திருவள்ளுவர் பல்கலைக்கழகம்

Thiruvalluvar University

Master of science

Degree course

M.Sc Mathematics

Under CBCS

Regulations & Syllabus

For University Department

With effect from 2014-2015

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M.Sc Mathematics Under CBCS

Regulations CBSC pattern

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Definitions:

Programme: “programme “means a course of study leading to the award of a degree in a discipline.

Course: “course” refers to a paper/ practical/ subject offierd under the degree programme. Each course is to be designed various under lectures/ tutorials/laboratory or field work/ seminar /practical/ Assignments Term paper or Report writing etc., to meet effective teaching and learning needs.

i. **Core course:**
“The Core course related to the programme concerned including practicals offered in the programme”

ii. **Elective Course:**
“Elective Course”related to the core course of the programme concerned offered in the programme.

A detailed explained of the above with relevant credit are given under “Scheme of Examination along with Distribution of Marks and Credits.

Duration: this means the stipulated year of study to complete a programme as prescribed by the University from tome to time. Currently for the Postgraduate programme the duration of the study is Two Year. These regulations shall apply to the regular course of study in approved institutions of the University.

Cerdits: the weightage given to each course of study (Subject) by the exparts of the Board of Studies concerned. The trem ‘Credit’ refers to the weightage given to a course, usually in relation to the instructional hours assigned to it. For instance, a six hours course per week is assigned 6/5/4 credits, a five course per week is assigned 5/4/3 credits and a four hour course per week is given 4/3/2 credits. However, in no instance of a course can be greater than the hours allotted to it. The total minimum credits, required for completing a PG program is 90.

Credit system: The course of study under this regulation, where weightage of credits are spread over to different semesters during the period of study and the cumulative Grade Point. Average shall be awarded based on the credits earned by

the students. A total of 90 credits are prescribed for the Postgraduate offered in two year.

Choice Based: All Postgraduate Programme offered by nthe University shall be under Choice Based Credit System.

Choice Based Credit system: (CBSC) this is enhance the quality and mobility of the student within and between the Universities in the country and abroad.

1. **Eligibility for admission to the course:**

A candidate who have passed the B.Sc Degree Examination in Mathematics of this University or an Examination oa any University with ,ore then one major with mathematics accepted by the Syndicate as equivalent there to shall be permitted to appear and quality for the Master of Science (M.SC) Degree Examintion of this University after a Course of two academic years in this University Department / Colleges affiliated to this University.

No student shall be eligible for admission to a Master's degree programme in any of the faculties unless he/she has successfully completed a three year undergraduate degree or earned prescribed number of credits for an undergraduate degree through the examination conducted by a University/ Autonomous institution or possesses such qualification recognized by the Thiruvalluvar University as equivalent to an undergraduate degree. Provided that candicate for admission into the specific main subject of study shall also possess such other qualifying conditions as may be prescribed by the University in the Regulations governing respective courses of study.

2. Duration of the course:

The course shall extend over a period two years comprising of four semesters with two semesters in one academic year. There shall not be less then 90 working days for each semester. Examination shall be conducted at the each of every semester for the respective subjects.

Each semester have 90 working days consists of 5 teaching hous per working day. Thus each semester has 450 teaching hours and the whole programme has 1800 teaching hours.

The old semesters shall consist of the period from July to November and the even semester from December to April.

3. Course of Study:

The course of study for Master Degree in Mathematics shall consist of core, Elective subject and a compulsory subject (Human Right) and a project in the fourth semester.

4. Distribution of credit point and Marks:

The minimum Credit requirement for a two year Master's programme shall be 90 (ninty) Credits. The break-up of credits for the programme is as follows:

(a) Core Course	: 63 Credits
(b) Elective Course	: 20 Credits
(c) Compulsory Course	: 2 Credits
(d) Project with Voce-Vice	: 5 credits

5. Continuous Internal Assessment Test:

The following assessment procedure will be followed for awaiting the internal marks in the evaluation of the students performance. The best 2 CIA tear marks out of 3 CIA tests marks, will be taken for awarding the internal marks.

(a) CIA Test Marks	: 15 marks
(b) Seminar	: 5 marks
(c) Assignment	: 5 marks
Total	25 Marks

6. requirement to appear for the examinations:

a) A candidate shall to appear for the university examination for any semester (theory as well as practical) if

i. He/She secures not less than 75% of attendance in theory as well as inpracticals (separate attendance registers shall maintance for theory and practicals) in the number of working days during the semester.

ii. In the case of married women candidates the minimum attendance requirement shall be not less than 55% of the total instructional days in theory as well as in practicals.

iii. His/her conduct shall be satisfactory.

a) Provided that it shall be open to the Syndicate, or any authority delegated with such powers by the Syndicate, to grant exemption to a candidate who has failed to earn 75% of attendance in theory as well s in practicals , prescribed, for valid reasons, subject to usual conditions.

b) A candidate who has secured less than 75% but 65% and above attendance in any semester separately for theory and practicals shall be permitted to take the recommendations of the Head of the Department to condone the lack of attendance on the payment of prescribed fees to the University, separately for theory and practicals.

c) A candidate who has secured less than 65% but 55% and above attendance in any semester in theory as well as in practicals, has ot compensate the shortage in attendance in the subsequent semester (in the next year) besides

earning the required percentage of attendance in that semester and appear for the both semester paper together at the end practicals. However, shortage of attendance in II semester shall be compensated while studying in III semester, shaortage of attendance in III & IV semesters shall compensated after rejoining the course in the 3rd Year. Also separate attendance registers shall be maintained in theory as well as practicals, for compensating the shortage of attendance. During the hours of compensation of attendance the candidate shall not be given attendance for the regulars semester classes.

d) A candidate who has secured less then 55% of attendance in any semester for theory and practiclas, shall not be permitted to appear for the regular examination in that particulars semester or in subsequent semester. He /She has to rejoin/ re do the semester in which the attendance is less than 55% on the prescribed fees to the University, separately for theory and practicals, after getting prior approval of the University.

e) A candidate who has secured less than 65% of attendance in the final semester separately for theory and practicals, has to compensate his her attendance shortage in a manner as decided by the concerned to rejoin in the 4th semester, after completing his/her regular 2 year course.

7. Guidelines for the project with Vive-voce:

(i) The topic of the project shall be assigned to the candidate at the end of the third semester and a copy of the same should be communicated to the University for approval.

(ii). The student should prepare three copies of the project and submit the same for the evaluation by examiners. After evaluation one copy is to be retained in the University Library, one in the Department Library and the one with the student.

(iii). Format for the preparation of the project work.

(a) Tittle page.
(b) Bonafide certificate
(c) Acknowledgement
(d) Table of contents.

Chapter No	Title	Page No
1.	Introduction	
2.	Review of Literature	
3.	Results	
4.	Summary	
5.	Referense	

8. Scheme of Examination:

a. Any theory examination is conducted only for 3 hours irrespective of total marks allotted for the examination.

b. There shall be theory examination at the end of each semester, for odd semesters in the month of October / November for even semester in April/May. However, there shall be practical examination at the end of even semesters in general. With exceptions in a few courses as prescribed by the Boards of Studies Concerned.

c. All candidate admitted in first year should get registered for the first semester examination, compulsorily. If registration is not possible owing to any reason including shortage of attendance beyond condonation limit, belated joining or on medical grounds, the candidates are permitted to rejoin the course in the next year.

d. In case of project work there will be a viva voce examination. Each candidate shall be required to mappear for Viva-voce Examination.

9. Retrication to appear for the Examination:

Any candidate having arrear paper(s) shall have the option to appear in any paper along with the regular semester papers, in theory as well as in practicals, as long as the transitory provision is applicable.

10. Medium of instruction and Examination:

The medium of instruction for the course is English only.

11. Question paper pattern:

The Question paper pattern for the University theory examination is as follows:

Time: Three Hours Maximum Marks: 75

Part – A(10 x 2 = 20 marks)

Answer ALL Questions

(Two Question from each unit with internal Choice [either or type]

Part –C (3x 10 = 30 marks)

Answer any three Question out of five Questions

(One Question from each unit)

12. Guidelines for evaluation of the project with Viva Voce:

(i). Thr project should be evaluation for 75 marks by an external examiner and 75 marks by the internal examiner and the viva voce should be conducted for 50 marks by the external examiner and the internal guide concerned.

(ii). The project report may consist of 30 to 50pages.

(iii). The candidate has to submit the project report 15 days before the commencement of the IV Semester examination.

(iv). A Candidate who fails in the project may be resubmit the report (on the same topic) with necessary modification / correction/ improvement in the subsequent semester evaluation.

13. Passing Minimum:

a) A candidate shall be decleared to have passed the whole examination, if the candidate passes in all the theory papers and practicals wherever prescribed as per the scheme of examination by earning 90 credits in core and Elective courses, including practicals.

b) A candidate should get not less than 50% in the University (External) Examination compulsorily, in all papers, including practicals. Also the candidate who secures not less than 50% marks in the external as well as internal (CIA) examinations put together in any paper / practical shall be declared to have successfully passed the examination in the subject in theory as well as practicals. There shall be no passing minimum for the CIA. The candidate who absent himself for CIA programmes, even after a repeated chance, will be awarded zero mark in the concerned subject (Zero to 25 for the theory and zero to 40 practicals).

14Distribution of marks:

Table -1(A) : the following are the distribution of marks for external and internal for University (external) examination and continuous internal assessment and passing minimum marks for theory papers of PG programmes.

