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 & II

Guidelines & Syllabus

DEPARTMENT OF MATHEMATICS

2023-2026

(With effect from the academic year 2023-2024)

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.

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
Core Lab Course	-	-
Elective Course	6 x 100	600
Elective Lab Course	-	-
Core Project	1 x 100	100
Total Marks		**1900**

Course Structure

(i) Curricular Courses:

Distribution of Hours and Credits

Course	SEMESTER				Total	
	I	II	III	IV	Hours	Credits
Core– Theory	7(5) + 7(5) + 6(4)	6(5)+ 6(5)+ 6(4)	6(5) + 6(5) + 6(5) + 6 (4)	6(5) + 6 (5)	74	57
Elective Course	5 (3) + 5 (3)	4 (3) + 4 (3)	3 (3) -	4 (3) -	25	18
Core Project		-		10 (7)	10	7
Skill Enhancement Course		4 (2)	3 (2)	4 (2)	11	6
Internship/ Industrial Activity			(2)		-	2
Extension Activity				(1)	-	1
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
MP231CC3	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++		
MP231EC4	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
MP232CC2	Core Course V: Real Analysis II	5	6
MP232CC3	Core Course VI: Partial Differential Equations	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		
MP232SE1	Skill Enhancement Course I – Modeling and Simulation with Excel	2	4
	Total	**22**	**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 Course (CEC)	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	PG232V01-PG232V12/ PG234V01-PG234V12	Generic Value-added Course	1+1
		Total	**10**

Specific Value Added Course

S. No.	Course code	Title of the course	Total hours
I	MP231V01	SCILAB	30
2.	MP231V02	Creating Documents using LaTex	30

Examination Pattern

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	5

course) (30 marks)	
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 3 x 4(Internal choice)	12	Part B 5 x 6 (Internal choice)	30
Part C 3 x 8 (Internal choice)	24	Part C 5 x 12 (Internal choice)	60
Total	**40**	**Total**	100

ii) 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) Skill Enhancement Course

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

Internal Components and Distribution of Marks

Components	**Marks**
Internal test (2)	10
Quiz (2)	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 5 (Open choice any **Five** out **of Eight**)	25

Part C 1 x 9 (Open choice O**ne** out of **Three**)	9	Part C 5 x 8 (Open choice any **Five** out **of Eight**)	40
Total	**25**	**Total**	**75**

iv) Internship/ Industrial Activity

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

v) Core 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**

Co-Curricular Courses:

(i) Life Skill Training

Internal Component

Components		**Marks**
Life Skill Training -I	Album (20 pages)	30
	Group Song, Mime, Skit (Group of 5students)	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:

Components	**Marks**
Field Work	50
Report & Viva-voce	50

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

Components	Marks
Internal	25
External	75

(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**

Outcome Based Education

(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		1	2	1	2	10

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

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.

iv. 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**

Self Study	Problems and definition

Text book

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 – Cesarosummability - 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 – Non-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**

Self Study	Continuous functions, Convergent Series, Convergence

Text books

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
MP231CC3	5	1	-	-	4	6	90	25	75	100

Pre-requisite: UG level Calculus and Differential Equations

Learning Objectives:

1. To develop strong background on finding solutions to linear differential equations with constant and variable coefficients and also with singular points.
2. To study existence and uniqueness of the solutions of first order differential equation

Course Outcomes

On the successful completion of the course, student will be able to:		
1.	establish the qualitative behavior of solutions of systems of differential equations.	**K3**
2.	recognize the physical phenomena modeled by differential equations and dynamical systems.	**K1**
3.	analyze solutions using appropriate methods and give examples.	**K4**
4.	formulate Green's function for boundary value problems.	**K5**
5.	understand and use the various theoretical ideas and results that underlie the mathematics in course.	**K2**

