V.V.VANNIAPERUMAL COLLEGE FOR WOMEN
(Belonging to Virudhunagar Hindu Nadars)
An Autonomous Institution Affiliated to Madurai Kamaraj University, Madurai
Re-accredited with 'A' Grade (3rd Cycle) by NAAC
VIRUDHUNAGAR - 626 001

OUTCOME BASED EDUCATION WITH CHOICE BASED CREDIT SYSTEM REGULATIONS AND SYLLABUS
(with effect from Academic Year 2023 - 2024)

V.V.Vanniaperumal College for Women, Virudhunagar, established in 1962, offers 13 UG Programmes (Aided), 14 UG Programmes (SF), 13 PG Programmes, and 6 Ph.D. Programmes. The curricula for all these Programmes, except Ph.D. Programmes, have been framed as per the guidelines given by the and University Grants Commission (UGC) & Tamil Nadu State Council for Higher Education (TANSCHE) under Choice Based Credit System (CBCS) and the guidelines for Outcome Based Education (OBE).

The Departments of Commerce, English, History, Mathematics, Biochemistry and Tamil upgraded as Research Centres offer Ph.D. Programmes as per the norms and regulations of Madurai Kamaraj University, Madurai and do not come under the purview of CBCS.

A. CHOICE BASED CREDIT SYSTEM (CBCS)

The CBCS provides an opportunity for the students to choose courses from the prescribed Courses. The CBCS is followed as per the guidelines formulated by the UGC. The performance of students is evaluated based on the uniform grading system. Computation of the Cumulative Grade Point Average (CGPA) is made to ensure uniformity in evaluation system.

List of Programmes in which CBCS/Elective Course System is implemented

UG PROGRAMMES

Arts & Humanities	:	History (E.M. & T.M.), English, Tamil
Physical & Life Sciences	:	Mathematics, Zoology, Chemistry, Physics, Biochemistry, Home Science - Nutrition and Dietetics, Costume Design and Fashion, Microbiology, Biotechnology, Computer Science, Information Technology, Computer Applications and Computer Applications - Graphic Design
Commerce & Management	:	Commerce, Commerce (Computer Applications), Commerce (Professional Accounting), Business Administration

PG PROGRAMMES

Arts & Humanities	:	History, English, Tamil
Physical & Life Sciences	:	Mathematics, Physics, Chemistry, Zoology, Biochemistry, Home Science - Nutrition and Dietetics, Computer Science, and Computer Applications (MCA) *
Commerce & Management	:	Commerce, Business Administration (MBA) *

* AICTE approved Programmes

OUTLINE OF CHOICE BASED CREDIT SYSTEM- PG

1. Core Courses
2. Project
3. Elective Courses
   3.1 Discipline Specific Elective Courses (DSEC)
   3.2 Non-Major Elective Course (NMEC)
4. Online Course – Practice for SET/NET – General Paper
5. Extra Credit Courses (Optional)

B. OUTCOME BASED EDUCATION (OBE) FRAMEWORK

The core philosophy of Outcome Based Education rests in employing a student - centric learning approach to measure the performance of students based on a set of pre-determined outcomes. The significant advantage of OBE is that it enables a revamp of the curriculum based on the learning outcomes, upgrade of academic resources, quality enhancement in research and integration of technology in the teaching-learning process. It also helps in bringing clarity among students as to what is expected of them after completion of the Programme in general and the Course in particular. The OBE directs the teachers to channelise their teaching methodologies and evaluation strategies to attain the Programme Educational Objectives (PEOs) and fulfill the Vision and Mission of the Institution.

Vision of the Institution

The founding vision of the Institution is to impart Quality Education to the rural womenfolk and to empower them with knowledge and leadership quality.

Mission of the Institution

The mission of the Institution is to impart liberal education committed to quality and excellence. Its quest is to mould learners into globally competent individuals instilling in them life-oriented skills, personal integrity, leadership qualities and service mindedness.

B.1 Programme Educational Objectives, Programme Outcomes and Programme Specific Outcomes

It is imperative for the Institution to set the Programme Educational Objectives (PEOs), Programme Outcomes (POs) and Course Outcomes (COs), consistent with its Vision and Mission statements. The PEOs and the POs should be driven by the Mission of the Institution and should provide distinctive paths to achieve the stated goals. The PEOs for each Programme have to fulfill the Vision and Mission of the Department offering the Programme.

Vision of the Department of M.Sc. MATHEMATICS

To impart intensive knowledge and skills to rural students through quality education and to provide an environment where students become competent users of Mathematics in other disciplines.

Mission of the Department of M.Sc. MATHEMATICS

To empower the students with profound knowledge in Mathematics, logical reasoning and analytical skills, to induce their passion for research and lifelong learning with a focus on moral values and social ethics.

B.1.1 Programme Educational Objectives (PEOs)

PEOs are broad statements that describe the career and professional achievements that the Programme is preparing the graduates to achieve within the first few years after graduation. PEOs are framed for each Programme and should be consistent with the Mission of the Institution.

Programme Educational Objectives (PEOs) of M.Sc. MATHEMATICS Programme
The Students will be able to

- become successful teachers in schools and Colleges, Bank officers, government officials, Statisticians and IT professionals.
- apply mathematical skills in analyzing and solving problems in real life situations.
- develop independent thinking for continuous learning and productive research contributions that would help in building a better nation

Key Components of Mission Statement	PEO1	PEO2	PEO3
Profound knowledge in Mathematics	✓	✓	✓
Logical reasoning and analytical Skills	✓	✓	✓
Focus on moral and ethical values	✓	-	✓
Passion for Research	-	-	✓

B.1.2 Programme Outcomes (POs)

POs shall be based on Graduate Attributes (GAs) of the Programme. The GAs are the attributes expected of a graduate from a Programme in terms of knowledge, skills, attitude and values. The Graduate Attributes include Disciplinary Knowledge, Communication Skills, Critical Thinking, Problem Solving, Analytical Reasoning, Research Related Skills, Co-operation/Team Work, Scientific Reasoning, Reflective Thinking, Information/Digital Literacy, Multicultural Competence, Moral and Ethical Awareness/Reasoning, Leadership Qualities and Lifelong Learning.

On successful completion of the Programme, the students will be able to

1 apply their in-depth domain knowledge and practical skills in interdisciplinary fields for research-based endeavours, employment and entrepreneurship development. (*Disciplinary Knowledge)*

2 communicate proficiently and confidently with the ability to present complex ideas both in spoken and written forms in a concise manner to assorted groups. (*Communication Skills*)

3 identify, formulate and solve problems in a consistent and systematic way with updated skills using modern tools and techniques. (*Scientific Reasoning and Problem Solving*)

4 analyze the data, synthesis the findings and provide valid conclusion by critical evaluation of theories, policies and practices for the fulfillment of the local, national, regional and global developmental needs. (*Critical Thinking and Analytical Reasoning*)

5 explore and evaluate globally competent research methodologies to apply appropriately in interdisciplinary research; Develop and sustain the research capabilities to meet the emerging needs for the welfare of the society. (*Research Related Skills*)

6 use ICT to mould themselves for lifelong learning activities to face career challenges in the changing environment. (*Digital Literacy, Self - directed and Lifelong Learning*)

7 self-manage and function efficiently as a member or a leader in diverse teams in a multicultural society for nation building. (*Co-operation/Team Work and Multicultural Competence*)

8 uphold the imbibed ethical and moral values in personal, professional and social life for sustainable environment. (*Moral and Ethical Awareness*)

B.1.3 Programme Specific Outcomes (PSOs)

Based on the Programme Outcomes, Programme Specific Outcomes are framed for each PG Programme**.** Programme Specific Outcomes denote what the students would be able to do at the time of graduation. They are Programme-specific and it is mandatory that each PO should be mapped to the respective PSO.

On Successful completion of M.Sc. Mathematics Programme, the students will be able to

PO 1: *Disciplinary Knowledge*

PSO 1.a: Apply the in-depth knowledge of theoretical concepts of mathematics in Research activities.

PSO 1.b: Apply the comprehensive knowledge and skill acquired in advanced mathematical courses to be employed in various sectors of the economy.

PO2: *Communication Skills*

PSO 2: Communicate effectively on advanced mathematical concepts, comprehend and write reports and design documents of data to suit the needs of business concerns, institution or organization.

PO3: *Scientific Reasoning and Problem Solving*

PSO 3: Apply the knowledge of advanced mathematics to formulate real life problems into mathematical models and find solution to the problems using appropriate mathematical techniques.

PO4: *Critical thinking and Analytical Reasoning*

PSO 4 a: Apply the skill of logical and analytical reasoning in advanced mathematics for employment.

PO5: *Research Related Skills*

PSO 5: Formulate need based mathematical research problems and apply appropriate research methodologies by exploring interdisciplinary research opportunities

PO6: *Digital Literacy, Self - directed and Lifelong learning*

PSO 6: Engage in independent and lifelong learning in broad context of technological change.

PO7: *Cooperation/Team Work and Multicultural Competence*

PSO 7: Demonstrate the knowledge of mathematics with team spirit in diverse Environment and become entrepreneur and bring multicultural richness in Mathematics

PO8: *Moral and Ethical awareness*

PSO 8 : Apply ethical principles of mathematics and be committed to professional ethics and responsibilities.

