Holy Cross College (Autonomous), Nagercoil

Kanyakumari District, Tamil Nadu.
Accredited with A$^+$ by NAAC - IV cycle – CGPA 3.35

Affiliated to
Manonmaniam Sundaranar University, Tirunelveli

Semester I - IV

Guidelines & Syllabus

DEPARTMENT OF MATHEMATICS

2023-2026

(With effect from the academic year 2024-2025)

Issued from
THE DEANS' OFFICE

Vision

To empower women globally competent with human values and ethics acquiring academic andentrepreneurship skills through holistic education.

Mission

1. To create opportunities which will ensure academic excellence in critical thinking,humanistic and scientific inquiry.
2. To develop application-oriented courses with the necessary input of values.
3. To create a possible environment for innovation, team spirit and entrepreneurial leadership.
4. To form young women of competence, commitment and compassion.

Graduate Attributes

Graduates of our College develop the following attributes during the course of their studies.

- **Creative thinking:**
  Equipping students with hands-on-training through skill based courses and promote startup.
- **Personality development:**
  Coping with increasing pace and change of modern life through value education, awareness on human rights, gender issues and giving counselling for the needful.
- **Environmental consciousness and social understanding:**
  Reflecting upon green initiatives and understanding the responsibility to contribute to the society; promoting social and cultural diversity through student training and service learning programmes.
- **Communicative competence:**
  Offering effective communication skills in both professional and social contexts through bridge courses and activities of clubs and committees.
- **Aesthetic skills:**
  Engaging mind, body and emotions for transformation through fine arts, meditation and exercise; enriching skills through certificate courses offered by Holy Cross Academy.
- **Research and knowledge enrichment:**
  Getting in-depth knowledge in the specific area of study through relevant core papers; ability to create new understanding through the process of critical analysis and problem solving.
- **Professional ethics:**
  Valuing honesty, fairness, respect, compassion and professional ethics among students. The students of social work adhere to the *National Association of Social Workers Code of Ethics*
- **Student engagement in the learning process:**
  Obtaining extensive and varied opportunities to utilize and build upon the theoretical and empirical knowledge gained through workshops, seminars, conferences, industrial visits and summer internship programmes.
- **Employability:**
  Enhancing students in their professional life through Entrepreneur development, Placement & Career guidance Cell.
- **Women empowerment and leadership:**
  Developing the capacity of self-management, team work, leadership and decision making through gender sensitization programmes.

Programme Educational Objectives (PEOs)

POs	Upon completion of M. Sc. Degree Programme, the graduates will be able to:	Mapping with Mission
PEO1	apply scientific and computational technology to solve social and ecological issues and pursue research.	**M1, M2**
PEO2	continue to learn and advance their career in industry both in private and public sectors.	**M4 & M5**
PEO3	develop leadership, teamwork, and professional abilities to become a more cultured and civilized person and to tackle the challenges in serving the country.	**M2, M5 & M6**

Programme Outcomes (POs)

Pos	Upon completion of M.Sc. Degree Programme, the graduates will be able to:	Mapping with PEOs
PO1	apply their knowledge, analyze complex problems, think independently, formulate and perform quality research.	**PEO1 & PEO2**
PO2	carry out internship programmes and research projects to develop scientific and innovative ideas through effective communication.	**PEO1, PEO2 & PEO3**
PO3	develop a multidisciplinary perspective and contribute to the knowledge capital of the globe.	**PEO2**
PO4	develop innovative initiatives to sustain ecofriendly environment	**PEO1, PEO2**
PO5	through active career, team work and using managerial skills guide people to the right destination in a smooth and efficient way.	**PEO2**
PO6	employ appropriate analysis tools and ICT in a range of learning scenarios, demonstrating the capacity to find, assess, and apply relevant information sources.	**PEO1, PEO2 & PEO3**
PO7	learn independently for lifelong executing professional, social and ethical responsibilities leading to sustainable development.	**PEO3**

Programme Specific Outcomes (PSOs)

PSO	Upon completion of M.Sc. Degree Programme, the graduates of Mathematics will be able to:	PO Addressed
PSO–1	acquire good knowledge and understanding, to solve specific theoretical & applied problems in different area of mathematics & statistics	**PO1 & PO2**
PSO–2	understand, formulate, develop mathematical arguments, logically and use quantitative models to address issues arising in social sciences, business and other context /fields.	**PO3 & PO5**
PSO–3	prepare the students who will demonstrate respectful engagement with other's ideas, behaviors, beliefs and apply diverse frames of references to decisions and actions	**PO6**
PSO–4	pursue scientific research and develop new findings with global Impact using latest technologies.	**PO4 & PO7**
PSO–5	possess leadership, teamwork and professional skills, enabling them to become cultured and civilized individuals capable of effectively overcoming challenges in both private and public sectors.	**PO5 & PO7**

Mapping of PO'S and PSO'S

POs	PSO1	PSO2	PSO3	PSO4	PSO5
PO 1	**S**	M	S	S	S
PO 2	S	S	S	S	M
PO 3	S	S	M	S	S
PO4	S	M	S	S	M
PO5	M	S	M	S	S
PO6	S	S	S	M	S
PO7	S	S	S	S	S

Strong -S (3), Medium – M (2), Low – L (1)

Eligibility

(i) For Admission: A candidate who is a graduate of this college or any other recognized University in the main subject/subjects as given below against each or who has passed an examination accepted as equivalent thereto by the Syndicate of Manonmaniam Sundaranar University, Tirunelveli, is eligible for admission.

ii)Degree

The candidates shall have subsequently undergone the prescribed Programme of study in Holy Cross College (Autonomous) affiliated to the Manonmaniam Sundaranar University for a period of not less than two academic years comprising four semesters, passed the examinations prescribed and fulfilled such conditions as have been prescribed there of.

Duration

The duration of PG Programme is for a period of two years.

Components

Core Course	12x 100	1200
Elective Course	7 x 100	700
Core Research Project	1 x 100	100
Total Marks		**2000**

Course Structure

Distribution of Hours and Credits

(i) Curricular Courses:

Course	**SEMESTER**				**Total**	
	I	**II**	**III**	**IV**	**Hours**	**Credits**
Core Course	7(5) + 7(5) + 6(4)	6(5)+ 6(5) + 6(4)	6(5) + 6(5) + 6(5)	6(5) + 6 (5)+ 6(5)	74	58
Elective Course	5 (3) + 5 (3)	4 (3) + 4 (3)	4(3) -	4 (3) + 4(3)	30	21
Core Research Project		-	5(4)		5	4
Skill Enhancement Course		4 (2)	3 (2)	4 (2)	11	6
Internship			(2)		-	2
Total	**30 (20)**	**30 (22)**	**30 (26)**	**30 (23)**	**120**	**91**

(ii) Co-curricular Courses

Course	SEMESTER				Total
	I	II	III	IV	Credits
Life Skill Training –I	-	(1)	-	-	1
Life Skill Training –II	-	-	-	(1)	1
Field Project	(1)		-		1
Specific Value-Added Courses	(1)		(1)		2
Generic Value-Added Courses		(1)		(1)	2
MOOC		(1)		(1)	2
Community Engagement Activity (UBA)		(1)			1

Total Number of Hours =120
Total Number of Credits =91 + (10)

Non-academic courses are mandatory and conducted outside the regular working hours.

COURSES OFFERED

Semester I

Course Code	Title of the Course	Credits	Hours
MP231CC1	Core Course I: Algebraic Structures	5	7
MP231CC2	Core Course II: Real Analysis I	5	7
MP241CC3	Core Course III: Ordinary Differential Equations	4	6
MP231EC1	Elective Course I: a) Number theory and Cryptography	3	5
MP231EC2	Elective Course I: b) Graph Theory and Applications		
MP231EC3	Elective Course I: c) Programming In C++		
MP241EC4	Elective Course II: a) Discrete Mathematics	3	5
MP231EC5	Elective Course II: b) Analytic Number Theory		
MP231EC6	Elective Course II: c)Fuzzy sets and their Applications		
	Total	**20**	**30**

Semester II

Course Code	Title of the Course	Credits	Hours
MP232CC1	Core Course IV: Advanced Algebra	5	6
MP242CC2	Core Course V: Real Analysis II	5	6

MP232CC3	Core Course VI: Partial Differential	4	6
MP232EC1	Elective Course III: a) Mathematical Statistics	3	4
MP232EC2	Elective Course III: b) Statistical Data Analysis using R Programming		
MP232EC3	Elective Course III: c) Programming in C++Practical		
MP232EC4	Elective Course IV: a) Operations Modeling	3	4
MP232EC5	Elective Course IV: b) Mathematical Python		
MP232EC6	Elective Course IV: c)Neural Networks		
MP242SE1	Skill Enhancement I Introduction to MS Excel 2007	2	4
	Total	**22**	**30**

Semester III

Course Code	Title of the Course	Credits	Hours / Week
MP233CC1	Core Course VII: Complex Analysis	5	6
MP233CC2	Core Course VIII: Topology	5	6
MP233CC3	Core Course IX: Traditional Mechanics	5	6
MP233RP1	Core Research Project	4	5
MP233EC1	Elective Course V: a) Algorithmic Network Analysis	3	4
MP233EC2	Elective Course V: b) Introduction to Machine Learning using Python		
MP233EC3	Elective Course V: c) Coding Theory		
MP233SE1	Skill Enhancement Course II : Research Methodology	2	3
MP233IS1	Internship	2	-
	Total	**26**	**30**

Semester IV

Course Code	Title of the Course	Credits	Hours / Week
MP234CC1	Core Course X: Functional Analysis	5	6
MP234CC2	Core Course XI: Probability Theory	5	6
MP234CC3	Core Course XII: Numerical Analysis	5	6
MP234EC1	Elective Course VI: a) Network Security and Cryptography	3	4
MP234EC2	Elective Course VI: b) Foundations of Computer Networking		
MP234EC3	Elective Course VI: c) Data Communication		
MP234EC4	Elective Course VII: a) Applications of Mathematics In Artificial Intelligence	3	4

MP234EC5	Elective Course VII: b) Financial Mathematics		
MP234EC6	Elective Course VII: c) Stochastic Process		
MP234SE1	Skill Enhancement Course III Training For Competitive Examinations	2	4
	Total	**23**	**30**

Co-curricular Courses

Semester	Code	Title of the Course	Credit
I & II	PG23LST1	Life Skill Training	1
II & IV	-	MOOC	1+1
II	PG232CE1	Community Engagement Activity (UBA)	1
III & IV	PG23LST2	Life Skill Training	1
I	MP231FP1	Field Project	1
I & III	MP231V01 / MP233V01	Specific Value-added Course	1+1
II & IV	GVAC2401 -	Generic Value-added Course	1+1
		Total	**10**

Specific Value added Course

Semester	Course code	Title of the course	Credits	Total hours
I	MP231V01	SCILAB	1	30
I	MP231V02	Creating Documents using LaTex	1	30
I	MP231V03	Resource Management Techniques	1	30
I	MP231V04	Mathematical Foundations for Data Science	1	30
III	MP233V01	Documentation using Overleaf and Mathcha	1	30
III	MP233V02	Chemical Graph Theory	1	30
III	MP233V03	Advanced Latex with Overleaf	1	30
III	MP233V04	Social Network Analysis	1	30

Self Learning Course

Semester	Course code	Title of the course
III	MP233SLI	Differential Equations for SET/ CSIR-NET Exam
IV	MP234SLI	Calculus of variations and integral equations

Examination Pattern

Curricular Courses:

i) Core Course / Elective Course

Internal: External–25:75

Continuous Internal Assessment (CIA)

Internal Components and Distribution of Marks

Components	Marks
Internal test (2) (40 marks)	10
Quiz (2) (20 marks)	5
Seminar (10 marks)	5
Assignment: (Model Making, Exhibition, Role Play, Group Discussion, Problem Solving, Class Test, Open Book Test (Minimum three items per course) (30 marks)	5
Total	**25**

Question Pattern

Internal Test	Marks	External Exam	Marks
Part A 4 x 1 (No choice)	4	Part A 10 x 1 (No choice)	10
Part B 2 x 6 (Internal choice)	12	Part B 5 x 6 (Internal choice)	30
Part C 2 x 12 (Internal choice)	24	Part C 5 x 12 (Internal choice)	60
Total	**40**	**Total**	**100**

ii) Core Lab Course:

Ratio of Internal and External= 25:75

Total: 100 marks

Internal Components and Distribution of Marks

Internal Components	Marks
Performance of the Experiments	10
Regularity in attending practical and submission of records	5
Record	5
Model exam	5
Total	**25**

Question pattern

External Exam	Marks
Major Practical	75
Minor Practical / Spotters /Record	
Total	**75**

iii) Core Research Project:

Ratio of Internal and External **25: 75**

Internal (Supervisor)	Marks
I Review	5
II Review	5
Report	15
External (External Examiner)	
Report	40
Viva-voce (individual, open viva-voce)	35
Total	**100**

iv) Skill Enhancement Course

Ratio of Internal and External = 2**5: 75**

Internal Components and Distribution of Marks

Components	Marks
Internal test (2) – (40 marks)	10
Quiz (2) – (20 marks)	5

Assignment: (Model Making, Exhibition, Role Play, Album, Group Activity (Mime, Skit, Song) (Minimum three items per course)	10
Total	**25**

Question Pattern

Internal Test	**Marks**	**External Exam**	**Marks**
Part A 2 x 2 (No Choice)	4	Part A 5 x 2 (No Choice)	10
Part B 3 x 4 (Open choice **Three** out of **Five**)	12	Part B 5 x 4 (Open choice any **Five** out **of Eight**)	20
Part C 1 x 9 (Open choice O**ne** out of **Three**)	9	Part C 5 x 9 (Open choice any **Five** out **of Eight**)	45
Total	**25**	**Total**	**75**

v) Internship

Components	**Marks**
Industry Contribution	50
Report & Viva-voce	50
Total	**100**

Co-Curricular Courses:

(i) Life Skill Training

Internal Component

Components		**Marks**
Life Skill Training -I	Album (20 pages)	30
	Group Activity (Group of 5 students)	20
	Total	**50**
Life Skill Training -II	Case Study (30 pages)	50
	Total	**50**

External Component

Written Test	Five out of Seven (5 x 10)	50
	Total	**50**

(ii) Field Project:

omponents	**Marks**
ield Work	50
ield Project Report & Viva-voce	50
Total	**100**

(iii) Specific Value-Added Courses & Generic Value-Added Courses:

omponents	**Marks**
nternal	25
xternal	75
Total	**100**

(iv) Community Engagement Activity-UBA

Internal Component	
Component	**Marks**
Attendance (Field Work)	30
Participation	20
Total	**50**

External Component

Component	Marks
Group Project Report/ Case Study (10-15 pages in print)	50
Total	**50**

(v)Self Learning Course

Internal Test	Marks	External Exam	Marks
Part A 2 x 2 (No Choice)	4	Part A 5 x 2 (No Choice)	10
Part B 3 x 4 (Open choice **Three** out of **Five**)	12	Part B 5 x 4 (Open choice any **Five** out **of Eight**)	20
Part C 1 x 9 (Open choice O**ne** out of **Three**)	9	Part C 5 x 9 (Open choice any **Five** out **of Eight**)	45
Total	**25**	**Total**	**75**

Outcome Based Education (OBE)

(i) Knowledge levels for assessment of Outcomes based on Blooms Taxonomy

S. No.	Level	Parameter	Description
1	KI	Knowledge/Remembering	It is the ability to remember the previously learned
2	K2	Comprehension/Understanding	The learner explains ideas or concepts
3	K3	Application/Applying	The learner uses information in a new way
4	K4	Analysis/Analysing	The learner distinguishes among different parts
5	K5	Evaluation/Evaluating	The learner justifies a stand or decision
6	K6	Synthesis /Creating	The learner creates a new product or point of view

(ii) Weightage of K – levels in Question Paper

Number of questions for each cognitive level:

Assessment	Cognitive Level	KI			K2			K3			K4, K5, K6			Total
Internal Test	Part	A	B	C	A	B	C	A	B	C	A	B	C	
	No. of Questions	1	1	-	-	-	-	1	-	1	2	1	1	8
External Examination	Part	A	B	C	A	B	C	A	B	C	A	B	C	
	No. of Questions	3	-	1	3	1	1	1	2	1	3	2	2	20

The levels of assessment are flexible and it should assess the cognitive levels and outcome attainment.

Evaluation

i. The performance of a student in each Course is evaluated in terms of percentage of marks with a provision for conversion to grade points.

ii. Evaluation for each Course shall be done by a Continuous Internal Assessment (CIA) by the Course teacher as well as by an end semester examination and will be consolidated at the end of the semester.

iii. There shall be examinations at the end of each semester, for odd semesters in October / November; for even semesters in April / May.

iv. A candidate who does not pass the examination in any course (s) shall be permitted to re-appear in such failed course (s) in the subsequent examination to be held in October / November or April / May. However, candidates who have arrears in Practical Examination(s) shall be permitted to re-appear for their arrears only along with Regular Practical examinations in the respective semester.

v. Viva- voce: Each candidate shall be required to appear for Viva-voce Examination in defense of the Project.

vi. The results of all the examinations will be published in the College website.

Conferment of the Master's Degree

A candidate shall be eligible for the conferment of the Degree of Master of Arts / Science/ Commerce only if the minimum required credits for the programme thereof (91 +10 credits) is earned.

Grading System

For a semester examination:

Calculation of Grade Point Average for End Semester Examination:

$$GPA = \frac{\text{Sum of the multiplication of grade points by the credits of the course}}{\text{Sum of the credits of the courses (passed) in a semester}}$$

For the entire programme:

Cumulative Grade Point Average (CGPA) $\Sigma_n\Sigma_i C_{ni}G_{ni} / \Sigma_{ni}\Sigma_i C_{ni}$

$$CGPA = \frac{\text{Sum of the multiplication of grade points by the credits of the entire programme}}{\text{Sum of the credits of the courses of the entire programme}}$$

where

C_i - Credits earned for course i in any semester

G_i - Grade point obtained for course i in any semester

n - semester in which such courses were credited

Final Result

Conversion of Marks to Grade Points and Letter Grade

Range of Marks	Grade Points	Letter Grade	Description
90-100	9.0-10.0	O	Outstanding
80-89	8.0-8.9	D+	Excellent
75-79	7.5-7.9	D	Distinction
70-74	7.0-7.4	A+	Very Good
60-69	6.0-6.9	A	Good
50-59	5.0-5.9	B	Average
00-49	0.0	U	Re-Appear
ABSENT	0.0	AAA	ABSENT

Overall Performance

CGPA	Grade	Classification of Final Results
9.5-10.0	O+	First Class – Exemplary*
9.0 and above but below 9.5	O	
8.5 and above but below 9.0	D++	First Class with Distinction*
8.0 and above but below 8.5	D+	
7.5 and above but below 8.0	D	
7.0 and above but below 7.5	A++	First Class
6.5 and above but below 7.0	A+	
6.0and above but below 6.5	A	
5.5and above but below 6.0	B+	Second Class
5.0 and above but below 5.5	B	
0.0 and above but below 5.0	U	Re-appear

*The candidates who have passed in the first appearance and within the prescribed semester are eligible.

SEMESTER I

CORE COURSE – I: ALGEBRAIC STRUCTURES

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP231CC1	5	2			5	7	105	25	75	100

Pre-requisite:
Students should know the basic concepts of modern Algebra

Learning Objectives:

1. To introduce the concepts and to develop working knowledge on class equation, solvability of groups.
2. To understand the concepts of finite abelian groups, linear transformations, real quadratic forms.

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	recall basic counting principle, define class equations to solve problems, explain Sylow's theorems and apply the theorem to find number of Sylow subgroups.	**K1**
2.	define Solvable groups, define direct products, examine the properties of finite abelian groups, define modules	**K2**
3.	define similar Transformations, define invariant subspace, explore the properties of triangular matrix, to find the index of nilpotence to decompose a space into invariant subspaces, to find invariants of linear transformation, to explore the properties of nil potent transformation relating nilpotence with invariants.	**K3**
4.	define Jordan, canonical form, Jordan blocks, define rational canonical form, define companion matrix of polynomial, find the elementary devices of transformation, apply the concepts to find characteristic polynomial of linear transformation.	**K3, K4**
5.	define trace, define transpose of a matrix, explain the properties of trace and transpose, to find trace, to find transpose of matrix, to prove Jacobson lemma using the triangular form, define symmetric matrix, skew symmetric matrix, adjoint, to define Hermitian, unitary, normal transformations and to Evaluate whether the transformation in Hermitian, unitary and normal	**K5**

K1–Remember**K2** - Understand **K3** - Apply **K4**– Analyze**K5**-Evaluate

Units	Contents	No. of Hours
I	Counting Principle - Class equation for finite groups and its applications – Sylow's theorems (For theorem 2.12.1, First proof only). Chapter 2: Sections 2.11 and 2.12 (Omit Lemma 2.12.5)	**21**
II	Solvable groups - Direct products - Finite abelian groups- Modules Chapter 5: Section 5.7 (Lemma 5.7.1, Lemma 5.7.2, Theorem 5.7.1) Chapter 2: Section 2.13 and 2.14 (Theorem 2.14.1 only) Chapter 4: Section 4.5	**21**
III	Linear Transformations: Canonical forms –Triangular form - Nilpotent	**21**

	transformations. Chapter 6: Sections 6.4, 6.5	
IV	Jordan form - rational canonical form. Chapter 6: Sections 6.6 and 6.7	**21**
V	Trace and transpose - Hermitian, unitary, normal transformations, real quadratic form. Chapter 6: Sections 6.8, 6.10 and 6.11 (Omit 6.9)	**21**
	Total	**105**

Self Study	Problems and definition

Textbook

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

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 W.H.Freeman (1980); also published by Hindustan Publishing Company, New Delhi.

Web Resources

1.https://math.libretexts.org/Bookshelves/Abstract_and_Geometric_Algebra/Abstract_Algebra%3A_Theory_and_Applications_(Judson)/13%3A_The_Structure_of_Groups/13.01%3A_Finite_Abelian_Groups
2.https://groupprops.subwiki.org/wiki/Finite_abelian_group
3.https://math.libretexts.org/Bookshelves/Abstract_and_Geometric_Algebra/Abstract_Algebra%3A_Theory_and_Applications_(Judson)/13%3A_The_Structure_of_Groups/13.02%3A_Solvable_Groups
4.https://math.berkeley.edu/~kpmann/SylowNotes.pdf
5.https://brilliant.org/wiki/sylow-theorems

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2	1	1	3	3	3	2	2
CO2	3	3	1	2	2	1	2	3	3	3	2	2
CO3	3	3	1	2	2	1	2	3	3	3	2	2
CO4	3	3	2	2	2	1	2	3	3	3	3	2
CO5	3	3	2	2	2	1	1	3	3	3	3	2
TOTAL	**15**	**15**	**8**	**10**	**10**	**5**	**8**	**15**	**15**	**15**	**12**	**10**
AVERAGE	**3**	**3**	**1.6**	**2**	**2**	**1**	**1.6**	**3**	**3**	**3**	**2.4**	**2**

3 – Strong, 2- Medium, 1- Low

SEMESTER I

CORE COURSE – II: REAL ANALYSIS I

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP231CC2	5	2	-		5	7	105	25	75	100

Pre-requisite:

Students should know UG level Real Analysis concepts.

Learning Objectives:

1. To work comfortably with functions of bounded variation, Riemann-Stieltjes Integration, convergence of infinite series, infinite product and uniform convergence.
2. To relate its interplay between various limiting operations.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	analyze and evaluate functions of bounded variation and Rectifiable Curves.	**K4 & K5**
2	describe the concept of Riemann-Stieltjes integral and its properties.	**K1 & K2**
3	demonstrate the concept of step function, upper function, Lebesgue function and their integrals.	**K3**
4	construct various mathematical proofs using the properties of Lebesgue integrals and establish the Levi monotone convergence theorem.	**K3 & K5**
5	formulate the concept and properties of inner products, norms and measurable functions.	**K2 & K3**

K1-Remember **K2**- Understand K**3** - Apply **K4**- Analyze **K5** - Evaluate

Units	Contents	No. of Hours
I	**Functions of bounded variation** - 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. **Chapter 6: 6.1 to 6.8** **Infinite Series:** Absolute and conditional convergence - Dirichlet's test and Abel's test - Rearrangement of series - Riemann's theorem on conditionally convergent series. **Chapter 8: 8.8, 8.15, 8.17, 8.18**	**21**
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. **Chapter 7: 7.1 to 7.14**	**21**
III	**The Riemann-Stieltjes Integral** - Integrators of bounded variation-Sufficient conditions for the existence of Riemann-Stieltjes integrals-Necessary conditions for the existence of RS integrals- Mean value theorems -integrals as a function of the interval – Second fundamental theorem of integral calculus- Change of variable -Second Mean Value Theorem for Riemann integral- Riemann-Stieltjes integrals depending on a parameter- Differentiation under	**21**

	integral sign-Lebesgue criterion for existence of Riemann integrals. **Chapter 7: 7.15 to 7.26**	
IV	**Infinite Series and infinite Products** - Double sequences - Double series - Rearrangement theorem for double series - A sufficient condition for equality of iterated series - Multiplication of series – Cesaro summability - Infinite products. **Chapter 8: 8.20 to 8.26** **Power series** - Multiplication of power series - The Taylor's series generated by a function - Bernstein's theorem - Abel's limit theorem - Tauber's theorem **Chapter 9: 9.14, 9.15, 9.19, 9.20, 9.22, 9.23**	**21**
V	**Sequences of Functions** – Pointwise convergence of sequences of functions - Examples of sequences of real - valued functions - Uniform convergence and continuity - Cauchy condition for uniform convergence - Uniform convergence of infinite series of functions - Riemann - Stieltjes integration – No n-uniform Convergence and Term-by-term Integration - Uniform convergence and differentiation - Sufficient condition for uniform convergence of a series - Mean convergence. **Chapter 9: 9.1 to 9.6, 9.8, 9.9, 9.10, 9.11, 9.13**	**21**
	Total	**105**

Self Study	Continuous functions, Convergent Series, Convergence

Textbooks

Tom M. Apostol.1974.Mathematical Analysis (Second Edition). Addison-Wesley Publishing Company Inc., New York.

Reference Books

1. Bartle, R.G. 1976. Real Analysis. John Wiley and Sons Inc., New Delhi.
2. Rudin, W. 1976. Principles of Mathematical Analysis (Third Edition). McGraw Hill Company, New York.
3. Malik, S.C., Savita Arora. 1991. Mathematical Analysis. Wiley Eastern Limited, New Delhi.
4. Sanjay Arora, BansiLal. 1991. Introduction to Real Analysis. Satya Prakashan, New Delhi.
5. Gelbaum, B.R., J. Olmsted.1964.Counter Examples in Analysis. Holden day, San Francisco:
6. A.L.Gupta, N.R.Gupta. 2003. Principles of Real Analysis. Pearson Education, India.

