KARNATAK UNIVERSITY, DHARWAD

'A' Grade
NAAC Accredited 2008

Regulations and Syllabus

for

P.G. Department of Studies in

MATHEMATICS

(I to IV Semesters)

Under Choice Based Credit System

From

2011-12 & onwards

KARNATAK UNIVERSITY, DHARWAD

Post Graduate Department of Studies in Mathematics

SYLLABUS & REGULATIONS

For

M.A. / M.Sc. (MATHEMATICS)

(Choice Based Credit System)

w.e.f. 2008-2009

Regulations and Scheme of Examination

for

M.A. / M.Sc. (Mathematics) Degree Course under

Choice Based Credit System (CBCS)

1.0. Duration of the Course:

The M.A. / M.Sc. Degree Course is of two years duration, spread over four semesters each of four months duration.

1.2 (A) Eligibility for Admission:

B.A. / B.Sc. Graduates of Karnatak University or of any other University recognized as equivalent there to with Mathematics as optional subject. The candidate should have obtained at least 45% of marks in optional subjects as well as in aggregate. Relaxation in respect of SC / ST / Cat-I etc. will be followed as per prevailing rules of the University.

(B) Admission:

(i) **Intake:** 70 students (but may vary from time to time with the permission from the University) for the first semester. This includes admission under enhanced fee structure. Other rules for admission are as per University notification from time to time.

(ii) **Admission to other Semesters:** Students are allowed to take admissions to successive semesters under carry over benefit (COB) facility.

2. Attendance:

Every student must have at least 75% attendance in each of the courses (Theory & Practical) in each semester. Shortage of attendance will be dealt with as per the University rules from time to time.

3. Medium of Instruction:

The medium of instruction shall be English.

4. Scheme of Instructions:

In the First three Semesters (I, II, III) there will be 3 Core Theory Papers of 4 credits each. In addition, in the I Semester there will be 3 Core Theory Papers of 2 credits each. In each of the II and III Semesters there will be 2 Core Theory Papers of 2 credits each.

In IV Semester there will be 4 Core Theory Papers of 4 credits each, 3 Core Theory Papers of 2 credits each.

In each of II, III, IV Semesters there will be 1 Core Practical Paper of 2 Credits.

In each of I, II, III Semesters there will be two Elective Theory Papers of 4 and 2 Credits. These elective papers have to be chosen by the students of other departments.

Our M.A. / M.Sc. students have to take electives of 6 Credits in each of I, II, III Semesters offered by other departments.

5. Scheme of Evaluation:

Examination will be conducted at the end of each semester.

Each Core theory paper of credits 4 and 2 will have an examination of 3 and 2 hours duration respectively and carrying maximum of 75 marks and 35 marks respectively. Each Core practical will have examination of 2 hours duration.

For each theory / practical of 4 and 2 credits, there will be an internal assessment test carrying 25 and 15 marks respectively.

Each elective paper of 4 credits will have examination of 3 hours duration carrying 75 marks and will have internal assessment test for 25 marks.

Each elective paper of 2 credits will have examination of 2 hours carrying 35 marks and will have Internal Assessment Test for 15 marks.

6. Maximum period for the completion of the Degree Programme:

There shall be fully carry over system from first through fourth semesters. Maximum number of years for a student to complete the degree is as specified by the University from time to time.

8. The General Regulations Governing Post-Graduate Programmes under CBCS and Regulations Governing Post-Graduate Programmes in the Faculty of Science and Technology under CBCS of Karnatak University, Dharwad are applicable to this course for all the matters not covered under this.

Regulations Governing Post-Graduate Programmes in the Faculty of Science & Technology under Choice Based Credit System
(*Framed under Section 44(1)(c) of the K.S.U. Act 2000*)

1.1. Title

These Regulations shall be called "Regulations Governing the Post-Graduate Programmes in the Faculty of Science & Technology under the Choice Based Credit System" in Karnatak University, Dharwad.

2.0. Commencement

These Regulations shall come into force with effect from the academic year 2011-12.

3.0. Definitions

a. In these Regulations, unless otherwise provided: "Academic Council" means Academic Council of the University constituted according to the Karnataka State Universities Act, 2000.

b. "Board of Studies" means P.G. Board of Studies of the University, Adhoc / Combined and Steering Committees of International Diploma Programmes in the discipline / subjects concerned.

c. "Compulsory Course" means fundamental paper, which the student admitted to a particular Post-Graduate Programme, should successfully complete to receive the Post Graduate Degree in the concerned subject.

d. "Course Weightage" means number of credits assigned to a particular course.

e. "Credit" means the unit by which the course work is measured. One Credit means one hour of teaching work or two hours of practical work per week. As regards the marks for the courses, 1 Credit is equal to 25 marks, 2 credits are equal to 50 marks, 3 credits are equal to 75 marks and 4 credits are equal to 100 marks.

f. "Cumulative Grade Point Average (CGPA)" refers to the cumulative Grade Point Averages weighted across all the semesters and is carried forward from first semester to subsequent semesters.

g. "Degree" means Post-Graduate Degree.

h. "Grade" is an index to indicate the performance of a student in the selected course. These Grades are arrived at by converting marks scored in each course by the candidate in both Internal Assessment and Semester – end Examinations.

i. "Grade Point Average (GPA)" refers to an indication of the performance of the student in a given semester. GPA is the weighted average of all Grades a student gets in a given semester.

j. "Open Elective Course" means a paper offered by a Department to the students of other Departments.

k. "Post Graduate Programme" means semesterised Master's Degree Programmes excluding P.G. Diploma.

l. "Specialization course" means advanced paper offered by a Department that a student of that Department can opt as a special course.

m. "Student" means the student admitted to programmes under (k).

n. "University" means Karnatak University, Dharwad.

4.0. Minimum Eligibility for Admission

A candidate, who has successfully completed Bachelor's Degree programme in Science or any other Degree programme of this University or of any other University recognized as equivalent thereto by this University, shall be eligible for admission to the Post Graduate Programmes in science provided the candidate also satisfies the conditions like the minimum percentage of marks and other eligibility conditions as prescribed by the University from time to time.

Admissions shall be as per Government of Karnataka reservation policy and the directions issued in this regard from time to time.

5.0. Duration of the Programme

The duration of the study for the Post-Graduate Degree programme shall extend over a period of two (three in case of MCA) consecutive academic years, each academic year comprising two semesters and each semester comprising sixteen weeks with a minimum of ninety working days.

However, the students, who discountinue the programme after one or more semesters due to extraordinary circumstances, are allowed to continue and complete the programme with due approval from the Registrar. Candidates shall not register for any other regular course other than Diploma and Certificate courses being offered on the campus during the duration of P.G. Programme.

6.0. Medium of Instruction and Evaluation

The medium of instruction shall be English. However, the students may write the examinations in Kannada if so provided by the concerned Board of Studies.

7.0. Programme Structure

7.1. The students of Post-Gradute Programme shall study the courses as may be approved by the concerned Board of Studies, Faculty and the Academic Council of the University from time to time subject to minimum and maximum credits as outlined in these regulations.

7.2. There shall be three categories of courses namely, Compulsory Courses, Specialization Courses and Open Elective Courses.

7.3. Each programme shall have a set of Compulsory Courses, as stipulated in the regulations governing the concerned programme, that a student must complete to get the concerned degree.

7.4. In those programmes that offer specialization courses, the students shall choose the prescribed number of Specialization Courses offered within the Department.

7.5. Each Department shall offer Open Elective courses for students of other Departments. The students of a Department shall choose Open Elective courses from among those prescribed by the University and selected by the Department from time to time. P.G. Centers and affiliated colleges, can offer those Open Elective Courses which are approved or prescribed by their Parent Department of the University. Such Open Elective courses shall be taught by qualified teachers approved by the University.

7.6. The credits for each of the Compulsory Courses may vary from 2 to 4; for Specialization Course, from 2 to 4; and for Open Elective Course, from 2 to 4. Wherever project work / field work / practical are involved in the course, the credits ma extend to 6 or as otherwise provided by concerned programme.

7.7. The minimum credits for P.G. Programme shall be 96. In the case of MCA, the minimum number of credits shall be 158 and in case of M.Sc. Computer Science the minimum credits are 116.

7.8. The students shall undertake project / field work during the programme as a compulsory course or in lieu of Specialization Course or Open Elective Course if so specified by the concerned Board of Studies.

7.9. The ratio between Compulsory, Specialization and Open Elective may differ from department to department.

7.10. The detailed programme structure for Faculty of Science & Technology shall be as prescribed and shown in Annexure-I, Annexure-Ia & Annexure-Ib.

7.11. The Open Elective Courses generally will have practical component, unless otherwise specified by the respective Board of Studies. The number of students admitted to the course shall commensurate with the availability of infrastructure.

8.0. Attendance

8.1. Each course shall be taken as a unit for the purpose of calculating the attendance.

8.2. Each student shall sign the attendance register maintained by the Department for each course for every hour / unit of teaching / practical. The course teachers shall submit the monthly attendance report to the Chairperson of the Department who shall notify the same on the notice board of the Department during the second week of the subsequent month.

8.3. Marks shall be awarded to the student for attendance as specified in the regulations concerning evaluation.

8.4. A student shall be considered to have satisfied the required attendance for each course if he / she has attended not less than 75% of the total number of instructional hours during the semester.

8.5. There is no provision for condoning shortage of attendance.

8.6. The students who do not satisfy the prescribed requirement of attendance shall not be eligible for the ensuing examination. Such candidates may seek admission afresh to the given semester.

8.7. Such of the candidates who have participated in State / National level Sports, NSS, NCC, Cultural activities and other related activities as stipulated under the existing regulations shall be considered for giving attendance for actual number of days utilized in such activities (including travel days) subject to the production of certificates from the relevant authorities within two weeks after the event.

9.0. Examination

9.1. There shall be an examination at the end of the each semester. The odd semester examinations shall be conducted by the respective Departments / P.G. Centres / Colleges. The even semester examinations shall be conducted by the University.

9.1.1. Unless otherwise provided, there shall be semester – end examination of 3 hours duration for 75 / 100 marks; 1.5 hours for 50 marks and 2 / 4 hours for 35 / 75 marks practical examination.

9.1.2. Every student shall register for each semester – end examination as per the University Notification by submitting duly completed application form through the proper channel and shall also pay the fees prescribed.

