RANI CHANNAMMA UNIVERSITY, BELAGAVI

DEPARTMENT OF STUDIES IN MATHEMATICS UNDER THE SCHOOL OF MATHEMATICS & COMPUTING SCIENCES

M.Sc. MATHEMATICS

CHOICE BASED CREDIT SYSTEM

REGULATIONS AND COURSE STRUCTURE

with effect from

Academic Year 2020-21 and onwards

1.0 Course Offered: M.A/ M.Sc. Degree in Mathematics
2.0 Duration:

The Course shall be of Four Semester and each semester is of 16 weeks duration student shall not be permitted to obtain degree earlier than 4 semesters. The student shall complete the course within **four** years from the date of admission to the first semester of Post graduate Programme. The academic session in each semester provide 90 teaching days.

However, the students, who discontinue the programme after one or more semester 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 during the duration of the PG programme.

3.0 Eligibility Criteria for Admission:

3.1 Candidates who possess a Bachelor's degree in Arts/ Science of this University or a equivalent Degree of any other university recognized as equivalent there to with Mathematics as one of the subjects, having at least 45% of marks in aggregate at degree level is eligible to apply. However, relaxation of 5% of marks in respect of SC/ST/Cat-I will be allowed as per prevailing rules of the University and Government Orders issued from time to time.

3.2 The admission shall be made as per the reservation policy and directions issued in this regard from time to time by the Government of Karnataka and also as per rules as prescribed by the University from time to time.

4.0 Medium of Instruction:

The medium of Instruction shall be English.

5.0 Course Structure:

The Course are of Four types

i. Core Subjects

ii. Soft core/Specialization/ Optional Subjects

iii. Practicals

iv. Open Elective Courses.

In the first semester there shall be 5 (five) core Subject and 1 (one) Soft core/Specialization/ Optional theory papers of 4 credits in each. In the second semester there shall be 3 (three) core theory papers of 4 credits each, 1 (one) core theory paper of 3 credits and 1 (one) Soft core/Specialization/ Optional theory paper of 4 credits. There shall be practicals of one credit and one open Elective course (theory) paper of 4 credits. In the third semester there shall be 3 (three) core papers of 4 credits each, 1 (one) core theory paper of 3 credits and 1 (one) Soft core/Specialization/ Optional theory paper of 4 credits. There shall be practicals of one credit and one Open Elective Course (theory) paper of 4 credits. In the fourth semester there shall be 4 (four) core papers of 4 credits each, one Soft core/Specialization/ Optional theory paper of 4 credits and in addition the student shall carry out a project of 4 credits.

6.0 Minimum and Maximum Credits:

6.1 "Credit" means the unit by which the course work is measured. For this Regulation, 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 as used in conventional system.

6.2 There are two courses of 3 credits, two practical's are of 1 credit and remaining all other courses are of 4 credits.

6.3 A Student shall register for 24 credits in each semester.

6.4 Total Credits for MA/M.Sc. in Mathematics shall be 96.

6.5 There shall be practicals (Lab) conducted batchwise and each batch shall consists of 25 students.

7.0 Attendance:

7.1 Each paper/ course shall be taken as a unit for the purpose of calculating the attendance.

7.2 Each student shall sign the attendance maintained for each course for every hour of teaching of each paper.

7.3 Marks shall be awarded to the students for attendance as specified in the regulations concerning the evaluation as shown below:

Attendance (in percentage)	90 and above	Above 80 and up to 90	Above 75 and up to 80	75 and Below
Marks	3	2	1	No Marks

7.4 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 number of instructional hours during the semester.

7.5 There is no provision for condoning shortage of attendance.

7.6 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.

7.7 Such of the candidates who have participated in State/ National level Sports, NSS, NCC, Cultural activities and other related activities and as stipulated under the existing regulations shall be considered forgiving 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.

8.0 Examination:

8.1 There shall be an examination at the end of each semester.

8.2 Unless otherwise provided, there shall be a semester end examination of 3 hours duration for 80 marks and internal assessment for 20 marks in core/soft core/ specialization/ optional paper. Practical examination is of two hours duration for 35 marks and practical internal assessment is for15 marks.

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

8.4 The office of the Registrar (Evaluation) shall allot the Register Number to the candidate in the 1st Semester examination. That will be the Register Number of the candidate for all the subsequent appearances and semester examinations.