Uni. Exam Total (ESE)	Passing Minimum for Uni Exam	CIA total	Passing Minimum for CIA	Total marks Allotted	Passing Minimum (Uni.Exam+CIA)
75	38	25	0	100	50

15. Grading

Once the marks of the CIA and end –semester examination for each of the course are available they shall be added. The mark thus be converted to the relevant letter grade, grade point as per the details given below:

Conversion of Marks to Grade Points and Letter Grade (Performance in a Course/paper)

RANGE of MARKS	GRADE POINTS	LETTER GRADE	DESCRIPTION
90-100	9.0-10.0	O	Outstanding
80-89	8.0-8.9	D+	Distinction
75-79	7.5-7.9	D	
70-74	7.0-7.9	A+	First Class
60-69	6.0-6.9	A	
50-59	5.0-5.9	B	Second Class
00-49	0.0	U	Re-appear
Absent	0.0	AAA	ABSENT

Ci= Credits earned for courser i in any semester

Gi= Grade Point obtained for course i in any semester

N= refers to the semester in which such course were credited

Grade point average (for a Semester):

Calculation of grade point average semester-wise and part-wise is as follows:

- **GRADE POINT AVERAGE [GPA] = ΣiCiGi / ΣiCi**

Sum of the multiplication of grade points by the credits of the courses offered under each part

GPA = ----------

Sum of the credits of the courses under each part in a semester

Calculation of Grade Point Average (CGPA) (for the entire programme):

A candidate who has passed all the examinations prescribed is eligible for the following partwise computed final grades based on the range of CGPA.

CUMULATIVE GRADE POINT AVERAGE [CGPA] = ΣnΣiCniGni / ΣnΣiCni

Sum of the multiplication of grade points by the credits of the entire programme under each part

CGPA = ----------

Sum of the credits of the courses of the entire programme under each part

CGPA	GRADE
9.0 and above but below 10.0	O
8.0 and above but below 9.0	D+
7.5 and above but below 8.0	D
6.5 and above but below 7.5	A+
6.0 and above but below 6.5	A
5.0 and above but below 6.0	B
0.0 and above but below 5.0	U

16. **Improvement of Marks in the subjects already passed:**

Candidates desirous of improving the marks awarded in a passed subject in their first attempt shall reappear once within a period of subsequent two semesters by paying the fee prescribed from time to time. The improved marks shall be considered for classification but not for ranking. When there is no improvement, there shall not be any change in the original marks already awarded. If candidate improves his marks, then his improved marks will be taken into consideration for the award of Classification only. Such improved marks will not be counted for the award of Prizes / Medals, Rank and Distinction. If the Candidate does not show improvement in the marks, his previous marks will be taken into consideration.

No candidate will be allowed to improve marks in the Practicals, Project, Viva-voce and Field work.

17. **Classification of Successful candidates:**

A candidate who passes all the examinations including practicals securing following CGPA and Grades shall be declared as follows **for Part I or Part II**:

CGPA	GRADE	CLASSIFICATION OF FINAL RESULT
9.0 and above but below 10.0	O	First Class - Outstanding
8.0 and above but below 9.0	D+	First Class with Distinction
7.5 and above but below 8.0	D	

6.5 and above but below 7.5	A+	First Class
6.0 and above but below 6.5	A	
5.0 and above but below 6.0	B	Second Class

a. A candidate who has passed all the examination including practicalsin the first appearance within the prescribed duration of the PG programme and secured a CGPA of 9 to 10 and equivalent grade "O" in Core and Elective subjects shall be placed in the category of "**First Class – Outstanding**".

b. A candidate who has passed all the examination including practicalsin the first appearance within the prescribed duration of the PG programmes and secured a CGPA of 7.5 to 9 and equivalent grades "D" or "D+" in Core and Elective shall be placed in the category of "**First Class with Distinction**".

c. A candidate who has passed all the examination including practicalsof the PG programme and secured a CGPA of 6 to 7.5 and equivalent grades "A" or "A+" shall be declared to have passed that parts in "**First Class**".

d. A candidate who has passed all the examination including practicalsof the PG programmes and secured a CGPA of 5.5 to 6 and equivalent grade "B" shall be declared to have passed those parts in "**Second Class**".

18. Conferment of the Degree:

No candidate shall be eligible for conferment of the Degree unless the candidate;

i. has undergone the prescribed course of study for a period of not less than four semesters in Thiruvalluvarthe University or has been exempted from in the manner prescribed and has passed the examinations as have been prescribed therefor.

ii. has completed all the components prescribed under core and elective subjects in the CBCS pattern to earn 90 credits.

19. Ranking

- A candidate who qualifies for the PG degree course passing all the examinations in the first attempt, within the minimum period prescribed for the course of study from the date of admission to the course and secures I or II class shall be eligible for ranking. In the case of candidates who pass all the examinations prescribed for the course with a break in the first appearance due to the reasons as furnished in the Regulations 6(a) (iii) Supra are eligible for classification / Distinction.

The marks obtained in improvement examinations shall not be taken into consideration for ranking.

20. Revision of Regulations and Curriculum

The above Regulation and Scheme of Examinations will be in vogue without any change for a minimum period of three years from the date of approval of the Regulations. The University may revise /amend/ change the Regulations and Scheme of Examinations, if found necessary.

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THIRUVALLUVAR UNIVERSITY

MASTER OF SCIENCE IN DEGREE COURSE

M.Sc., MATHEMATICS under CBCS

(with effect from 2014 - 2015)

The course of Study and the Scheme of Examinations:

Sl. No	Study Component	Course Title	Ins. Hrs. / Week	Credits	Title of the Paper	Maximum Marks		
						CIA	UNI. EXAM	TOTAL
SEMESRTER - I								
1	CORE	PAPER – 1	6	5	Algebra – I	25	75	100
2	CORE	PAPER – 2	6	5	Real Analysis – I	25	75	100
3	CORE	PAPER – 3	6	4	Ordinary Differential Equations	25	75	100
4	CORE	PAPER – 4	6	4	Number of Theory	25	75	100
5	ELECTIVE	PAPER – 1	6	4	Elective – I A)	25	75	100
Total			**30**	**22**	**Total**	**125**	**375**	**500**
SEMESRTER – II								
1	CORE	PAPER-5	6	5	Algebra – II	25	75	100
2	CORE	PAPER-6	6	4	Real Analysis – II	25	75	100
3	CORE	PAPER-7	5	4	Partial Differential Equations	25	75	100
4	CORE	PAPER-8	6	4	Machanics	25	75	100
5	ELECTIVE	PAPER-2	5	4	Elective	25	75	100
6	Compulsory Paper		2	2	Human Rights	25	75	100

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THIRUVALLUVAR UNIVERSITY
MASTER OF SCIENCE IN DEGREE COURSE
M.Sc., MATHEMATICS under CBCS
(with effect from 2014 - 2015)

The course of Study and the Scheme of Examinations:

Sl. No	Study Component	Course Title	Ins. Hrs. / Week	Credits	Title of the Paper	Maximum Marks		
						CIA	UNI. EXAM	TOTAL
SEMESTER – III								
1	CORE	PAPER-9	6	5	Topology	25	75	100
2	CORE	PAPER-10	6	5	Complex Analysis	25	75	100
3	CORE	PAPER-11	6	5	Mathematical Statics	25	75	100
4	CORE	PAPER-12	6	4	Measure Theory	25	75	100
5	ELECTIVE	PAPER-3	6	4	Elective	25	75	100
Total			**30**	**23**	**Total**	**125**	**375**	**500**
SEMESTER – IV								
1	CORE	PAPER - 13	6	5	Functional Analysis	25	75	100
2	CORE	PAPER - 14	6	4	Numerical Analysis	25	75	100
3	ELECTIVE	PAPER - 15	6	4	ELECTIVE	25	75	100
4	ELECTIVE	PAPER - 16	6	4	ELECTIVE	25	75	100
5	PROJECT		6	5		50	150	100
Total			**30**	**22**	**Total**	**150**	**450**	**600**

List of Elective Courses

Sl.No	Title	
1		Discrete Mathematics
2		Differential Geometry
3		Stability Theory
4		Stochastic Differential Equations
5		Cryptography and Data Security
6		Applied Algebra
7		Algebraic Graph Theory
8		Fuzzy Mathematics
9		Difference Equations
10		Operations Research
11		Applied Statistical Methods
12		Mathematical Modelling
13		Financial Mathematics
14		Tensor Analysis and Relativity Theory
15		Bio-mathematics
16		Special functions
17		Combinatorics
18		MatLab & LaTeX

Distribution of Core, Elective and Compulsory Subjects

Subject	Papers	Credits	Total Credits	Marks	Total Marks
Core	14	4-5	71	100	1600
Elective	5	4	17	100	400
Compulsory	1	2	2	100	100
Project	1	5	5	200	200
Total	21	-	90	-	2200

SEMESTER – I CORE PAPER 1

ALGEBRA – I

Unit I: Introduction to Groups

Dihedral groups – Homomorphisms and Isomorphisms - Group actions – Subgroups - Definition and Examples – Centralizers and Normalizer, Stabilizers and Kernels - Cyclic groups and Cyclic subgroups of a group – Subgroups generated by subsets of a group.

Chapter 1: 1.2, 1.6 & 1.7 and **Chapter 2:** 2.1 - 2.4. **(18 Hours)**

Unit II: Quotient Groups and Homomorphisms

Definitions and Examples – More on cosets and Lagrange's Theorem – The isomorphism theorems - Composition series and the Holder program – Transpositions and the Alternating group.

Chapter 3: **(18 Hours)**

Unit III: Group Actions

Group actions and permutation representations – Groups acting on themselves by left multiplication - Cayley's theorem – Groups acting on themselves by conjugation – The class equation – Automorphisms – The Sylow theorems – The simplicity of A_n – Direct and semi-direct products and abelian groups - Direct Products – The fundamental theorem of finitely generated abelian groups.

Chapter 4 & Chapter 5: 5.1 - 5.2 **(18 Hours)**

Unit IV: Introduction to Rings

Basic definitions and examples – Examples - Polynomial rings - Matrix rings and group rings - Ring Homomorphisms and quotient rings – Properties of Ideals - Rings of fractions – The Chinese remainder theorem.