9.1.3. The Office of the Registrar (Evaluation) shall allot the Register Number to the candidate at the 1st semester – end examination. That will be the Register Number of the candidate for all subsequent appearances at semester – end examinations.

9.1.4. The Answer scripts shall be in the safe custody of the University for a maximum period of six months from the date of announcement of results. These shall be disposed off after six months.

9.1.5. The programme under CBCS is a fully carry-over system. A candidate reappearing for either the odd or even semester examinations shall be permitted to take examinations as and when they are conducted (even semester examination in even semester and odd semester examination in odd semester).

9.1.6. Candidates who have failed, remained absent or opted for improvement in any course / courses shall appear for such course / courses in the two immediate successive examinations that are conducted. However, in the case of the candidates appearing for improvement of their marks, the marks secured in the previous examination shall be retained, if the same is higher.

9.1.7. Candidates who desire to challenge the marks awarded to them, in the even semester – end examinations, may do so by submitting an application along with the prescribed fee to the Registrar (Evaluation) within 15 days from announcement of results.

9.2. Odd Semester Examination

9.2.1. There shall be a Board of examiners to set, scrutinize and approve question papers.

9.2.2. The BOE shall scrutinize the question papers submitted in two sets by the paper setters and submit the same to the office of the Registrar (Evaluation).

9.2.3. The office of the Registrar Evaluation shall dispatch the question papers to the Departments / P.G. Centres / Colleges who shall conduct the Examinations according to the Schedule announced by the University.

9.2.4. The Chairperson of the Department / Administrator of the P.G. Centre / Principal of the College shall appoint one of their full time course teachers as Post Graduate Programme (PGP) Coordinator who shall conduct the examinations and arrange for evaluation of answer scripts.

9.2.5. Answer scripts shall be valued by the examiners appointed by the University. However, in those centres where an examiner for a particular course is not available, then the answer scripts of that course shall be dispatched to the office of the Registrar (Evaluation) who shall arrange for valuation of the same.

9.2.6. There shall be single valuation. The examiners (Internal or External) shall value the answer scripts and shall indicate the marks awarded to each question on the answer script.

9.2.7. The Marks List, a copy of the Examination Attendance Sheet and the sealed bundles of the answer scripts shall be dispatched by the PGP Coordinator to the Registrar (Evaluation)'s Office at the conclusion of the valuation at the respective centers.

9.2.8. The Office of the Registrar Evaluation shall process and announce the results.

9.3. Even Semester

9.3.1. There shall be a Board of Examiners to set, scrutinize and approve question papers.

9.3.2. As far as practicable, it will be ensured that 50% of the paper setters and examiners are from other Universities / Research Institutes.

9.3.3. Each answer script of the semester – end examination (theory and project report) shall be assessed by two examiners (one internal and another external). The marks awarded to that answer script shall be the average of these two evaluations. If the difference in marks between two evaluations exceeds 20% of the maximum marks, such a script shall be assessed by a third examiner. The marks allotted by the third examiner shall be averaged with nearer award of the two evaluations.

9.3.4. Provided that in case the number of answer scripts to be referred to the third examiner in a course exceeds minimum of 5 or 20% of the total number of scripts, at the even semester – end examinations, such answer scripts shall be valued by the Board of Examiners on the date to be notified by the Chairperson of the Board of Examiners and the marks awarded by the Board shall be final.

9.3.5. Wherever dissertation / project work is prescribed in the even semesters of a programme, the same shall be evaluated by both internal and external examiners. The evaluation shall be as prescribed by the concerned Board of Studies.

9.3.6. In case of programmes with practical examination details of maximum marks, credits or duration may vary from Department to Department as specified by the concerned Board of Studies.

9.4. Evaluation

9.4.1. Each Course shall have two evaluation components – Internal Assessment (IA) and the Semester End Exams.

9.4.2. The IA component in a course shall carry 25% / 30% / 50% and the Semester End Examination shall carry 75% / 70% / 50% respectively, as the case may be. Courses having 25% & 30% / 50% marks as internal assessment shall have 3 / 5 marks allotted to attendance. However, in case of project work, the distribution of marks for Internal Assessment and Examination shall be left to the discretion of the concerned BOS.

9.4.3. Marks for attendance shall be awarded to the students according to the following table. For courses carrying 25% of marks for IA, the attendance marks shall be

Attendance (in percentage)	Marks
Above 90	3
Above 80 and up to 90	2
Above 75 and up to 80	1

9.4.4. Internal Assessment (IA) shall be based on written tests, practical and seminars. However, the number of IA components per course per semester shall not be less than two.

9.4.5. The IA marks list shall be notified on the Department Notice Board as and when the individual IA components are completed and the consolidated list shall be submitted to the Office of the Registrar Evaluation before the commencement of semester – end examination, or as directed by the University.

9.4.6. The tests shall be written in a separately designated book supplied the University which shall be open for inspection by the students after evaluation.

9.4.7. There is no provision for seeking improvement of Internal Assessment marks.

9.4.8. The IA records, pertaining to Semester Examination, shall be preserved by the department / centres / colleges for a period of one year from the date of semester examination. These records may be called by the University or a body constituted by the University as and when deemed necessary.

9.4.9. The dissertation / project work viva-voce shall be conducted by an internal and external examiner.

10.0. Maximum duration for completion of the Programme

10.1. A candidate admitted to a post graduate programme shall complete it within a period, which is double the duration the programme from the date of admission.

10.2. Whenever the syllabus is revised, the candidate reappearing shall be allowed for the examinations only according to the new syllabus.

11.0. Declaration of Results

11.1. The minimum for a pass in each course shall be 40% of the total marks including both the IA and the semester – end examinations. Further, the candidate shall obtain at least 40% of the marks in the semester – end examination. There is no minimum for the IA marks.

11.2. Candidates shall secure a minimum of 50% in aggregate in all courses of a programme in each semester to successfully complete the programme.

11.3. Candidates shall earn the prescribed number of credits for the programme to qualify for the PG Degree.

11.4. For the purpose of announcing the results, the aggregate of the marks secrured by a candidate in all the semester examinations shall be taken into account. However, Ranks shall not be awarded in case the candidate has not successfully completed each of the semesters in first attempt or has not completed the programme in the stipulated time (vide Regulation 5) or had applied for improvement of results.

12.0. Marks, Credit Points, Grade Points, Grades and Grade Point Average

The Grade points and the grade letters to candidates in each course shall be awarded as follows:

Credit Point (CP): The Credit Point for each course shall be calculated by multiplying the grade point obtained by the credit of the course.
The award of Grade Point Average (GPA) for any student is based on the performance in the whole semester. The student is awarded Grade Point Average for each semester based on the Total Credit Points obtained and the total number of credits opted for. The GPA is calculated by dividing the total credit points earned by the student.

KARNATAK UNIVERSITY, DHARWAD

Department of Mathematics

CHOICE BASED CREDIT SYSTEM (CBCS)

(w.e.f. 2011-12)

Programme Specific Outcomes (PSOs)

After completion of this programme, the student will be able to:

PSO1. Understand the fundamentals in mathematics

PSO2. Capable to develop ideas based on mathematical axioms.

PSO3. Apply different methods for the solution of problems.

PSO4. Able to develop the research studies in mathematics and related areas.

PSO5. Understand the applications of mathematics with problem solving skills, thinking, creativity and demonstration.

Course Structure and Scheme of Examination

Paper Code	Paper & Title	Credits	No. of Hrs/ week Theory/ Practical	Duration of exam in Hrs Theory/ Practical	Internal Assessment Marks Theory/ Practical	Marks at the Exams	Total Marks
	I Semester						
PG83T101	Algebra-I	4	4	3	25	75	100
PG83T102	Real Analysis	4	4	3	25	75	100
PG83T103	Topology-I	4	4	3	25	75	100
PG83T104	Differential Equations-I	2	2	2	15	35	50
PG83T105	Discrete Mathematics	2	2	2	15	35	50
PG83T106	Computer Programming	2	2	2	15	35	50
PG83T107	**Operations Research**	**4**	**4**	**3**	**25**	**75**	**100**
	Total of I Semester	**22**					**550**
	II Semester						
PG83T201	Algebra-II	4	4	3	25	75	100
PG83T202	Complex Analysis-I	4	4	3	25	75	100
PG83T203	Linear Algebra	4	4	3	25	75	100
PG83T204	Functions of Several Variables	2	2	2	15	35	50
PG83T205	Differential Equations-II	2	2	2	15	35	50
PG83P206	Programming Lab-I	2	4	3	15	35	50
PG83T207A	Fuzzy Sets & Fuzzy Logic	4	4	3	25	75	100
	Total of II Semester	**22**					**550**

Paper Code	Paper & Title	Credits	No. of Hrs/ week Theory/ Practical	Duration of exam in Hrs Theory/ Practical	Internal Assessment Marks Theory/ Practical	Marks at the Exams	Total Marks
	III Semester						
PG83T301	Measure Theory	4	4	3	25	75	100
PG83T302	Complex Analysis-II	4	4	3	25	75	100
PG83T303	Topology-II	4	4	3	25	75	100
PG83T304	Differential Geometry-I	2	2	2	15	35	50
PG83T305	Numerical Methods	2	2	2	15	35	50
PG83P306	Programming Lab-II	2	4	3	15	35	50
PG83T307A	Discrete Mathematical Structures	4	4	3	25	75	100
	Total of III Semester	**22**					**550**
	IV Semester						
PG83T401	Functional Analysis	4	4	3	25	75	100
PG83T402A PG83T402B PG83T402C PG83T402D PG83T402E PG83T402F	(a) Fuzzy Topology OR (b) Dimension Theory OR (c) Relativity OR (d) Ring Theory OR (e) Galois Theory OR (f) Number Theory	4	4	3	25	75	100
PG83T403A PG83T403B PG83T403C PG83T403D PG83T403E PG83T403F	(a) Graph Theory OR (b) Differentiable Manifolds OR (c) Nevanlinna Theory OR (d) Geometric Function Theory OR (e) Group Theory OR (f) Commutative Algebra	4	4	3	25	75	100
PG83T404	Differential Equations-III	2	2	2	15	35	50
PG83T405	Differential Geometry-II	2	2	2	15	35	50
PG83T406	Integral Transforms and Integral Equations	2	2	2	15	35	50
PG83P407	Programming Lab - III	2	4	3	15	35	50
PG83T408	Project Work	4	4		25	75	100
	Total of IV Semester	**24**					**600**
	Grand total of all semesters (I to IV)	**90**					**2250**

Note: CT – Compulsory Theory
CP – Compulsory Practical
CPW – Compulsory Project Work
OEC – Open Elective Course (for other Department Students)

Syllabus of M.A. / M.Sc. (Mathematics) under Choice Based Credit System

M.A. / M.Sc. I SEMESTER

CORE PAPERS:

Paper Code and Name: PG83T101: Algebra-I	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. To simplify algebraic expression, using commutative, associative and distributive properties. CO2. Identify the types of group. CO3. Understand the concepts of Sylow's theorem. CO4. Explain and demonstrate accurate and efficient use of advanced techniques. CO5. Prove and explain the concepts from advance algebra	

Unit I: Peano axioms. Natural numbers. Properties of natural numbers. Natural numbers as a well-ordered set. Finite sets and their properties. Infinite sets, countable and uncountable sets. Examples. Cardinal numbers and its arithmetic. Schroeder-Bernstein theorem. Cantor's theorem and continuum hypothesis. Zorn's lemma, Axiom of choice and well-ordering principle and their equivalence.