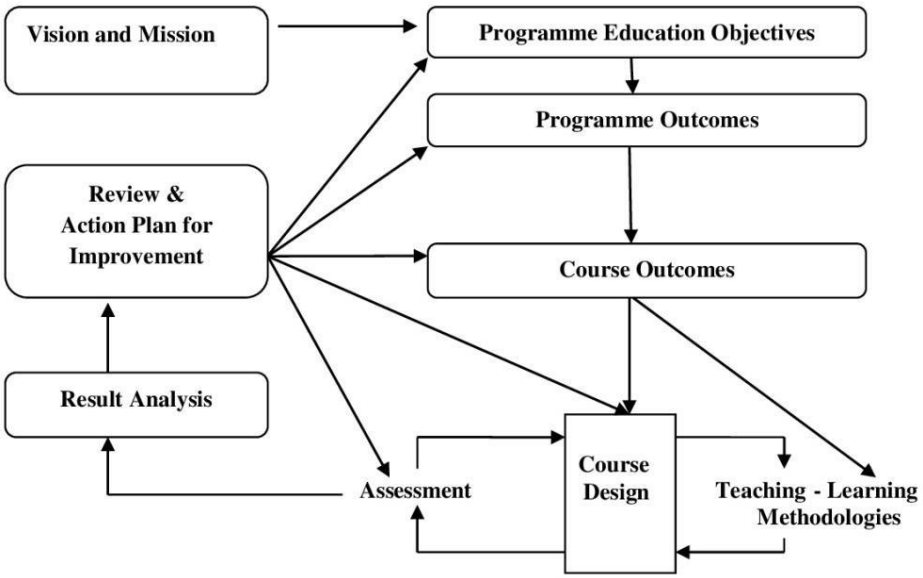
PO-PEO Mapping Matrix

Attainment of PEOs can be measured by a PO-PEO matrix. PEOs should evolve through constant feedback from alumnae, students, industry, management, *etc*. It is mandatory that each PEO should be mapped to at least one of the Pos.

PEOs / POs/PSOs	PEO1	PEO2	PEO3
PO1/PSO1	✓	✓	✓
PO2/PSO2	✓	✓	✓
PO3/PSO3	✓	✓	✓
PO4/PSO4	✓	✓	-
PO5/PSO5	-	✓	✓
PO6/PSO6	✓	✓	✓
PO7/PSO7	✓	✓	✓
PO8/PSO8	✓	✓	-

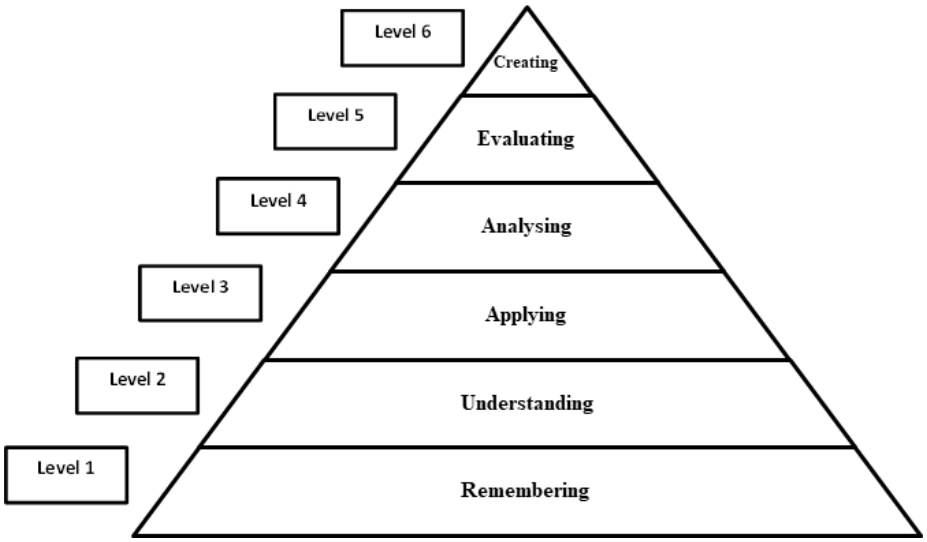
B.1.4 Course Outcomes (COs)

Course Outcomes are narrow statements restricted to the course contents given in five units. Course Outcomes describe what students would be capable of, after learning the contents of the Course. They reflect the level of knowledge gained, skills acquired and attributes developed by the students after learning of Course contents. COs are measurable, attainable and manageable in number. COs contribute to attain POs in such a way that each CO addresses at least one of the POs and also each PO is reasonably addressed by adequate number of COs.



It is important to determine the methods of assessment. A comprehensive assessment strategy may be outlined using the revised Bloom's Taxonomy levels.

BLOOM'S TAXONOMY



CO - PO Mapping of Courses

After framing the CO statements, the COs framed for each course is mapped with POs based on the relationship that exists between them. The COs which are not related to any of the POs is indicated with (-), signifying Nil. Measurement Mapping is based on Four Points Scale [High (H), Medium (M), Low (L) and Nil (-)]. For calculating weighted percentage of contribution of each Course in the attainment of the respective POs, the weights assigned for H, M and L are 3, 2 and 1 respectively.

CO-PO/PSO Mapping Table (Course Articulation Matrix)

PO/PSOs / COs	PO1/ PSO1	PO2/ PSO2	PO3/ PSO3	PO4/ PSO4	PO5/ PSO5	PO6/ PSO6	PO7/ PSO7	PO8/ PSO8
CO1								
CO2								
CO3								
CO4								
CO5								

ELIGIBILITY FOR ADMISSION

The candidate should have passed in B.Sc. Mathematics or B.Sc. Mathematics with Computer Applications of any recognized university.

DURATION OF THE PROGRAMME

The candidates shall undergo the prescribed Programme of study for a period of two academic years (four semesters).

MEDIUM OF INSTRUCTION

English

B.2 EVALUATION SCHEME

Components	Internal Assessment Marks	External Examination Marks	Total Marks
Theory	25	75	**100**

B.2.1 Core Courses, Discipline Specific Elective Courses

INTERNAL ASSESSMENT
Distribution of Marks

Theory

Mode of Evaluation		Marks
Internal Test	:	20
Assignment	:	5
Total	**:**	**25**

Three Periodic Tests - Average of the best two will be considered
Two Assignments - Better of the two will be considered

Practical

Mode of Evaluation		Marks
Internal Test	:	30
Record Performance	:	10
Total	**:**	**40**

Internal Test - Average of the best two will be considered

Performance - Attendance and Record

Question Pattern for Periodic Test **Duration: 2 Hours**

Section	Q. No.	Types of Question	No. of Questions	No. of Questions to be answered	Marks for each Question	Total Marks
A	1 - 5	Fill in & Sentence Form	5	5	1	5
B	6-9	Internal Choice – Either… or Type	4	4	5	20
C	10 - 11	Internal Choice – Either…. or Type	2	2	10	20
					Total	**45***

*The total marks obtained in the Periodic Test will be calculated for 20 marks

Summative Examination

External Assessment

Distribution of Marks

Mode of Evaluation		Marks
Summative Examination	**:**	60
Seminar Presentation	**:**	15
Total	**:**	**75**

Summative Examination

Question Pattern **Duration: 3 Hours**

Section	Q. No.	Types of Question	No. of Questions	No. of Questions to be answered	Marks for each Question	Total Marks
A	1 - 5	Fill in & Sentence Form	5	5	1	5
B	6 - 10	Internal Choice - Either ….or Type	5	5	5	25
C	11 - 13	Internal Choice - Either …or Type	3	3	10	30
					Total	**60**

B.2.2 Extra Credit Courses

- Two credits are allotted for each Extra Credit Course offered by the Department.
- Extra credits are allotted for the completion of Open Online Courses offeredby MOOC to the maximum of 15 credits.
- The Courses shall be completed within the first III Semesters of the Programme.
- The allotment of credits is as follows

4weeks Course - 1 credit
8 weeks Course - 2 credits
12 weeks Course - 3 credits

ELIGIBILITY FOR THE DEGREE

- The candidate will not be eligible for the Degree without completing the prescribedCourses of study and a minimum of 50% Pass marks in all the Courses.
- No Pass minimum for Internal Assessment for other Courses.
- Pass minimum for External Examination is 27 marks out of 60 marks for Core Courses, Discipline Specific Elective Courses and Non-Major Elective Course.
- Pass minimum for Practice for SET/NET - General Paper is 50 Marks.

Attendance

- The students who have attended the classes for 76 days (85%) and above are permitted to appear for the Summative Examinations without any condition.
- The students who have only 60-75days (66% -84%) of attendance are

permitted to appear for the Summative Examinations after paying the required fine amountand fulfilling other conditions according to the respective cases.

- The students who have attended the classes for 59 days and less – upto 45 days (50% - 65%) can appear for the Summative Examinations only after getting special permission from the Principal.
- The students who have attended the classes for 44 days or less (<50%) cannot appear for the Summative Examinations and have to repeat the whole semester.
- These rules are applicable to UG, PG and M.Phil. Programmes and come into effect from 2020-2021 onwards.

- For Certificate, Diploma, Advanced Diploma and Post Graduate Diploma Programmes, the students require 75% of attendance to appear for the Theory/Practical Examinations.

B.3 ASSESSMENT MANAGEMENT PLAN

An Assessment Management Plan that details the assessment strategy both at the Programme and the Course levels is prepared. The continuous assessment is implemented using an assessment rubric to interpret and grade students.

B.3.1 Assessment Process for CO Attainment

Assessment is one or more processes carried out by the institution that identify, collect and prepare data to evaluate the achievement of Course Outcomes and Programme Outcomes. Course Outcome is evaluated based on the performance of students in the Continuous Internal Assessments and in End Semester Examination of a course. Target levels of attainment shall be fixed by the Course teacher and Heads of therespective departments.

Direct Assessment (Rubric based) - Conventional assessment tools such as Term Test, Assignment, Quiz and End Semester Summative Examination are used.