8.5 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 the results. These shall be disposed off after six months.

8.6 The programme under CBCS is a fully carry-over system. A candidate reappearing 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).

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

8.8 Candidates who desire to challenge the marks awarded to them, in the examinations, may do so by submitting an application along with the prescribed fee to the Registrar (Evaluation) within fifteen days from the announcement of the result.

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

9.0 Course Weightage:

Course Weightage would be equal to the number of credits awarded to the particular course. For instance, if the Course has a credit award of 4, then the appropriate weightage for the course would be 4.

10.0 Course Evaluation:

10.1 Each course shall have two evaluation components – Internal assessment (IA) and the Semester end examinations for both theory and practicals.

10.2 The IA component in a course shall carry 20 marks (including 3 marks for attendance as specified above) and the semester end examination shall carry 80 marks. The IA Component in practical shall carry 15 marks and the semester end examination shall carry 35 marks

10.3 The various components of I.A. marks are as follows:

i) Attendance : 3 marks for both theory papers and practicals

ii) Assignment : 3 marks for theory papers and 2 marks for practicals

ii) Test : 14 marks for theory and 10 marks for practicals

Total – 20 marks for theory and 15 marks for practicals.

10.4 Calendar of tests shall be notified in the first week of each semester.

10.5 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 in this regard from time to time.

10.6 The tests shall be written in a separate sheet supplied by the Department/College which shall be open for inspection by the students after evaluation.

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

10.8 If a candidate remains absent for I.A Test, there is no provision for Re-test.

10.9 The Project/ Dissertation / report to be submitted at the end of the IV semester.

10.10 Twenty marks(20) shall be allocated for Internal assessment by the concern Guide, 50 Marks wood be allotted for Evaluation of project/ Dissertation report, next 30 marks is allocated for viva-voce Examination.

11.0 Declaration of Results:

11.1 Minimum for a pass in each paper shall be 40% of the total 100 marks including the IA/ Practicals and the semester end examinations marks. However, candidate shall obtain at least 40% of the marks in the Semester end Examination (i.e 32/80). There is no minimum in the IA / Practical marks. However, after adding the IA / Practical and the semester end examinations marks, the candidate shall score a minimum 40% of the maximum marks for the course/paper.

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

11.3 Candidates shall earn the prescribed number of credits (i.e. 96) for the programme to qualify for the PG Degree in mathematics.

11.4 For the purpose of announcing the results, the aggregate of the marks secured 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 or had applied for improvement of results.

11.5 The candidates, seeking improvement of their results shall submit an application along with prescribed fee to the Registrar (Evaluation) and surrender the degree certificate / provision pass certificate / original marks cards of that semester within 15 days from the date of announcement of the result, or as per the prevailing rules of University from time to time.

12.0 Marks, Credit Points, Grade Points, Grades and grade Point Average:

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

Percentage of marks	Grade Points	Grade Letter
75 and above, up to 100.00%	7.50 to 10.00	A
60 and above but less than 75%	6.00 and above but less than 07.5	B
50 and above but less than 60%	5.00 and above but less than 6.0	C
40 and above but less than 50%	4.00 and above but less than 05.00	D
Less than 40.00%	Less than 4.00	F

12.2 Credit Point (CP): The Credit Point for each course/paper shall be calculated by multiplying the grade point obtained by the credit of the course.

12.3 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 in all the courses by the total number of credits of those courses of the semester.

12.4 The Cumulative Grade Point Average (CGPA) Shall be calculated by dividing the total number of credit points in all the semesters by the total number of credits in all the semesters. The CGPA to data shall be calculated by dividing the total number of credit points in all the semesters to date by the total number of credits in all the semesters to date.

CGPA for the I semester = Sum of the CP of the I sem ÷ Sum of the credits of the I semester

CGPA for the II semester =

(Sum of the CP of the I sem + Sum of the CP of the II sem) ÷ (sum of the credits of the I sem + sum of the credits of the II sem)

CGPA for the III and IV Semesters shall be computed accordingly.

12.5 The Grade Card at each semester examination shall indicate the courses opted by the student, the credit for the course chosen by the student, the credit points obtained in each course, the grade letter and the grade point average. No class shall be awarded for each semester and the same shall only be awarded at the end of all the semesters based on Cumulative Grade Point average.

