Board of Studies Meeting

Department of Mathematics

(M.Sc.)

Dr C S Rao PG Centre

Sri Y N College(Autonomous)

(Affiliated to Adikavi Nannaya University)

Thrice Accredited by NAAC at ‘A’ Grade

Recognized by UGC as “College with Potential for Excellence”

Narsapur,AP,India

12th October,2021

AGENDA

- To discuss and ratify the M.Sc.MATHEMATICS Structure for all four semesters.
- To discuss and approve the Syllabi of the third and fourth semesters of M.Sc.MATHEMATICS.
- To discuss and revise first and second semesters syllabi.
- To discuss and finalise the pattern & blue prints of the Internal and External Examinations.
- To discuss and decide the allotment of Internal marks for Assignments & Seminars.
- To discuss about the Teaching Methodology to be adopted.
- To discuss the syllabus and model paper for certificate course on “Analytical Skills”.
- Any other item.

Board of Studies Members

Chairman

1. Sri.G.Rangababu
   HOD, Dept. of Mathematics
   Dr.C.S.RaoP.G.Centre,
   Sri Y.N.College(A)

University Nominee

2. Dr.G.Nanaji Rao
   Professor & Head
   Department of Mathematics,
   Andhra University,Visakhapatnam

Subject Experts

3. Smt.K.Hemalatha
   HOD, Dept. of P.G. Mathematics
   Sir C.R.ReddyP.G.Courses,
   Eluru

4. Smt.K.Sridevi
   HOD of Mathematics,
   K.G.R.L.College of P.G Courses(A),
   Bhimavaram

Special Invitee

5. Dr.Yedlapalli Phani
   Associate Professor
   Department of Basic Science
   Shri Vishnu Engineering College for Women, Vishnupur
   Bhimavaram-2

Alumni

6. Sri.Ch.Bala Raju
   Lecturer in Mathematics(UG)
   Sri Y.N.College(A)

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   Lecturer in Mathematics
   Dr.C.S.RaoP.G.Centre
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8. Smt.R.Padma Sailaja
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   Dr.C.S.RaoP.G.Centre,
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9. Kum.Ch.Kalyani Bhargavi
   Lecturer in Mathematics
   Dr.C.S.RaoP.G.Centre,
   Sri Y.N.College(A)

10. Sri.S.Siva
    Lecturer in Mathematics
    Dr.C.S.RaoP.G.Centre,
    Sri Y.N.College(A)

Dr.C.S.RAO P.G. CENTRE

SRI Y.N .COLLEGE (AUTONOMOUS), NARSAPUR, W.G.Dt.,A.P.

NAAC Accredited 'A' Grade CollegeAffiliated to AdikaviNannaya University

BOARD OF STUDIES OF

DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS STRUCTURE AND SYLLABUS

(w.e.f. 2020-2021 Admitted Batch)

DEPARTMENT OF MATHEMATICS

Dr. C. S .RAO P.G. CENTRE: SRI Y.N .COLLEGE (AUTONOMOUS)

BOARD OF STUDIES

M.Sc. MATHEMATICS– SYLLABUS

(With effect from the admitted batch of 2020-2021 Academic Year)

Programme Outcomes: The study of M.Sc. degree programme will enable the students:

1. To obtain through knowledge in Pure Mathematics.
2. To obtain a basic knowledge in research & methodology.
3. To develop aptitude skills and skill based knowledge.
4. To improve logical and reasoning capacity.
5. To receive training to face SET/NET examinations.

Programme Specific Outcomes: The study of M.Sc. degree programme will enable the students:

1. To become an individual academic excellence in the discipline of Mathematics.
2. To acquire knowledge for research programme.
3. To be an entrepreneur for training SET/NET examinations.
4. To been capable of executing research and research projects
5. To become a Software professional.

REGULATIONS

1. The M.Sc Mathematics is a full-time **Two** year programme with **Four** semesters.

2. Eligibility for admission into the M.Sc Mathematics programme is a graduation degree with 50% of marks or equivalent CGPA in the case of all category students.

3. The admission process is governed by Adikavi Nannaya University, Rajamahendravaram through the APPGCET. In the case of spot admission category students, APPGCET qualification is not mandatory.

4.The Papers in four semesters are divided into Core and Elective. Each semester contains five papers. In first two semesters only Core papers are offered. In the third and fourth semesters, Elective papers are offered along with the Core Papers.

5.Each paper carries 100 marks out of which 25 marks are internal and 75 marks are external. The pass mark in each paper is 40.

6.Two internal theory examinations are conducted in every paper for 20 marks. The average marks are awarded finally. In addition, two marks are awarded for two assignments in each paper and three marks are awarded for seminar presentation. **There is no minimum pass mark for internal exams.**

7.Students shall put in attendance to the college for not less than 75% of the total number of working days. Condonation of shortage of attendance may be granted on medical grounds between 60 and 75% .

8.Blue print for Internal Examinations

Max Marks:25Time:1:30 Hours

Theory Exam • Short notes 2 out of 4 -2x3 =6 marks • Essay Questions 2 either or choice - 2x7 =14 marks ****Average of two Internal Exams is to be considered**	20 marks
• **Assignment-**2x1marks	2 marks
• **Seminar -1x3**marks	3 marks
Total	**25 Marks**

10.Blue Print for External Semester – End Examinations

Max Marks:75 **Time: 3Hours**

S.No.	Type of Question	No. of Questions to be given	No. of Questions to be written	Marks allotted to each question	Total Marks
1	Section-A Essay Question	4+4 (either or choice)	4 (one from each unit)	15	60
2	Section-B Short Answer Question	5	3	5	15
Total					75

1. **Se**ction – A:Essay Questions 4, either or choice 4 x 15M = 60 Marks
2. Section – B:Short Answer Questions 3 out of 5 3 x 5M = 15 Marks
   Total Marks = 75 Marks
3. One question compulsory from each unit.

10.The Question paper will be set by the External Paper Setters of other Autonomous Colleges and the valuation of the answer scripts will be done by the External Faculty at the end of each semester.

11. Grading system is followed in awarding marks the performance of the student is evaluated on a ten point grading scale with seven letter grades i.e., **O, A^{+}, A, B^{+}, B, C, P** and **F.** A candidate shall be declared to have passed in any paper if he /she secures not less than ‘P’ grade in theory .

Letter Grades and Grade points:

S.No.	Range of Marks (%)	Grade	Grade Points	Description
01	90 – 100	O	10	O(Out Standing)
02	80 – 89.99	A^+	9	A^+ (Excellent)
03	70 – 79.99	A	8	A(Very Good)
04	60 – 69.99	B^+	7	B^+ (Good)
05	55 – 59.99	B	6	B(Above Average)
06	50 – 54.99	C	5	C(Average)
07	40- 49.99	P	4	P(Pass)
08	0 – 39.99	F	0	F(Fail)
		Ab	0	Absent

Terms used and their explanation:

- **Credit Point:** It is the product of grade point and number of credits for a course.
- **Credit:** A unit by which the course work is measured. It determines the number of hours of instructions required per week.
- **Grade Point:** It is a numerical weight allotted to each letter grade on a 10 point scale.
- **Letter Grade:** It is an index of the performance of students in a said course. Grades are denoted by letters O, A^+, A, B^+, B, C, P and F.

- **Semester:** Each semester consists of 15-18 weeks of academic work equivalent to 90 actual teaching days.
- **Semester Grade Point Average(SGPA):** It is a measure of performance of work done in a semester. It is the ratio of total credit points secured by a student in a semester and the total course credits taken during that semester.
- **Cumulative Grade Point Average(CGPA):** It is a measure of overall cumulative performance of a student in all semesters. The CGPA is the ratio of total credit points secured by a students in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.

M.Sc. MATHEMATICS PROGRAMME STRUCTURE

M.Sc. MATHEMATICS SEMESTER -I

S.No.	Semester-I	Paper title	Paper Code	Total Marks	Internal Marks	External Marks	Teaching Hours	Credits
1	Paper-I	Algebra –I	M101	100	25	75	6	5
2	Paper-II	Real Analysis –I	M102	100	25	75	6	5
3	Paper-III	Differential equations	M103	100	25	75	6	5
4	Paper-IV	Topology	M104	100	25	75	6	5
5	Paper-V	Discrete Mathematics	M105	100	25	75	6	5
Total				500	125	375	30	25

M.Sc. MATHEMATICS SEMESTER -II

S.No.	Semester-II	Paper title	Paper Code	Total Marks	Internal Marks	External Marks	Teaching Hours	Credits
1	Paper-I	Algebra –II	M201	100	25	75	6	5
2	Paper-II	Real Analysis –II	M202	100	25	75	6	5
3	Paper-III	Complex Analysis –I	M203	100	25	75	6	5
4	Paper-IV	Linear Algebra	M204	100	25	75	6	5
5	Paper-V	Probability theory & Statistics	M205	100	25	75	6	5
Total				500	125	375	30	25

Single Elective:

The Elective papers will be offered in the Third and Fourth semesters. The students should choose any **ONE** of the listed Elective papers in the third and fourth semesters of M.Sc. Mathematics.

M.Sc. MATHEMATICS SEMESTER - III

S.No.	Semester-III	Paper title	Paper Code	Total Marks	Internal Marks	External Marks	Teaching Hours	Credits
1	Paper-I	Functional Analysis	M301	100	25	75	6	5
2	Paper-II	Lebesgue Theory	M302	100	25	75	6	5
3	Paper-III	Analytical Number Theory	M303	100	25	75	6	5
4	Paper-IV	Partial differential Equations	M304	100	25	75	6	5
5	Elective – I	Commutative Algebra Lattice Theory Complex Analysis-II Semi Groups-I	M305	100	25	75	6	5
Total				500	125	375	30	25

M.Sc. MATHEMATICS SEMESTER - IV

S.No.	Semester-IV	Paper title	Paper Code	Total Marks	Internal Marks	External Marks	Teaching Hours	Credits
1	Paper-I	Measure Theory	M401	100	25	75	6	5
2	Paper-II	Numerical Analysis	M402	100	25	75	6	5
3	Paper-III	Graph Theory	M403	100	25	75	6	5
4	Paper-IV	Linear Programming	M404	100	25	75	6	5
5	Elective – II	Discrete Dynamical systems Operator Theory Advanced Differential Equations Non-Linear Functional Analysis	M405	100	25	75	6	5
Total				500	125	375	30	25

Total Marks : 2000

Dr. C. S .RAO P.G. CENTRE: SRI Y.N .COLLEGE (AUTONOMOUS)

DEPARTMENT OF MATHEMATICS

BOARD OF STUDIES (M.Sc. MATHEMATICS)

Constituted on 11th October - 2020

S.No.	Name	Designation
1	**Sri.G.Rangababu** HOD, Dept. of Mathematics Dr.C.S.RaoP.G.Centre, Sri Y.N.College(A), Narsapur. Mobile No.:9949482360 Email Id: rangababugedda@gmail.com	Chairman
2	**Dr.G.Nanaji Rao** Professor & Head Department of Mathematics, Andhra University,Visakhapatnam Mobile No. : 9440367745 Email Id : 1. nani6us@yahoo.com 2. gnanajirao.math@auvsp.edu.in	University Subject Expert
3	**Smt.K.Hemalatha** HOD, Dept. of P.G. Mathematics Sir C.R.ReddyP.G.Courses, Eluru, W.G.Dist, AP. Mobile N o.: 8332904936 Email Id : katnenihemalatha@gmail.com	Subject Expert
4	**Smt.K.Sridevi** HOD of Mathematics, K.G.R.L.College of P.G Courses(A), Bhimavaram, W.G.Dist, AP. Mobile No.:9491322999 Email Id: sridevi.kommasani@gmail.com	Subject Expert

5	**Dr.Yedlapalli Phani** Associate Professor Department of Basic Science Shri Vishnu Engineering College for Women, Vishnupur Bhimavaram-2, W.G.Dist, AP Mobile No.: 9849052452 Email Id: phaniyedlapalli23@gmail.com	Special Invitee
6	**Sri.Ch.Bala Raju** Lecturer in Mathematics(UG), Sri Y.N.College(A), Narsapur. Mobile No.: 7095222504 Email Id: balarajuchinta999@gmail.com	Alumni Member
7	**Smt.P.Chandra Lalitha** Lecturer in Mathematics Dr.C.S.RaoP.G.Centre, Sri Y.N.College(A), Narsapur. Mobile No:9177522799 Email Id: pchlalitha@gmail.com	Member
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10	**Sri. Sirigineedi Siva** Lecturer in Mathematics Dr.C.S.RaoP.G.Centre, Sri Y.N.College(A), Narsapur. Mobile No:9666288890 Email Id: sivasai14456@gmail.com	Member

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS I YEAR SEMESTER I

(W.e.f. 2020-2021 Admitted Batch)

M101: ALGEBRA-I

Course Outcomes: The study of M.Sc. degree programme will enable the students:

1. To discuss Normal Subgroups and Normal series like Isomorphism theorem and Automorphism.
2. To explain Structure theorem of Groups like Finitely generated Abelian group and Sylow's theorem
3. To discribe Ideal's and Homomorphism, Unique Factorization domain and Euclidean domains.

UNIT-I: Normal subgroups: **Normal subgroups and quotient groups-Isomorphism theorem-** Automorphisms - Conjugacy and G-sets- Normal series solvable groups- Nilpotentgroups.
(Section 1,2,3 and 4 of Chapter 5, Sections 1,2,3 of Chapter 6)

UNIT-II: Structure theorems of groups: Direct product- Finitely generated abelian groups- Invariants of a finite abelian group- Sylow's theorems- Groups of orders p2 ,pq .

(Sections 1 to 5 of Chapter 8)

UNIT-III: Ideals and homomorphism- Sum and direct sum of ideals, Maximal and prime ideals- Nilpotent and nil ideals- Zorn's lemma.
(Sections 1 to 6 of Chapter 10)

UNIT-IV: Unique factorization domains - Principal ideal domains- Euclidean domains-

Polynomial rings over UFD.

(Sections 1 to 4 of Chapter 11)

Additional Inputs: Normal subgroups and quotient groups, Isomorphism theorem.

PRESCRIBED TEXT BOOK: Basic Abstract Algebra, Second Edition by P.B. Bhattacharya, S.K. Jain and S.R. Nagpaul.
REFFERECE TEXT BOOK: Topics in Algrbra By I. N. Herstein.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS I YEAR SEMESTER I

(W.e.f. 2020-2021 Admitted Batch)

M101: ALGEBRA-I

Model Question Paper

Time: 3 hours **Max Marks:** 75

SECTION – A

Answer **ALL** questions. Each question carries 15 marks. $\mathbf{4 \times 15 = 60}$

1. (a) If N be a normal subgroup of the group G, then prove that the mapping $\emptyset: G \rightarrow G/N$ defined by $x \mapsto xN$ is an epimorphism with $Ker\emptyset = N$.
   (b) State and prove Burnside theorem.

