Dr. N.G.P. ARTS AND SCIENCE COLLEGE

(An Autonomous Institution, Affiliated to Bharathiar University, Coimbatore)
Approved by Government of Tamil Nadu and Accredited by NAAC with 'A++' Grade (3rd Cycle-3.64 CGPA)
Dr. N.G.P. – Kalapatti Road, Coimbatore-641048, Tamil Nadu, India
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REGULATIONS 2023-24 for Post Graduate Programme
(Outcome Based Education model with Choice Based Credit System)
M.Sc. Mathematics Degree

(For the students admitted during the academic year 2023-24 and onwards)

Programme: M.Sc. Mathematics
Eligibility:

A candidate who has passed the Degree Examination in B.Sc. (Mathematics) or B.Sc. (Mathematics with Computer Applications) of Bharathiar University and as per the norms set by the Government of Tamil Nadu or an Examination accepted as equivalent thereto by the Academic Council, subject to such conditions as may be prescribed thereto are permitted to appear and qualify for the **Master of Science in Mathematics** Degree Examination of this College after a course of study of two academic years

Programme Educational Objectives:

The Curriculum is designed to attain the following learning goals which students shall accomplish by the time of their graduation:

1. To meet the demand for well trained Post Graduates in Mathematics with academic Excellence.
2. To demonstrate an understanding of the theoretical concepts and axiomatic underpinnings of Mathematics and an ability to construct proofs at the appropriate level.
3. To demonstrate competency in Mathematical modeling of complex phenomena, problem solving and decision making.
4. To demonstrate a level of proficiency in quantitative and computing skills sufficient to meet the growing demands of society upon modern education.

PROGRAMME OUTCOMES:

On the successful completion of the program, the following are the expectedoutcomes.

PO Number	PO Statement
PO1	Students will have knowledge, understanding and Mathematical thinking of the basic and advanced concepts, techniques from different topics
PO2	They have a fundamental and advanced understanding of at least one Mathematical topic of their choice and able to solve problem related to the topic
PO3	They can be able to communicate clearly in writing and orallying the detailed technical arguments of complex Mathematical concepts
PO4	The students develop problem solving skill and apply them independently to problems in pure and applied Mathematics
PO5	They can develop the knowledge of formulating, analyzing and problem solving in core areas of the Mathematics including Analysis, Algebra and Statistics

PG Credit Distribution:

Part	Subjects	No. of Papers	Credit	Semester No.
III	Core	16	13 x 04 = 52 02 x 03 = 06 01 x 05 = 05	I - IV
	Elective	04	04 x 04 = 16	I - IV
	EDC	01	01 x 03 = 03	II
	Industrial Training	01	01 x 02 = 02	III
	Project Work	01	01 x 08 = 08	IV
TOTAL CREDITS			**92**	-

PG
CURRICULUM

M.Sc. MATHEMATICS – AY 23-24

Course Code	Course Category	Course Name	L	T	P	Exam (h)	Max Marks			Credits
							CIA	ESE	Total	
First Semester										
232MT2A1CA	Core – I	Algebra	4	1	-	3	25	75	100	4
232MT2A1CB	Core – II	Advanced Analysis	4	2	-	3	25	75	100	4
232MT2A1CC	Core – III	Ordinary Differential Equations	4	1	-	3	25	75	100	4
232MT2A1CD	Core - IV	Operations Research	4	1	-	3	25	75	100	4
232MT2A1CE	Core - V	Advanced Statistics	3	2	-	3	25	75	100	3
232MT2A1DA	DSE -I	Numerical Analysis	4	-	-	3	25	75	100	4
232MT2A1DB		Commutative Algebra								
232MT2A1DC		Mathematical Modeling								
		Total	23	7					600	23

BoS Chairman/HoD
Department of Mathematics
Dr. N. G. P. Arts and Science College
Coimbatore – 641 048

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12.06.23	14.07.23	05.08.23

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Course Code	Course Category	Course Name	L	T	P	Exam (h)	Max Marks			Credits
							CIA	ESE	Total	
Second Semester										
232MT2A2CA	Core - VI	Complex Analysis	4	1	-	3	25	75	100	4
232MT2A2CB	Core - VII	Topology	4	1	-	3	25	75	100	4
232MT2A2CC	Core - VIII	Partial Differential Equations	4	1	-	3	25	75	100	4
232MT2A2EP	Core -IX	Computational Mathematics	3	-	4	3	40	60	100	5
234DA2A2EB	EDC	Foundations of Data Analytics	3	1	-	3	25	75	100	3
232MT2A2DA	DSE-II	Wavelet Analysis	4	-	-	3	25	75	100	4
232MT2A2DB		Information and Coding Theory								
232MT2A2DC		Mathematical Finance								
Total			22	4	4				600	24

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Course Code	Course Category	Course Name	L	T	P	Exam (h)	Max Marks			Credits
							CIA	ESE	Total	
Third Semester										
232MT2A3CA	Core - X	Functional Analysis	4	1	-	3	25	75	100	4
232MT2A3CB	Core - XI	Classical Mechanics	3	2	-	3	25	75	100	3
232MT2A3CC	Core - XII	Stochastic Differential Equations	4	2	-	3	25	75	100	4
232MT2A3CD	Core -XIII	Advanced Graph Theory	4	1	-	3	25	75	100	4
232MT2A3CE	Core - XIV	Fluid Dynamics	4	1	-	3	25	75	100	4
232MT2A3CT	IT	Industrial Training					40	60	100	2
232MT2A3DA	DSE -III	Finite Element Theory	4	-	-	3	25	75	100	4
232MT2A3DB		Algebraic Number Theory								
232MT2A3DC		Actuarial Mathematics								
		Total	**23**	**7**	-				**700**	**25**

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Course Code	Course Category	Course Name	L	T	P	Exam (h)	Max Marks			Credits
							CIA	ESE	Total	
Fourth Semester										
232MT2A4CA	Core – XV	Mathematical Methods	4	1	-	3	25	75	100	4
232MT2A4CB	Core – XVI	Distribution Theory	4	1	-	3	25	75	100	4
232MT2A4CV	Core – XVII	Project and Viva voce	-	-	16	3	80	120	200	8
232MT2A4DA	DSE -IV	Boundary Layer Theory	4	-	-	3	25	75	100	4
232MT2A4DB		Lie Algebra								
232MT2A4DC		Mathematical Ecology								
Total			**12**	**2**	**16**				**500**	**20**
***Grand Total**									2400	92

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DISCIPLINE SPECIFIC ELECTIVE

Students shall select the desired course of their choice in the listed elective course during Semesters I to IV

Semester I (Elective I)

List of Elective Courses

S. No.	Course Code	Name of the Course
1.	232MT2A1DA	Numerical Analysis
2.	232MT2A1DB	Commutative Algebra
3.	232MT2A1DC	Mathematical Modeling

Semester II (Elective II)

List of Elective Courses

S. No.	Course Code	Name of the Course
1.	232MT2A2DA	Wavelet Analysis
2.	232MT2A2DB	Information and Coding Theory
3.	232MT2A2DC	Mathematical Finance

Semester III (Elective III)

List of Elective Courses

S. No.	Course Code	Name of the Course
1.	232MT2A3DA	Finite Element Theory
2.	232MT2A3DB	Algebraic Number Theory
3.	232MT2A3DC	Actuarial Mathematics

Semester IV (Elective IV)

List of Elective Courses

S. No.	Course Code	Name of the Course
1.	232MT2A4DA	Boundary Layer Theory
2.	232MT2A4DB	Lie Algebra
3.	232MT2A4DC	Mathematical Ecology

EXTRA CREDIT COURSES

Self-study paper offered by the Mathematics Department

S. No.	Course Code	Course Title
1.	232MT2ASSA	Research Methodology, IPR and Entrepreneurship
2.	232MT2ASSB	Mathematics of Bioinformatics

PG REGULATION (R5)

(2023-24 and onwards)

(OUTCOME BASED EDUCATION WITH CBCS)

Effective from the academic year 2023-24 and applicable to the students admitted to the Degree of Master of Arts/Commerce/Management/Science.

1.NOMENCLATURE

1.1 Faculty: Refers to a group of programmes concerned with a major division of knowledge. Eg. Faculty of Computer Science consists of Programmes like Computer Science, Information Technology, Computer Technology, Computer Applications, Cognitive Systems, Artificial Intelligence and Machine Learning and Cyber Security and Data Analytics etc.

1.2 Programme: Refers to the Master of Arts/Management/Commerce/Science Stream that a student has chosen for study.

1.3 Batch: Refers to the starting and completion year of a programme of study. Eg. Batch of 2023–2025 refers to students belonging to a 2-year Degree programme admitted in 2023 and completing in 2025.

1.4 Course: Refers to component of a programme. A course may be designed to involve lectures / tutorials / laboratory work / seminar / project work/ practical training / report writing / Viva voce, etc or a combination of these, to effectively meet the teaching and learning needs and the credits may be assigned suitably.

a) Core Courses A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

b) Extra Departmental Course (EDC): A course chosen generally from a related discipline/subject, with an intention to seek exposure in the discipline relating to the core domain of the student.

c) Discipline Specific Elective Course (DSE): Elective courses are offered under main discipline/ subject of study.

d)Internship/Industrial Training (IT)

Students must undertake industrial / institutional training for a minimum of 15 days during the II semester summer vacation. The students will submit the report for evaluation during III semester.

e) Project Work: It is considered as a special course involving application of knowledge in problem solving/analyzing/exploring a real-life situation. The Project work will be given in lieu of a Core paper.

f) Extra credits Extra credits will be awarded to a student for achievements in co-curricular activities carried out outside the regular class hours. The guidelines for the award of extra credits are given in section two, these credits are not mandatory for completing the programme.

g) Advanced Learner Course (ALC): ALC is doing work of a higher standard than usual for students at that stage in their education. Research work / internships carried out in University/ Research Institutions/ Industries of repute in India or abroad for a period of 15 to 30 days.

2. STRUCTURE OF PROGRAMME

- Core Course
- Extra Departmental Course (EDC)
- Discipline Specific Elective (DSE)
- Industrial Training (IT)
- Project

3. DURATION OF THE PROGRAMME

M.Sc. /M.Com. / M.A. Programme must be completed within 2 Years (4 semesters) and maximum of 4 Years (8 semesters) from the date of acceptance to the programme. If not, the candidate must enroll in the course determined to be an equivalent by BoS in the most recent curriculum recommended for the Programme.

4. REQUIREMENTS FOR COMPLETION OF A SEMESTER

Every student shall ordinarily be allowed to keep terms for the given semester in a program of his/ her enrolment, only if he/ she fulfills at least seventy five percent (75%) of the attendance taken as an average of the total number of lectures, practicals, tutorials, etc. wherein short and/or long excursions/field visits/study tours organised by the college and supervised by the faculty as envisaged in the syllabus shall be credited to his attendance. Every student shall have a minimum of 75% as an overall attendance.

5. EXAMINATIONS

The end semester examinations shall normally be conducted after completing 90 working days for each semester. The maximum marks for each theory and practical course as follows,

Mark distribution for Theory Courses

Continuous Internal Assessment (CIA) : 40 Marks

End Semester Exams (ESE) : 60 Marks

Total : 100 Marks

i) Distribution of Internal Marks

S.No.	Particulars	Distribution of Marks
1	CIA I (2.5 Units) (On completion of 45th working day)	5
2	Model (All 5 Units) (On completion of 85th working day)	5
3	Attendance	05
4	Library Usage	05
5	Skill Enhancement *	05
	Total	**25**

Breakup for Attendance Marks:

S.No	Attendance Range	Marks Awarded
1	95% and Above	5
2	90% - 94%	4
3	85% - 89%	3
4	80% - 84%	2
5	75% - 79%	1

Note:
Special Cases such as NCC, NSS, Sports, Advanced Learner Course, Summer Fellowship and Medical Conditions etc. the attendance exemption may be given by principal and Mark may be awarded.

Break up for Library Marks:

S.No	Attendance Range	Marks Awarded
1	10h and above	5
2	9h- less than 10h	4
3	8h - less than 9h	3
4	7h - less than 8h	2
5	6h - less than 7h	1

Note:
In exception, the utilization of e-resources of library will be considered.

***Components for "Skill Enhancement" may include the following:**

Class Participation, Case Studies Presentation/Term paper, Field Study, Field Survey, Group Discussion, Term Paper, Presentation of Papers in Conferences, Industry Visit, Book Review, Journal Review, e-content Creation, Model Preparation, Seminar and Assignment.