Unit II: Group, subgroup-definition, examples and elementary properties. Normal subgroup and quotient group. Group homomorphisms. Isomorphism theorems and the correspondence theorem. Center of a group and commutator subgroup of a group. Cyclic group. Lagrange's theorem. Euler's and Fermat's theorems as consequences of Lagrange's theorem. Symmetric group S_n. Structure theorem for symmetric groups. Action of a group on a set. Examples. Orbit and stabilizer of an element.

Unit III: Class equation of a finite group. Cauchy's theorem for finite groups. Sylow theorems. Applications. Wilson's theorem.

Unit IV: Subnormal series of a group. Solvable group. Solvability of S_n. Composition series of a group. Jordan-Holder theorem.

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6) J. J. Rotman, The Theory of Groups, an Introduction, Allya & Bacon (1965)
7) S. Maclane & G. Birkhoff, Algebra, Mc Millan Co., New York (1967)
8) S. M. Srivastava, A Course on Borel Sets (Chapter – I), Springer-Verlag, New York (1998)
9) M. Artin, Algebra, Prentice Hall of India (2004)

Paper Code and Name: PG83T102: Real Analysis	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Describe the real line as a complete ordered field and prove the properties of real numbers. CO2. Understand interior point, limit point, closed set, open set, compact set and prove their properties. CO3. Explain the basic theory of metric space and its related concepts such as continuity, completeness, compactness and connectedness and prove their results in the metric space. CO4. Apply the Mean Value Theorem and the Fundamental Theorem of Calculus to problems in the context of real analysis. CO5. Determine the Riemann integrability of a bounded function and prove theorems concerning integration.	

Unit I: The Completeness Property of R: The Least Upper Bound Property (LUB Property) and the Greatest Lower Bound Property (GLB Property). Archimedean Property. The existence of $\sqrt{2}$. Density of Rational Numbers. Nested Interval Property. Bolzano Weierstrass Theorem. Heine-Borel theorem.

Unit II: Metric spaces. Basic definition. Compactness, connectedness, sequences, subsequences and Cauchy sequences in a metric space. R as a complete metric space. Limit, continuity and connectedness. Kinds of discountinuities. Algebraic completeness of the complex field.

Unit III: Differentiation. Mean value theorems. The continuity of derivatives. Derivatives of higher orders. Taylor's theorem. Analytic functions. Functions of class C^{∞} (which are not analytic).

Unit IV: Riemann-Stieltjes integral, its existence and linearity, the integral as a limit of sum, change of variables. Mean value theorems. Functions of bounded variation. The fundamental theorem of calculus.

Unit V: Absolute and conditional convergence of series. Riemann's derangement theorem. Sequences and series of functions. Uniform convergence. Uniform convergence and continuity, Uniform convergence and integration. Uniform convergence and differentiation. The Stone-Weierstrass theorem.

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5) L. W. Cohen and G. Ehrlich, Real Number System, 'Van Nostrand' (1963)
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Paper Code and Name: PG83T103: Topology-I	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand to construct topological spaces using general properties of open sets, closed sets, neighborhoods, basis and sub-basis and from metric spaces. CO2. Apply the properties of open sets, closed sets, interior points, accumulation points and derived sets in deriving the proofs of various characterizations of topological spaces. CO3. Use continuous functions and homeomorphisms to understand structure of topological spaces CO4. Understand the concepts and properties of the compact, locally compact and connected topological spaces.	

Unit I: Topological Spaces: Topological Spaces, open sets, closed sets, closure, accumulation points, derived sets, interior, boundary. Bases and subbasis, dense sets, closure operator, neighborhood system, subspaces, convergence of sequences.

Unit II: Continuity and other Maps: Continuous maps, continuity at a point, continuous maps into R, open and closed maps, homeomorphisms, finite product spaces, projection maps.

Unit III: Connectedness: Connected and disconnected spaces, separated sets, intermediate value theorem, components, local connectedness, path connectedness.

Separation Axioms: T_0 , T_1 and T_2 spaces.

Unit IV: Compactness: Cover, subcover, compactness, characterizations, invariance of compactness under maps, properties.

Metric Spaces: Metrics on sets, distances between sets, diameters, open spheres. Topology induced by a metric, equivalent metrics, continuity of the distance, convergence in metric spaces.

Nets and Filters: Topology and convergence of nets, Hansdorffness and nets, compactness and nets. Filters, convergence of filters, ultrafilters, Cauchy filters.

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Paper Code and Name: PG83T104: Differential Equations-I	Teaching Hours: 25
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Solve ODE with constant coefficients. CO2. Apply Method of variation of parameters. CO3. Apply Strum comparison theorem. CO4. Apply Picard's method for solution of IVP. CO5. Apply Laplace Transforms to solve ODE.	

Unit I: Second order ordinary differential equations (o.d.e) with constant co-efficients, non homogeneous equations, method of variation of parameters. Wronskian and linearly independent solutions.

Qualitative properties of solutions. Sturm comparison theorem. Picard's method of solution of i.v.p.

Unit II: Laplace transforms – linearity, existence theorem, LT of derivatives and integrals. Shifting theorem. Differentiation and integration of transforms. Convolution theorem. Inverse LT. Solution of o.d.e. and integral equations.

REFERENCES

1) G. F. Simmons, Differential Equations with applications. T.M.H. New Delhi (2002)
2) G. Birkoff and G. C. Rota, Ordinary differential equations Ginn and Co. (1995)
3) E. Kreyszig, Advanced Engineering Mathematics, John Wieley and Sons (2002)
4) J. Cronin, Differential equations, Marcel and Dekkar (1994)
5) F. Ayers, Theory and problems of differential equations, McGraw Hill (1972)
6) E. A. Coddington, Introduction to Ordinary Differential Equations, EEE (1996)

Paper Code and Name: PG83T105: Discrete Mathematics	Teaching Hours: 25
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand Boolean algebra CO2. Apply Coding theory CO3. Understand the Basic Graph theory CO4. Check traversability of a network.	

Unit I: BOOLEAN ALGEBRA AND LATTICES:

Partially ordered sets. Lattices, Complete, Distributive, Complemented lattices. Boolean functions and expressions. Propositional calculus, logical connectives, truth values and tables. Boolean algebra to digital networks and switching circuits.

Coding Theory: Coding of binary information and error detection, Group codes, decoding and error correction.

Unit II: Graph Theory: Basic Concepts: Different types of graphs, subgraphs, walks and connectedness. Degree sequences, directed graphs, distances and self-complementary graphs.

Blocks: Cut-points, bridges and blocks, block graphs and cut-point graphs.

Trees and Connectivity: Characterization of Trees, Spanning Trees, centers and centroids, connectivity, edge connectivity, arboricity and vertex arboricity.

Partitions and Traversability: Eulerian and Hamiltonian graphs.

REFERENCES

1. C. L. Liu: Elements of discrete Mathematics, McGraw Hill, International (1986)
2. B. Kolman, R. C. Busby and S. Ross: Discrete Mathematical structures, Prentice Hall of India, New Delhi (1998)
3. J. P. Tremblay and R. Manohar: Discrete Mathematical structure with Applications to Computer Science, Tata McGraw Hill Edition (1997)
4. K. D. Joshi: Foundations of Discrete Mathematics, Wiley Eastern (1989)
5. J. A. Bonday and U.S.R. Murthy: Graph Theory with Applications, MacMillan, London.
6. N. Deo: Graph Theory with Applications to Engineering and Computer Sciences, Prentice Hall of India.
7. F. Harary, Graph Theory, Narosa Publishing House, New Delhi.

8. L. Lovasz, J. Pelikan, K. Vesztergombi, Discrete Mathematics, Springer, Second Edition (2004)
9. V. Krishnamurthy, Combinatorics, Theory and Applications, Affiliated East-West Press Pvt. Ltd.

Paper Code and Name: PG83T106: Computer Programming	Teaching Hours: 25
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Develop the algorithm. CO2. Understand the computer programming language. CO3. Develop the skill for C-Programming. CO4. Understand the data structure in the programme.	

Unit I: C – Programming:

C – essentials, basic structure of a C – program. Character set, constants and variables, data types, declaration of variables, assignment statement, symbolic constants, arithmetic operators, relational operators, logical operators, assignment operators, increment and decrement operators, conditional operator, arithmetic expressions – evaluation. Input / output operations: reading / writing a character, formatted input / output.

Unit II: Decision making and branching: IF statement, IF ELSE, Nested if ….. else statements, else if ladder, switch statement, the ? : operator, GO TO statement. Decision making and Looping : The while loops, do statement, for statement, jumps in loops. Arrays : one and two dimensional arrays and initialization. Multidimensional arrays, structures, pointers and file handling.

REFERENCES

1) V. Rajaraman, Fundamentals of Computers PHI (1991) (Chapters I, III, IV, IX)
2) E. Balagurusamy, Programming in ANSI – C, Tata McGraw Hill Pub. Co. (1992) (Chapters 1 to 7)
3) B. S. Gottfried, Programming with C, Tata McGraw Hill (Schaum's Outlines) (1998)
4) B. W. Kernighan and D. M. Ritchie, The C programming Language, PHI (1998)
5) G. B. Sanders, Computer Today (1982)
6) M. Cooper, The Spirit of 'C' – An introduction to modern programming Jaico Pub. House (1987)

Paper Code and Name: PG83T107: Operations Research	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Formulate Linear Programming problems. CO2. Apply methods to solve LPP CO3. Understand Transportation Problems and Assignment Problems. CO4. Compute Game Theory Problems. CO5. Use Queuing Theory for Stochastic Process and Markov Chain.	