(OR)

2. (a) Let G be a group. Then the following are true.
   i) The set of conjugate classes of G is a partition of G.
   ii) $|C(a)| = [G: N(a)]$.
   iii) If G is finite, $|G| = \sum[G: N(a)]$.
   (b) Define an alternating group A_n . Show that the alternating group A_n
   is generated by the set of all 3 – cycles inS_n.
3. (a) State and prove fundamental theorem of finitely generated abliean group.
   (b)State and prove Cauchy's theorem.

(OR)

4. (a) A group G is nilpotent if and only if G a normal series$|e| = G_0 \subset G_1 \subset \cdots \subset G_m = G$
Such that $G_i \,/\, G_j \subset Z\left({}^{G}/_{G_{i-1}}\right)$ for all i=1,…….m.
   (b) State and prove 2^{nd} and 3^{rd}sylow theorems.

5. (a) If a ring R has unity, then every ideal I in the matrix ring R_n is of the form A_n,where A is some ideal in R.

(b)If K is an ideal in a ring R, then show that each ideal in $R/_K$ is of the form $A/_K$where A is an ideal in R containing K.

(OR)

6. (a) f be a homomorphism of a ring R into a ring S with kernel N, then prove that $R/_N \simeq Imf$.

(b) Let $f: R \to S$ be a homomorphism of Ring R into a ring S,then prove $kerf = \{0\}$ if and only if is 1-1.

7. (a) R is a non – zero ring with unity and I is an ideal in R such that $I\ XR$, then prove that there exists a maximal ideal M of R such that $I \cong M$.

(b) Prove that an irreducible element in a commutative principal ideal domain (PID) is always prime.

(OR)

8. (a) show that every Euclidean ring is a principal ideal domain

(b) State and prove Gauss lemma

SECTION – B

9. Answer any THREE questions of the following $\mathbf{3 \times 5 = 15}$

(a) Define the following and give one example for each

(i)Aut(G)

(ii)Eisenstein Criteria of irreducibility.

(b) (i) Define invariants of a group.

(ii) Define p – group and give an example.

(c) (i) define an ideal and give two examples.

(ii) Define a principal ideal and given an example of a principal ideal ring.

(d) (i) define nilpotent ideal and give an example.

(ii) Show that every nilpotent ideal is nil. What about the converse? Justify?

(e) (i) write Zorn's lemma and give an application.

(ii) Define a Euclidean domain and give an example.

Dr. C. S .RAO PG CENTRE

SRI Y.N .COLLEGE (AUTONOMOUS), NARSAPUR, W.G.Dt.,A.P.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS I YEAR SEMESTER I

(W.e.f. 2020-2021 Admitted Batch)

M102:REAL ANALYSIS-I

Course Outcomes: The study of M.Sc. degree programme will enable the students:

1. To describe the Basic Topology and Numerical Sequences & Series.
2. To explain about Continuity like Continuity and Connectedness & Continuity and Compactness.
3. To Understand some special theorems of Differentiation like Mean value theorems and Taylor's theorem and further more learn about Differentiation of vector valued functions.

UNIT-I: Basic Topology: Finite-Countable- and Uncountable Sets- Metric spaces- Compact sets- Perfect Sets-Connected sets, The Real and Complex Number systems –Ordered sets , Fields.
(Chapter 2 of the text book)

UNIT-II: Numerical Sequences and Series: Convergent Sequences- Subsequences -Cauchy Sequences- Upper and Lower limits- Some Special Sequences- Series- Series of Non-negative Terms- The number e -The Root and Ratio tests- Power series -Summation by parts - Absolute Convergence-Addition and Multiplication of series-Rearrangements.
(Chapter 3 of the text book)

UNIT-III: Continuity: Limits of Functions- Continuous Functions- Continuity and Compactness- Continuity and Connectedness- Discontinuities- Monotonic Functions- Infinite Limits and Limits at Infinity.
(Chapter 4 of the text book)

UNIT-IV: Differentiation: The Derivative of a Real Function -Mean Value Theorems - The Continuity of Derivatives- L' Hospital's Rule- Derivatives of Higher order- Taylor's theorem- Differentiation of Vector- valued Functions.
(Chapter 5 of the text book)

Additional Inputs: The Real and Complex Number systems –Ordered sets , Fields.

PRESCRIBED TEXT BOOK: Principles of Mathematical Analysis by Walter Rudin, International Student Edition, 3rd Edition, 1985.

REFERENCE TEXT BOOK: Mathematical Analysis by Tom M. Apostal, Narosa Publishing House, 2nd Edition,1985.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS I YEAR SEMESTER I

(W.e.f. 2020-2021 Admitted Batch)

M102: REAL ANALYSIS-I

Model Question Paper

Time: 3 hours **Max Marks:** 75

SECTION - A

Answer **ALL** questions. Each question carries 15 marks. $\mathbf{4 \times 15 = 60}$

1. (i) Prove that Every infinite subset of a countable set A is countable
(ii) Define Metric Space. And Prove that "Every neighborhood is an open set".

(OR)

2. Prove that "Every K– cell is compact".

3. Prove that, (i) If $|a_n| \leq c_n\, for\, n \geq n_0\ where\, N_0$ is some fixed integer , if $\sum c_n$ converges then $\sum a_n$ converges.(ii) If $a_n \geq d_n\, for\, n \geq N_0$ and if $\sum d_n$ diverges then $\sum a_n$ diverges.

(OR)

4. Prove that , $\lim_{n \to \infty} (1 + \frac{1}{n})^n = e$.

5. Prove that "a mapping f of a metric space X into a metric space Y is continuous on X if and only if $f^{-1}(V)$ is open in X for every open set V in Y.

(OR)

6. Prove that " if f is a continuous mapping of a compact metric space X into a metricspace Y, then f is uniformly continuous on X".

7. State and Prove Chain Rule.

(OR)

8. State and Prove Mean Value Theorem.

SECTION – B

9. Answer any three questions of the following. Each question carries 5 marks. $\mathbf{3 \times 5 = 15}$

(i) Define Cantor Set.

(ii) State and Prove LEIBNITZ Theorem.

(iii) If $\{p_n\},\{q_n\}$ are Cauchy sequences in a metric space, then showthat $(d(p_n,q_n))$ converges

(iv) Prove that every differentiable function is continuous.

(v) Let f be defined on $[a, b]$ if f has a local maximum at a point $x \in (a, b)$ and if $f^{\prime}(x)$ exists then $f^{\prime}(x) = 0$.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS I YEAR SEMESTER I

(W.e.f. 2020-2021 Admitted Batch)

M103:DIFFERENTIAL EQUATIONS

Course Outcomes: The study of M.Sc. degree programme will enable the students:

1. To discuss the second order linear differential equations and analyze homogeneous equation with constant coefficients, undetermined coefficients and method of variation of parameters.
2. To explain Oscillation theory and Boundary value problems like Eigen values and Eigen functions.
3. To describe Power series solutions and Systems of first order equations.

UNIT-I: Second order linear differential equations: Introduction-general solution of the homogeneous equation - Use of a known solution to find another - Homogeneous equation with constant coefficients - method of undetermined coefficients - method of variation of parameters.
Chapter 3 (Sec 14-19)

UNIT-II: Oscillation theory and boundary value problems: Qualitative properties of solutions – The Sturm comparison theorem - Eigen values, Eigen functions and the vibrating string.
Chapter 4 (Sec 22-24, Appendix A)

UNIT-III: Power series solutions: A review of power series-series solutions of first order equations-second order linear equations - ordinary points-regular singular points-Gauss's hypergeometric equation.

Chapter 5 (Sec 25-30)

UNIT-IV: Systems of first order equations: Linear systems - Homogeneous linear systems with constant coefficients - Existence and Uniqueness of solutions - successive approximations - Picard's theorem - Some examples.
Chapter 7 (Sec 36-38) and Chapter 11(Sec 55-56)

Additional Inputs: Gauss's hypergeometric equation.

PRESCRIBED TEXT BOOK: George F. Simmons, Differential Equations, Tata McGraw-Hill Publishing Company Limited, New Delhi.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS I YEAR SEMESTER I

(W.e.f. 2020-2021 Admitted Batch)

M103:DIFFERENTIAL EQUATIONS

Model Question Paper

Time: 3 hours **Max Marks:** 75

SECTION – A

Answer **ALL** questions. Each question carries 15 marks. $\mathbf{4 \times 15 = 60}$

1. If $y_1(x)\ and\ y_2(x)$ are the linearly independent solutions of the homogeneous equation $y'' + p(x)y' + Q(x)y = 0$ on the interval [a,b], then prove that $c_1 y_1(x) + c_2 y(x)$ is a solution of the differential equation. Also prove that Wronskian $W = W(y_1, y_2)$ is either identically zero or never zero on [a,b].

(OR)

2. (a) Find the general solution of $y'' - 3y' + 2y = 14\sin 2x - 18\cos 2x$ by the method of undetermined coefficients.

(b) Find particular solution of $y'' + y = cosec\ x$ by the method of variation of parameters.

3. State and prove Sturm comparison Theorem.

(OR)

4. Find the Frobenius series solution and the general solution for the differential equation $4x^2y'' - 8x^2y' + (4x^2 + 1)y = 0$.

5. (a) Find the differential equation satisfied by the function $y(x) = (1 + x)^p$ where p is any arbitrary constant, and then solve this equation by power series.

(b) Solve the differential equation $y'' + y = 0$ by using the method of power series.

(OR)

6. Solve the Legendre differential equation.

7. (a) Solve the system

$\frac{dx}{dt} = x + y$

$\frac{dy}{dt} = 4x - 2y.$

(b) Solve the system

$\frac{dx}{dt} = 3x - 4y$

$\frac{dy}{dt} = x - y.$

(OR)

8. State and prove Picard's theorem.

SECTION – B

9.Answer any three questions of the following. Each question carries 5 marks. $\mathbf{3 \times 5 = 15}$

(i) Explain the method of undetermined coefficients $y'' + p(x)y' + q(x)y = \sin\ bx$ and Solve $y'' + 10y' + 25y = 14e^{-5x}$.

(ii) prove that ‘if $q(x) < 0$ and $u(x)$ is a nontrival solution of $u'' + q(x)u = 0$, then $u(x)$ Has at most one zero’?

(iii) Find the general solution of $(1 + x^2)y'' + 2xy' - 2y = 0$ in terms of power series in x.

(iv) Write two independent Frobenius series solution for $xy'' + 2y' + xy = 0$.

(v) Solve the linear system

$\frac{dx}{dt} = x + y - 5t + 2$

$\frac{dy}{dt} = 4x - 2y - 8t - 8.$

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS I YEAR SEMESTER I

(W.e.f. 2020-2021 Admitted Batch)

M104:TOPOLOGY

Course Outcomes: The study of M.Sc. degree programme will enable the students:

1. To discuss the basic concepts of Sets and Functions and also know about Countable Sets & Uncountable Sets, further more about Partitions and equivalence relations.
2. To learn about Metric spaces like open sets, closed sets and continuous mappings and also learn about Euclidean and unitary spaces.
3. To describe Compactness like compact spaces, Product of spaces and discuss about some important theorems like Tychnoff's Theorem and Ascoli's theorem.

UNIT-I: Sets and Functions: Sets and Set inclusion – The algebra of sets – Functions – Products of sets– Partitions and equivalence relations – Countable sets – Uncountable sets – Partially ordered sets and lattices.
(Chapter I: Sections 1 to 8.)

UNIT-II: Metric spaces: The definition and some examples – Open sets – Closed sets – Convergence, Completeness and Baire's theorem – Continuous mappings.
(Chapter 2: Sections 9 to 13.)

UNIT-III: Metric spaces (Continued): Spaces of continuous functions – Euclidean and unitary spaces.
Topological spaces: The definition and some examples – Elementary concepts – Open bases and open sub bases – Weak topologies – The function algebras C(X, R) and C(X, C).
(Chapter 2: Sections 14,15 and Chapter 3: 16 to20.)

UNIT-IV: Compactness: Compact spaces – Product of Spaces – Tychonoff's theorem and locally Compact spaces – Compactness for metric spaces – Ascoli theorem – Limit point compactness
(Chapter 4: Sections 21 to 25.)
Additional Inputs: limit point compactnesss.

PRESCRIBED TEXT BOOK-1: Introduction to Topology by G.F.Simmons, Mc.Graw-Hill book company.
PRESCRIBED TEXT BOOK – 2: Topology by James R. Munkers,Second edition ,Pearson education Asia – Low price edition.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS I YEAR SEMESTER I

(W.e.f. 2020-2021 Admitted Batch)

M104:TOPOLOGY

Model Question Paper

Time: 3 hours **Max Marks:** 75

SECTION – A

Answer **ALL** questions. Each question carries 15 marks. $\mathbf{4 \times 15 = 60}$

1. (i) Let X be a non-empty set. A relation ~ in X is called circular if $x \sim y$ & $y \sim z \Rightarrow z \sim x$ & triangular if $x \sim y$ & $x \sim z \Rightarrow y \sim z$. Then prove that a relation in X is an equivalence if and only if it is reflexive & circular if and only if it is reflexive & triangular.
(ii) State Schroeder Bernstein Theorem.

(OR)

2. Prove that, (i) Any subset of a Countable Set is Countable.
(ii) A Countable union of countable sets is countable.

3. (i) Define metric space. Prove that any metric space X each open sphere is an openset.

(ii) Let X be metric space and let A be a subset of X. If x is a limit point of A. Show that eachopen sphere centered on x contains an infinite number of distinct points ofA.

(OR)

4. Define open set and closed set. Let (X, d) be a metric space. Let A is subset of X. Then thefollowing hold.
(i) $b(A) = \overline{A} \cap \overline{A^{1}}$
(ii) b(A) is a closedset.
(iii) A is closed $\Leftrightarrow$ b (A) $\subseteq$A.

5. (i) State and prove Minkowski's inequality.

(ii) Define Topological space. Let X be a topological space and A is an arbitrary sub set of X.

Then $\overline{A}$ = {x ∈ X | each neighborhood of x intersects A}

$\overline{A}$ = {x ∈ X/G⋂A≠$, for any neighborhood G of x}.

(OR)

6. (i) State and Prove Lindelof'stheorem.

(ii) Show that every separable metric space is second countable.

7. (i) Prove that any closed subspace of a compact space iscompact.

(ii) Prove that a metric space is sequentially compact if it has the Bolzano Weierstrass property.

(OR)

8. State and prove Ascoli'stheorem.

SECTION – B

9. Answer any three questions of the following. Each question carries 5 marks. $\mathbf{3 \times 5 = 15}$

(i) Prove that the set of all positive rational numbers are countable.
(ii) State Cantor Intersection Theorem.
(iii) Prove that a sub set F of metric space is closed iff its's complement F* isopen.
(iv) Prove that any continuous image of compact space iscompact.
(v) Prove that every compact metric space is separable.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS I YEAR SEMESTER I

(W.e.f. 2020-2021 Admitted Batch)

M105:DISCRETE MATHEMATICS

Course Outcomes: The study of M.Sc. degree programme will enable the students:

1. To discuss lattices as partially ordered sets, some properties of lattices, lattices as algebraic systems.
2. To acquire the knowledge from Boolean forms and free Boolean algebras, values of Boolean expressions.
3. To Describe representations and minimizations of Boolean functions and to explain finite state machines, Introductory sequential circuits, equivalence of Finite state Machines.