Chapter 7: **(18 Hours)**

Unit V: Euclidean domains, principal ideal domains and unique factorization domains

Principal ideal domains – Unique factorization domains – Polynomial rings - Definitions and basic properties – Polynomial rings over fields - Polynomial rings that are unique factorization domains – Irreducibility criteria – Polynomial ring over fields.

Chapter 8 & Chapter 9: **(18 Hours)**

Text Book:

David S. Dummit and Richard M. Foote, Abstract Algebra (Second Edition), Wiley, 2003.

References:

1. Serge Lang, Algebra, Springer, 2002.
2. I.N. Herstein. Topics in Algebra (II Edition) Wiley Eastern Limited, New Delhi, 1975.
3. M. Artin, Algebra, Prentice Hall of India, 1991.
4. N. Jacobson, Basic Algebra, Vol. I & II, published by Hindustan Publishing Company, New Delhi, 1980.
5. I.S. Luther and I.B.S. Passi, Algebra, Vol. I - Groups (1996); Vol. II *Rings,* Narosa Publishing House , New Delhi, 1999
   Joseph A. Gallian, Contemporary Abstract Algebra, Brooks/Cole Pub Co.,2012

SEMESTER I CORE PAPER – 2

REAL ANALYSIS – I

Unit 1: The algebraic order properties of R- Absolute value and the real line- the completeness property of R- Applications of the supremum of R- intervals.

(18 Hours)

Chapter 2 of R.G Bartle and D.R. Sherbert, Introducation to Real Analysis, 4th Edition, John-Wiley & Sons, Inc, 2011

Unit II: Basic topology, Metric Spaces-Finite and infinite Sets- Countable sets-Cantor's theorem*Mertic spaces-open ans closed sets of metric spaces-Compact sets-Perfect sets-connected sets. **(18 Hours)**

Chapter 2 of Wakter Rudin, Principals Mathematical Analysis (Third Edition), Mc Graw Hill, Inc, 1964.

Unit III: Continuity: Limits of function Limit Theorems- Continuous functions- Continuity and compactness - Continuity and connectedness –Discontinuities – Monotonic functions-infinite limits ad limits at infinity.

Chapter 4 of Walter Rudin, Principal of Mathematics Analysis (Third Edition), Mc Grew Hills, Inc, 1964.

Unit IV: Differentiation: The Derivative of a real function – Mean value Theoreme – The Cotinuity of derivatives – L' Hospital's rule – Derivative of Higher Order- Taylor's theorem-Differentiation of Vector valued functions.

Chapter 5 of Walter Rudin, Principal of Mathematical Analysis (Third Edition), Mc Grew Hills, Inc, 1964.

Unit V: The Riemann – Stielitjes integral: Definition and existence of the integral – Properties of Integral- Integration and Differentiation – Integration of vector functions-Rectifiable Curves.

Chapter 6 of Walter Rudin, Principal of Mathematical Analysis (Third Edition), Mc Grew Hills, Inc, 1964.

References :

1. Tom M. Apostal, "**Mathematical Analysis**", Addison - Wesley Publishing Company, 1974.
2. Anthony W. Knapp, "**Basic Real Analysis"**, Birkhauser, 2005.
3. Wilder, R. L., "**The Foundations of Mathematics"**, second Edition, John Wiley & Sons, New York, 1965.
4. Kenneth A. Ross, "**Elementary Analysis: Theory of Calculus"**, Second edition Springer, 2013.

Semester I – Core Paper 3

Ordinary Differential Equations

Unit I: Linear Differential Equations of Higher Order

Introduction - Higher Order Equations - A Modeling Problem - Linear Independence - Equations with Constant Coefficients - Equations with Variable Coefficients – Wronskian -Variation of Parameters - Some Standard Methods - Method of Laplace Transforms.

Chapter -2. **(18 Hours)**

Unit II: Systems of Linear Differential Equations

Introduction - Systems of First Order Equations - Model for arms Competition between two Nations - Existence and Uniqueness Theorem - Fundamental Matrix - Non-homogeneous Linear Systems - Linear Systems with Constant Coefficients - Linear Systems with Periodic Coefficients.

Chapter 4: **(18 Hours)**

Unit III: Existence and Uniqueness of Solutions

Introduction – Preliminaries - Successive Approximations - Picard's Theorem - Some Examples - Continuation and Dependence on Initial Conditions – Fixed point methods.

Chapter 5: 5.1 - 5.6 **(18 Hours)**

Unit IV: Boundary Value Problems

Introduction - Strum-Liouville Problem - Green's Function - Application of Boundary Value Problems (BVP) - Picard's Theorem.

Chapter 7: 7.1 – 7.5 **(18 Hours)**

Unit V: Stability of Linear and Nonlinear Systems

Introduction - Elementary Critical Points - System of Equations with Constant Coefficients - Linear Equation with Constant Coefficients - Lyapunov Stability.

Chapter 9: 9.1 - 9.5 **(18 Hours)**

Text Book S.G. Deo, V. Lakshmikantham and V. Raghavendra, "Ordinary Differential Equations", Second Edition, Tata Mc Graw-Hill publishing company Ltd, New Delhi, 2004.

References :

1. Earl. A. Coddington, "An Introduction to Ordinary Differential Equations", Prentice Hall of India, New Delhi.
2. G.F. Simmons, S.G. Krantz, "Differential Equations: Theory, Technique and Practice" Tata Mc - Graw Hill Book Company, New Delhi, India, 2007.
3. Clive R. Chester "Techniques in partial Differential Equations", Mc Grew-Hills 1970

Semester I – Core Paper 3

Number Theory

Unit I: Divisibility - Primes- The Binomial Theorem – Congruences – solutions of congruence the Chinese Remainder Theorems.

Chapter1 : 1.1-1.4 & Chapter 2: 2.1-2.3 (18 Hours)

Unit II : Prime power Moduli – Prime Modulus – Primitive Roots and Power Residues- Congruences of degree tow prime modulus – Number Theory form Algebraic View Point- Groud, Ring and Fields.

Chapter 2: 2.6-2.11 (18 Hours)

Unit III : Quadratic residues – quadratic reciprocity- the Jacobi symbol- binary quqdratic froms – Equivalence and reduction of Binary quadratic forms- sum of two squares- positive definite Binary Quadratic forms.

Chapter 3 (18 Hours)

Unit IV: Greatest integer Function – Arthmetic Functions – The Mobious inverse function- Recurrence Functions- Combinatorial Number Theory.

Chapter4: (18 Hours)

Unit V: The Equation ax + by =c- Simultaneous Linear Equations – Pythagorean Triangle – Assorted Examples.

Chapter 5: 5.1 – 5.4 **(18 Hours)**

Text book : I. Niven, H.S. Zuckerman and H.L. Montagomery, An Introduction to the Theory of Numbers, 5 Edition, John Wiley & sons, inc, 1991.

Reference :

1. Gareth A. Jones and J. Mary Jones, Elementary Number Theory, Springer Verlag, Indian Reprint, 2005.
2. David M. Burton, Elementary Number Theory, 6th edition, McGraw Hill, 2007
3. Geogre Andrews, Theory of Numbers , Saunders, 1971.
4. J. William , Fundamentals of Number Theory, Leveque, Addision Wesley publishing Company , Phillipines, 1977.

SEMESTER – II - CORE PAPER – 5

ALGEBRA – II

Unit I: Vector Spaces
Definitions and basic theory – The Matrix of a linear transformation – Dual vector spaces – Determinants. **(18 Hours)**

Chapter 11: 11.1 - 11.4

Unit II: Module over Principal Ideal Domain
Basic definitions and examples – The Basic Theory –The Rational Canonical Form – The Jordan Canonical Form. **(18 Hours)**

Chapter 10: 10.1 & Chapter 12 : 12.1 - 12.3

Unit III: Field theory
Basic Theory of field extensions – Algebraic Extensions. **(18 Hours)**

Chapter 13: 13.1 - 13.2

Unit IV: Field Theory (Cont...)
Splitting fields and Algebraic closures – Separable and inseparable extensions - Cyclotomic polynomials and extensions.

Chapter 13: 13.4 - 13.6 **(18 Hours)**

Unit V: Galois Theory
Basic definitions – The fundamental theorem of Galois theory – Finite Fields.
Chapter 14: 14.1 - 14.3 **(18 Hours)**

Text Book : David S. Dummit and Richard M. Foote, Abstract Algebra (Second Edition), Wiley, 2003.

References:

1. Serge Lang, Algebra, Springer, 2002.
2. I.N. Herstein. Topics in Algebra (II Edition) Wiley Eastern Limited, New Delhi, 1975.
3. M.Artin, Algebra, Prentice Hall of India, 1991.
4. N.Jacobson, Basic Algebra, Vol. I & II W.H.Freeman; also published by Hindustan Publishing Company, New Delhi, 1980.
5. I.S.Luther and I.B.S.Passi, Algebra, Vol. I - Groups (1996); Vol. II *Rings,* Narosa Publishing House , New Delhi, 1999.
   Joseph A. Gallian, Contemporary Abstract Algebra, Brooks / Cole Pub Co., 2012.

Semester II – Core Paper 6
Real Analysis II

Unit I: Sequences and series of functions: Discussion of Main Problem- Uniform Convergence- Uniform convergence and continuity – Uniform convergence and Integration. (18 Hours)
Chapter 7: 7.1 -7.4

Unit II : Uniform convergence and differentiation- Equi – continuous families of functions – The stone –Weierstrass theorem. (18 Hours)
Chapter 7 : 7.5-7.7

Unit III : Functions of Several Variables: Linear transformations- Differentiation – The contraction Principal- The Inverse function theorem – The Implicit function Theorem. (18 Hours)
Chapter 9 : 9.1 – 9.5

Unit IV: Determinants - Derivatives of higher order- Differentiation of Integrals – Integration of Differential forms: Integration- Primitive Mappings- Partitions of Unity –Change of Variables.
Chapter 9: 9.7-9.9 & Chapter 10: 10.1-10.4 (18 Hours)

Unit V: Differential forms – Simplexes and chains – Stokes' Theorem- Closed forms and exact forms- Vector Analysis. (18 Hours)
Chapter 10: 10.5- 10.9

Text Book: Walter Rudin, Principals of Mathematical Analysis, Mc Grew Hill Inc. 1964.