UNIT-I: Linear Programming: Introduction, Formulation of LPP, General Mathematical model of LPP. Slack and Surplus variables, Canonical and Standard from of LPP, Graphical method, Standard LPP and Basic solution, Fundamental Theorem of LPP, Simplex Algorithm, Big-M method and Revised Simplex Algorithm.

UNIT-II: Concept of duality: Formulation of dual LPP, Duality theorem, Advantages of duality, Dual Simplex Algorithm and Sensitivity Analysis.

UNIT-III: Transportation Problem: Introduction, Transportation Problem, Loops in Transportation Table, Methods for finding initial basic Feasible Solution, Tests for Optimality, Unbounded Transportation Problem.

Assignment problem: Mathematical form of the Assignment Problem, Methods of solving Assignment Problem, Variations of the Assignment Problem.

UNIT-IV: Game Theory: Introduction, 2 x 2 Game, Solution of Game, Network Analysis by Linear Programming, Brow’s Algorithm. Shortest route and Maximal flow Problems, CPM and PERT.

Queuing Theory: Introduction to Stochastic Process, Markov chain, t.p.m., c-k equations, Poisson process, Birth and Death process, Concept of queues, Kendall’s notation, m/m/1, m/m/s queues and their variants.

REFERENCES:

1. H. Taha – Operations Research, ed. III, Mc Millan (1982)
2. B.E. Gillett, Introduction to Operations Research, a Computer Oriented Algorithmic Approach, Tata McGraw Hill (2008)

3. F.S. Hiller & G.J. Liebermann: Introduction to Operations Research, International Editions (1995)
4. C. K. Mustafi: Operations Research, Wiley – Eastern (1998)
5. J. K. Sharma: Operations Research: Theory and Applications, Macmillan India Ltd. (2006)
6. S. D. Sharma: Operations Research, Kedar Nath Ram and Company, Meerut (1996)

M.A. / M.Sc. MATHEMATICS

II – SEMESTER

CORE PAPERS:

Paper Code and Name: PG83T201: Algebra-II	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand rings, ideals, field and Euclidean domain. CO2. Find the roots of polynomials. CO3. Understand the characteristic of rings and fields. CO4. Understand the fundamental concepts of homomorphism and their role in mathematics. CO5. Apply uniqueness theorem.	

Ring Theory:

Unit I: Ring, subring, ideal, factor ring-definition and examples. Homomorphism of rings. Isomorphism theorems. Correspondence theorem. Integral domain, field and embedding of an integral domain in a field. Prime ideal, maximal ideal of a ring. Polynomial ring R[X] over a ring R in an indeterminate X.

Unit II: Principal ideal domain. Euclidean domain. The ring of Gaussian integers as an Euclidean domain. Fermat's theorem. Unique Factorization domain. Primitive polynomial. Gauss lemma. F[X] is a unique factorization domain for a field F. Eisenstein's criterion of irreducibility for polynomials over a UFD.

Field Theory:

Unit III: Field, subfield, prime subfield – definition and examples. Characteristic of a field. Characteristic of a finite field.

Field extensions. Finite extensions. Algebraic extensions. Transitivity theorems. Simple extension.

Unit IV: Roots of polynomials. Splitting field of a polynomial. Existence and uniqueness theorems. Existence of a field with p^n element for a prime p and a positive integer n.

REFERENCES

1) I. N. Herstein, Topics in Algebra, 2nd Edition, John – Wiley & Sons. New York (1975)
2) Surjit Singh & Qazi Zameeruddin, Modern Algebra, Vikas publishing House (1990)
3) S. K. Jain, P. B. Bhattacharya & S. R. Nagpaul, Basic Abstract Algebra, Cambridge University Press (1997)
4) J. J. Rotman, Galois theory, 2nd Edition, Universitext, Springer – Verlag (1998)
5) I. N. Herstein, Abstract Algebra, Maxwell – McMillan Publication (1990)

Paper Code and Name: PG83T202: Complex Analysis-I	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Discuss the convergence of power series expansions. CO2. Use Cauchy's Theorem, and Cauchy's Integral Formulae to solve contour integration. CO3. Express an analytic function in terms of power series in the domain of analyticity. CO4. Understand the characteristic of a complex function in the neighbourhood. CO5. Acquire the skill of contour integration to evaluate complicated real integrals via residue calculus. CO6. Apply Rouches theorem to determine the number of zeros and poles of a meromorphic function in the given domain.	

Unit I: Analytic functions. Cauchy – Riemann equations. Harmonic functions. Harmonic conjugate functions; their relation to analytic functions.

Unit II: Power series. Radius of convergence. Integration and differentiation of power series. Uniqueness of series representation. Relation between power series and analytic functions. Trigonometric exponential and logarithmic functions.

Unit III: Complex line integral. Basic properties. Cauchy's theorem for a triangle. Cauchy's integral formula. Liouville's theorem. Fundamental theorem of algebra. Morera's theorem.

Unit IV: Taylor and Laurent's expansions. Singularities. Poles. Removable and Isolated essential singularities. Classification of singularities using Laurent's expansion. Behaviour of an analytic function in the neighborhood of a singularity. Principles of analytic continuation.

Residue theorem and contour integrals. Argument principle. Rouch's theorem. Its applications.

REFERENCES

1) L. V. Ahlfors, Complex Analysis, Second Edition, McGraw Hill Book Co., New York (1966)
2) John B. Conway, Functions of one Complex variable (second edition) Springer Verlag, New York (1973)
3) E. C. Titchruarsh, Theory of Functions, (second edition) Oxford university Press, N. J. Fairlawn (1939)
4) T. O. Moore and E. H. Hadlock, Complex Analysis, Allied Publishers Ltd. (1993)
5) Serge Lang, Complex Analysis, Addison – Wesley, Publishing Company (1997)

Paper Code and Name: PG83T203: Linear Algebra	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand Vector spaces CO2. Apply Linear Transformations CO3. Compute eigenvalues and eigenvectors CO4. Formulate the diagonalization of matrices.	

Unit I: Definition and examples of vector spaces. Subspaces. Sum and direct sum of subspaces. Linear span. Linear dependence, independence and their basic properties. Basis. Finite dimensional vector spaces. Existence theorem for bases. Invariance of number of elements of a basis set. Dimension. Existence of complementary subspace of a subspace of a finite dimensional vector space. Dimension of sums of subspaces. Quotient space and its dimension.

Unit II: Linear transformations and their representation as matrices. The algebra of linear transformations. The rank nullity theorem. Change of basis. Dual space. Bidual space and natural isomorphism. Adjoint of a linear transformation.

Unit III: Eigenvalues and eigenvectors of a linear transformation. Diagonalization. Annihilator of a subspace. Bilinear, Quadratic and Hermitian forms. Solutions of homogeneous systems of linear equations.

Unit IV: Canonical forms – Similarity of linear transformations. Invariant subspaces. Reduction to triangular forms. Nilpotent transformations. Index of nilpotency. Invariants of a linear transformation. Primary decomposition theorem. Jordan blocks and Jordan forms.

REFERENCES

1) I. N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New York (1975)
2) S. Lang, Introduction to Linear Algebra, 2nd Edition, Springer – Verlag (1986)
3) K. Hoffman and R. Kunze, Linear Algebra, 2nd Edition, Addison Wesley Publishing Co. (1972)
4) Surjit Singh, Liner Algebra, Vikas Publishing House Pvt. Ltd. (1997)
5) L. Smith, Linear Algebra, Springer – Verlag, New York (1984)
6) A. R. Rao and P. Bhimashankaram, Linear Algebra, 2nd Edition, Hindustan Book Agency (2000)

Paper Code and Name: PG83T204: Functions of Several Variables	Teaching Hours: 25
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand inner product space CO2. Apply metric space CO3. Discuss convergence of sequences in R^n CO4. Apply Inverse and Implicit Function Theorem in R^n	

Unit I: Euclidean space $\Re^n$ as a real vector space and a real inner product space. Topology of $\Re^n$. Bolzano – Weierstrass property for $\Re^n$ Heine-Borel Theorem for $\Re^n$ Functions $f : E \to \Re^m$ from a subset E of $\Re^n$ into $\Re^m$.

Unit II: Component functions of f. Limits, continuity and differentiation and their partial derivatives. Contraction principle, inverse function theorem, implicit function theorem, rank theorem. Determinants, Jacobian.

REFERENCES

1. W. Rudin: Principles of Mathematical Analysis, 3rd Edition, McGraw Hill Book Co. (1964)
2. W.R. Wade: An Introduction to Analysis, Second Edition, Prentice Hall of India (International edition) (2000)
3. C. Goffman; Calculus of Several Variables, Harper series (1965)
4. M. Spivak; Calculus on Manifolds, W. A. Benjamin (1965)
5. W. H. Fleming: Functions of Several Variables, Addison Wesley (1968)

Paper Code and Name: PG83T205: Differential Equations-II	Teaching Hours: 25
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand series solution about ordinary and regular singular points. CO2. Apply Power and Frobenius methods. CO3. Understand variable coefficient ODE. CO4. Understand orthogonality of special functions.	

Unit I: Linear second order equations with variable coefficients, solution about ordinary and regular singular points. Frobenius method, Hermite, Legendre, Bessel and Chebyshev equations and their solutions.

Unit II: Sturm-Liouville problem. Orthogonality of eigenfunctions, Bessel, Hermite, Legendre, Chebyshev functions, problems.

REFERENCES

1. G. F. Simmons: Differential Equations with applications and historical notes, THM, New Delhi (2000)
2. I. N. Sneddon: Elements of p.d.e. McGraw Hill (1999)
3. D. W. Jordan and P. Smith: Nonlinear o.d.e. Oxford, Indian Edition (1999)
4. P. Prasad and R. Ravindran: Partial Differential Equations, Wiley Eastern (1998)
5. S. J. Farlow: P. D. E. for Scientists and Engineers, John Wiley (1998)
6. E. C. Zachmanoglou and Dale W. Thoe: Introduction to p.d.e. with applications Dover (1996)
7. P. L. Sachdev: Nonlinear o.d.e. Marcel and Dekkar (1998)
8. L. C. Evans: Partial Differential Equations, American Mathematical Society (1998)

Paper Code and Name: PG83P206: Programming Lab-I	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Develop C-language codes. CO2. Develop Programme to solve mathematical problems. CO3. Compute scientific problems with C-Programming. CO4. Analyze obtained data.	

