P. D. E. A's
Prof. Ramkrishna More Arts, Commerce and Science College Akurdi Pune-411044

Affiliated to

Savitribai Phule Pune University [SPPU]

M.Sc. Mathematics

(Two Years M.Sc. Program)

Choice Based Credit System [CBCS]
Under
Autonomy and NEP-2020
(2024 Pattern)

From Academic Year
2025-2026

Syllabus

Second Year Post-Graduate (M.Sc. II) Mathematics

Board of Studies in Mathematics

Rules and Regulations

1. **National Credit Framework (NCrF):** For creditisation and integration of all higher education qualifications leading to a certificate/ diploma/ degree with multiple entry and exit options, college will refer to National Credit Framework (NCrF) which encompasses the qualification frameworks for higher education, vocational and skill education and school education, namely National Higher Education Qualification Framework (NHEQF), National Skills Qualification Framework (NSQF) and National School Education Qualification Framework (NSEQF) respectively.

2. **Structure of Four years multidisciplinary UG Programme and Five Years Integrated Multidisciplinary Master's Degree Programmes with Multiple Entry and Exit Options at Different Level**

   (i) Students will have the flexibility to enter four years multidisciplinary Under Graduate Programme in odd semesters and exit a programme after the successful completion of even semesters as per their future career needs.

   (ii) Students will get a Certificate after a One year programme (minimum 40 Credits), a Diploma after two years (minimum 80 Credits), a Bachelor's degree after three years (minimum 120 Credits), and a Bachelor's degree with Research or Honours after Four years (minimum 160 Credits).

3. **Qualification Type and Credit Requirements of Four Years Multidisciplinary Degree Programme with Multiple Entry and Exit Options**

   (i) Details of qualifications, minimum credit requirements, exit credit courses, year and semester are as under:

Levels	Qualification Title	Credit Requirements		Semester	Year
		Minimum	Maximum		
4.5	UG Certificate	40	44	2	1
5.0	UG Diploma	80	88	4	2
5.5	Three Years Bachelor's degree	120	132	6	3
6.0	Bachelor's degree Honour's with Major	160	176	8	4
	Bachelor's degree Honour's with Major	160	176	8	4
7.0	Master's Degree	200	220	10	5
8.0	Ph. D.	----	-----	-----	----

(ii) An exit 6-credit bridge course(s) lasting two months, including at least 6-credit job specific internship/apprenticeship that will help the graduates acquire job-ready competencies required to enter the workforce will be an additional requirement for the award of the undergraduate Certificate/ Diploma/ three year Bachelor's Degree.

(iii) On exit, the students will have the option to re-enter the programme in the college, or in a different higher education institution. Re-entry at various levels for lateral entrants in academic programmes should be based on the earned and valid credits as deposited and accumulated in the Academic Bank of Credits (ABC) through Registered Higher Education Institutions (RHEI) and proficiency test records.

(iv) Eligibility for admission to the fourth year of four-year **Honours with Research Degree Programmes** as per UGC guidelines: Minimum CGPA of 7.5 or minimum 75% at three-year degree.

(v) PG curriculum, as illustrated below, have flexibility a) One-year Post-Graduate Diploma (PGD), b) Two year Post-graduate Programme and c) 5 Years Master's degree programmes with multiple Entry and Exit options at different levels.

(a) Post-Graduate Diploma (PGD): Programme duration- One year (2 semesters) after any bachelor's degree, min. 40 credits

(i) UGC: 1-Year (2 semesters) Post-Graduate Diploma (PGD) after 3-years Bachelor's degree: Level 6.0

(ii) UGC: 1-Year (2 semesters) PGD after 4 years Bachelor's degree (Honors/ Research): Level 6.5

(b) Master's Degree:

(i) UGC: 2-Years (four semesters) Master's Degree after obtaining a 3-years Bachelor's degree, Minimum 40 credits/year, second year devoted entirely to research, PG – 2nd year: Level 6.5

OR

(i) 1-Year (two semesters) Master's Degree after obtaining a 4-year Bachelor's degree (Honours/Research): Minimum 40 credits: Level 6.5

(c) Level 8 represents Ph. D. Research Degree.

(d) A 5-year Integrated Bachelor's and Master's programme shall have a minimum of 220 credits.

(e) Master's and doctoral programmes, while providing rigorous research-based specialization, should also provide opportunities for multidisciplinary work, in academia, government, research institutions, and industry.

4. Lateral Entry/ Re-entry at higher Levels after exit from lower levels of four years multidisciplinary UG degree programme:

(i) The credit points earned and accumulated shall be used to determine the eligibility for taking admission to various programs at multiple levels, subject to fulfilment of the broad principles laid down under NCrF. Students who leave with a Certification, Diploma, or a Basic Bachelor's Degree will be eligible to re-enter the programme at the exit level to complete or progress to the next level through lateral entry mode. Depending upon the academic and physical facilities available, the State Universities/ Autonomous Colleges (Higher Education Institutions or HEI) may earmark specific seats/ intake for lateral entry into the second year/ third year/ fourth year of a four years multidisciplinary UG degree programme as approved by Professional Standard

Setting Bodies (PSSB/Govt. of Maharashtra/ statutory council of affiliating University plus any consequential vacancies caused by exits to an ongoing programme (four-year Degree Programme and Integrated Master's or second year Master's). Lateral entry or Re-entry is open to those students if he/she has either –

(a) successfully completed the first year/second year/third year of the particular four years multidisciplinary degree programme in any ABC registered HEI with valid credits in ABC and re-entering into the second year/third year/fourth year, respectively of the same four years degree programme of any ABC registered HEI, within stipulated/ permissible period of years as decided by Statutory Councils of that HEI

OR

(b) Already successfully completed a multidisciplinary four-year first-degree programme and is desirous of and academically capable of pursuing another multidisciplinary four years first-degree programme in an allied subject.

(ii) A student will be allowed to enter/re-enter only at the odd semester. Re-entry at various levels for lateral entrants in academic programmes should be based on the earned and valid credits as deposited and accumulated in Academic Bank of Credits (ABC) through Registered Higher Education Institutions (RHEI) and proficiency test records. However, in terms of the admission eligibility requirements, the student shall belong to the same faculty/ discipline in terms of Major Subject i.e., the Major subject of his earlier Programme and the Major subject of the new Programme for which he is seeking admission must be from the same faculty/discipline. Reservation for lateral entry will be executed as per the Government of Maharashtra norms.

5. Distribution of Credits across Multidisciplinary Four Years Degree Programme:

(i) Four-year multidisciplinary degree programme with Honours/ Specialization Degree will have Internship and Core /Major Courses with a minimum of 22 credits per sem. in the Fourth Year.

(ii) Four-year multidisciplinary degree programme with Research will have Research Projects, Seminars, Dissertations and Internships with a minimum of 22 credits per Sem. in the Fourth Year.