UNIT-I: Relations and ordering: Relations- properties of binary relations in a set-Relation matrix and the graph of a relation, partition and covering of a set, equivalence relations, compatability relation, composition of binary relations- partially ordereing- Partially ordered sets - representation and associated terminology.

[2-3.1 to 2-3.9 of Chapter 2 of the Text Book]

UNIT-II: Lattices: Lattices as partially ordered sets - some properties of Lattices - Lattices as algebraic systems - sub-Lattices - direct product and homomorphism some special Lattices.

[4-1.1 to 4-1.5 of Chapter 4 of the Text Book]

UNIT-III: Boolean Algebra: Sub algebra - direct product and Homorphism - Boolean forms and free Boolean Algebras - values of Boolean expressions and Boolean function.

[4-2.1,4-2.2,4- 3.1, 4-3.2 of Chapter 4 of the Text Book]

UNIT-IV: Representations and minimization of Boolean Function: Representation of Boolean functions – minimization of Boolean functions- Finite State Machines - Introductory Sequential Circuits - Equivalence of Finite-State Machines, Connectives – Negation , Conjunction , Disjunction , Statement formulas and Truth tables.

[4-4.1,4-4.2,4-6.1, 4-6.2 of Chapter 4 of the Text Book]

Additional Inputs: Connectives – Negation , Conjunction , Disjunction , Statement formulasand Truth tables.

PRESCRIBED TEXT BOOK: Discrete Mathematical structures with applications to Computer Science by J.P.Trembly and R. Manohar, Tata McGraw-HillEdition.

REFERENCE TEXT BOOKS:1. Discrete Mathematics for Computer Scientists and Mathematicians by J.L.Mott, A.Kandel and T.P. Baker, Prentice-Hall India.

2. Discrete Mathematical Structures by Kolman & Busby & Sharen Ross

3. Applied Abstract Algebra by Rudolf Lidl & Gunter Pilz ,Published by springer Verlag.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS I YEAR SEMESTER I

(W.e.f. 2020-2021 Admitted Batch)

M105:DISCRETE MATHEMATICS

Model Question Paper

Time: 3 hours **Max Marks:** 75

SECTION – A

Answer **ALL** questions. Each question carries 15 marks. $4 \times 15 = 60$

1) Let X = {1, 2, 3} if R = {(x, y)/ x ∈ X ∧ y ∈ X ∧ ((x − y) is an integral non-zero multiple of 2)}, S = {(x, y)/ x ∈ X ∧ y ∈ X ∧ ((x − y) is an integral non-zero multiple of3)}
(a) Find R∪S and R∩S.
(b) IfX={1,2,3,….} ,What is R∩S for R and S as defined in(a)

(OR)

2) Let A be a given finite set and q(A) its power set. Let ⊆ be the inclusion relation on the elements of q(A). Draw Hasse diagrams of (q(A), ⊆) for (a) A= {a}; (b) A={a,b}; (c) A= {a, b, c} (d) A= {a, b, c, d}

3) Let (L, ≤) be a lattice. For any a, b, c ∈ L show that the following holds:
$a \leq c \Leftrightarrow a \oplus (b * c) \leq (a \oplus b) * c$

(OR)

4) Show that in a lattice (L,≤), for any a , b, c∈ L, the distributive inequalities hold:

$$a \oplus (b * c) \leq (a \oplus b) * (a \oplus c)$$
$$a * (b \oplus c) \geq (a * b) \oplus (a * c)$$

5) Write the following Boolean expression in an equivalent sum of products canonical form in three variables x_1, x_2 and x_3(a) $x_1 * x_2$ (b) $x_1 \oplus x_2$(c) $(x_1 \oplus x_2)' * x_3$

(OR)

6) Obtain the values of the Boolean forms $x_1*(x_1' \oplus x_2)$, x_1*x_2 and $x_1 \oplus (x_1 * x_2)$ over the ordered pairs of the two-element Boolean algebra.

7) Prove that if for some integer k , $p_{k+1} = p_k$, then $p_k = p$ and conversely.

(OR)

8) Find the value of the function $f_{\alpha,\beta} : B^n \to B$ $for\ x_1 = a , x_2 = 1, x_3 = b\ where\ a, b,$ 1 are the elements of the Boolean algebra and $\alpha(x_1, x_2, x_3)$ is the expression $\alpha(x_1, x_2, x_3) = (x_1 \oplus x_2)' * x_3.$

SECTION – B

9. Answer any three questions of the following. Each question carries 5 marks. $\mathbf{3 \times 5 = 15}$

(i) DrawHassediagramofthesetx={2,3,6,12,24,36}andtherelation≤besuchthat $x \leq y$ if x divides y

(ii) Write some properties oflattices

(iii) Define subalgebra, Direct product and Homomorphism.

(iv) Obtain the product of sums canonical forms of the Boolean expression x_1*x_2

(v) Write about finite state machines.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS I YEAR SEMESTER II

(W.e.f. 2020-2021 Admitted Batch)

M201:ALGEBRA-II

Course Outcomes: The study of M.Sc. degree programme will enable the students:

1.To discuss about Rings of Fractions and Algebraic Extensions of Fields.
2.To explain Normal and Separable extensions like Splitting fields, Multiple roots and Finite fields.
3.To discuss about Galois theory and it's applications to classical problems like cyclic extensions, Roots of Unity and Cyclotomic polynomials.

UNIT-I: Rings of fraction: Rings of fraction-Rings with Ore condition, Algebraic extensions of fields: Irreducible polynomials and Eisenstein criterion- Adjunction of roots- Algebraic extensions-Algebraically closed fields.
(Sections 1&2of chapter 12, section 1 to 4 of Chapter 15)

UNIT-II: Normal and separable extensions: Splitting fields- Normal extensions- Multiple roots- Finite fields- Separable extensions.
(Sections 1 to 5 of Chapter 16)

UNIT-III: Galois theory: Automorphism groups and fixed fields- Fundamental theorem of Galois theory-Fundamental theorem of Algebra.
(Sections 1 to 3 of Chapter 17)

UNIT-IV: Applications of Galioes theory to classical problems: Roots of unity and cyclotomic polynomials- Cyclic extensions- Polynomials solvable by radicals - Ruler and Compass constructions.

(Sections 1 to 3 and 5 of Chapter 18)

Additional Inputs: Rings of fraction,Rings with Ore condition

PRESCRIBED TEXT BOOK: Basic Abstract Algebra , Secound Editionby P.B. Bhattacharya, S.K. Jainand S.R. Nagpaul

REFERENCE TEXT BOOK: Topics in Algrbra By I. N. Herstein.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS I YEAR SEMESTER II

(W.e.f. 2020-2021 Admitted Batch)

M201:ALGEBRA-II

Model Question Paper

Time: 3 hours **Max Marks:** 75

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1. (a) (i) state and prove Gauss lemma.
   (ii) let F is contained in E is contained in K be fields. If $[K:E] < \infty$ and $[E:F] < \infty$ then
   (i) $[K:F] < \infty$
   (ii) $[K:F] = [K:E][E:F]$

(OR)

   (b) Let$E = F(u_1, u_2, \ldots u_r)$be a finitely generated extension of F such that each $u_i, i = 1,2, \ldots r$ is algebraic over F then prove that each E is finite over F and hence an Algebraic extension of F.

2. (a) Let F be a field. Then show that there exists an algebrically closed field K containing F as a subfield.
   (b) Let E be a finite extension of a field. Then the following are equivalent.
   i) $E = F(\propto)$ for some $\propto\in$ E.
   ii) There are only a finite number of intermediate fields between F and E.

3. (a) Let F be an field.Then their exist an algebraically closed field K containing F as a subfield.
   (b)State and prove uniqueness of splitting field.

(OR)

4. (a) Let f(x) be an irreducible polynomial over F.Then f(x) multiple root if and only if $f^1(x) = 0$.
   (b) If f(x)$\in f[x]$ is irreduciable over F, roots of f(x) have the same multiplicity.

5. Let H be a finite subgroup of the group of Automorphism of a field E. Then $[E: E_h] = |H|$.

(OR)

6.State and prove fundamental theorem of Galois theory.

7.$\emptyset_n(x) = \pi_\omega(x - \omega), \omega$ primitive nth root in C, is an irreducible polynomial of degree $\emptyset(n) is\ Z[x]$.

(OR)

8.a)Let F be a field and let n be a positive integer. Then there exists a primitive nth root of unity in some extension E of F if and only if either $char\ F = 0\ or\ char\ F \nmid n$.

b) If P is a prime number and if a subgroup G of Sp is a transitive group of permutations containing a transposition (a,b) then $G = S_p$.

SECTION – B

9.Answer any three questions of the following. Each question carries 5 marks.$\mathbf{3 \times 5 = 15}$

a)Let $f(x) = a_0 + a_1x + \cdots + a_{n-1}x^{n-1} + x^n \in Z[x]$ be a monic polynomial. If f(x) has a root $a \in Q$, then $a \in Z\ and\ a|a_0$.

b) the degree of the extension of the splitting field of $x^3 - 2 \in Q[x] is\ 6$.

c) Show that the multiplicative group of non zero elements of a finite field in cyclic.

d) If E is a finite extension of a field F,then prove that $\left|G\left({}^{E}/_{F}\right)\right| \leq [E: F]$.

e) Show that if a>0 is constructiable ,then $\sqrt{a}$ is constructiable.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS I YEAR SEMESTER II

(W.e.f. 2020-2021 Admitted Batch)

M202:REAL ANALYSIS-II

Course Outcomes: The study of M.Sc. degree programme will enable the students:

1. To describe the Riemann stieltjes Integral and Sequences and Series of the functions like Uniform convergence, Uniform convergence and Continuity and Integration further more know about Equicontinuous families of functions,the stone wierstrass theorem.
2. To explain the concept of Power Series and Functions of Several Variables like linear transformations ,the contraction principle and the inverse function theorem.
3. To learn about the the Implicit function theorem,the Rank theorem and further more about Derivatives of higher order and Differentiation of integrals.

UNIT-I: Riemann-Stieltjes Integral: Definition and existence of the Riemann Stieltjes Integral,Properties of the Integral, Integration and Differentiation, the fundamental theorem of calculus–Integral of Vector- valued Functions, Rectifiable curves.
(Chapter 6)
UNIT-II: Sequences and Series of the Functions: Discussion on the Main Problem, Uniform Convergence, Uniform Convergence and Continuity, Uniform Convergence and Integration, Uniform Convergence and Differentiation, Equicontinuous families of Functions, the Stone- Weierstrass Theorem.(Chapter 7)
UNIT-III: Power Series: (A section in Chapter 8 of the text book) , the exponential and logarithmic functions.Functions of Several Variables: Linear Transformations, Differentiation, The ContractionPrinciple, The Inverse Function theorem.
(First Four sections of chapter 9 of the text book)
UNIT-IV: Functions of several variables Continued: The Implicit Function theorem, The Rank theorem, Determinates, Derivatives of Higher Order, Differentiation of Integrals.
(5 th to 9 th sections of Chapter 9 of the text book)
Additional Inputs: The exponential and logarithmic functions.
PRESCRIBED TEXT BOOK: Principles of Mathematical Analysis by Walter Rudin, International Student Edition, 3 rd Edition, 1985.
REFERENCE TEXT BOOK: Mathematical Analysis by Tom M. Apostal, Narosa Publishing House,2 nd Edition, 1985.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS I YEAR SEMESTER II

(W.e.f. 2020-2021 Admitted Batch)

M202:REAL ANALYSIS-II

Model Question Paper

Time: 3 hours **Max Marks:** 75

SECTION – A

Answer **ALL** questions. Each question carries 15 marks. $\mathbf{4 \times 15 = 60}$

1. (i) Prove that , $f \in R(\alpha)\ on\ [a\ , b]$ if and only if for every $\varepsilon > 0$ there exists a partition P such that $U(P, f, \alpha) - L(P, f, \alpha) < \varepsilon$.
(ii) Prove that ,If f is monotonic on [a , b] and if α is continuous on [a , b] ,then $f \in R(\alpha)$.

(OR)

2. (i)State and prove integration by parts formula.
(ii) Prove that ,Ifγ' is continuous on [a , b] , then γ is rectifiable , and $\Lambda(\gamma) = \int_a^b \left|\gamma'(t)\right| dt$.

3. (i) State and prove Cauchy's criterion for uniform convergence of sequence offunction.
(ii) State and prove Weirstrass M- Test.

(OR)

4. (i) State and prove Stone-WeirstrassTheorem.
(ii) Prove that there exists a real continuous function on the real line which is nowhere differentiable.

5. i) State and prove Abel'sTheorem.
(ii) State and prove Taylor's Theorem

(OR)

6. (i) State and prove contractionprinciple.
(ii) Supposethat$f$mapsaconvexopensetE⊂R^n,$f$isdifferentiableinE,and thereisarealnumberMsuchthat$\|f'(x)\|$≤Mforevery$x \in E$. Then |f(b) – f(a)| ≤ M|b– a| for all $a \in E, b \in E$.

7. Prove that ,(i) If I is the identity operator on R^n ,then

$\det[I] = \det(e_1, \ldots, e_n)$.

(ii) If $[A]_1$ is obtained from $[A]$ by interchanging two columns ,then$det[A]_1 = -det[A]$.

(OR)

8. Suppose f is defined in an open set $E \subset R^2$, suppose that $D_1 f, D_{21} f, and\ D_2 f$ exist at every point of E ,and $D_{21} f$ is continuous at some point (a , b) $\in E$.

<u>SECTION – B</u>

9. Answer any three questions of the following. Each question carries 5 marks. $\mathbf{3 \times 5 = 15}$

(i) Suppose $\{f_n\}$ is a sequence of functions defined on E ,and suppose $\left|f(x)\right| \le M_n , x \in E, n = 1,2,3, \ldots \ldots$ Then prove that $\sum f_n$ coverged uniformly on E if $\sum M_n$ converges.

(ii) If $f \in R(\alpha) \& g \in R(\alpha)\ on\ [a , b]$, then prove that $fg \in R(\alpha)$.

(iii) Let B be the uniform closure of an algebra of bounded functions .Then B is a uniformly closed algebra.

(iv) If [A] and [B] are n by n matrices , then prove that $\det([B][A]) = \det[B] \det[A]$.

(v) State contraction principle and Inverse function theorem.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS I YEAR SEMESTER II

(W.e.f. 2020-2021 Admitted Batch)

M203:COMPLEX ANALYSIS-I

Course Outcomes: The study of M.Sc. degree programme will enable the students:

1. To discuss the elementary properties and examples of Analytic functions like Power series and Mobius transformations.
2. To study complex integration and analyze Riemann-Stiltjes integrals, Cauchy theorem and Integral formula.
3. To describe classification of Singularities, Residues and argument principle.