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

Units	Contents	No. of Hours
I	**Linear equations with constant coefficients:** Second order homogeneous equations-Initial value problems-Linear dependence and independence-Wronskian and a formula for Wronskian-Non-homogeneous equation of order two. Chapter 2: Sections 1 to 6	**18**
II	**Linear equations with constant coefficients:** Homogeneous and non-homogeneous equation of order n —Initial value problems- Annihilator method to solve non-homogeneous equation - Algebra of constant coefficient operators. Chapter 2: Sections 7 to 12.	**18**
III	**Linear equation with variable coefficients:** Initial value problems -Existence and uniqueness theorems — Solutions to solve a non-homogeneous equation — Wronskian and linear dependence — reduction of the order of a homogeneous equation — homogeneous equation with analytic coefficients-The Legendre equation. Chapter 3: Sections 1 to 8 (Omit section 9)	**18**
IV	**Linear equation with regular singular points:** Euler equation — Second order equations with regular singular points — Exceptional cases — Bessel Function. Chapter 4: Sections 1 to 4 and 6 to 8 (Omit sections 5 and 9)	**18**
V	**Existence and uniqueness of solutions to first order equations:** Equation with variable separated — Exact equation — method of successive approximations — the Lipschitz condition — convergence of the successive approximations and the existence theorem.	**18**

	Chapter 5: Sections 1 to 6 (Omit Sections 7 to 9)	

Self-study	**1.** Wronskian and a formula for Wronskian **2.** Questions related to the above topics, from various competitive examinations UPSC / TRB / TNPSC / others to be solved

Text book

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

Reference Books

1. Williams E. Boyce and Richard C. DI Prima, 1967, *Elementary differential equations and boundary value problems*, New York, John Wiley and sons.

2.George F Simmons, 1974, *Differential equations with applications and historical notes*, Delhi, Tata McGraw Hill.

3. N.N. Lebedev, 1965, *Special functions and their applications*, New Delhi, Prentice Hall of India.

4. W.T. Reid, 1971, *Ordinary Differential Equations*, New York , John Wiley and Sons.

5. M.D.Raisinghania, 2001, *Advanced Differential Equations*, New Delhi, S. Chand & Company Ltd.

6. B.Rai, D.P.Choudary and H.I. Freedman, 2002, *A Course in Ordinary Differential Equations*, New Delhi, Narosa Publishing House.

Web Resources

1. https://www.iitg.ac.in/jiten/Extra/Coddrington.pdf
2. http://mathforum.org, http://ocw.mit.edu/ocwweb/Mathematics,
3. http://www.opensource.org, www.mathpages.com

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	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	1	2	3	3	3	2	3	2	2	2	2
TOTAL	12	7	14	9	15	15	10	15	10	10	10	10
AVERAGE	2.4	1.4	2.8	1.8	3	3	2	2	2	2	2	2

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**

Self Study	Arithmetic functions

Text Books

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*. N e w D e l h i : Narosa Publishing House.
4. Graham Everest andThomasWard(2008).*AnIntroductiontoNumberTheory*. 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**

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

Text book

J.A. Bondy, U.S.R. Murthy. 1976. Graph Theory with Applications. Macmillan Co., London.
Chapter 2: 2.1 to 2.3
Chapter 3
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**

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
MP231EC4	**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:		
CO1	remember and interpret the basic concepts in permutations and combinations and distinguish between distribution of distinct and non-distinct objects	**K1, K2, K4**
CO2	interpret the recurrence relation and generating functions and evaluate by using the technique of generating functions	**K2, K3**
CO3	solve the problems by the principle of inclusion and exclusion	**K3**
CO4	to prove the basic theorems in boolean algebra and to develop the truth table for a boolean expression	**K2**
CO5	differentiate between variety of lattices and their properties	**K4**

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

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: Introduction – Basic Theorems on Boolean Algebra – Duality Principle – Boolean Functions – Applications of Boolean algebra	**15**
V	Posets and Lattices: Introduction – Totally Ordered Set or Chain – Product Set and Partial Order Relation – Hasse Diagrams of Partially Ordered Sets – Lattice- Duality – Types of Lattices	**15**
TOTAL		**75**

Self-Study Portion: Definition of Permutations and combinations

Textbooks:

1. Liu C. L (1968).*Introduction to Combinatorial mathematics*. NewYork: 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. J.K.Sharma (2011). *Discrete Mathematics.* Macmillan Publishers India Ltd.
Chapter 13: 13.1 to 13.6; Chapter 14: 14.1 to 14.7

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, Discrete Mathematics with Graph Theory and Combinatorics, Tata McGraw Hills Publishing Company Limited, 7th Reprint, 2008
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. Dr.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

	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	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. Exercise problems: Chapter 4: 3, 4, 5, 8.	**15**
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:		
CO1	understand the definition of Fuzzy sets and its related concepts	**K1, K2**
CO2	define Fuzzy Graphs and can explain the concepts	**K3**
CO3	explain the concepts in Fuzzy sets and its relations	**K3**
CO4	discuss about Fuzzy logic	**K2**
CO5	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 VALUEADDED COURSE -SCILAB

Course Code	Credits	Total Hours	Total Marks
MP231V01	**1**	**30**	**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**

Self study	Carrying On - Defining Commands and Environments

Text book

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

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 OUTCOME

	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	Credits	Total Hours	Total Marks
MP231V02	**1**	**30**	**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 Chapter 3 - 3.5 – 3.5.1, 3.5.2, 3.6 – 3.6.1, 3.6.2	**6**

	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**

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 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	

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	2	1	3	1	3	2	3	3	3	3	2	2
CO2	3	3	2	2	3	3	3	3	3	3	2	2
CO3	3	2	2	2	2	3	3	3	3	3	3	2
CO4	3	3	3	1	1	3	3	3	3	2	3	3
CO5	3	2	3	1	2	3	3	3	3	3	3	3
CO6	3	3	3	1	2	3	3	3	3	3	3	3
TOTAL	17	14	16	8	13	17	18	18	18	14	16	15
AVERAGE	2.8	2.3	2.6	1.3	2.1	2.8	3	3	3	2.3	2.6	2.5

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
MP232CC2	5	1	-	-	5	6	90	25	75	100

Pre-requisite: Elements of Real Analysis

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:		
6.	recall and describe the basic concepts of measure, integration of functions, Fourier series on real line and multivariable differential calculus, implicit functions and extremism problems.	**K1 &K2**
7.	compare Boral measure with Lebesgue measure and the total derivatives with partial derivatives.	**K3**
8.	determine the matrix representation and Jacobian determinant of functions.	**K3**
9.	analyze the properties of measurable functions, Riemann and Lebesgue integrals, convergence of Fourier series and extrema of real valued functions.	**K4**
10.	test measurable sets and measurable functions.	**K5**

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

Units	Contents	No. of Hours
I	**Measure on the Real line** - Lebesgue Outer Measure - Measurable sets - Regularity - Measurable Functions - Borel and Lebesgue Measurability. **Chapter - 2 Sec 2.1 to 2.5 (de Barra)**	**18**
II	**Integration of Functions of a Real variable** - Integration of Non- negative functions - The General Integral - Riemann and Lebesgue Integrals. **Chapter - 3 Sec 3.1,3.2 and 3.4 (de Barra)**	**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 –Cesarosummability 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	**18**

	total derivative expressed in terms of partial derivatives - The matrix of linear function - The Jacobian matrix - The chain rule - Matrix form of chain rule - The mean - value theorem for differentiable functions - A sufficient condition for differentiability - 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**

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

Text books

1. G. de Barra, 2000. *Measure Theory and Integration*, Reprint, New Age International Publisher, 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. Roydon,H.L. and Fitzpatrick, 2016. *Real Analysis*, Fourth Edition, Pearson India Education Services Pvt. Ltd., Chennai.

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 MathWorld
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	1	3	2	3	3	2	3	2	1	2	2
CO2	2	1	3	1	3	3	2	3	2	1	2	2
CO3	3	2	3	1	3	3	2	3	2	1	2	2
CO4	1	2	3	2	3	3	2	3	2	1	2	2
CO5	3	1	2	3	3	3	2	3	2	1	2	2
TOTAL	12	7	14	9	15	15	10	15	10	5	10	10
AVERAGE	2.4	1.4	2.8	1.8	3	3	2	2	2	1	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**

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.
2. 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**

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**

Self-study	R and its development history

Text Book

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 IN 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**

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.	