(iii) Students shall select a 'Major or Core Subject/ Discipline' and a '**Minor Subject/Discipline' from the lists of various Subject Combinations and Options provided the Colleges.** In general, for the four years multidisciplinary bachelor's degree programme, the distribution of credits will be as follows:

(a) Disciplinary/interdisciplinary Major/ Core Subject (minimum of 68 credits)- Mandatory and Elective Courses

(b) Disciplinary/interdisciplinary Minor Subject (maximum of 22 credits)

(c) Skill based/Vocational studies corresponding to the Major/ Core Subject (8 credits)

(d) Field projects/internship/apprenticeship/community engagement and service corresponding to the Major/ Core Subject (14-22 credits) with a maximum of six credits per Semester

(e) Generic/ Open Electives through Baskets of Elective Courses (12 credits),

(f) Ability Enhancement Courses including Languages, Literature and Environmental Studies (12 credits),

(g) In-built modules on the Indian Knowledge System (IKS) in Major/ Core Subject at Level 4.5 – 2 credits

(h) Value-based Education, Life Skills and Professional Ethics: Co-curricular Courses such as Sports and Culture, NSS/NCC and Fine/ Applied/Visual Arts (8 credits).

Student can earn some credits (SEC/VSC/GE/OE) in the form of online from-

(i) The National Skills Qualifications Framework (NSQF) organizes qualifications for Vocational and Skill Courses in a series of 8 levels based on professional knowledge, professional skills, core skills and responsibilities, in the increasing order of complexity and competency.

(ii) University Grants Commission (Credit Framework For Online Learning Courses through Study Webs of Active-Learning for Young Aspiring Minds) Regulations, 2021, **permits up to 40 per cent of the total courses being offered in a particular programme in a semester through the Online Learning Courses offered through the Study Webs of Active-Learning for Young Aspiring Minds (SWAYAM) platform**.

6. Examination and Assessment Process:

(i) The basic principle of the credit framework is that credits are a function of the successful completion of a program of study/ vocational education/ training and assessment. No credit can be earned by the student unless the student is assessed for the achievement of the desired competencies and outcome of a program.

(ii)Exit options are provided with certification, diploma and basic Bachelor's degrees to the students at the end of the second, fourth and sixth semesters of a four years multidisciplinary degree programme. Students will receive a Bachelor's degree with Honours/ Research on successfully completing of all eight semesters of the UG Program either at a stretch or with opted exits and re-entries.

(iii) For the smooth success of four-year multidisciplinary degree programme with multiple entry and exit systems, the examination mode will be based on the combination of innovative trends in formative (informal and formal tests administered during the learning process) and summative (evaluation of students learning at the end of an instructional unit) examination modes. This is in line with the UGC Report on 'Evaluation Reforms in Higher Educational Institutions (2019)'.

(iv) Evaluation of each students in each course will be done as follows

a. Each theory or practical course will be of 2 credits = 50 mark

b. Internal evaluation 30% weightage (15 mark)

c. External evaluation 70% weightage (35 marks)

d. Students should secure 40% marks in each type of evaluation for successful completion of a course (student should secure at least 6 marks in internal and 14 marks in external evaluation).

(v) Evaluation Pattern.

a. Internal evaluation - Two written test, each of 20 marks will be conducted i. e. two tests on two modules. 1st assignment after completing 6 weeks of teaching and 2nd on completion of 13th week of teaching. Question paper should be designed so that evaluation of CO, PO, PSO can be performed. 10 marks out of 15 will be assigned from these written tests. Remaining 5 marks will be assigned from other types of evaluation such as seminars, orals, poster presentation, open book challenging tests, surprise test, objective test on whole syllabus of the course (at least 40 questions of objective type must be designed), etc. for 5 marks at least two different types technique must be utilized.

b. External Evaluation - External evaluation will be done at the end of semester. For theory, 35 marks written examination will be conducted and time of examination will be 2-hours.

7. Declaration of Results:

(i) Declaration of result is based on the Semester Grade Point Average (SGPA) earned towards the end of each semester or the Cumulative Grade Point Average (CGPA) earned at the completion of all eight semesters of the programme and the corresponding overall alpha-sign or letter grades as given in Table 2. If some candidates exit at the completion of the first, second or third year of the four years Undergraduate Programmes, with Certificate, Diploma or Basic Degree, respectively, then the results of successful candidates at the end of the second, fourth or sixth semesters shall also be classified on the basis of the CGPA obtained in the two, four, six or eight semesters, respectively. Successful candidates at the end of the tenth semester of the integrated Master's Degree Programmes shall also be classified on the basis of CGPA obtained in the ten semesters of the Programmes. Likewise, the successful candidates of one year or two semesters Master's Degree Programme are also classified on the basis of the CGPA of two semesters of the Master's Degree Programme.

Table-2: Grades on degree certificate/mark sheet will be assigned to the students as per the following table

Semester GPA/ Program CGPA Semester/Program	**% of Marks**	**Alpha-Sign / Letter Grade Result**
9.00-10.00	90-100	O (outstanding)
8.00 - <9.00	80.00 – <90.00	A+ (Excellent)
7.00 - <8.00	70.00-<80.00	A (Very Good)
6.00 - <7.00	60.00-<70.00	B+ (Good)
5.50 - <6.00	55.00-<60.00	B (Above Average)
5.00 - <5.50	50.00-<55.00	C (Average)
4.00 - <5.00	40.00-<50.00	P (Pass)
Below 4.00	< 40	F (Fail)
Ab	----------	Absent

(i) A student obtaining Grade F shall be considered failed and will be required to reappear in the examination. For non-credit courses 'Satisfactory' or "Unsatisfactory' shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA.

2. Award of Major and Minor Degree:

(i) A student pursuing four-year multidisciplinary UG programme will be awarded an appropriate Honours/ Research degree in Major/ Core Subject on completion of VIII Semester with the minimum of 176 credits if he secures in that Subject at least 50% of the total credits for that programme. He shall thus study the specific number of Mandatory Core Courses, Core Electives, Vocational and Skill Courses and Field projects/ Internships connected to Core Subjects in eight semesters so as to cover at least 50% of the total credits.

(ii) In case of Research Degree, a student shall pursue research project and write dissertation in that Major in the VII and VIII semesters.

On the basis of above rules and regulations under NEP-2020 following course frame work is adopted by the Prof. Ramkrishna More Arts, Commerce and Science College, Akurdi, Pune-411044 for the completing of four years honours degree in Major and Minor subjects.

3. Distribution of Credits across Four Years Degree Programmes:

In general, for the four years' bachelor's degree programme, the distribution of credits will be as follows:

(a) Major (Core) Subject comprising Mandatory and Elective Courses:

i. Minimum 50% of total credits corresponding to Three/Four - year UG Degree-Mandatory Courses offered in all Four years;

ii. 2 credit course on Major Specific IKS shall be included under Major;

iii. Elective courses of Major will be offered in the third and/or final year.

iv. Vocational Skill Courses, Internship/ Apprenticeship, Field Projects, Research Projects connected to Major first to fourth year.