Indirect Assessment - Done through Course Exit Survey.

CO Assessment Rubrics

For the evaluation and assessment of COs and POs, rubrics are used. Internal assessment contributes 40% and End Semester assessment contributes 60% to the total attainment of a CO for the theory courses. For the practical courses, internal assessment contributes 50% and Semester assessment contributes 50% to the total attainment of a CO. Once the Course Outcome is measured, the PO can be measured using a CO-PO matrix.

CO Attainment

Direct CO Attainment

Course Outcomes of all courses are assessed and the CO - wise marks obtained by all the students are recorded for all the assessment tools. The respective CO attainment level is evaluated based on set attainment rubrics.

Target Setting for Assessment Method

For setting up the target of internal assessment tools, 55% of the maximum mark is fixed as target. For setting up the target of End Semester Examination, the average mark of the class shall be set as target.

Formula for Attainment for each CO

Attainment = Percentage of students who have scored more than the target marks

$$\text{Percentage of Attainment} = \frac{\text{Number of Students who Scored more than the Target}}{\text{Total Number of Students}} \times 100$$

Attainment Levels of COs

Assessment Methods	**Attainment Levels**	
Internal Assessment	Level 1	50% of students scoring more than set target marks in Internal Assessment tools
	Level 2	55% of students scoring more than set target marks in Internal Assessment tools
	Level 3	60% of students scoring more than set target marks in internal Assessment tools
End Semester Summative Examination	Level 1	50% of students scoring more than average marks in End Semester Summative Examination
	Level 2	55% of students scoring more than average marks in End Semester Summative Examination
	Level 3	60% of students scoring more than average marks in End Semester Summative Examination

Indirect CO Attainment

At the end of each Course, an exit survey is conducted to collect the opinion of the students on attainment of Course Outcomes. A questionnaire is designed to reflect the views of the students about the Course Outcomes.

Overall CO Attainment=75% of Direct CO Attainment + 25 % of Indirect CO Attainment

In each Course, the level of attainment of each CO is compared with the predefined targets. If the target is not reached, the Course teacher takes necessary steps for the improvement to reach the target.

For continuous improvement, if the target is reached, the Course teacher can set the target as a value greater than the CO attainment of the previous year.

B.3.2 Assessment Process for Overall PO Attainment

With the help of CO - PO mapping, the PO attainment is calculated. PO assessment is done by giving 75% weightage to direct assessment and 25% weightage to indirect assessment. Direct assessment is based on CO attainment, where 75% weightage is given to attainment through End Semester examination and 25 % weightage is given to

attainment through internal assessments. Indirect assessment is done through Graduate Exit Survey and participation of students in Co-curricular/Extra-curricular activities.

PO Assessment Tools

Mode of Assessment	Assessment Tool	Description
Direct Attainment (Weightage -75%)	CO Assessment	This is computed from the calculated CO Attainment value for each Course.
Indirect Attainment (Weightage - 25%)	Graduate Exit Survey 10%	At the end of the Programme, Graduate Exit Survey is collected from the graduates and it gives the opinion of the graduates on attainment of Programme Outcomes.
	Co-curricular / Extra-curricular activities 15%	For participation in Co-curricular/Extra-curricular activities during the period of their study.

Programme Articulation Matrix (PAM)

Course Code	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
Average Direct PO Attainment									
Direct PO Attainment in percentage									

Indirect Attainment of POs for all Courses

POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
Graduate Exit Survey								
Indirect PO Attainment								

Attainments of POs for all Courses

POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
Direct Attainment(Weightage - 75%)								
Indirect Attainment(Weightage - 25%)								
Overall PO Attainment								

Overall PO Attainment= 75% of Direct PO Attainment +
25% of Indirect PO Attainment (Graduate Exit Survey
& Participation in Co- curricular and
Extra-curricular Activities)

Expected Level of Attainment for each of the Programme Outcomes

POs	Level of Attainment
Attainment Value ≥70%	Excellent
60% ≤ Attainment Value < 70%	Very Good
50% ≤ Attainment Value < 60%	Good
40% ≤ Attainment Value < 50%	Satisfactory
Attainment Value <40%	Not Satisfactory

Level of PO Attainment

Graduation Batch	Overall PO Attainment (in percentage)	Whether Expected Level of PO is Achieved? (Yes/No)

B.3.3 Assessment Process for PEOs

The curriculum is designed so that all the courses contribute to the achievement of PEOs. The attainment of PEOs is measured after 3 years of completion of the Programme only through Indirect methods.

Target for PEO Attainment

Assessment Criteria	Target (UG)	Target (PG)
Record of Employment	15% of the class strength	30 % of the class strength
Progression to Higher Education	50% of the class strength	5 % of the class strength
Record of Entrepreneurship	2 % of the class strength	5 % of the class strength

Attainment of PEOs

Assessment Criteria & Tool	Weightage
Record of Employment	10
Progression to Higher Education	20
Record of Entrepreneurship	10
Feedback from Alumnae	30
Feedback from Parents	10
Feedback from Employers	20
Total Attainment	**100**

$$\text{Percentage of PEO Attainment from Employment} = \frac{\text{Number of Students who have got Employment}}{\text{Target}} \times 100$$

$$\text{Percentage of PEO Attainment from Higher Education} = \frac{\text{Number of Students who pursue Higher Education}}{\text{Target}} \times 100$$

$$\text{Percentage of PEO Attainment from Entrepreneurship} = \frac{\text{Number of Students who have become Entrepreneurs}}{\text{Target}} \times 100$$

Expected Level of Attainment for each of the Programme Educational Objectives

POs	Level of Attainment
Attainment Value ≥70%	Excellent
60% ≤ Attainment Value < 70%	Very Good
50% ≤ Attainment Value < 60%	Good
40% ≤ Attainment Value < 50%	Satisfactory
Attainment Value <40%	Not Satisfactory

Level of PEO Attainment

Graduation Batch	Overall PEO Attainment (in percentage)	Whether Expected Level of PEO is Achieved? (Yes/No)

C. PROCESS OF REDEFINING THE PROGRMME EDUCATIONAL OBJECTIVES

The college has always been involving the key stakeholders in collecting information and suggestions with regard to curriculum development and curriculum revision. Based on the information collected, the objectives of the Programme are defined, refined and are inscribed in the form of PEOs. The level of attainment of PEOs defined earlier will be analysed and will identify the need for redefining PEOs. Based on identified changes in terms of curriculum, regulations and PEOs, the administrative system like Board of Studies, Academic Council and Governing Body may recommend appropriate actions. As per the Outcome Based Education Framework implemented from the Academic Year 2020-2021, the following are the Programme Structure, the Programme Contents and the Course Contents of M.Sc. Mathematics Programme

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MASTER OF SCIENCE - MATHEMATICS (7013)

Outcome Based Education with Choice Base Credit System

Programme Structure - Allotment of Hours and Credits

For those who join in the Academic Year 2023-2024

Components	Semester				Total Number of Hours (Credits)
	I	II	III	IV	
Core Course	6(5)	6(5)	6(5)	6(5)	24(20)
Core Course	6(5)	6(5)	6(5)	6(5)	24(20)
Core Course	6(4)	6(4)	6(4)	-	18(12)
Core Course	6(4)	6(4)	5(3)	-	17(11)
Project	-	-	-	6(5)	6(5)
Discipline Specific Elective Course	6(4)	6(4)	-	6(4)	18(12)
Elective Course	-	-	5(3)	-	5(3)
Skill Enhancement Course/ Professional Competency Skill	-	-	2 (2)	5 (3)	7 (5)
Self Study Course	-	-	0(1)	-	0(1)
Ability Enhancement Compulsory Course	-	-	-	1(1)	1(1)
Total	**30 (22)**	**30 (22)**	**30 (23)**	**30 (23)**	**120 (90)**
Extra Credit Course (Optional) - offered by the Department	-	-	0(2)	-	0(2)
Extra Credit Course (Optional) - MOOC	-	-	-	-	Limited to a maximum of 15 credits

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MASTER OF MATHEMATICS -7013

PROGRAMME CONTENT

SEMESTER I

(2023 – 2024 onwards)

S.No.	Components	Title of the Course	Course Code	Hours per Week	Credits	Exam. Hours	Marks		
							Int.	Ext.	Total
1	Core Course -1	Algebraic Structures	23PMTC11	6	5	3	25	75	100
2	Core Course -2	Real Analysis - I	23PMTC12	6	5	3	25	75	100
3	Core Course -3	Ordinary Differential Equations	23PMTC13	6	4	3	25	75	100
4	Core Course -4	Graph Theory and Applications	23PMTC14	6	4	3	25	75	100
5	Discipline Specific Elective -1	Fuzzy Algebra / Advanced Calculus / Theory of Computations	23PMTE11 / 23PMTE12 / 23PMTE13	6	4	3	25	75	100
			Total	**30**	**22**				**500**

SEMESTER II

S.No.	Components	Title of the Course	Course Code	Hours per Week	Credits	Exam. Hours	Marks		
							Int.	Ext.	Total
1	Core Course – 5	Advanced Algebra	23PMTC21	6	5	3	25	75	100
2	Core Course – 6	Real Analysis – II	23PMTC22	6	5	3	25	75	100
3	Core Course – 7	Partial Differential Equations	23PMTC23	6	4	3	25	75	100
4	Core Course – 8	Mathematical Statistics	23PMTC24	6	4	3	25	75	100
5	Discipline Specific Elective -2	Modelling and Simulation with Excel/ Wavelets/ Neural Networks	23PMTE21 / 23PMTE22 / 23PMTE23	6	4	3	25	75	100
			Total	**30**	**22**				**500**