Implimentation of programs using C

(based on M.A. / M.Sc. 1.6 and 2.3)

ELECTIVE PAPER:

Paper Code and Name: PG83T207A: OEC-Fuzzy Sets and Fuzzy Logic	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand Fuzzy sets and fuzzy logic. CO2. Apply operations on fuzzy sets. CO3. Understand fundamentals of computers. CO4. Apply ability logically and arithmetically for quantitative aptitude	

Unit I: Brief History of Mathematics, Set theory, Logic, Fuzzy set theory, Life history of world famous Mathematicians and their works and contributions.

Unit II: Set Theory Union, intersection, Complementation, functions, characteristics functions, Mathematical Logic, Logical connectives, two valued & three valued logics, Applications.

Unit III: Boolean Algebra, Fuzzy set theory & Fuzzy logic, Operations on fuzzy sets, Functions on fuzzy sets, Image and inverse image properties, α - cuts.

Unit IV: Introduction to Computers and Fundamentals.

Unit V: Quantitative Aptitude & Mental / logic ability and data interpretation – Arithmetic ability, Percentage, Profit and Loss, Ratio and Proportion, Partnership, Numbers GCD & LCM, Time and Work, Simple and Compound Interest, Volume surface and area, Races & Games of skills, Stocks and Shares, Bankers Discount, Heights and distance, odd man out series, Tabulation, Bar graph, Pie graph, Line graphs.

REFERENCES

1. A Text book of Mathematics I & II – B.G. and P.G. Umarani
2. A Text book of Mathematics I & II – B. M. Sreenivas Rao, Excellent Publication
3. Discrete Mathematics – Rajendra Akerkar & Rupali Akerkar, Pearson Publication
4. Fuzzy Sets & Fuzzy Logic – Klir and Yuan, PHI
5. Computer Fundamentals – Rajaraman
6. Quantitative Aptitude – R. S. Agarawala, S. Chand & Co.

M.A. / M.Sc. III SEMESTER

CORE PAPERS:

Paper Code and Name: PG83T301: Measure Theory	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand measure of a set and measurable sets CO2. Understand measurable functions. CO3. Approximating measurable functions by specific functions. CO4. Compute Lebesgue integrals.	

Unit I: Lebesgue outer measure on the real line. Lebesgue measurable sets and measurable functions.

Unit II: Algebra of measurable functions. Egoroff's theorem. Lebesgue integral of bounded function over a set of finite measure.

Unit III: Bounded convergence theorem. Fatou's lemma. General Lebesgue integral. Lebesgue's monotone convergence theorem.

Unit IV: Lebesgue General (Dominated) Convergence theorem. Differential of an integral. Lp – space. Completeness of Lp – space.

REFERENCES

1) H. L. Royden: Real Analysis (Chapter 1, 3, 4, 5 and 6). 3rd Edition, MacMillan, New York (1963)
2) C. Goffman: Real Functions, Holt, Rinehart and Winston Inc. New York (1953)
3) P. K. Jain and V. P. gupta: Lebesgue Measure and Integration, Wiley Eastern Ltd. (1986)
4) I. K. Rana: An introduction to Measure and Integration, Narosa Publishing House (1997)
5) G. DeBarra: Measure and Integration, Wiley Eastern Ltd. (1981)

Paper Code and Name: PG83T302: Complex Analysis-II	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand the characteristic of analytic functions. CO2. Understand conformal mapping to compute geometric mappings. CO3. Extend analyticity continuation to analytic function and its natural boundary. CO4. Discuss convergence of a sequence of complex functions. CO5. Understand the effect of uniform convergence.	

Unit I: Maximum Modulus Principle, Minimum Modulus Principle. Schwarz's Lemma. Some Applications of Schwarz's Lemma. Basic Properties of Univalent Functions.

Unit II: Open Mapping Theorem. Deduction of Maximum Modulus Principle using Open Mapping Theorem. Hadamard's Three Circles Theorem.

Unit III: Conformal Mapping. Linear Transformations. Unit Disc Transformations. Sequences and Series of Functions. Normal Families'.

Unit IV: Weierstrass Theorem, Hurwitz's Theorem. Montel's Theorem. Riemann Mapping Theorem. Analytic Continuation of Functions with Natural Boundaries. Schwarz's Reflection Principle.

REFERENCES

1) L. V. Ahlfors: Complex Analysis, 2nd Edition, McGraw Hill Book Company, New York (1966)
2) J. B. Conway: Functions of One Complex Variable, 2nd Edition , Springer Verlag, New York, Inc. (1973)
3) T. O. Moore and E. H. Hadlock: Complex Analysis, Allied Publisher, Ltd. (1995)
4) C. L. Siegel: Nine Introductions in Complex Analysis, North Holland (1981)
5) I. Stewart and D. Tall: Complex Analysis, Cambridge University Press (1983)

Paper Code and Name: PG83T303: Topology-II	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand to construct the separation axioms using open and closed sets. CO2. Know the concepts of convergence and compactification. CO3. Demonstrate knowledge and understanding of metric spaces. CO4. Apply theoretical concepts in topology to understand the real world applications.	

Unit I: Separation Axioms: regular and T_3 spaces, normal and T_4 spaces, Urysohn's Lemma, Tietze's, Extension Theorem, completely regular and Tychonoff spaces, completely normal and T_5 spaces.

Unit II: Countability Axioms: First and Second Axioms of countability. Lindelof spaces, separable spaces, countably compact spaces, Limit point compact spaces.

Unit III: Convergence in Topology: Sequences and subsequences, convergence in topology. Sequential compactness, local compactness, one point compactification, Stone – Cech compactification.

Unit IV: Metric Spaces and Metrizability: Separation and countability axioms in metric spaces, convergence in metric spaces, complete metric spaces.

Product Spaces: Arbitrary product spaces, product invariance of certain separation and countability axioms. Tychonoff's Theorem, product invariance of connectedness.

REFERENCES

1) James Dugundji: Topology, PHI (2000)
2) J. R. Munkres: Topology – A first course, PHI (2000)
3) S. Willard: General topology, Addison – Wesley (1970)
4) S. Lipschutz: General topology, Mcgraw hill, Int., Schaum's series (1981)
5) J. V. Deshpande: Introduction to Topology, Tata McGraw Hill (1988)
6) R. Engelking: General Topology, Polish Scientific Publishers, Warszawa (1977)
7) J. L. Kelley: General Topology, Van Nostrand (1995)
8) K. D. Joshi: Introduction to General Topology, Wiley Eastern Ltd. (1983)
9) G. F. Simmons: Introduction to Topology and Modern Analysis, McGraw Hill (1963)
10) S. Nanda and S. Nanda: General Topology, MacMillan India Ltd. (1990)
11) C. W. Baker: Introduction to Topology, W. C. Brown (1991)

12) N. Bourbaki: General Topology Part – I (Trausl), Addison Wesley (1966)

13) M. G. Murdeshwar: General Topology, Wiley Eastern (1990)

Paper Code and Name: PG83T304: Differential Geometry-I	Teaching Hours: 25
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand Euclidean space, Tangent vectors, Vector fields. CO2. Find directional derivatives. CO3. Obtain dot product in E^3 and dot product of tangent vectors. CO4. Understand curvature and torsion of a unit speed curve.	

Unit I: Introduction, Euclidean space, Tangent vectors, Vector fields, Directional derivatives, curves in E^3.

1 – Forms, differential forms, Mappings on Euclidean spaces, derivative map, dot product in E^3, dot product of tangent vectors, Frame at a point.

Unit II: Cross product of tangent vectors, curves in E^3, arc length, reparametrization, The Frenet formulas, frenet frame field, Curvature and torsion of a unit speed curve.

REFERENCES

1) Barrett. O. Neill, Elementary Differential Geometry, Academic Press, New York (1998)
2) T.J.Willmore, An introduction to Differential Geometry, Oxford University Press (1999)
3) N.J.Hicks, Notes on Differential Geometry, Van Nostrand, Princeton (2000)
4) Nirmala Prakash, Differential Geometry - An integrated approach, Tata McGraw Hill Pub. Co. New Delhi (2001)

Paper Code and Name: PG83T305: Numerical Methods	Teaching Hours: 25
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand error analysis. CO2. Apply Numerical methods for solving nonlinear equations. CO3. Use interpolation and extrapolation for Numerical differentiation and Integration. CO4. Apply multistep methods for solving Initial Value Problems (IVP)	

Unit I: Solution of equations: Bisection, secant, regula falsi, Newton's method. Bairstow and Birgaviete methods, system of equations. Gauss, Gauss-Jordon methods. Jacobi and Gauss-Seidel iteration methods. LU decomposition and SOR methods.

Eigenvalue problems: Gerschgorian theorems. Power method, Jacobi method, Given's method.

Interpolation: Newton, Lagrange and Hermite interpolations. Numerical differentiation and Integration. Simpson, trapezoidal and Romberg integration. Gaussian quadrature formula.

Unit II: Approximations: Least squares polynomial approximation. Approximations with trigonometric, exponential and Chebychev polynomials and Rational functions / Pade' approximants.

Numerical Solution of I.V.P. and B.V.P.

Single step methods: Taylor series, Euler and R. K. methods, multistep methods, solutions using finite differences.

REFERENCES

1) R. K. Jain, S. R. K. Iyengar and M. K. Jain, Numerical methods for scientific and Engineering computation, Wiley Eastern (2001)
2) S. D. Conte and Carl De Boor, Elementary Numerical Analysis, McGraw Hil (2000)
3) C. E. Froberg, Introduction to Numerical Analysis Addison Wesley (1995)
4) M. K. Jain, Numerical Solution of Differential Equations, Wiley Eastern (1990)
5) G. D. Smith, Numerical Solution of p.d.e. Oxford University Press (1998)
6) J. W. Thomas, Numerical Solution of p.d.e. Finite Difference Methods, Springer (2000)

Paper Code and Name: PG83P306: Programming Lab-II	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand for loop to solve matrix related problems. CO2. Solve the diversified solutions such as arithmetic operations on matrices and finding the norm of a matrix. CO3. Solve system of equations by implementing C-Programming. CO4. Handle runtime error during execution.	