(b) Minor Subject: 18-20 Credits

i. The Minor subjects may be from the different disciplines of the same faculty of DSC Major (Core) or they can be from different faculty altogether.

ii. The credits of Minor subjects shall be completed in the first three years of UG Programme.

(c) Generic/ Open Elective Courses (OE): 10-12 credits

i. It is to be offered in I and/or II year

ii. Faculty-wise baskets of OE shall be prepared by University/ Autonomous Colleges.

iii. OE is to be chosen compulsorily from faculty other than that of the Major.

(d) Vocational and Skill Enhancement Courses (VSEC): 14-16 credits

Vocational Skill Courses (VSC): 8-10 credits, including Hands on Training corresponding to the Major and/or Minor Subject:

i. To be offered in first to three years;

ii. Wherever applicable vocational courses will include skills based on advanced laboratory practicals of Major

 # Skill Enhancement Courses (SEC): 06 credits

i. To be offered in I and II year;

ii. To be selected from the basket of Skill Courses approved by University/ Autonomous Colleges

(e) Ability Enhancement Courses (AEC), Indian Knowledge System (IKS) and Value Education Courses (VEC): 14 Credits

- **AEC: 08 credits**

i. To be offered in I and II year

ii. English: 04 Credits

iii. Modern Indian Language: 04 credits

iv. To be offered from the Basket approved by the College;

The focus for both languages should be on linguistic and communication skills.

- **IKS: 2 Credits**

i. To be offered in I Year

ii. Courses on IKS to be selected from the basket of IKS courses approved by the Colleges

- **VEC: 04 Credits**

iii. To be offered in I year

iv. Value Education Courses (VEC) Environmental Science Education (Compulsory), Understanding India, and Digital and Technological Solutions.

(f) Field Projects/ Internship/ Apprenticeship/ Community Engagement and Service corresponding to the Major (Core) Subject, Co-curricular Courses (CC) and Research

Project

- **Internship/Apprenticeship corresponding to the Major (Core) Subject: 8 Credits**
- **Field Projects/Community Engagement and Service corresponding to the Major (Core) Subject: minimum 4-6 credits**

To be offered in II, and III years of UG Degree Programmes.

- **Co-curricular Courses (CC) such as Health and Wellness, Yoga education sports, and fitness, Cultural Activities, NSS/NCC and Fine/ Applied/ Visual/ Performing Arts: 8 credits.** To be offered in I and/or II year
- **Research Projects: 12 credits**

To be offered in the final year for 4-year Honours with Research UG Degree

The UGC Regulations, 2021 permit up to 40% of the total courses being offered in a particular programme in a semester through the Online Learning Courses offered through the SWAYAM platform and/or other State Level Common Platforms which can be developed in due course with the participation of different Universities/ HEIs.

Abbreviations: Generic/ Open Electives: **GE**/**OE**; Vocational Skill and Skill Enhancement Courses: **VSEC**; Vocational Skill Courses: **VSC**; Skill Enhancement Courses**: SEC**; Ability Enhancement Courses: **AEC**; Indian Knowledge System: **IKS**; Value Education Courses: **VEC; OJT**: On Job Training: Internship/ Apprenticeship; Field projects: **FP**; Community engagement and service: **CEP**; Co-curricular Courses: **CC**; Research Methodology-**RM**; Research Project: **RP** Note: The Credit Distribution Table given above is illustrative only. The Universities/ Autonomous Colleges may suitably modify within the broader framework of credit distribution across six verticals.

Post Graduate Degree Course Framework under Autonomy as per NEP-2020
If not mentioned, each proposed course (theory/practical) is of 2 credits

Sem.	Major Courses	Major Elective Curses	Minor Curses	FP/OJT/CEP	Total Credits
I	(5×2C)T Credits 2×2C(T/P)	2T+2T/P credits	RM 4 Credits (T)	0	**22-Credits**
II	(5×2C)T Credits 2×2C(T/P)	2T+2T/P credits	0	OJT (4 Credit) (P)	**22-Credits**
III	(4+4+2)T credits (2+2)T/P	2T+2T/P credits	0	Research Project-I (4 credits) (P)	**22-Credits**
IV	(4+4+2)T credits (2)T/P	2T+2T/P credits	0	Research Project-II (6 credits) (P)	**22 -Credits**
Total Credits	**54 Credits**	**16 Credits**	**4 Credits**	**14 Credits**	**88 Credits**

Important Note:

1. Theory course may be 2 or 4 credit.

2. Practical course for any type of course will be of 2 credits.

3. For any programs in any type course where practical are included (Major, Minor, VSC,

SEC, GE/OE: Percent practical should be in the range 30 to 40%.

Long Forms:

T-Theory; **P-** Practical; **RM** – Research methodology; **RP -** Research Project; **OJT** – On Job training;

Definitions:

1. One semester = 15 weeks

2. 1-credit theory = 15 hours i.e. for 1 credit, 1 hour per week teaching is to be performed.

15 hours of 1-credit are splinted as 12 hours actual teaching + 3 hours Tutorial (practice problem solving sessions, repeated discussion on difficult topics, discussion on student's difficulties, questions discussion and internal evaluation)

3. 1-credit practical = 30 hours. Thus, 1 credit practical = 2 contact hours in laboratory per week. 30 hours splinted as 24 hours actual table work and 6 hours for journal competition, oral on each practical and other internal evaluation.

4. Each practical course of any course is of 2 credits = 60 hours per semester

a. Minimum 12 laboratory sessions will be conducted in one semester.

b. Each laboratory sessions will be of 4 hours.