Web Resources

1. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics
2. http://www.opensource.org, www.mathpages.com
3. https://mathcs.org/analysis/reals/
4. https://ocw.mit.edu/courses/18-100c-real-analysis-fall-2012/
5. http://websitem.karatekin.edu.tr/user_files/farukpolat/files/probookmathanal1.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	1	1	2	1	3	3	2	3	2
CO2	3	3	2	1	2	1	2	3	3	2	3	2
CO3	3	3	2	1	2	2	1	3	3	3	3	2
CO4	3	3	2	1	2	2	1	3	3	3	2	2
CO5	3	3	2	2	2	1	2	3	3	2	3	2
TOTAL	**15**	**15**	**11**	**6**	**9**	**8**	**7**	**15**	**15**	**12**	**14**	**10**
AVERAGE	**3**	**3**	**2.2**	**1.2**	**1.8**	**1.6**	**1.4**	**3**	**3**	**2.4**	**2.8**	**2**

3 - Strong, 2- Medium, 1- Low

SEMESTER I

CORE COURSE III:ORDINARY DIFFERENTIAL EQUATIONS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP241CC3	**5**	1	-	-	**5**	6	**90**	**25**	**75**	**100**

Pre-requisite:

UG-level Calculus and Differential Equations

Learning Objectives:

1. To develop proficiency in solving second-order linear ordinary differential equations using methods such as variation of parameters and power series solutions.
2. To solve systems of first-order linear differential equations with constant coefficients, understanding the existence and uniqueness of solutions

Course Outcomes

On the successful completion of the course, students will be able to:		
1	recall and describe the fundamental concepts of second-order linear ordinary differential equations, including homogeneous and non-homogeneous forms.	**K1**
2	understand the method of variation of parameters for solving non-homogeneous second-order linear differential equations and illustrate its application through examples.	**K2**
3	apply power series solutions to solve first and second-order linear ordinary differential equations, distinguishing between ordinary points and regular singular points.	**K3**
4	analyze the stability and behaviour of solutions for systems of first-order linear differential equations with constant coefficients, identifying critical points and their implications.	**K4**
5	utilize special functions such as Legendre polynomials and Bessel functions to solve differential equations and evaluate their effectiveness in addressing specific mathematical and physical problems.	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate;

Units	Contents	No. of Hours
I	Second-order Linear Equations: The general solution of a homogeneous equation-The use of a known solution to find another-The method o f variation of parameters.	**18**
II	Power series solutions and special functions: A review of power series-Series solutions of first-order equations - Second-order linear equations - Ordinary points – Regular singular points.	**18**
III	Systems of first-order equations: Linear systems - Homogeneous Linear systems with constant coefficients.	**18**
IV	Legendrepolynomials-propertiesofLegendrepolynomials-Bessel'sfunctions–TheGammafunctions-Properties of Bessel Functions.	**18**
V	The Existence and Uniqueness of Solutions: The Method of Successive Approximations -Picard's theorem-Systems –The second order linear equations.	**18**
	Total	**90**

Self-study	Legendre polynomials-properties of Legendre polynomials

Textbook:

1. Simmons, G. F., 1991. *Differential Equations with Applications and Historical Notes*, Second Edition, McGraw Hill International Editions, India.
   Chapter3:Sections-14,15,16,19.
   Chapter5: Sections-26 to30.
   Chapter8: Sections-44, 45, 46, 47.
   Chapter10: Sections-55, 56.

Reference Books:

1. Sharma, A. K., 2010. *Advanced Differential Equations*, Discovery Publishing House, New Delhi.
2. Raisinghania, M. D., 2012. *Ordinary and Partial Differential Equations*, Fourteenth Revised Edition, S. Chand and Company Ltd, Ramnagar, New Delhi.
3. Arnold, V. I., 2009. *Ordinary Differential Equations*, PHI Learning Private Limited, New Delhi.
4. Polking, J. C., & Arnold, D., 2011. *Ordinary Differential Equations*, Second Impression, Dorling Kindersley Pvt. Ltd, India.
5. Doshi, J. B., 2009. *Differential Equations for Scientists & Engineers*, Narosa Publishing House, New Delhi.

Web Resources:

1. G. F. Simmons Differential Equations : G.F. Simmons : Free Download, Borrow, and Streaming : Internet Archive
2. https://www.iitg.ac.in/jiten/Extra/Coddrington.pdf
3. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics
4. http://www.opensource.org, www.mathpages.com
5. https://content.kopykitab.com/ebooks/2016/07/8107/sample/sample_8107.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	1	3	2	2	3	3	3	3	3
CO2	3	3	3	3	3	2	3	3	3	3	2	3
CO3	3	2	3	2	3	2	2	3	3	3	3	3
CO4	3	2	3	3	3	2	3	3	2	3	2	3
CO5	3	3	2	3	3	2	3	3	3	3	3	3
TOTAL	**15**	**13**	**14**	**12**	**15**	**10**	**13**	**15**	**14**	**15**	**13**	**15**
AVERAGE	**3**	**2.6**	**2.8**	**2.4**	**3**	**2**	**2.6**	**3**	**2.8**	**3**	**2.6**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER I

ELECTIVE COURSE I: a) NUMBER THEORY AND CRYPTOGRAPHY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP231EC1	4	1	-	-	3	5	75	25	75	100

Pre-requisite:

Students should know the basic concepts of Number Theory.

Learning Objectives:

1. To gain deep knowledge about Number theory.
2. To know the concepts of Cryptography.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	understand quadratic and power series forms and Jacobi symbol.	**K1 & K2**
2	apply binary quadratic forms for the decomposition of a number into sum of sequences.	**K3**
3	determine solutions using Arithmetic Functions.	**K3**
4	calculate the possible partitions of a given number and draw Ferrer's graph.	**K4**
5	identify the public key using Cryptography.	**K5 & K6**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Units	Contents	No. of Hours
I	Divisibility and Euclidean algorithm - Congruences, Euler's theorem, Wilson's Theorem, Chinese Remainder Theorem, Primitive roots **Chapter 1: 1.2, Chapter 2: 2.1,2.3,2.8**	**15**
II	Quadratic Residues – Quadratic Reciprocity – The Jacobi Symbol. **Chapter 3: 3.1, 3.2, 3.3**	**15**
III	Arithmetic functions – The Mobius Inversion Formula – Multiplication of arithmetic functions. **Chapter 4: 4.2, 4.3**	**15**
IV	Linear Diophantine equations – Sum of Four and Five Squares – Sum of Fourth Powers - Sum of Two Squares. **Chapter 5: 5.1,5.3 ,5.4**	**15**
V	**Public Key Cryptography** Public key Cryptography – Concepts of public key Cryptography – Modular arithmetic – RSA – Discrete logarithm – Elliptic curve Cryptography **Text book 2. Chapter 4: 4.1, 4.2, 4.3 Chapter 6: 6.1, 6.2**	**15**
	Total	**75**

Self Study	Arithmetic functions

Textbooks

1. Ivan Niven, Herbert S. Zuckerman and Hugh L. Montgomery (2006). *An Introduction to the Theory of Numbers*. United States: John - Wiley & Sons.
2. Neal Koblitz (1987). *A Course in Number Theory and Cryptography*. NewYork: Springer.

Reference Books

1. Hardy, G. H., & Wright E. M. (1975). *An Introduction to the Theory of Number*. United States: Oxford at the Clarendon Press.
2. David M. Burton (1989). *Elementary Number Theory*. Dubuque, Iowa: Wm. C. Brown Publishers
3. Tom. M. Apostol.(1998). *Introduction to Analytic Number Theory*. New Delhi: Narosa Publishing House.
4. Graham Everest and ThomasWard(2008).*An Introduction to NumberTheory*. NewYork: Springer**.**
5. Kenneth Ireland and Michael Rosen (1990). *A classical Introduction to Modern Number Theory*. NewYork: Springer.

Web Resources

1. https://youtu.be/PkpFBK3wGJc
2. https://youtu.be/mIStB5X4U8M?list=PL-BD05SCClbag8KTPzaPzzggJ96aBsVkT
3. https://ejionascu.ro/notes/ntbook.pdf
4. https://cse.buffalo.edu/~xinhe/cse191/Classnotes/note07-1x2.pdf
5. https://www.maths.dur.ac.uk/users/athanasios.bouganis/entc1415/lecture_notes.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	2	3	3	3	3	3
CO2	3	3	3	2	2	3	2	3	3	3	3
CO3	3	3	2	2	2	2	3	3	3	3	3
CO4	3	3	2	2	2	2	3	3	3	3	2
CO5	3	3	3	3	2	3	2	3	3	3	3
TOTAL	**15**	**15**	**12**	**11**	**11**	**12**	**13**	**15**	**15**	**15**	**14**
AVERAGE	**3**	**3**	**2.4**	**2.2**	**2.2**	**2.4**	**2.6**	**3**	**3**	**3**	**2.8**

3 – Strong, 2- Medium, 1- Low

SEMESTER I

ELECTIVE COURSE I: b) GRAPH THEORY AND APPLICATIONS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP231EC2	4	1	-		3	5	75	25	75	100

Pre-requisite:

Students should know basic concepts of Graph Theory.

Learning Objectives:

1. To help students to understand various parameters of Graph Theory with applications.
2. To stimulate the analytical mind of the students, enable them to acquire sufficient knowledge and skill in the subject that will make them competent in various areas of mathematics.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	recall the basic concepts of graph theory and know its various parameters.	**K1**
2	understand the many results derived on the basis of known parameters.	**K2**
3	apply the concepts to evaluate parameters for the family of graphs.	**K3 & K5**
4	analyze the steps of various theorems and know its applications.	**K1 &K4**
5	create a graphical model for the real-world problem using the relevant ideas.	**K6**

K1-Remember**K2**- Understand K**3** - Apply **K4**- Analyze K**5**–Evaluate**K6** - Create

Units	Contents	No. of Hours
I	**Trees** Trees - Cut Edges and Bonds - Cut Vertices. **Connectivity** Connectivity – Blocks - Construction of Reliable Communication Networks.	**15**
II	**Euler Tours and Hamilton Cycles** Euler Tours – Hamilton Cycles –The Chinese Postman Problem - Fleury's Algorithm.	**15**
III	**Matchings** Matchings. **Edge Colourings** Edge Chromatic Number – Vizing's Theorem.	**15**
IV	**Independence sets and Cliques** Independent Sets. **Vertex Colourings** Chromatic Number – Brook's Theorem – Hajos' Conjecture.	**15**
V	**Planar Graphs** Plane and Planar Graphs – Euler's Formula – Kuratowski's Theorem (statement only) – The Five Colour Theorem and Four Colour Conjecture.	**15**
	Total	**75**

Textbook

J.A. Bondy, U.S.R. Murthy. 1976. Graph Theory with Applications.Macmillan Co., London.
Chapter 2: 2.1 to 2.3

Chapter 3

Self Study	Graph Isomorphism, Distance, Radius, Diameter, The Incident and Adjacency Matrices, Vertex Degrees, Paths and Connection, Cycles.

Chapter 4: 4.1 to 4.3
Chapter 5: 5.1
Chapter 6: 6.1, 6.2
Chapter 7: 7.1
Chapter 8: 8.1 to 8.3
Chapter 9: 9.1, 9.3, 9.6

Reference Books

1. Gary Chartrand, Ping Zhang. 2006. Introduction to Graph Theory. McGraw Hill Education, India.
2. R. Balakrishnan, K. Ranganathan. 2000. Text Book of Graph Theory. Springer, New Delhi.
3. D.B.West. 2001. Introduction to Graph Theory. Prentice Hall, India.
4. J. Clark, D.A. Holton. 1995. A First look at Graph Theory. Allied Publishers, New Delhi.
5. F. Harary. 1969. Graph Theory. Addison –Wesley, Reading Mass,.

Web Resources

1. https://www.slideshare.net/mcsharma1/accounting-for-depreciation-1
2. https://www.slideshare.net/ramusakha/basics-of-financial-accounting
3. https://www.accountingtools.com/articles/what-is-a-single-entry-system.html
4. https://www.coursera.org/learn/graphs
5. https://www.tutorialspoint.com/graph_theory/index.htm

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	3	2	2	3	2	3	3	3	3	2
CO2	2	2	3	3	2	2	2	3	3	2	2	2
CO3	3	3	3	3	1	2	2	3	3	3	3	2
CO4	3	3	3	1	2	2	2	3	3	2	3	2
CO5	3	3	3	2	1	2	2	3	3	3	3	2
TOTAL	**13**	**14**	**15**	**11**	**8**	**11**	**10**	**15**	**15**	**13**	**14**	**10**
AVERAGE	**2.6**	**2.8**	**3**	**2.2**	**1.6**	**2.2**	**2**	**3**	**3**	**2.6**	**2.8**	**2**

3 - Strong, 2- Medium, 1- Low

SEMESTER I

ELECTIVE COURSE I C): PROGRAMMING IN C++

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP231EC3	4	1	-	-	3	5	75	25	75	100

Pre-requisite:
Basics of Computer Programming

Learning Objectives:
1. To apply mathematical concepts in programming
2. To create programs and applications

Course Outcomes

On the successful completion of the course, student will be able to:		
1	understand and analyze the concepts of tokens, expressions and control structures	**K1**
2	develop the knowledge in functions and arguments	**K2**
3	solve simple programs using classes and objects in C++	**K3**
4	apply the properties of constructors and destructors to solve programs	**K4**
5	create programs and applications using C++	**K5**

K1– Remember**K2 -** Understand **K3 -** Apply **K4**– Analyze**K5**–Evaluate **K6 -** Create

Units	Contents	No. of Hours
I	**Beginning with C++ & Tokens, Expressions and Control Structures** What is C++ - Applications of C++ - Asimple C++ Program – More C++ Statements – An Example with Class – Structure of C++ Program – Creating the Source File – Compiling and Linking – Token and Keyword – Identifiers and Constants – Basic Data Type – User-Defined Data Types – Control Structures Chapter 2: 2.1 - 2.8 Chapter 3: 3.2 – 3.6, 3.24	**15**
II	**Functions in C++** Introduction – TheMain Function – Function Prototyping – Call by Reference – Return by Reference – Inline Functions – Defaults Arguments – const Arguments – Function Overloading – Friend and Virtual Functions – Math Library Functions Chapter 4: 4.1 – 4.11	**15**
III	**Classes** Introduction – C Structures Revisited – Specifying a Class – Defining Membership Functions – A C++ Program with Class – Making an Outside Function Inline – Nesting of Member Functions – Private Member Functions – Arrays with a Class	**15**

	Chapter 5: 5.1 – 5.9	
IV	**Objects** Memory Allocation for Objects – Static Data Member – Static Member Functions – Arrays of Objects – Objects as Function Arguments – Friendly Functions – Returning Objects – const Member Functions – Pointers of Members – Local Classes Chapter 5: 5.10 – 5.19	**15**
V	**Constructors and Destructors** Introduction – Constructors– Parameterized Constructors – Multiple constructors in a class – Constructors with Default Arguments - Dynamic Initialization of Objects– Copy Constructor– Dynamic Constructors– Constructing Two–Dimensional Arrays– const Objects – Destructors Chapter 6: 6.1 – 6.11	**15**
	Total	**75**

Self-Study	Inline Function, Defaults Arguments, const Arguments, Arrays with a Class, Destructors

Text books

E. Balagurusamy (2008). *Object Oriented Programming with C++, Fourth Edition*. New Delhi: The McGraw–Hill Company Ltd.

Reference Books

1. V. Ravichandran (2006). *Programming with C++, Second Edition*. New Delhi: McGraw-Hill Company Ltd.
2. H. Schildt (2003). *The complete Reference of C++*.New Delhi: McGraw–Hill Company Ltd.
3. S. B. Lipman and J. Lafer (1998). *C++ Primer*. Addition Wesley, Mass.
4. Ashok N.Kamthane (2003).*Object Oriented Programming with ANSI and TURBO C++*. Pearson Education(P) Ltd.

Web Resources

1.https://www.anandinstitute.org/pdf/Balaguruswamy%20Object%20Oriented%20Programming%20With%20C++%20Fourth%20Edition%20(3).pdf

2.http://www.uml.org.cn/c%2B%2B/pdf/C%2B%2BComplete%20Reference%20(3rd%20Ed.).pdf

3.https://zhjwpku.com/assets/pdf/books/C++.Primer.5th.Edition_2013.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	2	2	2	2	2	3	3	3	2	2	2
CO2	3	3	3	3	2	2	3	3	3	2	3	2
CO3	3	2	2	2	2	2	3	3	2	2	2	2
CO4	3	2	2	2	2	3	3	3	2	3	2	2
CO5	3	3	3	3	2	2	3	2	3	2	3	3
TOTAL	**15**	**12**	**12**	**12**	**10**	**11**	**15**	**14**	**13**	**11**	**12**	**11**
AVERAGE	**3**	**2.4**	**2.4**	**2.4**	**2**	**2.2**	**3**	**2.8**	**2.6**	**2.2**	**2.4**	**2.2**

3 – Strong, 2- Medium, 1- Low

SEMESTER I

ELECTIVE COURSE II: a) DISCRETE MATHEMATICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP241EC4	**4**	**1**	**-**	**-**	**3**	**5**	**75**	**25**	**75**	**100**

Prerequisites:

Basic Concepts in Algebra and Set Theory

Learning Objectives

1. To learn the concepts of Permutations, Combinations, Boolean Algebra and Lattices
2. To motivate the students to solve practical problems using Discrete mathematics

Course Outcomes

On the successful completion of the course, student will be able to:		
1	remember and interpret the basic concepts in permutations and combinations and distinguish between distribution of distinct and non-distinct objects	**K1,K2, K4**
2	to prove the basic theorems in boolean algebra and to develop the truth table for a boolean expression	**K2**
3	interpret the recurrence relation and generating functions and evaluate by using the technique of generating functions	**K2, K3**
4	solve the problems by the principle of inclusion and exclusion	**K3**
5	differentiate between variety of lattices and their properties	**K4**

K1 – Remember **K2** - Understand **K3** - Apply **K4** – Analyse

Unit	Contents	No. of Hours
I	Permutations and combinations-The rules of sum and product- Permutations - Combinations - Distribution of distinct objects- Distribution of non-distinct objects	**15**
II	Generating functions - Generating functions for combinations - Recurrence relations -Linear recurrence relations with constant coefficients - Solution by the technique of generating functions	**15**
III	The principle of inclusion and exclusion - The general formula – Derangements	**15**
IV	Boolean Algebra and Logic Circuits: Introduction – Boolean Algebra – Unique features – Basic operations – Boolean function – De-Morgan's theorem – Logic Gate – Sum of products and product of sums form – Normal form – Expression of a Boolean function as a canonical form- Simplification of Boolean Expression by Algebraic method – Boolean expression from logic and switching network – Implementation of logic expressions with logic gates and switching circuits – Functionally Complete Sets	**15**
V	Posets and Lattices: Introduction – Partially Ordered Sets – Product and Lexicographic Order – Hasse Diagram – Special elements in Posets – Lattice - Lattices Algebraic System – Sublattices – Some special Lattices - Finite Boolean Algebra	**15**
TOTAL		**75**
Self-Study	Definition of Permutations and combinations	

Textbooks:

1. Liu C.L 1968. *Introduction to Combinatorial mathematics.* New York: McGraw Hill Publications

Chapter 1: 1.1 to 1.6; Chapter 2: 2.1, 2.2; Chapter 3: 3.1 to 3.3; Chapter 4: 4.1 to 4.4

2. Swapan Kumar Sarkar 2016. *A Textbook of Discrete Mathematics*. Ninth Edition, S. Chand and Company Ltd.

Chapter 3: 3.1 to 3.14; Chapter 9: 9.1 to 9.10

Reference Books:

1. Kenneth H. Rosen. 2012 *Discrete Mathematics and it's Applications,* 7th Edition/ McGraw Hill Education, New York, Units I, II, III.
2. T. Veerarajan, 2008.*Discrete Mathematics with Graph Theory and Combinatorics*, Tata McGraw Hills Publishing Company Limited, 7th Reprint,
3. Kolman, Busby and Ross 2012. Discrete Mathematical Structures (6th Edition). New Delhi: PHI Learning Private Ltd.

4.Malik .D.S and Sen M.K 2010. Discrete Mathematics. Cengage Learning Private Ltd.

5. Deepankar Sharma 2015. Discrete Mathematics. Savera Publishing House

Web Resources

1. https://www.slideshare.net/praveenjigajinni/13-boolean-algebra
2. https://www.slideshare.net/rafayfarooq/combinatorics-15052419
3. https://s2.smu.edu/~mhd/2353f07/part1.ppt
4. https://www.slideserve.com/wayne-barron/combinatorics-powerpoint-ppt-presentation
5. https://www.khanacademy.org/computing/pixar/crowds/crowds-1/v/intro-crowds

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	1	2	2	3	3	3	2	2	2
CO2	3	3	3	1	2	3	2	3	3	2	3	2
CO3	3	3	3	2	2	3	3	3	3	2	3	2
CO4	3	2	3	2	3	3	3	3	3	2	3	2
CO5	3	2	2	3	2	2	2	3	3	2	3	2
TOTAL	**15**	**12**	**14**	**9**	**11**	**13**	**13**	**15**	**15**	**10**	**14**	**10**
AVERAGE	**3**	**2.4**	**2.8**	**1.8**	**2.2**	**2.6**	**2.6**	**3**	**3**	**2**	**2.8**	**2**

3 – Strong, 2- Medium, 1- Low

SEMESTER I

ELECTIVE COURSE II: b) ANALYTIC NUMBER THEORY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP231EC5	4	1	-	-	3	5	75	25	75	100

Prerequisites: Knowledge of differential and integral calculus of real functions in several variables, convergence of series, (uniform)convergence of sequences of functions, basics of complex analysis

Learning Objectives

1. To understand Dirichlet multiplication, a concept which helps clarify Interrelationship between various arithmetical functions.
2. To understand some equivalent forms of the prime number theorem.

Course Outcomes

On the successful completion of the course, student will be able to:		
CO1	study the basic concepts of elementary number theory	**K1, K2**
CO2	explain several arithmetical functions and construct their relationships	**K3**
CO3	apply algebraic structure in arithmetical functions	**K3**
CO4	demonstrate various identities satisfied by arithmetical functions	**K2**
CO5	determine the application to $\mu(n)$&$\Lambda(n)$ and several equivalent form of prime number theorem	**K4**

K1 – Remember **K2** - Understand **K3** - Apply **K4** – Analyse**K5** – Evaluate **K6** - Create

Unit	Contents	No. of Hours
I	**UNIT-I:** The Fundamental Theorem of Arithmetic. Chapter 1 : Section 1.1 - 1.8 Exercise Problems: Chapter1:1-11.	**15**
II	**UNIT-II:** Arithmetic Functions. Chapter 2: Sections 2.1 - 2.8. Exercise problems: Chapter 2:1 - 6.	**15**
III	**UNIT-III:** Multiplicative Functions and Dirichlet Multiplication. Chapter 2: Sections 2.9 – 2.14. Exercise problems: Chapter 2:21 - 23, 25, 26.	**15**
IV	**UNIT-IV:** Averages of Arithmetical Functions. Chapter 3: Sections 3.1 - 3. 9. Exercise problems: Chapter 3: 1 – 4	**15**
V	**UNIT-V:** Partial sums of Dirichlet Product, Chebyshev's Functions – Equivalent forms of Prime Number Theorem. Chapter3: Sections:3.10,3.11, Chapter4:Sections4.1– 4.4.	**15**

	Exercise problems: Chapter 4: 3, 4, 5, 8.	
TOTAL		**75**
Self-Study: Definition of Permutations and combinations		

Textbooks:

Introduction to Analytic Number Theory–Tom M.A postol -Springer, International Student Edition.

Reference Books

1. *Problems in Analytic Number Theory*, M.RamMurty, Springer(2001)

2. Steps into Analytic Number Theory, Paul Pollack, Akash Singha Roy,Springer(2021)

Web Resources

http://mathworld.wolfram.com/
http://www.numbertheory.org/
https://planetmath.org/
https://services.math.duke.edu/~jonhanke/NumberTheory/
https://ocw.mit.edu/courses/mathematics/18-785-analytic-number-theory-spring-2003/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO 4	PSO 5
CO1	3	2	3	1	2	2	3	3	3	2	2	2
CO2	3	3	3	1	2	2	2	3	3	2	3	3
CO3	3	3	3	2	2	2	3	3	3	2	3	2
CO4	3	2	3	2	3	2	3	3	3	2	3	2
CO5	3	2	2	3	2	2	2	3	3	2	3	2
TOTAL	**15**	**12**	**14**	**9**	**11**	**10**	**13**	**15**	**15**	**10**	**14**	**11**
AVERAGE	**3**	**2.4**	**2.8**	**1.8**	**2.2**	**2**	**2.6**	**3**	**3**	**2**	**2.8**	**2.2**

3 – Strong, 2- Medium, 1- Low

SEMESTER I

ELECTIVE COURSE II: c) FUZZY SETS AND THEIR APPLICATIONS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP231EC6	**4**	**1**			**3**	**5**	**75**	**25**	**75**	**100**

Prerequisites: Knowledge of graphs, relations, composition

Learning Objectives

1.To study about Fuzzy sets and their relations, Fuzzy graphs, Fuzzy Relations.

2. To gain knowledge on Fuzzy logic and laws of Fuzzy compositions

Course Outcomes

On the successful completion of the course, student will be able to:		
1	understand the definition of Fuzzy sets and its related concepts	**K1, K2**
2	define Fuzzy Graphs and can explain the concepts	**K3**
3	explain the concepts in Fuzzy sets and its relations	**K3**
4	discuss about Fuzzy logic	**K2**
5	analyze the compositions of Fuzzy sets.	**K4**

K1 – Remember **K2 -** Understand **K3 -** Apply **K4** – Analyse**K5** – Evaluate **K6 -** Create

Unit	Contents	No. of Hours
I	Fundamental Notions. Chapter I: Sec.1to8	**15**
II	Fuzzy Graphs. Chapter II: Sec.10to18	**15**
III	Fuzzy Relations. Chapter II: Sec.19to29	**15**
IV	Fuzzy Logic. Chapter III: Sec.31to40(omitSec.37,38,41)	**15**
V	The Laws of Fuzzy Composition. Chapter IV: Sec.43to49	**15**
TOTAL		**75**
Self-Study: Fundamental Notions.		

Textbooks:

1.A. Kaufman,IntroductiontothetheoryofFuzzysubsets,Vol.I,AcademicPress,NewYork,(1975).