Components for Skill Enhancement
Any one of the following should be selected by the course coordinator

S.No.	Skill Enhancement	Description
1	Class Participation	• Engagement in class • Listening Skills • Behaviour
2	Case Study Presentation/ Term Paper	• Identification of the problem • Case Analysis • Effective Solution using creativity/imagination
3	Field Study	• Selection of Topic • Demonstration of Topic • Analysis & Conclusion
4	Field Survey	• Chosen Problem • Design and quality of survey • Analysis of survey

5	Group Discussion	• Communication skills • Subject knowledge • Attitude and way of presentation • Confidence • Listening Skill
6	Presentation of Papers in Conferences	• Sponsored • International/National • Presentation • Report Submission
7	Industry Visit	• Chosen Domain • Quality of the work • Analysis of the Report • Presentation
8	Book Review	• Content • Interpretation and Inferences of the text • Supporting Details • Presentation
9	Journal Review	• Analytical Thinking • Interpretation and Inferences • Exploring the perception if chosen genre • Presentation
10	e-content Creation	• Logo/ Tagline • Purpose • Content (Writing, designing and posting in Social Media) • Presentation
11	Model Preparation	• Theme/ Topic • Depth of background Knowledge • Creativity • Presentation
12	Seminar	• Knowledge and Content • Organization • Understanding • Presentation

13	Assignment	• Content and Style • Spelling and Grammar • References

ii) Distribution of External Marks

Total : 75
Written Exam : 75

Marks Distribution for Practical course

Total : 100
Internal : 40
External : 60

i) **Distribution of Internals Marks**

S. No.	Particulars	Distribution of Marks
1	Experiments/Exercises	15
2	Test 1	10
3	Test 2	10
4	Observation Notebook	05
	Total	**40**

ii) Distribution of Externals Marks

S.No.	Particulars	External Marks
1	Practical	40
2	Record	10
3	Viva- voce	10
	Total	**60**

Practical examination shall be evaluated jointly by Internal and External Examiners.

A) Mark Distribution for Project

Total : 200
Internal : 80
External : 120

i) Distribution of Internal Marks

S.No.	Particulars	Internal Marks
1	Review I	30
2	Review II	40
3	Attendance	10
	Total	**80**

ii) Distribution of External Marks

S.No	Particulars	External Marks
1	Project Work & Presentation	100
2	Viva -voce	20
	Total	**120**

Evaluation of Project Work shall be done jointly by Internal and External Examiners.

6 . Credit Transfer

a. Upon successful completion of 1 NPTEL Course (4 Credit Course) recommended by the department, during Semester I to II, a student shall be eligible to get exemption of one **4 credit course** during the 3rd semester. The proposed NPTEL course should cover content/syllabus of exempted core paper in 3rd semester.

S. No.	Course Code	Course Name	Proposed NPTEL Course	Credit
1			Option – 1 Paper title	4
			Option – 2 Paper title	
			Option – 3 Paper title	

b. Upon successful completion of **2 NPTEL Courses** (2 Credit each) recommended by the department, during Semester I to II, a student shall be eligible to get exemption of **one 4 credit course** during the 3rd semester. Out of 2 NPTEL proposed courses, **at least 1 course** should cover content/syllabus of exempted core paper in 3rd semester.

<u>Mandatory</u>

The exempted core paper in the 3rd semester should be submitted by the students for approval before the end of 2nd semester

Credit transfer will be decided by equivalence committee

<table>
<tr><th>S. No.</th><th>Course Code</th><th>Course Name</th><th>Proposed NPTEL Course</th><th>Credit</th></tr>
<tr><td rowspan="3">1</td><td rowspan="3"></td><td rowspan="3"></td><td>Option – 1 Paper title</td><td rowspan="3">2</td></tr>
<tr><td>Option – 2 Paper title</td></tr>
<tr><td>Option – 3 Paper title</td></tr>
<tr><td rowspan="3">2</td><td rowspan="3"></td><td rowspan="3"></td><td>Option – 1 Paper title</td><td rowspan="3">2</td></tr>
<tr><td>Option – 2 Paper title</td></tr>
<tr><td>Option – 3 Paper title</td></tr>
</table>

NPTEL Courses to be carried out during semester I – II.

<table>
<tr><th>S. No.</th><th>Student Name</th><th>Class</th><th colspan="2">Proposed NPTEL Course</th><th>Proposed Course for Exemption</th></tr>
<tr><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td>Course I</td><td>Option 1- Paper Title
Option 2- Paper Title
Option 3- Paper Title</td><td rowspan="2">Any one Core Paper in 3rd Semester</td></tr>
<tr><td>Course II</td><td>Option 1- Paper Title
Option 2- Paper Title
Option 3- Paper Title</td></tr>
</table>

Class Advisor **HoD** **Dean**

7. Internship/Industrial Training

Mark Distribution for Internship/ Industrial Training

Total	:	100
Internal	:	40
External	:	60

i) Distribution of Internal Marks

S.No.	Particulars	Internal Marks
1	Review I	15
2	Review II	20
3	Attendance	5
	Total	**40**

ii) Distribution of External Marks

S.No	Particulars	External Marks
1	Internship /Industrial training Presentation	40
2	Viva –voce	20
	Total	**60**

Internship/ Industrial training shall be evaluated jointly by Internal and External Examiners.

9. Extra Credits: 10

Earning extra credit is not essential for programme completion. Student is entitled to earn extra credit for achievement in Curricular/Co-Curricular/ Extracurricular activities carried out other than the regular class hours.

A student is permitted to earn a maximum of 10 extra Credits during the programme period. A maximum of 1 credit under each category is permissible.

Category	Credit
Self study Course	1
CA/ICSI/CMA (Foundations)	1
CA/ICSI/CMA (Inter)	1
Sports and Games	1
Publications / Conference Presentations (Oral/Poster)/Awards	1
Innovation / Incubation / Patent / Sponsored Projects / Consultancy	1
Representation in State / National level celebrations	1
Awards/Recognitions/Fellowships	1
Advanced Learner Course (ALC)*	2

Credit shall be awarded for achievements of the student during the period of study only.

GUIDELINES

Self study Course

A pass in the self study courses offered by the department.

The candidate should register the self study course offered by the department only in the III semester.

CA/ICSI/CMA(Foundations)

Qualifying foundation in CA/ICSI/CMA / etc.

CA/ICSI/CMA(Inter)

Qualifying Inter in CA/ICSI/CMA / etc.

Sports and Games

The Student can earn extra credit based on their Achievement in sports in University/ State / National/ International.

Publications / Conference Presentations (Oral/Poster)

Research Publications in Journals

Oral/Poster presentation in Conference

Innovation / Incubation / Patent / Sponsored Projects / Consultancy

Development of model/ Products /Prototype /Process/App/Registration of Patents/ Copyrights/Trademarks/Sponsored Projects /Consultancy

Representation in State/ National level celebrations

State / National level celebrations such as Independence day, Republic day Parade, National Integration camp etc.

Awards/Recognitions/Fellowships

Regional/ State / National level awards/ Recognitions/Fellowships

***Advanced Learner Course (ALC):**

ALC is doing work of a higher standard than usual for students at that stage in their education.

Research work/internships carried out in University/ Research Institutions/ Industries of repute in India or abroad for a period of 15 to 30 days will be considered as Advanced Learners Course.

QUESTION PAPER PATTERN

CIA Test I : [1½ Hours-2.5 Units] - 25 Marks

SECTION	MARKS	DESCRIPTION	TOTAL	Remarks
Section – A	8 x 0.5= 04 Marks	MCQ	25 Marks	Marks secured will be converted To 5 mark
Section - B	3 x 2 = 06 Marks	Answer ALL Questions Either or Type ALL Questions Carry Equal Marks		
Section - C	3 x 05 = 15 Marks			

CIA Test II/ Model [3 Hours-5 Units] - 75 Marks

SECTION	MARKS	DESCRIPTION	TOTAL	Remarks
Section – A	10 x 1 = 10 Marks	MCQ		
Section - B	5 x 3 = 15 Marks	Answer ALL Questions (Either or Type Questions) Each Questions Carry Equal Marks	75 Marks	Marks secured will be converted To 5 mark
Section - C	5 x 8 = 40 Marks			
Section - D	1 x 10 = 10 Marks	Compulsory Question		

End Semester Examination [3 Hours-5 Units] - 75 Marks

SECTION	MARKS	DESCRIPTION	TOTAL
Section – A	10 x 1 = 10 Marks	MCQ	
Section - B	5 x 3 = 15 Marks	Answer ALL Questions (Either or Type Questions) Each Questions Carry Equal Marks	75 Marks
Section - C	5 x 8 = 40 Marks		
Section - D	1 x 10 = 10 Marks	Compulsory Question	

Course Code	Course Name	Category	L	T	P	Credit
232MT2A1CA	ALGEBRA	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- elementary group theory and how to solve contemporary problems
- elementary principles on certain algebraic structures
- Sylow's theorems that describe the structure of certain finite groups

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	define the orbits and p-groups	K1
CO2	apply Sylow theory in the factorization of polynomials	K2
CO3	analyze the structure of finite fields	K3
CO4	explain the applications of Automorphisms and Isomorphism	K5
CO5	explain the applications of Galois theory	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓		✓	✓	✓
CO2				✓	✓
CO3		✓		✓	
CO4		✓	✓		
CO5	✓	✓	✓		✓

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A1CA	ALGEBRA	SEMESTER I

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Direct Products 12 h

External and internal direct products - group action on a set: Fixed sets and Isotropy subgroups – orbits - application on G-Sets to counting: p-groups - Sylow theorems.

Unit II Applications of the Sylow Theory and Rings of Polynomials 11 h

Applications to p-Groups and the class equation - further applications. Rings of polynomials: polynomials in an indeterminate - evaluation homomorphisms - division algorithm in $F[x]$ - irreducible polynomials – ideal structure in $F[x]$ - uniqueness of factorization in $F[x]$.

Unit III Introduction to Extension Fields 13 h

Extension fields - algebraic and transcendental elements - irreducible polynomial for α over F - simple extensions -Algebraic extensions: finite extensions – algebraically closed fields and algebraic closures.

Unit IV Automorphisms of Fields 14 h

Basic isomorphism of algebraic field theory - Automorphisms and fixed fields - Frobenius automorphism - Isomorphism extension theorem: extension theorem - splitting fields.

Unit V Separable Extensions and Galois Theory 10 h

Multiplicity of zeros of a polynomial-separable extensions-perfect fields-normal extensions - main theorem - Galois group over finite fields - illustrations of Galois theory: symmetric functions

Text Books

1 Fraleigh J.B, 2003,"A First Course in Abstract Algebra", 3rd Edition, Narosa Publishing House, New Delhi.

References

1 Herstein I.N, 2007, "Topics in Algebra", 2nd Edition, Narosa Publishing House, New Delhi.

2 Artin M, 1991, "Algebra", Prentice-Hall of India, New Delhi.

3 Fraleigh J.B, 2014,"A First Course in Abstract Algebra", Seventh Edition, Pearson Education Limited, London.

4 Anderson M and Feil T, 2014, "A First Course in Abstract Algebra Rings, Groups, and Fields", 3rd Edition, Chapman and Hall/CRC, London.

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12.06.23	14.07.23	05.08.23

Course Code	Course Name	Category	L	T	P	Credit
232MT2A1CB	ADVANCED ANALYSIS	CORE	4	2	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the concept of Riemann Stieltjes integral
- the inverse and Implicit function theorems
- the concept of Lebesgue measure and Lebesgue integral

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	identify the Riemann Stieltjes Integral of various real functions	K1
CO2	describe the properties of various forms of uniform convergence and continuity	K2
CO3	discuss the concept behind contraction principle of a function	K3
CO4	demonstrate the Lebesgue measure and its properties	K4
CO5	apply the properties of Lebesgue integral of the bounded functions	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	✓
CO2	✓	✓		✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓		✓	
CO5	✓	✓		✓	

MAPPING WITH PROGRAMME OUTCOMES

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A1CB	ADVANCED ANALYSIS	SEMESTER I

Total Credits: 4

Total Instructions Hours: 72 h

Syllabus

Unit I Riemann Stieltjes Integral 15h

Definition and existence of the Integral – properties of the integral – Integration and differentiation – Integration of vector valued functions – rectifiable curves.

Unit II Sequences and Series of Functions 14 h

Uniform convergence and continuity - uniform convergence and integration - uniform convergence and differentiation – equicontinuous families of functions – The Stone Weierstrass theorem.

Unit III Functions of Several Variables 14 h

Linear transformations-differentiation – contraction principle – Inverse function theorem – Implicit function theorem.

Unit IV Lebesgue Measure 14 h

Outer measure – Measurable sets and Lebesgue measure – Measurable functions – Littlewood's three principles.

Unit V Lebesgue Integral 15h

Riemann Integral - The Lebesgue integral of bounded functions over a set of finite measure – integral of a non –negative function – general Lebesgue integral.