Structure of the course: M. Sc. Mathematics

Semester	Course Type	Course Code	Generic Name	Title of the Course	Credit	No. of Hours/ Practical to be conducted
III	Core	MTMAT-631	Mathematics theory paper-13	General Topology	4	60
		MTMAT-632	Mathematics theory paper-14	Field Theory	4	60
		MTMAT-633	Mathematics theory paper-15	Graph Theory	2	30
		MTMAP-634	Mathematics Practical paper-7	Combinatorics	2	12
		MTMAP-635	Mathematics Practical paper-8	Scientific Writing Using Latex	2	12
	Elective	MTMET-631- A	Mathematics theory paper-16- A	Coding Theory	2	30
		MTMET-631-B	Mathematics theory paper-16-B	Foundation Of Data Science	2	30
		MTMEP-632- A	Mathematics Practical paper-9-A	Coding Theory	2	12
		MTMEP-632- B	Mathematics Practical paper-9-B	Foundation Of Data Science	2	12
	RP-1	MTRPP-631		Research Project	4	

IV	Core	MTMAT-641	Mathematics theory paper-17	Fourier Series and Boundary Value Problems	4	60
		MTMAT-642	Mathematics theory paper-18	Functional Analysis	4	60
		MTMAT-643	Mathematics theory paper-19	Lattice Theory	2	30
		MTMAP-644	Mathematics practical paper-10	Probability and Statistics	2	12
	Elective	MTMET-641-A	Mathematics theory paper-20-A	Data Analytics using Python	2	30
		MTMET-641- B	Mathematics theory paper-20-B	Differential Geometry	2	30
		MTMEP-642-A	Mathematics Practical paper11-A	Data Analytics using Python	2	12
		MTMEP-642- B	Mathematics Practical paper-11-B	Differential Geometry	2	12
	RP-2	MTRPP-641		Research Project	6	

Program Outcomes:

PO1: Knowledge Skill: Equip the student with skills to analyse problems, formulate an hypothesis, evaluate and validate results, and draw reasonable conclusions thereof. Capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge.
PO-2: Problem Analysis: Well equipped with an understanding of the analytical methods involved, they are in a position to interpret and analyse results obtained from experiments and draw suitable conclusions against their supported data acquired.
PO-3:Designing Solutions: Having acquired knowledge of mathematical subjects, students are trained to think out of the box, design and model that demonstrate their understanding of the mathematical methods and processes involved.

PO4: Scientific Communication Skills: Imbibe effective mathematical communication in both oral and written proof of theorems. Ability to show the importance of the subject as precursor to various scientific developments since the beginning of civilization.

PO-5: Analytical Reasoning: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyse and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples.

PO-6: Leadership Qualities: Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination in a smooth and efficient way.

PO-7: Self-Directed and Life-Long learning: Work independently, identify appropriate resources required for a project, and manage a project through to completion. Exhibit subject-specific transferable knowledge in Mathematics relevant to job trends and employment opportunities.
Po-8: Environment and Sustainability: Understand the issues of environmental contexts and sustainable development.
PO-9: Critical Thinking: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

PO-10: Research Skills: Prepare students for pursuing research or careers in industry in concerned subject and allied fields. Capability to use appropriate software to solve various problems and to apply programming concepts of Python to various scientific investigations , problem solving and interpretation.

Program Specific Outcomes:
PSO1: **Strong Foundation in Knowledge:** Have strong foundation in core areas of Mathematics, and be able to communicate Mathematics effectively.
PSO 2: **Abstract Skills:** Evaluate hypotheses, theories, methods and evidence within their proper contexts.
PSO3: **Problem Solving**: Solve complex problems by critical understanding, analysis and Synthesis.

SEMESTER-III
Mathematics theory paper 13

Course Code: MTMAT-631 **Course Type: Theory**
Course Name: General Topology
Credits: 4 **Hours: 60**

Module-I

Unit 1 Prerequisite **[5 Hours]**

1. Cartesian Products
2. Finite set
3. Countable and Uncountable Sets
4. Well-ordered Sets

Unit 2 Topological Spaces and Continuous Function **[20 Hours]**

1. Topological Spaces
2. Basis for a Topology
3. Order Topology
4. Product Topology on X× Y
5. Subspace Topology
6. Closed Sets and Limit Points

7. Continuous Functions
8. The Product Topology, Metric Topology

Module-II

Unit 3 Connected and Compact Spaces **[20 Hours]**

1. Connected spaces
2. Connected Subspaces of Real Line
3. Components and Local Connectedness
4. Compact spaces
5. Compact Subspaces of the Real Line
6. Limit point compactness
7. Local Compactness

Unit 4 Countability and Separation Axions **[15 Hours]**

1. The Countability Axioms
2. The Separation axioms and Normal Spaces
3. Urysohm Lemma
4. The Urysohn Metrization Theorem
5. Tietz Extention Theorem
6. Tychonoff's Theorem

Recommended Books:

J. R. Munkres, Topology: A First Course, (Prentice Hall, Second Edition), 2000.

Course Outcomes:

CO 1: Define fundamental set theory concepts like Cartesian products and countable sets.

CO 2: Explain structures of topological spaces and their various topologies.

CO 3: Apply properties of closed sets, limit points, and continuous functions.

CO 4: Analyse connected and compact spaces in topology.

CO 5: Evaluate Countability and separation axioms effectively.

CO 6: Solve problems using advanced theorems like Urysohn's and Tychonoff's Theorem.

SEMESTER-III

Mathematics theory paper 14

Course Code: MTMAT-632 **Course Type: Theory**

Course Name: Field Theory

Credits: 4 **Hours: 60**

Module-I

Unit 1 Field Extensions **[35 Hours]**

1. Basic theory of Field Extensions
2. Algebraic Extensions

3. Splitting Fields and Algebraic Closures
4. Separable and Inseparable Extensions
5. Cyclotomic Polynomials and Extensions
6. Normal Extensions and Transcendental Extensions

Module-II

Unit 2 Galois Theory **[25 Hours]**

1. Basic Definitions
2. The Fundamental Theorem of Galois Theory
3. Finite Fields
4. Galois Groups of Polynomials
5. Solvable and Radical Extensions: Insolvability of the Quintic

Recommended Books:

Dummit and Foote, Abstract Algebra, 2nd Edition, Wiley Eastern Ltd.

Course Outcomes:

CO 1: Define the fundamental concepts of field extensions and algebraic extensions.

CO 2: Describe the concept of splitting fields, algebraic closures, and separable vs. inseparable extensions.

CO 3: Determine cyclotomic polynomials, normal extensions, and transcendental extensions

CO 4: Analyse the basic definitions and principles of Galois theory.

CO 5: Evaluate the problems involving finite fields and Galois groups by using the fundamental theorem of Galois theory to.

CO 6: Investigate solvable and radical extensions, including the insolvability of the quintic**.**

SEMESTER- III

Mathematics theory paper 15

Course Code: MTMAT-633 **Course Type: Theory**

Course Name: Graph Theory

Credits: 2 **Hours: 30**

Module I

Unit 1 Topics in Graph Theory **[15 Hours]**

1. Graphs; Graphs as Models; Matrices and Isomorphism; Decomposition and Special Graphs; Degree of a vertex; Counting and Bijections
2. Paths, Cycles, Trails: Connection in Graphs; Bipartite Graphs; Eulerian Circuits; Hamiltonian Cycles
3. Directed Graphs: Definition and Examples; Vertex Degrees; Eulerian Digraphs

Module II

Unit 2 **Trees** **[12 Hours]**

1. Trees: Properties of Trees; Distance in Trees and Graphs
2. Enumeration of Trees: Spanning Trees in Graphs; Minimum Spanning Trees; Shortest Paths; Connectivity; Edge Connectivity

Unit 3 Matchings **[03 Hours]**

1. Maximum Matchings ; Hall‟s Matching Condition

Recommended Books:

D. B. West: Introduction to Graph Theory; 2 Edn; PHI Learning Pvt.Ltd.

Course Outcomes:

CO1: Describe the concepts of graphs.
CO2: Give examples on counts and bijections in graphs.
CO3: Trace paths, cycles and traces in a certain graphs.
CO4: Differentiate different types of graphs.
CO5: Visualize and analyze the tree pattern of graphs.
CO6: Recognize matchings in various graphs and relate them in various real life applications.