Implementation of programs

(based on M.A. / M.Sc. 2.3 and 3.5)

ELECTIVE PAPER:

Paper Code and Name: PG83T307A: OEC-Discrete Mathematical Structures	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand concept of Mathematical induction CO2. Perform operations on sets and Relations CO3. Apply counting principle. CO4. Understand tree network. CO5. Solve data interpretation problems.	

Unit I: Brief History of Mathematics & Discrete maths, Life history of world known Mathematicians and their works and contributions.

Unit II: Mathematical Induction, Permutations and Combinations, Binomial Theorem, Set Theory – Relations – Functions, Mathematical logic, Fuzzy Set Theory and Fuzzy Logic.

Unit III: Graph Theory – Trees – Networks, Algorithms, Euclid's Algorithms, Recursive Algorithm, Counting principles, Fibonacci Numbers, Pigenhole principle.

Unit IV: Computers and Fundamentals – Applications.

Unit V: Quantitative Aptitude and Data interpretation, Arithmetic ability, Percentage, Profit and Loss, Ratio and Proportion, Partnership, Time and Work, Simple and Compound Interest, Volume and area, Stocks and Shares, Bankers Discount, Tabulation, Bar graph, Pie graph, Line graphs.

REFERENCES

1.A Text book of Mathematics I & II – B.G. and P.G. Umarani

2.A Text book of Mathematics I & II – B. M. Sreenivas Rao, Excellent Publication

3.Discrete Mathematics – Kolman and Busby, PHI

4.Discrete Mathematics – Rajendra Akerkar & Rupali Akerkar, Pearson Publication

5.Computer Fundamentals – Rajaraman

6.Quantitative Aptitude – R. S. Agarawala, S. Chand & Co.

M.A. / M.Sc. IV SEMESTER

CORE PAPERS:

Paper Code and Name: PG83T401: Functional Analysis	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand concept of Normed linear spaces, Banach spaces and Hilbert spaces. CO2. Compute the dual spaces of certain Banach space and Hilbert space CO3. Find the orthonormal vectors CO4. Obtain self-adjoint and normal operators.	

Unit I: Norm on a linear space over F (either R or C), Banach space. Examples. Norm on quotient space. Continuous linear transformation of normed linear space. The Banach space $B(N, N')$ for Banach spaces, N, N′.

Unit II: Dual space of a normed linear space. Equivalence of norms. Dual space of C[a, b]. Isometric isomorphisms.

Unit III: Hahn – Banach theorem and its applications. Separable normed linear spaces.

Unit IV: Canonical embedding of N into N**. Reflexive spaces, Open mapping theorem, closed graph theorem, principle of uniform boundedness (Bancah – Steinhaus Theorem) Projection on Banach spaces.

Hilbert spaces: definition and examples. Orthogonal complements. Orthonormal basis, Gram – Schmidt process of orthonormalization. Bessel's inequality, Riesz – Fisher theorem.

Unit V: Adjoint of an operator. Self – adjoint, normal, unitary and projection operators.

REFERENCES

1. G. F. Simmons: Introduction to Topology and Modern Analysis, McGraw Hill Book Com. Inc. (1963)
2. C. Goffman and G. Pedrick: First Course in Functional Analysis, Prentice Hall of India Pvt. Ltd. New Delhi (1974)
3. B. V. Limaye: Functional Analysis, 2nd Edition, New Age International (P) Ltd. Publications (1997)

4. D. Somasundaram: Functional Analysis, S. Vishwanathan (printers & Publishers) Pvt. Ltd. (1994)

ELECTIVES: FUZZY TOPOLOGY / DIMENSION THEORY / RELATIVITY / RING THEORY / GALOIS THEORY / NUMBER THEORY

Paper Code and Name: PG83T402A: Fuzzy Topology	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Construct the appropriate fuzzy sets using membership function of uncertain problems. Co2. Understand the differences in crisp sets and fuzzy sets. CO3. Construct the fuzzy numbers corresponding to uncertain and imprecise collected data. CO4. Create new fuzzy topological spaces by using fuzzy sets.	

Unit I: Introduction: From classical Sets (crisp sets) to fuzzy sets, Basic definitions, basic operations on fuzzy sets, fuzzy sets induced by mappings, Types of fuzzy sets.

Fuzzy Sets Versus Crisp Sets: The α - cuts, strong α - cuts, properties of cuts, representation of fuzzy sets, decomposition theorems, Zadeh's extension principle.

Unit II: Operations on Fuzzy Sets: Types of operations, fuzzy complements, fuzzy intersections, t – norms, fuzzy unions, t – conorms, combinations of operations, aggregation operations.

Fuzzy Arithmetic: Fuzzy numbers, Linguistic variables, arithmetic operations on intervals and fuzzy numbers, fuzzy equations.

Unit III: Fuzzy Relations: Crisp and fuzzy relations, Projections and cylindric extensions, binary fuzzy relations, membership matrices and sagittal diagram, inverse and composition of fuzzy relations, binary fuzzy relation on a single set, fuzzy equivalence relation, fuzzy ordering relation, fuzzy morphisms, sup and inf compositions.

Fuzzy Logic: An overview of classical logic. Multivalued logics, fuzzy propositions, fuzzy quantifiers, Linguistic hedges, inferences from conditional fuzzy propositions, qualified fuzzy propositions and quantified fuzzy propositions.

Fuzzy rule based systems and fuzzy nonlinear simulation.

Unit IV: Fuzzy Topology: Change's and Lowen's definition of fuzzy topology. Continuity, open and closed maps. α - shading families, α - connectedness and α - compactness.

Applications: Applications of fuzzy sets and fuzzy logic to various disciplines including Computer Science.

REFERENCES

1. G. J. Klir and B. Yuan: Fuzzy Sets and Fuzzy Logic; Theory and Applications, PHI (1997)
2. A. Kaufmann: Introduction to the theory of Fuzzy Subsets, Vol. – I, Academic Press (1975)
3. L. Y. Ming & L. M. Kung: Fuzzy Topology, World Scientific Pub. Co. (1997)
4. T. J. Ross: Fuzzy Logic with Engineering Applications, Tata McGraw Hill (1997)
5. S. V. Kartalopoulos: Understanding Neural Networks and Fuzzy Logic, PHI (2000)
6. H. J. Zimmermann: Fuzzy Set Theory and its Applications, Allied Pub. (1991)
7. N. Palaniappan: Fuzzy Topology, Narosa (2002)

Paper Code and Name: PG83T402B: Dimension Theory	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1.Understand local finiteness and point-finiteness of a family of subsets of a topological space. CO2. Identify paracompact spaces and its related spaces. CO3. Discuss perfect function. CO4. Understand Local dimension Theory.	

Unit I: Local finiteness and point-finiteness of a family of subsets of a topological space, Paracompact spaces, Completely normal spaces, totally normal spaces and perfectly normal spaces, Hereditarily paracompact spaces, Weakly paracompact spaces, (Meta-compact spaces), Strongly paracompact spaces.

Unit II: Pseudometrizable spaces, Nagata-Smirnov Theorem on pseudometrizability. Perfect mappings.

Unit III: Lebesgue's covering dimension, function dim, Characterizations, dimension of Euclidean space R, The countable sum Theorem, Subset Theorems. The small inductive dimension function – ind.

Unit IV: The subset theorem, properties, the large inductive dimension function – Ind, the subset theorem, interrelations, other properties. Local dimension Theory.

REFERENCES

1. A.R. Pears, Dimension Theory of General Spaces, Cambridge University Press.
2. J. Nagata, Modern Dimension Theory, Elsevier.
3. K. Nagami, Dimension Theory, Academic Press.
4. Hurewicz and Wallman, H. Dimension Theory, Princeton University Press.
5. R. Engel King, General Topology, Polish Scientific Publishers, Warszawa.
6. S. Willard, General Topology, Addision Wesley Pub. Co.
7. J. Dagundji, Topology, PHI.
8. J.R. Munkres, Topology – A First Course, PHI.

Paper Code and Name: PG83T402C: Relativity	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Represent Lorentz group, Time dilation, Space contraction. CO2. Understand contraction symmetric and skew symmetric tensors. CO4. Understand tensor algebra and calculus in curved space-time. CO4. Derive Einstein field equation.	

Unit I: Special Theory of relativity, Lorentz transformations. Representation of Lorentz group. Time dilation. Space contraction. Relativistic mechanics and particle dynamics.

Unit II: Covariant, contravariant vectors and tensors. Tensor algebra. Transformation laws. Contraction Symmetric and Skew symmetric tensors.

Unit III: Space-time as a differentiable manifold Tensor algebra and calculus in curved space-time. Parallel transport, covariant derivative, Connection coefficient. Geodesics, geodesic deviation. Reimann curvature tensor. The bianchi identities.

Unit IV: The general Theory of Relativity. Principle of equivalence. The Newtonian limit. Derivation of Einstein field equation.

REFERENCES

1. S. Weinberg: Gravitation on Cosmology, Principles and applications of the general theory of Relativity. John Wiley and Sons, Inc. (1972)
2. J. V. Narlikar: Introduction to cosmology Cambridge University Press (1993)
3. L. D. Landan & E. M. Lifshitz: The classical theory of fields, Pergmon Press (1980)
4. R. K. Sachs & H. Wu: General Relativity for Mathematicians (1977)

Paper Code and Name: PG83T402D: Ring Theory	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand the characteristics of ring and ideal. CO2. Discuss Modules. CO3. Apply Schur's lemma and Jordan-Holder theorem. CO4. Determine ideals in matrix ring. CO5. Understand Noetheriam and Artinian rings.	

Unit I: Ring, subring, left ideal, right ideal, ideal, factor ring-definition and examples. Ring homomorphism, isomorphism theorems, correspondence theorem.

Unit II: Module, submodule, factor module-definition and examples. Homomorphisms of modules, isomorphism theorems, correspondence theorem. Simple module, Schur's lemma. Noetherian, Artinian modules, composition series of modules, Jordan-Holder theorem, modules of finite length.

Unit III: The ring M_n (R) of nxn matrices over a ring R. Ideals in matrix ring, ring with matrix units. Simple rings.

Jacobson radical J (R) of a ring. Basic properties. Prime ring semiprime ring, right primitive ring, Jacobson's density theorem. Prime ideal, semiprime ideal.

Unit IV: Noetheriam and Artinian rings, Levitzki's theorem. Wedderburn theorem for division rings.