Reference Books

1. 1. H.J.Zimmermann, Fuzzy Set Theory and its Applications, AlliedPublishers, Chennai, (1996)
2. George J.Klir and BoYuan,Fuzzy sets and Fuzzy Logic-Theory and Applications, Prentice Hall India, New Delhi, (2001).

Web Resources

1. https://people.eecs.berkeley.edu/~jordan/courses/294-fall09/lectures/fuzzylec.pdf
2. http://www.cs.toronto.edu/~dianeh/soft/fuzzy/fuzzy.html
3. http://www.cise.ufl.edu/research/FSR/learning.html
4. https://www.tutorialspoint.com/fuzzy_logic/index.htm
5. http://www.ganeshmj.org/book/book.html

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	1	2	2	3	3	3	2	2	3
CO2	3	3	3	1	2	3	2	3	3	2	3	3
CO3	3	3	3	2	2	3	3	3	3	2	3	3
CO4	3	2	3	2	2	3	3	3	3	2	3	3
CO5	3	2	2	3	2	2	2	3	3	2	3	3
TOTAL	**15**	**12**	**14**	**9**	**10**	**13**	**13**	**15**	**15**	**10**	**14**	**15**
AVERAGE	**3**	**2.4**	**2.8**	**1.8**	**2**	**2.6**	**2.6**	**3**	**3**	**2**	**2.8**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER I

SPECIFIC VALUE ADDED COURSE -SCILAB

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP231V01	**2**	**-**	**-**	**-**	**1**	**2**	**30**	**25**	**75**	**100**

Pre-requisite:

Basic knowledge of Matrices and Programming languages.

Learning Objectives:

1. To make the students aware of SCILAB programming environment.
2. To acquire the practical knowledge of SCILAB for solving the matrics, polynomials and differential equations.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	learn basic SCILAB programming.	**K1**
2	understand the basic mathematical operations using SCILAB software.	**K2**
3	execute SCILAB codes for vectors, matrices, plotting lines, polynomial and differential equations	**K3**
4	implement simple mathematical functions/ equations in numerical computation environment such as SCILAB.	**K4**
5	interpret and visualize simple mathematical functions and operations by using plots.	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Units	Contents	No. of Hours
I	Login - Talking between SCILAB and the Editor - Basic Commands - Linear Algebra - Loops and Conditionals - Help in SCILAB. (Chapter 1: Sections 1.1 to 1.7)	**6**
II	Matrices and Vectors - Solving Equations - Creating Matrices - Systems of Equations. (Chapter 2: Section 2.2)	**6**
III	Plotting Lines and Data - Adding a Line - Hints for Good Graphs – Graphs - Function Plotting - Component Arithmetic - Printing Graphs - Saving Graphs. (Chapter 3: Sections 3.2, 3.3).	**6**
IV	Evaluation of Polynomials – Polynomials - Linear Least Squares (Heath Computer Problem). (Chapter 6: Sections 6.2, 6.3, 6.4).	**6**
V	Differential Equations - Scalar ODE‟s - Order 2 ODE‟s. (Chapter 8: Sections 8.2).	**6**
	Total	**30**

Textbook

Graeme Chandler and Stephen Roberts. (2002). *Scilab Tutorials for Computational Science.*

Self study	Carrying On - Defining Commands and Environments

Reference Books

1. Sandeep Nagar. (2017).*Introduction to Scilab: For Engineers and Scientists*. Apress publisher, New York.
2. Nair,A.S. (2012).*SCILAB* (*A free software to MATLAB*). S. Chand Publishing, New Delhi.
3. Anil Kumar Verma. (2018). SCILAB – A Beginners Approach (1st Edison). Cengage India.
4. Surendran, K. S. (2007). *SCILAB FOR DUMMIES*(Version 2.6).

Web Resources

1. https://www.scilab.org
2. https://onlinecourses.swayam2.ac.in/aic20_sp38/preview
3. https://www.udemy.com/course/scilab-the-first-course-beginners-to-intermediate/mediate
4. https://youtu.be/AzElVPaS71U
5. https://youtu.be/RE3-HYNBFag

MAPPING FOR PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2	3	2	3	2	2	3	2
CO2	3	3	2	2	3	2	2	3	2	2	3	2
CO3	3	3	2	3	2	2	2	3	2	3	3	2
CO4	3	3	2	2	2	3	2	3	2	2	3	2
CO5	3	3	3	3	3	2	2	3	2	3	3	3
TOTAL	**15**	**15**	**11**	**12**	**12**	**12**	**10**	**15**	**10**	**12**	**15**	**11**
AVERAGE	**3**	**3**	**2.2**	**2.4**	**2.4**	**2.4**	**2**	**3**	**2**	**2.4**	**3**	**2.2**

3 – Strong, 2- Medium, 1- Low

SEMESTER I

SPECIFIC VALUE- ADDED COURSE: CREATING DOCUMENTS USING LaTex

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP231V02	**2**	**-**	**-**	**-**	**1**	**2**	**30**	**25**	**75**	**100**

Pre-requisite:

Basic understanding of Mathematics and related commands, Idea of Microsoft Word

Learning Objectives:

1. To understand LaTeX, a document preparation system for high-quality typesetting.
2. To have hands on experience to become a user of LaTeX.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	typeset complex mathematical formulae using LaTeX	**K2& K3**
2	use tabular and array environments within LaTeX	**K2 & K3**
3.	prepare a LaTeX document, to make scientific article and project report	**K3 & K6**
4.	create automatic generation of table of contents, bibliographies	**K6**
5.	learn about graphics in LaTex	**K2& K3**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Units	Contents	No. of Hours
I	**Getting Started** Preparing an Input File - The Input – Sentences and Paragraphs - The Document – Sectioning Chapter 2 - 2.1, 2.2 - 2.2.1, 2.2.2, 2.2.3	**6**
II	**Getting Started** Displayed Material - Running Latex **Carrying On** Changing the Type Style - Mathematical formulas – Some Common Structures - Mathematical Symbols Chapter 2- 2.2.4, 2.3 Chapter 3 - 3.1, 3.3- 3.3.1, 3.3.2	**6**
III	**Carrying On** Arrays – Delimiters - Multiline Formulas – Putting One Thing Above Another - Spacing in Math mode - Defining Commands and Environments – Defining Commands - Defining Environments Chapter 3 - 3.3.3 to 3.3.7, 3.4 – 3.4.1, 3.4.2	**6**
IV	**Carrying On** Figures and Other Floating Bodies – Figures and Tables – Marginal Notes - Lining it up in Columns - The tabbing Environment- The tabular Environment **Moving Information Around** The Table of Contents - Cross-References – Bibliography and Citation	**6**

	Chapter 3 - 3.5 – 3.5.1, 3.5.2, 3.6 – 3.6.1, 3.6.2 Chapter 4 - Sections 4.1, 4.2, 4.3	
V	**Designing it yourself** Document and Page Styles- Document-Class Options, Page Styles - Title Page and Abstract, Customizing the Style, Line and Page Breaking – Line Breaking, Numbering, Centering and Flushing Chapter 6 - 6.1- 6.1.1 to 6.1.4, 6.2 - 6.2.1, 6.2.2, 6.3, 6.5	**6**
	Total	**30**
Self study	Carrying On - Defining Commands and Environments	

Text book

Lamport, L, 1994, *LATEX A Document Preparation System, User's Guide and Reference Manual* (second edition), Addison-Wesley Publishing Company, New York

Reference Books

1. Martin J. Erickson, Donald Bindner, 2011,*A Student's Guide to the Study, Practice,and Tools of Modern Mathematics*, CRC Press, Boca Raton, FL.
2. Griffits. D.F, Higham D.J, 1997, *Learning Latex*, Siam, Philadelpha
3. Kopka, Helmut, Daly P.W,2007, A *Guide to LATEX and Electronic Publishing*, (4th Edition), Addison Wesley Longman Limited.
4. Grätzer, G, 2007, *More Math Into LATEX*, (4th Edition), Springer Science + Business Media, LLC.

Web Resources

1. http://latex-beamer.sourceforge.net.
2. https://tobi.oetiker.ch/lshort/lshort.pdf
3. https://www.udemy.com/topic/latex/
4. https://onlinecourses.swayam2.ac.in/aic20_sp17/preview
5. https://www.overleaf.com/learn/latex/Free_online_introduction_to_LaTeX_(part_1)
6. https://freecomputerbooks.com

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2	3	2	3	2	2	3	2
CO2	3	3	2	2	3	2	2	3	2	2	3	2
CO3	3	3	2	3	2	2	2	3	2	2	3	2
CO4	3	3	2	2	2	3	2	3	2	2	3	2
CO5	3	3	3	3	3	2	2	3	2	2	3	3
TOTAL	**15**	**15**	**11**	**12**	**12**	**12**	**10**	**15**	**10**	**10**	**15**	**11**
AVERAGE	**3**	**3**	**2.2**	**3**	**2.6**	**2.2**	**2**	**3**	**2**	**2**	**3**	**2.2**

3 – Strong, 2- Medium, 1- Low

SEMESTER I
SPECIFIC VALUE ADDED COURSE
RESOURCE MANAGEMENT TECHNIQUES

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP231V03	2	-	-	-	1	2	30	25	75	100

Pre-requisite:
Basics in Operations Research

Learning Objectives:

1. Be familiar with resource management techniques
2. Learn to solve problems by linear programming and CPM and PERT

Course Outcomes

On the successful completion of the course, students will be able to:		
1	understand the methods of optimization and to solve the problems	**K2**
2	define how to formulate an LPP with linear constraints	**K2**
3	maximize the profit, minimize the cost, minimize the time in transportation problem, Travelling salesman problem, Assignment problem	**K3**
4	analyze a problem and formulate it as an LPP	**K4**
5	solve problems using Critical path method	**K5**

K2 - Understand; **K3** – Apply; **K4** - Analyze; **K5** - Evaluate

Units	Contents	No. of Hours
I	Linear programming - Formulation - Graphical solution - Simplex method	**6**
II	Duality – Primal-dual relation - Dual simplex method - Revised simplex method	**6**
III	Transportation problems –Travelling salesman problem -Assignment problems	**6**
IV	Sequencing problem - n jobs through 2 machines - n jobs through 3 machines - two jobs through m machines - n jobs through m machines.	**6**
V	Network diagram representation – Critical path method – Time charts and resource leveling – PERT	**6**
	Total	**30**

Self-study	Transportation problems –Travelling salesman problem -Assignment problems

Textbook:

1. Taha H.A., Operation Research, Macmillan Publishing Company, New York.

Reference Books:

1. Goldsmith, E.B., Goddard, H.W. (2004). Resource Management for Individuals and Families. McGraw-Hill Education.
2. Sutherland, J.W., McGrath, M.A. (2007). Resource Management. Pearson.
3. Manas, J. (2012). The Resource Management and Capacity Planning Handbook. CRC Press.
4. Odden, A.R., Kelly, J.A. (2002). Strategic Management of Human Capital in Education: Improving Instructional Practice and Student Learning. Routledge.

5. Kerzner, H. (2017). Project Management: A Systems Approach to Planning, Scheduling, and Controlling. Wiley.

Web Resources:

1. https://math.mit.edu/~goemans/18310S15/lpnotes310.pdf
2. https://sde.uoc.ac.in/sites/default/files/sde_videos/SLM-%2019566-B%20Sc-%20Linear%20Programming.pdf
3. https://www.selfstudys.com/cuet/mathematics/online/exam/notes/12-linear-programming
4. https://workflowautomation.net/blog/resource-management
5. https://www.projectmanager.com/blog/quick-guide-resource-management

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	2	3	3	3	3	3	3	3	3
CO4	3	3	3	2	2	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3
TOTAL	**15**	**15**	**15**	**13**	**14**	**15**	**15**	**15**	**15**	**15**	**15**	**15**
AVERAGE	**3**	**3**	**3**	**2.6**	**2.8**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER I
SPECIFIC VALUE- ADDED COURSE
MATHEMATICAL FOUNDATIONS FOR DATA SCIENCE

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP231V04	2	-	-	-	1	2	30	25	75	100

Pre-requisite:

Knowledge of basic concepts in Linear Algebra and Statistics

Learning Objectives:

1. To gain a deep understanding of foundational mathematical concepts such as linear algebra, probability theory, and statistics, which form the basis for data science.
2. To acquire skills in applying mathematical techniques to analyze and manipulate data sets effectively.

Course Outcomes

On the successful completion of the course, students will be able to:		
1	acquire necessary skills and knowledge to excel in the fields of computer graphics development and cryptography, enabling them to design advanced graphics applications and implement secure communication systems effectively.	**K2& K3**
2	understand the concept of confidence intervals, hypothesis testing of means and variances	**K2& K4**
3	use linear algebra techniques such as matrix operations, eigenvalue decomposition for data transformation and dimensionality reduction, enabling efficient data representation and visualization.	**K3**
4	use probability theory to assess uncertainties, calculate probabilities of events, and make probabilistic decisions in data-driven scenarios, such as risk assessment, predictive modeling, and business analytics.	**K3**
5	solve real-world data science problems, collaborate with domain experts, and contribute meaningfully to data science projects and initiatives.	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Units	Contents	No. of Hours
I	Basics of Data Science: Introduction; Big data and Data Science Hype, Datafication, Data Science Jobs.	**6**
II	Linear Algebra: Matrices and their properties (determinants, traces, rank, nullity, etc.); Eigenvalues and eigenvectors; Inner products.	**6**
III	Linear Algebra Applications: Computer Graphics; Linear Algebra for Cryptography	**6**
IV	Probability: Probability theory and axioms; Random variables; Probability distributions and density functions (univariate and multivariate); Expectations and moments	**6**
V	Statistics: Hypothesis testing of means and variances, Confidence (statistical) intervals.	**6**
	Total	**30**

Self study	Inner Products, Basic Concepts of Cryptography

Textbooks

1. G. Strang, Introduction to Linear Algebra, Wellesley-Cambridge Press, Fifth edition, USA, 2016.
2. Montgomery, D. C. and G. C. Runger. Applied Statistics and Probability for Engineers. 5th Edition. John Wiley & Sons, Inc., NY, USA, 2011

Reference Books

1. CathyO'Neiland Rachel Schutt,Doing Data Science, O'Reilly Media, 2013.
2. CabrielPeyre, Mathematical Foundations of Data Sciences, 2021.
3. Carlos Fernandez-Granda, Probability and Statistics for Data Science, August 2017.
4. SorinMitran, Linear algebra for data science, University of North Carolina at Chapel Hill.
5. C. H. Taubes, Lecture Notes on Probability, Statistics And Linear Algebra, Harvard University Cambridge, Spring, 2010.

Web Resources

1. https://www.analyticsvidhya.com/blog/2017/05/comprehensive-guide-to-linear-algebra/
2. https://cims.nyu.edu/~cfgranda/pages/stuff/probability_stats_for_DS.pdf
3. https://www.knowledgehut.com/blog/data-science/probability-and-statistics-for-data-science
4. https://www.kdnuggets.com/2022/07/linear-algebra-data-science.html
5. http://mitran-lab.amath.unc.edu/courses/MATH347DS/textbook.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	3	3	3	3	3	3	2	3
CO2	3	3	3	2	3	3	3	3	3	2	2	3
CO3	2	3	2	2	4	2	3	3	3	2	3	3
CO4	3	2	3	3	3	3	3	3	3	3	2	3
CO5	3	3	3	3	2	3	3	3	3	3	3	3
TOTAL	**14**	**12**	**13**	**13**	**14**	**14**	**15**	**15**	**15**	**13**	**12**	**15**
AVERAGE	**2.8**	**2.4**	**2.6**	**2.6**	**2.8**	**2.8**	**3**	**3**	**3**	**2.6**	**2.4**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER II

CORE COURSE IV: ADVANCED ALGEBRA

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP232CC1	5	1	-	-	5	6	90	25	75	100

Pre-requisite

Algebraic Structures

Learning Objectives

1. To study field extension, roots of polynomials, Galois Theory, finite fields, division rings, solvability by radicals
2. To develop computational skill in abstract algebra.

Course Outcomes

On the successful completion of the course, students will be able to:		
1	exhibit a foundational understanding of essential concepts, including field extensions, roots of polynomials, Galois Theory, and finite extensions	**K1**
2	demonstrate knowledge and understanding of the fundamental concepts including extension fields, Galois Theory, Automorphisms and Finite fields	**K2**
3	compose clear and accurate proofs using the concepts of Field extension, Galois Theory and Finite field	**K3**
4	examine the relationships between different types of field extensions and their implications by applying algebraic reasoning	**K4**
5	evaluate the validity of statements and theorems in field theory by providing proofs or counter examples	**K5**

K1 – Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate

Units	Contents	No. of Hours
I	Extension fields – Transcendence of e Chapter 5: Sections 5.1 and 5.2	**18**
II	Roots of Polynomials- More about roots Chapter 5: Sections 5.3 and 5.5	**18**
III	Elements of Galois theory Chapter 5: Section 5.6	**18**
IV	Finite fields - Wedderburn's theorem on finite division rings. Chapter 7: Sections 7.1 and 7.2 (Theorem 7.2.1 only)	**18**
V	Solvability by radicals - A theorem of Frobenius - Integral Quaternions and the Four - Square theorem. Chapter 5: Section 5.7 (omit Lemma 5.7.1, Lemma 5.7.2 and Theorem	**18**

	5.7.1) Chapter 7: Sections 7.3 and 7.4	
	Total	**90**

Self-study	1. Solvability by Radicals 2. Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC / others to be solved

Textbook

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

Reference Books

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

Web Resources

1. http://mathforum.org
2. http://ocw.mit.edu/ocwweb/Mathematics,
3. http://www.opensource.org
4. www.algebra.com
5. https://www.khanacademy.org/test-prep/v2-sat-math/x0fcc98a58ba3bea7:algebra-harder

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3	2	3	3	3	3	3	2	2	1
CO2	2	1	3	1	3	3	3	3	3	2	2	1
CO3	3	2	3	1	3	3	3	3	3	2	2	1
CO4	1	2	3	2	3	3	3	3	3	2	2	1
CO5	3	1	2	3	3	3	3	3	3	2	2	1
TOTAL	**12**	**7**	**14**	**9**	**15**	**15**	**15**	**15**	**15**	**10**	**10**	**5**
AVERAGE	**2.4**	**1.4**	**2.8**	**1.8**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**1**

3 – Strong, 2- Medium, 1- Low

SEMESTER II

CORE COURSE V: REAL ANALYSIS - II

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP242CC2	5	1	-	-	5	6	90	25	75	100

Pre-requisite:

Standard elementary concepts of calculus.

Learning Objectives:

1. To introduce measure on the real line, Lebesgue measurability and integrability, Fourier Series and Integrals.
2. To get the in-depth study in multivariable calculus

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	recall the basic concepts of measurable sets, measurable function, integration of functions, Fourier series on real line and multivariable differential calculus, implicit functions and extremum problems.	**K1**
2.	describe the elementary facts of Lebesgue measure, Lebesgue integral, Fourier series and multivariable differential calculus; understand the implicit functions and extremun problems.	**K2**
3.	determine the measurable sets, measurable functions, the matrix representation and Jacobian determinant of functions.	**K3**
4.	analyze the properties of measurable functions, Riemann and Lebesgue integrals, convergence of Fourier series and extrema of real valued functions.	**K4**
5.	test measurable sets and measurable functions.	**K5**

K1 – Remember; **K2**– Understand; **K3 –** Apply; **K4**-Analyze; **K5** – Evaluate

Units	Contents	No. of Hours
I	**Lebesgue Measure** –Introduction - Outer Measure - Measurable sets and Lebesgue measure–A non measurable set - Measurable Functions –Littlewood's three principles. Chapter 3: Section 1 to 6 (H. L. Royden)	**18**
II	**The Lebesgue Integral**–The Riemann Integral –The Lebesgue integral of a bounded function over a set of finite measure–The integral of a nonnegative function - The general Lebesgue integral. Chapter 4: Section 1 to 4 (H. L. Royden)	**18**
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 orthonormal system - Properties of Fourier Coefficients - The Riesz-Fischer Theorem - The convergence and representation problems for trigonometric series - The Riemann - Lebesgue Lemma - The Dirichlet Integrals - An integral representation for the partial sums of Fourier series - Riemann's localization theorem - Sufficient conditions for convergence of a Fourier series at a particular point –Cesaro summability of Fourier series- Consequences of Fejes's theorem - The Weierstrass approximation theorem. Chapter 11: Sections 11.1 to 11.15 (Apostol)	**18**
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	**18**

	function - The Jacobian matrix - The chain rule - Matrix form of chain rule - The mean - value theorem for differentiable functions - A sufficient condition for differentiability - A sufficient condition for equality of mixed partial derivatives - Taylor's theorem for functions of R^n to R^1. Chapter 12: Section 12.1 to 12.5 and 12.7 to 12.14 (Apostol)	
V	**Implicit Functions and Extremum Problems:** Introduction - 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. Chapter 13: Sections 13.1 to 13.7 (Apostol)	**18**
	Total	**90**

Self Study	The convergence and representation problems for trigonometric series and the chain rule.

Textbooks

1. Royden H. L., 2004. *Real Analysis*, Third Edition, Prentice - Hall of India Private Limited, New Delhi. (for Units I and II).
2. Tom M. Apostol, 2002. *Mathematical Analysis*, 2nd Edition, 12th Reprint, Narosa Publishing House Pvt. Ltd. New York, Addison-Wesley Publishing Company Inc. (for Units III, IV and V)

Reference Books

1. Burkill,J.C, 1951. *The Lebesgue Integral*, Cambridge University Press.
2. Munroe,M.E, 1971. *Measure and Integration*. Addison-Wesley Publishing House..
3. G. de Barra, 2000. *Measure Theory and Integration*, Reprint, New Age International Publisher, New Delhi.
4. Rudin, W., 2013. *Principles of Mathematical Analysis*, Third Edition, New York, McGraw Hill Education Pvt. Ltd.
5. Malik,S.C. and Savita Arora, 2017. *Mathematical Analysis*, Fifth Edition, New Age International Publishers, New Delhi.
6. Sanjay Arora and Bansi Lal, 1991. *Introduction to Real Analysis*, New Delhi, Satya Prakashan.

Web Resources

1. Lebesgue Measure -- from Wolfram Math World
2. Measure and Integration 15 - Lebesgue Integral of nonnegative function - YouTube
3. Lecture 53-Fourier integrals - YouTube
4. Multivariable Calculus | Khan Academy
5. Differential Calculus of Several Variables - 1 - YouTube

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	2	3	3	2	3	2	2	2	2
CO2	2	2	3	1	3	3	2	3	2	2	2	2
CO3	3	2	3	1	3	3	2	3	2	2	2	2
CO4	1	2	3	2	3	3	2	3	2	2	2	2
CO5	3	2	2	3	3	3	2	3	2	2	2	2
TOTAL	**12**	**10**	**14**	**9**	**15**	**15**	**10**	**15**	**10**	**10**	**10**	**10**
AVERAGE	**2.4**	**2**	**2.8**	**1.8**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**

3 – Strong, 2- Medium, 1- Low

SEMESTER II

CORE COURSE VI: PARTIAL DIFFERENTIAL EQUATIONS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP232CC3	**5**	1	**-**	**-**	**4**	**6**	**90**	**25**	**75**	**100**

Pre-requisite

UG-level partial differential equations

Learning Objectives

1.To formulate and solve different forms of partial differential equations.
2. Solve the related application-oriented problems.

Course Outcomes

On the successful completion of the course, students will be able to:		
1	recall the definitions of complete integral, particular integral, and singular integrals.	**K1 & K2**
2	learn some methods to solve the problems of non-linear first-order partial differential equations. homogeneous and non-homogeneous linear partial differential equations with constant coefficients and solve related problems.	**K2 & K3**
3	analyze the classification of partial differential equations in three independent variables – Cauchy's problem for a second-order partial differential equation.	**K2 & K3**
4	solve the boundary value problem for the heat equations and the wave equation.	**K1 & K2**
5	apply the concepts and methods in physical processes like heat transfer and electrostatics.	**K2 & K3**

K1 - Remember; **K2** - Understand; **K3** - Apply

Units	Contents	No. of Hours
I	Non-linear Partial Differential Equations of order one - complete integral, particular integral, singular integral - Compatible system of First Order Equations - Charpit's Method. **Chapter 3: 3.1, 3.4 to 3.8B.**	**18**
II	Homogeneous and Non Homogeneous Linear Partial Differential Equations with constant coefficients - Solution of Homogeneous and Non Homogeneous Linear Partial Differential Equations with constant coefficients - Method of finding Complementary Function of Linear Homogeneous Partial Differential Equations with constant coefficients - Particular Integral of Homogeneous Partial Differential Equations - General method of finding Particular Integral of Linear Homogeneous Partial Differential Equations. **Chapter 4: 4.1 to 4.6, 4.12, 4.13.**	**18**
III	Non Homogeneous Linear Partial Differential Equations with constant coefficients - Reducible and Irreducible Linear Differential operators - Reducible and Irreducible Linear Differential Equations with constant coefficients - Determination of Complementary Function of Reducible Non Homogeneous Linear Partial Differential Equations with constant coefficients with working rule - General Solution of Non Homogeneous Linear Partial Differential Equations with constant coefficients - Determination of Particular Integral of Non	**18**

	Homogeneous Linear Partial Differential Equations with constant coefficients. **Chapter 5: 5.1 to 5.7, 5.10 to 5.13.**	
IV	Classification of Partial Differential equations of second order - Classification of P.D.E. in three independent variables – Cauchy's problem for a second order P.D.E. Characteristic equation and Characteristic curves of the second order P.D.E. – Laplace transformation. Reduction to Canonical (or normal) forms. **Chapter 8: 8.1 to 8.11.**	**18**
V	Boundary Value Problem - Solution by Separation of variables - Solution of One-dimensional Wave Equation - Solution of Two-dimensional Wave Equation - Vibration of Circular Membrane - Solution of One-Dimensional Heat Equation - Solution of Two-Dimensional Laplace's Equation - Solution of two-dimensional heat equation **Chapter 12: 12.1 to 12.8.**	**18**
	Total	**90**

Self-study	Simple portions, eg. definition, meaning, solving problems

Textbooks

1. M.D. Rai Singhania, 1988. *Advance Differential Equations*, (16thRevised and Corrected Edition). New Delhi: S. Chand and Company Ltd.
1. Sharma, A. K, 2010. *Advanced Differential Equations*, Discovery Publishing House.

Reference Books

1. Amaranth,T. An Elementary Course in Partial Differential Equations. (2^{nd} Edition). New Delhi: Narosa Publishing House.
2. Ian Sneddon. 1957. Elements of Partial Differential Equations. International Edition.
3. Kevorkian, J, 2006. Partial Differential Equations. Springer International Edition.
4. Sharma, I. N., &Kehar Singh, 2009. Partial Differential Equations for Engineers and Scientists. (Second Edition). Narosa Publishing House PVT. LTD.
5. Lawrence C. Evans, 2009. Partial Differential Equations. (1^{st} Indian Edition). Rhode Island, American Mathematical Society Providence.