Semester-III

Mathematics Practical Paper 7

Course Code: MTMAP-634 **Course Type: Practical**
Course Name: Combinatorics
Credits: 2 **Practical: 12**

Practical No. 01: Two Basic Counting Principals
Practical No. 02: Simple Arrangements and Selections
Practical No. 03: Arrangements and Selections with Repetitions
Practical No. 04: Distributions
Practical No. 05: Generating Functions
Practical No. 06: Coefficients of Generating Functions
Practical No. 07: Partitions
Practical No. 08: Exponential Generating Functions
Practical No. 09: Recurrence Relation
Practical No. 10: Solution of Linear Recurrence Relation
Practical No. 11: Counting with Venn Diagram
Practical No. 12: Inclusion-Exclusion Formula

Recommended Books:

Applied Combinatorics, Sixth Edition by Alan Tucker.

Course Outcomes:

CO 1: Identify the basic counting principles, difference between arrangements and selection (with repetition and without repetition).

CO 2: Represent the students can determine the probability that one of a certain subset of equally likely outcomes occurs requires counting the size of the subset.

CO 3: Modify Students will be able to find generating functions for different counting principles.

CO 4: Explain the formula for finding coefficients of Generating functions, students can find out the required count.

CO 5: Find errors recurrence Relations and its solution and will find solutions of example based on Inclusion-Exclusion principle.

CO 6: Develop logical thinking among students and will teach students how to reason and model combinatorically.

SEMESTER-III

Mathematics Practical Paper 8

Course Code: MTMAP-635 **Course Type: Practical**

Course Name: Scientific Writing Using Latex

Credits: 2 **Practical: 12**

Practical No. 1: Simple equations and array of equations

Practical No. 2: Alignment and Numbering a set of equations

Practical No. 3: Text and Blank space in math Mode

Practical No. 4: Conditional Expressing, Evaluation and Splitting of equations

Practical No. 5: vectors, Matrices and Stacking terms

Practical No. 6: Lists of Contents

Practical No. 7: Boxed Items

Practical No. 8: Letter and Article Writing

Practical No. 9: Slide Preparation I

Practical No. 10: Slide Preparation II

Practical No. 11: BEAMER Presentation

Practical No. 12: Question Paper Writing

Course Outcomes:

CO 1: Typesetting mathematical formulae using Latex.

CO 2: Create and typeset a Latex Document.

CO 3: Learn about Alignment and boxed items in Latex.

CO 4: Create question Paper in Latex.

CO 5: Create Slides with Beamers.

CO 6: Typesetting of articles and Slide Presentations.

SEMESTER-III

Mathematics Theory Paper 16 A

Course Code: MTMET-631-A **Course Type: Theory**

Course Name: Coding Theory

Credits: 2 **Hours: 30**

Module-I

Unit 1: Error detection: [6 Hours]

1. Correction and decoding: Communication channels
2. Hamming distance, nearest neighbor/minimum distance decoding, Distance of a Code

Unit 2: Linear codes: [10 Hours]

1. Vector spaces over finite fields, Linear codes, Hamming weight, Bases of linear codes
2. Generator matrix and parity check matrix, Equivalence of linear codes, Encoding with a linear code, Decoding of linear codes
3. Cossets, nearest neighbor decoding for linear codes

Module-II

Unit 3: Bounds in Coding Theory: [8 Hours]

1. Main coding theory problem, lower bounds, sphere covering bounds, Gilbert Varshamov bound, Hamming Codes
2. Hamming bound and MDS codes

Unit 4: Cyclic codes: [6 Hours]

1. Definitions, Generator polynomials
2. Generator and parity check matrices
3. Decoding of cyclic codes, Burst-error-correcting codes

Recommended Books:

San Likg and Chaoing sing, Coding Theory – A first Course (Cambridge University Press, 2004).

Course Outcomes:

CO 1: Describe the Concepts of Correction and decoding.

CO 2: Discuss the concept of Hamming distance.

CO 3: Explain generator matrix and parity check matrix.

CO 4: Evaluate the problem of syndrome decoding.

CO 5: Summarize the concept of Gilbert Varshamov bound.

CO 6: Adapt the concept of Burst-error-correcting codes.

SEMESTER-III

Mathematics Practical Paper 9 A

Course Code: MTMEP-632-A **Course Type: Practical**
Course Name: Coding Theory **Practical: 12**
Credit allotted: 2

Practical No. 1: Correction and decoding: Communication channels
Practical No. 2: Correction and decoding: Maximum likelihood decoding
Practical No. 3: Hamming distance and minimum distance decoding
Practical No. 4: Encoding with Linear codes
Practical No. 5: Generator Matrix and parity checker matrix
Practical No. 6: Encoding with Linear codes
Practical No. 7: Nearest neighbor decoding for linear codes
Practical No. 8: Sphere covering bound and gilbert varshamov bound
Practical No. 9: Hamming bound
Practical No. 10: MDC codes
Practical No. 11: Decoding of cyclic codes
Practical No. 12: Burst-error-correcting codes

Course Outcomes:
CO 1: Enumerate the term correction and decoding.
CO 2: Describe the concept of minimum distance decoding.
CO 3: Apply the concept of Generator matrix and parity checker matrix.
CO 4: Analyse sphere covering bound and gilbert varshamov bound in coding theory.
CO 5: Justify the concept of decoding of cyclic codes.
CO 6: Solve the problems on Burst-error- correcting codes.