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M.Sc. MATHEMATICS
(2023 - 24 onwards)

Semester I	**ALGEBRAIC STRUCTURES**	Hours/Week: 6	
Core Course-1		Credits: 5	
Course Code **23PMTC11**		Internal 25	External 75

COURSE OUTCOMES

On completion of the course, students will be able to

CO1: explain the fundamental concepts of class equation, solvability of groups, finite abelian groups, linear transformations, real quadratic forms. [K2]

CO2: apply the Sylow's theorem to find number of Sylow subgroups, apply the concepts of linear transformation and Jordan blocks to find invariants of linear transformation and characteristic polynomial.[K3]

CO3: apply the concepts to characterize the solvable groups, direct products, finite abelian groups and modules. [K3]

CO4: analyse the properties of matrices and nilpotent transformation to find the index of nilpotence to decompose a space into invariant subspaces. [K4]

CO5: examine the properties of finite abelian groups and and to verify whether the transformation in Hermitian, unitary and normal [K4]

UNIT I

Counting Principle - Class Equation for Finite Groups and its Applications - Sylow's Theorems (For theorem 2.12.1, First proof only). **(18 Hours)**

UNIT II

Solvable groups - Direct products - Finite abelian groups- Modules **(18 Hours)**

UNIT III

Linear Transformations: Canonical Forms: Triangular Form - Nilpotent Transformations. **(18 Hours)**

UNIT IV

Jordan Form - Rational Canonical Form**.** **(18 Hours)**

UNIT V

Trace and Transpose - Hermitian, Unitary and Normal Transformations, Real Quadratic Form. **(18 Hours)**

TEXT BOOK

I.N. Herstein, (1975). *Topics in Algebra* (II Edition) Wiley Eastern Limited, New Delhi.

Unit	Chapter	Section
I	2	2.11 and 2.12 (Omit Lemma 2.12.5)
II	5	5.7 (Lemma 5.7.1, Lemma 5.7.2, Theorem 5.7.1)
	2	2.13 and 2.14 (Theorem 2.14.1 only)
	4	4.5
III	6	6.4 , 6.5
IV	6	6.6 and 6.7
V	6	6.8, 6.10 and 6.11 (Omit 6.9)

REFERENCE BOOKS

1. John B. Fraleigh, (1982). *A First Course in Abstract Algebra*, Third Edition, Narosa Publications, Eighth Reprint, 1996.
2. Joseph A. Gallian, (2013). *Contemporary Abstract Algebra*, 8th Edition, BROOKS/COLE, Cengage Learning

Course Code 23PMTC11	PO1		PO2		PO3	PO4	PO5	PO6	PO7	PO8
	PSO 1.a	PSO 1.b	PSO 2, a	PSO 2.b	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	1	3	3	1	-	3	3	1	-
CO2	3	2	3	1	2	2	3	3	1	-
CO3	3	2	3	1	2	2	3	3	1	-
CO4	3	1	2	3	2	2	2	3	1	-
CO5	3	1	1	2	3	3	2	3	1	-

Strong (3) Medium (2) Low (1)

Dr. A. Uma Devi
Head of the Department

Dr.A.Uma Devi
Course Designer

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VIRUDHUNAGAR - 626 001

M.Sc. Mathematics
(2023 -24 onwards)

Semester I	**REAL ANALYSIS - I**	Hours/Week: 6	
Core Course-2		Credits: 5	
Course Code **23PMTC12**		Internal 25	External 75

COURSE OUTCOMES

On completion of the course, students will be able to

CO1: explain the fundamental concepts of Riemann-Stieltjes integral and its properties, step function, upper function, Lebesgue function and their integrals, properties of inner products, norms and measurable functions. [K2]

CO2: apply Dirichlet's test and Abel's test to test the convergence of infinite series. [K3]

CO3: apply the integral theory to prove results about specific classes of functions. [K3]

CO4: explain the concepts of metric space, continuity, uniform continuity and differentiation in real line. [K4]

CO5: analyze the proofs of various theorems in real number system. [K4]

UNIT I

Functions of Bounded Variation and Rectifiable Curves - Introduction - Properties of monotonic functions - Functions of bounded variation - Total variation - Additive property of total variation - Total variation on [a, x] as a function of x - Functions of bounded variation expressed as the difference of two increasing functions - Continuous functions of bounded variation.

Infinite Series and Infinite Products: Absolute and conditional convergence - Dirichlet's test and Abel's test - Rearrangement of series - Riemann's theorem on conditionally convergent series. **(18 Hours)**

UNIT II

The Riemann - Stieltjes Integral - Introduction - Notation - The definition of the Riemann - Stieltjes integral - Linear Properties - Integration by parts- Change of variable in a Riemann - Stieltjes integral - Reduction to a Riemann Integral – Euler's summation formula - Monotonically increasing integrators, Upper and lower integrals - Additive and linearity properties of upper, lower integrals - Riemann's condition - Comparison theorems. **(18 Hours)**

UNIT III

The Riemann-Stieltjes Integral - Integrators of bounded variation-Sufficient conditions for the existence of Riemann-Stieltjes integrals-Necessary conditions for the existence of Riemann-Stieltjes integrals- Mean value theorems for Riemann-Stieltjes integrals -Integrals as a function of the interval – Second fundamental theorem of integral calculus-Change of variable in a Riemann integral -Second Mean Value Theorem for Riemann integral- Riemann-Stieltjes integrals depending on a parameter-Differentiation under integral sign-Lebesgue criterion for existence of Riemann integrals**.** **(18 Hours)**

UNIT IV

Continuity

Limits of Function - Continuous Functions - Continuity and Compactness - Continuity and Connectedness – Discontinuities - Monotonic Functions - Infinite Limits and Limits at Infinity**.** **(18 Hours)**

UNIT V

Differentiation

The Derivative of a Real function - Mean Value Theorems - The Continuity of Derivatives - L'Hospital's Rule - Derivatives of Higher Order - Taylor's Theorem - Differentiation of Vector-valued Functions. **(18 Hours)**

TEXT BOOK

1. Tom M.Apostol : *Mathematical Analysis*, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974.
2. Walter Rudin, (2016). *Principles of Mathematical Analysis*, Third Edition, McGraw - Hill, International Editions.

Unit	Chapter	Section
I	Text Book 1	
	6	6.1 to 6.8
	8	8.8, 8.15, 8.17, 8.18
II	7	7.1 to 7.14
III	7	7.15 to 7.26
	Text Book 2	
IV	4	4.1 – 4.34
V	5	5.1 – 5.19

REFERENCE BOOKS

1. Bartle, R.G. *Real Analysis*, John Wiley and Sons Inc., 1976.
2. Malik,S.C. and Savita Arora. *Mathematical Anslysis*, Wiley Eastern Limited.New Delhi, 1991.
3. Sanjay Arora and Bansi Lal, *Introduction to Real Analysis*, Satya Prakashan, New Delhi, 1991.
4. Gelbaum, B.R. and J. Olmsted, *Counter Examples in Analysis*, Holden day, San Francisco, 1964.
5. A.L.Gupta and N.R.Gupta, *Principles of Real Analysis*, Pearson Education, (Indian print) 2003.

Course Code 23PMTC12	PO1		PO2		PO3	PO4	PO5	PO6	PO7	PO8
	PSO 1.a	PSO 1.b	PSO 2, a	PSO 2.b	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	3	3	2	2	2	2	3	1	-
CO2	3	2	1	1	1	2	2	3	1	-
CO3	3	1	2	2	2	2	3	3	1	-
CO4	3	1	1	1	1	2	3	3	1	-
CO5	3	1	1	1	3	2	3	3	1	-

Strong (3) Medium (2) Low (1)

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Dr.M.Uma Maheswari
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VIRUDHUNAGAR - 626 001

M.Sc. Mathematics

(2023 -24 onwards)

Semester I	**ORDINARY DIFFERENTIAL EQUATIONS**	Hours/Week: 6	
Core Course-3		Credits: 4	
Course Code **23PMTC13**		Internal 25	External 75

COURSE OUTCOMES

On completion of the course, students will be able to

CO1: explain the fundamental concepts of linear and nonlinear differential equations. [K2]

CO2: solve problems of Ordinary Differential Equations arising in various fields. [K3]

CO3: apply various computational techniques to obtain the solution of Ordinary Differential Equations. [K3]

CO4: analyze the Ordinary Differential Equations of various types, their solutions and fundamental concepts about their existence and uniqueness. [K4]

CO5: analyze the solutions using appropriate methods and give examples. [K4]

UNIT I

Linear Equations with Constant Coefficients

Introduction - The second order homogeneous equation - Initial value problems for second order equations - Linear dependence and independence- A formula for the Wronskian - The non-homogeneous equation of order two. **(18 Hours)**

UNIT II

Linear Equations with Constant Coefficients

The homogeneous equation of order n –Initial value problems for n^{th} order equations – Equations with real constants - The non - homogeneous equation of order n – A special method for solving the non - homogeneous equation - Algebra of constant coefficient operators**.** **(18 Hours)**

UNIT III

Linear Equations with Variable Coefficients

Introduction - Initial value problems for the homogeneous equation – Solutions of the homogeneous equation – The Wronskian and linear independence – Reduction of the order of a homogeneous equation – The non - homogeneous equation - Homogeneous equations with analytic coefficients - The Legendre equation. **(18 Hours)**

UNIT IV

Linear Equations with Regular Singular Points

Introduction – The Euler equation – Second order equations with regular singular points – an example - Second order equations with regular singular points – the general case –The exceptional cases – The Bessel equation - The Bessel equation (continued).