12.6 Class shall be awarded to the successful candidates based on the Cumulative Grade Point average (CGPA) as specified below:

Cumulative Grade Point Average(CGPA)	**Class to be awarded**
7.5 to 10.0	First Class with Distinction
6.0 and above but below 7.5	First Class
5.0 and above but below 6.0	Second Class
Less than 5.0	Fails

13.0 Question paper pattern:

13.1 The question paper pattern contains 3 parts namely Part A, Par B and Part C.

13.2 A Student shall answer any 5 questions by choosing at least one question from each Part.

13.3 All question carry equal marks

14.0 Miscellaneous:

14.1 The provisions of any order, rules or regulations in force shall be inapplicable to the extent of its inconsistency with these Regulations.

14.2 The University shall issue such orders, instructions, procedures and prescribe such format as it may deem fit to implement the provisions of these Regulations.

14.3 Procedural details may be given by the University from time to time.

14.4 Any unforeseen problems/difficulties may be resolved by the Vice- Chancellor, whose decision in the matter shall be final.

Illustrative Model:
Grade Card

Programme:________________

Name of the candidate:

Semester: I/II/

Sear No: Month & Year:

Papers/Courses	**Paper/ Courses Code No.**	**Credits**	**Max. Marks**	**Marks Obtained**	**Semester Grade Point**	**Credit Points**
Core Courses						
Paper- I		04	100	60	6.00	24.00
Paper- II		04	100	74	7.40	29.60
Paper- III		04	100	43	4.30	17.20
Paper- IV		04	100	52	5.20	20.80
Paper- V		04	100	54	5.40	21.60
Soft/Specialization / Optional course Paper-VI		04	100	65	6.50	26.00
Practicals Open Elective Paper VII		04	100	75	7.50	30.00

Illustrative Model:

Grade Card

Programme:________________

Name of the candidate:

Semester: III/IV

Sear No: Month & Year:

Papers/Courses	**Paper/ Courses Code No.**	**Credits**	**Max. Marks**	**Marks Obtained**	**Semester Grade Point**	**Credit Points**
Core Courses						
Paper- I		04	100	60	6.00	24.00
Paper- II		04	100	74	7.40	29.60
Paper- III		04	100	43	4.30	17.20
Paper- IV		04	100	52	5.20	20.80
Soft/Specialization / Optional course Paper-V		04	100	65	6.50	26.00
Practicals Open Elective Paper VII Project		04	100	75	7.50	30.00

GPA for I semester = Total no. of CP ÷ Total no of Credits =

CGPA for I semester =GPA=

$$\text{CGPA for II Sem} = \frac{\text{CP (I Sem)} + \text{CP (II Sem)}}{\text{Credits (I Sem)} + \text{Credits (II Sem)}}$$

$$\text{CGPA for III Sem} = \frac{\text{CP (I Sem)} + \text{CP (II Sem)} + \text{CP (IIISem)}}{\text{Credits (I Sem)} + \text{Credits (II Sem)} + \text{Credits (III Sem)}}$$

$$\text{CGPA for the programme} = \frac{\text{CP (I Sem)} + \text{CP (II Sem)} + \text{CP (IIISem)} + \text{CP (IV Sem)}}{\text{Credits (I Sem)} + \text{Credits (II Sem)} + \text{Credits (III Sem)} + \text{Credits (IV Sem)}}$$

(* CP: Credit Points)

RANI CHANNAMMA UNIVERSITY, BELAGAVI

Department of Mathematics

Syllabus

for

Master of Science in Mathematics

I to IV Semester

(with effect from 2020 – 21)