Lower nilradeal, upper nilradieal. Levitzki's radical of a ring.

Subdirect product of rings, subdirectly irreducible ring, Birkhoffs theorem.

REFERENCES

1. C. Musili: Introduction to rings and Modules, 2nd Revised Edition, Narosa Publishing House (1994)
2. N. H. McCoy: Theory of rings, MacMillan Co. (1964)
3. T. Y. Lam: A First Course in Noncommulative Ring Theory, Graduate Text in Mathematics, No. 131, Springer – Verlag (1991)
4. L. H. Rowen: Ring Theory, Vol. – I, Academic Press (1988)

Paper Code and Name: PG83T402E: Galois Theory	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand characteristic of a field and splitting field of a polynomial. CO2. Understand algebraic extension, algebraic closure and algebraically closed field. CO3. Apply Artin's theorem, Hilbert's theorem and Artin – Schreier's theorem. CO4. Discuss Galois groups of quadratic, cubic and quartic polynomials.	

Unit I: Introduction : Field extensions, characteristic of a field, finite field , splitting field of a polynomial .

Unit II: Algebraic extension , algebraic closure , algebraically closed field . Separable extension , simple extension , primitive element theorem . Inseparable extension, purely inseparable extension . Perfect field , imperfect field . Normal extension, group of automorphisms of field extensions .

Unit III: Linear independence of characters , Artin's theorem . Norm and trace . Cyclic extension , Hilbert's theorem 90 , Artin – Schreier's theorem .

Unit IV: Solvable extension , solvability by radicals, insolvability of the quuintic, theorem of Abel – Ruffini . Galois groups of quadratic, qubic and quartic polynomials over the rational field .

REFERENCES

1. J.J. Rotman , Galois Theory , Universitext , Springer- Verlag , 1990.
2. D.J.H. Garling , A Course in Galois Theory , Cambridge University Press , 1986 .
3. Ian Stewart , Galois Theory , Chapman and Hall , London , New York , 1973 .
4. S. Lang , Algebra , Addison – Wesley Publishing Co., 1970 .
5. I.N.Herstein , Topics in Algebra , Blaisdell , New York , 1964 .
6. Surjit Singh and Qazi Zameeruddin , Modern Algebra , Vikas Publishing House , 1990 .

Paper Code and Name: PG83T402F: Number Theory	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand residue systems and linear congruences. CO2. Discuss Diophantine equations. CO3. Discuss primitive roots with modulo p. CO4. Understand quadratic congruences. CO5. Apply Euler's partition theorem.	

Congruences:

Unit I: Basic properties, residue systems, linear congruences, the Theorems of Fermat and Wilson (Rearsited). The Chinese Remainder Theorem, polynomial congruences, Diophantine equations. Arithmetic functions - φ (n), d (n) and σ (n), their multiplicative properties, mobius Inversion formulas.

Unit II: Primitive roots – properties of reduced residue systems, primitive roots modulo P.

Prime numbers – Elementary properties of T (x), Tchebychev's Theorem, some unsolved problems.

Unit III: Quadratic congruences – Eulers criterion, the Legendre symbol, the quadratic reciprocity low and its applications.

Unit IV: Partition theory – Euler's partition theorem, generating functions, Identities between infinite series and products.

Geometric Number Theory – Lattic points, Gauss's circle problem, Dirchelets Division problem.

REFERENCES

1. George E. Andrews: Number Theory, Hindustan publishing Corporation (India) (1989)
2. G. H. Hardy and Littlewood: Number Theory, CUP

ELECTIVES: GRAPH THEORY / DIFFERENTIABLE MANIFOLDS / NEVNLINNA THEORY / GEOMETRIC FUNCTION THEORY / GROUP THEORY / COMMUTATIVE ALGEBRA

Paper Code and Name: PG83T403A: Graph Theory	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Discuss factorization and coverings of graphs. CO2. Understand the planarity of graphs. CO3. Apply coloring of graphs. CO4. Discuss spectra of graphs CO5. Discuss domination parameters of graphs.	

Unit I: Factorization – 1-factorization, 2-factorization, Decomposition and labelings of Graphs.

Coverings: Vertex covering, edge covering, independence number and matchings and matching polynomials.

Unit II: Planarity: Planar graphs, outerplanar graphs, Kuratowaski criterion for planarity and Eulers polyhedron formula.

Graph Valued functions: Line graphs, subdivision graph and total graphs.

Unit III: Colorings: Chromatic numbers and chromatic polynomials.

Spectra of Graphs: Adjacency matrix, incidence matrix, characteristic polynomials, eigen values, graph parameters, strongly regular graphs and Friendship Theorem.

Unit IV: Groups and Graphs: Automorphism group of a graph, operations on permutation graphs, the group of a composite graph.

Domination: Dominating sets, domination number, domatic number and its bounds, independent domination of a number of a graph, other domination parameters.

Theory of External graphs and Ramsey Theory.

REFERENCES

1. M. Behzad, G. Charatrand and L. Lesniak-Foster: Graphs and Digraphs, Wadsworth, Belmont, Calif (1981)
2. Narasing Deo: Graph Theory with Applications to Engineering and Computer Science, Prentice Hall, India (1995)

3. J. A. Bondy and V. S. R. Murthy: Graph Theory with Applications, MacMillan, London.
4. F. Buckley and F. Harary: Distance in Graphs, Addison-Wesley (1990)
5. Diestel: Graph Theory, Springer-Verlag, Berlin.
6. R. Gould: Graph Theory, The Benjamin / Cummings Publ. Co. Inc. Calif (1988)
7. F. Harary: Graph Theory, Addison Wesley, Reading mass (1969)
8. O. Ore: Theory of Graphs, Amer-Maths. Soc. Collg. Publ. – 38, providence (1962)
9. D. Cvetkovic, M. Doob and H. Sachs, Spectra in Graphs, Academic Press, New York (1980)
10. Tulasiraman and M. N. S. Swamy: Graphs, Networks and Algorithms, John Wiley (1989)
11. Bela Bollobas, Modern Graph Theory, Springer (1998)
12. Reinhard Diestel, Graph Theory, 2nd Edition, Springer (2000)

Paper Code and Name: PG83T403B: Differentiable Manifolds	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand the charts and atlases. CO2. Discuss pull back functions, tangent vectors and tangent spaces. CO3. Understand the dual of the differential map. CO4. Discuss Tensor product of finite dimensional vector spaces. CO5. Understand torsion and curvature tensors.	

Unit I: Charts and atlases. Differentiable manifold. Induced Topology on a manifold. Functions and maps. Pull back functions. Tangent vectors and tangent spaces. The differential of a map. Tangent bundle.

Unit II: Pull-back vector-fields. Lie bracket contangent space and contangent bundle. The dual of the differential map.

One parameter group and vector-field. Lie derivatives of vector fields and differential 1 – forms.

Unit III: Tensor product of finite dimensional vector spaces. Tensors. Contraction, symmetric and alternating tensors. The exterior algebra. Lie derivative of tensor fields. Exterior differentiation. Lie derivatives of differential forms.

Unit IV: Connections, parallel translation, covariant differentiation of tensor fields. Torsion and curvature tensors, Bianchi identities.

REFERENCES

1. W. M. Boothby: An introduction to Differentiable manifolds and Riemann Geometry. Academic Press (1975)
2. S. Helgason: Differential Geometry and Symmetric Spaces, 2nd Edition, Academic Press.
3. N. J. Hicks: Notes on Differential Geometry, Van – Nostrand (1963)
4. Loomis and Sternberg: Advanced Calculus, Addison Wesley publishing Co. (1968)
5. Kobayashi, Namizu: Foundations of Differential Geometry Vol. – I, Wiley Interscience, New York (1963)
6. Singer and Thrope: Lecture Notes on Elementary Topology and Geometry, Springer Verlag (1967)
7. M. Spivak: Calculus on Manifolds, Benjamin, New York (1965)
8. Comprehensive Introduction to Differential Geometry, Vol. – I, II, III (2nd Edition) Publish or Perish Inc., Boston, Masgachusetts.

Paper Code and Name: PG83T403C: Nevanlinna Theory	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand entire and meromorphic functions. CO2. Apply Poisson –Jenson's formula for meromorphic functions. CO3. Discuss Proximity function, Counting function and Characteristic function. CO4. Apply Picard's theorem and Borel's theorem to prove second fundamental theorem of Nevanlinna theory and uniqueness theorem.	

Unit I: Basic Properties of Entire Functions. Order and Type of an Entire Function. Relationship between the Order of an entire Function and its Derivative. Poisson Integral Formula. Poisson – Jensen Theorem. Jensen's Formula. Exponent of Convergence of Zeros of an Entire Function. Picard and Borel's Theorems for Entire Functions.

Unit II: Asymptotic values and Asymptotic Curves. Connection between Asymptotic and various Exceptional Values.

Unit III: Meromorphic Functions. Nevanlinna's Characteristic Function. Cartan's Identity and Convexity Theorems. Nevanlinna's First and Second Fundamental Theorems. Order and Type of Meromorphic Function. Order of a Meromorphic Function and its Derivative. Relationship between T (r, f) and log M (r, f) for an Entire Function. Basic Properties of T (r, f).

Unit IV: Deficient Values and Relation between the Various Exceptional Values. Fundamental Inequality of Deficient Values. Some Applications of Nevanlinna's Second Fundamental theorem. Functions taking the same values at the same points. Fix – points of Integral Functions.

REFERENCES

1. A. I. Markushevich: Theory of Functions of Complex Variable, Vol. – II, Prentice – Hall (1965)
2. A. S. B. Holland: Introduction to the theory of Entire Functions, Academic Press, New York (1973)
3. C. L. Siegel; Nine Introductions in Complex Analysis, North Holland (1981)
4. W. K. Hayman: Meromorphic Functions, Oxford University, Press (19640
5. Yang La: Value Distribution Theory, Springer Verlag, Scientific Press (1964)
6. I. Laine: Nevanlinna theory and Complex Differential Equations, Walter De Gruyter, Berlin (1993)

Paper Code and Name: PG83T403D: Geometric Function Theory	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Discuss conformal mapping, Unit disc transformation and normal families. CO2. Discuss Dirichlet's problem. CO3. Discuss power series with finite radius of convergence. CO4. Apply Area theorem, Distortion theorem, Bieberbach theorem.	