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

Pre-requisite:

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

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

Text book

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**

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 COURSE I: MODELING AND SIMULATION WITH EXCEL

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
MP232SE1	4	-	-	-	2	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 know about modifying a spreadsheet and workbook.
2. To understand the concept of data analysis tools and data analysis for two data sets.

Course Outcomes

On the successful completion of the course, students will be able to:		
1.	learn the spreadsheet and workbook.	**K1 & K2**
2.	understand the types of charts and graphs.	**K2 & K4**
3.	apply the custom data formats and layouts.	**K3 & K4**
4.	analyze the data with Excel.	**K4 & K5**
5.	create spreadsheets, workbooks and charts.	**K2 &K6**

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

Units	Contents	No. of Hours
I	**Introduction to Spreadsheet Modeling** Feng Shui of Spreadsheets, Spreadsheet Makeover – Julia's Business Problem-A Very Uncertain Outcome, Ram's Critique, Julia's New and Improved Workbook. **Chapter 1: 1.5, 1.6**	**12**
II	**Presentation of Quantitative Data: Data Visualization** Introduction, Data Classification, Data Context and Data Orientation, Data Preparation Advice **Chapter 2: 2.1, 2.2, 2.3**	**12**
III	Types of Charts and Graphs – Ribbons and the Excel Menu System, Some Frequently Used Charts, Specific Steps for Creating a Chart, An Example of Graphical Data Analysis and Presentation, Example – Tere's Budget for the 2nd Semester of college, Collecting Data, Summarizing Data, Analyzing Data, Presenting Data. **Chapter 2: 2.4, 2.5**	**12**
IV	**Analysis of Quantitative Data** Introduction, Data Analysis, Data Analysis Tools, Data Analysis for Two Data Sets – Time Series Data: Visual Analysis, Cross-Sectional Data: Visual Analysis, Analysis of Time Series Data: Descriptive Statistics, Analysis of Cross-Sectional Data: Descriptive Statistics. **Chapter 3: 3.1, 3.2, 3.3, 3.4**	**12**

V	**Presentation of Qualitative Data – Data Visualization** Introduction, Essentials of Effective Qualitative Data Presentation – Planning for Data Presentation and Preparation, Data Entry and Manipulation – Tools for Data Entry and Accuracy, Data Transposition to Fit Excel, Data Conversion with the Logical IF, Data Conversion of Text from Non-Excel Sources **Chapter 4: 4.1, 4.2, 4.3.**	**12**

Self-study	Spreadsheets, Data Analysis

Textbook

Hector Guerrero, 2019, Excel Data Analysis: Modeling and Simulation (Second Edition), Springer Nature Switzerland AG, Switzerland.

Reference Books

1. Curtis D. Frye, 2010. Microsoft Excel 2010. Microsoft Press, Washington.
2. Joan Lambert and Curtis Frye, 2022. Microsoft Excel Step by Step, Pearson Education.
3. Wayne Winston, 2022. Microsoft Excel Data Analysis and Business Modeling, Pearson Education.
4. Chandan Sengupta, 2004. Financial Modeling Using Excel and VBA, John Wiley & Sons, Canada.
5. Balaji, K., 2023. Modeling with Excel, Scientific International Publishing House.

Web Resources

1.https://dspace.agu.edu.vn/handle/agu_library/13428

2. https://www.tandfonline.com/doi/abs/10.1080/00220485.2015.1029177

3.https://www.researchgate.net/publication/293135019_Excel_data_analysis_Modeling_and_simulation

4. https://www.theexcelexperts.com/modelling-simulation/

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	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 – 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	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	
CO1	understand deeper insight of the meaning of their existence.	K1
CO2	recognize the philosophy of life and individual qualities	K2
CO3	acquire the skills required for a successful personal and professional life.	K3
CO4	develop as socially responsible citizens.	K4
CO5	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 behavior	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 Portion: Salient values for life, Human Rights, Social Evils and how to tackle them, Holistic living, Duties and responsibilities.

Textbooks

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