Choice based credit system (CBCS)
Course structure

	Sl. No.	Paper & Title	Credit	No of Hrs/week Theory/ Practical	Duration of exam in Hrs Theory/ Practical	IA Marks Theory/ Practical	Marks at the Exams	Total Marks
	I Semester							
Core Subject	1.1	Algebra -I	4	4	3 Hrs	20	80	100
	1.2	Topology	4	4	3 Hrs	20	80	100
	1.3	Real Analysis - I	4	4	3 Hrs	20	80	100
	1.4	Linear Algebra	4	4	3 Hrs	20	80	100
	1.5	Ordinary Differential Equations	4	4	3 Hrs	20	80	100
(Softcore\ Specilization\ optional)	1.6	Discrete Mathematical Structures	4	4	3 Hrs	20	80	100
	Total Credits/Hours		24	24	-	-	-	600
	II Semester							
Core Subject	2.1	Algebra – II	4	4	3 Hrs	20	80	100
	2.2	Complex Analysis	4	4	3 Hrs	20	80	100
	2.3	Partial Differential Equations	3	4	3 Hrs	20	80	100
	2.4	Real Analysis-II	4	4	3 Hrs	20	80	100
(Softcore\ Specilization\ optional)	2.5	Classical Mechanics	4	4	3 Hrs	20	80	100
Practicals:	2.6	Latex and Beamer Lab	1	2	2Hrs	15	35	50
OEC	2.7	**Open Elective Course** I. Set Theory (Arts & Commerce stream)	4	4	3 Hrs	20	80	100
		II. Integral Transforms (Science stream)						
	Total Credits/Hours		24	26				650

	III Semester								
Core Subject	3.1	MeasureTheory& Lebesgue Integration	4	4	3 Hrs	20	80	100
	3.2	Numerical Analysis	3	4	3 Hrs	20	80	100
	3.3	Differential Geometry	4	4	3 Hrs	20	80	100
	3.4	Number theory and cryptology	4	4	3 Hrs	20	80	100
(Softcore\ Specilization \ optional)	3.5	a)Algebraic Topology-I b) Fourier Analysis c) Fluid Mechanics d) Combinatorial Network Theory	4	4	3 Hrs	20	80	100
Practicals	3.6	Scilab Lab	1	2	2Hrs	15	35	50
OEC	3.7	Open Elective Course I. Statistics (Arts & Commerce stream) II.Computational Methods (Science stream)	4	4	3 Hrs	20	80	100
		Total Credits/Hours	24	26				650
	IV Semester								
Core Subject	4.1	Functional Analysis	4	4	3 Hrs	20	80	100
	4.2	Mathematical Methods	4	4	3 Hrs	20	80	100
	4.3	Advanced Graph Theory	4	4	3 Hrs	20	80	100
	4.4	Advanced Numerical methods	4	4	3 Hrs	20	80	100
(Softcore\ Specilization \ optional)	4.5	a) Algebraic Topology- II b) Banach Algebra c) Mathematical Modelling d)Galois Theory	4	4	3 Hrs	20	80	100
	4.6	Project	4	The candidate shall submit a dissertation carrying 80 marks and appear for viva-voce carrying 20 marks				100
		Total Credits/Hours	24	-				600
		Grand Total Credits/Hours	96	-				2500

SEMESTER – I

Paper Code: 1.1	**Paper Title: ALGEBRA – I**
Teaching Hours: 4 Hrs / Week	**Marks: Theory - 80 + IA - 20**
Teaching Hours: 3Hrs	**Credits: 04**

Unit 1:

Group axioms with examples including Dihedral Groups, Symmetric Groups, Matrix groups; Homomorphisms and Isomorphisms; Subgroups; Lagrange's Theorem.

Unit 2:

Cyclic groups, generators and relation; Quotient groups; Cayley's Theorem.

Unit 3:

Normal subgroups; Kernel of a Homomorphisms; Iso-morphism Theorems; Centers of a groups, Centralizer and Normalizers

Unit 4:

Group action; Orbits and Stabilizers; Class equation; Cauchy Theorem; Sylow Theorems; Derect products; Semidirect products; free groups; free abelian groups.

Unit 5:

Structure Theorem for finite abelian groups; simple groups and solvable groups; nilpotent groups; simplicity of alternating groups; composition series; Jordan-Holder Theorem.

REFERENCES

1. J.B.Fraleigh, Abstract Algebra, Narosa Publications
2. Joseph A. Gallian, Contemporary Abstract Algebra, Narosa Publications
3. N.S.Gopalakrishnan, University Algebra,
4. I.N.Herstein,Topics in Algebra, Wiley
5. David S. Dummit & Richard M. Foote, Abstract algebra, John Willy & Sons, Inc., 2004.

Paper Code: 1.2	**Paper Title: TOPOLOGY**
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 3Hrs	**Credits: 04**

Unit 1:

Axiom of choice, Zorn's lemma, Topological Spaces; open sets, closed sets, neighbourhoods, bases, sub-bases, limit points, closures. Interiors; Exampels of topological spaces; sub-space topology, product topology, metric topology, order topology.