UNIT-I: Elementary properties and examples of analytic functions: Power series- Analytic functions- Analytic functions as mappings, Mobius transformations.
(1,2,3 of chapter-III)
UNIT-II: Complex Integration: Riemann- Stieltjes integrals- Power series representation ofanalyticfunctions- zeros of an analytic functions- The index of a closed curve.
(1,2,3,4 of chapter-IV)

UNIT-III: Cauchy’s theorem and integral formula- the homotopic version of Cauchy’s theorem andsimple connectivity- Counting zeros; the open mapping theorem.

(5,6,7of chapter-IV)
UNIT-IV: Singularities: Classifications of singularities- Residues- The argument principle,
The Maximum Modulus Theorem:The Maximum Principle-Schwarz’s Lemmma
(1,2,3 of chapter-V ,1,2 of chapter-VI)

Additional Inputs: The Maximum Modulus Theorem:The Maximum Principle-Schwarz’s Lemma

PRESCRIBED TEXT BOOK: Functions of one complex variables by J.B.Conway : Second edition, Springer International student Edition, Narosa Publishing House, NewDelhi.
REFERENCE TEXT BOOK: A first course in complex analysis with applications by Dennis G.Zill and Patrick Shanahan.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS I YEAR SEMESTER II

(W.e.f. 2020-2021 Admitted Batch)

M203: COMPLEX ANALYSIS-I

Model Question Paper

Time: 3 hours **Max Marks:** 75

SECTION – A

Answer **ALL** questions. Each question carries 15 marks. $\mathbf{4 \times 15 = 60}$

1. (a) Let G be an open connected set in C. If f: G → C is differentiable with f'(z) =0 for all z in G, prove that f is constant.
   (b) Let $u\ and\ v$ be two real valued continuous functions defined on a region G. If $u\ and\ v$ have continuous first order partial derivatives, satisfying $u_x = v_y$ and $u_y = v_x$, then prove that the function f:G →C defined by $f(z) = u(z) + iv(z)$ is analytic in G.

(OR)

2. (a) Define cross ratio. If z_2, z_3, z_4 are distinct points and T is any Mobius transformation, Prove that $(Z, Z_2, Z_3, Z_4) = (TZ_1, TZ_2, TZ_3, TZ_4)$ for any point Z_1.
   (b) State and prove the symmetry principles.
3. (a) State and prove Leibniz 's theorem.
   (b) Let r be a rectifiable curve and suppose that f is a function continuous on {r}, prove That $\left|\int_r f\right| \leq \int |f|\, |dz| \leq V(r) \sup \{\left|\frac{f(z)}{z} \in \{r\}\}\right|$.

(OR)

4. State and prove Fundamental theorem of Algebra.
5. State and prove Cauchy's Integral formula second version.

(OR)

6. (a) State and prove the open mapping theorem.
   (b) State and prove Morera's Theorem.
7. (a) State and prove Casorarti-Weirstrass theorem.

(b) Show that $\int_0^\infty \frac{logx}{1+x^2} = 0$.

(OR)

8. (a) State and prove Rouche's Theorem.

(b) Obtain the Laurent Series Expansion for the function $f(z) = \frac{1}{(z-1)(z-2)}$ following annuli i) a(0;0,1) ii) ann(0;1,2) iii) ann(0;2,∞)

SECTION – B

9.Answer any three questions of the following. Each question carries 5 marks. $\mathbf{3 \times 5 = 15}$

(i) If $u(x,y) = e^x \cos x(x\ ,y) \in C$, prove that u is harmonic in C And find its harmonic conjugate.

(ii) Prove that any Mobius transformation has at most two fixed points

(iii) Define γ: $[0\ ,2\pi] \to C$ by $\gamma(t) = \exp\ (int)$ where n is some integer. Show That $\int_\gamma \frac{dz}{z} = 2\pi in$.

(iv) Find all entire functions such that $f(x) = e^x$ for all $x \in R$.

(v) Evaluate $\int_0^\infty \frac{sinx}{x} dx = \frac{\pi}{2}$.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS I YEAR SEMESTER II

(W.e.f. 2020-2021 Admitted Batch)

M204:LINEAR ALGEBRA

Course Outcomes: The study of M.Sc. degree programme will enable the students:

1. To Explain elementary canonical forms, annihilating polynomials, invariant subspaces.
2. To Describe direct –sum decompositions, invariant direct-sums.
3. To Acquire the knowledge in the Jordan forms, computation of invariant factors, semi simple operators.

UNIT-I: Elementary Canonical Forms : Introduction – Characteristic Values – Annihilating Polynomials –invariant subspaces – Simultaneous Triangulation – Simultaneous Diagonalization.
(Sections 6.1,6.2,6.3,6.4,6.5 of chapter-6)

UNIT-II: Direct – sum Decompositions – invariant direct sums – the primary decomposition theorem – cyclic subspaces and Annihilators – cyclic decompositions and the rational form.
(Sections 6.6,6.7,6.8 of chapter-6 and Sections 7.1,7.2 of chapter - 7)

UNIT-III: The Jordan Form – Computation of Invariant Factors – Semi Simple Operators, Linear Transformations.(Sections 7.3,7.4,7.5 of chapter - 7)

UNIT-IV: Bilinear Forms : Bilinear Forms – Symmetric Bilinear Forms – Skew Symmetric Bilinear Forms– Group Preserving Biliear Forms.

(Sections 10.1,10.2,10.3,10.4 of chapter - 10)

Additional Inputs : Linear Transformations.

PRESCRIBED TEXT BOOK: Linear Algebra second edition By Kenneth Hoffman and Ray Kunze, PrenticeHall of india Private Limited, New Delhi.

REFERENCE TEXT BOOK: SCHAUM'S outlines by MURRAY,R.SPIEGEL, JOHN SCHILLER, R.ALU SRINIVASAN.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS I YEAR SEMESTER II

(W.e.f. 2020-2021 Admitted Batch)

M204:LINEAR ALGEBRA

Model Question Paper

Time: 3 hours **Max Marks:** 75

SECTION – A

Answer **ALL** questions. Each question carries 15 marks. $\mathbf{4 \times 15 = 60}$

1. Let T be a linear operator on the finite dimensional space V. Let $c_1, c_2, \dots, c_k$ be the distinct characteristic values of T and let w_i be the If $w = w_1 + w_2 + \cdots + w_k$ then dimension of $w = dimw_1 + dimw_2 + \cdots + dimw_k$infact if β_i is an ordered basic for w_i then $\beta = \beta_{1+}\beta_2 \dots + \beta_k$is an ordered basic for w.

(OR)

2. Let T be a linear operator on an n-dimensional V.S V(F). The characteristic equation and minimal polynomials for T have same roots except for multiplicities.
3. State and prove primary decomposition theorem.

(OR)

4. Let T be a linear operator on the finite dimensional vector space V and$W_1 \dots W_K$ are subspaces of V and $E_{1, \dots} E_k$are projections corresponding to the linear operator T. Then a necessary and sufficient condition that each subspace W_I be invariant under T is that T is commutes with each of the projections E_I .
5. let Mbe an $m \times m$ matrix with entries in the polynomial algebra $F[x]$. Then M is equivalent to a matrix N which is in normal form.

(OR)

6. Find all rational canonical for with minimal polynomial $m(t) = (t-1)^3$ and characteristic polynomial $\Delta(t) = (t-1)^7$.

7. Let V be a finite dimensional vector space over the field F. Let F be a symmetric bilinear form on V which has a rank r then there is an ordered basis $\mathfrak{B} = \{\beta_1, \beta_2 \dots \beta_n\}$ for V such that

i) The matrix of F in the ordered basis $\mathfrak{B}$ is diagonal.

ii) $f(\beta_j, \beta_j) = \begin{cases} 1 \; if \; j = 1,2, \dots r \\ 0 \; if \; j > r \end{cases}$

(OR)

8. Let f be a non-degenerate bilinear form on a finite dimensions vector space V. The set of all linear operators on V which preserves f is a group under the operation of composition.

SECTION – B

9. Answer any three questions of the following. Each question carries 5 marks. $\mathbf{3 \times 5 = 15}$

(i)Prove that similar matrices have the same charactersticPolynomial.

(ii)Let E_1,E_k be linear operators on the space V suchthatE_1 + ……….+E_k=I. Thenprovethat ifE_iE_j=0 fori≠j, then ^{2}= $E_i$foreachi.

(iii)Define a Smith Normal form and give an example.

(iv)Define a bilinear form and give an example.

(v) Let V be a finite-dimensionalvecor space over the field F and f a symmetric bilinear form on V . For each subspace W of V , let X be the set of all vectors a in V suchthat f (α , β) = 0 for every β in then show that X is asubspace.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS I YEAR SEMESTER II

(W.e.f. 2020-2021 Admitted Batch)

M205:PROBABILITY THEORY & STATISTICS

Course Outcomes: The study of M.Sc. degree programme will enable the students:

1. It gives insight about the concepts, definitions and theorems of Probability and analyze the Probability distributions like Binomial, Poisson and Normal distributions.
2. Describe correlation and regression analysis concepts.
3. Understand the concepts of sampling and explain the large sample test.

UNIT-I:Sample Space & Events, Axioms of Probability, Some theorems on Probability, Boole's inequality, Conditional probability, Multiplication theorem on probability, Independent events, Multiplication theorem on probability for Independent Events, Extension of Multiplication theorem on probability to n events, Pair-wise Independent Events, Baye's theorem

[Section 3.8 to 3.15 , Page no: 3.2 to 3.98 & Section 4.2, Page no: 4.4 to 4.20]

UNIT-II: Distribution function, Discrete Random variables, Continuous random variables, Mathematical Expectation, Expected value of function of a random variable, Properties of Expectation, Properties of variance, Covariance, Moment Generating Function, Characteristic function, Binomial Distribution, Poisson Distribution, Normal Distribution,Uniform Distribution, Random Experiment, Mutually exclusive events, Exhaustive number of cases, Population, Level of significance and Degrees of freedom.

[Section5.2to5.4,Pageno:5.2 to5.31,Section6.2to6.6,Pageno:6.1to6.22,Section

7.1, 7.3(7.3.1&7.3.2 only), Page no: 7.2 to 7.6, Page no: 7.9 to 7.15, Section 8.4, 8.5,Page

no:8.4to8.47,Section9.2.1to9.2.11and9.2.14,9.3, Pageno:9.2to9.12,9.14to9.28, and 9.3 to 9.37]

UNIT-III: Correlation: Introduction, meaning of correlation, scatter diagram, Karl Pearson's Coefficient of Correlation, Rank Correlation, Linear and Curvilinear Regression:Introduction, linear regression, curvilinear regression

[Section 10.1 to 10.4(10.4.1, 10.4.2 only & in 10.7 –10.7.1 only), Page no: 10.1 to 10.16

and 10.23 – 10.25, Section 11.1 to 11.3, Page no: 11.1 to 11.19]

UNIT-IV: Large Sampling theory: Introduction, types of sampling, parameters and

statistic, tests of significance, procedure for testing of hypothesis, tests of significance for large samples.

[Section 14.1 – 14.6, Page no: 14.1 to 14.22]

Additional Inputs : Random Experiment, Mutually exclusive events, Exhaustive number of cases, Population, Level of significance and Degrees of freedom.

PRESCRIBED TEXT BOOK: Fundamentals of Mathematical Statistics, S.C.Gupta,V.K.Kapoor Eleventh Thoroughly Revised Edition Published by: Sultan Chand & Sons, NEW-DELHI.

REFERENCE TEXT BOOK: Statistical methods by S.P Gupta.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS I YEAR SEMESTER II

(W.e.f. 2020-2021 Admitted Batch)

M205: PROBABILITY THEORY & STATISTICS

Model Question Paper

Time: 3 hours **Max Marks:** 75

SECTION – A

Answer **ALL** questions. Each question carries 15 marks. $\mathbf{4 \times 15 = 60}$

1. (a) State and prove addition theorem of probability.

(b) The probability that a contractor will get a plumbing contract is 2/3 and the probability that he will not get an electric contact is 5/9.If the probability of getting atleast one contract is 4/5,what is the probability that he will get both the contracts?

(OR)

2. (a) State and prove Bayes' theorem.

(b) In a bolt factory, machines A, B, C manufacture respectively 25%, 35%, and 40% .Of the total of their output 5%, 4%, and 2% are known to be defective bolts. A bolt is drawn at random from the product and is found to be defective. What are the probabilities that it was manufactured by

i) Machine A ii) Machine B and

iii) Machine C

3. (a) Derive the moment generating function of Binomial distribution. Hence find the mean and variance of Binomial distribution.

(b) Fit a Poisson distribution to the following data:

Number of mistakes per page	0	1	2	3	4	Total
Number of pages	109	65	22	3	1	200

(OR)

4. (a) The distribution of monthly income of 500 workers may be assumed to be normal with mean of Rs.2000 and a standard deviation of Rs. 200. Estimate the number of workers with incomes

(i) Exceeding Rs.2300 per month

(ii) Between Rs. 1800 and Rs.2300 per month.

(b) If X is uniformly distributed with mean 1 and variance $\frac{4}{3}$, then find P(X<0).

5. Calculate the Karl Pearson's correlation coefficient for the following heights of fathers(X) and their sons(Y):

X	65	66	67	67	68	69	70	72
Y	67	68	65	68	72	72	69	71

(OR)

6. (a)Prove that if one of the regression coefficients is greater than unity, the other must be less than unity.

(b) Obtain the equations of two lines of regression for the following data. Also obtain the estimate of X for Y = 70.

X	65	66	67	67	68	69	70	72
Y	67	68	65	68	72	72	69	71

7 . (a) A random sample of 500 pineapples was taken from a large consignment and 65 were found to be bad. Show that the S.E. of the proportion of bad ones in a sample of this size is 0.015 and deduce that the percentage of bad pineapples in the consignment almost certainly lies between 8.5 and 17.5.

(b) Twenty people were attacked by a disease and only 18 survived. Will you reject the hypothesis that the survival rate, if attacked by this disease, is 85% in favour of the hypothesis that it is more, at 5% level.

(OR)

8. A company has the head office at Kolkata and a branch at Mumbai. The personal director wanted to know if the workers at the two places would like the introduction of a new plan of work and a survey was conducted for this purpose. Out of a sample of 500 workers at , 62% favoured the new plan. At Mumbai out of a sample 400 workers, 41% were against the new plan. Is there any significant difference between the two groups in their attitude towards the new plan at 5% level?

SECTION – B

9. Answer any three questions of the following. Each question carries 5 marks. $\mathbf{3 \times 5 = 15M}$

(i) From a city population, the probability of selecting (a) a male or a smoker is 7/10, (b) a male smoker is 2/5, and (c) a male, if a smoker is already selected is 2/3. Find the probability of selecting a smoker, if a male is first selected.

(ii) A problem in Statistics is given to three students A, B and C whose chances of solving it are 1/2, 3/4, and 1/4 respectively. What is the probability that the problem will be solved if all of them try independently.