Web Resources

1. http://mathforum.org,
2. http://ocw.mit.edu/ocwweb/Mathematics,
3. http://www.opensource.org,
4. www.mathpages.com
5. https://howellkb.uah.edu

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	1	3	2	3	3	3	3	3	2	2	1
CO2	2	1	3	1	3	3	3	3	3	2	2	1
CO3	3	2	3	1	3	3	3	3	3	2	2	1
CO4	1	2	3	2	3	3	3	3	3	2	2	1
CO5	3	1	2	3	3	3	3	3	3	2	2	1
TOTAL	**12**	**7**	**14**	**9**	**15**	**15**	**15**	**15**	**15**	**10**	**10**	**5**
AVERAGE	**2.4**	**1.4**	**2.8**	**1.8**	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**1**

3 – Strong, 2- Medium, 1- Low

SEMESTER II

ELECTIVE COURSE III: a) MATHEMATICAL STATISTICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP232EC1	**3**	1	**-**	**-**	**3**	**4**	**60**	**25**	**75**	**100**

Pre-requisite

Knowledge in Probability Theory and Statistics

Learning Objectives

1. To enhance knowledge in mathematical statistics and acquire basic knowledge about various distributions.
2. To understand about mathematical expectations, moment generating function technique and the Central Limit Theorem.

Course Outcomes

On the successful completion of the course, students will be able to:		
1	recall the basic probability axioms, conditional probability, random variables and related concepts	**K1**
2	learn the transformation technique for finding the p.d.f of functions of random variables and use these techniques to solve related problems	**K2**
3	compute marginal and conditional distributions and check the stochastic independence	**K3**
4	employ the relevant concepts of analysis to determine limiting distributions of random variables	**K2**
5	design probability models to deal with real world problems andsolve problems involving probabilistic situations.	**K3**

K1 - Remember; **K2** - Understand; **K3**– Apply

Units	Contents	No. of Hours
I	Distributions of Functions of Random Variables – Sampling Theory – Transformations of Variables of the Discrete Type – Transformations of Variables of the Continuous Type – The t and F Distributions Chapter 4: 4.1 – 4.4	**12**
II	Limiting Distributions – Stochastic Convergence – Limiting Moment Generating Functions – The Central Limit Theorem Chapter 5: 5.1 – 5.4	**12**
III	Estimation – Point Estimation – Measures of Quality of Estimators – Confidence Intervals for Means – Confidence Interval for Difference of Means – Confidence Interval for Variances Chapter 6: 6.1 – 6.5	**12**
IV	Statistical Hypothesis – Some Examples and Definitions – Certain Best Tests – Uniformly Most Powerful Tests – Likelihood Ratio Tests Chapter 7: 7.1 – 7.4	**12**
V	Other Statistical Tests – Chi-Square Tests – The Distributions of Certain Quadratic Forms – A Test of Equality of Several Means – Noncentral χ^2 and Noncentral F Chapter 8: 8.1 – 8.4	**12**
	Total	**60**

Self-study	Sampling Theory

Textbook

Robert V. Hogg and Allen T. Craig, 1978. *Introduction to Mathematical Statistics,* Fourth Edition, New York: Macmillan Publishing Co

Reference Books

1.Kapur, J.N., and Saxena, H.C, 2010. *Mathematical Statistics*, 12thEdition, S. Chand & Co.
2.KadarkaraiThangam, K., and Subas Chandra Bose. A, 1995. *Probability and Statistics*, 1stEdition, Jeyalakshmi Publishers.
3. Morris H. DeGroot, 1975. *Probability and Statistics*, Addison Wesley Publishing Company.
4.Suddhendu Biswass.,and Sriwastav, G.L, 2011. *Mathematical Statistics*, Narosa Publishing House.
5. Murthy, T.S.R, 1995. *Probability and Statistics*, 1stEdition, I.K. International Publishing House.

Web Resources

1. https://onlinecourses.nptel.ac.in/noc21_ma74/preview
2. https://users.encs.concordia.ca/~doedel/courses/comp-233/slides.pdf
3. https://www.utstat.toronto.edu/mikevans/jeffrosenthal/book.pdf
4. http://www.uop.edu.pk/ocontents/Book.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	3	3	3	3	1	2	3	1	2	3
CO2	3	2	3	2	2	2	3	2	2	3	2	3
CO3	3	3	2	2	3	3	3	2	2	3	3	2
CO4	3	3	2	3	2	2	3	3	2	3	3	2
CO5	2	2	3	3	3	2	2	2	2	2	2	3
TOTAL	**12**	**12**	**13**	**13**	**14**	**12**	**12**	**11**	**11**	**12**	**12**	**13**
AVERAGE	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER II

ELECTIVE COURSE III: b) STATISTICAL DATA ANALYSIS USING R PROGRAMMING

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP232EC2	4	-	-	-	3	4	60	25	75	100

Pre-requisite:

Students should know basic skills of computer.

Learning Objectives:

1. The basics of statistical computing and data analysis.
2. How to use R for analytical programming.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	recall R and its development history	**K1**
2.	demonstrate how to import and export data with R	**K2 & K4**
3.	explain discrete distributions	**K3**
4.	apply various concepts to write programs in R	**K3 & K5**
5.	apply estimation concepts in R programming	**K2 & K3**

K1 - Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate

Units	Contents	No. of Hours
I	Statistical Software R - R and its development history – Structure of R - installation of R **Chapter 1: 1.1, 1.2, 1.3**	**12**
II	Descriptive Statistics – Basics - Excursus: Data Import and Export with R – Import of ICU-Dataset **Chapter 2: 2.1, 2.2, 2.3**	**12**
III	Colors and Diagrams – Colors - Excursus: Export of diagrams - Diagrams **Chapter 3: 3.1, 3.2, 3.3**	**12**
IV	Probability Distributions – Discrete Distributions – Continuous Distributions **Chapter 4: 4.1 and 4.2**	**12**
V	Estimation – Introduction – Point Estimation **Chapter 5: 5.1 and 5.2**	**12**
	Total	**60**

Self-study	R and its development history

Textbook

1. Matthias Kohl, 2015. *Introduction to statistical data analysis with R*, (First edition), bookboon.com, The e Book company.

Reference Books

1. Torsten Hothorn, Brian Everitt S, 2014. *A Handbook of Statistical Analyses using R*, (Third edition), CRC PRESS, Taylor & Francis Group
2. Purohit S.G., Gore S.D., and Deshmukh S.R., 2015. *Statistics using R*, (Second edition), Narosa Publishing House, New Delhi.
3. Crawley, M. J, 2006. *Statistics - An introduction using R*, (Second edition), John Wiley, London 32.
4. Verzani J, 2005. *Using R for Introductory Statistics*, (Second edition), Chapman and Hall /CRC Press, New York
5. Braun W. J., and Murdoch D. J, 2021. *A First Course in Statistical Programming with R*, (Third edition), Cambridge University Press, New York.
6. Dalgaard P, 2008. *Introductory Statistics with R*, (Second edition), Springer.
7. Gardener M, 2012. *Beginning R: The Statistical Programming Language*, Wiley Publications.

Web Resources

1. https://www.udemy.com/course/statistics-using-r/
2. https://sims.strathmore.edu/executive-education/r-programming/
3. https://www.educba.com/statistical-analysis-with-r/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3	2	3	3	3	2	3	2
CO2	3	3	2	2	2	3	2	3	3	2	3	2
CO3	3	3	2	2	2	2	3	3	3	3	3	2
CO4	3	3	2	2	2	2	3	3	3	3	2	2
CO5	3	3	2	3	2	3	2	3	3	2	3	2
TOTAL	**15**	**15**	**10**	**11**	**11**	**12**	**13**	**15**	**15**	**12**	**14**	**10**
AVERAGE	**3**	**3**	**2**	**2.2**	**2.2**	**2.4**	**2.6**	**3**	**3**	**2.4**	**2.8**	**2**

3 - Strong, 2- Medium, 1- Low

SEMESTER II

ELECTIVE COURSE III: c) PROGRAMMING with C++ PRACTICAL

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP232EC3	-	2	2	-	3	4	60	25	75	100

Pre-requisite

Basic functionality of computer programs.

Learning Objectives

1. To introduce a higher level language C++ for hands-on experience on computers.
2. Adhere to best practices and coding standards in C++ programming

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	understand about object oriented programming and learn how to store one object inside another object	**K2, K3**
2.	gain knowledge about the capability to store information together in an object.	**K1**
3.	understand the capability of a class to rely upon another class.	**K1, K4**
4.	analyze the process of exposing the essential data to the outside of the world andhiding the low level data	**K4**
5.	understand about constructors which are special type of functions	**K2**

K1– Remember**K2** - Understand **K3** - Apply **K4**– Analyze

Units	Contents	No. of Hours
I	Vector Representation using Class - Sum of two types of objects - String Class	**12**
II	Matrix Operations using Operator Overloading - Overloaded = = Operator for String Comparison	**12**
III	Conversion from Polar to Rectangle and Rectangle to Polar - Friend Function	**12**
IV	Virtual Function - Extending Shape class to find area of circle	**12**
V	Text Process - Text file process - Creating data file with name and phone numbers - Creation and Process of telephone files	**12**
	Total	**60**

Self-study	Matrix Operations using Operator Overloading

Textbook

Balagurusamy, 1999. *Object Oriented Programming with C++*,Tata McGraw Hill, New Delhi.

Reference Books

1. Ravichandran.V. 2006. *Programming with C++*, Second Edition Tata McGraw- Hill, New Delhi.

2. Devi Prasad, 2006, *An Introduction to Numerical Analysis* (3rd edn)Narosa Publishing House, New Delhi,.
3. Ravichandran.D. 1996. *Programming with C++*, Tata McGraw Hill,New Delhi.
4. Conte and de Boor, 1990. *Numerical Analysis*, McGraw Hill, NewYork.
5. John H.Mathews, 2000. *Numerical Methods for Mathematics*, Scienceand Engineering (2nd Edn.), Prentice Hall, New Delhi.

Web Resources

1. https://www.prebytes.com
2. https://www.oreilly.com
3. https://www.ctae.ac.in
4. https://www.udemy.com
5. https://www.geeksforgeeks.org

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	2	2	2	2	3	2	2	3
CO2	3	2	2	2	2	1	2	1	2	2	1	2
CO3	3	2	2	3	2	2	2	2	2	2	2	2
CO4	2	2	2	1	2	2	2	2	2	2	2	1
CO5	2	2	2	1	1	2	2	1	2	2	1	1
TOTAL	**12**	**10**	**10**	**9**	**9**	**9**	**10**	**8**	**11**	**10**	**8**	**9**
AVERAGE	**2.4**	**2**	**2**	**1.8**	**1.8**	**1.8**	**2**	**1.6**	**2.2**	**2**	**1.6**	**1.8**

3 – Strong, 2- Medium, 1- Low

SEMESTER II

ELECTIVE COURSE IV: a) OPERATIONS MODELING

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP232EC4	3	1	-	-	3	4	60	25	75	100

Pre-requisite

Knowledge of probability distributions and statistics

Learning Objectives

1. To analyze different situations in the industrial/ business scenario involving limited resources
2. To finding the optimal solution within constraints.

Course Outcomes

On the successful completion of the course, students will be able to:		
1	build and solve Transportation and Assignment problems using appropriate method	**K1**
2	learn the constructions of network and optimal scheduling using CPM and PERT	**K2**
3	ability to construct linear integer programming models and solve linear integer programming models using branch and bound method	**K3**
4	understand the need of inventory management.	**K2**
5	to understand basic characteristic features of a queuing system and acquire skills in analyzing queuing models	**K3**

K1 - Remember; **K2** - Understand; **K3** - Apply

Units	Contents	No. of Hours
I	Transportation Models and its Variants: Definition of theTransportationModel–Non-TraditionalTransportationModel– TransportationAlgorithm – TheAssignment Model. Chapter 5: Sections 5.1, 5.2, 5.3, 5.4. Exercise problems.	**12**
II	Network Analysis: Network Definitions– MinimalSpanningTreeAlgorithm–ShortestRouteProblem– MaximumFlowModel –CPM –PERT. Chapter 6: Sections 6.2, 6.3, 6.4, 6.5, 6.7. Exercise problems.	**12**
III	Inventory Theory: Basic Elements of an Inventory Model – Deterministic Models: Single Item Stock Model With And Without Price Breaks –Multiple Items Stock Model With Storage Limitations Chapter11–Sections11.1,11.2,11.3,	**12**
IV	Probabilistic Models: Continuous Review Model- Single Period Models. Chapter16–Sections16.1, 16.2, 16.3, Exercise problems.	**12**
V	Queuing Theory: Basic Elements of Queuing Model –Role of Poisson and Exponential Distributions– Pure Birth and Death Models –	**12**

	Specialised Poisson Queues-(M/G/1):GD/∞/∞)- Pollaczek - Khintechine Formula. Chapter 17: Sections 17.2, 17.3, 17.4, 17.6, 17.7. Exercise problems.	
	Total	**60**

Self-study	Exercise Problems

Textbooks

1. Hamdy A.Taha, *OperationsResearch*(SixthEdition), Prentice Hall of India Private Limited, New Delhi.
2. HamdyA.Taha, *OperationsResearch*(Third Edition),Prentice Hall of India Private Limited, New Delhi.

Reference Books

1. Pathak, H.K, Dr. Pradeep, K. Joshi and C.Sharma,Shree *Operations Research*, Shiksha Sahitya Prakashan Publication, Reprint2022-23.
2. Srinivasan G,*Operations Research :Principles and Applications*, Second Edition, Easrern Economy Edition, PHI.
3. Hamdy A. Taha, *Operations Research* (seventh Edition)Prentice Hall of India Private Limited, New Delhi.
4. Kanti Swarup, P.K. Gupta and Man Mohan, *Operations Research*, 13th edition, Sultan. Chand and Sons, 2007.
5. R.K. Gupta, Operations Research, Krishna Prakashan Media, 1992.

Web Resources

1.https://en.wikipedia.org/wiki/Operations_ research
2.https://www.techtarget.com/whatis/definition/operations-research-OR
3.https://www.britannica.com/topic/operations-research
4.https://www.springer.com/journal/12351
5.https://www.or.ncsu.edu/about/what-is-operations-research/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	1	2	3	3	3	3	1	2	3	1	2	3
CO2	3	2	3	3	2	2	3	2	2	3	2	3
CO3	3	3	2	2	3	3	3	2	2	3	3	2
CO4	3	3	2	3	2	2	3	3	2	3	3	2
CO5	2	2	3	3	3	2	2	2	3	2	2	3
TOTAL	**12**	**12**	**13**	**14**	**14**	**12**	**12**	**11**	**12**	**12**	**12**	**13**
AVERAGE	**2**	**2**	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER II
ELECTIVE COURSE IV: b) MATHEMATICAL PYTHON

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP232EC5	**3**	**-**	**1**	**-**	**3**	**4**	**60**	**25**	**75**	**100**

Pre-requisite:

Students should know basic skills of computer

Learning Objectives:

1. To familiarize the students with Python programing for Mathematics.
2. To train them to develop programs and create functions for Mathematics in Python.

K1-Remember **K2**- Understand **K3** – Apply **K4**- Analyze **K5** - Evaluate

Course Outcomes

On the successful completion of the course, student will be able to**:**		
1	acquire knowledge on Python and learn to run the program.	**K1**
2	understand and discuss about different data types and flow control statements.	**K2 & K4**
3	write programs in python using Lists Tuples, Sets and Dictionaries	**K3**
4	understand For and While loops and conditional statements.	**K3 & K5**
5	creates Functions and Arrays in Python	**K2 & K3**

Units	Contents	No. of Hours
I	Python Getting started: Installing Python, different tabs in Jupiter notebook, Magics, Markdown **Sec: 1.1, 1.2 (1.21 - 1.27)**	**12**
II	Programming Python: Python data types, Containers, Controlling the flow **Sec: 2.1 – 2.6, 3.1 – 3.4, 4.1 – 4.8**	**12**
III	Packaging and reusing the code – Functions, Modules, Comprehensions, General expression and Comments **Sec: 5.1 – 5.5**	**12**
IV	Numerical Computing: Numpy – Array creation, Array properties, Array operation, Array indexing and slicing, Indexing with integer Arrays and Boolean Arrays. **Sec: 6.1 – 6.6**	**12**
V	Differential Equations: First order differential equations, Higher Order differential equations, Systems of equations **Sec: 8.1 – 8.3**	**12**

Self –Study	Installing Python, Array Operations

Textbook

Scientific and Mathematical Computing Using Python - Adam Cunningham University at Buffalo Department of Biostatistics

Reference Books

1. Kenneth A Lambert, Fundamentals of Python First programs 2nd Edition - Cengage, Learning India.
2. Amit Saha, Doing Math with Python, No starch Press,
3. E. Balgurusamy, Problem solving and Python programming, Tata McGraw Hill.
4. Mark Lutz, Learning Python,5th Edition O'Reilly Media
5. Paul Barry Head First Python, 2nd Edition O'Reilly Media

Web Resources

1. https://www.udemy.com/course/scientific-computing-with-numpy/
2. https://www.msuniv.ac.in/images/e-content/6.Computer%20%20Fundamentals%20and%20Office%20Automation.pdf
3. https://web.pdx.edu/~gjay/teaching/mth271_2020/pdf/OER.pdf
4. https://library.oapen.org/bitstream/id/56d27e73-e92a-4398-8198-239be7aacc93/2020_Book_IntroductionToScientificProgra.pdf
5. https://patrickwalls.github.io/mathematicalpython
6. https://fliphtml5.com/ntsfv/tmnj/basic/301-336
7. https://www.oreilly.com/library/view/learning-python-5th/9781449355722/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	3	2	3	3	3	2	3	2
CO2	3	3	2	2	2	3	2	3	3	2	3	2
CO3	3	3	2	2	2	2	3	3	3	3	3	2
CO4	3	3	2	2	2	2	3	3	3	3	2	2
CO5	3	3	2	3	2	3	2	3	3	2	3	2
TOTAL	**15**	**15**	**10**	**11**	**11**	**12**	**13**	**15**	**15**	**12**	**14**	**10**
AVERAGE	**3**	**3**	**2**	**2.2**	**2.2**	**2.4**	**2.6**	**3**	**3**	**2.4**	**2.8**	**2**

3 - Strong, 2- Medium, 1- Low

SEMESTER II

ELECTIVE COURSE IV: c) NEURAL NETWORKS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP232EC6	**3**	1	-	-	**3**	**4**	**60**	**25**	**75**	**100**

Pre-requisite

Familiarity with linear algebra, multivariate calculus and probability theory

Learning Objectives

1. To know the main fundamental principles and techniques of neural network systems and investigate the principal neural network models and applications.
2. Apply neural networks to classification and generalization problems.

Course Outcomes

On the successful completion of the course, students will be able to:		
1	understand and analyze different neutron network models	**K2, K4**
2	understand the basic ideas behind most common learning algorithms for multilayerperceptions, radial basis function networks.	**K2**
3	describe Hebb rule and analyze back propagation algorithms with examples	**K1, K4**
4	study convergence and generalization and implement common learning algorithms.	**K3**
5	study directional derivatives and necessary conditions for optimality and to evaluatequadratic functions.	**K5**

K1– Remember**K2 -** Understand **K3 -** Apply **K4**– Analyze**K5**–Evaluate **K6 -** Create

Units	Contents	No. of Hours
I	**Neuron Model and Network Architectures:** MathematicalNeural Model-Network Architectures- Perceptron - Hamming Network-Hopfield Network-Learning Rules.	**12**
II	**Perceptron Architectures:** Perceptron Architectures andLearning Rules with proof of convergence-Supervised Hebbian Learning-Linear Associator.	**12**
III	**Supervised Hebbian Learning:** The Hebb Rule-Pseudoinverse rule-Variation of Hebbian Learning-Back Propagation - Multilayer Perceptrons.	**12**
IV	**Back Propagation**: Back Propagation algorithm-convergence and Generalization-Performances surfacesand optimum points-Taylor series.	**12**

V	**Performance surface and performance optimizations**: Directional derivatives-Minima-Necessary conditions for optimality - Quadratic functions-Performance optimizations-Steepest Descent Newton's method-Conjugate Gradient.	**12**
	Total	**60**

Self-study	The Hebb Rule, Pseudoinverse rule and Variation of Hebbian Learning

Textbook

Martin T. Hagan, Howard B/Demuth and Mark Beale, 2002, *Neural Network Design*, Vikas Publishing House, New Delhi,

Reference Books

1. James A. Freeman, David M. Skapura, 2003. *Neural Networks Algorithms, Applications and Programming Techniques*, Pearson Education.
2. Bishop, C. M, 2006. *Pattern Recognition and Machine Learning*, Volume 1, Springer.
3. Duda, R. O., Hart, P. E., & Stork, D. G, 2012. *Pattern Classification*, Volume 1 (2nd Edition), Wiley.
4. Hagan, M. T., Demuth, H. B., & Beale, M. H, 2014. *Neural Network Design*, Volume 1 (2nd Edition), Martin Hagan.
5. Marsland, S. 2009. *Machine Learning: An Algorithmic Perspective*, Volume 1, CRC Press.

Web Resources

1. https://www.coursera.org/learn/neural-networks-deep-learning
2. http://neuralnetworksanddeeplearning.com/
3. https://ai.googleblog.com/
4. https://nptel.ac.in/courses/117/105/117105084/
5. https://nptel.ac.in/courses/106/106/106106184/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	2	2	2	2	2	2	3	2	2	3
CO2	3	2	2	1	1	1	2	1	2	2	1	2
CO3	1	2	2	3	1	2	2	1	2	2	2	2
CO4	2	2	1	1	2	2	1	2	1	2	2	1
CO5	2	2	2	1	1	1	2	1	2	2	1	2
TOTAL	**11**	**9**	**9**	**8**	**7**	**8**	**9**	**7**	**10**	**10**	**8**	**10**
AVERAGE	**2.2**	**1.8**	**1.8**	**1.6**	**1.4**	**1.6**	**1.8**	**1.4**	**2**	**2**	**1.6**	**2**

3 – Strong, 2- Medium, 1- Low

SEMESTER II

SKILL ENHANCEMENT I: INTRODUCTION TO MS EXCEL 2007

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP242SE1	4	-	-	-	3	4	60	25	75	100

Pre-requisite

Students should know about the fundamental skills of a computer and some useful shortcuts.

Learning Objectives

1. To familiarize the students with Excel's basic features.
2. To acquire skills for data analysis using MS Excel.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	understand the Excel interface including the ribbon, worksheets and cells	**K2**
2.	enter and format data effectively including text, numbers and formulas	**K3& K4**
3.	use basic functions like SUM, AVERAGE and COUNT for simple calculations	**K3 & K4**
4.	manage data effectively through organization, sorting and filtering	**K3 & K4**
5.	create various chart types including bar charts, line graphs, pie charts, and scatter plots to visually represent data.	**K4 & K5**

K2-Understand;**K3**-Apply;**K4**-Analyze;**K5**-Evaluate;**K6**– Create

Units	Contents	No. of Hours
I	**Getting Started with Excel 2007** Introduction to Excel 2007 User Interface – Title Bar – Office Button – Quick Access Toolbar – Ribbon – Command Tabs – Contextual Tabs – Command Sets – Dialog Box Launchers – Mini Toolbar – Live Preview – Key Tips – Super ToolTips – Name Box – Formula Bar – Work Area – Zoom Controls – Creating a New Workbook – Using a Blank Workbook Template – Saving a Workbook – Closing the Current Workbook – Opening an Existing Workbook – Closing MS Excel **Chapter 1: Pages 4-18, 23-28**	**12**
II	**Working with Data and Data Tables** Introduction – Entering Data using AutoFill – AutoFill a Text Series - AutoFill a Number Series – Creating Your Own Custom List – Using Merge & Center –Turning on Text Wrapping – Changing Number Formats – Increasing or Decreasing Decimals in Numeric Data **Chapter 2: Pages 32, 40-57**	**12**
III	**Working with Data and Data Tables** Sorting Data – Sorting Data using Some Predefined Criteria – Sorting Data by Defining Custom Sort Criteria – Filtering Data – Linking Data – Adding a Hyperlink – Editing a Hyperlink – Removing a Hyperlink – Creating a Table - Creating a Table from a Blank Cell Range - Creating a Table from an Existing Data Range – Editing a Table – Formatting a Table – Sorting a Table – Filtering a Table **Chapter 2: Pages 65-88**	**12**
IV	**Using Formulas and Functions**	**12**

	Introduction – Understanding Formulas – Operators in Excel 2007 – Operator Precedence – Creating a Formula – Editing a Formula – Defining Range Names –Assigning a Range name– Selecting a Range – Editing a range Name – Referencing Ranges in Formulas- Referencing Cells from Other Worksheets – Using Relative and Absolute Cell References – Understanding Functions – Some Common Excel Functions – Applying a Function – Editing a Function - Calculating Total of Cell Data with AutoSum. **Chapter 5: Pages 178-210**	
V	**Working with Charts** Introduction – Creating a chart – Changing the Chart Layout – Changing the Chart Styles – Changing the Chart Type – Adding a Chart Title – Adding Axis Titles – Adding Data Labels – Adding a Legend –Adding Gridlines. **Chapter 7: Pages 258-281**	**12**
	Total	**60**

Self-study	Range Names – Assigning a Range name– Selecting a Range – Editing a range Name

Textbook

Kogent Learning Solutions Inc, Excel 2007 in Simple Steps, 2010, Dreamlech Press

Reference Books

1. McKie. D, 2009, Introduction to MS Excel 2007, Centre for Educational Technology, University of Cape Town.
2. Joan Lambert and Curtis Frye, 2022, Microsoft Excel Step by Step, Pearson Education.
3. Rutkosky, Seguin, Microsoft Excel 2007, 2008, A Visual Approach to Learning Computer Skills, BPB Publications

Web Resources

1. .https://www.gacbe.ac.in/pdf/ematerial/18BCS5EL-U5.pdf
2. https://www.sgul.ac.uk/about/our-professional-services/information-services/library/documents/training-manuals/Excel-Fundamentals-Manual.pdf
3. .https://www.csun.edu/sites/default/files/excel07basics.pdf
4. https://ptgmedia.pearsoncmg.com/images/9780735623040/samplepages/9780735623040.pdf
5. https://www.geeksforgeeks.org/introduction-to-ms-excel/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	3	2	3	2	3	2	3	3	2
CO2	3	3	3	3	2	3	2	3	2	3	3	2
CO3	3	3	3	3	2	3	2	3	2	3	3	2
CO4	3	3	3	3	2	3	2	3	2	3	3	2
CO5	3	3	3	3	2	3	2	3	2	3	3	2
TOTAL	**15**	**13**	**13**	**14**	**15**	**15**	**12**	**15**	**14**	**13**	**11**	**15**
AVERAGE	**3**	**2.6**	**2.6**	**2.8**	**3**	**3**	**2.4**	**3**	**2.8**	**2.6**	**2.2**	**3**

3–Strong,2-Medium,1-Low

SEMESTER I & II

LIFE SKILL TRAINING – I ETHICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PG23LST1	1	-	-	-	1	1	15	50	50	100

Prerequisites: Value education-its purpose and significance in the present world

Learning Objectives

1. To familiarize students with values of the individual, society, culture, one's own health and life philosophy,
2. To impart knowledge of professional ethical standards, codes of ethics, obligations, safety, rights, and other worldwide challenges.