Unit 2:

Continuous functions; homeomorphisms; Connected Spaces; Connected subspaces of the Real Line with usual topology; Intermediate value theorem; Local Connectedness.

Unit 3:

Compact Spaces; Compact subspaces of the Real Line, with usual Topology, Limit Point Compactness, Local Compactness. The Countability Axioms,

Unit 4:

The Separation Axioms,Para-compactness. Hausdorff spaces, Normal Spaces, the Urysohn Lemma, Regular Lindelof spaces.

Unit 5:

The Urysohn Metrization Theorem, The Tietze Extention Theorem, The Tychonoff Theorem

REFERENCES:

1. J.R.Munkers : Topology, Pearson, 2000
2. M.A.Armstrong, Basic Topology, Springer, 1983.
3. J.L.Kelley : General Topology,Van Nostrand (1995).
4. O. Ya. Viro et. Al., Elementary, Topology problem textbook, American Mathematical Society,2008.

Paper Code:1.3.	Paper Title: REAL ANALYSIS - I
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 3Hrs	**Credits: 04**

Unit 1:

Intergers, Rational Numbers; Real and Complex Number Systems; The field axioms, order axioms, Cauchy- Schwarz inequality, The least upper bound, greatest lower bound, properties of L.U.B and G.L.B, Archimedean Property, countable and uncountable sets, The completeness property of R; ..

Unit 2:

Euclidean space R^n, open balls and open Sets in R^n. Closed Sets, Limit point, Adherent Points, Bolzano- Weierstrass Theorem, The Cantor intersection theorem, Lindelof covering theorem, Heine- Borel covering theorem, compactness in R^n.

Unit 3:

Metric spaces. Point Set in Metric spaces, compact Subsets of a metric space, Sequences, Subsequences, Convergent and Cauchy Sequences in a metric space, Complete metric space.

Unit 4:

Limit, Continuity, Continuity of composite functions, continuity and inverse image of open and closed sets. Functions continuous on compact sets. Connectedness, Uniform continuity, Fixed point theorem for contractions.

Unit 5:

Differentiation, Algebra of derivatives, chain rule, One Sided derivatives and infinite derivatives, Rolle's theorem, Mean- value Theorem for derivatives. Intermediate- value theorem, Taylor's formula with remainder. Functions of bounded variation, Total variation, Continuous functions of bounded variations, Rectifiable paths and arc length, Additive and continuity properties of arc length, Equivalence of path.

REFERENCES:

1.Apostol T.M- Introduction to Mathematical Analysis, Narosa Publishing House,2002.
2.Terence Tao, Analysis- I and Analysis- II, TRIM series, HBA.
3. Richard,Goldberg, Real Analysis, Oxford and IBH.
4.S.R.Ghorpade and B.V.Limaye, A Course in Calculus and Real Analysis,UTM,Springer
5 W.Rudin, Introduction to Mathematical Analysis, Wiley.

Paper Code:1.4.	**Paper Title: LINEAR ALGEBRA**
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 3Hrs	**Credits: 04**

Unit 1:

Vector space over a field, subspaces, Linear span , Linear dependence, independence and their basic properties. Basis and Dimension. Quotient space and its dimension, Subspace, Sum and direct sum of subspaces.

Unit 2:

Linear transformations; the algebra of linear transformation; representation of linear transformation by matrices. Rank-Nullity theorem; duality and transpose; Linear Functionals; dual and bidual space, natural isomorphism.

Unit 3:

Eigen values and eigenvectors of a linear transformation, Diagonalization. Minimal Polynimial; Caley Hamilton Theorem; Annihilator of a subspace; Direct-Sum Decompositions; Invariant Direct Sums; The Primary Decomposition Theorem.

Unit 4:

Nilpotent transformations; Index of nilpotency; Cyclic Subspaces and Annihilators; Cyclic Decompositions and the Rational Forms; The Jordan Forms.

Unit 5:

Inner product spaces; Gram-Schmidt orthonormalization; Linear operators and adjoint; normal and self-adjoint operators; Unitary and Normal operators; orthogonal projections and spectral Theorem.