(iii) A random variable X has the following probability function:

Values of X, x	0	1	2	3	4	5	6	7
P(x)	0	K	2k	2k	3k	k^2	$2k^2$	$7k^2 + k$

(a) Find k, and (b) Evaluate $P(X < 6)$, $P(X \geq 6)$.

(iv) Prove that correlation coefficient is lies between± 1.

(v) Explain the procedure for testing of hypothesis.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS II YEAR SEMESTER III

(W.e.f. 2020-2021 Admitted Batch)

M301: FUNCTIONAL ANALYSIS

Course Outcomes: The study of M.Sc. degree programme will enable the students:

1. To discuss the Banach spaces definition with examples, continuous linear transformation, the Hahn- Banach theorem and the natural imbedding of N in N^{**}.
2. To discuss Hilbert spaces the definition and some simple properties, orthogonal complements and orthonormal sets.
3. To explain Finite- dimensional spectral theory Matrices, determinants and the spectrum of an operator and the spectral theorem.

UNIT-I **Banach spaces**: the definition and some examples, continuous linear transformation, the Hahn-Banach theorem, the natural imbedding of N in N^{**}, The open mapping theorem.

(Sections 46 – 50 of chapter 9)

UNIT-II The conjugate of an operator, **Hilbert spaces:** The definition and some simple properties, orthogonal complements, orthonormal sets.

(Sections 51 of chapter 9 and Sections 52- 54 of chapter 10)

UNIT-III The Conjugate space H^*, the ad joint of an operator, Self- ad joint operators, Normal and Unitary operators, Projections.

(Sections 55 - 59 of chapter 10)

UNIT-IV **Finite- dimensional spectral theory:** Matrices, determinants and the spectrum of an operator,the spectral theorem, A survey of the situation.

(Sections 60 - 63 of chapter - 11)

PRESCRIBED TEXT BOOK: Introduction to Topology and Modern Analysis by G.F.Simmons, McGraw Hill Book Company, Inc-International student ed.

REFERENCE TEXT BOOK: First course in functional analysis by Casper-Goffman, George pedrick.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS II YEAR SEMESTER III

(W.e.f. 2020-2021 Admitted Batch)

M301: FUNCTIONAL ANALYSIS

Model Question Paper

Time: 3 hours **Max Marks:** 75

SECTION – A

Answer **ALL** questions. Each question carries 15 marks. $\mathbf{4 \times 15 = 60}$

1. a) Define a Banach Space. Prove that the real linear space R^n is a Banach Space.
   b) In a Banach Space B, prove that the vector addition and scalar multiplication are jointly continuous.

(OR)

2. a) State and prove Hahn-Banach theorem.
   b)Prove that the mapping $X \to F_x : N \to N^{**}$ where $F_x(f) = f(x)$,$\forall f \in N^*$ is an isometric isomorphism of N into N^{**}.
3. a) State and prove open mapping theorem.
   b) State and prove uniform boundedness theorem.

(OR)

4. a)If M and N are two closed linear subspaces of a Hilbert space H such that $M \perp N$ then $M + N$ is also a closed linear subspace of H.
   b) State and prove Bessel's Inequality (finite case).
5. a) Prove that the mapping $y \to f_y$ is a norm preserving mapping of H into H^* where $f_y(x) = \langle x, y \rangle$ for all $x \in H$.
   b) If T is an operator on a Hilbert space H for which $\langle Tx, x \rangle = 0$ for all $x \in H$,then prove that T = 0 on H .

(OR)

6. a)If T is an operator on a Hilbert space H then prove that the following conditions are all equivalent to one another .

(i) $T^{*}T = I$

(ii)$\|Tx\| = \|x\|$

(iii) $(Tx, Ty) = (x, y) \forall x \& y$.

b) Prove that a closed linear subspace M of H is invariant under T an opearator T on H if and Only if $M^{\perp}$ is invariant under T^{*}.

7. a) Prove that two matrices of A_n are similar if and only if they are the matrices of a single opearator on H relative to (possibly) different bases.

b) Prove that an operator T on H is singular if and only if $\theta \in \sigma(T)$.

(OR)

8. State and prove Spectral theorem.

SECTION – B

9. Answer any **THREE** of the following. Each Question carries 5 marks. $\mathbf{3 \times 5 = 15M}$

a) Prove that every normal linear space is a metric space.

b) State and prove Schwartz inequality.

c) Define an orthogonal set in a Hilbert space H and given an example.

d) Define Eigen value and Eigen vector.

e) Let T be an operator on a Hilbert space H be such that adjoint T* of T is a polynomial in T, then prove that T is Normal.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS II YEAR SEMESTER III

(W.e.f. 2020-2021 Admitted Batch)

M302:LEBESGUE THEORY

Course Outcomes: The study of M.Sc. degree programme will enable the students:

1. To discuss Algebra of sets, Lebesgue measure, Outer measure, Measurable set and Lebesgue measure etc.
2. To discuss the Riemann integral, the Lebesgue integral of a bounded function over a set of finite measures etc.
3. To discuss Differentiation of monotonic functions, functions of bounded variation, differentiation of an integral, absolute continuity, Lp- Spaces the Holder's and Minkowski inequalities etc.

UNIT-I : Algebra of sets, Lebesgue measure, Outer measure, Measurable set and Lebesgue measure, a non-measurable set, measurable function, Little woods's Three principles.(Chapter 3)

UNIT-II : The Riemann integral, the Lebesgue integral of a bounded function over a set of finite measures, the integral of a non-negative function, the general Lebesgue integral convergence in measure. (Chapter 4)

UNIT-III : Differentiation of monotonic functions, functions of bounded variation, differentiation of an integral, absolute continuity. (Chapter 5)

UNIT-IV : Lp- Spaces the Holder's and Minkowski inequalities, convergence and completeness

(Chapter 6)

PRESCRIBED TEXT BOOK: H.L.Royden, Real Analysis, Macmillan Publishing Company, New York, Third Edition, 1988.

REFERENCE TEXT BOOK: Real Analysis by H.L.Roydan, P.M.Fitzpatrick

DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS II YEAR SEMESTER III

(W.e.f. 2020-2021 Admitted Batch)

M302: LEBESGUE THEORY

Model Question Paper

Time: 3 hours **Max Marks:** 75

SECTION – A

Answer **ALL** questions. Each question carries 15 marks. $\mathbf{4 \times 15 = 60}$

1. Define measurability of a set and prove that the set of all measurable sets m is a σ –algebra.

(OR)

2. Every Borel set is measurable. In particular each open set and each closed set is measurable.
3. State and prove Lebesgue convergence theorem

(OR)

4. State and prove bounded convergence theorem
5. State and prove Fatou's lemma and hence prove the monotone convergence theorem.

(OR)

6. State and prove Vitali Lemma.
7. State and prove Minkowski Inequality in L^P

(OR)

8. State and prove Riesz – Fischer theorem.

SECTION – B

9. Answer any **THREE** of the following. Each Question carries 5 marks. $\mathbf{3 \times 5 = 15M}$

a) Define the outer measure of a set and prove that if E_1 and E_2 are measurable then $E_1 \cup E_2$ is measurable.

b) Describe the invariance property.

c) Define convergence in measure.

d) If *f* and g are non negative measurable functions, then show that $\int_E cf = c\int_E f$, $c > 0$ and $\int_E (f+g) = \int_E f + \int_E g$.

e) State bounded convergence theorem and monotone convergence theorem.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS II YEAR SEMESTER III

(W.e.f. 2020-2021 Admitted Batch)

M303: ANALYTICAL NUMBER THEORY

Course Outcomes: The study of M.Sc. degree programme will enable the students:

1. To discuss basic concepts of arithemetical functions and dirichlet multiplication like Mobius function μ(n), Euler quotient function φ(n), Mangoldt function $\Lambda(n)$, Multiplicative functions, Liouville's function λ(n), Divisor functions $\sigma_\alpha(n)$- and Generalized convolutions.
2. To explain Averages of arithemetical functions, big oh notation, Euler's summation formula, The average order of d(n), The average order of the divisor functions $\sigma_\alpha(n)$, The average order of φ(n), application to the distribution of lattice points visible from the origin and applications to μ (n) and Λ(n).
3. To discuss some elementary theorems on the distributions of prime numbers chebyshev's function ψ(x) and ϑ(x), Relations connecting ϑ(x) and π(x), Some equivalent forms of the prime number theorem, Shapiro's Tauberian theorem, Definition and basic properties of congruences, Euler-Fermat theorem, Polynomial congruences modulo p. Lagrange's theorem and it's applications, Chinese remainder Theorem and it's applications etc.

UNIT-I:ARITHMETICAL FUNCTIONS AND DIRICHLET MULTPLICATION :-Introduction – The Mobius function μ (n).-The Euler quotient function φ(n)-A relation connecting φ and μ- A product formula for φ(n)-The Dirichlet product of arithmetical functions- Dirichlet inverses and the Mobius inversion formula- The mangoldt function $\Lambda(n)$- multiplicative functions- multiplicative function and Dirichlet multiplication – The inverse of a completely multiplicative function- Liouville's function λ(n)- The divisor functions $\sigma_\alpha(n)$- Generalized convolutions.

(Sections 2.1 – 2.14 of chapter 2)

UNIT-II : AVERAGES OF ARITHMETICAL FUNCTIONS:- Introduction- The big oh notation. Asymptotic equality of functions – Euler's summation formula – Some elementary asymptotic formulas – The average order of d(n)-The average order of the divisor functions $\boldsymbol{\sigma_{\alpha}(n)}$- The average order of φ(n)-An application to the distribution of lattice points visible from the origin– the average order of μ (n) and $\wedge(\boldsymbol{n})$– The partial sums of a Dirichlet product- Applications to μ (n) and $\wedge(\boldsymbol{n})$– Another identity for the partial sums of a Dirichlet product.

(Sections 3.1 – 3.12 of chapter 3)

UNIT-III :SOME ELEMENTARY THEOREMS ON THE DISTRIBUTION OF PRIME NUMEBRS:- Introduction – chebyshev's function ψ(x) and $\vartheta(x)$- Relations connecting $\vartheta(x)$ and π(x) – Some equivalent forms of the prime number theorem - Inequalities for π(n) and p_n – Shapiro's Tauberian theorem – Applications of Shapiro's theorem – An asymptotic formula for the partial sums$\sum_{p\leq x}(1/p)$- The partial sums of the Mobius function- Selberg's asymptotic formula.

(Sections 4.1 to 4.9 and 4.11 of Chapter 4)

UNIT-IV : CONGRUENCES :- Definition and basic properties of congruences – Residue classes and complete residue systems – linear congruences – Reduced residue systems and the Euler-Fermat theorem – Polynomial congruences modulo p. Lagrange's theorem –Applications of Lagrage's theorem – Simultaneous linear congruences. The Chinese remainder Theorem- Applications of the Chinese remainder Theorem – Polynomial congruences with prime power moduli.

(Sections 5.1 – 5.9 of chapter 5)

Additional Input: Selberg's asymptotic formula.

PRESCRIBED TEXT BOOK : Introduction to Analytic Number Theory – By T.M.APOSTOL – Springer Verlag New York, Heidlberg – Berlin – 1976.

REFERENCE TEXT BOOK: Analytical Number Theory: An Introductory course by Harold G.Diamond and Paul T.Bateman.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS II YEAR SEMESTER III

(W.e.f. 2020-2021 Admitted Batch)

M303: ANALYTICAL NUMBER THEORY

Model Question Paper

Time: 3 hours **Max Marks:** 75

SECTION – A

Answer **ALL** questions. Each question carries 15 marks. $\mathbf{4 \times 15 = 60}$

1. Define Euler totient function and prove if $n \geq 1$ then $\sum_{d/n} \emptyset(d) = n$ and also prove $\emptyset(p^{\propto}) = p^{\propto} - p^{\propto-1}$ for prime p and $\propto \geq 1$.

(OR)

2. Define Multiplicative function and prove both g and $f * g$ are multiplicative then f is also multiplicative.
3. State and prove Euler summation formula.

(OR)

4. Prove that for $x \geq 2$ we have $\sum_{p \leq x} \left[\frac{x}{p}\right] logp = xlogx + O(x)$ where the sum is extended over all primes $\leq x$.
5. Let p_n denote the n[th] prime then the following asymptotic relations are logically equivalent $\lim_{x\to\infty} \frac{\pi(x)logx}{x} = 1$ $\lim_{x\to\infty} \frac{\pi(x)log\pi(x)}{x} = 1$ $\lim_{x\to\infty} \frac{p_n}{nlogn} = 1$

(OR)

6. For $n \geq 1$ the n[th] prime p_n satisfies the inequalities $$\frac{1}{6}nlogn < p_n < 12\left(nlogn + nlog\frac{12}{e}\right)$$
7. State and prove Lagrange's theorem.

(OR)

8. State and prove Chinese remainder theorem.

SECTION – B

9. Answer any **THREE** of the following. Each Question carries 5 marks. $\mathbf{3 \times 5 = 15M}$

(a) State and prove Generalized inversion formula.

(b) If $x \geq 1$ then prove that $\sum_{n \leq x} \frac{1}{n^s} = \frac{x^{1-s}}{1-s} + C(s) + O(x^{-s})$ if $s > 0, s \neq 1$.

(c) For $x > 0$ then prove that $0 \leq \frac{\varphi(x)}{x} - \frac{\vartheta(x)}{x} \leq \frac{(logx)^2}{2\sqrt{x}log2}$.

(d) Solve the congruence $5x \equiv 3(mod24)$.

(e) State and prove Wilson’s theorem.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS II YEAR SEMESTER III

(W.e.f. 2020-2021 Admitted Batch)

M304:PARTIAL DIFFERENTIAL EQUATIONS

Course Outcomes: The study of M.Sc. degree programme will enable the students:

1. To discuss about basics of partial differential equations and method of solutions of dx/P = dy/Q = dz/R and know about pfaffian differential forms and equations and their solutions in three variables.
2. To describe linear & non-linear equations of the first order and solving the orthogonal surfaces and compatible systems of first order equations further more about some methods like,charpit's method,jacobi's method.
3. To solve the second order partial differential equations and discuss about solutions f linear hyperbolic equations and explaining method of separation of variables,monger's method and further more about Laplace equation and some elementary solutions and solving boundary value problems and more about wave equation and elementary solution in one dimensional form.

UNIT I: Introduction, Methods of Solution of dx/P = dy/Q = dz/R, Orthogonal trajectories of a system of curves on a surface, Pfaffian Differential forms and equations, Solutions of Pfaffian differential equations in three variables, Cauchy's problem for first order partial differential equations.

(Sections 3 to 6 of Chapter 1, Sections 1 to 3 of Chapter 2)

UNIT II: Linear Equations of the first order, Integral surfaces, orthogonal surfaces, non linear partial differential equations of the first order, Cauchy's method of characteristics, Compatible systems of first order equations, Charpit's Method, Special types of first order equations, Jacobi's method.