Text Book

1 Walter Rudin, 1976, Principles of Mathematical Analysis, McGraw Hill, New York.

2 H.L. Roydon, 2005, Real Analysis, Third Edition, Prentice Hall of India, New Delhi.

References

1 R. G. Bartle, 1976, Elements of Real Analysis, 2nd Edition, John Wily and Sons, New York,.

2 Mainak Mukherjee, 2015, A course in Real Analysis, Narosa publishing house. New Delhi.

3 Tom M Apostol, 2002, Mathematical Analysis, Narosa Publishing House Pvt Ltd., Second Edition, New Delhi.

4 Somasundaram.D and Choudhary,B. 2015, A first course in Mathematical Analysis, Narosa publishing house, New Delhi.

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BoS- 15th	AC - 15th	GB - 20th
12.06.23	14.07.23	05.08.23

Course Code	Course Name	Category	L	T	P	Credit
232MT2A1CC	ORDINARY DIFFERENTIAL EQUATIONS	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the first order and second order ordinary differential equations
- the usage of power series method to solve differential equations
- the homogenous and non-homogenous ordinary differential equations

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	define Legendre and Bessel equations	K2
CO2	discribe the concept of fundamental matrix of systems	K2
CO3	apply Lipschitz condition in Mathematical problems	K3
CO4	inspect the existence and uniqueness of solutions	K4
CO5	analyze the solution using oscillatory theorems	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓		✓	✓
CO2		✓	✓		✓
CO3	✓	✓		✓	✓
CO4	✓		✓		
CO5	✓	✓	✓		✓

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A1CC	**ORDINARY DIFFERENTIAL EQUATIONS**	**SEMESTER I**

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Solutions in power series 12 h

Introduction-second order linear equations with ordinary points-Legendre equation and Legendre polynomials-second order equation with regular singular point-properties of Bessel functions.

Unit II System of Linear differential equations 11 h

System of first order equations- model for ARMS competition between two nations-existence and uniqueness theorem-fundamental matrix.

Unit III Non homogeneous linear system 10 h

Non-homogeneous linear systems- linear system with constant coefficients- linear systems with periodic coefficients.

Unit IV Existence and uniqueness of solutions 13 h

Preliminaries- successive approximations- Picard's theorem- some examples-continuation and dependence on initial conditions- existence of solutions in the large- existence and uniqueness of solutions of system.

Unit V Oscillations of second order equations 14 h

Fundamental results- Sturm's comparison theorem- elementary linear oscillations-comparison theorem of Hille-Winter -Oscillations of $x'' + a(t)x = 0$

Text Books

1 Deo S.G, Lakshmikandham V and Raghavendra V, 2007, "Text book of Ordinary Differential Equations", Second Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.

References

1 Reid W T, 1971, "Ordinary Differential Equations", John Wiley & sons, New York.

2 Coddington E A and Levinson N, 2006, "Theory of Ordinary Differential Equations", Tata McGraw-Hill Publishing Company Limited, New Delhi.

3 Tesch I G, 2012, "Ordinary Differential Equations and Dynamics Systems", American Mathematical Society, Providence.

4 Coddington E A, 2006, "An introduction to Ordinary Differential Equations", PHI Private Limited, New Delhi.

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BoS- 15th 12.06.23	AC - 15th 14.07.23	GB - 20th 05.08.23

Course Code	Course Name	Category	L	T	P	Credit
232MT2A1CD	OPERATIONS RESEARCH	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the dynamic, integer programming and decision analysis
- concept of queueing and inventory
- the method of solving the queueing models

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	illustrate the characteristics of dynamic programming problem	K2
CO2	derive importance of integer programming	K5
CO3	explain the concept of Markov chain and Markov process in decision making	K3
CO4	define the behavior of various queueing models	K4
CO5	analyze the applications of inventory	K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓		✓		
CO2		✓			✓
CO3	✓			✓	
CO4			✓		✓
CO5	✓	✓			

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A1CD	OPERATIONS RESEARCH	SEMESTER I

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Dynamic Programming 14 h

Prototype example for dynamic programming - characteristics of dynamic programming problems - deterministic and probabilistic dynamic programming

Unit II Integer Programming 13 h

Prototype example - some BIP applications - innovative uses of binary variables in model formulation - some formulation examples - some perspectives on solving integer programming problems

Unit III Decision Analysis 10 h

Prototype example - decision making without experimentation - decision making with experimentation - decision trees, Markov chains: Stochastic processes - Markov chains

Unit IV Queueing Theory 12 h

Prototype example - basic structure - examples of real Queueing systems - role of the exponential distribution – birth and death process - Queueing models based on birth and death process

Unit V Inventory Theory 11 h

Examples - components - deterministic continuous and periodic review model - deterministic multiechelon inventory model for supply chain management

Text Books

1 Frederick S. Hillier, Gerald J. Lieberman, 2010,"Introduction to Operations Research-Concepts and Cases ", 9th Edition, McGraw-Hill Companies, New Delhi.

References

1 Taha H.A, 2006, "Operations Research: An Introduction", 8th Edition, Prentice-Hall of India Private Limited, New Delhi.

2 Kandiswarup, Gupta P.K and Man Mohan, 1998,"Operations Research", S. Chand & Sons Education Publications, New Delhi.

3 Ravindran, Phillips D.T and Solberg J.J, 2005, "Operations Research-Principles and Practice", & John Wiley Sons, New Jersey.

4 Hillier F and Lieberman G, 2010, "Introduction to Operations Research", 9th Edition, McGraw-Hill Professional, New Delh.

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BoS- 15th	AC - 15th	GB - 20th
12.06.23	14.07.23	05.08.23

Course Code	Course Name	Category	L	T	P	Credit
232MT2A1CE	ADVANCED STATISTICS	CORE	3	2	-	3

PREAMBLE

This course has been designed for students to learn and understand

- the procedure of finding estimation
- the methods of testing hypothesis under various conditions
- the importance of linear regression models

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	define the point estimation	K1
CO2	identity the confidence intervals for population variance and population parameters	K2
CO3	explain the procedures for hypothesis testing	K3
CO4	analyze the linear regression models and method of solving it variance	K4
CO5	apply various types of non-parametric test to validate hypothesis	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1		✓		✓	
CO2	✓			✓	
CO3	✓	✓			✓
CO4			✓	✓	
CO5	✓	✓			✓

✓	Skill Development	✓	Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A1CE	ADVANCED STATISTICS	SEMESTER I

Total Credits: 3

Total Instruction Hours: 60 h

Syllabus

Unit I Point Estimation 12 h

Introduction-method of moments and maximum likelihood-some desirable properties of point estimators-other desirable properties.

Unit II Interval Estimation 12 h

Introduction–large sample confidence intervals: one sample case-small sample confidence intervals for μ-a confidence interval for the population variance-confidence interval concerning two population parameters.

Unit III Hypothesis Testing 12 h

Introduction-Neyman-Pearson-likelihood ratio test–hypotheses for a single parameter-testing of Hypotheses for two samples-Chi-Square tests for count data.

Unit IV Linear Regression Models 12 h

Introduction–simple linear regression model-inferences on the least square estimators-predicting a particular value.

Unit V Non Parametric Tests 12 h

Introduction –nonparametric confidence interval-nonparametric hypothesis tests for one sample-nonparametric hypothesis tests for two independent samples nonparametric hypothesis tests for $k \geq 2$ sample.

Text Books

1 Kandethody M. Ramachandran, Chris P. Tsokos, 2009, "Mathematical Statistics with Applications", Elsevier, Gurgaon.

References

1 Irwin Miller and Marylees Miller, John E. Freund's, 2007,"Mathematical Statistics with Applications", Seventh Edition, Prentices-Hall India Pvt Ltd, New Delhi.

2 Hogg and Craig, 2003, "Introduction to Mathematical Statistics", Pearson Education, New Delhi.

3 J.M. Kapur and H.C. Saxena, 2001, "Mathematical Statistics", S. Chand & Co, New Delhi.

4 Ronald E.Walpole, Raymond H. Myers, Sharon L. Myers, Keying E. Ye,2018,Probability and Statistics, Pearson Education, New Delhi.

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Course Code	Course Name	Category	L	T	P	Credit
232MT2A1DA	NUMERICAL ANALYSIS	DSE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the method of solving nonlinear equations
- analyze the solution of ordinary differential equations
- analyze the convergence of various methods

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	identify the numerical method to solve nonlinear equations	K1
CO2	categorize the system of equations and solve by appropriate method	K2
CO3	examine the solution got by applying various of numerical differentiation and integration methods	K3
CO4	Analyze the method of solving differential equation and the way to find optimized solution	K4
CO5	analyze the nature of solution of one and two dimensional partial differential equations	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1					
CO2	✓				
CO3	✓				
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A1DA	NUMERICAL ANALYSIS	SEMESTER I

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Nonlinear Equations 10 h

Interval halving (Bisection) - linear interpolation methods - Newton's method - Muller's method - fixed-point iteration: $x = g(x)$ method - Multiple Roots - Nonlinear Systems

Unit II Solving System of Equations 10 h

Matrices and Vectors - elimination methods - inverse of a matrix and matrix pathology - Ill-Conditioned systems - iterative methods - parallel processing

Unit III Numerical Differentiation and Integration 10 h

Derivatives from divided difference table - higher order derivatives - extrapolation techniques -Trapezoidal rule - Simpson's rules - Fourier Series and Fourier Transforms - adaptive integration - Gaussian quadrature - multiple Integrals - applications of Cubic Splines

Unit IV Numerical Solution of Ordinary Differential Equations and Optimization 9 h

Taylor-Series Method - Euler method - Runge- Kutta methods - multistep methods - Higher-Order Equations and Systems. Optimization: finding the minimum of $y = f(x)$- minimizing a function of several variables-linear programming

Unit V Numerical Solutions of Partial-Differential Equations 9 h

Elliptic equations: Liebmann's method - Poisson's equation - derivative boundary conditions - implicit method - Parabolic equations: heat equation - Crank-Nicolson method - Theta method - stability - analytical argument- Hyperbolic equations: vibrating string - D'Alembert solution - wave equation.

Text Books

1 Gerald C. F. and Wheatley P. O., 1999, "Applied Numerical Analysis", 7th Edition, Pearson Education, New York.

References

1 Smith. G. D., 1985, "Numerical Solution of Partial Differential Equations – Finite Difference Methods", Oxford University Press, Oxford.

2 Jain M. K., Iyengar S. R. K. and Jain R. K., 1993, "Numerical Methods for Scientific and Engineering Computation", 3rd Edition, Wiley Eastern Ltd, Noida.

3 Marghitu D. B. and Dupac M., 2012, "Advanced Dynamics: Analytical and Numerical Calculations with MATLAB", Springer, New York.

4 Samuel Conte D. and Boor C. D., 1983, "Elementary Numerical Analysis", McGraw- Hill International Edition, New Delhi.

Course Code	Course Name	Category	L	T	P	Credit
232MT2A1DB	COMMUTATIVE ALGEBRA	DSE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the concepts of ideals and modules through examples
- the properties to decompose the Noetherian and Artin rings.
- the importance of dimension theory of rings and modules.

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	define new modules using operations like tensor product and other operations	K1
CO2	discuss the construction of field	K2
CO3	demonstrate the concept of integral dependence of extension ring and chain conditions of modules.	K3
CO4	analyze the importance of discrete valuation of rings and dedekind domains	K4
CO5	summarize the various forms of dimension theory and its influence in local rings	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	✓
CO2	✓		✓	✓	✓
CO3	✓	✓		✓	✓
CO4	✓	✓	✓	✓	✓
CO5	✓	✓		✓	✓

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A1DB	COMMUTATIVE ALGEBRA	SEMESTER I

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Rings and Ideals 9 h

Rings and ring homomorphisms - ideals - quotient rings - zero divisors, nilpotent elements, units - prime ideal and maximal ideals - nilradical and Jacobson radical - operations on ideals - extension and contraction.