SEMESTER-III

Mathematics Theory Paper 16 B

Course Code: MTMET-631-B **Course Type: Theory**
Course Name: Foundation of Data Science
Credits: 2 **Hours: 30**

Module-I

Unit 1. Introduction to Data Science **[6 Hours]**

1. Introduction to Data Science
2. Why learn Data Science?
3. Application of Data Science
4. The Data Science Lifecycle
5. Data Scientist's toolbox
6. Types Of Data
7. Data Sources
8. Data Formats

Unit 2. Statistical Data Analysis **[8 Hours]**

1. Role of statistics in data science
2. Descriptive statistics
3. Inferential Statistics
4. Measuring Data similarity and dissimilarity
5. Concept of outliers, Types of outliers, Outlier detection method

Module-II

Unit 3. Data Preprocessing **[10 Hours]**

1. Data Objects and Attribute types
2. Data Quality: Why preprocess the data?
3. Components and Local Connectedness
4. Data Munging/Wrangling Operations
5. Cleaning Data
6. Data Transportation
7. Data Reduction
8. Data Discretization

Unit 4. Data Visualization **[6 hours]**

1. Introduction to Exploratory Data Analysis
2. Data Visualization and Visual Encoding
3. Data Visualization Libraries
4. Basic Data Visualization tools
5. Advanced Data Visualization tools
6. Visualization of Geospatial Data
7. Data Visualization types

Recommended Books:

Data Science Fundamentals and Practical Approaches, **Gypsy Nandi, Rupam Sharma, BPB Publications, 2020.**

Reference Books:

1. **The Data Science Handbook, Field Cady, John Wiley & Sons, Inc, 2017.**
2. **Data Mining Concepts and Techniques, Third Edition, Jiawei Han, Micheline Kamber, Jian Pei, Morgan Kaufmann, 2012.**
3. **A Hands-On Introduction to Data Science, Chirag Shah, University of Washington Cambridge University Press.**

Course Outcomes:

CO 1: Describe the basics of data science and its applications.
CO 2: Discuss the importance of statistics in data analysis.
CO 3 : Explain data preprocessing methods for cleaning and transforming data.
CO 4: Analyze data types, sources, and quality.
CO 5: Find outliers and patterns in datasets.
CO 6: Solve problems using data visualization techniques.

SEMESTER-III

Mathematics Practical Paper 9 B

Course Code: MTMEP-632-B **Course Type: Practical**

Course Name: Foundation of Data Science **Practical: 12**

Credits: 2

Practical No. 1: Introduction to data
Practical No. 2: Outliers in data
Practical No. 3: Data cleaning
Practical No. 4: Data transportation
Practical No. 5: Data reduction
Practical No. 6: Data discretization
Practical No. 7: Exploratory Data Analysis
Practical No. 8: Data Visualization
Practical No. 9: Data Visualization libraries
Practical No.10: Data Visualization tools
Practical No.11: Visualization of Geospatial Data
Practical No. 12: Data Visualization types

Course Outcomes:
CO 1: Describe the basics of data science and its applications.
CO 2: Discuss the importance of statistics in data analysis.
CO 3 : Explain data preprocessing methods for cleaning and transforming data.
CO 4: Analyze data types, sources, and quality.
CO 5: Find outliers and patterns in datasets.
CO 6: Solve problems using data visualization techniques.

SEMESTER-IV

Mathematics Theory Paper 17

Course Code: MTMAT-641 **Course Type: Theory**
Course Name: Fourier Series and Boundary Value Problems
Credit allotted: 4 **Hours: 60**

Module-I

Unit 1 Fourier Series **[10 Hours]**

1. Piecewise Continuous Functions, Fourier Cosine Series, Examples,
2. Fourier Sine Series, Examples,
3. Fourier Series, Examples,
4. Adaptations to other Intervals

Unit 2 Convergence of Fourier Series **[10 Hours]**

1. One-Sided Derivatives, Property of Fourier Coefficients

2. Two Lemmas, Fourier Theorem, Discussion of the theorem and its Corollary, Convergence on other intervals, Lemma
3. Absolute and uniform convergence of Fourier series, Differentiation of Fourier series,
4. Integration of Fourier series

Unit 3 The Fourier Method [10 Hours]

1. Linear Operators, Principle of Superposition
2. A Temperature Problem, A Vibrating String

Module-II

Unit 4 Boundary Value Problems [15 Hours]

1. A Slab with Faces at Prescribed Temperatures, A Slab with Internally Generated Heat, Steady Temperatures in a Rectangular Co-ordinates
2. Cylindrical Coordinates, String with Prescribed Initial Conditions, Resonance, Elastic Bar

Unit 5 Orthonormal Sets [15 Hours]

1. Inner Products and Orthonormal Sets, Examples
2. Generalized Fourier series, Examples
3. Best approximation in the Mean, Bessel's Inequality and Perseval's Equation
4. Application to Fourier series

Recommended Book:

J.W.Brown & R.V.Churchill: Fourier series and Boundary Value Problems. VIIth Edition, McGraw Hill Education (India) Private Limited, New Delhi.

Course Outcomes:

CO 1: Define the fundamental concepts of Fourier series, boundary value problems, orthonormal sets, and convergence properties of Fourier series.

CO 2: Explain the principles of Fourier sine and cosine series, generalized Fourier series, and their applications to solve real-world problems.

CO 3: Examine Bessel's inequality, Parseval's equation, and other relevant theorems using examples and mathematical proofs.

CO 4: Analyse mathematical functions and problems in terms of orthonormal sets and Fourier series for simplification and analysis.

CO 5: Evalute the Fourier coefficients, convergence of Fourier series, and solutions to boundary value problems for given conditions.

CO 6:,solve steady-state and vibrating systems in engineering and science applications by using appropriate methods, such as Fourier methods and orthonormal sets.

SEMISTER-IV

Mathematics Theory Paper 18

Course Code: MTMAT-642 **Course Type: Theory**

Course Name: Functional Analysis

Credit: 4 **Hours: 60**

Module-I

Unit 1 Banach Spaces **[25 Hours]**

1. The definition and some examples
2. Continuous linear transformations
3. The Hahn-Banach theorem.
4. The natural imbedding of N in N**
5. The open mapping theorem
6. The conjugate of an operator

Module-II

Unit 2 Hilbert Spaces **[25 Hours]**

1. The definition and some simple properties
2. Orthogonal complements
3. Orthonormal sets
4. The conjugate space H*
5. The adjoint of an operator
6. Self-adjoint operators
7. Normal and unitary operators
8. Projections

Unit 3 Finite-Dimensional Spectral Theory **[10 Hours]**

1. Matrices
2. Determinants and the spectrum of an operator
3. The spectral theorem
4. A survey of the situation

Recommended Books:

G. F. Simmons, Introduction to Topology and Modern Analysis, Tata McGraw Hill.

Course Outcomes:

CO 1: Define Banach spaces and Hilbert spaces, including their examples, and basic properties.

CO 2: Associate appropriate methods for identifying and proving properties of continuous linear transformations.

CO 3: Complete the analysis of orthonormal sets and orthogonal complements in Hilbert spaces.

CO 4: Apply the open mapping theorem and its implications in solving operator equations.

CO 5: Find the adjoint and conjugate of given operators in Banach and Hilbert spaces.

CO 6: Adapt the spectral theorem for finite-dimensional operators and appraise its role in spectral theory.