Course Outcomes	On completion of this course the student will be able to	
1	understand deeper insight of the meaning of their existence.	K1
2	recognize the philosophy of life and individual qualities	K2
3	acquire the skills required for a successful personal and professional life.	K3
4	develop as socially responsible citizens.	K4
5	create a peaceful, communal community and embrace unity.	**K3**

Unit	Contents	No. of Hours
I	**Goal Setting:** Definition - Brainstorming Session – Setting Goals – Few components of setting goals.	3
II	**Group Dynamics:** Definition - Nature of Groups – Types of Groups – Determinants of group behaviour	3
III	**Conflict Resolution:** Definition – What is a conflict resolution – Why should conflicts be resolved? - Lessons for life	3
IV	**Decision Making:** Definition – 3C's of decision making – Seven Steps to effective decision making – Barriers in effective decision making	3
V	**Anger Management:** Effects of anger – Tips to reduce anger – Anger warning signs – Identify your triggers – Ways to cool down your anger.	3
TOTAL		15
Self-Study: Salient values for life, Human Rights, Social Evils and how to tackle them, Holistic living, Duties and responsibilities.		

Textbook

Life Skill Training – I Ethics, Holy Cross College (Autonomous), Nagercoil

Reference Books

1. Holy Cross College (Autonomous), Nagercoil (2007). Foundation Course Life's Challenges. Sipca Computers.
2. Mathew, Sam (2010). Self Help Life Book. Opus Press Publisher.
3. Swati Mehrotra. (2016). Inspiring Souls Moral Values and Life Skills (1st ed.) [English]. Acevision Publisher Pvt. Ltd.
4. Irai Anbu, v. (2010, August). Random Thoughts (1st ed.) [English]. THG Publishing Private Limited, 2019.
5. Holy Cross College (Autonomous), Nagercoil (2007). Foundation Course Life's Challenges. Sipca Computers.

Web Resources

1. https://positivepsychology.com/goal-setting-exercises/
2. https://www.gov.nl.ca/iet/files/CCB_GroupDynamicsGuide.pdf
3. https://en.wikipedia.org/wiki/Conflict_resolution
4. https://asana.com/resources/decision-making-process
5. https://www.mayoclinic.org/healthy-lifestyle/adult-health/in-depth/anger-management/art-20045434

SEMESTER III

CORECOURSE VII : COMPLEX ANALYSIS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP233CC1	6	-	-	-	5	6	90	25	75	100

Pre-requisite:

UG level Complex Analysis

Learning Objectives:

1. To understand the fundamental concepts and theorems of complex analysis, including Cauchy's Integral Formula, Taylor's Theorem, and the Residue Theorem.
2. To develop proficiency in applying complex analysis techniques to solve problems involving harmonic functions, power series expansions, and entire functions.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	demonstrate the ability to compute line integrals over rectifiable arcs and apply Cauchy's Theorem to evaluate integrals in various domains.	**K2, K3**
2.	interpret and apply advanced concepts such as Jensen's Formula and Hadamard's Theorem to analyze the behavior of entire functions and infinite products.	**K3, K4**
3.	apply the calculus of residues to evaluate definite integrals and utilize harmonic functions to solve boundary value problems using Poisson's Formula and Schwarz's Theorem.	**K3, K5**
4.	construct power series expansions using Weierstrass's Theorem and apply partial fractions and factorization techniques to manipulate complex functions.	**K3, K6**
5.	analyze the local properties of analytic functions, including removable singularities, zeros, poles, and the Maximum Principle.	**K4**

K2 - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate; **K6**– Create

Units	Contents	No. of Hours
I	**Complex Integration:** Line Integrals – Rectifiable Arcs – Line Integrals as Functions of Arcs – Cauchy's Theorem for a Rectangle – Cauchy's Theorem in a Disk–**Cauchy's Integral Formula:** The Index of a Point with respect to a Closed Curve – The Integral Formula – Higher Derivatives. Chapter 4: Section 1, Section 2.	**18**
II	**Local Properties of Analytic Functions:** Removable Singularities – Taylor's Theorem – Zeros and Poles – The Local Mapping – The Maximum Principle **- The General Form of Cauchy's Theorem:** Chains and Cycles: Simple Connectivity – Homology – The General Statement of Cauchy's Theorem – Proof of Cauchy's Theorem. Chapter 4: Section 3, Section 4: 4.1 – 4.4.	**18**
III	**The Calculus of Residues:** The Residue Theorem – The Argument Principle – Evaluation of Definite Integrals - **Harmonic Functions:** Definition and Basic Properties – The Mean-Value Property. Chapter 4: Section 5, Section 6: 6.1 – 6.2	**18**
IV	Poisson's Formula – Schwarz's Theorem – The Reflection Principle– **Power Series Expansions:** Weierstrass's Theorem – The Taylor's Series	**18**

	– The Laurent Series. Chapter 4: Section 6: 6.3 – 6.5; Chapter 5: Section 1	
V	**Partial Fractions and Factorization:** Partial Fractions – Infinite Products – Canonical Products – **Entire Functions:** Jensen's Formula – Hadamard's Theorem. Chapter 5: Section 2: 2.1 – 2.3, Section 3	**18**
	Total	**90**

Self-study	The Residue Theorem, The Argument Principle, Evaluation of Definite Integrals

Textbook:

1. Lars V. Ahlfors, 1979. *Complex Analysis*, (3rd edition) McGraw Hill Co., New York.

Reference Books:

1. Presfly, H. A., 2003. *Introduction to Complex Analysis*, Clarendon Press, Oxford.
2. Ponnusamy, S., 2011. *Foundations of Complex Analysis*, 2nd Edition, Narosa Publishing House.
3. Conway, J. B., 1995. *Functions of One Complex Variable*, 2nd Edition, Springer-Verlag, Narosa Publishing Co.
4. Narayanan, S., & Mittal, P. K., 2011. *Theory of Functions of a Complex Variable*, S. Chand & Co Publication.
5. Bak, J., & Newman, D. J., 2010. *Complex Analysis*, 3rd Edition, Springer.
6. Brown, J. W., & Churchill, R. V., 2014. *Complex Variables and Applications*, 9th Edition, McGraw-Hill Education.

Web Resources:

1. https://mccuan.math.gatech.edu/courses/6321/lars-ahlfors-complex-analysis-third-editionmcgraw-hill-science_engineering_math-1979.pdf
2. https://psm73.files.wordpress.com/2009/03/conway.pdf
3. https://namitatiwaridotorg.files.wordpress.com/2017/10/ponnusamy-s-silverman-h-1-complex-variables-with-applications.pdf
4. https://homepages.uc.edu/~herronda/complex_analysis/Texts/Intro2ComplexAnalysis.pdf
5. file:///C:/Users/MariaJini/Downloads/1588542562-complex-variables-and-applications-brown-and-churc.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	2	2	2	3	3	3	2	2
CO2	3	2	2	2	2	2	2	3	3	3	2	2
CO3	3	2	2	2	2	2	2	3	3	3	2	2
CO4	3	2	2	2	2	2	2	3	3	3	2	2
CO5	3	2	2	2	2	2	2	3	3	3	2	2
TOTAL	**15**	**10**	**10**	**10**	**10**	**10**	**10**	**15**	**15**	**15**	**10**	**10**
AVERAGE	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**2**	**2**

3 – Strong, 2- Medium, 1- Low

SEMESTER III
CORE COURSE VIII: TOPOLOGY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP233CC2	**6**	-	-	-	**5**	6	**90**	**25**	**75**	**100**

Pre-requisite:

Fundaments of Real Analysis

Learning Objectives:

1. To distinguish spaces by means of simple topological invariants.

2. To lay the foundation for higher studies in Geometry and Algebraic Topology.

Course Outcomes

On the successful completion of the course, students will be able to:		
1	recall the definitions of topological space, basis, various topologies, closed sets, limit points, continuity, connectedness, compactness, separation axioms, countability axioms and completeness	**K1**
2	defends the basic results in topological spaces, continuous functions, connectedness, compactness, countability and separation axioms and complete metric spaces	**K2**
3	solve problems on topological spaces, continuous functions and topological properties	**K3**
4	analyse various facts related to continuous functions, connected spaces, compact spaces, countable spaces, separable spaces, normal space and compact spaces	**K4**
5	evaluate the comparison between different types of topological spaces	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate;

Units	Contents	No. of Hours
I	Topological spaces and Examples - Basis for a topology - The order topology - The product topology on $X \times Y$ - The subspace topology - Closed sets and Limit points -Continuous function. Chapter 2: Sections 12 – 18.	**18**
II	The Product Topology – The metric topology – Sequence lemma – Uniform limit theorem - Connected spaces – Components and Local connectedness. Chapter 2 : Sections 19 – 21 & Chapter 3 : 23, 25.	**18**
III	Compact spaces - Compact subspaces of the Real Line – Uniform Continuity theorem – Limit point Compactness – Local Compactness. Chapter 3 :Sections 26 - 29.	**18**
IV	Countability Axioms - First and Second countable spaces –Lindeloff and Separable spaces - The separation axioms - Normal spaces - The Urysohn's Lemma. Chapter 4 :Sections 30 – 33.	**18**
V	The Urysohn Metrization Theorem - Tietze Extension Theorem – Complete metric spaces- Compactness in Metric Spaces. Chapter 4: Sections 34, 35 & Chapter 7 : Sections 43, 45.	**18**
	Total	**90**

Self-study	Closed sets and Limit points

Textbook:

1. James R. Munkres, 2015. *Topology*, (2^{nd} Edition), Pearson Education Inc.
   Sections: 12 - 21, 23, 25- 28, 30 - 35, 43, 45

Reference Books:

1. Gupta, K. P., 2013. *Topology*, 21st Edition, Pragati Prakashan Publishers.
2. Kelley, J. L., 2009. *General Topology*, 3rd Indian Reprint, Springer-Verlag.
3. Simmons, G. F., 2004. *Introduction to Topology and Modern Analysis*, 2nd Indian Reprint, McGraw Hill.
4. Willard, S., 1970. *General Topology*, Addison-Wesley Publishing Company.
5. Joshi, K. D., 1983. *Introduction to General Topology*, Wiley Eastern Ltd.

Web Resources:

1. https://www.uio.no/studier/emner/matnat/math/MAT4500/h18/dokumenter/topology.pdf
2. http://www.math.iitb.ac.in/~ronnie/Spring2022/Lecture-Notes.pdf
3. https://www.math.colostate.edu/~renzo/teaching/Topology10/Notes.pdf
4. https://www.youtube.com/watch?v=XHKcrs8YaSo
5. https://www.youtube.com/watch?v=vv3JNSPKeEU

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	3	2	2	3	2	3	2	2	2	2
CO2	3	3	3	2	2	3	2	3	2	2	2	2
CO3	3	3	3	2	2	3	2	3	2	2	2	2
CO4	3	3	3	2	2	2	2	3	2	2	2	2
CO5	3	3	3	2	2	2	2	3	2	2	2	2
TOTAL	**14**	**14**	**15**	**10**	**10**	**13**	**10**	**15**	**10**	**10**	**10**	**10**
AVERAGE	**2.8**	**2.8**	**3**	**2**	**2**	**2.6**	**2**	**3**	**2**	**2**	**2**	**2**

3 – Strong, 2- Medium, 1- Low

SEMESTER III
CORECOURSE IX: TRADITIONAL MECHANICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP233CC3	6	-	-	-	5	6	90	25	75	100

Pre-requisite:

Foundational understanding of principles like force, motion, energy, and momentum. Critical thinking and problem-solving skills for applying these concepts to various scenarios.

Learning Objectives:

1. To gain deep insight into concepts of Dynamics
2. To do significant contemporary research.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	grasp concepts like time dilation, relativistic dynamics, and the equivalence principle.	**K1**
2.	understand classical mechanics principles such as coordinates, constraints, and energy-momentum relationships for analyzing mechanical systems.	**K2**
3.	apply Lagrangian methods to special cases such as impulsive motion and systems with constraints, thereby expanding their problem-solving abilities	**K3**
4.	integrate classical and relativistic mechanics, enabling them to analyze systems ranging from everyday mechanics to those involving high speeds and gravity.	**K4**
5.	become proficient in using Lagrangian mechanics to solve complex problems and identify integral properties of motion.	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyze; **K5** - Evaluate;

Units	Contents	No. of Hours
I	The Mechanical System - Generalized coordinates - Constraints - Virtual work and D' Alembert's Principle - Energy and Momentum.	**18**
II	Derivation of Lagrange's equations - Problems using Lagrange's equation – Integrals of the motion.	**18**
III	Special Applications of Lagrange's Equations – Rayleigh's Dissipation Function – Impulsive Motion – Impulsive and momentum - Lagrangian method - Ordinary constraints - Impulsive constraints – Energy considerations- Quasi –coordinates. Examples	**18**
IV	Introduction to Relativity – Introduction –Galilean transformation – Maxwell's equations – The ether theory – The principle of relativity – Relativistic Kinematics – The Lorentz transformation equations – Events and simultaneity – Einstein's train – Time dilation- Longitudinal contraction- the invariant interval – proper time and proper distance- The world line – the twin paradox - Addition of velocities – the relativistic Doppler effect.	**18**
V	Relativistic Dynamics -Momentum – Energy - The momentum-energy four vector - Force – Conservation of energy – Mass and energy – inelastic collision – The principle of equivalence - Lagrangian and Hamiltonian formulations- Accelerated systems – Rocket with constant acceleration - Rocket with constant thrust	**18**

	Total	**90**

Self-study	The Lorentz transformation equations – Events and simultaneity – Einstein's train – Time dilation- Longitudinal contraction- the invariant interval – proper time and proper distance

Textbook:

1.Greenwood, D. T., 1979. *Classical Dynamics*, Prentice-Hall Inc., Englewood Cliffs, N.J., U.S.A.

Reference Books:

1. Goldstein, H., 1994. *Classical Mechanics*, 2nd Edition, Narosa Publishing.
2. Synge, J. L., & Griffith, B. A., 1959. *Principle of Mechanics*, McGraw Hill.
3. Rutherford, D. E., 2000. *Classical Mechanics*, Oliver Boyd, New York.
4. Chorlton, F., 1969. *Textbook of Dynamics*, Van Nostrand.
5. Hasbun, J. E., 2009. *Classical Mechanics*, Jones and Bartlett Publishers.

Web Resources:

1. https://www.coursera.org/courses?query=introduction%20to%20classical%20mechanics
2. https://www.youtube.com/channel/UC7_gcs09iThXybpVgjHZ_7g
3. https://www.youtube.com/user/MIT
4. https://www.youtube.com/user/khanacademy/playlists?view=50&sort=dd&shelf_id=9
5. https://www.youtube.com/user/physicswoman

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	2	3	3	3	3	3	2
CO2	3	3	3	2	3	2	3	3	3	3	3	2
CO3	3	3	3	2	3	2	3	3	3	3	3	2
CO4	3	3	3	2	3	2	3	3	3	3	3	3
CO5	3	3	3	2	3	2	3	3	3	3	3	3
TOTAL	**15**	**15**	**15**	**10**	**15**	**10**	**15**	**15**	**15**	**15**	**15**	**12**
AVERAGE	**3**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2.4**

3 – Strong, 2- Medium, 1- Low

SEMESTER III
CORE - RESEARCH PROJECT

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP233RP1	-	-	-	-	4	5	75	25	75	100

Pre-requisite:

Basic knowledge of research methods and ethical guidelines.

Learning Objectives:

1. Acquire skills in data analysis using statistical software or qualitative analysis methods, depending on the nature of the data.
2. Develop the ability to interpret research findings accurately, drawing conclusions based on evidence and relating them to the research question.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	learn to manage research projects, adhering to timelines and adapting to challenges.	**K1**
2.	understand ethical considerations in research and collaborate effectively with peers and advisors.	**K2**
3.	conduct independent research, from formulating questions to gathering data.	**K2**
4.	communicate their research findings through written reports and oral presentations.	**K3, K5**
5.	develop critical thinking skills, analyzing findings and drawing informed conclusions.	**K4, K6**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate; **K6** – Create

Course Requirements:

1. All students are mandated to undertake a dissertation in their final year (III semester).
2. Students may pursue their project in another institution with consent from the Supervisor, HoD, and Principal, especially with MoU/Collaboration for project completion.

Evaluation Structure:

Evaluation	Marks	Month/ Date	Evaluator
Proposed title, review of literature and objectives.	-	3rd Week of III Semester	-
I Review	5	July	Supervisor
II Review	5	August	Supervisor
Report	15	September/ October	Supervisor
External - Dissertation *Viva-voce (individual & open)	40 35	October /November	Ext. examiner
Total marks	100		

- The presentation mode is by PowerPoint.

Dissertation Format:

- Dissertation format specifications include:
- Font: Times New Roman
- Heading: Font size 14 (Bold, Uppercase)

- Subheadings: Font size 12 (Bold, Lowercase), numbered (e.g., Introduction 1; Subheading 1.1; 1.2)
- Text content: Font size 12 (Normal)
- Citation: Follow specified citation formats for referencing other researchers' work.
- Line spacing: 1.5
- Margin: 2" left, 1" right, Gutter: 0.5
- Page numbering: Bottom middle alignment, excluding initial pages and references.
- Total pages: Minimum 30, Maximum 50 (excluding initial pages and references).
- Tables and Figures should be included subsequently after referring to them in the text.
- Chapters should be printed on both sides.

- Project reports must be completed within the stipulated time.
- Submission requirements include one soft copy (PDF format on CD) and three hard copies (soft binding) duly signed and endorsed by the Supervisor and the Head.

Structure of Project Report:

1. Initial Pages:
   - Title Page
   - Supervisor's Certificate
   - Candidate's Declaration (endorsed by Supervisor and HoD)
   - Acknowledgment (one-page, signed by the candidate)
   - Table of Contents
   - List of Abbreviations
   - Abstract
2. Main Body:
   - Introduction with Literature Review and Objectives
   - Methodology
   - Results
   - Discussion
   - Summary
   - References
3. Reference guidelines for various sources are provided for proper citation.

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	3	3	2	3	2	3	3	3	3	2
CO2	2	2	3	3	2	2	2	3	3	2	3	2
CO3	3	3	3	3	2	2	2	3	3	3	3	2
CO4	3	3	3	3	2	2	2	3	3	2	3	2
CO5	3	3	3	3	2	2	2	3	3	3	3	2
TOTAL	**13**	**14**	**15**	**15**	**10**	**11**	**10**	**15**	**15**	**13**	**15**	**10**
AVERAGE	**2.6**	**2.8**	**3**	**3**	**2**	**2.2**	**2**	**3**	**3**	**2.6**	**3**	**2**

3 - Strong, 2- Medium, 1- Low

SEMESTER III
ELECTIVE COURSE V: a) ALGORITHMIC NETWORK ANALYSIS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP233EC1	4	-	-	-	3	4	60	25	75	100

Pre-requisite:

Understanding of basic data structures, algorithms, and graph theory concepts.

Learning Objectives:

1. To master fundamental algorithms and data structures, enabling efficient problem-solving.
2. To develop analytical skills for evaluating and implementing algorithms, addressing real-world challenges in various domains.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	recall and identify basic concepts and facts related to algorithms, data structures, and graph theory, including definitions, properties, and terminology.	**K1**
2.	demonstrate a solid understanding of the principles and theories including their applications in problem-solving and computational analysis.	**K2**
3.	apply algorithmic techniques to solve real-world problems efficiently.	**K3**
4.	analyze algorithms, data structures, and graph theory concepts to identify optimal solutions for computational problems.	**K4**
5.	represent graphs in a computer using different data structures.	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate;

Units	Contents	No. of Hours
I	An Introduction to Algorithms – Algorithmic Complexity, Search Algorithms, Sorting Algorithms, Greedy Algorithms, Representing Graphs in a Computer. Chapter 2: Section 2.1 – 2.3, 2.5, 2.6	**12**
II	Trees – Properties of trees, Depth-First Search, Depth-First Search: A Tool for Finding Blocks, Breadth-First Search, The Minimum Spanning Tree Problem – Kruskal's Algorithm, Prim's Algorithm. Chapter 3: Section 3.1, 3.3 – 3.6	**12**
III	Paths and Distance in Graphs – Distance in Graphs, Distance in Weighted Graphs, The Center and Median of a Graph Chapter 4: Section 4.1 – 4.3	**12**
IV	Networks – An Introduction to Networks, The Max-Flow Min-Cut Theorem, A Max-Flow Min-Cut Algorithm, Connectivity and Edge-Connectivity, Menger's Theorem Chapter 5: Section 5.1 – 5.3, 5.5, 5.6	**12**
V	Digraphs – Strong Digraphs, Depth-First Search in Digraphs, Depth-First Search Algorithm for Digraphs, Strongly Connected Components, Tournaments Chapter 11: Section 11.1 – 11.4	**12**
	Total	**60**

Self-study	Paths and Distance in Graphs – Distance in Graphs, Distance in Weighted Graphs, The Center and Median of a Graph.

Textbook:

1.Gary Chartrand, Ortrud R. Oellermann, 1993. *Applied and Algorithmic Graph Theory*, McGraw-Hill, New York.

Reference Books:

1. Cormen, T. H., Leiserson, C. E., Rivest, R. L., Stein, C., 2022. *Introduction to Algorithms*, The MIT Press, Cambridge, Massachusetts, London, England.
2. Diestel, R., 2017. *Graph Theory*, Springer, New York.
3. Even, S., 2012. *Graph Algorithms*, Cambridge University Press, New York.
4. Cormen, T. H., Leiserson, C. E., Rivest, R. L., Stein, C., 2010. *Introduction to Algorithms*, 3rd Edition, PHI Learning Pvt. Limited.
5. Murugan, M., 2003. *Graph Theory and Algorithms*, Muthali Publishing House.

Web Resources:

1. https://alexjbest.github.io/mjolnir/warwick2/CS254/CS254.pdf
2. https://www.mathe2.uni-bayreuth.de/axel/papers/mchugh:algorithmic_graph_theory.pdf
3. https://www.ime.usp.br/~am/328/DaMNeD.pdf
4. https://arxiv.org/ftp/arxiv/papers/1302/1302.4378.pdf
5. https://www.shahucollegelatur.org.in/Department/Studymaterial/sci/it/BCS/FY/book.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	2	3	3	2	3	2	2	2	3
CO2	3	2	2	3	3	3	2	3	3	2	2	3
CO3	3	3	3	3	3	3	2	3	3	3	2	3
CO4	3	3	3	3	3	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3
TOTAL	**15**	**13**	**13**	**14**	**15**	**15**	**12**	**15**	**14**	**13**	**11**	**15**
AVERAGE	**3**	**2.6**	**2.6**	**2.8**	**3**	**3**	**2.4**	**3**	**2.8**	**2.6**	**2.2**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER III

ELECTIVE COURSE V: b) INTRODUCTION TO MACHINE LEARNING USING PYTHON

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP233EC2	4	-	-	-	3	4	60	25	75	100

Pre-requisite:

Familiarity with programming concepts and basic Python syntax

Learning Objectives:

1. To learn machine learning and the usage of Python for data analysis.
2. To explore probability theory and data visualization techniques using Python.

Course Outcomes

On the successful completion of the course, students will be able to:		
1	gain a solid understanding of probability theory, including random experiments and the binomial distribution.	**K1, K2**
2	understand the importance of machine learning and its application in analytics	**K2**
3	declare variables, use conditional statements, generate sequence numbers, implement control flow statements, and define functions.	**K3**
4	acquire knowledge of statistical concepts such as the normal distribution, and other important probability distributions, enabling them to analyze data effectively using Python	**K4**
5	possess skills in data exploration and visualization, capable of drawing various plots including bar charts and comparing distributions.	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyze; **K5** - Evaluate;

Units	Contents	No. of Hours
I	Introduction to Analytics and Machine Learning - Why Machine Learning ? - Framework for Developing Machine Learning Models - Why Python? - Python Stack for Data Science.	**12**
II	Introduction to Python-Declaring Variables-Conditional Statements-Generating Sequence Numbers-Control Flow Statements-Functions.	**12**
III	Exploration of Data using Visualization-Drawing Plots-Bar Chart-Histogram-Distribution or Density Plot-Box Plot-Comparing Distributions.	**12**
IV	Probability Theory-Terminology-Random Experiment-Sample Space-Event-Random Variables-Binomial Distribution.	**12**
V	Normal Distribution-Example of Normal Distribution-Mean and Variance-Confidence Interval-Cumulative Probability Distribution-Other Important Distributions.	**12**
	Total	**60**

Self-study	Exploration of Data using Visualization-Drawing Plots-Bar Chart-Histogram-Distribution or Density Plot-Box Plot-Comparing Distributions

Textbook:

1.Manaranjan Pradhan, Dinesh Kumar.U. 2023. *Machine Learning using Python,* Wiley India Pvt.Ltd

Reference Books:

1. Müller, A.C., Guido, S., 2016. *Introduction to Machine Learning with Python: A Guide for Data Scientists*, 1st Edition, O'Reilly Media, Sebastopol.
2. Matthes, E., 2015. *Python Crash Course*, 1st Edition, No Starch Press, San Francisco.
3. Provost, F., Fawcett, T., 2013. *Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking*, 1st Edition, O'Reilly Media, Sebastopol.
4. Healy, K., 2018. *Data Visualization: A Practical Introduction*, 1st Edition, Princeton University Press, Princeton.
5. Blitzstein, J.K., Hwang, J., 2019. *Introduction to Probability*, 1st Edition, CRC Press, Boca Raton.