Modules: modules and module homomorphisms - submodulus and quotient modulus - operations on submodules - finitely generated modulus

Unit II Rings ,modules of fractions and primary decomposition 9 h

Local properties - extended and contracted ideals in rings of fractions - primary decomposition

Unit III Integral dependence and valuations 9 h

Integral dependence - the going up theorem -Integrally closed integral domains - the going down theorem - valuation rings - Chain conditions

Unit IV Noetherian rings, artin rings , Discrete valuation rings and Dedekind domains 9 h

Primary decomposition in Noetherian rings - Artin rings -structure theorem for Artin rings- Discrete valuation rings - Dedekind domains - Fractional ideals

Unit V Completions and Dimension Theory 12 h

Topologies and completions - filtrations - graded rings and modules - the associated graded ring - Hilbert functions - dimension theory of Noetherian local rings - regular local rings - Transcendental dimension

Text Books

1 Atiyah-Macdonald, 1994, Commutative Algebra, Westview Press, London

References

1 Zariski and Samuel, 1991, Commutative Algebra I, II, Springer, New York.

2 Eisenbud, 1995 Commutative Algebra with a View Towards Algebraic Geometry, Springer, New York.

3 Bourbaki, 1989, Commutative Algebra, Springer, New York.

4 Herstein I N, 2000, Topics in Algebra, Second Edition, John Wiley and Sons, New Jersey.

Course Code	Course Name	Category	L	T	P	Credit
232MT2A1DC	MATHEMATICAL MODELING	DSE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the deterministic states and analysis of models
- the stochastic analysis of models
- various evolution of models

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	describe the optimal power and exponential models	K2
CO2	discuss the dimensional analysis and similarity	K2
CO3	apply the concept of probability density function to define stochastic states	K3
CO4	analyze the properties of various forms of changes using modeling	K4
CO5	develop the models for situations involving evolution theory	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓		
CO2	✓		✓		
CO3		✓		✓	✓
CO4			✓	✓	
CO5		✓		✓	✓

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A1DC	MATHEMATICAL MODELING	SEMESTER I

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Deterministic Analysis of Observations 9 h

Data transformations: Linear model –polynomial models –population modeling – global warming modeling - model errors – optimal linear models – optimal quadratic models – optimal power and exponential models.

Unit II Deterministic States 10 h

Dimensional analysis and similarity - applications of low-complexity - applications of medium complexity- time measurement - applications of high-complexity.

Unit III Stochastic States 9 h

Probability density functions – models for probability density functions – data analysis – real distribution.

Unit IV Deterministic and stochastic Changes 10 h

Linear changes - linear changes with delays - nonlinear changes - linear stochastic changes - diffusion - Brownian motion - population dynamics.

Unit V Deterministic and Stochastic Evolution 10 h

Heat and Mass Transfer: Balance – Newton's laws of motion: oscillations – population ecology: growth and self-limitation – oscillations and collapse - PDF evolution equations - Solutions to the Fokker Plank equation.

Text Books

1 Stefen Heinz, 2011,"Mathematical Modeling", Springer-Verlag, New York

References

1 J.N. Kapur, 1998, "Mathematical Modeling", New Age International (P) Limited, New Delhi

2 Crossand, and Moscrcadini A.O, 1976,"The Art of Mathematical Modeling", Ellis Harwood and John Wiley, New york

3 Sarah. P.Otto and Troy Day, 2000, "A Biologist guide to Mathematical Modeling in Ecology and Evolution", Princeton University Press, Princeton

4 Frank. R.Glordance, Maurice D. Weir and William P.Fox, 2003, "A First course in Mathematical Modeling", Thomson Learning, London

BoS Chairman/HoD
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Course Code	Course Name	Category	L	T	P	Credit
232MT2A2CA	COMPLEX ANALYSIS	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the methods of integration with complex function.
- the existence and applications of conformal mapping.
- the concept of elliptic functions.

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	apply the concept of analytic function and linear transformations..	K2
CO2	illustrate complex integration through Cauchy's integral formula.	K3
CO3	analyze the calculus of residues and evaluating complex integrals	K3
CO4	assess the boundary behavior at an angle through reflection principle	K3
CO5	examine the properties of simply periodic functions and doubly periodic functions.	K3

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	✓
CO2		✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓		
CO5	✓	✓	✓		✓

COURSE FOCUSES ON

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A2CA	COMPLEX ANALYSIS	SEMESTER II

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Complex integration 14 h

Fundamental Theorems: Line integrals - Rectifiable arcs – Line integrals as functions of arcs – Cauchy's theorem for a rectangle - Cauchy's theorem in a disk - Cauchy's integral formula: Higher derivatives- Local Properties: Removable singularities - Taylor's theorem – zeros and poles – local mapping – maximum principle.

Unit II Residues and Harmonic Functions 12 h

Calculus of residues: Residue theorem – argument principle – evaluation of definite integrals. Harmonic functions: Mean-value property – Poisson's formula.

Unit III Series and product developments 10 h

Power series expansions: Weierstrass's theorem – Taylor series – Laurent series. Partial fractions and factorization: Partial fractions – Infinite products – Canonical products.

Unit IV Conformal Mapping 11 h

Riemann mapping theorem: Statement and proof – Boundary behavior – Use of the reflection principle – Analytic arcs. Conformal mapping of polygons: Behavior at an angle –Schwarz-Christoffel formula – Mapping on a rectangle

Unit V Elliptic Functions 13 h

Simply periodic functions: The Fourier development – Functions of finite order. Doubly periodic functions: The period module – Unimodular transformations – the Canonical Basis – general properties of Elliptic functions. Weierstrass Theory: The Weierstrass p-function – differential equations.

Text Books

1 Ahlfors Lars V, 2019, "Complex Analysis", 3rd Edition. McGraw-Hill, New Delhi.

References

1 James Ward Brown and Churchill, Ruel V, 2013, "Complex Variables and Applications", 9th Edition, Tata McGraw Hill, New Delhi.

2 Joseph Bak, Donald J. Newman, 2010, "Complex Analysis", 3rd Edition, Springer, New York.

3 Kasana, H.S, 2005, "Complex Variables: Theory and Applications", 2nd Edition, PHI Learning, New Delhi.

4 Conway, John B, 2000, "Functions of one Complex variable", 2nd Edition, Narosa Publication, New Delhi.

Course Code	Course Name	Category	L	T	P	Credit
232MT2A2CB	TOPOLOGY	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the concept of topological Spaces.
- the countability and seperation axioms.
- the influence of metric space in topology.

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	explain the concepts behind topological spaces.	K2
CO2	analyzing connectedness and compactness concepts.	K3
CO3	applying countability axioms to find the existence of countable set with certain properties.	K3
CO4	examine the properties of metric spaces.	K4
CO5	analyzing the concept of complete metric spaces and function spaces.	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓		✓	
CO2	✓	✓	✓		✓
CO3	✓	✓		✓	
CO4	✓		✓	✓	✓
CO5	✓	✓	✓	✓	✓

COURSE FOCUSES ON

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A2CB	TOPOLOGY	SEMESTER II

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I	Topological Spaces and Continuous Functions	14 h

Topological spaces – basis – order topology – subspace topology - closed sets and limit points – continuous functions – product topology – metric topology.

Unit II	Connectedness and compactness	12 h

Connected Spaces – connected subspaces of the real line – components and local connectedness – compact spaces – compact subspaces of the real line - limit point compactness - local compactness.

Unit III	Countability and separation axioms	12 h

Countability axioms – separation axioms - normal spaces – Urysohn's Lemma – Urysohn metrization theorem - Tietz extension theorem.

Unit IV	The Tychonoff Theorem, metrization Theorems and paracompactness	12 h

Tychonoff Theorem - Stone-Cech compactification - local finiteness - Nagata-Smirnov metrization theorem - paracompactness - The Smirnov metrization theorem.

Unit V	Complete Metric spaces and Function Spaces	10 h

Complete metric spaces – compactness in metric Spaces – pointwise and compact convergence - Ascoli's theorem.

Text Books

1 Munkres, J. R., 2006, "Topology", 2nd Edition., Prentice-Hall of India Private Limited, New Delhi.

References

1 Nainpally, S. and Peters, J, 2013, "Topology with Applications: Topological Spaces via Near and Far", World Scientific, Singapore.

2 Sze-Tsen Hu., 1966, "Introduction to General Topology", Holden-Day, INC., San Franscisco.

3 Adams and Franzosa, 2007, "Introduction to Topology: Pure and Applied", Pearson-Prentice Hall, New Delhi.

4 Simmons, G.F., 2004, "Introduction to topology and modern analysis", Tata McGraw-Hill, New Delhi.

Course Code	Course Name	Category	L	T	P	Credit
232MT2A2CC	PARTIAL DIFFERENTIAL EQUATIONS	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the basic forms of partial differential equations and methods to solve it.
- analytical techniques used to solve parabolic and hyperbolic equations.
- the various forms of solutions that exists for partial differential equations.

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	identify the method of solving first order partial differential equations	K2
CO2	determine the characteristic curve for a second order partial differential equations	K3
CO3	analyze the characteristics of Laplace's equation	K4
CO4	analyze the solvability of wave equations	K4
CO5	evaluating diffusion equations by using integral transforms method	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1		✓	✓		✓
CO2		✓	✓	✓	✓
CO3	✓	✓	✓	✓	
CO4	✓	✓		✓	
CO5	✓			✓	

COURSE FOCUSES ON

- [✓] Skill Development
- [✓] Employability
- [ ] Intellectual Property Rights
- [ ] Social Awareness/ Environment
- [ ] Entrepreneurial Development
- [ ] Innovations
- [ ] Gender Sensitization
- [ ] Constitutional Rights/ Human Values/ Ethics

232MT2A2CC	PARTIAL DIFFERENTIAL EQUATIONS	SEMESTER II

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Partial differential equations of first order 14 h

Cauchy's problem for first order equations-nonlinear partial differential equations of the first order-Cauchy's method of characteristics-compatible systems–Charpit's method-special types–solutions satisfying given conditions.

Unit II Partial differential equations of second order 13 h

Origin–second order and higher order equations in physics-linear partial differential equations with constant coefficients–equations with variable coefficients–characteristic curves - characteristics of equations in three variables.

Unit III Laplace equation 11 h

Occurrence-elementary solutions of Laplace's equation–families of equipotential surfaces-boundary value problems-separation of variables-problems with axial symmetry.

Unit IV Wave equation 12 h

Occurrence–elementary solutions of the one-dimensional wave equation–Riemann- Volterra solution - Vibrating Membranes : Application of the Calculus of variations–three dimensional problems - general solution of the wave equation.

Unit V The Diffusion equation 10 h

Occurrence–resolution of boundary value problems-elementary solutions of the diffusion equation–separation of variables-use of integral transforms - use of Green's functions.

Text Books

1 Sneddon, I. N., 2006, "Elements of Partial Differential Equations", Dover Publications, New York.

References

1 TynMyint-U and Lokenath Debnath, 2007, "Linear Partial Differential Equations for Scientists and Engineers", 4th Edition, Birkhavser, Boston.

2 AslakTveito and Ragnar Winther, 1998, "Introduction to Partial Differential Equations: A Computational Approach", Springer-Verlag, New York.

3 Hillen T, Leonard E.I and Van Roessel H, 2012, "Partial Differential Equations: Theory and Completely Solved Problems", John Wiley & Sons, New Jersey.

4 O'Neil V., 2008, "Beginning Partial Differential Equations", 2nd Edition. John Wiley & Sons, New Jersey.

Course Code	Course Name	Category	L	T	P	Credit
232MT2A2EP	COMPUTATIONAL MATHEMATICS	CORE	3	-	4	5

PREAMBLE

This course has been designed for students to learn and understand

- the method of typesetting using Latex
- various build - in functions from Latex and MATLAB
- the logic of coding in MATLAB

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	define various basic commands in Latex	K1
CO2	illustrate the method of representing equations, tables and diagrams in Latex	K2
CO3	describe the basic commands in MATLAB	K3
CO4	design graphs by computation through MATLAB	K4
CO5	employ MATLAB for computation	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓		✓		✓
CO2		✓	✓		✓
CO3		✓		✓	
CO4		✓		✓	✓
CO5	✓	✓	✓		✓

COURSE FOCUSES ON

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A2EP	COMPUTATIONAL MATHEMATICS	SEMESTER II

Total Credits: 5

Total Instruction Hours: 72 h

Syllabus

(Embedded)

Unit I LATEX: Basics and Basic Typesetting 13 h

Introduction to LATEX: Pros and Cons – basics - document hierarchy - document management - labels and cross - references - bibliography - table of contents and lists of things - class files – packages - errors and troubleshooting.

Running text: Special characters– abbreviations - alignment

Practical

1 Creating a Latex document with Mathematical formulas

2 Creating a Latex document with proper justification

3 Create a bibliography using Latex

Unit II LATEX: Tables, Diagrams, and Data Plots 14 h

Presenting External Pictures: Figure environment - special packages - external picture files - graphicx package - setting default key values - setting a search path - graphics extensions.

Presenting Diagrams: tikzpicture Environment - \tikz command - grids - paths - coordinate labels - extending paths - actions on paths - nodes and node labels - spy library – trees – logic circuits – commutative diagrams – option – styles..

Practical

4 Creating a Latex document with table, graph or picture

5 Designing the power point presentation using Latex

6 Creating a simple project using Latex

Unit III MATLAB: Introduction and Iterative Computation 14 h

Introduction: Basics of MATLAB.

Iterative Computation: Matrices and vectors - matrix and array operations - character strings - command line functions - using build-in functions and on-line help - saving and loading data - plotting simple graph.