SEMESTER-IV

Mathematics Theory Paper 19

Course Code: MTMAT-643 **Course Type: Theory**

Course Name: Lattice Theory

Credits: 2 **Hours: 30**

Module-I

Unit 1 Introductory Concepts of Lattices [10hours]

1. Posets, Semi-lattice, two definitions of lattices
2. Hasse Diagrams
3. How to describe Lattices
4. Some Algebraic Concepts, The Homomorphism Theorem
5. Polynomials, identities and inequalities, product of lattices
6. Special elements, complete lattice, Distributive and modular inequalities and Identities

Unit 2 Distributive Lattices [10 hours]

1. Characterization Theorems and Representation Theorems
2. Heredity Subsets Boolean lattice
3. Stone Theorem
4. Nachbin Theorem
5. Hashimoto Theorem
6. Congruence Relation, compact lattice

Module-II

Unit 3 Modular and Semi-modular Lattices [10 hours]

1. Modular Lattices
2. Semi-Modular Lattices
3. Geometric Lattice
4. Complemented Modular Lattices

Recommended Books:

General Lattice Theory, George Gratzer (Birkhauser, Second Edition)

Course Outcomes:

CO 1: Read Concepts of Poset, Chain conditions.
CO 2: Discuss the lattice theoretic duality principle.
CO 3: Explain complements, relative complements of bounded lattices.
CO 4: Apply Distributive lattice and prove relates theorem.
CO 5: Justify Congruence relation in lattice theory.
CO 6: Design Modular and Semi-modular Lattices.

SEMESTER-IV

Mathematics Practical Paper 10

Course Code: MTMAP-644 **Course Type: Practical**

Course Name: Probability and Statistics

Credit allotted: 2 **Practical: 12**

Practical No. 1: Sample space and probability of an event
Practical No. 2: Multiplicative rule and Bay's rule
Practical No. 3: Discrete probability distribution
Practical No. 4: Continuous probability distribution
Practical No. 5: Joint probability distribution
Practical No. 6: Mean of random variable
Practical No. 7: Variance of random variable
Practical No. 8: Mean and co-variance and variance and co-variance of random variable
Practical No. 9: Binomial and multinomial function
Practical No. 10: Hypergeometric and geometric distribution
Practical No. 11: Uniform and normal distribution
Practical No. 12: Gamma, Exponential, Chi-squared distribution

Course Outcomes:

CO 1: Select problems related to probability and statistics.
CO 2: Classify the concept of probability distributions.
CO 3: Explain the concept of random variables.
CO 4: Analyze for understanding risks and data consistency.
CO 5: Evaluate the concept of Gamma, Exponential, Chi-squared distribution.
CO 6: Solve problems on mean and variance of random variable.

SEMESTER-IV

Mathematics Theory Paper 20 A

Course Code: MTMET-641-A **Course Type: Theory**

Course Name: Data Analytics using Python

Credit allotted: 2 **Hours: 30**

Module-I

Unit 1: Introduction to Data Analytics **[06 Hours]**

1. Concept of data analytics
2. Data analysis vs Data analytics
3. Types of analytics: Diagnostic Analytics, Predictive Analytics, Prescriptive Analytics, Exploratory Analysis, Mechanistic Analysis
4. Mathematical models – Concept, Model evaluation

Unit 2: Machine Learning Overview [06 Hours]

1. Introduction to Machine Learning, deep learning, Artificial intelligence
2. Applications for machine learning in data science
3. The modeling process - Engineering features and selecting a model, Training the model
4. Validating the model, predicting new observations
5. Types of machine learning - Supervised learning, unsupervised learning, Semi-supervised learning, ensemble techniques
6. Regression models – Linear Regression, Polynomial Regression, Logistic Regression
7. Concept of classification, clustering and reinforcement learning

Module-II

Unit 3: Mining Frequent Patterns, Associations, and Correlations [10 Hours]

1. What kind of patterns can be mined- Class/Concept Description: Characterization and Discrimination, Mining Frequent Patterns, Associations, and Correlations, Classification and Regression, for Predictive Analysis, Cluster Analysis, Outlier Analysis
2. Mining frequent patterns - Market Basket Analysis
3. Frequent Item sets, Closed Item sets, and Association Rules
4. Apriori Algorithm

Unit 4: Social Media and Text Analytics [08 Hours]

1. Overview of social media analytics
2. Key social media analytics methods
3. Social network analysis
4. Introduction to Natural Language Processing

Recommended Books:

Data Science Fundamentals and Practical Approaches, Gypsy Nandi, Rupam Sharma, BPB Publications, 2020.

Reference Books:

1. **The Data Science Handbook, Field Cady, John Wiley & Sons, Inc, 2017.**
2. **Data Mining Concepts and Techniques, Jiawei Han, Micheline Kamber, Jian Pei, Morgan Kaufmann, Third Edition, 2012.**

Course Outcomes:

CO 1: Define Data Analysis and Data Analytics.

CO 2: Select appropriate models of analysis, assess the quality of input, and derive insight from results.

CO 3: Apply different data mining techniques like classification, prediction, clustering and association rule mining

CO 4: Analyze data, choose relevant models and algorithms for respective applications

CO 5: Test various mathematical models.

CO 6: Develop different mathematical models by applying modeling and data analysis techniques to find the solutions of real world business Problems

SEMESTER-IV

Mathematics Practical Paper 11 A

Course Code: MTMEP-642-A **Course Type: Practical**

Course Name: Data Analytics Using Python

Credit: 2 **Practical: 12**

Practical No. 1: Types of dialogue boxes (alert, prompt, confirm)
Practical No. 2: Mathematical models
Practical No. 3: Types of analytics
Practical No. 4: Selecting and training a model
Practical No. 5: Supervised and unsupervised learning
Practical No. 6: Regression models
Practical No. 7: Clustering and reinforcement learning
Practical No. 8: Mining frequent patterns
Practical No. 9: Key social media analytics methods
Practical No. 10: Frequent Item sets, Closed Item sets, and Association Rules
Practical No.11: Apriori Algorithm
Practical No.12: Social network analysis

Course Outcomes:

CO 1: Define Data Analysis and Data Analytics.
CO 2: Select appropriate models of analysis, assess the quality of input, and derive insight from results.
CO 3: Apply different data mining techniques like classification, prediction, clustering and association rule mining
CO 4: Analyze data, choose relevant models and algorithms for respective applications
CO 5: Test various mathematical models.
CO 6: Develop different mathematical models by applying modeling and data analysis techniques to find the solutions of real world business Problems

Semester-IV

Mathematics Theory Paper-20B

Course Code: MTMET-641-B Course Type: Theory

Course Name: Differential Geometry

Credits: 2 Hours:30

Module- I

Unit 1. Graphs and Level sets, Vector fields, The Tangent space. [6 Hours]

1.Graphs
2. Level Sets
3.Vector Fields
4.The Tangent Space

Unit 2. Surfaces, Vector fields on surfaces, Orientation. [8 Hours]

1. Surfaces
2. Vector fields on surfaces
3. Orientation

Module- II

Unit 3. Gauss Map, Geodesics, Parallel transport. [10 Hours]

1. Gauss Map
2. Parallel transport
3. Geodesics

Unit 4. The Weingarten Map. [6 Hours]

1. Definitions
2. Properties
3. Examples

Recommended Books:

J.A. Thorpe : Elementary Topics in Differential Geometry (Springer Verlag).