(18 Hours)

UNIT V

Existence and Uniqueness of Solutions to First Order Equations

Introduction - Equations with variables separated – Exact equations – The method of successive approximations – The Lipschitz condition – Convergence of the Successive approximations. **(18 Hours)**

TEXT BOOK

1. E.A.Coddington, *A introduction to ordinary differential equations* (3rd Printing) Prentice- Hall of India Ltd., New Delhi, 1987.

Unit	Chapter	Section
I	2	1 to 6
II	2	7 to 12.
III	3	1 to 8 (Omit section 9)
IV	4	1 to 4 and 6 to 8 (Omit sections 5 and 9)
V	5	1 to 6 (Omit Sections 7 to 9)

REFERENCE BOOKS

1. Williams E. Boyce and Richard C. DI Prima, *Elementary differential equations and boundary value problems,* John Wiley and sons, New York, 1967.
2. George F Simmons, *Differential equations with applications and historical notes,* Tata McGraw Hill, New Delhi, 1974.
3. N.N. Lebedev, *Special functions and their applications*, Prentice Hall of India, New Delhi, 1965.
4. W.T. Reid. *Ordinary Differential Equations*, John Wiley and Sons, New York, 1971
5. M.D.Raisinghania, *Advanced Differential Equations*, S.Chand & Company Ltd. New Delhi 2001
6. B.Rai, D.P.Choudary and H.I. Freedman, *A Course in Ordinary Differential Equations,* Narosa Publishing House, New Delhi, 2002.

Course Code 23PMTC13	**PO1**		**PO2**		**PO3**	**PO 4**	**PO5**	**PO6**	**PO7**	**PO8**
	PSO 1.a	**PSO 1.b**	**PSO 2, a**	**PSO 2.b**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**
CO1	3	1	2	3	1	1	2	2	1	-
CO2	3	2	2	1	2	1	2	3	1	-
CO3	2	1	1	1	2	2	2	1	1	-
CO4	3	1	3	3	2	2	3	2	1	-
CO5	1	1	3	2	3	2	3	2	1	-

Strong (3) Medium (2) Low (1)

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M.Sc. MATHEMATICS
(2023 - 24 onwards)

Semester I	**GRAPH THEORY AND APPLICATIONS**	Hours/Week: 6	
Core Course-4		Credits: 4	
Course Code **23PMTC14**		Internal 25	External 75

COURSE OUTCOMES

On completion of the course, the students will be able to

CO1: explain the basic concepts in Graph Theory**.** [K2]

CO2: solve problems by identifying the properties in graph structures [K3]

CO3: apply the graph theoretical concepts in graph structures**.** [K3]

CO4: analyze the various parameters in graph structures. [K4]

CO5: analyze the results in Graph Theory to find applications in real life. [K4]

UNIT I

Trees, Cut Edges and Bonds, Cut Vertices, Cayley's Formula –Applications: The Connector Problem – Connectivity, Blocks – Applications: Construction of Reliable Communication Networks. **(18 Hours)**

UNIT II

Euler Tours, Hamiltonian Cycles – Applications: The Chinese Postman Problem, The Travelling Salesman Problem. **(18 Hours)**

UNIT III

Matching's, Matching's and Coverings in Bipartite Graphs, Perfect Matching – Applications: The Personnel Assignment Problem, The Optimal Assignment Problem**.**

(18 Hours)

UNIT IV

Chromatic Number, Brook's Theorem, Hajos' Conjecture, Chromatic Polynomials, Girth and Chromatic Number – Applications: A Storage Problem. **(18 Hours)**

UNIT V

Directed Graphs, Directed Paths, Directed Cycles – Applications: A Job Sequencing Problem, Designing as Efficient Computer Drum, Making a Road System One-Way.

(18 Hours)

TEXT BOOK

J.A Bondy and U.S.R Murty, Graph Theory with Applications, North Holland, 1976.

Unit	Chapter	Section
I	2	2.1-2.5
	3	3.1-3.3
II	4	4.1-4.4.
III	5	5.1-5.5
IV	8	8.1-8.6.
V	10	10.1-10.6.

REFERENCE BOOKS

1. John Clark and D. Allan Holton; Graph theory World Scientific Publishing Co. Pvt.Ltd, 1991.
2. Narsingh Deo; Graph Theory with Applications to Engineering and Computer Science, Prentice Hall, 1974.

Course Code 23PMTC14	PO1		PO2		PO3	PO4	PO5	PO6	PO7	PO8
	PSO 1.a	PSO 1.b	PSO 2. a	PSO 2.b	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	3	1	3	1	1	1	1	2	-
CO2	3	3	1	1	2	2	2	1	1	-
CO3	3	3	1	1	2	2	2	1	2	-
CO4	3	3	1	3	2	2	2	1	1	-
CO5	3	3	1	2	2	2	2	2	1	-

Strong (3) Medium (2) Low (1)

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M.Sc. Mathematics
(2023 -24 onwards)

Semester I	**FUZZY ALGEBRA**	Hours/Week: 6	
DSEC - 1		Credits: 4	
Course Code **23PMTE11**		Internal 25	External 75

COURSE OUTCOMES

On completion of the course, students will be able to

CO1: explain the basic concepts of Fuzzy sets, relations, Operation on Fuzzy sets. [K2]

CO2: apply the acquired knowledge in Fuzzy sets in proving theorems and solving problems. [K3]

CO3: apply fuzzy relations, binary fuzzy relations, fuzzy equivalence relations in real life problems. [K3]

CO4: analyze the concepts of fuzzy sets, relations in various algebraic structures. [K4]

CO5: analyze the algebraic structures by using advanced ideas in Fuzzy algebra. [K4]

UNIT I

From Classical (CRISP) Sets to Fuzzy sets: A Grand Paradigm Shift:

Fuzzy Sets: Basic Types – Fuzzy Sets: Basic Concepts

Fuzzy Sets versus Crisp Sets:

Additional Properties of α- Cuts – Representation of Fuzzy Sets – Extension Principle for Fuzzy Sets. **(18 Hours)**

UNIT II

Operations on Fuzzy sets:

Types of Operations - Fuzzy Complements- Fuzzy Intersection: t-Norms- Fuzzy Unions: t- Conorms – Combinations of Operations.

Fuzzy Relations:

Crisp versus Fuzzy Relations – Binary Fuzzy Relations – Binary Relations on a Single Set – Fuzzy Equivalence Relations - Fuzzy Compatibility Relations.

(18 Hours)

UNIT III

Fuzzy Subgroups:

Definition of Fuzzy Subgroups – Examples and Properties – Union of two Fuzzy Subgroups – Fuzzy Subgroup generated by a Fuzzy Subset– Fuzzy Normal Subgroups.

(18 Hours)

UNIT IV

Fuzzy Subgroups:

Fuzzy Normal Subgroups under Homomorphisms – Characteristics Subgroups – Fuzzy Conjugate Subgroups – Fuzzy Sylow Subgroups**.** **(18 Hours)**

UNIT V

Fuzzy Ideals and their Operations:

Some Elementary Properties – Union of Fuzzy Subrings (Fuzzy Ideals) – Fuzzy Subring (Fuzzy Ideal) Generated by a Fuzzy Subset – Fuzzy Ideals and Homomorphisms – Fuzzy Cosets**.** **(18 Hours)**

TEXT BOOKS

1. Georgr J. Klir and Bo Tuan, Fuzzy Sets and Fuzzy Logic Theory and applications, PHI Leaning private Limited, New delhi, 2009.
2. Rajeshkumar, (1993). Fuzzy Algebra Vol I, University of Delhi, Publication Division.

REFERENCE BOOKS

1. A.K. Bhargava: Fuzzy Set Theory, Fuzzy Logic and their Applications, published by S. Chand Pvt limited, 2013
2. S. Rajasekaran & Y.A. VijiaylakshmiPai, Neural Networks, Fuzzy logic and genetic algorithms, Prentice Hall of India.

Unit	Chapter	Section
Text Book - I		
I	1	1.3-1.4
	2	2.1-2.3
II	3	3.1-3.5
	5	5.1, 5.3-5.6
Text Book - II		
III	1	1.2.16 - 1.2.2
	2	2.1- 2.3 (up to 2.3.3)
IV	2	2.3.4 – 2.3.14 & 2.4
V	3	3.1 -3.5

Course Code 23PMTE11	**PO1**		**PO2**		**PO3**	**PO 4**	**PO5**	**PO 6**	**PO7**	**PO8**
	PSO 1.a	**PSO 1.b**	**PSO 2 a**	**PSO 2.b**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**
CO1	3	3	1	3	2	2	1	1	1	-
CO2	3	3	1	1	1	2	1	1	1	-
CO3	3	3	1	1	1	2	1	1	1	-
CO4	3	3	1	3	2	2	1	1	1	-
CO5	3	3	1	2	2	2	1	2	1	-

Strong (3) Medium (2) Low (1)

Dr.A.Uma Devi
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M.Sc. Mathematics
(2023 -24 onwards)

Semester I	**ADVANCED CALCULUS**	Hours/Week: 6	
DSEC-1		Credits: 4	
Course Code **23PMTE12**		Internal 25	External 75

COURSE OUTCOMES

On completion of the course, students will be able to

CO1: explain the basic idea of differentiation of transforms. [K2]

CO2: solve the problems in Differential Geometry and Vector Calculus**.** [K3]

CO3: apply the theorems of Green, Gauss and Stoke's in solving problems. [K3]

CO4: analyze theorems in Advanced Calculus. [K4]

CO5: estimate integrals over curves and surfaces. [K4]

UNIT I

Integration

The Definite integral – Evaluation of Definite Integrals. (18 Hours)

UNIT II

Differentiation of Transforms

Differentials of Transformations – Inverses of Transformations. (18 Hours)

UNIT III

The Implicit function Theorems – Functional Dependence. (18 Hours)

UNIT IV

Applications to Geometry and Analysis

Transformations of Multiple Integrals – Integrals over curves and surfaces. (18 Hours)

UNIT V

Differential Geometry and Vector Calculus

Differential forms – Vector Analysis – The theorems of Green, Gauss, and Stoke's– Exact forms and closed forms – Applications. (18 Hours)

TEXT BOOK

Creighton Buck. R., (1978).Advanced *Calculus*, Third Edition, McGraw, HillKogakusha Ltd.