Reference:

1. Tom M. Apostal, "**Mathematical Analysis**", Addison - Wesley Publishing Company, 1974.
2. Anthony W. Knapp, "**Basic Real Analysis"**, Birkhauser, 2005.
3. Dieudonne, J. Foundations of Modern Analysis, Academic press, Inc, New York 1960.
4. N.L. Carothers, Real Analysis, Cambridge University Press, 2000.

PARTIAL DIFFERENTIAL EQUATIONS

(CORE PAPER – 7)

UNIT - I: Nonlinear Partial differential Equations of the first order **-** Cauchy's method of Characteristics system First order equations- Charpit's method – Specials types First order equations – Jacobi's method.

Chapter 2: 2.7 – 2.11 & 2.13 **(18 Hours)**

UNIT - II: Partial differential Equations of the second order – The origin of second order equations – Linear partial differential equations with constant co efficient – Equations with variable co efficient- Characteristics curves of second- order equations – Characteristics of equations in three variables.

Chapter 3: 3.4-3.7 **(18 Hours)**

UNIT - III: The solution of Linear Hyperbolic Equations of Variables – The method of Intergral Transforms - Nonlinear Equations of the second order.

Chapter 3: 3.8-3.11 **(18 Hours)**

UNIT - IV: Laplace equation – The occurrence of laplace's equation in physics –Elementary solution of Laplace' Equations – Families of Equipotential surface Boundary value problem- Separation of variables – problems with axial symmetry.

Chapter 3: 3.1 to 3.7 and 3.9. (omit 3.8) **(18 Hours)**

Recommended Text: K. Sankar Rao, *Introduction to Partial Differential Equations*, 2nd Edition, Prentice Hall of India, New Delhi. 2005

Reference Books:

1. R.C.McOwen, *Partial Differential Equations*, 2nd Edn. Pearson Eduction, New Delhi, 2005.
2. I.N.Sneddon, *Elements of Partial Differential Equations,* McGraw Hill, New Delhi, 1983.
3. R. Dennemeyer, *Introduction to Partial Differential Equations and Boundary Value Problems,* McGraw Hill, New York, 1968.
4. M.D.Raisinghania, *Advanced Differential Equations,* S.Chand & Company Ltd., New Delhi, 2001.

MECHANICS

CORE PAPER – 4

Unit - I: Mechanical system

The Mechanical system - Generalized coordinates - Holonomic and non-holonomic systems - constraints – Virtual work – D' Alembert's principle – Energy and Momentum.

(18 Hours)

Unit - II: Lagrange's Equations

Derivation of Lagrange's equations – Examples – integrals of motion - cyclic or ignorable coordinates.

(18 Hours)

Unit - III: Hamilton's Equations

Hamilton's principle - Hamilton's equations - other variational principle - Principle of Least action.

(18 Hours)

Unit - IV: Hamilton – Jacobi Theory

Hamilton principle function - Hamilton–Jacobi equation - Separability. **(18 Hours)**

Unit - V: Canonical Transformation

Differential forms and generating functions – Special Transformations – Lagrange and Poisson brackets.

(18 Hours)

Text Book: D. Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985.

References:

1. H. Goldstein, Classical Mechanics (Second Edition), Narosa Publishing House, India, New Delhi.
2. N.C.Rane and P.S.C. Joag, Classical Mechanics, McGraw Hill, 1991.
3. J.L. Synge and B.A. Griffth, Principles of Mechanics (3rd Edition), McGraw Hill Book Co. New York, 1970.

SEMESTER III – CORE PAPER 9

TOPOLOGY

Unit I: Topological Spaces

Topological Spaces - Examples– Basis for a topology – Sub-basis – closed sets –interior – closure - boundary – Limitpoints – Hausdorff spaces – Subspace topology – The product topology on $X \times Y$ - Projections.

(18 Hours)

Unit II: Continuous Functions

Continuous functions–Examples–Homeomorphisms – topological property – pasting lemma – the product topology – Box topology - Comparison of the product topology and the box topology – the metric topology – Sequence Lemma – Uniform Limit theorem. **(18 Hours)**

Unit III: Connected Spaces

Connected Spaces– connected subspace of the real line – Linear continuum –Intermediate Theorem – components and Local connectedness – Totally disconnected spaces. **(18 Hours)**

Unit IV: Compact Spaces

Compact Spaces - Compact subspace of the real line – The Lebesque number lemma – Uniform continuity theorem – Limit point compactness – Local compactness – one point compactification.

(18 Hours)

Unit V: Countability and Separation Axioms

First countable and second countable spaces – separation axioms – regular and completely regular spaces– Normal and completely Normal spaces – Urysohn's lemma – Urysohn's metrization theorem – Tietze Extension theorem. **(18 Hours)**

Text Book: James R. Munkres, "Topology", 2nd Edition, Prentice Hall of India Pvt.Ltd., (Third Indian Reprint).

References :

1. J.Dugundji, Topology, Prentice Hall of India, New Delhi, 1975.
2. George F.Simmons, Introduction to Topology and Modern Analysis, McGraw Hill International Edition, New York, 1963.
3. J.L.Kelly, General Topology, Van Nostrand , Reinhold co., New York.
4. K.D.Joshi, Introduction to General Topology ,Wiley Eastern Ltd., 1983.

5. C.Wayne Patty, Foundations of Topology, (Student Edition), Jones & Bartlett India Pvt.Ltd., New Delhi.
6. Colin Adams, Robert Franzosa, Introduction to Topology Pure and Applied, Pearson Education, Indian Edition, 2009.

SEMESTER III – CORE PAPER 10
COMPLEX ANALYSIS

Unit I: Complex Functions

Spherical representation of complex numbers - Analytic functions - Limits and continuity - Analytic Functions - Polynomials - Rational functions - Elementary Theory of Power series - Sequences - Series - Uniform Convergence - Power series - Abel's limit functions - Exponential and Trigonometric functions - Periodicity - The Logarithm.

Chapter 1: 1.2 & 1.4 and **Chapter 2:** 2.1 – 2.3 **(18 Hours)**

Unit II: Analytical functions as mappings

Conformality - Arcs and closed curves - Analytic functions in Regions - Conformal mapping - Length and area - Linear transformations - Linear group - Cross ratio - symmetry - Oriented Circles - Families of circles - Elementary conformal mappings - Use of level curves - Survey of Elementary mappings - Elementary Riemann surfaces.

Chapter 3: 3.2 – 3.4 **(18 Hours)**

Unit III: Complex Integration

Fundamental Theorems - Line Integrals – Rectifiable Arcs- Line Integrals as Arcs- Cauchy's Theorem for a rectangle and in a disk- Cauchy's Integral Formula – Index of point with respect to a closed curve – The Integral formula – Higher order derivatives – Local properties of analytic functions – Taylor's Theorem – Zeros and Poles – Local mapping – Maximum Principle.

Chapter 4: 4.1 – 4.3 **(18 Hours)**

Unit IV: Complex Integration (Contd...)

The General form of Cauchy's Theorem - Chains and Cycles – Simple connectivity – Homology – General statement of Cauchy's theorem – Proof of Cauchy's theorem – Locally exact differentials - Multiply connected regions – Calculus of residues – Residue Theorem – Argument Principle – Evaluation of definite Integrals.

Chapter 4: 4.4 – 4.5 **(18 Hours)**

Unit V: Harmonic functions and Power Series expansions

Harmonic Functions – Definition and basic properties – Mean-value Property – Poisson's formula – Schwarz's Theorem – Reflection Principle – Weierstrass's theorem – Taylor's series- Laurent series.

Chapter 4: 4.6 and **Chapter 5:** 5.1 **(18 Hours)**

Text Book: "Complex Analysis" by L.V. Ahlfors, Third Edition, McGraw Hill, New York, 1979.

References:

1. J.B. Conway, Functions of One Complex Variable, Narosa Publication House, New Delhi, 1980.
2. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publication House, New Delhi 2004.
3. S. Lang, Complex Analysis, Addison - Wesley Mass, 1977.

SEMESTER III – CORE PAPER 11

MATHEMATICAL STATISTICS

Unit I: Randon events and Randon Variables: Random events – Probability axioms combinational formulae – conditional probability – bayes theorem – Independent events Random variables – Distribution Functions – Joint Distribution - Marginal Distribution – Marginal Distribution – Conditional Distribution- Independent random variables – Functional of Random Variables.

Chapter 1: 1.1-1.7 & Chapter 2: 2.1- 2.9 of M. Fisz, Probability theory and Mathematical statistic, John Willey and sons , NewYork, 1963.

(18 Hours)

Unit II: Characteristic Functions: Propertics of characteristic functions- Characteristic functions and moments- Semi invariants- Characteristic function of the sum of independent random variable – Determination of distribution function by the characteristic function – Characteristic function of multi-dimensional random vectors- probability generating function.

Chapter 4 : 4.1-4.7 of M. Fisz, Probability theory and Mathematical statistic, John Willey and Sons, NewYork. 1963.

Unit III : Some Probability Distribution : Probability of Distribution - Binomial, poisson Multinomial, Geometric, Normal, Exponential, Beta and Gamma Distribution – Bivariate Normal Distribution * Conditional and Marginal Distribution – Correlations and Regressions.