Reference Books:

1. B Oneill : Elementary differential Geometry (Academic - New York).

2. do Carmo M. : Differential Geometry of curves and surfaces. (Englewood Cliffs,

N.J., Prentice Hall, 1976).

3. R. Millman and G. Parker : Elements of differential Geometry. (Englewood Cliffs,

N.J., Prentice Hall, 1977).

Course Outcomes:
CO 1: Describe graphs, level sets, and their applications in geometry.
CO 2: Explain surfaces and orientation in geometry.
CO 3: Compute tangent spaces and analyze vector fields.
CO 4: Illustrate the gauss map and geodesics.
CO 5: Summarize parallel transport and its geometric implications.
CO 6: Simulate surface curvature using the Weingarten map.

SEMESTER-IV

Mathematics Practical Paper 11 B

Course Code: MTMEP-642B **Course Type: Practical**
Course Name: Differential Geometry
Credit allotted: 2 **Practical: 12**

Practical No. 1: Graphs
Practical No. 2: Level sets-1
Practical No. 3: Level sets-2
Practical No. 4: Vector fields
Practical No. 5: The Tangent space
Practical No. 6: Surfaces
Practical No. 7: Vector fields on surfaces
Practical No. 8: Orientation
Practical No. 9: Gauss Map
Practical No. 10: Geodesics
Practical No. 11: Parallel transport
Practical No. 12: The Weingarten Map

Course Outcomes:
CO 1: Describe graphs, level sets, and their applications in geometry.
CO 2: Explain surfaces and orientation in geometry.
CO 3: Compute tangent spaces and analyze vector fields.
CO 4: Illustrate the gauss map and geodesics.
CO 5: Summarize parallel transport and its geometric implications.
CO 6: Simulate surface curvature using the Weingarten map.

SEMESTER-III

Introduction to Cyber Security / Information Security

Syllabus for 'Introduction to Cyber Security / Information Security' program* for students of University of Pune is given below.

The program will be of 4 credits and it will be delivered in 60 clock hours**.

*: Course material for this program will be developed by CINS

**: These clock hours also includes practical sessions and demonstrations wherever required.

SR. NO.	TOPIC	HOURS	MARKS
1	**Module 1: Pre-requisites in Information and Network Security**	**14**	**25**
	Chapter 1: Overview of Networking Concepts	3	
	Chapter 2: Information Security Concepts	3	
	Chapter 3: Security Threats and Vulnerabilities	5	
	Chapter 4: Cryptography / Encryption	3	
2	**Module 2: Security Management**	**13**	**25**
	Chapter I: Security Management Practices	7	
	Chapter 2: Security Laws and Standards	6	
3	**Module 3: Information and Network Security**	**13**	**25**
	Chapter 1: Access Control and Intrusion Detection	3	
	Chapter 2: Server Management and Firewalls	4	
	Chapter 3: Security for VPN and Next Generation Technologies	6	
4	**Module 4: System and Application Security**	**20**	**25**
	Chapter 1: Security Architectures and Models	5	
	Chapter 2: System Security	5	
	Chapter 3: OS Security	5	
	Chapter 4: Wireless Network and Security	5	

Detail Syllabus for Credit Course for University of Pune

Module 1: Pre-requisites in Information and Network Security

Chapter 1: Overview of Networking Concepts

1. Basics of Communication Systems
2. Transmission Media
3. Topology and Types of Networks
4. TCP/IP Protocol Stacks
5. Wireless Networks
6. The Internet

Chapter 2: Information Security Concepts

1. Information Security Overview: Background and Current Scenario
2. Types of Attacks
3. Goals for Security
4. E-commerce Security
5. Computer Forensics
6. Steganography

Chapter 3: Security Threats and Vulnerabilities

1. Overview of Security threats
2. Weak / Strong Passwords and Password Cracking
3. Insecure Network connections
4. Malicious Code
5. Programming Bugs

6. Cyber crime and Cyber terrorism
7. Information Warfare and Surveillance

Chapter 4: Cryptography / Encryption

1. Introduction to Cryptography / Encryption
2. Digital Signatures
3. Public Key infrastructure
4. Applications of Cryptography
5. Tools and techniques of Cryptography

Module 2: Security Management

Chapter I: Security Management Practices

1. Overview of Security Management
2. Information Classification Process
3. Security Policy
4. Risk Management
5. Security Procedures and Guidelines
6. Business Continuity and Disaster Recovery
7. Ethics and Best Practices

Chapter 2: Security Laws and Standards

1. Security Assurance
2. Security Laws
3. IPR

4. International Standards
5. Security Audit
6. SSE-CMM / COBIT etc

Module 3: Information and Network Security

Chapter 1: Access Control and Intrusion Detection

1. Overview of Identification and Authorization
2. Overview of IDS
3. Intrusion Detection Systems and Intrusion Prevention Systems

Chapter 2: Server Management and Firewalls

1. User Management
2. Overview of Firewalls
3. Types of Firewalls
4. DMZ and firewall features

Chapter 3: Security for VPN and Next Generation Technologies

1. VPN Security
2. Security in Multimedia Networks
3. Various Computing Platforms: HPC, Cluster and Computing Grids
4. Virtualization and Cloud Technology and Security

Module 4: System and Application Security

Chapter 1: Security Architectures and Models

1. Designing Secure Operating Systems
2. Controls to enforce security services
3. Information Security Models

Chapter 2: System Security

1. Desktop Security
2. email security: PGP and SMIME
3. Web Security: web authentication, SSL and SET
4. Database Security

Chapter 3: OS Security

1. OS Security Vulnerabilities, updates and patches
2. OS integrity checks
3. Anti-virus software
4. Configuring the OS for security
5. OS Security Vulnerabilities, updates and patches

Chapter 4: Wireless Networks and Security

1. Components of wireless networks
2. Security issues in wireless

SEMESTER-III and IV
Subject: Skill Development-I
Paper Name: Competitive Exam Aptitude **Credit:2**
Paper Code: PGSDT-631 **Lectures: 30**

Module-I

Unit-I: Analysis
1. Real Analysis
2. Complex Analysis
3. Numerical Analysis
4. Metric Space and Topology

Unit-II: Algebra
1. Linear Algebra
2. Permutations and combinations
3. Fundamental of Arithmetic

Module-II

Unit-III: Abstract Algebra
1. Group Theory
2. Ring Theory
3. Field Theory

Unit-IV: Differential Equations
1. Ordinary Differential Equations
2. Partial Differential Equations
3. Classical Mechanics