Unit	Chapter	Section
I	4	4.2- 4.3
II	7	7.4 - 7.5
III	7	7.6 - 7.7
IV	8	8.3 & 8.6
V	9	9.2- 9.6

REFERENCE BOOK

1. Robert Wrede and Murray R. Spiegel, (2005).*Advanced Calculus*, Second Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi.

Course Code 23PMTE12	PO1		PO2	PO3	PO4		PO5	PO6	PO7	PO8
	PSO 1.a	PSO 1.b	PSO 2	PSO 3	PSO 4.a	PSO 4.b	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	3	3	1	1	2	1	2	1	-
CO2	3	3	2	2	3	2	3	2	1	-
CO3	3	3	3	3	3	2	3	2	1	-
CO4	3	3	2	3	3	2	3	2	1	-
CO5	3	3	2	2	3	3	3	3	1	-

Strong (3) Medium (2) Low (1)

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M.Sc. MATHEMATICS
(2023- 24 onwards)

Semester I	**THEORY OF COMPUTATIONS**	Hours/Week: 6	
DSEC-1		Credits: 4	
Course Code **20PMTE13**		Internal 25	External 75

COURSE OUTCOMES

On completion of the course, students will be able to

CO1: explainthe concepts in automata theory and theory of computation. [K2]

CO2: apply grammars to produce strings from a specific language. [K3]

CO3: determine the decidability and intractability of computational problems.[K3]

CO4: analyze different formal language classes and their relationships. [K4]

CO5: analyze theorems in automata theory. [K4]

UNIT I

Finite Automata and Regular Expressions

Finite state systems – Basic definitions – Nondeterministic finite automata – Finite automata with Є moves – Regular expressions – Finite Automata with output.

(18 Hours)

UNIT II

Properties of Regular Sets

The pumping lemma for regular sets – Closure properties of regular sets – Decision algorithm for regular sets – The Myhill-Nerode theorem and minimization of finite automata.

(18 Hours)

UNIT III

Context-Free grammars

Context free grammars – Derivation trees – Simplification of context free grammars – Chomsky normal form – Greibach normal form. (18 Hours)

UNIT IV

Pushdown Automata

Definitions – pushdown automata and context free languages – The pumping lemma for CFL„s – Closure properties of CFLs. (18 Hours)

UNIT V

Turing Machines

Introduction: The Turing machine model – Computable languages and functions. Undecidability- Problems, properties of recursive and recursively enumerable languages, Universal Turing Machines and an undecidable problem, Rice„s theorem and some more undecidable problems. (18 Hours)

TEXT BOOK:

1. John E. Hopcroft and Jeffery D. Ullman, (2002).*Introduction to Automata Theory, Languages, and Computation*, Narosa.Chennai.

Unit	Chapter	Section
I	2	2.1 -2.5, 2.7
II	3	3.1-3.4
III	4	4.2-4.6
IV	5	5.2, 5.3
	6	6.1, 6.2
V	7	7.1-7.3
	8	8.1-8.4

REFERENCE BOOKS:

1. Peter Linz, Jones and Bartlett, (2006).*An Introduction to Formal Languages and Automata.* New Delhi.
2. Raymond Greenlaw and H. James Hoover, (2009).*Fundamentals of the Theory of Computation:* Principles and Practice, Morgan Kaufmann Publishers.

Course Code 20PMTE13	PO1		PO2	PO3	PO4		PO5	PO6	PO7	PO8
	PSO 1.a	PSO 1.b	PSO 2	PSO 3	PSO 4.a	PSO 4.b	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	3	1	1	1	1	3	1	1	-
CO2	3	3	1	2	2	2	3	1	1	-
CO3	3	3	1	2	2	2	3	1	1	-
CO4	3	3	1	2	2	2	3	1	1	-
CO5	3	3	1	2	3	2	3	1	1	-

Strong (3) Medium (2) Low (1)

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Course Designer

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M.Sc. Mathematics

(2023 -24 onwards)

Semester II	**ADVANCED ALGEBRA**	Hours/Week: 6	
Core Course-5		Credits: 5	
Course Code **23PMTC21**		Internal 25	External 75

COURSE OUTCOMES

On completion of the course, students will be able to

CO1: explain the fundamental concepts and properties in Galois theory, finite fields and extension fields. [K2]

CO2: apply the basic ideas in proving theorems and lemmas in field theory. [K3]

CO3: solve the problems using the techniques in field theory. [K3]

CO4: analyze the relationship between different fields, roots of the polynomials and its Galois group, the adjoint operation in the real quaternions and the theorem of Frobenius. [K4]

CO5: derive the proofs of the statements in finite fields, extension fields, division ring and division ring of real quaternions. [K4]

UNIT-I

Extension fields – Transcendence of e. (18 Hours)

UNIT-II

Roots or Polynomials.- More about roots (18 Hours)

UNIT-III

Elements of Galois theory. (18 Hours)

UNIT-IV

Finite fields - Wedderburn's theorem on finite division rings. (18 Hours)

UNIT-V

Solvability by radicals - A theorem of Frobenius - Integral Quaternions and the Four - Square theorem. (18 Hours)

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper):

Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved

(To be discussed during the Tutorial hour)

TEXT BOOK

I.N. Herstein. *Topics in Algebra* (II Edition) Wiley Eastern Limited, New Delhi, 1975.

Unit	Chapter	Section
I	5	5.1 and 5.2
II	5	5.3 and 5.5
III	5	5.6
IV	7	7.1 and 7.2 (Theorem 7.2.1 only)
V	5	5.7 (omit Lemma 5.7.1, Lemma 5.7.2 and Theorem 5.7.1)
	7	7.3 and 7.4

REFERENCE BOOKS:

1. M.Artin, *Algebra*, Prentice Hall of India, 1991.
2. P.B.Bhattacharya, S.K.Jain, and S.R.Nagpaul, *Basic Abstract Algebra* (II Edition) Cambridge University Press, 1997. (Indian Edition)
3. I.S.Luther and I.B.S.Passi, *Algebra*, Vol. I –Groups(1996); Vol. II *Rings*,Narosa Publishing House , New Delhi, 1999
4. D.S.Malik, J.N. Mordeson and M.K.Sen, *Fundamental of Abstract Algebra*, McGraw Hill (International Edition), New York. 1997.
5. N.Jacobson, *Basic Algebra*, Vol. I & II Hindustan Publishing Company, New Delhi.

Course Code 23PMTC21	PO1		PO2		PO3	PO4	PO5	PO6	PO7	PO8
	PSO 1.a	PSO 1.b	PSO 2. a	PSO 2.b	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8
CO1	3	-	3	3	3	3	3	2	-	2
CO2	3	1	-	1	3	3	3	2	1	2
CO3	3	-	2	1	3	3	3	2	1	2
CO4	3	-	2	3	3	3	3	2	1	2
CO5	3	1	-	2	3	3	3	2	-	2

Strong (3) Medium (2) Low (1)

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M.Sc. Mathematics

(2023 -24 onwards)

Semester II	**REAL ANALYSIS - II**	Hours/Week: 6	
Core Course-6		Credits: 5	
Course Code **23PMTC22**		Internal 25	External 75

COURSE OUTCOMES

On completion of the course, students will be able to

CO1: explain the basic concepts of Lebesgue Outer Measure, Measurable Functions, Integration of Non- negative functions, Directional derivative and continuity, Fourierseries and Fourier integrals. [K2]

CO2: determine the measure of some sets, Riemann and Lebesgue Integrals, Fourier Seriesand Fourier Integrals, [K3]

CO3: determine the total derivative and extrema of real valued functions of severablevariables. [K3]

CO4: analyze the characteristics and equivalence criterions of various concepts of realfield. [K4]

CO5: analyze the representation and convergence problems of Fourier series. [K4]

UNIT I

Measure on the Real line - Lebesgue Outer Measure - Measurable sets – Regularity - Measurable Functions - Borel and Lebesgue Measurability (18 Hours)

UNIT II

Integration of Functions of a Real variable - Integration of Non- negative functions – The General Integral - Riemann and Lebesgue Integrals (18 Hours)

UNIT III

Fourier Series and Fourier Integrals - Introduction - Orthogonal system of functions – The theorem on best approximation - The Fourier series of a function relative to an rthonormal system - Properties of Fourier Coefficients - The Riesz-Fischer Theorem - The convergence and representation problems in for trigonometric series – The Riemann - Lebesgue Lemma - The Dirichlet Integrals - An integral representation for the partial sums ofFourier series - Riemann's localization theorem (18 Hours)

UNIT IV

Multivariable Differential Calculus - Introduction - The Directional derivative - Directional derivative and continuity - The total derivative - The total derivative expressed in terms of partial derivatives - The matrix of linear function – The Jacobian matrix - The chain rule - Matrix form of chain rule – The mean - value theorem for differentiable functions – A sufficient condition for differentiability (18 Hours)

UNIT V

Implicit Functions and Extremum Problems : Functions with non-zero Jacobian determinants – The inverse function theorem-The Implicit function theorem-Extrema of real valued functions of severable variables-Extremum problems with side conditions.