Practical

7	Create a simple MATLAB program using arithmetic operators
8	Write MATLAB code with matrix operations
9	Write MATLAB code for finding the results of the students in exam

Unit IV MATLAB: Graphics & Errors 14 h

Graphics: Basic 2-D plots - 3-D plots - handle graphics - saving and printing graphs - animation.

Errors

Practical

10	Designing a simple plot and multiple plots in a single window
11	Designing a bar chart and phi chart
12	Designing a 3D plot

Unit V MATLAB: Applications 17 h

Algebraic equations: Linear Algebra - nonlinear algebraic equations.

Data analysis and regression: Curve fitting and regression analysis - correlations - statistics.

Differential equations: Numerical integration - solution of ODEs for initial value problems - solution of ODEs for boundary value problems - advanced topics.

Practical

13	Solving a first order differential equation using Euler's method and Runge-Kutta fourth order method
14	Solve the wave and heat equations
15	Solve a simple equation using Newton Raphson Method

Text Books

1 Van Dongen M.R.C., 2012, "LATEX and Friends", Springer-Verlag Berlin Heidelberg, New York.

2 RudraPratap, 2017, "Getting started with MATLAB: A Quick Introduction for Scientists and Engineers", Oxford University Press, Newyork

References

1 Stefan Kottwitz, 2011, "LATEX Beginner's Guide", Packt Publishing Limited, London

2 Kopka H., and Daly P.W., 1999, "A Guide to LATEX", 3rd Edition, Addison Wesley, London

3 Nambudiripad K.B.M., 2014, "LATEX for Beginners", Narosa Publishing House Private Limited, New Delhi

4 Kirani Singh Y., and Chaudhuri B.B., 2007, "MATLAB Programming", 1st Edition, PHI Learning, New Delhi

Course Code	Course Name	Category	L	T	P	Credit
234DA2A2EB	FOUNDATIONS OF DATA ANALYTICS	EDC	3	1	-	3

PREAMBLE

This course has been designed for students to learn and understand

- principles and concepts of data analytics
- concept of data pre-processing and clustering
- application of frequent itemset mining, regression, and classification

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	Understand the various types of data and data science components	K2
CO2	Apply appropriate data preprocessing method to solve data driven problems	K3
CO3	Interpret various clustering methods	K2
CO4	Analyze the suitable type of itemset mining	K4
CO5	Apply the concepts of regression and classification in real world problems	K3

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓		✓	✓
CO2	✓	✓	✓		
CO3	✓		✓	✓	✓
CO4	✓	✓	✓	✓	✓
CO5	✓		✓	✓	✓

COURSE FOCUS ON

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

234DA2A2EB	FOUNDATIONS OF DATA ANALYTICS	SEMESTER II

Total Credits: 3

Total Instruction Hours: 48 h

Syllabus

Unit I Understanding Data and Data Analytics 10 h

Introduction - Types of Data: Numeric-Categorical Graphical-High dimensional data - sources : Time series- Transactional data- Biological data- Spatial data -Social Network data - Big Data and Data science - Big Data Architecture - Data Analytics - Examples of Data Use - Methodologies for Data Analytics - Knowledge Discovery in Databases (KDD) Process

Unit II Data Quality and Data Preprocessing 9 h

Data Quality - Missing values - Redundant data - Inconsistent Data - Noisy Data - Outliers - Converting Nominal to Relative - Converting Ordinal to Relative - Data Transformation -Dimensionality Reduction - Attribute Aggregation - Principal Component Analysis- Independent Component Analysis - Multidimensional Scaling- Attribute Selection - Filters - Wrappers - Embedded

Unit III Clustering 9 h

Clustering: Distance Measures - Distance Measures for objects with Quantitative Attributes- Distance Measures for Non-Conventional Attributes - Clustering Validation - Clustering Techniques - K -means - Centroids and Distance Measures - DBSCAN - Agglomerative Hierarchical Clustering Techniques - Dendrograms

Unit IV Frequent Pattern Mining 10 h

Frequent Itemsets - Setting the min_sup Threshold - Apriori a join-based Method - FP Growth- Maximal Frequent itemsets - Closed Frequent itemsets - Association Rules - Support and Confidence - Sequential patterns - Frequent Sequence Mining - Closed and Maximal sequences

Unit V Regression and Classification 10 h

Regression: Predictive Performance Estimation and Measures for Regression - Linear regression - Ridge Regression - Lasso Regression - Classification : Binary classification - Distance Based Learning Algorithms - K Nearest Neighbor Algorithm - Decision Trees - Probabilistic Classification Algorithms - Naïve Bayes Algorithm. Case Study: Using Linear Regression to Predict Performance with Excel

Text Books

1 Moreiraj.M, Andre Carvalho, T.Horvath, 2019, "A General Introduction to Data Analytics", John wiley and Sons, New Jersey.

References

1 Jain, V.K, 2018, "Data Science and Analytics", Khana Book Publishing , New Delhi.

2 Woz, R.J., 2017, "Data Analytics for Beginners" Createspace Independent Platform, California.

3 Ahmad.M, Pathan. A.K, 2019, "Data Analytics Concepts, Techniques and Applications", CRC Press, Florida.

4 Vipin Kumar, Pang-Ning Tan Michael Steinbach, 2006, "Introduction to Data Mining", Addison Wesley, London.

Course Code	Course Name	Category	L	T	P	Credit
232MT2A2DA	WAVELET ANALYSIS	DSE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- influence of Fourier analysis in processing signals
- the concept of Haar wavelet analysis and multi resolution analysis
- the necessity of wavelet algorithm, wavelet transform and its inverse

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	explain the relation between Fourier transform and discrete signals	K2
CO2	describe the concept of Haar wavelet analysis	K2
CO3	explain multi resolution analysis	K2
CO4	analyze the applications of Daubechies wavelets	K4
CO5	analyze the computational complexity and wavelet algorithm	K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓		✓
CO2		✓	✓	✓	✓
CO3	✓	✓		✓	✓
CO4	✓	✓			
CO5	✓	✓			✓

COURSE FOCUSES ON

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A2DA	WAVELET ANALYSIS	SEMESTER II

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I The Fourier transform and discrete Fourier analysis 9 h

Informal development of the Fourier transform - properties of the Fourier transform - discrete Fourier transform - discrete signals

Unit II Haar wavelet analysis 11 h

Haar wavelets: Haar scaling function - basic properties of the Haar scaling function - Haar wavelet -Haar decomposition and reconstruction algorithms: decomposition - reconstruction - filters and diagrams.

Unit III Multiresolution analysis 10 h

The multire solution framework : scaling relation - associated wavelet and wavelet spaces - implementing decomposition and reconstruction - decomposition and reconstruction algorithm - processing a signal - Fourier transform criteria.

Unit IV Daubechies wavelets 9 h

Daubechies' construction - classification , moments and smoothness - computational issues - the scaling function at dyadic points.

Unit V Wavelets in higher dimensions 9 h

Computational complexity - wavelets in higher dimensions - relating decomposition and reconstruction - wavelet transform

Text Books

1 Albert Boggess, Francis .J. Narcowich, 2009, "A first course in Wavelets with Fourier analysis", John Wiley & Sons, Inc, New Jersey.

References

1 Raghuveer Rao and AjitS.Bopardikar, 2000, "Wavelet transforms Introduction, Theory and applications", Pearson Education Asia, HongKong.

2 Goswami J.C and Chan A.K., 2011, "Fundamentals of Wavelets: Theory, Algorithms, and Applications", 2nd Edition, Wiley, New Jersey.

3 Michel Misiti, Yves Misiti, Georges Oppenheim, Jean-Michel Poggi, 2010, "Wavelets and their Applications", John Wiley & Sons, New Jersey.

4 Walker J.S, 2002, "A premier on Wavelets and their scientific applications", CRC Press, Florida.

Course Code	Course Name	Category	L	T	P	Credit
232MT2A2DB	INFORMATION AND CODING THEORY	DSE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the concept of information in the context of communication theory
- the error correcting codes to support error-free transmission
- the various kinds of linear codes and their matrix descriptions

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	define basic ideas of information and coding theory	K1
CO2	describe error-correcting codes using linear algebra and matrix theory concepts	K2
CO3	apply the entropy function to measure information along with theorem of Shannon	K4
CO4	analyze Hadamard matrices and codes	K3
CO5	explain the properties of various forms of linear codes	K2

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓		✓	✓
CO2	✓	✓			✓
CO3			✓	✓	✓
CO4	✓			✓	✓
CO5			✓	✓	✓

COURSE FOCUSES ON

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A2DB	INFORMATION AND CODING THEORY	SEMESTER II

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Source coding and optimal codes 10 h

Source coding: definitions and examples - uniquely decodable codes - Instantaneous Codes - constructing instantaneous codes - Kraft's inequality - McMillan's inequality - comments - Optimality binary Huffman codes - Average word-length - Optimality - r-ary Huffman codes - extensions of sources

Unit II Entropy and information 12 h

Entropy: Information and entropy - properties - entropy and average word-length - Shannon-Fano coding - entropy of extensions and products - Shannon's first theorem and example. Information Channels: The binary symmetric channel - system entropies - extension of Shannon's first theorem

Unit III Information channels 10 h

Mutual information - Mutual information for the binary symmetric channel - channel capacity - Decision rules - example of improved reliability - hamming distance - statement and outline proof of Shannon's theorem - comments

Unit IV Error-correcting codes 8 h

Introductory concepts - examples - minimum distance - Hamming's sphere-packing bound - the Gilbert-Varshamov bound - Hadamard matrices and codes

Unit V Linear codes 8 h

Matrix description of linear codes - equivalence of linear codes - minimum distance of linear codes - the Hamming Codes -the Golay codes - the standard array - syndrome decoding

Text Books

1 Gareth A. Jones and Mary Jones, 2002, "Information and Coding Theory", Springer-Verlag, New York.

References

1 Monica Borda, 2011, "Fundamentals in Information Theory and Coding", Springer-Verlag, New York.

2 Ranjan Bose, 2008, "Information Theory, Coding and Cryptography", second edition, Tata McGraw Hill Education, New Delhi.

3 P.S. Satyanarayana, 2005, "Concepts of Information Theory and Coding", Dynaram Publication, New Delhi.

4 Richard B. Wells, 2004, "Applied Coding and Information Theory for Engineers", Pearson Education Pte. Ltd, New Delhi.

Course Code	Course Name	Category	L	T	P	Credit
232MT2A2DC	**MATHEMATICAL FINANCE**	DSE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the basic terminologies in financial markets
- the influence of Stochastics in designing the pricing models
- the applications of Black-Scholes model

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	understand the basic knowledge in financial markets	K2
CO2	discuss the development of discrete pricing models	K2
CO3	analyze the concept of optimal stopping time	K3
CO4	explain the continuous probability measures in designing the continuous pricing models	K2
CO5	apply the Black-Scholes formula in pricing of options	K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	✓
CO2		✓	✓		✓
CO3	✓	✓		✓	✓
CO4					
CO5	✓		✓		✓

COURSE FOCUSES ON

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A2DC	MATHEMATICAL FINANCE	SEMESTER II

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Options and Arbitrage 9 h

Introduction - stock options -profit and payoff curves - time value - selling short - Forward contracts- futures contracts - Put-Call option parity formula - comparing option prices

Unit II Discrete Time Pricing Models 10 h

Assumptions - basic model - portfolio and trading strategies - preserving gains - Arbitrage trading strategies - martingale measure - characterizing Arbitrage - computing martingale measure - alternatives and replication - uniqueness of martingale measure - general and standard Binomial model

Unit III Optimal Stopping and American Options 11 h

An example - the model - Payoff process - stopping times - existence - snell envelope - smallest dominating super martingale - additional facts - Optimal stopping time and Doob decomposition - smallest and largest optimal stopping time

Unit IV Continuous Probability 8 h

Probability spaces - Probability measures -distribution and density functions - random variables - normal distribution - convergence - central limit theorem

Unit V Black Scholes Option Pricing formula 10 h

Stock prices and Brownian motion - Binomial model in the limit - natural Binomial model - martingale measure Binomial model - Black-Scholes option pricing formula - Volatility smiles - dividend's effect in Black-Scholes formula - Ito's lemma

Text Books

1 Steven Roman, 2012, "Introduction to the Mathematics of Finance - Arbitrage and Option Pricing", Springer, New York.

References

1 Joseph Stampfli and Victor Goodman, 2002, "The Mathematics of Finance: Modeling and Hedging", Thomson Asia Private Limited, Singapore.

2 Chandra, S. Dharmaraja, S. Paraná Mehra and Khemchandani R, 2014, "Financial Mathematics – An introduction", Narosa Publications, New Delhi.