REFERENCES:

1. Hoffeman and Kunze, Linear Algebra, Prentice-Hall, Inc.,,1971.
2. N.Herstein,Topics in Algebra,Wiley Eastern Ltd,New York (1975)
3. S.Lang,Introduction to Linear Algebra 2nd Edition Springer-Verlag (1986)
4. Kumaresan, Linear algebra: A geometric approach, Prentice Hll of India, 2000.

Paper Code:1.5.	**Paper Title: ORDINARY DIFFERENTIAL EQUATIONS**
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 3Hrs	**Credits: 04**

Unit 1:

Linear-differential equation of n^{th} order, fundamental sets of solution, Wronskian – Abel's Identity, theorem on linear dependence of solutions, Adjoint, self-adjoint linear operator, Green's formula.

Unit 2:

Adjoint equations, the n^{th} order non-homogenous linear equations. Variation of parameters,-zeros of solutions, comparison and separation theorem, Fundamental existence and uniqueness theorem, dependence of solution on initial conditions, existence and uniqueness for higher order system of differential equations.

Unit 3:

Eigen value problems, Strum-Liouville's problem, Eigen functions, Orthogonality of Eigen functions, expansion in a series of orthogonal functions, Green's function method.

Unit 4:

Power series solution of linear differential equations- ordinary and singular points of differential equations, Classification into regular and irregular singular points, Series solution about an ordinary point and a regular singular point – Frobenius method-Hermite, Laguerre, differential equations, Recurrence relations, Rodrigue's formula and Orthagonality properties.

Unit 5:

Chebyshev and Gauss Hypergeometric equations and their general solutions. Generating function, Recurrence relations, Rodrigue's formula-Orthagonality properties. Behavior of solution at irregular singular points and the point at infinity Linear system of homogeneous and non-homogeneous equations (matrix method) Linear and Non-linear autonomous system of equations - Phase plane - Critical points - stability - Liapunov direct method - Limit cycle and periodic solutions-Bifurcation of plane autonomous systems.

REFERENCE BOOKS:

1.G.F. Simmons: Differential Equations, TMH Edition, New Delhi, 1974.
2. M.S.P. Eastham: Theory of ordinary differential equations, Van Nostrand, London, 1970.
3. S.L. Ross: Differential equations (3rd edition), John Wiley & Sons, New York, 1984.
4. Boyce and Diprima, Elementary Differential Equations and Boundary Value Problems, J.Wiley.
5. E.Coddington, Introduction to Ordinary Differential Equations.

Paper Code:1.6.	**Paper Title: DISCRETE MATHEMATICAL STRUCTURES**
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 3Hrs	**Credits: 04**

Unit 1:

Boolean algebra and lattices, partially ordered sets lattices, complete, distributive, complimented lattices, Boolean functions and expressions, Propositional calculus, logical connectives , truth values and tables, Boolean algebra to digital networks and switching circuits.

Unit 2:

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

Unit 3:

Recurrence Relations and Recursive Algorithms - Introduction: Recurrence relations, linear recurrence relations with constant coefficients, Homogeneous solutions, particular solutions, total solutions, solution by a method of generating functions.

Unit 4:

Graph theory - Basic Concepts: Different types of graphs, sub-graphs, walks and connectedness. Degree sequences, directed graphs, distances in graphs, isomorphism and self complimentary graphs. Operations on graphs, Extremal graphs.
Trees and Fundamental circuits: Characterization of trees pendant vertices centers, centroids, spanning trees Fundamental circuits, cut sets properties of cut set fundamental circuits and cut sets connectivity and separability.

Unit 5:

Matrix Representation of graphs; Adjacency matrix, Incidence matrix, sub matrices of circuit matrix, fundamental circuit matrix and it's Rank. An application to switching network. Cut set matrix, relationship between the matrices, path matrix.

REFERENCES:

1. C. L. Liu, Elements of Discrete Mathematics, McGraw Hill.
2. B. K. Kolman, R.C.Busby and S.Ross, Discrete mathematical structures, PHI
3. K. D. Joshi, Foundations of Discrete Mathematics, Wiley eastern.
4. N. L. Biggs, Discrete Mathematics, Oxford University Press.
5. Ralpha P. Grimaldi and B. V. Ramana, Discrete abd Combinatorial Mathematics, Pearson Education, 5th Edition
6. Narsingh Deo, Graph Theory with applications to Engineering and Computer Science.