Chapter 4 : & Chapter 5: of M. Fisz, Probability theory and Mathematical statistic, John Willey and Sons, NewYork. 1963.

Unit IV : **Some Probability Distribution (Cont...)** The Distribution of the statistics (X,S) – Student's – Distribution – Fisher's Distribution – x^2 distribution – Concept of statistical test – Parametric tests for small – samples and large samples - x^2 - test.

Chapter 10 : 10.10 -10.11

Unit V : Analysis of Variance : one way classification and two –way classification – Hypotheses Testing : Poser Functions – OC Function – Most Powerful test – Uniformly most powerful test- Unbiased test.

Chapter 15 : 15.1 – 15.2 (Expect 15.3) & Chapter 16: 16.1 – 16.5 (Expect 16.6)

Text Book 2: Kapoor & Gupta (1995, Sulton Chand, Delhi.

SEMESTER III – CORE PAPER 12

MEASURE THEORY

Unit I: Measure on the Real Line: Lebesgue Measure, Measurable set, Regularity- Measurable Functions- Boral and Lebesgue Measurability
(18 Hours)

Chapter 2: 2.1 – 2.5

Unit II: Integration of functions of a Real Line- Integration of Non- Negative functions – Lebesgue integral – Fatou's Lemma- Lebesgue's Monotone Convergence theorem – The General Integral – Lebesgue's Dominated Convergence Theorem – Integration of Series- Reimann and Lebesgue Integrals.
(18 Hours) Chapter 3

Unit III: Abstract Measure Spaces- Measure and Outer Measures – Extension of a Measure- Uniqueness of the extension- Completion of a Measure spaces – Integration with respect to a Measure.

Chapter 5. (18 Hours)

Unit IV : Inequalities and the LP spaces – Convex function – Jensen's inequality- Inequalities of Holder and Minikowski Completeness of LP spaces.

Chapter 6. (18 Hours)

UnitV: Singed Measure and the Hahn Decomposition – The Jordan Decomposition – The Tadon – Nikodym Theorem- Measurability on a product space – The product Measure and Fubini's Theorem.

Chapter 8 : 8.1- 8.3 & Chapter 10: 10.1 – 10.2 (18 Hours)

Text Book: G. De Barra, Measure Theory and Integration , New International (p) Ltd, 1981.

Reference :

1. H.L. Royden, Real Analysis, Third Edition, Prentice Hall of India, New Delhi, 2001.
2. Rudin W. Real and complex analysis, Mc Graw – Hill, 1970.
3. Anthony W. Knapp, Basic Real Analysis, Birkhauser, 2005.
4. Elisa M. Stein & Rami Shakarchi, Real Analysis, Princedon University Press, 2005
5. I.K. Rana, An Introduction to Measure and Integration, Second Edition, American Mathematical Society, 2002.

SEMESTER IV CORE PAPER 13
FUNCTIONAL ANALYSIS

Unit I : Normal Spaces – Examples – Bounded operators - Banach Spaces – Linear Functional and Hahn Banach Theorem Its Consequences.
Chapter 2 & Chapter 3. (18 Hours)

Unit II : Finite dimensional Normal spaces- Uniform Boundedness principal: The Theorem and its consequences – Closed Graph Theorem - Boynded inverse Theoram – Open Mapping theorem.
Chapter 4 & Chapter 5. (18 Hours)

Unit III: Stone- Weiersttrass Theorem – Contraction Mapping Theorem and its applications- weak topologies and duality.
Chapter 6-8. (18 Hours)

Unit V : Adjoint operators – Algebra of Bounded Linear Operators.
Chapters : 11 & 12. (18 Hours)

Text Book: Bela Bollobas, Linear Analysis an Introductory course, Cambridge Mathematical Text Books, Cambridge University Press, 1990.

Reference :

1. G.F. Simmons, Introduction to Topology and Modern Analysis, MC Graw-Hill, 1963
2. B.V Limaye, Functional Analysis, Wiley Eastern Limited, Bombay, Second Print, 1985.
3. M. Thamban Nair, Functional Analysis: A frist course, Prentice Hall of India, 2002.
4. K. Yoside, Functional Analysis, Springer- Verlag, 1974
5. E. Kreysizig, Introductory Functional Analysis with application John Wiley, 1978.

SEMESTER IV CORE PAPER 14

NUMBERICAL ANALYSIS

UNIT I : Solving sets of Equations: The Elimination Method, The Gaussian Elimination and Gauss- Jordan Method, Iterative Methods, The Relaxation Method.

Text Book 1 : Chapter 2 : 2.3-2.4 & 2.10-2.11 (18 Hours)

Unit 2: Interpolation and curve Fitting: Lagrangian Polynomials Divided Differences, Interpolation with Cubic Spline, Least-Square Approximation, Approximation of Functions: Chebyshev Polnomials.

Text Book 1: Chapter 3:3.2-3.4 & 3.7 & Chapter 4: 4.1 (18 Hours)

Unit 3: Numerical Differentiation and Numerical Integration: Derivatives form Difference tables, Extrapolation Techniques, The Trapezoidal Rule –A Composite formula, Simpson's rules.

Text Book 1: Chapter 5: 5.2, 5.4 & 5.6-5.7 (18 Hours)

Unit 4: Numerical solution of Ordinary Differential Equations: The Taylor – Series method, Euler and Modified Euler methods, Runge- Kutta Methods, Milne's Method, The Adams- Moulton method.

Text Book 1: Chapter 6: 6.2- 6.4 & 6.6 – 6.7 (18 Hours)

Unit5: Numerical Solution of Pratical Differential Equations: Introduction, Difference Quotients, Geometrical representation of partial differential quotients, Classification of partial differential equations, Elliptic equations, Solution to Laplace's Equation by Liebmann's Iteration process, Poission's Equations and its solutions, Parabolic equations- Crank- Nicholson method Hyperbolic equations.

Text Book 1: Chapter 12: 12.1-12.7, 12.8.2 & 12.9 (18 Hours)

Text Books:

1. Curtis .F. Gerald, Patrick O. Wheatley, "Applied Numerical Analysis", 5th Edition Pearson Education, New Delhi, 2005.
2. V.N. Vadamurthy, N. Ch.S.N. Lyengar, Numerical Methods", Vikas Publishing House Pvt. Ltd., 2000.

Reference :

1. R.L. Burden, J. Dougles Faires, "Numerical Analysis", Thompson Books, USA, 2005.

2. S.S Sastry, "Introductory Methods of Numerical Analysis ", Prentice- Hall of India Pvt. Ltd., New Delhi, 2005.
3. M.K.Jain , S.R.K. Lyengar, R.K. Jain "Numerical Methods for scientific and Engineering Computation", 3rd Edition., Wiley Eastern Ltd., New Delhi, 1993.

COMPULSORY PAPER

HUMAN RIGHTS

Unit I:

Definition of Human Rights – Nature, Content, Legitimacy and Priority – Theories on Human Rights – Historical Development of Human Rights.

Unit II:

International Human Rights – Prescription and Enforcement upto World War II – Human Rights and the U.N.O. – Universal Declaration of Human Rights – International Covenant on Civil and Political Rights – International Covenant on Economic, Social and Cultural Rights and Optional Protocol.

Unit III:

Human Rights Declarations – U.N. Human Rights Declarations – U.N. Human Commissioner.

Unit IV:

Amnesty International – Human Rights and Helsinki Process – Reginal Developments – European Human Rights System – African Human Rights System – International Human Rights in Domestic Courts.

Unit V:

Contemporary Issues on Human Rights: Children's Rights – Women's – Dalit's Rights – Bonded Labour and Wages – Refugees – Capital Punishment - Fundamental Rights in the Indian Constitution- Directive Principles of State Policy – Fundamental Duties – National Human Rights Commission.

References :

1. International Bill of Human Rights, Amnesty International Publication, 1988.
2. Human Rights, Questions and Answers, UNESCO, 1982.
3. Mausice Cranston– What is Human Rights.
4. Desai, A.R. - Violation of Democratic Rights in India.
5. Pandey - Constitutional Law.
6. Timm. R.W. - Working for Justice and Human Rights.
7. Human Rights, A Selected Bibliography, USIS.

8. J.C.Johari - Human Rights and New World Order.
9. G.S. Bajwa - Human Rights in India.
10. Amnesty International, Human Rights in India.
11. P.C.Sinha&K.Cheous [Ed] - International Encyclopedia of Peace, Security Social Justice and Human Rights [Vols 1-7].
12. Devasia, V.V. - Human Rights and Victimology.

Magazines :

1. The Lawyer, Bombay.
2. Human Rights Today, Columbia University.
3. International Instruments of Human Rights, UN Publication.
4. Human Rights Quarterly, John Hopkins University, U.S.A.

ELECTIVE

DISCRETE MATHEMATICS

Unit I:

The Foundations: Logic, Sets and Functions: Logic – Propositional - Equivalences – Predicates and Quantifiers - Sets – Set Operations – Functions – Sequences and Summations – The Growth of Functions.

Chapter 1: **(18 Hours)**

Unit II:

The Fundamentals: Algorithms, the Integers, and Matrices Algorithms - Complexity of Algorithms - Integers and Algorithms - Applications of Number Theory - Matrices.

Chapter 2: **(18 Hours)**

Unit III:

Mathematical Reasoning: Methods of Proof - Mathematical Induction – Recursive Definitions – Recursive Algorithms -Program Correctness.

Chapter 3 **(18 Hours)**

Unit IV:

Relations: Relations and Their Properties – *n*-array Relations and Their Applications – Representing Relations – Closures of Relations – Equivalence Relations – Partial Orderings.

Chapter 6 **(18 Hours)**

Unit V:

Trees: Introduction of Trees – Applications of Tress – Tree Traversal – Trees and Sorting – Spanning Tress – Minimum Spanning Trees.

