remainder Theorem, Fermat Theorem, Wilson'sTheorem.
CO3: Study Mobius Inversion Formula, different number theoretic functions
CO4: Understand Primitive Roots, Indices and the Quadratic Reciprocity Law, Theory of Indices.

Unit I:Divisibility Theory in the Integers: Division Algorithm, the Greatest common Divisor, The Euclidean Algorithm, The Diophantine Equations ax+by = c, Fundamental Theorem of Arithmetic. **(12L+3T)**
Unit II:Theory of Congruences: Basic Properties of Congruences, Binary and Decimal Representations of Integers, Linear congruence and the Chinese Remainder Theorem. Fermat Theorem: Fermat Little theorem and Pseudo primes, Wilson's Theorem, The Farmat –Kraitchik Factorization Method , The Equation x2+y2= z2 , Fermat's last Theorem. **(12L+3T)**
Unit III: Euler's Generalization of Fermat's Theorem: Sum and Number of divisors, The Mobius Inversion Formula, The greatest Integer function, Euler's Phi- Function, Euler's theorem, Properties of Phi function.**(12L+3T)**
Unit IV:Primitive Roots, Indices and the Quadratic Reciprocity Law: The Order of an Integer Modulo n , Primitive Roots for Primes , Composite Numbers having primitive Roots, Theory of Indices, Euler's Criterion , The Legendre Symbol and its Properties , QuadraticCongruences with Composite Moduli. **(12L+3T)**

Text Book: Elementary Number Theory, By David M. Burton .Tata McGRAW-HILL,2006,
Scope: Chapter 2 to Chapter 9,

Reference Books:

1. A Baker, A concise Introduction to the Theory of Numbers, Cambridge University Press 1984
2. J.P. Serre, A course in arithmetic-. GTM Vol.7, Springer Verlag 1973
3. Tom M. Apostol. ,Introduction to Analytic number theory Narosa Publishing house 1980

4. Niven and Zuckerman, An Introduction to the Theory of Numbers, 4th Ed Wiley, New York,1980,
5. Rosen K.H., Elementary Number Theory and its Applications Pearson AddisionWesely, 5th Edition.

MATHE-206: Graph Theory

Course Objectives:

The objectives of the course are to discuss the concepts of graph, tree and cut set. Discuss the Chinese Postman Problem and Travelling salesman problem. Use an algorithm to produce a plane drawing of a planar graph, know whether some special graphs are planar.

Course Outcomes:

After completion of the course students will able to:
CO1: solve problems involving vertex and edge connectivity
CO2: Use algorithms for finding an Euler trail in a graph for solving the Chinese Postman Problem.
CO3: Model and solve real world problems using graphs and trees, both quantitatively and qualitatively.
CO4: Apply Ford and Fulkerson Algorithm to real life problems

Unit I: Introduction to Graphs: graphs, subgraphs, paths, cycles, matrix representation of a graph, fusion. Trees and connectivity: definition and properties, bridges, spanning trees, cut vertices and connectivity. **(12L+3T)**

Unit II: Euler tour and Hamiltonian cycles, Euler tour, Euler Graph, the Chinese postman problem, Hamiltonian graphs, Travelling salesman Problem. **(12L+3T)**

Unit III: Planar Graphs: planar graphs, Euler's formula, Kuratowski's theorem, Non-Hamiltonian plane graphs, the dual of a plane graph. **(12L+3T)**

Unit IV: Directed graphs and Networks: definitions and properties, Tournaments, Traffic flow, The Ford and Fulkerson Algorithm, Seperating sets. **(12L+3T)**

Textbook:
A First Look at Graph Theory: John Clark and Derek Allan Holton Allied Publishers Ltd.
Chapters:-1, 2, 3,5,7,8

Reference Books:

1. Graph Theory With Applications to Engineering and Computer Science: NarsingDeo, Prentice Hall of India.
2. Graph Theory: F. Harare, Addison Wesley.
3. Introduction to Graph Theory: Douglas B. West, Prentice- Hall, New Delhi (1999)
4. Basic Graph Theory: K. R. Parthasarthy, Tata McGraw- Hill Pub Comp Limited Delhi.

MATHP-207: Introduction to SciLab

Course Objectives:

Scilab, an alternate to MATLAB, is a scientific software package providing a powerful open computing environment for engineering and scientific applications. In this course, different tool boxes like related to plotting, matrices, polynomials, system of equations, etc. will be discussed.

Course Outcomes:

Upon successful completion, students will have the knowledge and skills to:

CO1: Install Scilab and execute looping and branching commands
CO2: Handle matrices and their operations in scilab; Plot and visualize 2D and 3D graphs of various functions
CO3: Demonstrate various tool boxes available in scilab.

Unit I: Introduction to SciLab, Installation of SciLab, Basic elements of the language, Looping and Branching: If, select, for, break, continue, Functions, return, Contour plots, tiles, axes, legends.

Unit II: Matrices: Creating matrices, sum, product of matrices, inverse, rank determinant, comparing matrices,system of equations, High level linear algebra features, working with polynomials, plotting 2D and 3D graphs, defining a function and output arguments.

Unit III: SciLab Demonstrations: Polynomials, discrete and continuous Random variables, Tcl/tk, spreadsheet, GUI: unicontrols, unicontrols with latex. Basic functions, animation, finite elements, Bezier curves and surfaces, matplot, complex elementary functions.Scilab help browser for mathematics.Parametric plots, Polar plots, Matrix Operations, Matrix inversions, Solving system of equations. Evaluation of definite integrals, Generating prime numbers, Illustration of Rolle's and Mean value theorems.

Reference Books:

1. Introduction to scilab, Michael Baudin, Scilab Consortium, digiteo, Nov 2010.
2. An introduction to scilab, SatishAnnigeri, free online version.
3. Introduction to Scilab, Graeme Chandler, Stephen Roberts, free online version 2002.
4. Introduction to Scilab, Gilberto E. Urroz, distributed by infoclearinghouse.com