SEMESTER – II

Paper Code:2.1.	**Paper Title: ALGEBRA-II**
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 3Hrs	**Credits: 04**

2.1 Unit 1:

Rings, subrings, ideals, factor ring (all definitions and examples). Homomorphism of Rings, Isomorphism theorems. 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 in an indeterminate X.

Unit 2:

Principal Ideal Domain (PID). Euclidean domain. The ring of Gaussian integers as an Euclidean domain. Fermat's theorem. Unique factorization domain. Primitive polynomial. Gauss lemma.

Unit 3:

F[X] is a unique factorization domain for a field. Eisenstein's criterion of irreducibility for polynomials over a unique factorization domain.

Unit 4:

Field, subfield, Prime fields-definition and examples, finite fileds Characteristic of a field. Field extensions, Algebraic extension. Transitivity theorem. Simple Extensions

Unit 5:

Roots of Polynomials. Splitting field of a polynomial. Existence and uniqueness theorems. Existence of a field with prime power elements.

REFERENCES:

1. N.S.Gopalakrishna University Algebra, New Age International Publishers
2. Joseph A. Gallian, Contemporary Abstract Algebra, Narosa Publications
3. I.N.Herstein, Topics in Algebra 2nd Edition, John –wiley and sons,New York
4. Surjit Singhand Quazi Zameeruddin,Modern Algebra, Vikas Pulishers(1990)
5. S.K.Jain, P.B.BhattaCharya and S.R.Nagpaul,Basic Abstract Algebra, Cambridge University Press.

Paper Code:2.2.	**Paper Title: COMPLEX ANALYSIS**
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 3Hrs	**Credits: 04**

Unit 1:

Complex plane, its algebra and topology, Holomorphic maps, Analytical function, power series as an analytical functions, inverse function, Zero's of Analytic function.

Unit 2:

Review of Complex integration, Basic properties of complex integral, Winding number, Cauchy-Gourasat theorem, Cauchy's theorem in a disk, triangle rectangle, Homotopy version of Cauchy's theorem, Morera's theorem, Cauchy integral formula. Laurent series.

Unit 3:

Maximum modulus Principle, Open mapping theorem , Hadamard three circle theorem and their consequences, Schwartz Lemma, Liouville's theorem

Unit 4:

Classification of singularities, Poles, Casorati- weierstrass theorem, Singularities at infinity, Residue at a finite point, Residue at the point at infinity. Residue theorem, Rouche's theorem,

Unit 5:

Intergral of types $\int_{\alpha}^{2\pi+\alpha} R(cos\theta, sin\theta)d\theta$, $\int_{-\infty}^{\infty} f(x)dx$, $\int_{-\infty}^{\infty} g(x)cosmxdx$, Mittag leffler's theorem, Normal families, Montel's theorem and Riemann mapping theorem.

REFERENCES:

1. S. Ponnusamy, Foundations of Complex Analysis
2. J.B.Conway, Functions of One complex variable, Springer.
3. Greene, Robert.F,S.Krantz, Functions of One Complex variable, Universities Press.
4 L.Ahlfors, Complex Analysis, McGraw Hill.

Paper Code:2.3.	**Paper Title: PARTIAL DIFFERENTIAL EQUATIONS**
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 3Hrs	**Credits: 03**

Unit 1:

First order Partial Differential Equations, the classification of solutions-Pfaffian differential equations-quasi linear equations, Lagrange's method-compatible systems,Charpit's method, Jacobi's method, integral surfaces passing through a given curve.

Unit 2:

Method of Characteristics for quasi-linear and non-linear equations, Monge's method , Monge cone, characteristic strip.

Unit 3:

Origin of second order partial differential equations, their classification, and wave equation-D'Alemberts solution, vibrations of a string of finite length, existence and uniqueness of solution-Riemann's Method.

Unit 4:

Laplace equation boundary value problems, Maximum and minimum principles,Uniqueness and continuity theorems, Dirichilet problem for a circle, Dirichilet problem for a circular annulus, Neumann problem for a circle, Theory of Green's function for Laplace equation.

Unit 5:

Heat equation, Heat conduction problem for an infinite rod, Heat conduction in a finite rod existence and uniqueness of the solution Classification in higher dimensions, Kelvins inversion theorem, Equi-potential surfaces.