Chapter 8 **(18 Hours)**

Text Book:

Kenneth H. Rosen, Discrete Mathematics and Its Applications, McGraw – Hill Publications, 1999.

Reference Books:

1. S. Lipschutz, M. Lipson, "**Discrete Mathematics**", Tata McGraw-Hill Publishing Company, New Delhi, 2006.
2. J. Truss, "**Discrete Mathematics for Computer Scientists**", Pearson Education Limited, England, 1999.
3. J. P. Trembley and R. Manohar, **"Discrete Mathematical Structures with Applications to Computer Sciences**", Tata McGraw Hill, Singapore, 1987.

ELECTIVE

DIFFERENTIAL GEOMETRY

Unit I : Graphs and Level sets - Vector fields - Tangent space.
(18 Hours)

Chapters 1 - 3.

Unit II: Surfaces - Vector fields on surfaces. **(18 Hours)**

Chapter 4 & Chapter 5.

Unit III : Gauss map – geodesics. **(18 Hours)**

Chapter 6 & Chapter 7.

Unit IV : Parallel Transport - Weingarten map. **(18 Hours)**

Chapter 8 & Chapter 9.

Unit V

Curvature of plane curves - arc length and Line integrals - Curvature of surfaces.

Chapter 10 -12. **(18 Hours)**

Text Book:

- J.A.Thorpe, Elementary topics in Differential geometry, Undergraduate texts in Mathematics, Springer-Verlag,1979.

References :

1. Struik, D.T. Lectures on Classical Differential Geometry, Addison - Wesley, Mass. 1950.
2. Kobayashi S. and Nomizu. K. Foundations of Differential Geometry, Interscience Publishers, 1963.
3. Wihelm Klingenberg: A course in Differential Geometry, Graduate Texts in Mathematics, Springer Verlag, 1978.
4. T.J. Willmore, An Introduction to Differential Geometry, Oxford University Press,(17th Impression) New Delhi 2002. (Indian Print).

ELECTIVE

CONTROL THEORY

Unit I: Observability:

Linear Systems – Observability Grammian – Constant coefficient systems – Reconstruction kernel – Nonlinear Systems.

Chapter 2 **(18 Hours)**

Unit II: Controllability:

Linear systems – Controllability Grammian – Adjoint systems – Constant coefficient systems – Steering function – Nonlinear systems.

Chapter 3: Sections 3.1-3.3 **(18 Hours)**

Unit III: Stability:

Stability – Uniform stability – Asymptotic stability of linear systems - Linear time varying systems – Perturbed linear systems – Nonlinear systems.

Chapter 4 **(18 Hours)**

Unit IV: Stabilizability:

Stabilization via linear feedback control – Bass method – Controllable subspace – Stabilization with restricted feedback.

Chapter 5 **(18 Hours)**

Unit V: Optimal Control:

Linear time varying systems with quadratic performance criteria – Matrix Riccati equation – Linear time invariant systems – Nonlinear Systems.

Chapter 6 **(18 Hours)**

Text Book: **K.Balachandran** and **J.P.Dauer**, *Elements of Control Theory*, Narosa, New Delhi, 1999.

Reference:

1. R.Conti, *Linear Differential Equations and Control,* Academic Press, London, 1976.
2. R.F.Curtain and A.J.Pritchard, *Functional Analysis and Modern Applied Mathematics,* Academic Press, New York, 1977.
3. J.Klamka, *Controllability of Dynamical Systems,* Kluwer Academic Publisher, Dordrecht, 1991.
4. J.Klamka, *Controllability of Dynamical Systems,* Kluwer Academic Publisher, Dordrecht, 1991.

ELECTIVE

STOCHASTIC DIFFERENTIAL EQUATIONS

Unit I: Mathematical Preliminaries and Itô Integrals

Probability Spaces – Random variables and Stochastic Processes – An Important Example: Brownian motion – Construction of the Itô Integral – Some Properties of the Itô Integral – Extensions of the Itô Integral.

Chapter 2: 2.1 - 2.2 and **Chapter 3:** 3.1 - 3.3 **(18 Hours)**

Unit II: Itô Formula and Martingale Representation Theorem

The 1 - dimensional Itô Formula - The Multi-dimensional Itô Formula – The Martingale Representation Theorem.

Chapter 4: 4.1 - 4.3 **(18 Hours)**

Unit III: Stochastic Differential Equations

Examples and Some Solution Methods – An Existence and Uniqueness Result – Weak and Strong Solutions.

Chapter 5: 5.1 - 5.3 **(18 Hours)**

Unit IV: The Filtering Problem

Introduction – The 1-Dimensional Linear Filtering Problem – The Multidimensional Linear Filtering Problem.

Chapter 6: 6.1 - 6.3 **(18 Hours)**

Unit V: Diffusions: Basic Properties

The Markov Property – The Strong Markov Property – The Generator of an Itô Diffusion – The Dynkin Formula – The Characteristic Operator.

Chapter 7: 7.1 - 7.5 **(18 Hours)**

Text Book : B. Oksendal, Stochastic Differential Equations: An Introduction with Applications, Sixth Edition, Springer - Verlag, Heidelberg, 2003.

References:

1. Avner Friedman, Stochastic Differential Equations and Application, Dover Publications, 2006.

2. Ludwig Arnold, Stochastic Differential Equations: Theory and Applications, Dover Publications, 2011.
3. Hui-Hsiung Kuo, Introduction to Stochastic Integration, Springer-Verlag, 2006
4. Douglas Henderson and Peter Plaschko, Stochastic Differential Equations in Science and Engineering, World Scientific, 2006.

ELECTIVE

CRYPTOGRAPHY AND DATA SECURITY

Unit I: Time estimates for doing arithmetic – Divisibility and the Euclidean algorithm – Congruences.

Chapter 1: Sections 1,2 and 3 **(18 Hours)**

Unit II:

Some applications to factoring – Quadratic residues and reciprocity.

Chapter 1: Section 4 and C**hapter 2:** Section 2 **(18 Hours)**

Unit III:

Some simple Cryptosystems – Enciphering matrices.

Chapter 3 **(18 Hours)**

Unit IV:

The idea of public key cryptography – RSA – Discrete log – Knapsack – Zero-Knowledge protocols and oblivious transfer.

Chapter 4 (except section 5) **(18 Hours)**

Unit V:

Pseudo primes – The rho method – Fermat factorization and factor bases – The continued fraction method – The quadratic sieve method.

Chapter 5 **(18 Hours)**

Text Book: Neal Koblitz, "A Course in Number Theory and Cryptography"- Second Edition, Springer Publishers.

References:

1. A.Menezes, P. van Oorschot and S. Vanstone, "Handbook of Applied Cryptography", CRC press, 1996.
2. Douglas R. Stinson "Cryptography theory and practice" Second Edition, Chapman and Hall / CRC.
3. Tom. M. Apostol**, "Introduction to Analytic Number Theory**", Springer, New Delhi, 1993.

ELECTIVE

ALGEBRAIC GRAPH THEORY

Unit I: Graphs and Groups

Graphs – Subgraphs – Automorhisms – Homomorphism - Circulant graphs - Johnson graphs - Line graph - Planar graphs. Groups: Permutation groups - Counting, Asymmetric graphs - Orbits on pairs.

Chapter 1 and **Chapter 2:** 2.1 - 2.4 **(18 Hours)**

Unit II: Transitive Graphs

Vertex Transitive Graphs - Edge Transitive Graphs - Edge connectivity - Vertex Connectivity.

Chapter 3: 3.1 - 3.4 **(18 Hours)**

Unit III: Transitive Graphs (Contd...)

Matchings - Hamiltonian path and Cycles - Cayley graphs – Directed Cayley graphs with No Hamiltonian Cycles.

Chapter 3: 3.5 - 3.8 **(18 Hours)**

Unit IV: Homomorphism

The Basics – Products - The Map Graph - Counting Homomorphism - Products and Colourings – Uniquely Colorable Graphs - Foldings and Covers.

Chapter 6: 6.1 & 6.3 - 6.8 **(18 Hours)**

Unit V: Matrix Theory

The Adjacency Matrix - The Incident Matrix – The Incident Matrix Oriented Graph – Symmetric Matrices – Eigen Vectors.

Chapter 8: 8.1 - 8.5 **(18 Hours)**

Text Book: Chris Godsil and Gordon Royle, Algebraic Graph Theory, Springer, 2001.

References:

1. Norman Biggs, Algebraic Graph Theory, Cambridge University Press, 1994.
2. *Lowell W. Beineke, Robin J. Wilson, Peter J. Cameron, Topics in Algebraic Graph theory(Edited Volume), University of London*

ELECTIVE

FUZZY MATHEMATICS

Unit I: Fuzzy Sets

Fuzzy sets – Basic types – basic concepts – Characteristics – Significance of the paradigm shift – Additional properties of α–cuts.

Chapter 1: 1.3 - 1.5 and **Chapter 2:** 2.1 **(18 Hours)**

Unit II: Fuzzy sets versus CRISP sets

Representation of fuzzy sets – Extension principle of fuzzy sets – Operation on fuzzy sets – Types of operation – Fuzzy Complements.

Chapter 2: 2.2 - 2.3 and **Chapter 3:** 3.1 - 3.2 **(18 Hours)**

Unit III: Operations on Fuzzy sets

Fuzzy intersection – t-norms, fuzzy unions – t-conorms – Combinations of operations – Aggregation operations.

Chapter 3: 3.3 - 3.6 **(18 Hours)**

Unit IV: Fuzzy Arithmetic

Fuzzy numbers – Linguistic variables – Arithmetic operation on intervals – Lattice of fuzzy numbers.

Chapter 4: 4.1 - 4.4 **(18 Hours)**

Unit V: Constructing Fuzzy Sets

Methods of construction on overview – direct methods with one expert – direct method with multiple experts – indirect method with multiple experts and one expert – Construction from sample data.