(18 Hours)

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper):

Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved

(To be discussed during the Tutorial hour)

TEXT BOOK

1. G. de Barra, *Measure Theory and Integration*, Wiley Eastern Ltd., New Delhi, 1981. (for Units I and II).
2. Tom M.Apostol : *Mathematical Analysis*, 2nd Edition, Addison-Wesley Publishing Company Inc. New York, 1974. (for Units III, IV and V).

Unit	Chapter	Section
Text Book 1		
I	2	2.1 to 2.5
II	3	3.1,3.2 and 3.4
Text Book 2		
III	11	11.1 to 11.11
IV	12	12.1 to 12.12
V	13	13.1 to 13.7

REFERENCE BOOKS

1. Burkill,J.C.*The Lebesgue Integral*, Cambridge University Press, 1951.
   2.Munroe,M.E.*Measure and Integration*. Addison-Wesley, Mass.1971.
3. Roydon,H.L.*Real Analysis*, Macmillan Pub. Company, New York, 1988.
4. Rudin, W. *Principles of Mathematical Analysis*, McGraw Hill Company, New York,1979.
5. Malik,S.C. and Savita Arora. *Mathematical Analysis*, Wiley Eastern Limited. New Delhi,1991.
6. Sanjay Arora and Bansi Lal, *Introduction to Real Analysis*, Satya Prakashan, New Delhi,1991

Course Code 23PMTC22	PO1		PO2	PO3	PO4		PO5	PO6	PO7	PO8
	PSO 1.a	PSO 1.b	PSO 2	PSO 3	PSO 4.a	PSO 4.b	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	3	2	2	2	2	1	3	2	1
CO2	3	3	2	2	2	2	1	3	2	1
CO3	3	3	2	2	2	2	1	3	2	1
CO4	3	3	2	2	2	2	1	3	2	1
CO5	3	3	-	2	2	2	1	3	2	1

Strong (3) **Medium (2)** **Low (1)**

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Dr.P.Getchial Pon Packiavathi
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VIRUDHUNAGAR - 626 001

M.Sc. Mathematics

(2023 -24 onwards)

Semester II	**PARTIAL DIFFERENTIAL EQUATIONS**	Hours/Week: 6	
Core Course-7		Credits: 4	
Course Code **23PMTC23**		Internal 25	External 75

COURSE OUTCOMES

On completion of the course, students will be able to

CO1: explain the fundamental concepts of Mathematical Models and Classification of second order equation, Cauchy Problem, Method of separation of variables, Boundary Value Problems and Green's Function. [K2]

CO2: solve problems of Partial Differential Equations arising in various fields. [K3]

CO3: apply various computational techniques to obtain the solution of Partial Differential Equations. [K3]

CO4: analyze Partial Differential Equations of varioustypes, their solutions and fundamental concepts about their existence and uniqueness. [K4]

CO5: analyze the solutions using appropriate methods and give examples. [K4].

UNIT I

Mathematical Models and Classification of Second Order Linear Equation : Classical Equations - The Vibrating String – The Vibrating Membrane – Waves in Elastic Medium – Conduction of Heat in Solids – The Gravitational Potential - Second Order Equations in Two Independent Variables – Canonical Forms – Equations with Constant Coefficients – General Solutions (18 Hours)

UNIT II

The Cauchy Problem : The Cauchy Problem – The Cauchy-Kowalewskaya Theorem – Homogeneous Wave Equations – Initial Boundary Value Problems - Non-homogeneous Boundary Conditions - Finite String with Fixed Ends – Non - homogeneous Wave Equations – Riemann Method – Goursat Problem – Spherical Wave Equation – Cylindrical Wave Equation. (18 Hours)

UNIT III

Method of Separation of Variables: Separation of Variables- Vibrating String Problem – Existence and Uniqueness of Solution of Vibrating String Problem – Heat Conduction Problem – Existence and Uniqueness of Solution of Heat Conduction Problem – Laplace and Beam Equations (18 Hours)

UNIT IV

Boundary Value Problems : Boundary Value Problems – Maximum and Minimum Principles – Uniqueness and Continuity Theorems – Dirichlet Problem for a Circle , a Circular Annulus , a Rectangle - Dirichlet Problem Involving Poisson Equation – Neumann Problem for a circle and a rectangle.

(18 Hours)

UNIT V

Green's Functions: The Delta Function – Green's Functions – Method of Green's Function – Dirichlet's Problem for the Laplace and Helmholtz Operators – Method of Images and Eigen Functions – Higher Dimensional Problem – Neumann Problem. (18 Hours)

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper):

Questions related to the above topics, from various competitive examinations UPSC/ TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved

(To be discussed during the Tutorial hour)

TEXT BOOK

Tyn Myint-U and Lokenath Debnath, *Partial Differential Equations for Scientists and Engineers* (Third Edition), North Hollan, New York, 1987.

Unit	Chapter	Section
I	2 3	2.1 to 2.6 3.1 to 3.4 (omit 3.5)
II	4	4.1 to 4.11
III	6	6.1 to 6.6 (omit section 6.7)
IV	8	8.1 to 8.9
V	10	10.1 to 10.9

REFERENCE BOOKS

1. M.M.Smirnov, *Second Order partial Differential Equations,* Leningrad, 1964.
2. I.N.Sneddon, *Elements of Partial Differential Equations,* McGraw Hill, New Delhi, 1983.
3. R.Dennemeyer, *Introduction to Partial Differential Equations and Boundary Value Problems,* McGraw Hill, New York, 1968.
4. M.D.Raisinghania, *Advanced Differential Equations,* S.Chand & Company Ltd., New Delhi, 2001.
5. S, Sankar Rao, *Partial Differential Equations*, 2nd Edition, Prentice Hall of India, New Delhi. 2004

Course Code 23PMTC23	PO1		PO2		PO3	PO4	PO5	PO6	PO7	PO8
	PSO 1.a	PSO 1.b	PSO 2,a	PSO 2.b	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	3	2	2	2	2	1	3	2	1
CO2	3	3	2	2	2	2	1	3	2	1
CO3	3	3	2	2	2	2	1	3	2	1
CO4	3	3	2	2	2	2	1	3	2	1
CO5	3	3	-	2	2	2	1	3	2	1

Strong (3) Medium (2) Low (1)

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M.Sc. Mathematics
(2023 -24 onwards)

Semester II	**MATHEMATICAL STATISTICS**	Hours/Week: 6	
Core Course-8		Credits: 4	
Course Code **23PMTC24**		Internal 25	External 75

COURSE OUTCOMES

On completion of the course, students will be able to

CO1: explain the basic concepts in Order Statistics, limiting distribution, probability distribution and Statistical test. [K2]

CO2: solve various problems in special distributions. [K3]

CO3: apply various computational techniques to solve problems in society. [K3]

CO4: analyze the statistical data using appropriate probability distributions, limiting distributions and transformation of variables. [K4]

CO5: analyse the statistical data using significance tests for large and small samples. [K4]

UNIT I

Sample Moments and their functions- The notion of Sample and statistic-The distribution of arithmetic mean and independent normally distributed random variables-The χ^2 distribution- The distribution of the statistic ($\bar{X}S$); Student's t- distribution-Fisher's Z-distribution-The distribution of $\bar{X}$ for some non-normal populations.

(18 Hours)

UNIT II

The distribution of sample moment and sample correlation coefficients of a two-dimensional normal population-The distribution of regression coefficients- Limit distribution of sample moments. Order Statistics-The notion of an order statistic –the empirical distributionfunction –Stochastic convergence of sample quantiles**.**

(18 Hours)

UNIT III

Limit distribution of sample quantiles - The limit distribution of successive sample elements- the joint distribution of a group of quantiles – The distribution of the sample range- Tolerance limits- Glivenko Theorem - The theorems of Kolmogorov and Smirnov- Renyi's theorem- theproblem of k-samples. (18 Hours)

UNIT IV

An Outline of the Theory of Runs- the notion of a run- the probability distribution of the number of runs - the expected value and the variance of the runs. (18 Hours)

UNIT V

Significance Test- The concepts of a statistical test- parametric test for small samples and largesamples- The χ^2 test- Test of the Kolmogorov and Smirnov Type- the wald Wolfovitz and Mann –Whitney test- Independence test by contingency tables. (18 Hours)

TEXT BOOK

M. Fisz, Probability Theory and Mathematical Statistics, John Wiley and Sons, New york,1963.

REFERENCE BOOK

1. Gupta. S.C. &Kapoor,V.K. (2002) . Fundamentals of Mathematical Statistics, Sultan Chand & Sons Pvt. Ltd. New Delhi
2. Mood A. M &Graybill F. A &Boes D. G (1974) : Introduction to theory of Statistics, Mcgraw Hill.
3. Hogg R. V. & Craig A. T. 1988) : Introduction to Mathematical Statistics, Mcmillan.

Bansilal and Arora (1989).New Mathematical Statistics, Satya Prakashan, New Delhi.