Web Resources:

1. https://machinelearningmastery.com/
2. https://www.programiz.com/python-programming
3. https://www.statisticshowto.com/probability-and-statistics/
4. https://stattrek.com/probability-distributions/normal.aspx
5. https://towardsdatascience.com/tagged/normal-distribution

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2	2	2	3	3	3	2	2
CO2	3	3	2	2	2	2	2	3	3	3	2	2
CO3	3	3	2	2	2	2	2	3	3	3	2	2
CO4	3	3	3	2	2	3	2	3	3	3	3	2
CO5	3	3	3	2	2	3	2	3	3	3	3	2
TOTAL	**15**	**15**	**12**	**10**	**10**	**12**	**10**	**15**	**15**	**15**	**12**	**10**
AVERAGE	**3**	**3**	**2.4**	**2**	**2**	**2.4**	**2**	**3**	**3**	**3**	**2.4**	**2**

3 – Strong, 2- Medium, 1- Low

SEMESTER III

ELECTIVE COURSE V : c) CODING THEORY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP233EC3	4	-	-	-	3	4	60	25	75	100

Pre-requisite:

A strong mathematical background in combinatorial theory and information theory is essential to learn coding theory

Learning Objectives:

1. To learn the different procedures of coding and decoding.
2. To avail job opportunities in a number of detective agencies

Course Outcomes

On the successful completion of the course, students will be able to:		
1	gain a deep understanding of fundamental concepts in coding theory, and their applications in error detection and correction.	**K1, K2**
2	understand how the information theory principles influence the design and optimization of error-correcting codes.	**K2**
3	apply combinatorial theory principles to construct efficient error-correcting codes, such as Hamming codes and Golay codes	**K3**
4	explore advanced coding methods and understand their constructions, properties, and applications in modern communication systems and cryptography.	**K4**
5	develop the ability to analyze and evaluate various coding techniques and algorithms, including majority logic decoding and weight enumerators	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyze; **K5** - Evaluate;

Units	Contents	No. of Hours
I	Mathematical Background: Algebra - Krawtchouk Polynomials – Combinatorial theory – Probability Theory Chapter 1, 1.1, 1.2, 1.3, 1.4	**12**
II	Linear codes: Block codes - Linear codes - Hamming codes - Majority logic decoding - Weight Enumerators Chapter 3 , 3.1, 3.2, 3.3, 3.4, 3.5	**12**
III	Some good codes: Hadamard codes and generalizations - The binary Golay code - The ternary Golay code - Constructing codes from other codes Chapter 4 , 4.1, 4.2, 4.3, 4.4	**12**
IV	Goppa Codes : Motivation – Goppa Codes – The minimum Distance of Goppa Codes – Asymptotic Behaviour of Goppa Codes - Decoding Goppa Codes. Chapter 9 , 9.1, 9.2, 9.3, 9.4, 9.5	**12**
V	Algebraic Geometry Codes: Divisors – The Riemann –Roch Theorem – Codes from Algebraic Curves Chapter 10 , 10.3, 10.5, 10.6	**12**
	Total	**60**

Self-study	Linear codes: Block codes - Linear codes - Hamming codes - Majority logic decoding - Weight Enumerators

Textbook:

1.Van Lint, J. H. 2000. *Introduction to Coding Theory*. 3rd Edition. Springer.

Reference Books:

1. Borda, M., 2011. *Fundamentals in Information Theory and Coding*, Springer
2. Hill, R., 1986. *A First Course in Coding Theory*. Clarendon Press, Oxford
3. Pless, V. 1998. *Introduction to the Theory of Error-Correcting Codes*. (3rd Edition). John Wiley and Sons Inc.
4. Huffman, W. C., & Pless, V. 2003. *Fundamentals of Error-Correcting Codes*. Cambridge University Press
5. Moser, S. M., & Chen, P-N. 2012. *A Student's Guide to Coding and Information Theory*. Cambridge University Press

Web Resources:

1. https://link.springer.com/book/10.1007/978-0-387-93877-7
2. https://ieeexplore.ieee.org/book/5226426
3. https://books.google.com/books/about/A_Course_in_Coding_Theory.html?id=UpTPAwAAQBAJ
4. https://www.sciencedirect.com/book/9780120890602/algebraic-coding-theory
5. https://onlinelibrary.wiley.com/doi/book/10.1002/9781118032872

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	3	3	2	3	2	3	3	3	3	2
CO2	2	2	3	3	2	2	2	3	3	2	3	2
CO3	3	3	3	3	2	2	2	3	3	3	3	2
CO4	3	3	3	3	2	2	2	3	3	2	3	2
CO5	3	3	3	3	2	2	2	3	3	3	3	2
TOTAL	**13**	**14**	**15**	**15**	**10**	**11**	**10**	**15**	**15**	**13**	**15**	**10**
AVERAGE	**2.6**	**2.8**	**3**	**3**	**2**	**2.2**	**2**	**3**	**3**	**2.6**	**3**	**2**

3 - Strong, 2- Medium, 1- Low

SEMESTER III

SKILL ENHANCEMENT COURSE II: RESEARCH METHODOLOGY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP233SE1	3	-	-	-	2	3	45	25	75	100

Pre-requisite

Foundational knowledge in critical thinking, statistics, ethics, and scientific method.

Learning Objectives

1. To write a scientific research manuscript containing important key sections
2. To realize the importance of Research Ethics and methodologies involved in the research process

Course Outcomes

On the successful completion of the course, students will be able to:		
1	understand the objectives and methods of research , standard structure of a scientific paper and avoid plagiarism.	**K2**
2	analyzing research data and statistical measures such as measures of central tendency, dispersion, and asymmetry.	**K4**
3	identify the ethics of scientific paper writing and analyze research problems	**K4**
4	develop research designs for specific research problems and assess the significance of research in various fields.	**K5**
5	create structured scientific research papers and write project proposals and progress reports for research funding.	**K6**

K2 - Understand; **K3** - Apply; **K4** - Analyze; **K5**– Evaluate; **K6**- Create

Units	Contents	No. of Hours
I	Research Methodology: An Introduction - Meaning of Research - Objectives of Research - Motivation in Research - Types of Research - Research Approaches - Significance of Research - Research Methods versus Methodology - Research and Scientific Method - Importance of Knowing How Research is Done - Research Process - Criteria of Good Research - Problems Encountered by Researchers in India **Text Book 1: Chapter 1**	**9**
II	Defining the Research Problem - Selecting the Problem - Necessity of Defining the Problem -Technique Involved in Defining a Problem - An Illustration - Research Design - Meaning of Research Design - Need for Research Design - Research Methodology - Features of a Good Design - Important Concepts Relating to Research Design - Different Research Designs - Basic Principles of Experimental Designs - Developing a Research Plan. **Text Book 1: Chapter 2 & Chapter 3**	**9**
III	Processing and Analysis of Data - Processing Operations - Some Problems in Processing - Elements/Types of Analysis - Statistics in Research - Measures of Central Tendency - Measures of Dispersion - Measures of Asymmetry (Skewness) **Text Book 1: Chapter 7 upto page 137**	**9**
IV	Research Project – Difference between a Dissertation and a Thesis – Basic Requirements of a Research Degree – Deciding on a research topic – Writing a	**9**

	proposal – Familiarity with Codes of Practice/ Rules and Regulations–Ethical considerations - Different components of a Research Project – Title page – Abstract – Acknowledgement – List of Contents – Introduction– Literature Review – Methodology – Style of Presentation. **Text Book 2: Chapter 5 ; Sec 5.1, 5.2, 5.3, 5.4, 5.6, 5.12, 5.13** **Chapter 6: Section 6.1 – 6.4, 6.6, 6.7, 6.8.1(only), 6.9.1(only), 6.11, 6.12.1(only), 6.13**	
V	Publishing and Presenting your Research and Tool kit–Journal Articles –A book – Conference Presentation– A final note –All punctuations. **Text Book 2: Chapters 7 & 8**	**9**
	Total	**45**

Self-study	Publishing and Presenting your Research and Tool kit–Journal Articles –A book – Conference Presentation– A final note –All punctuations.

Textbooks

1. Kothari C.R. 2004, *Research Methodology - Methods & Techniques*, New Age International Publishers, Second Edition.
2. Neil Murray and Geraldine Hughes, 2008, *Writing up your University Assignments and Research Projects – A Practical Handbook*, McGraw Hill Open University Press. First Edition.

Reference Books

1. Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams, 2003, *The craft of Research*, The University of Chicago Press London, Second Edition.
2. Kenneth S. Bordens, Bruce B. Abbott, 2008, *Research Design and Methods, A Process Approach*, The McGraw Hill Companies.
3. George C. Thomas, 2021, *Research Methodology and Scientific Writing*, Springer, Second Edition.
4. Ranjit Kumar, 2011, *Research Methodology, a step-by-step guide for beginners*, Sage Publications Ltd, Third Edition.
5. Yogesh Kumar Singh, 2006, *Fundamental of Research Methodology and Statistics*, New age International Publishers.

Web Resources

1. https://www.youtube.com/watch?v=EVcPmmfK1Do
2. https://www.youtube.com/watch?v=GSeeyJVD0JU
3. https://www.youtube.com/watch?v=mAVswCbz_jM
4. https://www.youtube.com/watch?v=9IJscfF_irU
5. https://www.youtube.com/watch?v=ZLjmuKwUfWk

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	2	3	3	3	3	3	2
CO2	3	3	3	2	3	2	3	3	3	3	3	2
CO3	3	3	3	2	3	2	3	3	3	3	3	2
CO4	3	3	3	3	3	2	3	3	3	3	3	3
CO5	3	3	3	3	3	2	3	3	3	3	3	3
TOTAL	**15**	**15**	**15**	**12**	**15**	**10**	**15**	**15**	**15**	**15**	**15**	**12**
AVERAGE	**3**	**3**	**3**	**2.4**	**3**	**2**	**3**	**3**	**3**	**3**	**3**	**2.4**

3 – Strong, 2- Medium, 1- Low

SEMESTER III

SPECIFIC VALUE ADDED COURSE: DOCUMENTATION USING OVERLEAF AND MATHCHA

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP233V01	2	-	-	-	1	2	30	25	75	100

Pre-requisite:

Basic understanding of Mathematics and related commands, Idea of Microsoft Word

Learning Objectives:

1. To understand LaTeX, a document preparation system for high-quality typesetting.
2. To have hands on experience to become a user of Overleaf and Mathcha.

Course Outcomes

On the successful completion of the course, students will be able to:		
1	type set complex mathematical formulae using LaTeX	**K2& K3**
2	use tabular and array environments within LaTeX	**K2 & K3**
3	prepare a LaTeX document, to make scientific article and project report	**K3 & K6**
4	create automatic generation of table of contents, bibliographies	**K6**
5	learn about graphics in LaTex using Mathcha	**K2& K3**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate; **K6** – Create

Units	Contents	No. of Hours
I	Introduction to LaTeX, Overleaf and Mathcha - Basic structure of LaTeX document - Basic text typing and formatting	**6**
II	Math equation typing - Listing items	**6**
III	Table creation - drawing and inserting Figure	**6**
IV	Article preparation - Thesis Preparation	**6**
V	Presentation Creation - Beamer Class	**6**
	Total	**30**

Self-study	LaTeX coding for Mathematics symbols

Textbook:

1. Leslie Lamport. 1994. *LATEX: A document Preparation System,* (Second Edition), Addison Wesley Publishing.

Reference Books:

1. Kopka H, Daly P.W.2003. *A Guide to LaTeX*, Addison- Wesley.
2. David R. Wilkins. *The Art of LaTeX*.Jeff Clark, *LaTeX Tutorial*.
3. *LaTeX Tuorials-A Primer Indian TEX Users Group*, Indian TEX Users Group (TUG).

4. Donald E. Knuth, Tracy L. LaQuey, and Paul M. Roberts. 1989. *Mathematical Writing*. Mathematical Association of America.

Web Resources:

1. http://latex-beamer.sourceforge.net.
2. https://tobi.oetiker.ch/lshort/lshort.pdf
3. https://www.udemy.com/topic/latex/
4. https://onlinecourses.swayam2.ac.in/aic20_sp17/preview
5. https://www.overleaf.com/learn/latex/Free_online_introduction_to_LaTeX_(part_1)
6. https://freecomputerbooks.com

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	3	2	3	3	3	3	3	3
CO2	3	3	3	2	3	2	3	3	3	3	3	3
CO3	3	3	3	2	3	2	3	3	3	3	3	3
CO4	3	3	3	2	2	2	3	3	3	3	3	3
CO5	3	3	3	2	3	2	3	3	3	3	3	3
TOTAL	**15**	**15**	**15**	**10**	**14**	**10**	**15**	**15**	**15**	**15**	**15**	**15**
AVERAGE	**3**	**3**	**3**	**2**	**2.8**	**2**	**3**	**3**	**3**	**3**	**3**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER III

SPECIFIC VALUE ADDED COURSE – CHEMICAL GRAPH THEORY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP233V02	2	-	-	-	1	2	30	25	75	100

Pre-requisite:

Basic knowledge of Graph Theory and Chemistry.

Learning Objectives:

1. To understand the principles and concepts of chemical graph theory, including molecular topology, Huckel graphs.
2. To analyze and apply chemical graph theory to model and predict properties of chemical compounds, such as aromaticity, stability, and reactivity, using graph theoretical tools and algorithms.

Course Outcomes

On the successful completion of the course, students will be able to:		
1	understand the relationship between graph theory and chemistry.	**K2**
2	apply graph theoretical concepts to model and analyze chemical compounds, molecular topology, and molecular structures.	**K3**
3	develop skills in analyzing and manipulating weighted graphs, including vertex and edge weighted graphs, and understanding their significance in optimization problems and network analysis.	**K2, K4**
4	develop critical thinking and problem-solving exercises involving various chemical graphs.	**K2, K3**
5	explore the mathematical properties and applications in areas like material science and network design.	**K4**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate; **K6**– Create

Units	Contents	No. of Hours
I	**Elements of Graph Theory** – The Definition of a Graph – Isomorphic Graphs and Automorphism – Walks, Trails, Paths, Distances and Valencies in Graphs – Subgraphs – Regular Graphs. Chapter 2: Sections I – V	**6**
II	Trees – Planar Graphs – The Story of the Konigsberg Bridge Problem and Eulerian Graphs – Hamiltonian Graphs – Line Graphs. Chapter 2: Sections VI – X	6
III	**Chemical Graphs** – The concept of a Chemical Graph – Molecular Topology – Huckel Graphs. Chapter 3: Sections I – III	6
IV	Weighted Graphs – Vertex and Edge Weighted Graphs – Mobius Graphs. Chapter 3: Section V	6
V	**Distance in Graphs and the Wiener Index** – External Problems in	6

	General Graphs and Trees – The Wiener Index of Trees with a given Degree Sequence – The Wiener Index of Trees with a given Segment Sequence Chapter 2: Sections 2.3, 2.4, 2.5 (Textbook 2)	
	Total	30

Self-study	Elements of Graph Theory – The Definition of a Graph – Isomorphic Graphs and Automorphism – Walks, Trails, Paths – Subgraphs – Regular Graphs - Trees – Planar Graphs – The Story of the Konigsberg Bridge Problem and Eulerian Graphs – Hamiltonian Graphs – Line Graphs.

Textbooks:

1. Nenad Trinajstić, 1990. Chemical Graph Theory, 2nd Edition, CRC Press.
2. Stephen Wagner, Hua Wang, 2019. Introduction to Chemical Graph Theory, CRC Press.

Reference Books:

1. Ivan Gutman, Nenad Trinajstić, 1992. Chemical Graph Theory: Introduction and Fundamentals, 1st Edition, CRC Press.
2. Alexandru T. Balaban, 1976. Chemical Applications of Graph Theory, 1st Edition, Academic Press.
3. Tomaž Pisanski, Dragan Marušič, 1994. The Symmetry of Polyhedra and Polyhedral Sets in Space: Chemical Applications, 1st Edition, Kluwer Academic Publishers.
4. Balaban Alexandru T., Cvetković Dragos M., Gutman Ivan, 2011. Mathematical Chemistry Series: Chemical Graph Theory, 1st Edition, CRC Press.
5. Jonathan L. Gross, Jay Yellen, 2007. Graph Theory and Its Applications**,** 2nd Edition, CRC Press.

Web Resources:

1. https://www.docdroid.net/L3DrG6B/chemical-graph-theory-trinajstic-pdf
2. http://www.hyle.org/journal/issues/19-1/balaban.pdf
3. https://api.pageplace.de/preview/DT0400.9780429833991_A36190126/preview-9780429833991_A36190126.pdf
4. https://mir.kashanu.ac.ir/article_95507_bbf21ebf318b0d63b6a7ed64364739ab.pdf
5. https://dudhnoicollege.ac.in/online/attendence/classnotes/files/1626791827.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2	2	2	3	2	2	3	2
CO2	3	3	2	2	2	2	2	3	2	2	3	2
CO3	3	3	2	2	2	2	2	3	2	2	3	2
CO4	3	3	2	2	2	2	2	3	2	2	3	2
CO5	3	3	2	2	2	2	2	3	2	2	3	2
TOTAL	**15**	**15**	**10**	**10**	**10**	**10**	**10**	**15**	**10**	**10**	**15**	**10**
AVERAGE	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**3**	**2**

3 – Strong, 2- Medium, 1- Low

SEMESTER III

SPECIFICVALUE-ADDED COURSE*:* ADVANCED LATEX WITH OVERLEAF

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP233V03	2	-	-	-	1	2	30	25	75	100

Pre-requisite:

Basic Computer Knowledge

Learning Objectives:

1. To create professional documents and presentations efficiently.
2. To produce structured documents, incorporate mathematical expressions and design dynamic presentations.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	include mathematical expressions, tables, and images in documents using LaTeX	**K2 & K3**
2	understand document structure and organization, including abstracts, chapters, sections, and lists.	**K2& K4**
3	create well-formatted documents and presentations suitable for academic and professional purposes.	**K3& K6**
3	generate tables of contents, captions, labels, and references in LaTeX documents	**K3& K6**
4	understand the Beamer class for creating presentations, including customization of themes, fonts, and layouts	**K6**

K2 - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

Units	Contents	No. of Hours
I	**LaTeX Basics** What is LaTeX? – Why learn LaTeX? – Writing your first piece of LaTex – The preamble of a document – Including title, author and date information.	6
II	**LaTeX Basics** Bold, italics and underlining – Adding images – Captions, labels and references – Creating lists in LaTex – unordered lists – ordered lists.	6
III	**Adding math to LaTeX** Inline math mode – Display math mode – More complete examples	6
IV	**Basic Document Structure** Abstracts – Paragraphs and new lines - Chapter and sections - Creating a basic table in LaTeX – Adding borders - Captions, labels and references – Adding a table of contents – Downloading your finished document.	6
V	**Presentation in LaTeX** Introduction – Beamer main features – The title page – Creating a table of contents - Adding effects to a presentation – Highlighting important sentences / words – Customizing your presentation – Themes and color themes – Berkeley theme – Copenhagen theme - Using a color theme – Fonts – Font sizes – Font types – Columns.	6
	Total	30

Self study	Adding math to LaTex, More complete examples

Text book

1. https://www.overleaf.com/learn/latex/Learn_LaTeX_in_30_minutes
2. Beamer - Overleaf, Online LaTeX Editor

Reference Books

1. Martin J. Erickson, Donald Bindner, 2011,*A Student's Guide to the Study, Practiceand Tools of Modern Mathematics*, CRC Press, Boca Raton, FL.
2. Griffits. D.F, Higham D.J, 1997, *Learning Latex*, Siam, Philadelpha
3. Kopka, Helmut, Daly P.W,2007, A *Guide to LATEX and Electronic Publishing*, (4th Edition), Addison Wesley Longman Limited.
4. Grätzer, G, 2007, *More Math Into LATEX*, (4th Edition), Springer Science + Business Media, LLC.

Web Resources

1. https://www.overleaf.com/latex/learn/free-online-introduction-to-latex-part-1.pdf
2. https://www.overleaf.com/latex/learn/free-online-introduction-to-latex-part-2.pdf
3. https://dl.icdst.org/pdfs/files3/1051dd40ea24f97d588475be7c5ba0d8.pdf
4. https://faculty.buffalostate.edu/cunnindw/overleaf.pdf
5. https://nbednar.com/wp-content/uploads/2021/08/latex_lesson.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	3	2	3	3	3	3	3	3	3	2	2
CO2	3	3	2	2	3	3	3	3	3	2	2	3
CO3	3	3	3	2	3	2	3	3	3	2	3	3
CO4	3	2	3	3	3	3	3	3	3	3	2	3
CO5	2	3	3	3	3	3	3	3	3	3	3	3
TOTAL	**13**	**14**	**13**	**13**	**15**	**14**	**15**	**15**	**15**	**13**	**12**	**14**
AVERAGE	**2.6**	**2.8**	**2.6**	**2.6**	**3**	**2.8**	**3**	**3**	**3**	**2.6**	**2.4**	**2.8**

3 – Strong, 2- Medium, 1- Low

SEMESTER III

SPECIFIC VALUE ADDED COURSE: SOCIAL NETWORK ANALYSIS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP233V04	2	-	-	-	1	2	30	25	75	100

Pre-requisite

Basic knowledge of Graph theory.

Learning Objectives

1. To study the basic concepts and analyze the techniques in social network.
2. To detect and generate fundamental network structures.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	understand the fundamental concepts and theories in social network analysis.	**K1 & K2**
2	develop the skills in collecting and organizing network data.	**K2 & K4**
3	apply appropriate methods and tools for analyzing social networks.	**K3**
4	interpret and visualize the network data effectively.	**K4 & K5**
5	explore real-world applications of social network analysis in different domains.	**K6**

K1 – Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**- Create

Units	Contents	No. of Hours
I	Networks and Relations: Relations and Attributes - An Overview - The Development of Social Network Analysis: Sociometric Analysis and Graph Theory. Chapter 1: Sections 1.1and 1.2 Chapter 2: Section 2.1	**6**
II	Interpersonal Configurations and Cliques - Networks: Total and Partial - The Harvard Breakthrough. Chapter 2: Sections 2.2, 2.3 and 2.4	**6**
III	Handling Relational Data: The Organization of Relational Data - The Storage of Relational Data. Chapter 3: Sections 3.1 and 3.2	**6**
IV	Points, Lines and Density: Sociograms and Graph Theory - Density: Ego-centric and Socio-centric. Chapter 4: Sections 4.1 and 4.2	**6**
V	Centrality and Centralization: Centrality: Logal and Global - Centralization and Graph Centres Chapter 5: Sections 5.1 and 5.2	**6**
	Total	**30**

Textbook

1.John Scott, 2000, *Social Network Analysis: A Handbook* (Second Edition), SAGE Publications India Pvt. Limited, New Delhi.

Reference Books

1. David Knoke and Song Yang, 2008, *Social Network Analysis* Second Edition,

SAGE Publications, Thousand Oaks, California.
2. Ian McCulloh, Helen Armstrong and Anthony Johnson, 2013, *Social Network Analysis with Applications* First Edition, John Wiley & Sons Inc.
3. Tanmoy Chakraborty, 2021, *Social Network Analysis*, Wiley India Pvt. Limited, Noida.
4. Stanley Wasserman and Katherine Faust, *Social Network Analysis: Methods and Applications*, Cambridge University Press.
5. Brain V. Carolan, 2013, *Social Network Analysis and Education: Theory, Methods & Applications*(First Edition, SAGE Publications.

Web Resources

1. https://www.researchgate.net/publication/324575362_Social_network_analysis_An_overview
2. https://onlinecourses.nptel.ac.in/noc22_cs117/preview
3. https://www.researchgate.net/publication/318013493_Social_Network_Analysis
4. https://www.publichealth.columbia.edu/research/population-health-methods/social-network-analysis
5. https://www.sciencedirect.com/topics/social-sciences/social-network-analysis

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	3	3	3	3	3	3	2	3
CO2	3	2	3	2	3	3	3	3	3	2	2	3
CO3	3	3	2	2	3	2	3	3	3	2	3	3
CO4	3	2	3	3	3	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3
TOTAL	**15**	**12**	**13**	**13**	**15**	**14**	**15**	**15**	**15**	**13**	**12**	**15**
AVERAGE	**3**	**2.4**	**2.6**	**2.6**	**3**	**2.8**	**3**	**3**	**3**	**2.6**	**2.4**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER III
SELF LEARNING COURSE:
DIFFERENTIAL EQUATIONS FOR SET/ CSIR-NET EXAM

Course Code	Credit	Marks		
		CIA	External	Total
MP233SL1	1	25	75	100

Pre-requisite

Knowledge of differential equations.

Learning Objectives

1.To enhance analytical thinking, problem solving skills.

2. To enable the students to clear the SET/ CSIR-NET Exam

Course Outcomes

On the successful completion of the course, student will be able to:		
1	proficiency in solving second order ordinary differential equations with constant coefficients.	**K2 & K3**
2	develop deeper understanding of differential equations concepts.	**K2 & K4**
3	ability to solve various types of first order ordinary differential equations.	**K3 & K5**
4	critical thinking and problem solving skills through the analysis and interpretation of differential equations and their solutions.	**K3 & K6**
5	develop analytical thinking.	**K4**

K2 - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**- Create

Units	Contents	No. of Hours
I	To solve SET/NET based problems in Ordinary Differential Equations - Existence and Uniqueness of solutions of initial value problems for first order Ordinary Differential Equations.	**6**
II	To solve SET/NET based problems in Singular solutions of first order Ordinary Differential Equations- System of first order Ordinary Differential Equations-General Theory of Homogeneous and Non-Homogeneous Linear Ordinary Differential Equations.	**6**
III	To solve SET/NET based problems in Variation of Parameters-Sturm-Liouville-Boundary Value Problem-Green's Function.	**6**
IV	To solve SET/NET based problems in Partial Differential Equations - Lagrange and Charpit methods for solving first order Partial Differential Equations- Cauchy Problem for first order Partial Differential Equations.	**6**
V	To solve SET/NET based problems in Classification of second order Partial Differential Equations - General solution of higher order Partial Differential Equations with constant coefficients.	**6**
	Total	**30**

Self-study	1. First order Ordinary Differential Equations 2. Lagrange method

Textbook

1.Pawan Sharma, Neha Sharma, Suraj Singh, *UGC CSIR NET/ SET (Junior Research Fellowship & Lectureship) Mathematical Sciences*, Arihant Publications (India) Limited.

Reference Books

1. Dr.Alok Kumar, *CSIR-UGC NET/ JRF/ SET Mathematical Sciences*, Upkar Prakashan, Agra-2.

2. T. Amrnath, 2003,*An Elementary Course in Partial Differential Equations* (Second Edition), Narosa Publishing House, New Delhi.
3. Dr. Gajendra Purohit, 2023, *Advanced CSIR-NET/ JRF Mathematis* (Third Edition), Invincible Publication Pvt. Limited.
4. Dr. A.P. Singh, 2017,*Differential Equations*(Third Edition), Infostudy Publications, Chandigarh.
5. Akhilesh Mani Tripathi and Sunil Kushwaha, *UGC-CSIR NET for JRF/ Lectureship Mathematical Sciences,* Danika Publishing Company, New Delhi.