Chapter 10: 10.1 - 10.7 **(18 Hours)**

Text Book:

- G.J Kilr and Bo Yuan, Fuzzy sets and Fuzzy Logic: Theory and Applications, Prentice Hall of India Ltd, New Delhi, 2005.

References:

1. H.J Zimmemann, Fuzzy Set Theory and its Applications, Allied Publishers, Chennai, 1996.
2. A.Kaufman, Introduction to the Theory of fuzzy subsets, Academic press, New York, 1975.
3. V.Novak, Fuzzy Sets and Their Applications, Adam Hilger, Bristol, 1969.

ELECTIVE

DIFFERENCE EQUATIONS

Objectives : To Introduce the process of discretization, Discrete version in Differential Equations, Discrete oscillation and the asymptotoic behaviour of solutions of certain class of Difference Equations for linear cases only. Solution of Difference Equations using z-transforms is stressed.

UNIT I: LINEAR DIFFERENCE EQUATIONS OF HIGHER ORDER

Difference Calculus – General Theory – of Linear Difference Equations – Linear Homogeneous Equations with constant coefficients – Linear non-homogeneous Equations – Method of undetermined coefficients, the method of variation of constants – Limiting behavior of solutions.

Chapter 2: Sec 2.1 – 2.5 **(18 Hours)**

UNIT II: SYSTEM OF DIFFERENCE EQUATIONS

Autonomous system – The basic theory – The Jordan form – Linear periodic system.

Chapter 3: Sec 3.1 – 3.4 **(18 Hours)**

UNIT III: THE Z - TRANSFORM METHOD

Definition, Example and properties of Z-transform – The inverse Z-transform and solution of Difference Equations: Power series method, partial fraction method, the inverse integral method – Volterra Difference Equations of Convolution types – Volterra systems.

Chapter 5: Sec 5.1 – 5.5 (Except 5.4) **(18 Hours)**

UNIT IV: ASYMPTOTIC BEHAVIOR OF DIFFERENCE EQUATIONS

Tools and Approximations – Poincare's Theorem – Second order Difference Equations – Asymptotic diagonal systems – Higher order Difference Equations.

Chapter 8: Sec 8.2 – 8.5 **(18 Hours)**

UNIT V: OSCILLATION THEORY

Three-term Difference Equations – Non-linear Difference Equations – Self-Adjoint second order Equations.

Chapter 7: Sec 7.1 – 7.3 **(18 Hours)**

Text Books: Saber N.Elaydi, An Introduction to Difference Equations, Springer Verlag, New York, 1996.

Reference:

1. R.P. Agarwal., Difference Equations and Inequalities, Marcel Dekker, 1999.
2. S.Goldberg, Introduction to Difference Equations, Dover Publications, 1986.
3. V.Lakshmi Kantham and Trigiante, Theory of Difference Equations, Academic Press, New York, 1988.
4. Peterson, A Difference Equations, An Introduction with Applications, Academic Press, New York, 1991.

ELECTIVE
OPERATIONS RESEARCH

Objectives: This Course aims to introduce decision theory, PERT, CPM, deterministic and Probabilistic inventory systems, queues, replacement and maintenance problem.

UNIT I: Decision Theory : Steps in Decision theory, approach- Types of Decision Making Environments – Decision Making under Uncertainty Decision Making under Risk – Posterior Probabilities and Bayesian Analysis – Decision Tree Analysis – Decision Making with Utilities.

Chapter 11: 11.1 – 11.8. (18 Hours)

UNIT II: PROJECT NETWORK SCHEDULING BY (PERT AND CPM) : Basic differences between PERT and CPM - Steps in PERT / CPM Techniques - PERT / CPM Network components and Precedence Relationships - Critical Path Analysis - Probability in PERT Analysis - Project Time - Cost Trade Off - Updating the Project.

Chapter 13: 13.1 – 13.7. (18 Hours)

UNIT III: DETERMINISTIC INVENTORY CONTROL MODELS : Meaning of Inventory Control - Functional classification - Advantage of Carrying Inventory - Features of Inventory System - Inventory Model building - Deterministic Inventory Models with or without shortage - Probabilistic Inventory models with or without shortage.

Chapter 14: 14.1 – 14.8 (18 Hours)

UNIT IV: QUEUEING THEORY : Essential features of Queueing System - Operating Characteristic of Queueing System - Probabilistic Distribution in Queueing Systems - Classification of Queueing Models - Solution of Queueing Models - Probability Distribution of Arrivals and Departures.

Chapter 16: 16.1 – 14.8 ; Appendix 16.A (PP774- 781) (18 Hours)

UNIT V: REPLACEMENT AND MAINTENANCE MODELS : Failure Mechanism of Item - Replacement models of Items that deteriorate with time – Replacement of item that fail completely – Other Replacement Problem..

Chapter 17: 17.1 – 17.5 (18 Hours)

Text Books : J.K.Sharma, Operations Research Theory and Applications, 3rd Edition (2007), Macmillan India Ltd.

Reference:

1. F.S. Hiller and J. Lieberman, Introduction to Operations Research (8th Edition, Tata McGrew Hill Publishing Company, New Delhi, 2006.
2. Beightlet. C. D. Philips, B. Wilde, Foundations of Optimization (2nd Edition), Prentice Hall Pvt. Ltd., New York, 1979.
3. Bazaraa, M.S; J.J. Jarvis, H.D. Sharall, Linear Programming and Network Flow, John Wiley and Sons, New York, 1998
4. Gross, D and C.M.Harris, Fundamentals of Queueing Theory, (3rd Edition), John Wiley and Sons, New York, 1998.
5. Hamdy A.Taha, Operations Research (6th Edition), Prentice Hall of India Private Limited, New Delhi.

ELECTIVE

BIO-MATHEMATICS

Unit I: Single species Non-age structured population Models: Single. Logistic Models- Logistic Models with Time-Delay effects- Discrete-Time. Discrete-Age-scale population models- Continuous-Time Discrete. Age scale population Models.Chapter: 3.1 - 3.2 & 4.1 - 4.2 **(18 Hours)**

Unit II: Epidemic models: Deterministic models without removal, general deterministic model with removal, general deterministic model with removal and immigration, control of an epidemic.

Chapter: 8.1 - 8.4 **(18 Hours)**

Unit III: Mathematical models in Pharmacokinematics: Basic equations and their solution, solutions for special cases, determination of transfer co efficient and compartment volumes, mathematical techniques used in compartment analysis, stochastic compartment models. **(18 Hours)**

Unit IV: Models for Blood Flow: Some basic concepts for fluid dynamics, basic concepts about blood, cardiovascular system and blood flows, steady non-Newtonian fluid flow in circular tubes, Newtonian pulsatile flows in rigid and elastic tubes, blood flow through artery with mild stonesis Peristaltic flow in tubes and channels, models for air flow in lungs, diffusion and Diffusion – reaction modles, the diffusion equations , oxygen diffusion living tissues. **(18 hours)**

Unit V: Optimization Models in Biology and Medicine – Some simple Optimization Models- Optimization for Blood Testing and patient care- Models for optimal of Water Pollution.

Chapter : 14.1 – 14.3 **(18 Hours)**

Text Book: Mathematical Modelling in Biology Medicine: J.N. Kapoor

References:

(1) Mathematical Modelling: J.N. Kapoor.

(2) Mathematical Biology: J.D. Murty.

(3) Ecology and Resource Management: K.E.F. Watt.

ELECTIVE

MATHEMATICAL MODELLING

Unit I: Mathematical modeling through system of ordinary differential equations of the first order: Mathematical modeling in population dynamics, Mathematical modeling of epidemics through system of ordinary differential equations of first order- Mathematical modeling in dynamics through systems of ordinary differential equations of first order. **(18 Hours)**

Chapter 3: 3.1 - 3.2 & 3.5 - 3.6 of J.N. Kapoor, Mathematical Modelling, Wiley Eastern Limited, Reprint- 2000.

Unit II: Mathematical Models for Blood flows: Some basic concepts of Fluid Dynamics- Basic concepts about blood, cardiovascular system and Blood flows- Steady Non-Newtonian fluid flows in circular tubes- Newtonian pulsatile flows in rigid and elastic tubes- Blood flow through Artery with mild Stenosis. **(18 Hours)**

Chapter 11: 11.1 - 11.5 of J.N. Kapoor, Mathematical Models in Biology and Medicine, Affiliated East – West Press Private limited, Reprint – 2010.

Unit III: Mathematical Models of flows for other Bio-fluids: Peristaltic flows in tubes and channels- Models for gas exchange and airflow in lungs – Two-dimensional flow in renal tube – Lubrication of Human joints. **(18 Hours)**

Chapter 12: 12.1 - 12.4 of J.N. Kapoor, Mathematical Models in Biology and Medicine, Affiliated East – West Press Private limited, Reprint – 2010.

Unit IV: Diffusion and Diffusion – Reaction Models: The Diffusion equation – Diffusion in Artificial Kidney (Hemodialyser) – Oxygen diffusion through living tissues – Absorption and Diffusion of Gamma- Globulin by living tissues.**(18 Hours)**

Chapter 13: 13.1 - 13.4 of J.N. Kapoor, Mathematical Models in Biology and Medicine, Affiliated East – West Press Private limited, Reprint – 2010.

Unit V: Mathematical Modelling through Calculus of Variations and Dynamic Programming: Optimization principles and techniques – Mathematical modeling through calculus of variations – Mathematical Modelling through dynamic programming. **(18 Hours)**

Chapter 9: 9.1 - 9.3 of J.N. Kapoor, Mathematical Modelling, Wiley Eastern Limited, Reprint- 2000.