3 Hastings K. J., 2015, "Introduction to Financial Mathematics (Advances in Applied Mathematics)", 1st Edition. Chapman and Hall/CRC, New York.

4 Marek Capińskí and Tomasz Zastawniak, 2011, "Mathematics for Finance: An Introduction to Financial Engineering", 2nd Edition. Springer, New York.

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18.10.23	13.12.23	05.01.24

Academic Council ★ CHAIRMAN ★ Dr.N.G.P. Arts and Science College

Course Code	Course Name	Category	L	T	P	Credit
232MT2A3CA	FUNCTIONAL ANALYSIS	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the basic concepts on Banach space, Hilbert space and its applications
- the types of operators that can be defined on normed spaces
- the convergence property of bounded operators

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	recognize the fundamental properties of the normed space	K2
CO2	discuss the applications of closed graph and open mapping theorems	K3
CO3	demonstrate the influence of duals in bounded linear operator	K3
CO4	analyze the properties of Hilbert spaces	K4
CO5	integrate the bounded operators on Hilbert spaces	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓		✓
CO2		✓	✓	✓	✓
CO3	✓	✓		✓	✓
CO4	✓	✓	✓		
CO5	✓	✓			✓

COURSE FOCUSES ON

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A3CA	FUNCTIONAL ANALYSIS	SEMESTER III

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Fundamentals of normed spaces 12 h

Normed spaces - continuity of linear maps - Hahn Banach theorems.

Unit II Banach Space 14 h

Banach space - uniform boundedness principle - closed graph and open mapping theorem - bounded inverse theorem.

Unit III Spectrum of a bounded operator 10 h

Spectrum of a bounded operator - duals and transposes, duals of L^p ([a, b]) and C([a, b]).

Unit IV Hilbert spaces 13 h

Inner product spaces - orthonormal sets - projection and Riesz representation theorem.

Unit V Bounded operators on Hilbert spaces 11 h

Bounded operators and adjoints - normal, unitary and self-adjoint operators - spectrum and numerical range.

Text Books

1 Balmohan V Limaye, 2013, "Functional Analysis", Second Edition, New Age International Publishers, New Delhi

References

1 Simmons G. F, 2004, "Introduction to Topology and Modern Analysis", Tata McGraw Hill Publishing Company, New Delhi

2 Nair M. T, 2004, "Functional Analysis: A First Course", Prentice-Hall of India, New Delhi

3 Goffman C and Pedrick G, 2002, "First Course in Functional Analysis", Prentice-Hall of India, New Delhi

4 Bachman G and Narici L, 2000,"Functional Analysis", Dover Publications, New York

Course Code	Course Name	Category	L	T	P	Credit
232MT2A3CB	CLASSICAL MECHANICS	CORE	3	2	-	3

PREAMBLE

This course has been designed for students to learn and understand

- the concept of virtual work
- the influence of Hamilton-Jacobi theory in mechanical system
- the applications of generating functions

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	describe the characteristics of the mechanical system	K2
CO2	illustrate the properties of Lagrange's equation	K3
CO3	demonstrate the applications of Hamilton's equations	K3
CO4	analyze the systems through Jacobi's theory	K4
CO5	construct canonical transformations for generating functions	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓			✓	✓
CO2		✓	✓		
CO3	✓	✓	✓	✓	✓
CO4		✓	✓		✓
CO5	✓	✓			✓

COURSE FOCUSES ON

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A3CB	CLASSICAL MECHANICS	SEMESTER III

Total Credits: 3

Total Instruction Hours: 60 h

Syllabus

Unit I Introductory concepts 13 h

The mechanical system - generalized coordinates - constraints - virtual work.

Unit II Lagrange's equations 12 h

Derivation of Lagrange's equations - examples - integrals of the motion.

Unit III Hamilton's equations 11 h

Hamilton's principle - Hamilton's equations - other variational principles.

Unit IV Hamilton-Jacobi theory 12 h

Hamilton's principal function - Hamilton-Jacobi equation - separability.

Unit V Canonical transformations 12 h

Differential forms and generating functions - Lagrange and Poisson brackets - more general transformations - matrix formulations.

Text Books

1 Donald T. Greenwood, 1977, "Classical Dynamics", Dover Publications, New York

References

1 Herbert Goldstein, 2001, "Classical Mechanics", Narosa Publishing House, New Delhi

2 Sankara Rao, 2000, "Classical Mechanics", PHI Learning Private Limited, New Delhi

3 Mondal C.R., 2008, "Classical Mechanics", Prentice Hall of India, New Delhi

4 Tiwari R.N, Thakur B.S., 2008, "Classical Mechanics Analytical Dynamics", Prentice Hall of India, New Delhi

Course Code	Course Name	Category	L	T	P	Credit
232MT2A3CC	STOCHASTIC DIFFERENTIAL EQUATIONS	CORE	4	2	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the concept behind the formation of Stochastic differential equations
- the stability of solutions of Stochastic differential equations
- the solvability of Stochastic functional differential equations

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	discuss the relation between stochastic process and Brownian motion	K2
CO2	identify the different forms of solutions of Stochastic differential equations	K3
CO3	illustrate and explore Stochastic differential equation with real time applicationS	K4
CO4	analyze the stability property of Stochastic differential equations	K4
CO5	apply various forms stability theorems for Stochastic functional differential equations	K3

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	✓
CO2		✓		✓	
CO3	✓	✓	✓		✓
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓		✓

COURSE FOCUSES ON

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A3CC	STOCHASTIC DIFFERENTIAL EQUATIONS	SEMESTER III

Total Credits: 4

Total Instruction Hours: 72 h

Syllabus

Unit I Brownian Motion 16 h

Basic notations of probability – stochastic processes – Brownian motions – stochastic integrals – Ito's formula – moment inequalities – Gronwall-type inequalities.

Unit II Stochastic Differential Equations 14 h

Stochastic differential equations - existence and uniqueness of solutions - Lp estimates - almost surely asymptotic estimates - Caratheodory's approximate solutions – Euler's-Maruyama's approximate solutions.

Unit III Linear Stochastic Differential Equations 12 h

Stochastic Liouville's formula – variation of constants formula - examples.

Unit IV Stability 15 h

Stability in probability – almost sure exponential stability – stochastic stabilization and destabilization.

Unit V Stochastic Functional Differential Equations 15 h

Existence and uniqueness theorems – exponential estimates - approximate solutions – stability theorems.

Text Books

1 Xuerong Mao., 2011, "Stochastic Differential Equations and Applications", Second Edition, Woodhead Publishing, New Delhi.

References

1 Evans L.C, 2012,"An Introduction to Stochastic Differential Equations", American Mathematical Society, New York.

2 Oksendal B, 2003, "Stochastic Differential Equations: An Introduction with Applications", Sixth Edition, Springer-Verlag, New York.

3 Friedman A, 2006,"Stochastic Differential Equations and Applications", Dover Publications, New York.

4 Douglas Henderson and Peter Plaschko, 2006, "Stochastic Differential Equations in Science and Engineering", World Scientific Publishing Co Pvt. Ltd, Singapore.

Course Code	Course Name	Category	L	T	P	Credit
232MT2A3CD	ADVANCED GRAPH THEORY	Core	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the way of representation of graphs and trees
- the connectivity and colouring properties of graphs
- the planar graphs and its importance

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	recognize various types of graphs	K1
CO2	illustrate the applications of Hamilton's cycles	K2
CO3	apply matching concept in timetabling problem	K3
CO4	analyze the Ramsey's number and chromatic number	K4
CO5	demonstrate four and five color conjectures	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓		✓		✓
CO2	✓	✓		✓	
CO3		✓		✓	✓
CO4		✓	✓		✓
CO5	✓		✓	✓	

COURSE FOCUSES ON

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A3CD	ADVANCED GRAPH THEORY	SEMESTER III

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Graph, Subgraphs and Trees 10 h

Graphs and simple Graphs – Graph isomorphism –incidence and adjacency matrices – Sub graphs – vertex degrees – paths and connection – cycles- shortest path problem

Trees – Cut edges and bonds – cut vertices – Cayley's formula- connector problem

Unit II Connectivity, Euler tours and Hamilton Cycles 12 h

Connectivity – blocks - construction of reliable communication networks.

Euler tours - Hamilton Cycle - Postman problem

Unit III Matching 12 h

Matchings - matchings and coverings in bipartite graphs – perfect matchings.

Edge chromatic number – Vizing's theorem- timetabling problem

Unit IV Independent sets, Cliques and Vertex Colourings 12 h

Independent sets – Ramsey's theorem - Turan's theorem - Schur's theorem

Chromatic Number – Brooks' Theorem – Hajos Conjecture – chromatic polynomials – Girth and chromatic number

Unit V Planar Graphs 14 h

Plane and planar Graphs – dual graphs – Eulers' formula – bridges – Kuratowski's theorem – five-colour theorem and four-colour conjecture – Non-Hamiltonian planar Graphs.

Text Books

1 Bondy, J.A and Murty, U.S.R. 1976, "Graph Theory with Applications", Elsevier Publishing Company Inc., New York.

References

1 Narsingh Deo, 1999, "Graph Theory with Applications to Engineering and Computer Science", Prentice Hall of India, New Delhi.

2 Robin J. Wilson, 2010, "Introduction to Graph Theory", 5th Edition, Pearson Education Limited, Essex.

3 Reinhard Diestel, 2017, "Graph Theory", 5th Edition, Springer, Berlin.

4 Harary, 2001, "Graph Theory", Narosa Publishing House Pvt. Ltd, New Delhi

Course Code	Course Name	Category	L	T	P	Credit
232MT2A3CE	FLUID DYNAMICS	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the concepts of the fluid motion
- the flow of viscous and inviscid incompressible fluids
- the Navier-Stokes equations of motion

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	explain about kinematics of fluids	K2
CO2	analyze the equation of motion, relation between stress and strain, flow of viscous compressible fluids	K4
CO3	analyze sources, sinks and doublets	K4
CO4	explore the Milne-Thomson circle theorem and its applications	K5
CO5	assess the components of stress and strain	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓		✓		✓
CO2	✓				
CO3	✓	✓		✓	✓
CO4	✓	✓	✓	✓	✓
CO5	✓	✓	✓	✓	✓

COURSE FOCUSES ON

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A3CE	FLUID DYNAMICS	SEMESTER III

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Kinematics of Fluids in Motion 14 h

Real fluids and ideal fluids - velocity of a fluid at a point - streamlines and pathlines; steady and unsteady flows - velocity potential- vorticity vector - local and particle rates of change - equation of continuity - worked examples - acceleration of a fluid – conditions at a rigid boundary - general analysis of fluid motion.

Unit II Equations of Motion of a Fluid 12 h

Pressure at a point in a fluid at rest - pressure at a point in a moving fluid - conditions at a boundary of two inviscid immiscible fluids - Euler's equations of motion - Bernoulli's equation - worked examples - discussion of the case of steady motion under conservative body forces - some potential theorems - some flows involving axial symmetry.

Unit III Three-Dimensional Flows 10 h

Sources, sinks and doublets - images in a rigid infinite plane and solid spheres - axi-symmetric flows; Stokes's stream function: some special forms of the stream function for axi-symmetric irrotational motions.

Unit IV Two-Dimensional Flows 10 h

Meaning of two-dimensional flow - use of cylindrical polar coordinates - the stream function - the complex potential for two-dimensional, irrotational, incompressible flow - complex velocity potentials for standard two-dimensional flows - some worked examples - two-dimensional image systems - Milne-Thomson circle theorem - theorem of Blasius.

Unit V Viscous Flow 14 h

Stress components in a real fluid- relations between cartesian components of stress - translational motion - rate of strain quadric and principal stresses - properties of the rate of strain quadric - stress analysis in fluid motion - relations between stress and rate of strain - coefficient of viscosity and laminar flow- Navier-Stokes equations of motion of a viscous fluid - some solvable problems in viscous flow - steady viscous flow in tubes of uniform cross-section.

Text Books

1 Chorlton F, 2004, "Textbook of Fluid Dynamics", First Edition, CBS Publishers and Distributors, New Delhi

References

1 Milne Thomson, L.M., 1968, "Theoretical Hydro Dynamics", Fifth Edition, McMillan Company, Noida

2 Curle N, Davies H. J, 1968, "Modern Fluid Dynamics, Volume I", D Van Nostrand Company Limited, London

3 Landau L.D, Lifshitz E.M, 1982, "Fluid Mechanics (Course of Theoretical Physics)", First Edition, Pergamon Press, Oxford

4 Pozrikidis C, 2017, "Fluid Dynamics: Theory, Computation and Numerical Simulation", Third Edition, Springer, New York

Course Code	Course Name	Category	L	T	P	Credit
232MT2A3DA	FINITE ELEMENT THEORY	DSE	4		-	4

PREAMBLE

This course has been designed for students to learn and understand

- the finite element method for stationary second order elliptic problems
- how to generate the governing FE equations for systems governed by partial differential equations
- the abstract theory on finite elements and its applications

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	understand the fundamental theory of the finite element method	K2
CO2	formulate the design and heat transfer problems with application of FEM	K2
CO3	analyze linear 1D problems and 2D structural problems	K3
CO4	solve 1D, 2D and dynamic problems using finite element method	K4
CO5	develop the computer code for solving weak problems and approximate by finite elements	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓		
CO2	✓	✓	✓		
CO3	✓	✓	✓	✓	
CO4			✓	✓	
CO5	✓			✓	✓

COURSE FOCUSES ON

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A3DA	FINITE ELEMENT THEORY	SEMESTER III

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Piecewise Polynomial Approximation in 1D 9 h

Piecewise polynomial spaces - interpolation - L^2-projection - quadrature - computer implementation.