(Sections 4 to 13 of Chapter 2)

UNIT III: Partial Differential Equations of the second order, Their origin, Linear partial Differential equations with constant and variable coefficients, Solutions of linear hyperbolic equations, Method of separation of variables, Monger's method. (Sections 1 to 5 and Sections 8,9,11 of Chapter 3)

UNIT IV: Laplace Equation, elementary solutions, families of equipotential surfaces, Boundary value problems, Method of separation of variables of solving Laplace equation, problems with axial symmetry, Kelvin's inversion theorem, The wave equation, Elementary solution in one dimensional form, Riemann-Volterra solution of one dimensional wave equation, The theory of Green's function for laplace's equation.

(Sections 1 to 8 of Chapter 4 and Sections 1 to 3 of Chapter 5)

Additional Inputs: The theory of Green's function for laplace's equation

PRESCRIBED TEXT BOOK: Elements of Partial Differential Equations by I.N.Sneddon, Mc Graw Hill, International Edition, Mathematics series.

REFERENCE BOOK: Fritz John, Partial Differential Equations, Narosa Publishing House, New Delhi, 1979

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS II YEAR SEMESTER III

(W.e.f. 2020-2021 Admitted Batch)

M304: PARTIAL DIFFERENTIAL EQUATIONS

Model Question Paper

Time: 3 hours **Max Marks:** 75

SECTION – A

Answer **ALL** questions. Each question carries 15 marks. $\mathbf{4 \times 15 = 60}$

1. Find the integral curves of the equations $\frac{dx}{y(x+y)+az} = \frac{dy}{x(x+y)-az} = \frac{dz}{z(x+y)}$.

(OR)

2. A necessary and sufficient condition that there exists between two functions $u(x,y)$ and $v(x,y)$ a relation $F(u,v) = 0$, not involving x or y explicitly is that $\frac{\partial(u,v)}{\partial(x,y)} = 0$.

3. Find the surface which is orthogonal to the one- parameter system $z = cxy(x^2 + y^2)$ and which passes through the hyperbola $x^2 - y^2 = a^2$,$z = 0$.

(OR)

4. Show that the equations $xp - yq = x$

$x^2p + q = xz$ are compatible and find their solution.

5. Reduce the equation

$$y^2\frac{\partial^2 z}{\partial x^2} - 2xy\frac{\partial^2 z}{\partial x \partial y} + x^2\frac{\partial^2 z}{\partial y^2} = \frac{y^2}{x}\frac{\partial z}{\partial x} + \frac{x^2}{y}\frac{\partial z}{\partial y}$$ to canonical form,and hence solve it.

(OR)

6. Solve the equation $rq^2 - 2pqs + tp^2 = pt - qs$.

7. Show that the surface $x^2 + y^2 + z^2 = cx^{\frac{2}{3}}$ can form a family of equipotential surfaces, and find the general form of the corresponding potential function.

(OR)

8. State and prove Kelvin's Inversion theorem.

<u>SECTION – B</u>

9. Answer any **THREE** of the following. Each Question carries 5 marks. $3 \times 5 = 15M$

(a) Eliminate the arbitrary function f from the equation $z = xy + f(x^2 + y^2)$.

(b) Find the general integral of the linear partial differential equation $z(xp - yq) = y^2 - x^2$.

(c) Prove that a pfaffian differential equation in two variables always possesses an integrating factor.

(d) Explain Charpit's method.

(e) Find the D-Alembert's Solution for one dimensional wave equation.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS II YEAR SEMESTER III

(W.e.f. 2020-2021 Admitted Batch)

M305.1 – LATTICE THEORY

UNIT-I: Partially Ordered sets – Diagrams – Special subsets of a poset – length – lower and upper bounds – the minimum and maximum condition – the Jordan Dedekind chain conditions – dimension functions.

(Sections 1 – 9 of Chapter 1)

UNIT-II: Algebras – lattices – the lattice theoretic duality principle – semi lattices – lattices as posets –diagrams of lattices – semi lattices, ideals – bound elements of Lattices – atoms and dual atoms – complements, relative complements, semi complements – irreducible and prime elements of a lattice – the homomorphism of a lattice – axioms systems of lattices.

(Sections 10 - 21 of Chapter 2).

UNIT-III: Completer lattices – complete sub lattices of a completer lattice – conditionally complete lattices – lattices – compact elements, compactly generated lattices – sub algebra lattice of an algebra – closure opoerations – Galois connecitons, Dedekind cuts – partilally ordered sets as topological spaces..

(Sections 22 - 29 of Chapter 3)

UNIT-IV:Distributive lattices – infinitely distributive and completely distributive lattices – modular lattices – characterization of modular and distributive lattices by their sub lattices – distributive sublattices of modular lattices – the isomorphism theorem of modular lattices, coveing conditions- meet representations in modular and distributive lattices – some special subclasses of the class of modular lattices – preliminary theorems – modular lattices of locally finite length– the valuation of a lattice, metric and quasi metric lattices – complemented modular lattices.

(Sections 30 – 40 of Chapter 4)

PRESCRIBED TEXT BOOK: Introduction to Lattice Theory by Gabor Szasz, Academic Press, New York.

REFERENCE TEXT BOOK :General Lattice theory by G.Gratzer, Academic Press, New York.

DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS II YEAR SEMESTER III

(W.e.f. 2020-2021 Admitted Batch)

M305.1: LATTICE THEORY

Model Question Paper

Time: 3 hours **Max Marks:** 75

SECTION – A

Answer **ALL** questions. Each question carries 15 marks. $\mathbf{4 \times 15 = 60}$

1) Define Partly Ordered Set. State maximum and minimum condition for partly ordered set. Give an example of a poset satisfying minimum condition but failing to satisfy maximum condition.

(OR)

2) State and prove Kuratowski-Zorn Lemma.
3) In a lattice L if we define the order relation "≤ " by a ≤ b ⇔ a ∧ b = a for all a, b ∈ L, show that every finite subset {a1,a2, a3,............. ,an} of L has an infimum and supremum.

(OR)

4) i) In a complemented lattice, show that every join prime element except the least one is an atom.

   ii) Show that, if a homomorphism of a lattice has a kernel, then the kernel is an ideal of the lattice.

5) (i) Prove that every order preserving mapping of a complete lattice into itself has a fix element. (ii)Show that, if we affix bound elements to a conditionally complete lattice, then we obtain a complete lattice.

(OR)

6) Show that every lattice is isomorphic to some sub-lattice of a complete lattice.

7) If H is a non-void subset of a modular lattice L. For the sublattice H of L generated by

H to be distributive, it is necessary and sufficient that for every finite distributive, it is

necessary and

sufficient that for every finite subsystem $\{x_1, x_2 \dots . x_m, y_1, y_2, \dots . . y_n\}$ of H $\bigcup_{j=1}^{m} x_j \cap \bigcap_{k=1}^{n} y_k = \bigcup_{j=1}^{m} (x_j \cap \bigcap_{k=1}^{n} y_k)$

(OR)

8) (i) Show that a lattice is distributive if and only if every triplet of its elements has a median.

(ii)Show that every element of a distributive lattice has at most one irredundant meet representation.

SECTION – B

9)Answer any three of the following .Each question carries 5 marks. $\mathbf{3 \times 5 = 15}$

(a) Define a Lattice. Give two examples.

(b) Show that every uniquely complemented lattice is weakly complemented.

(c) Define the concepts of (i) an atom (ii) a dual atom and (iii) an atomic lattice

(d) Show that every complete lattice is bounded.

(e) A lattice L is modular if and only if every triplet a, b, c of L satisfies

a ∪ (b ∩ (a ∪ c)) = (a ∪ b) ∩ (a∪ c)

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS II YEAR SEMESTER III

(W.e.f. 2020-2021 Admitted Batch)

M305.2: COMMUTATIVE ALGEBRA

Course Outcomes: The study of M.Sc. degree programme will enable the students:

1. To explain the concepts of Rings and ring homomorphism, ideals, quotient rings, prime ideals and Maximal ideals, nil radical and Jacobson radical.
2. To study Modules and module homomorphisms, Sub modules and quotient modules, operations on submodules, direct sum and product, finitely generated modules and exact sequences.
3. To discuss the topics Local Properties, Extended and Contracted ideals in rings of fractions and Primary decompostitions.

UNIT-I : Rings and ring homomorphism, ideals, quotient rings, zero divisors, Nilpotent elements, units, prime ideals and Maximal ideals, nil radical and Jacobson radical, operations on ideals, Extensions and contractions.

UNIT-II : Modules and module homomorphisms, Sub modules and quotient modules, operations on submodules, direct sum and product, finitely generated modules, exact sequences, Tensor product of modules, Restriction and extension of scalars, Exactness properties of the tensor product, algebras, tensor product of algebras.

UNIT-III : Local Properties, Extended and Contracted ideals in rings of fractions.

UNIT-IV : Primary decompostitions, ***Integral Dependence*** (Content and extent of chapters 1 to 4 of the prescribed text book)

Additional Inputs: Integral Dependence.

PRESCRIBED TEXT BOOK: Introduction to commutative algebra, M.F.ATIYAH and I.G.MACDONALD,

Addision – Wesley publishing Company, London.**REFERENCE TEXT BOOK:** Commutative Algebra book by Hideyuki Matsumura.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS II YEAR SEMESTER III

(W.e.f. 2020-2021 Admitted Batch)

M305.2: COMMUTATAIVE ALGEBRA

Model Question Paper

Time: 3 hours **Max Marks:** 75

SECTION – A

Answer **ALL** questions. Each question carries 15 marks. $\mathbf{4 \times 15 = 60}$

1. Prove that the nilradical of A is the intersection of all the prime ideals of A.

(OR)

2. Let A$\neq$ 0 be a ring then prove that the following are equivalent
   i) A is a field
   ii) The only ideals in A are (0) & (1)
   iii)Every homomorphism of A into a non-zero ring B is injective.

3. a) State and prove Nakayamas lemma.
   b) Let M be a finitely generated A-module and N be a submodule of M..let I be an idel of A contained in the Jacobson radical Rof A then M=IM+N implies M=N.

(OR)

4. a) If L contains M contains N are A-modules then(L/N)≅.(L/M)
   b) If M_1,M_2 are sub modules of M then M_1+M_2/M_1 ≅ M_2/ $M_1 \cap M_2$.
5. Let M be an A-module then the following are equivalent
   (i) M=0
   (ii) M_p=0 for all prime ideals p of A
   (iii) M_m=0 for all maximal ideals m of A.

(OR)

6. Prove that the operation S^{-1} commutes with formation of finite sums Products intersections and radicals.
7. a) State and prove First uniqueness theorem.

   b) Let I be a p-primary ,x is an element of A then

   (i) x∈I then (I:x)=(1).

   (ii) if x∉ I then (I:x) is p-primary and therefore r(I:x) = p.

   (iii) if x∉ p then (I:x)=I.

(OR)

8. Let S be a M.C.S of A and q be a primary ideal then
   (i) S∩P≠ ∅ ⇒ S^{-1}q=S^{-1}A
   (ii) S∩P=∅ ⇒ s^{-1}q is s^{-1}p- primary and its contraction in A is q.

SECTION – B

9. Answer any three of the following. Each question carries 5 marks. $\mathbf{3 \times 5 = 15}$
   a) x∈R iff 1-xy is a unit in A ∀ y∈A.
   b) Every ring A≠0 has atleast one maximal ideal.
   c) Let M be a finitely generated A-Module and let I be an ideal of A such that IM=M then there exists x≅ 1(mod I)suchthat xM=0.
   d) Show that $S^{-1}A$ is a flat A-module.
   e) Let q be a primary ideal in a ring A then r(q) is the smallest prime ideal Containing q.

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M.Sc. MATHEMATICS II YEAR SEMESTER III

(W.e.f. 2020-2021 Admitted Batch)

M305.3: COMPLEX ANALYSIS - II

UNIT-I: The maximum modulus theorem: The maximum principle – Schwarz's lemma – convex

function's and hadamard's three circles theorem – Phargmem – Lindelof theorem.

(1,2,3,4 of chapter-VI)

UNIT-II:Compactness and Convergence in the Space of Analytic Functions: The space of continuous function C (G, Ω) – Spaces of Analytic functions – spaces of meromorhic functions – The Riemann Mapping Theorem – Weierstrass factorization theorem – Factorization of sine functions. .

(1,2,3,4,5,6 of chapter-VII)

UNIT-III: Runge's Theorem : Runge's Theorem – Simple connectedness – Mittang – Leffler's Theorem, Analytic Continuatin and Riemann Surfaces, Schwarz Reflection Principle – Analytic Continuatin Along A Path – Mondraomy Theorem..

(1,2,3 of chapter-VIII and 1,2,3 of chapter IX)

UNIT-IV:Harmonic Functions : Basic properties of Harmonic functions – Harmnic functions on a disk. Jenson's formula, the genus and the order of an entire function Hadamard's factorization theorem. .

(1,2, of chapter-X and 1,2,3 of chapter XI)

PRESCRIBED TEXT BOOK: Functions of one complex variables by J.B.Conway : Second edition, Springer International student Edition, Narosa Publishing House, New Delhi

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M.Sc. MATHEMATICS II YEAR SEMESTER III

(W.e.f. 2020-2021 Admitted Batch)

M 305.4- SEMI GROUPS- I

UNIT-I: Basic definition, monogenic semigroups, ordered sets,

semilatttices and lattices, binary relations,equivalences and congruences.

UNIT-II : Free semigroups, Ideals and Rees' congruences, Lattices of equivalences and congruences. Green's equivalences, the structure of D-classes, regular semigroups.

UNIT-III : Simple and 0-simple semigroups, Principal factors, Rees' theorem, Primitive idempotents.

UNIT-IV : Congruences on completely 0-simple semi groups, The lattice of congruences on a completely 0-simple semigroup, Finite congruence free semigroups.

Contents of the syllabus-Chapters 1,2 and 3 of the text book.

PRESCRIBED TEXT BOOK: An introduction to semi group theory by J.M. Howie, 1976, Academic press, New York.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS II YEAR SEMESTER IV

(W.e.f. 2020-2021 Admitted Batch)

M401:MEASURE THEORY

Course Outcomes: The study of M.Sc. degree programme will enable the students:

1. To discuss Convergence and Completeness, Measure spaces, Measurable functions, Integration, General convergence Theorems.
2. To discuss Signed Measures, The Raydon-Nikodym Theorem, the Lp spaces, Outer Measure and Measurability, The Extension theorem, The Lebesgue - Stieltjes Integral and Product measures.
3. To discuss Integral Operators, Inner Measure, Extension by sets of measure zero, caratheodory outer measure and Hausdroff Measure.