Unit	Chapter	Section
I	9	9.1 – 9.8
II	9	9.9, 9.10
	10	10.1 – 10.4
III	10	10.5 – 10.13
IV	11	11.1 -11.4
V	12	12.1 -12.7

Course Code	PO1		PO2	PO3	PO4		PO5	PO6	PO7	PO8
23PMTC24	PSO 1.a	PSO 1.b	PSO 2	PSO 3	PSO 4.a	PSO 4.b	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	3	2	2	2	2	1	3	2	1
CO2	3	3	2	2	2	2	1	3	2	1
CO3	3	3	2	2	2	2	1	3	2	1
CO4	3	3	2	2	2	2	1	3	2	1
CO5	3	3	-	2	2	2	1	3	2	1

Strong (3) Medium (2) Low (1)

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M.Sc. Mathematics

(2023 -24 onwards)

Semester II	**MODELLING AND SIMULATION WITH EXCEL**	Hours/Week: 6	
DSEC-2		Credits: 4	
Course Code **23PMTE21**		Internal 25	External 75

COURSE OUTCOMES

On completion of the course, students will be able to

CO1: understand a model's structure, its capabilities, and its underlyingassumptions.[K2]

CO2: solve problems in Simulation using Excel. [K3]

CO3: Perform data analysis on both quantitative and qualitative data leading tomodels of general and specific behaviour. [K3]

CO4: examine models in various forms and to understand the visual models of the behaviour of a system.[K4]

CO5: analyze the critical role of Excel in the early or rapid prototyping of problems.[K4]

UNIT I

Modelling and Simulation: Introduction Model, Classifications of Models, An Example of Deterministic Modelling, A Preliminary Analysis of the Event, Understanding the Important Elements of a Model, Pre-Modelling or Design Phase, Modelling Phase.

(18 Hours)

UNIT II

Resolution of Weather and Related Attendance, Attendees Play Games of Chance, OLPS Modelling Effort, Model Building with Excel, Basic Model, Sensitivity Analysis, Controls from the Forms Control Tools, Option Buttons, Scroll Bars. (18 Hours)

UNIT III

Types of Simulation and Uncertainty, Incorporating Uncertain Processes in Models, The Monte Carlo Sampling Methodology, Implementing Monte Carlo Simulation Methods.

(18 Hours)

UNIT IV

Modelling Arrivals with the Poisson Distribution, VLOOKUP and HLOOKUP Functions, A Financial Example–Income Statement, An Operations Example–Autohaus, Status of Autohaus Model. (18 Hours)

UNIT V

Building the Brain Worksheet, Building the Calculation Worksheet, Variation in Approaches to Poisson Arrivals: Consideration of Modelling Accuracy, Sufficient Sample Size, Building the Data Collection Worksheet, Results. (18 Hours)

TEXT BOOK

1. Hector Guerrero, Excel Data Analysis Modelling and Simulation, Second Edition, Springer.

Unit	Chapter	Section
I	7	7. 1 to 7.3 7.4 – 7.4.1, 7.4.2
II	7	7.4.3 – 7.4.6 7.5.1 – 7.5.5
III	8	8.2, 8.3 – 8.3.1 only
IV	8	8.3.3 , 8.3.4 8.4 8.5 – 8.5.1
V	8	8.5.2 – 8.5.7

REFERENCE BOOKS

1. Cliff T. Ragsdale, Spreadsheet Modelling and Decision Analysis, Ninth Edition.
2. **John** A. **Sokolowski**, Catherine M. Banks, Modelling and Simulation Fundamentals,A John Wiley & Sons, Inc. Publication, 2010.

Course Code 23PMTE21	PO1		PO2	PO3	PO4		PO5	PO6	PO7	PO8
	PSO 1.a	PSO 1.b	PSO 2	PSO 3	PSO 4.a	PSO 4.b	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	3	2	2	2	2	1	3	2	1
CO2	3	3	2	2	2	2	1	3	2	1
CO3	3	3	2	2	2	2	1	3	2	1
CO4	3	3	2	2	2	2	1	3	2	1
CO5	3	3	-	2	2	2	1	3	2	1

Strong (3) Medium (2) Low (1)

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M.Sc. Mathematics
(2023 -24 onwards)

Semester II	**WAVELETS**	Hours/Week: 6	
DSEC-2		Credits: 4	
Course Code **23PMTE22**		Internal 25	External 75

COURSE OUTCOMES

On completion of the course, students will be able to

CO1: understand Wavelets and to make use of the tools of Fourier Analysis. [K2**]**

CO2: apply Convergence Properties of Wavelets Series. [K3]

CO3: apply systematic method to produce orthonormal wavelets.[K3]

CO4: analyze scaling functions along with convergence properties and speed of convergence. [K4]

CO5: analyze the smoothness of functions using wavelets. **.** [K4]

UNIT I

Introduction to Wavelets, Motivation and Heuristics, Wavelet Transform, Haar Functions and Haar Series, Haar Sums and Dyadic Projections, Haar Series in C_0 and L_p Spaces, Pointwise Convergence of Haar Series. (18 Hours)

UNIT II

Multiresolution Analysis, Orthonormal Systems and Riesz Systems, Scaling Equations and Structure Constants, From Scaling Function to MRA, Meyer Wavelets**.**

(18 Hours)

UNIT III

From Scaling Function to Orthonormal Wavelet, Direct Proof that $V_1 \ominus V_0$ is spanned by $\{\psi(t-k)\}_{k\in\mathbb{Z}}$, Null Integrability of Wavelets without Scaling Functions.

. (18 Hours)

UNIT IV

Wavelets with Compact Support, From Scaling Filter to Scaling Function, Explicit Construction of Compact Wavelets, Smoothness of Wavelets, Cohen's Extension Theorem. (18 Hours)

UNIT V

Convergence Properties of Wavelets Expansions, Wavelet Series in L_p Spaces, Jackson's and Bernstein's Approximation Theorems. (18 Hours)

TEXT BOOK

Mark A. Pinsky: Introduction to Fourier Analysis and Wavelets, Cenage Learning India Pvt. Ltd, 2009.

Unit	Chapter	Section
I	6	6.1,6.2, 6.3 – 6.3.1 to 6.3.3
II	6	6.4.1 to 6.4.3
III	6	6.4.5
IV	6	6.5
V	6	6.6

REFERENCE BOOK

1. C. Sidney Burrus, Ramesh A. Gopinath, Haitao Guo: Introduction to Wavelets and Wavelet Transforms, Prentice Hall Upper Saddle River, New Jersey 07458.
2. Jonas Gomes Luiz Velho: From Fourier Analysis to Wavelets, Springer, 2015.
3. M.V. Altaisky: Wavelets Theory, Applications Implementation, University Press, 2009.
4. K.P. Soman, K.I. Ramachandran, N.G. Resmi: Insight into Waveletes from Theory to Practice, Third Edition.

Course Code 23PMTE22	PO1		PO2	PO3	PO4		PO5	PO6	PO7	PO8
	PSO 1.a	PSO 1.b	PSO 2	PSO 3	PSO 4.a	PSO 4.b	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	2	3	1	1	1	-	1	2	-
CO2	3	2	3	2	2	1	-	1	2	-
CO3	3	2	2	3	2	2	3	1	2	-
CO4	3	2	2	3	2	2	3	1	2	-
CO5	3	2	1	3	3	3	3	1	2	-

Strong (3) Medium (2) Low (1)

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M.Sc. MATHEMATICS
(2023 - 24 onwards)

Semester II	**NEURAL NETWORKS**	Hours/Week: 6	
DSEC-2		Credits: 4	
Course Code **23PMTE23**		Internal 25	External 75

COURSE OUTCOMES

On completion of the course, students will be able to

CO1: understand the Basics of Artificial Neural Networks. [K2]

CO2: apply Basic Learning Laws and Activation Dynamic Models. [K3]

CO3: solve Pattern Recognition Problems. [K3]

CO4: analyze Feedforward Neural Networks, Pattern Association Networks and Pattern Classification Networks. [K4]

CO5: analyze Feedback Neural Networks, Linear Autoassociative FF Networks and Pattern Storage Networks [K4]

UNIT I

Basics of Artificial Neural Networks:

Characteristics of Neural Networks - Historical Development of Neural Network Principles. (18 Hours)

UNIT II

Basics of Artificial Neural Networks:

Artificial Neural Networks: Terminology - Models of Neuron – Topology - Basic Learning Laws

Activation and Synaptic Dynamics

Activation Dynamics Models. (18 Hours)

UNIT III

Activation and Synaptic Dynamics

Synaptic Dynamics Models - Learning Methods - Stability and Convergence.

Functional Units of ANN for Pattern Recognition Tasks

Pattern Recognition Problem (18 Hours)

UNIT IV

Functional Units of ANN for Pattern Recognition Tasks

Basic Functional Units - Pattern Recognition Tasks by the Functional

Feedforward Neural Networks

Analysis of Pattern Association Networks - Analysis of Pattern Classification Networks. (18 Hours)

UNIT V

Feedback Neural Networks

Analysis of Linear Auto associative FF Networks - Analysis of Pattern Storage Networks. (18 Hours)

TEXT BOOK

B. Yegnanarayana, Artificial Neural Networks, Prentice Hall of India, 2005.

Unit	Chapter	Section
I	1	1.1, 1.2
II	1	1.3 – 1.6
	2	2.1, 2.2
III	2	2.3 – 2.5
	3	3.1
IV	3	3.2, 3.3
	4	4.1, 4.2 ,4.3
V	5	5.1 to 5.3

REFERENCE BOOKS:

1. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer
2. Adam Gibson and Josh Patterson, Deep Learning: A Practioner's Approach, First Editio

Course Code 23PMTE23	PO1		PO2	PO3	PO4		PO5	PO6	PO7	PO8
	PSO 1.a	PSO 1.b	PSO 2	PSO 3	PSO 4.a	PSO 4.b	PSO 5	PSO 6	PSO 7	PSO 8
CO1	3	3	1	1	1	1	3	1	1	-
CO2	3	3	1	2	2	2	3	1	1	-
CO3	3	3	1	2	2	2	3	1	1	-
CO4	3	3	1	2	2	2	3	1	1	-
CO5	3	3	1	2	3	2	3	1	1	-

Strong (3) Medium (2) Low (1)

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