Web Resources

1. https://www.mathscare.com/notes/csir-net-exam-ordinary-differential-equation-notes/
2. https://unacademy.com/content/csir-ugc/study-material/mathematical-sciences/differential-equations/
3. https://www.dipsacademy.com/Book/OrdinarydifferentialEquation NETJRF
4. https://pkalika.files.wordpress.com/2019/11/practice-ques-for-net-set-gate-38pages-kalika.pdf
5. https://www.quora.com/I-am-preparing-for-upcoming-NET-CSIR-examination-in-Mathematics-What-are-some-good-books-in-algebra-real-complex-and-differential-equations

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	3	3	3	3	3	3	2	3
CO2	3	3	3	2	3	3	3	3	3	2	2	3
CO3	2	3	2	2	4	2	3	3	3	2	3	3
CO4	3	2	3	3	3	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3
TOTAL	**14**	**12**	**13**	**13**	**15**	**14**	**15**	**15**	**15**	**13**	**12**	**15**
AVERAGE	**2.8**	**2.4**	**2.6**	**2.6**	**3**	**2.8**	**3**	**3**	**3**	**2.6**	**2.4**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV

CORE COURSE X : FUNCTIONAL ANALYSIS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP234CC1	6	-	-	-	5	6	90	25	75	100

Pre-requisite:

Elements of Real Analysis

Learning Objectives:

1. To provide students with a strong foundation in functional analysis, focusing on spaces, operators and fundamental theorems.
2. To develop student's skills and confidence in mathematical analysis and proof techniques.

Course Outcomes

On the successful completion of the course, students will be able to:		
1	able to demonstrate comprehension of the definitions and basic properties of Banach and Hilbert spaces	**K1**
2	able to apply the Hahn Banach theorem to extend continuous linear functionals on subspaces to the whole space	**K3**
3	describe the concept of adjoint operators in Hilbert spaces and recognize properties of self-adjoint, normal, and unitary operators	**K2**
4	analyze the concepts of determinants, spectrum, and the spectral theorem for operators in finite-dimensional spaces	**K4**
5	evaluate the structure of commutative Banach algebras, including understanding the Gelfand Mapping and applications of spectral radius formula	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate;

Units	Contents	No. of Hours
I	**Banach spaces:**The Definition and some examples - Continuous linear transformations - The Hahn Banach theorem. **Chapter 9:** Sections 46 – 48	**18**
II	**Banach spaces:**The natural imbedding of N into N** - The open mapping theorem - The conjugate of an operator. **Chapter 9:** Sections 49 – 51	**18**
III	**Hilbert spaces:** The Definition and some simple properties - Orthogonal complements - Orthonormal sets - The conjugate space H*. **Chapter 10:** Sections 52 – 55	**18**
IV	**Hilbert spaces:** The Adjoint of an operator - self adjoint operators - Normal and unitary operators – Projections. **Finite Dimensional Spectral Theory:**Determinants and Spectrum of an operator - The spectral theorem. **Chapter 10:** Sections 56 – 59, **Chapter 11:** Sections 61 – 62	**18**
V	**General Preliminaries on Banach Algebras:** The definition and some examples – Regular and singular elements –Topological divisors of Zero- The spectrum – The formula for the spectral radius. **Chapter 12:** Sections 64 - 68	**18**
	Total	**90**

Self-study	The Adjoint of an operator - self adjoint operators - Normal and unitary operators – Projections

Textbook:

1.Simmons, G. F. (1963). *Introduction to Topology and Modern Analysis*, Tata McGraw Hill.

Reference Books:

1. Soma Sundaram, D. (2014), *A first course in Functional Analysis*, Narosa Publishing House Pvt. Ltd.
2. Sharma. J. N, Vasistha. A. R. (2013), *Functional Analysis*, Krishna's Educational Publishers.
3. Chandra SekharaRao, K. (2002), *Functional Analysis*, Narosa Publishing House.
4. Thamban Nair, M. (2002), *Functional Analysis*, A First Course, Prentice Hall of India.
5. Erwin Kreyzig. (2006), *Introductory Functional Analysis with Applications*, John Wiley and Sons Publication.
6. Casper Goffman., & George Pedrick, (1974), *First course in Functional Analysis*, Prentice/ Hall of India Private Limited.

Web Resources:

1. https://gujejedadun.weebly.com/uploads/1/3/1/3/131398181/1804375.pdf
2.https://www.researchgate.net/publication/268054942_Number_Theory_through_Functional_Analysis
3.https://people.math.ethz.ch/~salamon/PREPRINTS/funcana.pdf
4.https://www.maths.usyd.edu.au/u/athomas/FunctionalAnalysis/daners-functionalanalysis-2017.pdf
5.https://59clc.files.wordpress.com/2012/08/functional-analysis-_-rudin-2th.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	2	1	1	3	3	3	2	1	3
CO2	3	3	2	1	2	3	2	3	3	2	2	3
CO3	3	3	1	2	2	1	3	3	2	3	2	2
CO4	3	2	3	2	1	3	1	3	3	1	3	2
CO5	3	3	2	3	2	2	2	3	3	2	1	1
TOTAL	**15**	**13**	**11**	**10**	**8**	**10**	**11**	**15**	**14**	**10**	**9**	**11**
AVERAGE	**3**	**2.6**	**2.2**	**2**	**1.6**	**2**	**2.2**	**3**	**2.8**	**2**	**1.8**	**2.2**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV

CORECOURSE XI: PROBABILITY THEORY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP234CC2	6	-	-	-	5	6	90	25	75	100

Pre-requisite:

UG level Algebra, Calculus, and knowledge of Probability Theory.

Learning Objectives:

1.To upgrade the knowledge of Probability theory

2. To solve NET /SET related Probability theory problems.

Course Outcomes

On the successful completion of the course, students will be able to:		
1	recall the basic probability axioms, conditional probability, random variables, and related concepts	**K1**
2	define Special Mathematical Expectations, The Binomial Distribution, and The Poisson Distribution.	**K2**
3	define The Exponential, Gamma, and Chi-square Distributions, The Normal Distribution.	**K2**
4	study Bivariate Distributions of discrete, and continuous types, The correlation coefficient, Conditional Distribution, and The Bivariate Normal Distribution.	**K5**
5	discuss Functions of one random variable, Transformations of two random variables, The central limit Theorem, Chebyshve's inequality, and convergence in probability, Limiting moment-generating functions.	**K3, K4**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyze;

Units	Contents	No. of Hours
I	Probability: Properties of Probability- Methods of enumeration – Conditional Probability – Independence Events – Baye's Theorem **Chapter 1: Sections 1.l to 1.5**	**18**
II	Discrete Distributions: Random Variables of the Discrete Type - Mathematical Expectation – Special Mathematical Expectation – The Binomial Distribution – The Poisson Distribution. **Chapter 2: Sections 2.1 to 3.6 (Except 2.5)**	**18**
III	Continuous Distributions: Random variables of continuous type –The Exponential, Gamma, and Chi-square Distributions –The Normal Distribution. **Chapter 3: Sections 3.1 to 3.3**	**18**
IV	Bivariate Distributions: Bivariate Distributions of discrete type – The correlation coefficient – Conditional Distribution - Bivariate Distributions of continuous type – The Bivariate Normal Distribution. **Chapter4: Sections4.1 to 4. 5**	**18**
V	Distributions of functions of Random variables: Functions of one random variable – Transformations of two random variable – Several random variables – The central limit Theorem – Chebyshve's inequality and convergence in probability – Limiting moment generating functions. **Chapter 5: Sections 5. l to 5.3, 5. 6, 5.8, 5.9**	**18**
	Total	**90**

Self-study	Probability: Properties of Probability- Methods of enumeration – Conditional Probability – Independence Events

Textbook:

1.Hogg, R. V., Tanis, E. A., Zimmerman, D. L., 2022. *Probability and Statistical Inference*, 9th Edition, Boston Columbus Indianapolis New York.

Reference Books:

1. Ash, R. B., 1972. *Real Analysis and Probability*, Academic Press, New York.
2. Chung, K. L., 1974. *A Course in Probability*, Academic Press, New York.
3. Durett, R., 1996. *Probability: Theory and Examples*, 2nd Edition, Duxbury Press, New York.
4. Rohatgi, V. K., 1988. *Introduction to Probability Theory and Mathematical Statistics*, 3rd Print, Wiley Eastern Ltd., New Delhi.
5. Resnick, S. I., 1999. *A Probability Path*, Birhauser, Berlin.
6. Bhat, B. R., 1999. *Modern Probability Theory*, 3rd Edition, New Age International (P) Ltd, New Delhi.

Web Resources:

1. http:/mathforum.org,
2. http:/ocw.mit.edu ocw. web Mathematics.
3. http:/wwW.0pensource.org.
4. http:/www.probabilitv.net

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	1	3	2	3	3	2	3	2	2	2	2
CO2	2	1	3	1	3	3	1	3	2	2	2	2
CO3	3	2	3	1	3	3	1	3	2	2	2	2
CO4	1	2	3	2	3	3	2	3	2	2	2	2
CO5	3	1	2	3	3	3	3	3	2	2	2	2
TOTAL	**12**	**7**	**14**	**9**	**15**	**15**	**9**	**15**	**10**	**10**	**10**	**10**
AVERAGE	**2.5**	**1.4**	**2.8**	**1.8**	**3**	**3**	**1.8**	**3**	**2**	**2**	**2**	**2**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV
CORE COURSE XII: NUMERICAL ANALYSIS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP234CC3	**5**	1	-	-	**5**	6	**90**	**25**	**75**	**100**

Pre-requisite:

Basic understanding of calculus, including differentiation and integration.

Learning Objectives:

1. Understand fundamental numerical analysis techniques and their applications.
2. Develop proficiency in implementing numerical algorithms using computational tools.

Course Outcomes

On the successful completion of the course, students will be able to:		
1	recall and list basic numerical methods covered in the course, including root-finding algorithms and interpolation techniques.	**K1**
2	understand the principles behind key numerical algorithms such as Newton's method, Gaussian elimination, and Runge-Kutta methods.	**K2**
3	apply numerical methods to solve algebraic equations, interpolate data points, fit curves to data sets, and solve systems of linear equations.	**K3**
4	analyse the accuracy, convergence, and stability of numerical solutions obtained using different techniques.	**K4**
5	evaluate the suitability and effectiveness of various numerical methods for specific mathematical problems based on computational efficiency and solution quality.	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate; **K6** – Create

Units	Contents	No. of Hours
I	Solution of Algebraic and Transcendental Equations - Introduction – Iteration Method- Newton-Raphson Method- Ramanujan's Method - Secant Method - Muller's Method. Chapter 2:2.1, 2.4 to 2.8	**18**
II	Differences of a polynomial - Newton's formulae for Interpolation - Central Difference Interpolation formulae - Gauss's central difference formulae - Stirling's formula - Bessel's formula - Everett's formula - Relation between Bessel's and Everett's formulae - Practical Interpolation. Chapter 3: 3.5 to 3.8	**18**
III	Least squares and Fourier Transforms - Introduction - Least squares Curve Fitting Procedure - Fitting a straight line - Multiple Linear Least squares - Linearization of Nonlinear laws - Curve fitting by Polynomials. Chapter 4: 4.1 and 4.2(4.2.1 to 4.2.4)	**18**
IV	Numerical Linear Algebra - Introduction - Triangular Matrices - LU Decomposition of a matrix - Solution of Linear systems - Direct Methods - Gauss elimination - Necessity for Pivoting - Gauss - Jordan method - Modification of the Gauss method to compute the inverse - LU Decomposition method - Solution of Linear systems - Iterative methods.	**18**

	Chapter 7: 7.1 to 7.3, 7.5(7.5.1 to 7.5.4 and 7.5.6), 7.6.	
V	Numerical Solution of Ordinary Differential Equations - Solution by Taylor's series - Euler's method - Runge - Kutta methods - II order and IV order, Numerical Integration – Trapezoidal Rule – Simpson's 1/3– Rule - Simpson's 3/8– Rule. Chapter 8: 8.1, 8.2, 8.4, 8.5; 6.4 (6.4.1 to 6.4.3)	**18**
	Total	**90**

Self-study	Numerical Solution of Ordinary Differential Equations - Solution by Taylor's series - Picard's method of successive approximations.

Textbook:

1.Sastry S.S, 2012. Introductory Methods of Numerical Analysis, (5th Edition), PHI Learning PVT.Ltd, New Delhi

Reference Books:

1. Arumugam S, Thangapandi Issac A, Somasundaram A. 2013. Numerical Methods, (Second Edition), Scitech Publications PVT Ltd. Chennai.
2. Sangara Rao K. 2011. Numerical Methods for Scientists and Engineers, (Third Edition), PHI Learning PVT. Ltd, New Delhi.
3. Goel Mittal. 2011. Numerical Analysis. (21^{st} Edition). Pragati Prakashan Educational Publishers.
4. Vedamurthy, V. N., & N. ch. S. N. Iyengar. 2009. Numerical Methods, Vikas Publishing House PVT. LTD, New Delhi.
5. Mullah S.A. 2011, Numerical Analysis and Computational Procedures, (Fourth Edition), Books and Allied (P) Ltd, Kolkata.

Web Resources:

1. https://www.siirt.edu.tr/dosya/personel/numerik-analiz-siirt-2019217142654486.pdf
2. https://pdfcoffee.com/numerical-methods-e-balaguruswamy-pdf-free.html
3. https://bayanbox.ir/view/1617240703537682923/Numerical-Analysis-By-Shanker-Rao.pdf
4. https://www.math.science.cmu.ac.th/docs/qNA2556/ref_na/Katkinson.pdf
5. https://zhilin.math.ncsu.edu/TEACHING/MA580/Stoer_Bulirsch.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	1	3	2	2	3	3	3	3	3
CO2	3	2	3	3	3	2	3	3	3	1	3	3
CO3	3	2	3	2	3	2	2	3	3	1	3	3
CO4	3	2	3	3	3	2	3	3	2	3	3	3
CO5	3	3	2	3	3	2	3	3	3	3	3	3
TOTAL	**15**	**12**	**14**	**12**	**15**	**10**	**13**	**15**	**14**	**11**	**15**	**15**
AVERAGE	**3**	**2.4**	**2.8**	**2.4**	**3**	**2**	**2.6**	**3**	**2.8**	**2.2**	**3**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV

ELECTIVE COURSE VI: a) NETWORK SECURITY AND CRYPTOGRAPHY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP234EC1	4	-	-	-	3	4	60	25	75	100

Pre-requisite:

Basic understanding of computer science fundamentals, including data structures and algorithms.

Learning Objectives:

1. To understand the fundamental principles and mechanisms of computer and network security, including security attacks, services, and encryption techniques.
2. To apply cryptographic protocols and techniques, such as symmetric and public-key encryption, message authentication codes, and user authentication protocols, to design and implement secure communication systems and protocols.

Course Outcomes

On the successful completion of the course, students will be able to:		
1	demonstrate proficiency in employing classical encryption techniques, including symmetric cipher models, substitution techniques, and transposition techniques, to secure data transmission and storage.	**K3, K4**
2	design and implement message authentication mechanisms to verify the integrity and authenticity of transmitted data.	**K3, K6**
3	analyze and identify various security attacks and vulnerabilities in computer and network systems.	**K4**
4	evaluate the principles and algorithms of public-key cryptography for ensuring confidentiality, integrity, and authenticity in communication channels.	**K5**
5	develop expertise in deploying user authentication protocols to authenticate remote users securely and manage access control in networked environments.	**K6**

K3 – Apply; **K4 -** Analyse; **K5 -** Evaluate; **K6** – Create

Units	Contents	No. of Hours
I	**Computer and Network Security Concepts:** Computer Security Concepts - Security Attacks – Security Services – Security Mechanisms- **Classical Encryption Techniques**: Symmetric Cipher Model – Substitution Techniques - Transposition Techniques. Chapter 1: Sections 1.1, 1.3, 1.4, 1.5 Chapter 3: 3.1, 3.2, 3.3	**12**
II	**Public-Key Cryptography and RSA -** Principles of Public-key Crypto systems – The RSA Algorithms – **Other Public-Key Crypto systems:** Diffie- Hellman Key Exchange – Elliptic Curve Cryptography - **Cryptographic Hash functions** – Applications of Cryptographic Hash Functions – Two Simple Hash Functions – Requirements and Security – Hash Functions Based on Cipher Block Chaining – Secure Hash Algorithm – SHA-3. Chapter 9: Sections 9.1, 9.2 Chapter 10: Sections 10.1, 10.4	**12**

	Chapter 11: Sections 11.1-11.6	
III	**Message Authentication Codes** –Message Authentication Requirements – Message Authentication Functions – Requirements for Message Authentication Codes – Security of MACs – MACs Based on Hash Functions – MACs Based on Block Ciphers: DAA and CMAC – Digital Signatures. Chapter 12: Sections 12.1 – 12.6 Chapter 13: Section 13.1	**12**
IV	**User Authentication -** Remote User Authentications Principles – Remote User Authentication using Symmetric Encryptions – Kerberos – Remote User Authentication using Asymmetric Encryption – **Electronic Mail Security** – Pretty Good Privacy – S/MIME – Domain Keys Identified Mail. Chapter 15: Sections 15.1 – 15.4 Chapter 19: 19.4, 19.5, 19.9	**12**
V	**Transport-Level Security** – Web Security Considerations –Transport Layer Security – HTTPS – Secure Shell –**Wireless Network Security –** Wireless Security – Mobile Device Security. Chapter 17: Sections 17.1 – 17.4 Chapter 18: 18.1, 18.2	**12**
	Total	**60**

Self-study	**Electronic Mail Security** – Pretty Good Privacy – S/MIME – Domain Keys Identified Mail.

Textbooks:

1. William Stallings, 2017. *Cryptography and Network Security*, PHI/Pearson Education, 7th Edition.
2. Atul Kahate, 2013. *Cryptography and Network Security*, 1st Edition, McGraw-Hill Education.

Reference Books:

1. Behrouz. A. Forouzan, 2006. *Data Communications and Networking*, (5th Edition), Tata McGraw Hill.
2. Bruce Schneier, 2015. *Applied Cryptography: Protocols, Algorithms, and Source Code in C*, 2ndEdition, Wiley.
3. Charlie Kaufman, Radia Perlman, and Mike Speciner, 2002. *Network Security: Private Communication in a Public World*, 2nd Edition, Prentice Hall.
4. Douglas Stinson, 2005. *Cryptography: Theory and Practice*, 3rd Edition, CRC Press.
5. Michael T. Goodrich and Roberto Tamassia, 2010. *Introduction to Computer Security*, 1stEdition, Addison-Wesley.

Web Resources:

1. https://www.cs.vsb.cz/ochodkova/courses/kpb/cryptography-and-network-security_-principles-and-practice-7th-global-edition.pdf
2. https://nayakuch.files.wordpress.com/2015/08/cryptography-network-security-atul-kahate.pdf
3. https://elcom-hu.com/Subjects/Computer/Compulsory/Communication/Data-Communications-and-Network-5e.pdf
4. https://mrajacse.files.wordpress.com/2012/01/applied-cryptography-2nd-ed-b-schneier.pdf

5. https://www.ic.unicamp.br/~rdahab/cursos/mo421-mc889/Welcome_files/Stinson-Paterson_CryptographyTheoryAndPractice-CRC%20Press%20%282019%29.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	2	2	3	2	3	2	3	3
CO2	3	3	3	2	2	2	3	2	3	2	3	3
CO3	3	3	3	3	2	2	3	3	3	3	2	3
CO4	3	3	3	3	2	2	3	3	3	3	2	3
CO5	3	3	3	2	2	2	3	3	3	3	2	2
TOTAL	**15**	**15**	**15**	**12**	**10**	**10**	**15**	**14**	**15**	**13**	**12**	**14**
AVERAGE	**3**	**3**	**3**	**2.4**	**2**	**2**	**3**	**2.8**	**3**	**2.6**	**2.2**	**2.4**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV

ELECTIVE COURSE VI :b) FOUNDATIONS OF COMPUTER NETWORKING

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP234EC2	4	-	-	-	3	4	60	25	75	100

Pre-requisite:

1. Basic understanding of computer science fundamentals, including data structures and algorithms.
2. Basic networking concepts such as IP addressing, routing, and switching.

Learning Objectives:

1. To understand the fundamental principles and components of network hardware, reference models, and protocols.
2. To analyze and apply various networking concepts such as data link layer design, routing algorithms, congestion control, and transport layer protocols.

Course Outcomes

On the successful completion of the course, students will be able to:		
1	demonstrate a thorough understanding of network hardware, reference models (such as OSI and TCP/IP), and the architecture of the Public Switched Telephone Network (PSTN).	**K2**
2	describe the architecture and services of the application layer, analyze protocols such as HTTP for web communication, and understand the principles of streaming media and real-time conferencing over networks.	**K2, K4**
3	design data link layer protocols, analyze error detection and correction techniques, and implement routing algorithms for efficient data transmission.	**K3, k4**
4	develop skills in identifying congestion control issues, apply appropriate congestion control algorithms, and implement traffic-aware routing strategies to optimize network performance.	**K3, k4**
5	demonstrate proficiency in analyzing and implementing transport layer protocols, particularly TCP, including connection establishment, data transfer, and connection release mechanisms.	**K4**

K2 - Understand; **K3** – Apply; **K4 -** Analyse;

Units	Contents	No. of Hours
I	**Introduction** – **Network Hardware:** Local Area Networks – Wide Area Networks. **Reference Models:** The OSI Reference Model – The TCP/IP Reference Model –**The Physical Layer** – Guided Transmission Media – Magnetic Media – Twister Pairs – Coaxial Cable – Power Lines – Fiber Optics. Chapter 1: 1.2 – 1.2.2, 1.2.4, 1.4 – 1.4.1, 1.4.2 Chapter 2: 2.2	**12**
II	**The Public Switched Telephone Network:** Structure of the Telephone System – The Local Loop: Modems, ADSL and Fiber – Switching. **The Data Link Layer**: Data Link Layer Design Issues: Framing– **Error Detection and Correction:** Error-Correcting Codes – Error-Detecting Codes–**Sliding Window Protocols:** A One-Bit Sliding Window Protocol – A Protocol using Go-Back – A Protocol using Selective Repeat. Chapter 2: 2.6 – 2.6.1, 2.6.3, 2.6.5	**12**

	Chapter 3: 3.1 – 3.1.2, 3.2, 3.4	
III	**The Network Layer – Network Layer Design Issues:** Store-and-Forward Packet Switching – **Routing Algorithms:** Shortest Path Algorithm – Distance Vector Routing – **Congestion Control Algorithms:** Approaches to Congestion Control – Traffic-Aware Routing. Chapter 5: 5.1 – 5.1.1, 5.2 – 5.2.2, 5.2.4, 5.3 – 5.3.1, 5.3.2	**12**
IV	**The Transport Layer – Congestion Control:** Desirable Bandwidth Allocation – Regulating the Sending Rate – Wireless Issues – **The Internet Transport Protocols:** Introduction to TCP – The TCP Protocol – The TCP Segment Header – TCP Connection Establishment – TCP Connection Release. Chapter 6: 6.3, 6.5 – 6.5.1, 6.5.3, 6.5.4, 6.5.5, 6.5.6	**12**
V	**The Application Layer – Electronic Mail:** Architecture and Services – The User Agent – Message Formats – Message Transfer – Final Delivery – **The World Wide Web:** Architectural Overview – Static Web Pages – Dynamic Web Pages and Web Applications – HTTP-The Hyper Text Transfer Protocol – The Mobile Web – Web Search – **Streaming Audio and Video:** Digital Audio – Digital Video – Streaming Stored Media – Streaming Live Media – Real-Time Conferencing. Chapter 7: 7.2, 7.3, 7.4	**12**
	Total	**60**

Self-study	The World Wide Web: Architectural Overview – Static Web Pages – Dynamic Web Pages and Web Applications – HTTP-The Hyper Text Transfer Protocol – The Mobile Web – Web Search

Textbooks:

1. Andrew S. Tanenbaum, and David J. Wetherall, 2010. *Computer Networks*, (5th Edition), Prentice Hall of India.
2. James F. Kurose and Keith W. Ross, 2016. *Computer Networking: A Top-Down Approach*, (7th edition), Pearson Education.

Reference Books:

1. Behrouz. A. Forouzan, 2006. *Data Communications and Networking*, (5th Edition), Tata McGraw Hill.
2. F. Halsall, 2008. *Data Communications, Computer Networks and Open Systems*, Pearson Education.
3. D. Bertsekas and R. Gallagher, 2008. *Data Networks*, (2nd Edition), Prentice Hall of India
4. Larry L. Peterson and Bruce S. Davie, 2011. *Computer Networks: A Systems Approach*, (5th edition), Morgan Kaufmann.
5. Olivier Bonaventure, 2013. *Computer Networking: Principles, Protocols and Practice* (1st edition), Create Space Independent Publishing Platform.

Web Resources:

1. https://csc-knu.github.io/sys-prog/books/Andrew%20S.%20Tanenbaum%20%20Computer%20Networks.pdf
2. https://www.ucg.ac.me/skladiste/blog_44233/objava_64433/fajlovi/Computer%20Networking%20_%20A%20Top%20Down%20Approach,%207th,%20converted.pdf
3. https://elcom-hu.com/Subjects/Computer/Compulsory/Communication/Data-Communications-and-Network-5e.pdf

4. https://titania.eng.monash.edu/netperf/docs/computer-networks-peterson-davie-v6.0.pdf
5. https://resources.saylor.org/wwwresources/archived/site/wp-content/uploads/2012/02/Computer-Networking-Principles-Bonaventure-1-30-31-OTC1.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	2	2	3	2	3	2	3	3
CO2	3	3	3	2	2	2	3	2	3	2	3	3
CO3	3	3	3	3	2	2	3	3	3	3	2	3
CO4	3	3	3	3	2	2	3	3	3	3	2	3
CO5	3	3	3	2	2	2	3	3	3	3	2	2
TOTAL	**15**	**15**	**15**	**12**	**10**	**10**	**15**	**14**	**15**	**13**	**12**	**14**
AVERAGE	**3**	**3**	**3**	**2.4**	**2**	**2**	**3**	**2.8**	**3**	**2.6**	**2.2**	**2.4**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV

ELECTIVE COURSE VI: c) DATA COMMUNICATION

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP234EC3	4	-	-	-	3	4	60	25	75	100

Pre-requisite:

Basic understanding of computer science fundamentals, including data structures and algorithms.

Learning Objectives:

1. To understand the fundamental concepts of networking, including line configuration, topology, transmission modes, and categories of networks.
2. To comprehend the OSI model and its layers, along with the functions of each layer in the context of the TCP/IP protocol suite.