UNIT- I : Convergence and Completeness, Measure spaces, Measurable functions, Integration, General convergence Theorems. [Section 3 of Chapter 6, Section 1 to 4 of Chapter 11 of the text book]

UNIT- II : Signed Measures, The Raydon-Nikodym Theorem, the Lp spaces. [Sections 5 to 7 of Chapter 11 of the text book]

UNIT- III : Outer Measure and Measurability, The Extension theorem, The Lebesgue - Stieltjes Integral, Product measures. [Sections 1 to 4 of Chapter 12 of the text book]

UNIT- IV : Integral Operators, Inner Measure, Extension by sets of measure zero, caratheodory outer measure, Hausdroff Measure.
[Sections 5 to 9 of Chapter 12 of the text book]

PRESCRIBED TEXT BOOK: Real Analysis by H. L. Royden, Macmillan Publishing Co. Inc. 3 rd Edition, New York, 1988.

REFERENCE TEXT BOOK: Real Analysis by H.L.Roydan, P.M.Fitzpatrick

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M.Sc. MATHEMATICS II YEAR SEMESTER IV

(W.e.f. 2020-2021 Admitted Batch)

M401: MEASURE THEORY

Model Question Paper

Time: 3 hours **Max Marks:** 75

SECTION – A

Answer **ALL** questions. Each question carries 15 marks. $\mathbf{4 \times 15 = 60}$

1. a) Prove that a normed linear space X is complete if and only if every absolutely summable series is summable.

   b) Let (X,) be measurable space and f be an extended real valued function defined on X then prove that the following statements are equivalent.

   (i) {x / f(x) < α} € $\mathfrak{B}$ for each α.

   (ii) {x / f(x) ≤ α} € $\mathfrak{B}$ for each α.

   (iii) {x / f(x) > α} € $\mathfrak{B}$ for each α.

   (iv) {x / f(x) ≥ α} € $\mathfrak{B}$ for each α.

(OR)

2. a) State and prove Fatous lemma.

   b) If (X,$\mathfrak{B}$,u) is any measure space then there exist a complete measure space $(X, \mathcal{B}_0, \mu_0)$ such that

   i) $\mathfrak{B} \subseteq \mathfrak{B}_0$

   ii) If B € $\mathfrak{B}$ then u (B) = u_0(B)

   iii) E € $\mathfrak{B}_0$ iff E = AU B then B € $\mathfrak{B}$ and A ⊆ C for some C € $\mathfrak{B}$ with u (C) = 0.

3. a) Let E be a measurable set such that $0 < \gamma(E) < \infty$. Then prove that there is a positive set A contained in E with $\gamma(A) > 0$.

b) State and prove Hahn Decomposition theorem.

(OR)

4. State and prove Riesz representation theorem.

5. a) Prove that the class $\mathfrak{B}$ of $\mathcal{u}^*$ measurable sets is a σ- algebra.

b) Let $\mathcal{u}$ be a measure on an algebra $\mathcal{G}$ and μ^* be a outer measure induced by $\mathcal{u}$ and E is any set then for any $\in > 0$ $\exists$ a set $A \in \mathcal{G}_\sigma$ with E $\subseteq$ A and $\mu^*(A) \leq \mu^*(E) + \in$ also there is a set $\mathcal{B} \in \mathcal{G}_{\sigma\delta}$ with $E \subseteq \mathcal{B}$ and $\mu^*(E) = \mu^*(\mathcal{B})$.

(OR)

6. state and prove Tonelli theorem.

7. a) Let E and F be two disjoint sets. Then prove that

$$\mu_*(E) + \mu_*(F) \leq \mu_*(E \cup F) \leq \mu_*(E) + \mu^*(F)$$
$$\leq \mu^*(E \cup F) \leq \mu^*(E) + \mu^*(F).$$

b) Suppose that $\mu^*(E) < \infty$. Then prove that E is measurable if and only if $\mu_*(E) = \mu^*(E)$.

(OR)

8. If $\mathcal{u}^*$ is a caratheodory outer measure with respect to Γ then prove that every function in Γ is $\mathcal{u}^*$ - measurable.

<u>SECTION – B</u>

9. Answer any three of the following. Each question carries 5 marks. $\mathbf{3 \times 5 = 15}$

a). Prove that every σ - finite measure is saturated.

b). Show that the Hahn decomposition need not be unique.

c). Show that if γ is a signed measure such that γ is mutually singular with respect to $\mathcal{u}$ and $\gamma << \mathcal{u}$ then γ =0.

d) .Let B be a $\mathcal{u}^*$ measurable set with $\mu^*(B) < \infty$. Prove that $\mathcal{u}_*(B) = \mathcal{u}^*(B)$.

e). Give an example for an algebra of sets which is not an σ - algebra of sets .Justify.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS II YEAR SEMESTER IV

(W.e.f. 2020-2021 Admitted Batch)

M402: NUMERICAL ANALYSIS

Course Outcomes: The study of M.Sc. degree programme will enable the students:

1. To perform the iterations for the smallest root by using Bisection method, Regulafalsi method, Newton- Raphson method, Mullers method, Chebyshev method, Multipoint iterative method and secant method.
2. To discuss the iterations for the smallest root by using Guass elimination method, Triangularization method, Cholesky method, Lagrange and Newton's divided difference interpolation, sterling and Bessel interpolation, Hermite interpolation, piecewise and Spline Interpolation method.
3. To find the smallest root by using Gauss Legendre Integration method, Euler's method, Taylor series method, Runge kutte second and forth order methods.

UNIT I : Transcendental and polynomial equations: Introduction, Bisection method, Iteration methods based on first degree equation; Secant method, Regulafalsi method, Newton- Raphson method, Iteration method based on second degree equation; Mullers method, Chebyshev method, Multipoint iterative method, Rate of convergence of secant method, Newton Raphson method,

(Section 1 of the Text Book pages 1 to 52 above specified methods only)

UNITII : System of linear algebraic equation: Direct methods, Guass elimination method, Triangularization method, Cholesky method, Partition method, Iteration method: Gauss seidel Iterative method, OR method.

(Section 2 of the Text Book pages 53 to 169 above specified methods only)

UNIT III : Interpolation and Approximation: Introduction, Lagrange and Newton's divided difference interpolation, Finite difference operators, sterling and Bessel interpolation, Hermite interpolation, piecewise and Spline Interpolation, least square approximation.

(Section 3 of the Text Book pages 210 to 300 above specified methods only)

UNIT IV : Numerical Differentiation: methods based on Interpolation, methods based on Finite difference operators Numerical Integration: methods based on Interpolation, Newton's cotes methods, methods based on Undetermined coefficients, Gauss Legendre Integration method, Numerical methods ODE: Single step methods: Euler's method, Taylor series method, Runge kutte second and forth order methods, Multistep methods: Adam Bash forth method, Adam Moulton methods, Milne-Simpson method.

(Section 4 of the Text Book pages 320 to 495 above specified methods only)

PRESCRIBED TEXT BOOK: Numerical Methods for Scientific and Engineering computation by M.K. Jain, S.R.K. Iyengar, R.K. Jain, New Age Int. Ltd., New Delhi.

REFERENCE TEXT BOOK: Introduction to Numerical Analysis, by S.S. Sastry,Prentice Hall Flied.

DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS II YEAR SEMESTER IV

(W.e.f. 2020-2021 Admitted Batch)

M402: NUMERICAL ANALYSIS

Model Question Paper

Time: 3 hours **Max Marks:** 75

SECTION – A

Answer **ALL** questions. Each question carries 15 marks. $\mathbf{4 \times 15 = 60}$

1. Perform five iterations of the bisection method to obtain the smallest positive root of the equation $x^3 - 5x + 1 = 0$.

(OR)

2. Perform four iterations of the Newton-Raphson method to find the smallest positive root of the equation $x^4 - x - 10 = 0$.

3. Solve the system of equations $\begin{bmatrix} 1 & 2 & 3 \\ 2 & 8 & 22 \\ 3 & 22 & 82 \end{bmatrix}\begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 5 \\ 6 \\ -10 \end{bmatrix}$ using the Cholesky method.

   Also determine A^{-1}.

(OR)

4. Find the inverse of the matrix A= $\begin{bmatrix} 2 & 1 & 1 & -2 \\ 4 & 0 & 2 & 1 \\ 3 & 2 & 2 & 0 \\ 1 & 3 & 2 & -1 \end{bmatrix}$ using partition method. Hence, solve the system of equation $AX = b$, where $b = [-10,8,7,-5]^T$

x	f(x)	$f^1(x)$
2	29	50

5. Construct the Hermite interpolation polynomial that fits the data

3	105	105

Interpolate f(x) at $x = 2.5$.

(OR)

6. Obtain the cubic spline approximation for the function defined by the data

x	0	1	2	3
f(x)	1	2	33	244

with $M(0) = 0, M(3) = 0$. Hence find an estimate of f(2.5).

7. Evaluate the integral $= \int_1^2 \frac{2x dx}{1+x^4}$, using the Gauss-Legendre 1-point, 2-point and 3-point quadrature rules. Compare with the exact solution $I = tan^{-1}(4) - (\frac{\pi}{4})$.

(OR)

8. Given the initial value problem $u' = -2tu^2, u(0) = 1$ estimate $u(0.4)$ using
   (i) modified Euler-cauchy method, and
   (ii) Heun method with $h = 0.2$. compare the results with the exact solution $u(t) = \frac{1}{1+t^2}$.

<u>SECTION – B</u>

9. Answer any Three of the following. Each question carries 5 marks. $\mathbf{3 \times 5 = 15}$
   a) Perform two iterations of the Chebyshev method to find an appropriated value of 1/7 . Take the initial approximation as $x_0 = 0.1$
   b) Solve the equations $10x_1 - x_2 + 2x_3 = 4$
   $x_1 + 10x_2 - x_3 = 3$
   $2x_1 + 3x_2 + 20x_3 = 7$
   Using the Gauss elimination method.
   c) Show that (i) $\delta = \nabla(1 - \nabla)^{-1/2}$ (ii) $\mu = \left(\frac{1+\delta^2}{4}\right)^{1/2}$

d) Find the approximate value of $I = \int_0^1 \frac{dx}{1+x}$ using Trapezoidal rule. Obtain a bound for the error. The exact value of $I = ln2 = 0.693147$ correct to six decimal places.

e) For the matrix $A = \begin{bmatrix} 1 & 2 & -2 \\ 1 & 1 & 1 \\ 1 & 3 & -1 \end{bmatrix}$, find all the eigen values.

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M.Sc. MATHEMATICS II YEAR SEMESTER IV

(W.e.f. 2020-2021 Admitted Batch)

M403:GRAPH THEORY

Course Outcomes: The study of M.Sc. degree programme will enable the students:

1. To understand the basic concepts of graphs and about trees & fundamental circuits.
2. To discuss about cutsets & cut vertices and planar & dual graphs, further more ,to learn about the matrix representation of graphs like, Incidence, Circuit,Path and Adjacency matrices of graphs.
3. To explain about the concepts of coloring , covering and partitioning of graphs and at athe end of the chapter we learn about graph theory in operation research.

UNIT-I: Basic concepts, Paths and Circuits, Trees andFundamental Circuits.

[Chapters 1, 2, 3 of the text book]

UNIT-II: Cut Sets and Cut Vertices: Cut sets, Some properties of a cut set, All cut sets in a graph, Fundamental circuits and cut sets, Connectivity and Separability, Network Flows, 1- Isimorphsm, 2-Isomorphsm; Planar and Dual Graphs: Combinatorial Vs Geometric graphs, Planar graphs, Kuratowski's Two graphs, Different Representations of Planar Graphs, Detection of Planarity, Geometric Dual, Combinational Duals of a Graph,

[Chapter 4 and Sections 5.1 to 5.7 of Chapter 5 of the text book]

UNIT-III: Matrix Representation of graphs: Incident matrix of a Graph, Sub Matrices of A(G), Circuit Matrix, Fundamental Circuit Matrix and Rank of B, An Applications to a Switching Network, Cut set matrix, Relationship among A_f, B_f and C_f,, Path Matrix and Adjacency Matrix, Directed Graphs:What is a digraph? Some types of digraph,Matrices A,B & C of digraphs.

[Chapter 7 & 9.1,9.2,9.8 of chapter-9 of the text book]

UNIT-IV: Coloring, Covering and Partitioning: Chromatic Number, Chromatic Partitioning, Chromatic Polynomial, Matchings, Coverings, The four color Problem; Graph Theory in Operation Research: Transport networks, Extensions of Max-flow Min cut theorem, Minimal cost flows.

[Chapter 8 and Sections 14.1 to 14.3 of Chapter 14 of the text book]

Additional Inputs: Directed Graphs:What is a digraph? Some types of digraph,Matrices A,B & C of digraphs.

PRESCRIBED TEXTBOOK: Graph Theory with applications to Engineering and computer Science by Narsingh Deo; Prentice-Hall of India.

REFERENCES: **1.** Graph Theory with applications by Bond JA and Murthy USR, North Holland, NewYork.

2. Introduction to Graph Theory by Donglas B. West. Prentice Hall of India.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS II YEAR SEMESTER IV

(W.e.f. 2020-2021 Admitted Batch)

M403: GRAPH THEORY

Model Question Paper

Time: 3 hours **Max Marks:** 75

SECTION – A

Answer **ALL** questions. Each question carries 15 marks. $\mathbf{4 \times 15 = 60}$

1. a) Explain Konigsberg Bridge Problem.
   b) (i) Define Euler Graph
   (ii) Prove that the number of vertices of odd degree in a graph is always even.

(OR)

2. a) Prove that in a complete graph with n vertices there are $(n-1)/2$ edge disjoint Hamiltonian circuits, if n is odd number ≥ 3.
   b) (i) Define Binary Tree
   (ii) Prove that a tree with n vertices has $n-1$ edges.
3. a) (i) Define cut set and give an example
   (ii) Prove that every circuit has an even number of edges in common with any cut set.
   b) Define 1-Isomorphism.

(OR)

4. a) Prove that a graph has a dual if and only if it is planar.
   b) In any simple connected planar graph with f regions ,n vertices and e edges($e > 2$) then prove that (i) $e \geq \frac{3}{2} f$
   (ii) $e \leq 3n - 6$.
5. a) (i) Define Incidence Matrix.
   (ii) Define fundamental circuit matrix.

b) Let B and A be, respectively, the circuit matrix and the incidence matrix (of a self - loop free graph) whose columns are arranged using the same order of edges. Then prove that, every row of B is orthogonal to every row A, that is, $AB^T = BA^T = 0 \ (mod\ 2)$.

(OR)

6. a) prove that, (i) $B_f = [I_\mu | A_c^T . A_T^{-1^T}]$

(ii) $C_f = A_t^{-1}.A_f$.

b) Prove that in a connected graph, the distance between two vertices v_i and v_j (for $i \neq j$) is k, if and only if k is the smallest integer for which the i,jth entry in X^k is non-zero. That is, $[X^k]_{ij} \neq 0$.

7. a) Prove that a graph with atleast one edge is 2-chromatic if and only if it has no circuit of odd length.

b) Prove that the vertices of every planar graph can be properly colored with five colors.

(OR)

8. a) Let a and b be two nonadjacent vertices in a graph G. Let G' be a graph obtained by adding an edge between $a$and b. Let G'' be a simple graph obtained from G by fusing the vertices a and b together and replacing sets of parallel edges with single edges. Then prove that,

$$P_n(\lambda) \text{of G} = P_n(\lambda) \text{of} G' + P_{n-1}(\lambda) \text{ of} G''.$$

b) State and Prove Max Flow Min Cut Theorem.