Unit II The Finite Element Method in 1D 10 h

Finite element method for a model problem - Mathematical modeling - model problem with variable coefficients - computer implementation - adaptive finite element methods.

Unit III Piecewise Polynomial Approximation in 2D 9 h

Meshes - piecewise polynomial spaces - interpolation- L^2-projection - quadrature and numerical integration - computer implementation.

Unit IV The Finite Element Method in 2D 10 h

Green's formula - finite element method for Poisson's equation - some useful inequalities - basic analysis of the finite element method - a model problem with variable coefficients.

Unit V Time-Dependent Problems 10 h

Finite difference methods for systems of ODE - heat equation - stability estimates - priori error estimates - space-time finite element approximation - wave equation.

Text Books

1 Larson M.G, Bengzon F, 2013, "The Finite Element Method: Theory, Implementation and Applications", Springer Heidelberg, New York

References

1 Seshu P, 2012,"Textbook of Finite Element Analysis", Prentice Hall of India Learning Private Limited, New Delhi.

2 Reddy J.N, 2006, "An Introduction to the Finite Element Method", Third Edition, Mc-Graw Hill, New York.

3 Johnson C, 1987, "Numerical solution of partial differential equations by the Finite Element Method", Cambridge University Press, Cambridge.

4 Mazumder S, 2016, "Numerical Methods for Partial Differential Equations: Finite Difference and Finite Volume Methods", Academic Press, London.

Course Code	Course Name	Category	L	T	P	Credit
232MT2A3DB	ALGEBRAIC NUMBER THEORY	DSE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the basic forms of Gaussian integers and to solve it.
- analytical techniques used to solve the p-adic numbers.
- the various laws of local reciprocity and formal groups.

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	explore the concepts of Minkowski Theory and Gaussian integers.	K2
CO2	determine the class number and analyze the Dirichlet's unit theorem	K4
CO3	analyze the characteristics of local fields and Henselian fields.	K4
CO4	analyze the core concept of abstract Galois theory and abstract valuation theory.	K4
CO5	evaluate the norm residue symbol over Qp	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓			
CO2	✓	✓	✓		
CO3	✓	✓	✓	✓	
CO4			✓	✓	
CO5	✓		✓	✓	✓

COURSE FOCUSES ON

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A3DB	ALGEBRAIC NUMBER THEORY	SEMESTER III

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Algebraic Integers 10 h

The Gaussian integers – integrality – ideals – lattices - Minkowski theory.

Unit II Advanced Algebraic Integers 10 h

The Class number- Dirichlet's unit theorem- extensions of dedekind domains - Hilbert's ramification theory - Cyclotomic fields.

Unit III The Theory of Valuations 9 h

The p-adic numbers - p-adic absolute value- valuations – completions - local fields - Henselian fields.

Unit IV Abstract Class Field Theory 9 h

Infinite Galois theory - projective and inductive limits - abstract Galois theory- abstract valuation theory.

Unit V Local Class Field Theory 10 h

The Local reciprocity law- norm residue symbol over Qp - Hilbert symbol - formal groups.

Text Books

1 Jurgen Neukirch, 1992, "Algebraic Number Theory", Springer, Newyork.

References

1 Ivan Nivan and Herberts Zucherman, 2011, "An Introduction to Theory of Numbers", 5th Edition, Wiley Eastern Limited, New Delhi.

2 David M Burton, 2012, "Elementary Number Theory", Seventh Edition, McGraw Hill Education (India) Private Limited, New Delhi.

3 Kenneth H Rosen, 1983, "Elementary Number Theory and its Applications", Addison-Wesley Publishing Company, London.

4 George E Andrews, 1994, "Number Theory", Dover Publications, New York.

Course Code	Course Name	Category	L	T	P	Credit
232MT2A3DC	ACTUARIAL MATHEMATICS	DSE	4		-	4

PREAMBLE

This course has been designed for students to learn and understand

- the concept of life insurance and annuities
- the method of construction of mortality table
- the concept of reserves and premiums

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	identify the present value of cash flows	K1
CO2	interpret the survivorship data in the form of mortality table	K2
CO3	estimate the survival benefit and death benefit based on the type of insurance	K3
CO4	analyze the requirement of the insured and calculate the premium	K4
CO5	analyze the reserves available with the estimation of premiums	K4

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	✓
CO2		✓		✓	
CO3	✓		✓		✓
CO4	✓	✓		✓	✓
CO5	✓	✓	✓		✓

COURSE FOCUSES ON

✓	Skill Development	✓	Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A3DC	ACTUARIAL MATHEMATICS	SEMESTER III

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Financial Mathematics 10 h

Compound interest - principle of consistency - discount factor- yield -present values - cash flows - accumulated values- annuities.

Unit II Mortality 9 h

Survival time - survival function - hazard function - actuarial values of mortality - force of mortality - future lifetime - laws of mortality - mortality table.

Unit III Life Insurance 10 h

Stochastic cash flows- survival benefit - death benefit - pure endowments - life insurance -whole life and term insurance - deferred insurance - endowments.

Unit IV Life Annuities and Premiums 10 h

Net premiums - gross premiums - life annuities - types - present values of annuities - premium-types - net premiums - annual premium.

Unit V Reserves 9 h

Reserves - net premium reserves - retrospective reserve - prospective reserve - policy value - negative reserves.

Text Books

1 Gupta A. K and Varga T, 2002, "An introduction to Actuarial Mathematics", Springer Science, New York

References

1 David Promislow S, 2015, "Fundamentals of Actuarial Mathematics ", John Wiley & sons, New Delhi

2 Dickson D.C.M, Herby M.R and Waters. H.R, 2010, "Actuarial Mathematics for Life Contingent Risks", Cambridge University Press, New York

3 Jozef Teugels and Bjorn Sundt, 2006, "Encyclopedia of Actuarial Science", John Wiley & Sons, London

4 Hossack I.B, Polard J.H and Zehnwirth, 1999, "Introductory Statistics with Applications in General Insurance", Cambridge University Press, Cambridge

232MT2ASSA	**SELF-STUDY: RESEARCH METHODOLOGY, IPR AND ENTREPRENEURSHIP**	**SEMESTER III**

Total Credits: 1

Syllabus

Unit I Hypotheses, Theories and Laws

Hypotheses – Theories – Laws. Scientific Statements: Their Justification and Acceptance: Verification – Falsification – Acceptance – Peer Review.

Unit II Experimentation and Design of Research

Validity and Reliability in Experimentation – Design of Experiments. Scientific and their Design of Research: The Scientific Method – Research Design.

Unit III Research Ethics and Responsibilities

Basic, Applied and Evaluation Research – Multidisciplinary and Interdisciplinary Research – The Value of having Research Skills – Formulating a Research Problem – Research in Relation to Teaching and Publishing. Research Ethics – Guidelines for Ethical practices in Research.

Unit IV Intellectual Property Rights

Introduction to intellectual property - Fundamentals of patent - Copyright - Trademarks.

Unit V The practice of Entrepreneurship

Entrepreneurial Management - The Entrepreneurial Business - Entrepreneurship in the Service Institution.

Text Books

1 Pruzan P., 2016, Research Methodology The Aims, Practices and Ethics of Science, Springer, Switzerland. (Unit-I, II & III)

2 Neeraj Pandey, Khusdeep Dharni, 2014, Intellectual Property Rights, PHI learning Pvt. Ltd. New Delhi. (Unit-IV)

3 Drucker P.F., 1986, Innovation and Entrepreneurship - Practice and Principles, Harper Publishers, New York. (Unit-V)

References

1 Thomas C.G., 2015, Research Methodology and Scientific Writing, Ane Books Pvt. Ltd., New Delhi.

2 Locharoenrat, K., 2017, Research Methodologies for Beginners, Pan Stanford Publishing, Singapore.

3 Deborah E. Bouchoux, 2000, Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets, Fourth edition, Cengage learning New York.

4 Birgitte Andersen, 2006, Intellectual Property Rights: Innovation, Governance and the Institutional Environment, Edward Elgar Publishing, UK.

232MT2ASSB	SELF STUDY : MATHEMATICS OF BIOINFORMATICS	SEMESTER III

Total Credits: 1

Syllabus

Unit I Genetic Codes, Matrices and Symmetrical Techniques

Introduction – Matrix theory and Symmetry - Genetic Codes and Matrices - Genetic Matrices, Hydrogen Bonds and the Golden Section - Symmetrical patterns, Molecular Genetics and Bioinformatics.

Unit II Biological Sequences and Sequence Alignment

Mathematical Sequence - Sequence Alignment and Sequence analysis.

Unit III Structures of DNA and Knot Theory

Knot theory preliminaries – DNA knot and links.

Unit IV Protein Structures, Geometry, and Topology

Introduction – Computational Geometry and Topology Preliminaries – Protein Structures and Prediction.

Unit V Biological Networks and Graph Theory

Introduction - Graph Theory Preliminaries and Network Topology.

Text Books

1 Matthew He and Sergey Petoukhov, 2011, Mathematics of Bioinformatics:- Theory, Practice and Applications, John Wiley, New Jersey.

References

1 Krane D.E., Raymer M.L., 2003, Fundamental Concepts of Bioinformatics, Benjamin Cummings.

2 Shanmughavel P., 2005, Principle of Bioinformatics, Pointer Publishers.

3 Shanmughavel P., 2006, Trends in Bioinformatics, Pointer Publishers.

4 Gulshan Wadhwa P., Shanmughavel, Atul Kumar Singh, Jayesh R. Bellare, 2018, Current trends in Bioinformatics: An Insight, Springer, New York.

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Course Code	Course Name	Category	L	T	P	Credit
232MT2A4CA	MATHEMATICAL METHODS	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the fundamentals of integral equations and their classification
- the variational problems and its applications
- the Mathematical methods collectively as asymptotic and perturbative analysis

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	define integral equations (linear and non-linear) and identify key components	K1
CO2	solve Fredholm and Volterra integral equations using approximations	K2
CO3	solve variational problems with multiple independent variables	K3
CO4	analyze the method of steepest descents and asymptotic evaluation	K4
CO5	analyze the mathematical structure of complex perturbative Eigenvalue problems	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓		✓	✓	✓
CO2		✓		✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓	✓	
CO5	✓	✓	✓		✓

COURSE FOCUSES ON

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A4CA	**MATHEMATICAL METHODS**	**SEMESTER IV**

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Integral Equations 12 h

Definition - Linear and Non-linear integral equations - Fredholm integral equation - Volterra integral equation - singular integral equation - special kinds of kernels - Eigen values and Eigen functions - Fredholm alternative - an approximate method

Unit II Method of Successive Approximations 12 h

Iterated kernels - resolvent kernel - solution of Fredholm and Volterra integral equation of the second kind by successive approximations. Classical Fredholm theory: Fredholm's first, second and third fundamental theorems.

Unit III Calculus of Variations 13 h

Variation and its properties - Euler's equation - functionals of the integral forms - functionals dependent on higher order derivatives - functionals dependent on the functions of several independent variables - variational problems in parametric form

Unit IV Asymptotic Expansion of Integrals 13 h

Introduction - elementary examples - integration by parts - Laplace's method and Watson's lemma - method of stationary phase - method of steepest descents -asymptotic evaluation of sums.

Unit V Perturbation Methods 10 h

Perturbation theory - regular and singular perturbation theory - perturbation methods for linear eigenvalue problems - asymptotic matching - mathematical structure of perturbative eigenvalue problems.

Text Books

1 Raisinghania M.D, 2021, "Integral Equations and Boundary value problems", S.Chand and Company Limited, New Delhi. (Unit I and II).

2 Elsgolts, 1977, "Differential Equations and Calculus of Variations", Moscow: Mir Publishers, Moscow (Unit III).

3 Bender C.M and Orszag S, 2010, "Advanced Mathematical Methods for Scientists and Engineers", Springer, New York (Unit IV and V).