Unit I: Conformal mapping Schwarz's lemma, Unit disc transformation and normal families. Riemann mapping theorem, Elementary properties of harmonic functions. Green's function. Subharmonic functions. Solution of the dirichlet's problem. Analytic continuation and singular points. General analytic function. Monodromy theorem, branch points.

Unit II: Power series with finite radius of convergence, singularities on the circle of convergence of analytic function defined by power series. Hadamard's gap theorem, Functions with natural boundaries, Examples of functions which cannot be continued outside a bounded domain. Schwarz reflexion principle.

Unit III: Univalent functions. Area theorem. Distortion theorems. Bieberbach theorem. Koebe's one quarter theorem. Starlike and convex functions. Close–to–convex functions and spirallike functions. Some coefficient theorems.

Unit IV: Subordination. Basic principles. Coefficient inequalities. Sharpend form of Schwarz lemma. Majorisation.

REFERENCES

1. L. V. Ahlfors : Complex Analysis, 2nd Edition, McGraw Hill Book Co., New York (1996)
2. S. Saks and Zygmund: Analytic functions, Warsaw and Wrocklaw, Monographic Matematyczne Vol-28 (1952)
3. Z. Nehari: Conformal Mapping, McGraw Hill Book Co. Inc., New York (1952)
4. E. Hille : Analytic function theory, Vol's I and II, Ginn and Company Boston Vol-I (1959), Vol-II (1962)
5. S. L. Siegel : Nine Introductions in Complex Analysis, North-Holland Publishing Co. (North Holland Mathematics Studies) (1953)
6. P. L. Duren : Univalent Functions (A series of comprehensive studies in Mathematics) Springer – Verlag (1980)
7. G. S. Goodman: Univalent Functions, Vol-I and II, Mariner Publishing Co., Tanga, Florida (1983)

Paper Code and Name: PG83T403E: Group Theory	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand groups, subgroups, normal subgroup, factor group. CO2. Apply Cauchy's theorem and Sylow theorem. CO3. Discuss solvable groups. CO4. Discuss Automorphism groups, semidirect products and factor sets. CO5. Discuss infinite abelian groups, torsion, reduced groups and finitely generated abelian groups.	

Unit I: Groups, subgroups, normal subgroup, factor group. Isomorphism theorems, correspondence theorem. Permutation groups, structure theorem. Alternating group A_n, simplicity of A_n. Direct product of groups. The basis theorem . The fundamental theorem of finite abelian groups. The class equation of a finite group, Cauchy's theorem, Sylow theorems . Applications .

Unit II: Normal and subnormal series of a group , solvable groups . Jordan – Holder theorem . A theorem of P. Hill . Central series and nilpotent groups .

Unit III: Automorphism groups, semidirect products, factor sets , Schur- Zassenhaus lemma.

Unit IV: Infinite abelian groups, torsion, torsion-free, divisible , reduced groups. Free abelian groups, finitely generated abelian groups.

REFERENCES

1. J.J. Rotman : The Theory of Groups, an Introduction , Allyn and Bacon Inc. Boston (1965).
2. W. Scott : Group Theory.
3. A. Kurosh : The Theory of Groups, Vol-I and II, Chelsea, New York (1956) .
4. H. Zassenhaus : The Theory of Groups, Chelsea, New York (1956) .
5. L. Fuchs : Infinite Abelian Groups, Vol. I , Academic Press (1970).

Paper Code and Name: PG83T403F: Commutative Algebra	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand rings, subrings, ideals, quotient rings. CO2. Apply operations on ideals. CO3. Understand modules, submodules and quotient modules. CO4. Discuss properties of rings. CO5. Understand Noetherian module. Artinian module. Modules of finite length.	

Unit I: Rings, subrings, ideals, quotient rings. Definitions and examples . Ring homomorphism . Isomorphism theorems . Correspondence theorem . Zero- divisors, nilpotent elements and units in a ring . Prime ideal . Maximal ideal. Nilradical and the Jacobson radical of a ring . Operations on ideals . Extensions and contractions of ideals . Polynomial rings . Power series ring.

Unit II: Modules, submodules , quotient modules . Definitions and examples . Homomorphisms of modules . Isomorphism theorems . Correspondence theorem . Operations on submodules . Direct product and direct sum of modules . Finitely generated modules . Nakayama lemma .

Unit III: Rings and modules of fractions . Local properties . Extended and contracted ideals in rings of fractions .

Unit IV: Noetherian module . Artinian module . Composition series of a module . Modules of finite length . Jordan- Holder theorem . Noetherian ring . Artinian ring . Hilbert basis theorem .

REFERENCES

1. M.F.Atiyah and I.G.Macdonald , Introduction to Commutative Algebra , Addison-Wesley Publishing Company, 1969 .
2. C.Musili , Introduction to Rings and Modules , Narosa Publishing House , Second Revised Edition, 1994 .
3. N. S. Gopalakrishnan, Commutative Algebra, Oxonian Press Private Limited, New Delhi (1984)
4. O. Zariski and P. Samuel, Commutative Algebra, Vol. I, Van Nostrand Company (1958)

CORE PAPERS:

Paper Code and Name: PG83T404: Differential Equations-III	Teaching Hours: 25
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand critical and simple critical points of linear and nonlinear system. CO2. Discuss periodic solutions. CO3. Understand classification of second order PDEs. CO4. Understand the solution of fundamental PDE's.	

Unit I: Introduction to nonlinear o.d.e. and their elementary properties. Homogeneous linear systems with constant co-efficients. Types of critical points and stability of linear systems. Simple critical points of nonlinear systems. Bendixson theorem and its applications.

Unit II: General first order p.d.e. Linear and quasi linear equations. Cauchy problem. Lagrange equation. Charpit's method, method of characteristics. General second order equations and their classifications. Canonical forms. Wave equation, Diffusion equation. Duhamel's principle, Elliptic equation, Poisson integral. Solutions using separation of variables and integral transforms.

REFERENCES

1. G. F. Simmons: Differential Equations with applications and historical notes, THM, New Delhi (2000)
2. N. Sneddon: Elements of p.d.e. McGraw Hill (1999)
3. D. W. Jordan and P. Smith: Nonlinear o.d.e. Oxford, Indian Edition (1999)
4. P. Prasad and R. Ravindran: Partial Differential Equations, Wiley Eastern (1998)
5. S. J. Farlow: P. D. E. for Scientists and Engineers, John Wiley (1998)
6. E. C. Zachmanoglou and Dale W. Thoe: Introduction to p.d.e. with applications Dover (1996)
7. P. L. Sachdev: Nonlinear Ordinary Differential Equations, Marcel and Dekkar (1998)
8. L. C. Evans: Partial Differential Equations, American Mathematical Society (1998)

Paper Code and Name: PG83T405: Differential Geometry-II	Teaching Hours: 25
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand arbitrary speed curves and Frenet formulas. CO2. Discuss connection forms of a frame field. CO3. Understand patches. CO4. Understand topological properties of surfaces and Manifolds. CO5. Discuss normal Curvature, Gaussian curvature, and Special curves in surfaces.	

Unit I: Arbitrary speed curves, Frenet formulas for arbitrary speed curve, Covariant derivatives, Frame field on E^3, connection forms of a frame field, Cartan's structural equations.

Unit II: Calculus on a surface, Co-ordinate patch, proper patch, surface in E^3, Monge patch, Patch computations, parametrization of a cylinder, Differentiable functions and tangent vectors, tangent to a surface, tangent plane, Vector-field, tangent and normal vector-fields on a surface. Mapping of surfaces, Topological properties of surfaces, Manifolds.

Shape Operators, Normal curvature, Gaussian curvature, Computational techniques, Special curves in surfaces.

REFERENCES

1. Barrett O. Neill, Elementary Differential Geometry, Academic Press, New York (1998)
2. T. J. Willmore, An introduction to Differential Geometry, Oxford University Press (1999)
3. N. J. Hicks, Notes on Differential Geometry, Van Nostrand, Princeton (2000)
4. Nirmala Prakash, Differential Geometry – An integrated approach, Tata McGraw Hill Pub. Co. New Delhi (2001)

Paper Code and Name: PG83T406: Integral Transforms and Integral Equations	Teaching Hours: 25
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Understand linear integral equations of the first and second kind. CO2. Discuss solution by successive substitutions and successive approximations. CO3. Apply Laplace Transform techniques to understand real world problems. CO4. Discuss Fourier series. CO5. Apply Fourier transform techniques to solve the partial differential equations.	

Unit I: Linear Integral Equations:

Linear Integral Equations of the first and second kind. Fredholm and Volterra types. Solution by successive substitutions and successive approximations. Equations with separable kernels. Theory of symmetric kernels.

Unit II: Integral Transforms:

Revision of Laplace Transforms and their applications. Fourier series even, odd, periodic and complex functions. Othogonality and general Fourier series, completeness and Gibbs phenomena, passage from Fourier series to Fourier Integrals. Application to the solution of heat, wave and Laplace equations. Introduction to Distribution, discrete and FFT.

REFERENCES

1. R. P. Kanwal: Linear Integral Equations, Academic press, New York (1998)
2. S. G. Mikhlin: Linear Integral Equations (translated from Russian) Hudson Book Agency (1980)
3. D. Porter and D. S. G. Stirling: Integral equations, Cambridge University Press (1998)
4. F. B. Hildebrand: Methods of Applied Mathematics, Prentice Hall (1990)
5. S. J. Farlow: Partial Differential Equations for Scientists and Engineers, John Wiley and Sons (1998)
6. W. A. Strausi: Partial Differential Equations, John Wiley and Sons (2000)
7. R. V. Chaurchill: Fourier series and b.v.p. McGraw Hill int. (1990)
8. R. S. Pathak: A course in Distribution Theory and Applications, Narosa, Publishing House (2001)

Paper Code and Name: PG83P407: Programming Lab-III	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Write and execute C-programming for numerical methods. CO2. Discuss sub routing of C-programming. CO3. Discuss arrays, functions and strings in mathematical problems. CO4. Handle possible errors during program execution.	

Implementation of programs

(Based on M.A. / M.Sc. 3.5 CT, 4.4 CT and 4.6 CT)

Paper Code and Name: PG83T408: Project Work	Teaching Hours: 50
Course Outcomes (COs)	
After completing this paper, the students will be able to: CO1. Survey literature. CO2. Understand real world problems through mathematical modeling. CO3. Formulate the problem and apply the suitable techniques for solution. CO4. Write the dissertation.	

Project Work