SECTION – B

9. Answer any three of the following. Each question carries 5 marks. **$3 \times 5 = 15$**

a) Prove that a graph G with n vertices,$n - 1$ edges, and no circuits is connected.

b) Prove that the complete graph of five vertices is non planar.

c) Define Circuit matrix and give an example.

d) Prove that every tree with two or more vertices is 2-chromatic.

e) Explain Multi Commodity Flow.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS II YEAR SEMESTER IV

(W.e.f. 2020-2021 Admitted Batch)

M404: LINEAR PROGRAMMING

Course Outcomes: The study of M.Sc. degree programme will enable the students:

1. To study the concepts of formulation of Linear Programming problems, Graphical solution, General formulation and Simplex Method.
2. To solve the problems by using the methods two-phase, Big-M, degeneracy, Concept of Duality in Linear Programming, Comparison of solutions of the Dual and its primal.
3. Mathematical formulation of Assignment problem, Reduction theorem, Hungarian Assignment Method, Travelling salesman problem, Mathematical formulation of Transportation problem, North West corner rule, Lowest cost entry method, Vogel's approximation methods,

UNIT I : Definition of O.R, Decision method of O.R, Methodology of O.R, Application of O.R, Concept of Dual Simplex method, Formulation of Linear Programming problems, Graphical solution of Linear Programming problem, General formulation of Linear Programming problems, Standard and Matrix forms of Linear Programming problems, Simplex Method.

[Sections 3.1 to 3.7 of Chapter 3 and Section 5.4 of Chapter 5 of the text book]

UNIT II : Two-phase method, Big-M method, Method to resolve degeneracy in Linear Programming problem, Alternative optimal solutions. Solution of simultaneous equations by simplex Method, Inverse of a Matrix by simplex Method, Concept of Duality in Linear Programming, Comparison of solutions of the Dual and its primal.

[Sections 5.5, 5.7, 5.8, 5.12, 5.13 of Chapter 5 and Sections 7.1, 7.7 of Chapter 7]

UNIT III : Mathematical formulation of Assignment problem, Reduction theorem, Hungarian Assignment Method, Travelling salesman problem, Formulation of Travelling Salesman problem as an Assignment problem, Solution procedure.

[Sections 12.1 to 12.4, 12.9 of Chapter 12 of the text book]

UNIT IV : Mathematical formulation of Transportation problem, Tabular representation, Methods to find initial basic feasible solution, North West corner rule, Lowest cost entry method, Vogel's approximation methods, Optimality test, Method of finding optimal solution, Degeneracy in transportation problem, Method to resolve degeneracy, Unbalanced transportation problem.

[Sections 11.1 to 11.5 and 11.8 to 11.12 of Chapter 11 of the text book]

Additional Inputs: Definition of O.R, Decision method of O.R, Methodology of O.R, Application of O.R, Concept of Dual Simplex method.

PRESCRIBED TEXT BOOKS: S. D. Sharma, Operations Research.

REFERENCE BOOKS:

[1] Kanti Swarup, P. K. Gupta and Manmohan, Operations Research.

[2] H. A. Taha, Operations Research – An Introduction.

DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS II YEAR SEMESTER IV

(W.e.f. 2020-2021 Admitted Batch)

M404: LINEAR PROGRAMMING

Model Question Paper

Time: 3 hours **Max Marks:** 75

SECTION – A

Answer **ALL** questions. Each question carries 15 marks. $\mathbf{4 \times 15 = 60}$

1. Solve the following Linear Programming Problem by using Graphical Method.

   $Max\ Z = 3x_1 + 4x_2$

   Subject to the Constraints

   $4x_1 + 2x_2 \leq 80$

   $2x_1 + 5x_2 \leq 180$

   and $x_1, x_2 \geq 0$.

(OR)

2. Solve the following Linear Programming Problem by using Simplex Method.

   $Max\ Z = 7x_1 + 5x_2$

   Subject to the Constraints

   $x_1 + 2x_2 \leq 6$

   $4x_1 + 3x_2 \leq 12$

   and $x_1, x_2 \geq 0$.

3. Use Big-M Method to solve the following Linear Programming Problem.

   $Min\ Z = 2x_1 + x_2$

   Subject to the Constraints

   $3x_1 + x_2 = 3$

   $4x_1 + 3x_2 \geq 6$

   $x_1 + 2x_2 \leq 3$

   and $x_1, x_2 \geq 0$.

(OR)

4. Apply the principle of Duality to solve the following Linear Programming Problem.
   $Max\ Z = 3x_1 + 4x_2$
   Subject to the Constraints
   $x_1 - x_2 \leq 1$
   $x_1 + x_2 \geq 4$
   $x_1 - 3x_2 \leq 3$ and $x_1, x_2 \geq 0$.
5. Solve the following Assignment Problem.

	JOBS				
	J_1	J_2	J_3	J_4	J_5
MACHINES					
M_1	130	160	190	200	175
M_2	120	135	160	175	130
M_3	110	140	170	185	155
M_4	50	50	80	110	80
M_5	35	55	80	105	70

(OR)

6. Solve the following Travelling Salesman problem so as to minimize the cost per cycle.

	TO ITEM				
	A	B	C	D	E
FROM ITEM					
A	∞	4	7	3	4
B	4	∞	6	3	4
C	7	6	∞	7	5
D	3	3	7	∞	7
E	4	4	5	7	∞

7. Obtain an optimum solution to the following Transportation Problem.

	D	E	F	G	Available
A	11	13	17	14	250
B	16	18	14	10	300
C	21	24	13	10	400
Requirement	200	225	275	250	

(OR)

8. Solve the following Transportation Problem.

$$
\begin{array}{ll}
 & \quad D \quad E \quad F \quad \text{Supply} \\
FROM \begin{array}{c} A \\ B \\ C \end{array} & \begin{bmatrix} 6 & 4 & 1 \\ 3 & 8 & 7 \\ 4 & 4 & 2 \end{bmatrix} \begin{array}{c} 50 \\ 40 \\ 60 \end{array} \\
\text{Demand} & \quad 20 \quad 95 \quad 35
\end{array}
$$

SECTION – B

9. Answer any **Three** of the following. Each question carries 5 marks. $\mathbf{3 \times 5 = 15}$

(a) Explain the concept of Degeneracy in Linear Programming Problem.

(b) Obtain the basic feasible solution of the system

$x_1 + 2x_2 + x_3 = 10$

$x_1 + 3x_2 + 6x_3 = 12$

(c) Describe briefly the general rules for converting any primal into its dual.

(d) Explain an Unbalanced Assignment Problem.

(e) Explain North-West Corner Rule method in Transportation Problem.

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DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS II YEAR SEMESTER IV

(W.e.f. 2020-2021 Admitted Batch)

M405: DISCRETE DYNAMICAL SYSTEMS

Course Outcomes: The study of M.Sc. degree programme will enable the students:

1. To discuss about Phase Portraits, Periodic Points and Stable Sets, Sarkovskii's theorem, Differentiability and its Implications.
2. To explain the concepts of Parameterized Families of Functions and Bifurcations; The Logistic Function Part I, The Logistic Function Part II Topological Conjugacy, The Logistic Function Part III and Newton's method.
3. Be able to write and understand the basic proofs of Numerical solutions of Differential Equations, The Dynamics of Complex functions, Quadratic Family and Mandelbrot Set.

UNIT I : Phase Portraits, Periodic Points and Stable Sets, Sarkovskii's theorem, Differentiability and its Implications [Hyperbolic, Attractive and Repelling Periodic Points]
[Chapters 1,4,5,6]

UNIT II : Parameterized Families of Functions and Bifurcations; The Logistic Function Part I [Cantor Sets], Symbolic Dynamics and Chaos.
[Chapters 7,8,9]

UNIT III : The Logistic Function Part II Topological Conjugacy, The Logistic Function Part III [Period Doubling Cascade], newton's Method
[Chapters 10,11,12]

UNIT IV : Numerical solutions of Differential Equations, The Dynamics of Complex functions [newton's Method in Complex Plane], the Quadratic Family and Mandelbrot Set
[Chapters 13, 15 and Sections 14.3, 14.5]

PRESCRIBED TEXT BOOK : Richard M. Holmgren, A First Course in Discrete Dynamical Systems,Springer Verlag.

REFERENCE TEXT BOOK: Introduction to Dynamical Systems by Michael Brin and Garrett Stuck.

DEPARTMENT OF MATHEMATICS

M.Sc. MATHEMATICS II YEAR SEMESTER IV

(W.e.f. 2020-2021 Admitted Batch)

M405: DISCRETE DYNAMICAL SYSTEMS

Model Question Paper

Time: 3 hours **Max Marks:** 75

SECTION – A

Answer **ALL** questions. Each question carries 15 marks. $\mathbf{4 \times 15 = 60}$

1. (a) Define fixed point and prove that if $I = [a, b]$ be a closed interval and $f: I \to I$ be a continuous function then f has a fixed point in I. (b) Define stable set and prove that the stable set of distinct periodic points do not intersect.

(OR)

2. State and prove Sarkovaskii's Ordering Theorem.
3. (a) Define Saddlenode Bifurcation with suitable example. (b) Define Cantor set and prove that the Cantor Middle-α Set is a Cantor set.

(OR)

4. Let $f: X \to X$ be a topologically transitive and suppose that periodic points of f are dense in X. If X is infinite then f exhibits sensitive dependence on initial conditions.
5. Let D and E be metric spaces, $f: D \to D$, $g: E \to E$ and $\tau: D \to E$ be a topological conjugacy of f and g then (a)$\tau^{-1}: E \to D$ is a topological conjugacy.

   (b) The periodic points of f are dense in D if and only if the periodic points of g are dense in E.

   (c) f is chaotic on D if and only if g is chaotic on E.

(OR)

6. (a) Let $f(x) = ax^2 + bx + c$ and $q(x) = x^2 - A$ where $A = (b^2 - 4ac)$ then $\tau(x) = 2ax + b$ is a topological conjugacy from $N_f(x)$ to $N_q(x)$.

   (b) Prove that the function $\Psi: \Lambda \longrightarrow \Sigma_2$ is topological conjugacy.

7. (a)Let f be a differentiable complex function and p be a fixed point of f. If $|f'(p)| < 1$, then the stable set of p contains a neighbourhood of p.

(b) Let $f(z) = az$ where 'a' is complex number whose module is not 1 and note that 0 is the only fixed point of f and investigate the orbit of z_0 when $z_0 \neq 0$.

(OR)

8. Let $f(z) = e^{i\theta}z$ and z_0 is a nonzero complex number. Show that

(a) z_0 is a periodic point of f if θ is a rational multiple of π.

(b) If θ is a rational multiple of π then z_0 is not a periodic point of f and its orbit is dense in the circle containing z_0.

SECTION – B

9. Answer any **Three** of the following. Each question carries 5 marks. $\mathbf{3 \times 5 = 15}$

(a) Define Discrete Dynamical system and give three examples.

(b) Define Shift map and prove that shift map is continuous

(c) If D and E be metric spaces, $f: D \to D$, $g: E \to E$ and $\tau: D \to E$ be a topological conjugacy of f and g prove that f is topological transitive on D iff g is topological transitive on E.

(d) Define attracting periodic point and repelling periodic point.

(e) Prove that $h(x) = rx(1-x)$ is chaotic on Λ when $4 < r \leq 2 \pm \sqrt{5}$.

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M.Sc. MATHEMATICS II YEAR SEMESTER IV

(W.e.f. 2020-2021 Admitted Batch)

M405.2 : OPERATOR THEORY

UNIT I : Banach fixed point theorem- application of Banach's theorem to linear equations - application of Banach's theorem to differential equations-application of Banach's theorem to integral equations.

[Chapter 5 of the text book]

UNIT II: Approximation in normed spaces-Uniqueness, strict convexity-uniform approximation
Chebyshev polynomials – Splines.

[Sections 6.1 to 6.4 and 6.6 of Chapter 6 of the text book]

UNIT III : Spectral theory in finite dimensional Normed spaces-basic concepts-spectral properties of bounded linear operators-further properties of Resovent and spectrum-use of complex analysis in spectral theory.

[Sections 7.1 to 7.5 of Chapter 7 of the text book]

UNIT IV: Compact linear operator of normed spaces-Further properties of compact linear operators Spectral properties of compact linear operators on normed spaces-further spectral properties of compact linear operators**.**

[Sections 8.1 to 8.4 of Chapter 8 of the text book.]

PRESCRIBED TEXT BOOK:

Introductory Functional Analysis and Applications by Kreyszig, John Wiley and Sons, Delhi, 2001.

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M405.3 - ADVANCED DIFFERENTIAL EQUATIONS

UNIT I : Boundary value problems: Preliminaries – Sturm – Liouville Problem – Green’s function –

Application of Boundary Value Problem – Picard’s theorem.

[Chapter 7 of prescribed text book.]

UNIT II :Oscillations of second order equations: Fundamental results – Sturm’s Comparisons theorem

– Elementary linear oscillations – Comparisons theorem of Hille – Wintner – oscillations of x” + a (t) x = 0..

[Chapter 8 of prescribed text book.]

UNIT III :Stability of linear and nonlinear systems: preliminaries – Elementary critical points – system of equations with constant coefficients – Linear equation with constant coefficients – Lyapunov stability – stability of quasi linear systems – second order linear differential equations**.**

[Chapter 9 of prescribed text book.]

UNIT IV :Equations with deviating arguments: Preliminaries – equations with constant delay – Equations

with piecewise constant delay – a few other types of delay equations.

[Chapter 11 of prescribed text book.]

PRESCRIBED TEXT BOOK:

S.G. Deo, V. Lakshmikantham and V. Raghavendra: Text book of ordinary Differential equations, Second edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1997.

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(W.e.f. 2020-2021 Admitted Batch)

M405.4 NONLINEAR FUNCTIONAL ANALYSIS

UNIT-I : Various forms of continuity- Geometry in normed spaces and duality mapping, Nemytskii,

Hammerstein and Urysohn operators.

Chapter 1 of the textbook

UNIT-II :Gateaux and Frechet derivative, Properties of derivative, Taylor's theorem, Inverse function

theorem and Implicit function theorem, Sub differential of convex functions.

Chapapter 2 of the text book

UNIT-III :Banach's contraction principle and its genrerliation, Nonexpansive mappings, Fixed point theorems of Brouwer and Schauder.

Secions 4.1 to 4.3 of Chapter 4 of the text book.

UNIT-IV:Fixed point theorems for multifunctions, common fixed point theorems, Sequences of contractions, generalized contractions and fixed points.

Sections 4.4 to 4.6 of Chapter 4 of the textbook.

PRESCRIBED TEXT BOOK:

Joshi, Mohan C., and Ramendra K. Bose. Some topics in nonlinear functional analysis. John

Wiley & Sons, 1985.