Reference :

1. D.J.G. James, and J.J. Macdonald, Case studies in Mathematical Modelling, Stainly Thames, Cheltonham
2. J.N. Kapur, Mathematical Entropy Models.
3. M. Crossand A.O. Moscrcadini, The art of Mathematical Modelling, Ellis Harwood and John Eilley.
4. C. Dyson, Elvery, Priniciples of Mathematical Modelling, Academic Press, New York.
5. D.N. Burghes, Modelling with Difference Equations, Ellis Harwood and John Wiley.

ELECTIVE

FINANCIAL MATHEMATICS

Unit I: Generalized Cash Flow model for financial transaction, making allowance for the probability of payment, Time value of money using concepts of compound interest and discounting, Interest rates or discount rates in terms of different time periods. **(18 Hours)**

Unit II: Calculation of the present value and the accumulated value of a stream of equal or unequal payments using specified rates of interest and the net present value at a real rate of interest, assuming a constant rate of inflation.
(18 Hours)

Unit III: Use of compound interest function, Equation of value, Repayment by regular installments of interest and capital, discounted cash flow techniques.
(18 Hours)

Unit IV: The investments and risk characteristics of the following types: Simple compound interest problems. The delivery price and the value of the forward contract using arbitrage free pricing methods.
(18 Hours)

Unit V: Basics of Reliability theory – Life time distributions – Hazard rate survival function – Exponential, Wei-bull-Gamma, Life Time Distributions.
(18 Hours)

Text Book: S.K. Sinha (1979), Reliability and Life – Testing, Wiley Eastern, New Delhi. (for unit-5).

ELECTIVE

TENSOR ANALYSIS AND RELATIVITY THEORY

Objectives: The Course aims to introduce vector algebra and vector calculus and specials relativity and relativistic kinematics, dynamics and accelerated systems.

Unit I: Tensor Algebra : Systems of different orders – Summation convention – Kronecker symbols – Transformation of coordinates in S_n. Invariants – Covariant and Contravariant vectors – Tensors of second order – Mixed tensors – Zero tensors – Tensor field – Algebra of tensors – Equality of tensors – Symmetric and Skew - Symmetric tensors – Outer multiplication, Contraction and Inner multiplication – Quotient Law of tensors – Reciprocal tensor of tensor – Relative tensor – Cross product of vectors.

Chapter 1: 1.1 – 1.3, 1.7 & 1.8 and **Chapter 2 :** 2.1 – 2.9 of U.C. De, Absos Ali Shaikh & Joydeep Sengupta, Tensor Calculus, Narosa Publishing House, New Delhi, 2004. **(18 Hours)**

Unit II: Tensor Calculus: Riemannian space – Christoffel symbols and their properties.

Chapter 3: 3.1 – 3.2 of U.C. De, Absos Ali Shaikh & Joydeep Sengupta, Tensor Calculus, Narosa Publishing House, New Delhi, 2004.

(18 Hours)

Unit III: Tensor Calculus (Contd ...) : Covariant differentiation of tensors – Riemann-Christoffel curvature tensor – Intrinsic differentiation.

Chapter 3: 3.3 – 3.5 of U.C. De, Absos Ali Shaikh & Joydeep Sengupta, Tensor Calculus, Narosa Publishing House, New Delhi, 2004.

(18 Hours)

Unit IV: Special Theory of Relativity : Galilean transformation – Maxwell's equations – The Ether theory – The principle of Relativity.

Relativistic Kinematics: Laurent's transformation equations – Events and simultaneity – Example – Einstein train – Time dilation – Longitudinal contraction – Invariant interval – Proper time and proper distance – World line – Example – Twin paradox – Addition of velocities – Relativistic Doppler effect.

Chapter 7: 7.1 – 7.2 of D. Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985. **(18 Hours)**

Unit V: Relativistic Dynamics : Momentum – Energy – Momentum-Energy four vector – Force – Conservation of energy – Mass and energy – Example – Inelastic collision – Principle of equivalence – Lagrangian and Hamiltonian formulations.

Accelerated Systems: Rocket with constant acceleration – Example – Rocket with constant thrust. **(18 Hours)**

Chapter 7: 7.3 – 7.4 of D. Greenwood, Classical Dynamics, Prentice Hall of India, New Delhi, 1985.

References:

1. J.L.Synge & A.Schild, Tensor Calculus, Toronto, 1949.
2. A.S.Eddington, The Mathematical Theory of Relativity, Cambridge University Press, 1930.
3. P.G.Bergman, An Introduction to Theory of Relativity, New York, 1942.
4. C.E.Weatherburn, Riemannian geometry and The Tensor Calculus, Cambridge, 1938.

Elective
Fluid Dynamic

Objectives: this course aims to kinematics of fluids in motion, equations of motion of fluid, three dimensional flows and viscous flows.

Unit I: Kinematics of fluids in motion: real fluids and ideals fluids- velocity of a point- Stream lines and path lines – steady and unsteady flow – the velocity potential – the vorticity vector – local and particle rates of changes – the equation of continuity – worked examples.

Chapter 2: 2.1-2.8 **(18 Hours)**

Unit II: Equation of motion of fluid : Pressure at a point in fluid at rest – Pressure at a point in a moving fluid – conditions at a boundary of two inviscid immiscible fluid – Euler's equation of motion – Bernoulli's equation – worked examples.
Chapter 3: 3.1-3.6 **(18 Hours)**

Unit III: Some three dimensional flows: introduction – Sources – sinks and doublets – Axis symmetric flow - Stokes stream function.
Chapter 4: 4.1-4.2 & 4.5 **(18 Hours)**

Unit IV: Some two dimensional flows: Meaning of two dimensional flows – use of cylindrical polar co coordinates – the stream function – the potential for two dimensional – irrotational – incompressible flows- complex velocity potential for standard two dimensional flows.
Chapter 5: 5.1-5.6 **(18 Hours)**

Viscous flows: Stress components in real fluids – relation between Cartesian components of stress – translation motion of a fluid element – the rate of stain quadric and principal stresses - some further properties of the rate of stain quadric stress analysis in fluid motion – relation between stress and rate of stain - the coefficient of viscosity and laminar flow - the Navier – Stokes equation of motion of a viscous fluid.
Chapter 8: 8.1-8.7 & 8.9 **(18 Hours)**

Text Book:

F. Cholton, Text of Fluid Dynamics, CBS Publication, New Delhi, 1985.

Reference:

1. G.B. Batchelor, An Introduction of Fluid Mechanics, Foundation Books, New Delhi 1993
2. A.R. Peterson, A first Course in Fluid Dynamics, Cambridge University Press, New York, 1987
3. R.K. Rathy, An Introduction to fluid Dynamics, IBHPublishing Company, New Delhi, 1976.
4. R. Von Mises, O. Friedrichs, Fluid Dunamics, Springer International Student Edition Narosa Publishing House, New Delhi.
5. S.W. Yuan, Foundation of Fluid Mechanics, Prentics, Prentics Hall Private Ltd, New Delhi, 1976.

ELECTIVE

CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS

Unit I : Variational problems with fixed boundaries:

The concept of variation and its properties – Euler's equation – Variational problems for Functions – Functional dependent on higher order derivatives – Functions of several independent variables - Some applications to problems of Mechanics.

Chapter 1: 1.1- 1.7 **(18 Hours)**

Unit II: Variational problems with moving boundaries:

Movable boundary for a functional dependent on two functions – one –sided variations- Reflection and Refraction of extremals - Diffraction of light rays.

Chapter 2: 2.1-2.5 **(18 Hours)**

Unit III: Integral Equation:

Introduction – Tyoes of Kernals- Eign value and Egien functions – connection with differential equations – Solution of an integral equation - Initial value problems – Boundary value problems.

Chapter1: 1.1 – 1.3 & 1.5- 1.8 **(18 Hours)**

Unit IV: Solution of Fredholm Intergral equation:

Second kind with separable kernel – Orthogonality and reality eigen function – Fredholm Integral equation with separable kernel – Solution of Fredholm Integral Equation by successive substitution – successive approximation – Volterra integral equation – Solution by successive substitution.

Chapter 2 : 2.1-2.3 & Chapter 4: 4.1 – 4.5 **(18 Hours)**

Unit V: Hilbert – Schmidt Theory :

Complex Hilbert space – Orthogonal system of function – Gram – Schmitorthognalization process – Hilbert – Schmidt theorems – Solutions of Fredholm of Integral equation of first kind.

Chapter 3: 3.1 – 3.4 & 3.8 – 3.9 **(18 Hours)**

Text Book:

1. A.S. Gupta, Calculus of Variations with Application, Prentice Hall of India, New Delhi, 2005.
2. Sudir k. Pundir and Rimple Pundir, Integral Equations and Boundary Value Problems, Pragati Prakasam, Meerut, 2005.

ELECTIVE

COMBINATORICS

Unit I: Permutations and Combinations-Generating functions. **(18 Hours)**

Chapter 1 & Chapter 2 of C.L. Liu, Introduction to Combinatorial Mathematics, McGraw-Hill Book Company, 1968.

Unit II: Recurrence relations. **(18 Hours)**

Chapter 3 of C.L. Liu, Introduction to Combinatorial Mathematics, McGraw-Hill Book Company, 1968.

Unit III: The principle of inclusion and exclusion. **(18 Hours)**

Chapter 4 of C.L. Liu, Introduction to Combinatorial Mathematics, McGraw-Hill Book Company, 1968.

Unit IV: Polya's theory of counting. **(18 Hours)**

Chapter 5 of C.L. Liu, Introduction to Combinatorial Mathematics, McGraw-Hill Book Company, 1968.

Unit V: Lattices and Boolean algebra. **(18 Hours)**

Chapter 6 of Brikhoff and Bartee, Modern Applied Algebra, McGraw Hill Inc., 1970.

References:

J. H. Van Lint , R. M. Wilson, A Course in Combinatorics, Cambridge University Press, 2001.

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