References

1 Debnath L and Bhatta P.D, 2012, "Textbook of Finite Element Analysis", Prentice Hall of India Learning Private Limited, New Delhi

2 Weinstock R,1952, "Calculus of Variations, with Applications to Physics and Engineering", McGraw-Hill, New York

3 Hinch E. J, 1991, "Perturbation Methods", Cambridge University Press, New York

4 Holmes M.H, 2013, "Introduction to Perturbation Methods", Springer, New York

Course Code	Course Name	Category	L	T	P	Credit
232MT2A4CB	DISTRIBUTION THEORY	CORE	4	1	-	4

PREAMBLE

This course has been designed for students to learn and understand

- The test function and distributions
- the Sobolev space and approximations by smooth function
- the unbounded operators and C_0 semigroup

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	recognize the importance of support in characterizing the behavior of distributions	K1
CO2	extend convolution techniques to distributions, demonstrating proficiency in convolution operations	K2
CO3	utilizing Sobolev Space in problem-Solving	K3
CO4	analyze the influence of imbedding and compactness in Sobolev space	K4
CO5	apply the unbounded linear operators in C_0 semigroup	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓			✓
CO2	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓
CO4	✓		✓	✓	
CO5			✓		✓

COURSE FOCUSES ON

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A4CB	DISTRIBUTION THEORY	SEMESTER IV

Total Credits: 4

Total Instruction Hours: 60 h

Syllabus

Unit I Distributions 13 h

Introduction - test functions and distributions-locally finite partition of unity-Dirac distribution- some operations with distributions- Leibniz formula-supports and singular supports of distributions.

Unit II Distributions and Convolution 12 h

Convolution of functions-convolution of distributions-fundamental solutions - the Fourier transform.

Unit III Distributions and Sobolev Spaces 11 h

The Schwartz space - Riemann Lebesque lemma- Tempered distributions. Sobolev space: definition and basic properties - approximation by smooth functions -Friedrichs theorem - Chain rule-Stampacchia theorem.

Unit IV Sobolev Spaces 12 h

Extension theorems - Poincare's inequality- imbedding theorems - Gagliardo lemma- Sobolev's inequality- compactness theorems - Rellich-Kondrasov theorem - Poincare-Wirtinger inequality.

Unit V Semigroup 12 h

Operators - bounded, adjoint, symmetric and monotone operators - The Exponential Map - C_0-Semigroups - infinitesimal generators - properties.

Text Books

1 S. Kesavan, 2003, "Topics in Functional Analysis and Applications", New Age International (P) Limited, New Delhi.

References

1 Michael Renardy and Robert C. Rogers, 2008, " An Introduction to Partial Differential Equations " Second Edition, Springer Verlag, New York.

2 L. Hormander, 2003, "The Analysis of Linear Partial Differential Operators I – Distribution Theory and Fourier Analysis", Second Edition, Springer Verlag, Berlin.

3 F.G. Friedlander and M. Joshi, 1998,"Introduction to the Theory of Distributions", Cambridge University Press, Cambridge.

4 R.P. Kanwal, 1983, "Generalized Functions - Theory and Technique", Academic Press, New York.

Course Code	Course Name	Category	L	T	P	Credit
232MT2A4DA	BOUNDARY LAYER THEORY	DSE	4			4

PREAMBLE

This course has been designed for students to learn and understand

- the characteristics and intricacies of fully developed turbulent flow
- the application of the energy equation to describe the equations of motion in flowing fluids
- the exact solutions of the Navier-Stokes equations for a variety of flows

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	identify the phenomenon of separation in boundary layersi	K1
CO2	examine the Stokes hypothesis, bulk viscosity, thermodynamic pressure, and energy equations	K2
CO3	Investigate the similarity laws for flow with buoyancy forces and natural convection	K3
CO4	compute the exact solutions of the Navier-Stokes equations for various steady plane flows	K4
CO5	analyze flow at a oscillating wall, Couette flow, , unsteady axisymmetric flows and vortex decay in-depth	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓			✓	
CO2		✓	✓	✓	✓
CO3	✓	✓		✓	✓
CO4	✓	✓	✓	✓	✓
CO5	✓	✓			✓

COURSE FOCUSES ON

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A4DA	BOUNDARY LAYER THEORY	SEMESTER IV

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Fundamentals of Boundary Layer Theory 9 h

Concept - laminar and turbulent boundary layer on a flat plate at zero incidence - fully developed turbulent flow in a pipe - boundary layer on an airfoil - separation - overview.

Unit II Field Equations for Flows of Newtonian Fluids 9 h

Description - Continuity equation-momentum equation - general stress state of deformable bodies - general state of deformation of flowing fluids - relation between stresses and rate of deformation - Stokes hypothesis - bulk viscosity and thermodynamic pressure - Navier-Stokes equations - energy equation – equations of motion.

Unit III General Properties of Equation of Motion 10 h

Similarity laws - Similarity laws for flow with buoyancy forces - similarity laws for natural convection - vorticity transport equation - limit of very small and large Reynolds number - mathematical example of the limit $Re \to \infty$ - non uniqueness of solutions of the Navier-Stokes equations.

Unit IV Exact Solution of the Navier Stokes Equations 10 h

Steady plane flows- steady axisymmetric flows: circular pipe flow - flow between two concentric rotating cylinder - axisymmetric stagnation point flows - flow at a rotating disk - axisymmetric free jet.

Unit V Unsteady Plane and Unsteady Axisymmetric Flows 10 h

Unsteady plane flows: flow at a wall suddenly set into motion and at an oscillating wall - start-up Couette flow - unsteady asymptotic suction - unsteady plane stagnation point flow - oscillating channel flow. Unsteady axisymmetric flows: vortex decay - unsteady pipe flow.

Text Books

1 Schlichting H and Gersten K, 2015, " Boundary Layer Theory", 8th Revised Edition, Springer, New Delhi.

References

1 Schlichting H, 2014, "Boundary Layer Theory", McGraw Hill Book Company, Seventh Edition, Noida.

2 Guy Metivier, 2012, "Small Viscosity and Boundary Layer Methods: Theory, Stability Analysis, and Applications", Springer Science - Business Media LLC, New York.

3 Raisinghania M.D, 2014, "Fluid Dynamics: With Complete Hydrodynamics and Boundary Layer Theory", S. Chand, New Delhi.

4 Oleinik O. A., Sunckhin V. N, 1999, "Mathematical Models in Boundary Layer Theory", Taylor & Francis Inc, New York.

Course Code	Course Name	Category	L	T	P	Credit
232MT2A4DB	LIE ALGEBRA	DSE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the foundational concepts of Lie group and their topological properties
- the classification of Lie Algebras and their applications
- universal covers, subgroups, sub algebras, and Lie's third theorem

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	recognize topological properties and homomorphisms in Lie groups.	K1
CO2	estimate the Exponential and Matrix Logarithm	K2
CO3	explore complexification of real Lie algebras	K3
CO4	apply advanced representation theory in complex scenarios	K4
CO5	analyze Lie's third theorem and its implications	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	✓
CO2	✓	✓	✓		✓
CO3	✓	✓	✓	✓	✓
CO4	✓	✓	✓		
CO5	✓	✓	-	✓	✓

COURSE FOCUSES ON

✓	Skill Development		Entrepreneurial Development
✓	Employability	✓	Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A4DB	LIE ALGEBRA	SEMESTER IV

Total Credits: 4
Total Instruction Hours: 48 h

Syllabus

Unit I Matrix Lie Groups 9 h

Definitions - examples -general and special linear groups- unitary and orthogonal groups-generalized orthogonal and Lorentz groups-symplectic groups-the Euclidean and Poincaré groups-the Heisenberg group-the compact symplectic group-topological properties - homomorphisms - Lie groups.

Unit II The Matrix Exponential 10 h

The exponential of a matrix-computing the exponential-the matrix Logarithm-further properties of the exponential- the polar decomposition.

Unit III Lie Algebra Homomorphism 10 h

Definitions & examples - simple, solvable and nilpotent Lie Algebras - examples - Lie group and Lie Algebra homomorphisms- complexification of a real Lie Algebra - the exponential map.

Unit IV Basic Representation Theory 9 h

Representations - examples - new representations from old: direct sums -tensor products-dual representations-complete reducibility-Schur's lemma - representations of sl(2;C)-group versus Lie algebra representations.

Unit V The Baker–Campbell–Hausdorff formula and Its Consequences 10 h

The Baker–Campbell–Hausdorff formula- derivative of the exponential map- proof of the BCH formula-the series form -group versus Lie Algebra homomorphisms-universal covers-subgroups and sub algebras-Lie's third theorem.

Text Books

1 Brian Hall, 2015, "Lie Groups, Lie Algebras and Representations - An Elementary Introduction", Springer, New York.

References

1 James E. Humphreys,1972, Introduction to Lie Algebras and Representation Theory, Springer, New York.

2 Karin Erdmann, Mark J Wildon, 2006, Introduction to Lie Algebras, Springer, New York.

3 Alexander Kirillov, Jr, Kirillov , 2008, An Introduction to Lie Groups and Lie Algebras, Cambridge University Press, Cambridge.

4 Robert Gilmore,2012, Lie Groups, Lie Algebras, and Some of Their Applications, Dover Publications, New York.

Course Code	Course Name	Category	L	T	P	Credit
232MT2A4DC	MATHEMATICAL ECOLOGY	DSE	4	-	-	4

PREAMBLE

This course has been designed for students to learn and understand

- the statistical and mathematical foundations behind these methods, enabling accurate assessment of population sizes and distribution
- how ecological interactions between species affect population sizes, structures, and the overall stability of ecosystem
- the multifaceted realm of biodiversity, including the various metrics and indices used to measure it

COURSE OUTCOMES

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

CO Number	CO Statement	Knowledge Level
CO1	describe the various grown models under single species populations	K1
CO2	identify different types of ecological relationships and their consequences for populations	K2
CO3	explore the mathematical foundations and statistical aspects of abundance estimation methods.	K3
CO4	demonstrate expertise in assessing biodiversity, including the ability to design and implement advanced sampling techniques	K4
CO5	develop and implement comprehensive ecosystem-based harvesting strategies	K5

MAPPING WITH PROGRAMME OUTCOMES

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	✓	✓	✓	✓	✓
CO2	✓			✓	✓
CO3	✓	✓		✓	✓
CO4	✓	✓	✓		
CO5	✓	✓		✓	✓

COURSE FOCUSES ON

✓	Skill Development		Entrepreneurial Development
✓	Employability		Innovations
	Intellectual Property Rights		Gender Sensitization
	Social Awareness/ Environment		Constitutional Rights/ Human Values/ Ethics

232MT2A4DC	MATHEMATICAL ECOLOGY	SEMESTER IV

Total Credits: 4

Total Instruction Hours: 48 h

Syllabus

Unit I Single Species Populations 10 h

Linear growth - exponential growth - sigmoidal growth - populations with age structure: discrete and continuous time - summarizing survivorship data: exponential distribution - Weibull distribution - bath tub models.

Unit II Populations of two Interacting Species 9 h

Introduction - Competition: Lotka-Volterra equations - some variants - symbiosis - Predation and parasitism: Lotka-Volterra model - model diagnostics using community matrix - model with carrying capacity - functional and model incorporating functional responses - Nicholson-Bailey model.

Unit III Estimation of Abundance 10 h

Nearest neighbor distance methods - line transect sampling and related methods -capture - recapture methods - fish stock assessment: estimating pattern of growth - modal progression and Bhattacharya method-estimation of natural and fishing mortalities - virtual population analysis - indirect methods of estimation.

Unit IV Biodiversity 10 h

Species abundance, negative binomial, logarithmic series and log normal distributions - diversity - effort needed to measure biodiversity - measurement of species richness - situation specific diversity measures - conservation priority.

Unit V Harvesting Biological Populations 9 h

Introduction - surplus yield approach-maximum sustainable yield - bionomic equilibrium - tragedy of commons - optimal harvesting policy for a sole owner- Beverton -Holt model - Thomson and Bell's method - optimal harvesting in primitive societies - harvesting under matrix model.

Text Books

1 Anil Gore, Sharayu Paranjpe, 2001, “A course in Mathematical and Statistical Ecology”, First edition, Springer, New Delhi.

References

1 Mark Kot ,2017,"Elements of Mathematical Ecology", Cambridge University Press, Cambridge.

2 Lawrence Perko, 2008, "Differential Equations and Dynamical Systems", Springer, New Delhi.

3 Nisbet and Gurney, 2014,"Modelling Fluctuating Populations", Third edition, John Wiley & Sons, FL, London.

4 John Pastor, 2019, Mathematical Ecology of Populations and Ecosystems, Wiley – Blackwell Publishers, New York.

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BoS - 18th 07.11.2024	AC - 18th 26.11.2024	GB -

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