Course Outcomes

On the successful completion of the course, students will be able to:		
1	understand the concepts of data terminal equipment (DTE) and data circuit-terminating equipment (DCE) interfaces, and functionality of modems, including 56K modems and cable modems, in digital data transmission.	**K2**
2	explain the OSI model and the functions of its layers and apply this knowledge to understand the operation of the TCP/IP protocol suite.	**K2, K3**
3	understand the encoding and modulation techniques and gain knowledge of digital-to-digital, analog-to-digital, digital-to-analog, and analog-to-analog conversion methods, along with their applications in data transmission.	**K2, K3**
4	describe and analyze line configurations, topologies, transmission modes, and various categories of networks.	**K4**
5	distinguish between analog and digital signals, describe their characteristics, and analyze their representation in both time and frequency domains.	**K4**

K2 - Understand; **K3** – Apply; **K4 -** Analyse;

Units	Contents	No. of Hours
I	**Basic Concepts:** Line Configuration – Topology – Transmission Mode – Categories of Networks – Internet Works. Chapter 2: Sections 2.1 – 2.5	**12**
II	**The OSI Model:** The Model – Functions of the Layers – TCP/IP Protocol Suite. Chapter 3: Sections 3.1 –3.3	**12**
III	**Signals:** Analog and Digital – Periodic and Aperiodic Signals – Analog Signals – Time and Frequency Domains – Composite Signals – Digital Signals. Chapter 4: Sections 4.1 – 4.6	**12**
IV	**Encoding and Modulating:** Digital-to-Digital Conversion – Analog-to-Digital Conversion – Digital-to-Analog Conversion – Analog-to-Analog Conversion. Chapter 5: Sections 5.1 – 5.4	**12**
V	**Transmission of Digital Data:** Interfaces and Modems: Digital Data	**12**

	Transmission – DTE-DCE Interface – Other Interface Standards – Modems – 56K Modems – Cable Modem. Chapter 6: Sections 6.1 – 6.6	
	Total	**60**

Self-study	Encoding and Modulating: Digital-to-Digital Conversion – Analog-to-Digital Conversion – Digital-to-Analog Conversion – Analog-to-Analog Conversion

Textbooks:

1. Behrouz. A. Forouzan, 2006. *Data Communications and Networking*, (5th Edition), Tata McGraw Hill.
2. Andrew S. Tanenbaum, and David J. Wetherall, 2010. *Computer Networks*, (5th Edition), Prentice Hall of India.

Reference Books:

1. F. Halsall, 2008. *Data Communications, Computer Networks and Open Systems*, PearsonEducation.
2. D. Bertsekas and R. Gallagher, 2008. *Data Networks*, (2nd Edition), Prentice Hall of India
3. Larry L. Peterson and Bruce S. Davie, 2011. *Computer Networks: A Systems Approach*, (5th edition), Morgan Kaufmann.
4. Olivier Bonaventure, 2013. *Computer Networking: Principles, Protocols and Practice* (1st edition), Create Space Independent Publishing Platform.
5. W. Richard Stevens, Gary R. Wright, and Kevin R. Fall, 2011. *TCP/IP Illustrated,Volume 1*: The Protocols, (1st edition), Addison-Wesley Professional.

Web Resources:

1. https://csc-knu.github.io/sys-prog/books/Andrew%20S.%20Tanenbaum%20%20Computer%20Networks.pdf
2. https://www.ucg.ac.me/skladiste/blog_44233/objava_64433/fajlovi/Computer%20Networking%20_%20A%20Top%20Down%20Approach,%207th,%20converted.pdf
3. https://elcom-hu.com/Subjects/Computer/Compulsory/Communication/Data-Communications-and-Network-5e.pdf
4. https://titania.eng.monash.edu/netperf/docs/computer-networks-peterson-davie-v6.0.pdf
5. https://resources.saylor.org/wwwresources/archived/site/wp-content/uploads/2012/02/Computer-Networking-Principles-Bonaventure-1-30-31-OTC1.pdf

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	2	2	2	3	2	3	2	3	3
CO2	3	3	3	2	2	2	3	2	3	2	3	3
CO3	3	3	3	3	2	2	3	3	3	3	2	3
CO4	3	3	3	3	2	2	3	3	3	3	2	3
CO5	3	3	3	2	2	2	3	3	3	3	2	2
TOTAL	**15**	**15**	**15**	**12**	**10**	**10**	**15**	**14**	**15**	**13**	**12**	**14**
AVERAGE	**3**	**3**	**3**	**2.4**	**2**	**2**	**3**	**2.8**	**3**	**2.6**	**2.2**	**2.4**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV

ELECTIVE COURSE V: a) APPLICATIONS OF MATHEMATICS IN ARTIFICIAL INTELLIGENCE

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP234EC4	4	-	-	-	3	4	60	25	75	100

Pre-requisite:

Basic understanding of Linear Algebra, Calculus and Probability Theory and Familiarity with Python Programming

Learning Objectives:

1. Understand the fundamental mathematical concepts essential for AI.
2. Develop the ability to apply mathematical principles and algorithms to solve real world problems in AI.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	demonstrate proficiency in mathematical concepts as applied toAI	**K3**
2.	apply mathematical algorithms to build, train, AI models using the programming language Python	**K3**
3.	analyse and interpret the behaviour of AI models using mathematical techniques	**K4**
4.	tackle a variety of AI challenges using mathematical reasoning and analytical techniques	**K5**
5.	propose novel approaches and solutions to complex problems in AI	**K6**

K3 – Apply; **K4** - Analyse; **K5** - Evaluate; **K6** - Create

Units	Contents	No. of Hours
I	Introduction to Artificial Intelligence: Overview of AI concepts and applications, Role of mathematics in AI.	**12**
II	Linear Algebra and AI: Vectors and matrices, matrix operations and properties, Eigen values and eigenvectors, Singular Value Decomposition (SVD)	**12**
III	Calculus for AI: Differentiation and gradients, Optimization techniques, Gradient Descent, Stochastic Gradient Descent, Calculus of variations	**12**
IV	Probability and Statistics for AI: Probability distributions, Bayes' Theorem and conditional probability, expectation, variance, covariance, Statistical inference	**12**
V	Applications and Case Studies: Real world applications of AI with a focus on mathematical principles, Case studies and projects	**12**
	Total	**60**

Self-study	Real world applications of AI with a focus on mathematical principles

Textbook:

1.Marc Peter Deisenroth, Aldo Faisal A, Chen Soon Ong. 2020. *Mathematics for Machine Learning,* (First Edition), Cambridge University Press.

Reference Books:

1.Christopher M. Bishop. 2006. *Pattern Recognition and Machine Learning*, (First Edition), Springer.

2. Gilbert Strang. 2005. *Linear Algebra and Its Applications*, Fourth Edition

3.Joseph K. Blitztein, Jessica Hwang. 2019. *Introduction to Probability*, Second Edition*)*, CRC Press.

4.Ian Goodfellow, Yoshua Bengio, Aaron Courville. 2002. *Deep Learning*, (Fourth Edition), Pearson Education.

5.Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani. *Introduction to Statistical Learning*, (Third Edition)

Web Resources:

1.https://www.khanacademy.org/math/linear-algebra

2. Coursera - Probability and Statistics

3. https://ocw.mit.edu/courses/18-02sc-multivariable-calculus-fall-2010/

4. https://ocw.mit.edu/courses/18-05-introduction-to-probability-and-statistics-spring-2022/

5. https://web.stanford.edu/class/ee364a/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	2	3	3	3	3	3	3	3	3
CO4	3	3	3	2	2	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3	3	3
TOTAL	**15**	**15**	**15**	**13**	**14**	**15**	**15**	**15**	**15**	**15**	**15**	**15**
AVERAGE	**3**	**3**	**3**	**2.6**	**2.8**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV

ELECTIVE COURSE VII: b) FINANCIAL MATHEMATICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP234EC5	3	1	-	-	3	4	60	25	75	100

Pre-requisite:

Basic Knowledge of Calculus I for Mathematical and Physical Sciences.

Learning Objectives:

1. To lay theoretical foundation with potential applications to financial problems.
2. To provide efficient introduction to theoretical skills that are genuinely used in financial institutions.

Course Outcomes

On the successful completion of the course, student will be able to:		
1	gain a solid understanding of interest rates, present value analysis and their role in financial decision-making.	**K1**
2	understand the principles of arbitrage and its application in pricing various financial contracts, including options.	**K2**
3	comprehend the Arbitrage Theorem and its implications in identifying and exploiting pricing inefficiencies in financial markets.	**K3**
4	develop familiarity with the Black-Scholes Formula, its properties and its application in options pricing.	**K4**
5	apply learned concepts to solve practical problems in options pricing, delta hedging strategies and identifying arbitrage opportunities in financial markets.	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate

Units	Contents	No. of Hours
I	**Interest Rates and Present Value Analysis** Interest Rates – Present Value Analysis – Rate of Return – Continuously Varying Interest Rates. Section: 4.1 – 4.4	**12**
II	**Pricing Contracts via Arbitrage** An Example in Options Pricing – Other Examples of Pricing via Arbitrage. Section: 5.1 – 5.2	**12**
III	**The Arbitrage Theorem** The Arbitrage Theorem – The Multiperiod Binomial Model – Proof of the Arbitrage Theorem. Section: 6.1 – 6.3	**12**
IV	Introduction to the Black Scholes Formula – Properties of the Black – Scholes option cost – The Delta Hedging Arbitrage Strategy Section : 7.1 – 7.4	**12**

V	Some Derivations – European put options – Exercises Section : 7.5 – 7.7	**12**
	Total	**60**

Self-Study	Interest Rates

Textbook:

Sheldon M. Ross (2011),*An Elementary Introduction to Mathematical Finance*,3rd Edition. Cambridge University Press.

Reference Books:

1. S.M. Ross (2002).*A First Course in Probability*, Englewood cliffs Prentice Hall – NJ.
2. J. Cox, M. Rubinstein (1985). *Option Market*, Englewood cliffs Prentice Hall – NJ.
3. J.E.Ingersill(1987).*Theory of Financial decision Making*,Lanjarn MD Rowerman of Little Fields.
4. Salih N. Neftci (2013).*An Introduction to the Mathematics of Financial Derivatives, Academic Press.*
5. Tomas Bjork (2009).*Arbitrage Theory in Continuous Time*, OUP Oxford.

Web Resources:

1. https://catdir.loc.gov/catdir/samples/cam033/2002073603.pdf
2. https://en.m.wikipedia.org/wiki/Geometric_Brownian_motion
3. https://www.sciencedirect.com/topics/economics-econometrics-and-finance/arbitrage-pricing
4. http://www.tcs.tifr.res.in/~sandeepj/avail_papers/chapter.pdf
5. http://plus.maths.org/content/what-financial-mathematics

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	2	2	3	2	3	2	2	3	2
CO2	3	3	2	2	3	2	2	3	2	2	3	2
CO3	3	3	2	3	2	2	2	3	2	2	3	2
CO4	3	3	2	2	2	3	2	3	2	2	3	2
CO5	3	3	3	3	3	2	2	3	2	2	3	3
TOTAL	**15**	**15**	**11**	**12**	**12**	**12**	**10**	**15**	**10**	**10**	**15**	**11**
AVERAGE	**3**	**3**	**2.2**	**3**	**2.6**	**2.2**	**2**	**3**	**2**	**2**	**3**	**2.2**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV

ELECTIVE COURSE VII: c) STOCHASTIC PROCESS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP234EC6	**3**	1	-	-	**3**	**4**	**60**	**25**	**75**	**100**

Pre-requisite:

Basic Probability Theory

Learning Objectives:

1.To understand the stochastic models.

2.To relate the models studied to real life probabilistic situations.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	recall the basic results of Markov Chains as Graphs- Higher Transition Probabilities	**K1**
2.	understand Stability of a Markov System	**K2**
3.	apply Generalisations of Poison Process-Poison Process in Higher Dimensions-	**K3**
4.	determine Discrete Stat Space-Introduction-Chapman-Kolmogorov Equations	**K4**
5.	calculate the possible partitions of a given number and draw Ferrer's graph	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate;

Units	Contents	No. of Hours
I	Stochastic Processes: An Introduction-Specification of Stochastic Processes-Definition and Examples-Transition Matrix (or Matrix of Transition Probabilities)- Order of a Markov Chain- Markov Chains as Graphs- Higher Transition Probabilities- Generalisation of Independent Bernoulli Trials: Sequence of Chain-Dependent Trials-Markov-Bernoulli Chain-Correlated Random Walk-Classification of States and Chains- Communication Relations-Class Property-Classification of Chains-Classification of States: Transient and Persistent(Recurrent) States .	**15**
II	Determination of Higher Transition Probabilities-Aperiodic Chain: Limiting Behaviour-Stability of a Markov System –Computation of the Equilibrium Probalities-Graph Theoretic Approach-Markov Chain with Denumerable Number of States-Reducible Chains-Finite Reducible Chains with a Single Closed Class-Chain with One Single Class of Persistent Non-null Aperiodic States-Absorbing Markov Chains-Extension: Reducible Chain with one Closed class of Persistent Aperiodic States- Further Extension: Reducible Chains with more than one Closed Class	**15**
III	Poisson Process-Introduction-Postulates for Poisson Process-Properties of Poisson Process-Poisson Process and Related Distributions-Interarrival Time-Further Interesting Properties of Poison Process-Generalisations of Poison Process-Poison Process in Higher Dimensions-Poisson Cluster Process(Compound or Cumulative Poisson Process)	**15**
IV	Birth and Death Process-Particular Cases-Markov Processes with Discrete Stat Space-Introduction-Chapman-Kolmogorov Equations-Limiting	**15**

	Distribution (Erodicity of Homogeneous Markov Process).Stationary Processes-Second-Order Processes-Stationarity-Gaussian Processes	
V	Time Series : Introduction-Purely Random Process –First Order Markov Process-Moving Average(MA) Process-Autoregressive Process(AR Process)-Autoregressive Process of Order Two(Yule Process)-Autoregressive Morning Average Process(ARMA Process)-time and Frequency Domain:Power Supremum-Properties of Covariance and Correlation Functions-Continuous Parameter Processes-Statistical Analysis of Time Series : Some Observations	**15**
	Total	**75**

Self-study	Classification of States and Chains- Communication Relations-Class Property

Textbooks:

1. Medhi, J., 1994. *Stochastic Processes*, Third Edition, New Age International Publishers, New Delhi.
   Chapter 2: Sections 2.1 - 2.9
   Chapter 3: Sections 3.1, 3.2, 3.3 (3.3.1, 3.3.2), 3.4, 3.5 (except 3.5.4)
   Chapter 4: Sections 4.1, 4.3 (except 4.3.5 - 4.3.7), 4.4
   Chapter 8: Sections 8.1 - 8.4
2. Medhi, J., 1994. *Stochastic Processes*, Second Edition, New Age International Publishers, New Delhi.

Reference Books:

1. Bhat, U. N., 1972. *Elements of Applied Stochastic Processes*, Second Edition, John Wiley & Sons, New York.
2. Prabhu, N. V., 1970. *Stochastic Processes*, Mac Millon, New York.
3. Bhat, B. R., 2010. *Stochastic Models Analysis and Applications*, New Age International (P) Limited Publishers.
4. Veerarajan, T., 2006. *Probability, Statistics and Random Processes*, Tata McGraw-Hill Publishing Company Limited.
5. Chaudhri, S. K., & Chakraborthy, A. K., 2009. *Statistical Methods*, Asian.

Web Resources:

1.https://ocw.mit.edu/courses/18-445-introduction-to-stochastic-processes-spring-2015/
2.https://web2.uwindsor.ca/math/hlynka/stochnotes.html
3.https://www.cambridge.org/highereducation/books/stochastic-processes/
4.https://www.edx.org/learn/stochastic-processes
5.https://www.sciencedirect.com/journal/stochastic-processes-and-their-applications

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
CO1	3	3	3	1	3	2	2	3	3	3	3	3
CO2	3	2	3	3	3	2	3	3	3	1	3	3
CO3	3	2	3	2	3	2	2	3	3	1	3	3
CO4	3	2	3	3	3	2	3	3	2	3	3	3
CO5	3	3	2	3	3	2	3	3	3	3	3	3
TOTAL	**15**	**12**	**14**	**12**	**15**	**10**	**13**	**15**	**14**	**11**	**15**	**15**
AVERAGE	**3**	**2.4**	**2.8**	**2.4**	**3**	**2**	**2.6**	**3**	**2.8**	**2.2**	**3**	**3**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV

SKILL ENHANCEMENT COURSE III: TRAINING FOR COMPETITIVE EXAMINATIONS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP234SE1	4	-	-	-	2	4	60	25	75	100

Pre-requisite:

Strong foundation in algebraic fundamentals, basic number theory, and familiarity with sets and set operations.

Learning Objectives:

1. To solve problems needed for various competitive examinations.
2. To develop a comprehensive understanding of algebraic principles enabling proficient problem-solving in various Mathematical contexts.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	describe the concepts of topological properties of metric spaces.	**K1**
2.	associate the concept of continuity and connectedness	**K2**
3.	apply Cauchy's integral formula and Maximum modulus principle to evaluate integral	**K3**
4.	outline Liouville's theorem and open mapping theorem	**K4**
5.	built the mental ability to face GATE, CSIR and SET examinations	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate

Units	Contents	No. of Hours
I	Problems in metric spaces- Convergence Complete.	**12**
II	Problems in metric spaces- Connected Continuity- totally bounded.	**12**
III	Problems in algebra of complex numbers- the complex plane – polynomials- Power Series – transcendental functions such as exponential trigonometric and hyperbolic functions- Analytic Functions Cauchy – Riemann equations	**12**
IV	Problems in contour integral, Cauchy theorem Cauchy's integral formula Liouville's theorem, Maximum modulus principle Schwarz lemma open mapping Theorem	**12**
V	Problem in Taylors Series, Laurents Series, calculus of residues, Conformal mappings, Mobius transformations	**12**
	Total	**60**

Self-study	Problem in Taylors Series, Laurents Series, calculus of residues, Conformal mappings, Mobius transformations

Textbooks:

1. Singh A. P, *CSIR-UGC NET Mathematics,* First Edition, Infostudy Publications

Reference Books:

1. Walter Rudin, 1991. *Functional Analysis*, Second Edition, Mc Graw- Hill, Inc., New York

2. *CSIR-UGC NET/ SET Eligibility for lectureship Examination Mathematical Sciences* 2011. Sakthi Publishing House, Chennai.

3.David S. Dummit, Richard M. Foote, 2004. *Abstract Algebra*, John Wiley & Sons, Inc.

4.Van Lint J. H, Wilson R. M, 2001. *A Course in Combinatorics*, Second Edition, Cambridge University Press, New York.

5.Charles C. Pinter, 1990. *A Book of Abstract Algebra*, Second Edition, Dover Publications, Inc., Mineola, New York.

Web Resources:

1. https://testbook.com/objective-questions/mcq-on-problem-on-trains--5eea6a1039140f30f369e863
2. https://www.indiabix.com/aptitude/boats-and-streams/
3. https://www.khanacademy.org/math/algebra
4. http://mathworld.wolfram.com/Ring.html
5. https://brilliant.org/wiki/inclusion-exclusion-principle/

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	2	3	2	3	2	2	2	2
CO2	3	2	3	3	3	2	2	3	2	2	2	2
CO3	3	2	3	3	3	3	2	2	3	2	2	2
CO4	3	2	3	3	2	2	2	3	2	2	2	2
CO5	3	2	3	3	3	3	2	2	3	2	2	2
TOTAL	**15**	**10**	**15**	**15**	**13**	**11**	**10**	**15**	**10**	**10**	**10**	**10**
AVERAGE	**3**	**2**	**3**	**3**	**2.6**	**2.2**	**2**	**3**	**2**	**2**	**2**	**2**

3 – Strong, 2- Medium, 1- Low

SEMESTER IV

SELF LEARNING COURSE: CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS

Course Code	Credit	Marks		
		CIA	External	Total
MP234SL1	1	25	75	100

Pre-requisite

Basic Knowledge of differentiation and integration

Learning Objectives

1.To understand variational methods for solving differential equations

2. To know different integral equations and methods of solving them.

Course Outcomes

On the successful completion of the course, students will be able to:		
1	find extreme values of functionals.	**K2**
2	solve boundary value problems through integral equations using Green's function.	**K3**
3	analyse variational problems with moving boundaries.	**K4**
4	use Green's function in reducing boundary value problems to integral equations.	**K5**
5	know functionals and the construction of Euler's equation.	**K6**

K2 - Understand; **K3 -** Apply; **K4 -** Analyze; **K5**– Evaluate; **K6-** Create

Units	Contents
I	The Calculus of Variations Introduction – Functionals – Euler's equations – Geodesics – Variational problems involving several unknown functions. **Chapter 9: 1 – 11**
II	Functionals dependent on higher order derivatives – Variational problems involving several independent variables – Constraints and Lagrange multipliers – Isoperimetric problems – The general variation of a functional – Variational problems with moving boundaries. **Chapter 9: 12 – 17**
III	Hamilton's principle – Lagrange's equations – Sturm-Liouville's problem and Variational Methods (Rayleigh's Principle) – The Ritz Method. **Chapter 9: 18 – 21**
IV	Integral Equations – Introduction – Relation between differential and integral equations – Relationship between Linear differential equations and Volterra integral equations – The Green's function and its use in reducing boundary value problems to integral equations. **Chapter 10: 1 – 5**
V	Fredholm equations with separable kernels – Fredholm equations with symmetric kernels : Hilbert Schmidt theory – Iterative methods for the solution of integral equations. **Chapter 10: 6 – 9**

Textbook

1.Dr. M.K.Venkataraman, 2001, *Higher Mathematics for Engineering and Sciences,* The National publishing Company, Chennai

Reference Books

1. Francis. B. Hildebrand, 1968, *Methods of Applied Mathematics*, Prentice-Hall of India Pvt. Ltd., New Delhi, Second Edition.
2. Krasnov, Kiselu and Marenko, 1971, *Problems and Exercises in Integral Equations*, MIR Publishers.
3. Ram. P. Kanwal, 2011, *Linear Integral Equations - Theory and Techniques*, Academic Press, New York,
4. Gupta A,S.2015, Calculus of Variations with Applications, PHI Learning Private Limited, Delhi
5. Robert Weinstock, 1974, *Calculus of Variations with Applications to Physics and Engineering*,Dover Publications

Web Resources

1. https://www.youtube.com/watch?v=SQLxrr9N8zM
2. https://www.youtube.com/watch?v=GiPOQC5nYMs
3. https://www.youtube.com/watch?v=zIbNv6F-kN8
4. https://www.youtube.com/watch?v=NehZXmQPEYU
5. https://www.youtube.com/watch?v=muNi4awjHss

MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	2	2	3	2	3	2	3	3	3	3	2	2
CO2	2	2	3	2	3	2	3	3	3	3	2	2
CO3	2	2	3	2	3	2	3	3	3	3	2	2
CO4	3	2	3	2	3	2	3	3	3	3	3	3
CO5	3	2	3	2	3	2	3	3	3	3	3	3
TOTAL	**12**	**10**	**15**	**10**	**15**	**10**	**15**	**15**	**15**	**15**	**12**	**12**
AVERAGE	**2.4**	**2**	**3**	**2**	**3**	**2**	**3**	**3**	**3**	**3**	**2.4**	**2.4**

3 – Strong, 2- Medium, 1- Low

SEMESTER III & IV
LIFE SKILL TRAINING – II - VALUES

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PG23LST2	1	-	-	-	1	1	15	50	50	100

Pre-requisites: Value education-its purpose and significance in the present world

Learning Objectives

1. To guide students in making wise choices and decisions, and to help them discover the true purpose of their lives.
2. To ensure students not only grasp the concept of values but also incorporate them into their actions and attitudes.

Course Outcomes

On completion of this course the student will be able to		
1	recognize the perception of life and lead a positive life	**K1**
2	understand relationship with family, friends and the society	**K2**
3	develop as socially responsible citizens.	**K3**
4	assess goals, fix targets and value life	**K4**
5	create a peaceful, communal community and embrace unity.	**K6**

K1-Remember; **K2**-Understand; **K3**-Apply; **K4 – Analyse; K6**- Create

Units	Contents	No. of Hours
I	**Positive Thinking -** Why you should change your thinking? – How to became a better thinker- Putting yourself in the right place to think- Portrait of the good thinker. **Habits-** Habits vs. Addiction- Why are life styles changes so difficult to hold on to? - Habit Swapping.	3
II	**Art of Listening-** Many faces of speech- To be truly present- Valuing the other- Activating the subconscious. **Leadership-** Introduction- Who is a better leader? - Qualities of a Leader- You too can be a leader.	3
III	**Interpersonal Relationship**- Introduction - Factors that build trust- Steps to build a positive personality. **Managing Emotions**- 7 'Root' emotions- Importance of managing emotions- Why is it important to manage emotions?	3
IV	**Stress Management –** Highly effective tips for relieving stress- Fast-Acting Self Relief Strategies. **Anger Management:** Effects of anger – Tips to reduce anger – Anger warning signs – Identify your triggers – Ways to cool down your anger.	3
V	**Forgiveness-** What is forgiveness- Value of forgiveness- Benefits of forgiving- Self-forgiveness. **Gratitude –** What is gratitude? – How gratitude arises? –Features of gratitude – Gratitude is recognizing and acknowledging.	3
TOTAL		**15**
Self-Study Salient values for life, Human Rights, Social Evils and how to tackle them, Holistic living, Duties and responsibilities.		

Textbooks

Life Skill Training – II, Holy Cross College (Autonomous), Nagercoil

Reference Books

1. Holy Cross College (Autonomous), Nagercoil (2007). Foundation Course Life's Challenges. Sipca Computers.
2. Mathew, Sam (2010). Self Help Life Book. Opus Press Publisher.
3. Romuald Andrade. (2015). *Habit Triggers: How To Create Better Routines And Success Rituals To Make Lasting Changes In Your Life*. Kindle Edition.
4. William Fergus Martin. (2014). *Four Steps to Forgiveness:* A *Powerful Way To Freedom, Happiness And Success*. Findhorn Press.
5. Robert A. Emmons and Joanna Hill (2001). *Words Of Gratitude for Mind, Body, and Soul*. USA: Templeton Foundation Press.

Web Resources

1.https://www.mayoclinic.org/healthy-lifestyle/stress-management/in-depth/positive-thinking/art-20043950
2.https://jamesclear.com/habits
3.https://www.skillsyouneed.com/ps/managing-emotions.html
4.https://emeritus.org/in/learn/what-is-leadership/
5.https://www.verywellmind.com/how-to-maintain-interpersonal-relationships-5204856