REFERENCES

1. I.J.Sneddon, Partial Differential equations, McGraw Hill.
2. F.John, PartialDifferentialEquations, Springer.
3. P.Prasad,R.Ravindran, Introduction to Partial Differential Equations, New AgeInternational
4. T.Amarnath, An Elementary Course on Partial differential Equations, Narosa Publishers.
5. K Shankara Rao, Introduction to Partial Differential Equations. PHI
6. Debnath and Tyn Myint-U Birkhauser Linear Partial Differntial Equations for Scientist and Engineers.

Paper Code:2.4.	**Paper Title: Real Analysis - II**
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 3Hrs	**Credits: 04**

Unit 1:

Rieman-Stieltjes integral, Linear properties, Intergration by parts, Change of Variables, step functions, Reduction of a Rieman-Stieltjes integral to a finite sum, sufficient and Necessary conditions for existence of Riemann- Stieltjes's integrals, Mean value theorems, Second fundamental theorem of integral calculus, Second mean value theorem.

Unit 2:

Sequences and series of functions, Uniform convergence, uniform convergence and continuity, Uniform convergence and differentiation, Uniform convergence and integration. The stone- Weierstnass theorem.

Unit 3:

Functions of Several Variables, Directional derivative and continuity total derivative total derivative expressed in terms of partial derivatives.

Unit 4:

Matrix of a Linear Function, Jacobian matrix, Chain rule, Matrix form of the chain rule, Mean value Theorems.

Unit 5:

Sufficient condition for differentiability and equality of mixed partial derivatives Taylor's Theorem, Inverse function Theorem, Implicit function Theorem.

REFERENCES

1. Apostol T.M- Mathematical Analysis(Ch.6,7,10 and 11)
2. Apostol T.M,Calculus-2-Part 2(Non-Linear Analysis)
3. Vector Analysis (Schaum Series)
4. Tarence Tau. Real Analysis. I and II Hindustan Book Agency
5. Goldberg, Real Analysis.
6. Michael Spvak CRC pass Calculus on Manifolds.

Paper Code:2.5.	**Paper Title: CLASSICAL MECHANICS**
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 3Hrs	**Credits: 04**

Unit 1:

Coordinate transformations, Cartesian tensors, Basic Properties, Transpose, Symmetric and Skew tensors, Isotropic tensors, Deviatoric Tensors, Gradient, Divergence and Curl in Tensor Calculus, Integral Theorems.

Unit 2:

Continuum Hypothesis, Configuration of a continuum, Mass and density, Description of motion, Material and spatial coordinates, Translation, Rotation, Deformation of a surface element, Deformation of a volume element, Isochoric deformation, Stretch and Rotation, Decomposition of a deformation, Deformation gradient, Strain tensors, Infinitesimal strain, Compatibility relations , Principal strains.

Unit 3:

Material and Local time derivatives Strain, rate tensor, Transport formulas, Stream lines, Path lines, Vorticity and Circulation, Stress components and Stress tensors, Normal and shear stresses, Principal stresses.

Unit 4:

Fundamental basic physical laws, Law of conservation of mass, Principles of linear and angular momentum, Equations of linear elasticity, Generalized Hooke’s law in different forms, Physical meanings of elastic moduli, Navier’s equation.

Unit 5:

Equations of fluid mechanics, Viscous and non-viscous fluids, Stress tensor for a non-viscous fluid, Euler’s equations of motion, Equation of motion of an elastic fluid, Bernoulli’s equations, Stress tensor for a viscous fluid, Navier-Stokes equation.

REFERENCE BOOKS

1. D.S. Chandrasekharaiah and L. Debnath: Continuum Mechanics, Academic Press, 1994.
2. A.J.M. Spencer: Continuum Mechanics, Longman, 1980.
3. Goldstein, Classical Mechanics, Addison – Wesley, 3rd Edition, 2001.
4. P. Chadwick : Continuum Mechanics, Allen and Unwin, 1976.
5. Y.C. Fung, A First course in Continuum Mechanics, Prentice Hall (2nd edition), 1977
6. A.S. Ramsey, Dynamics part II, the English Language Book Society and Cambridge University Press,(1972)
7. F. Gantmacher, Lectures in Analytical Mechanics, MIR Publisher, Mascow,1975.
8. Narayan Chandra Rana and Sharad Chandra Joag, Classical Mechanics, Tata McGraw Hill, 1991.
9. F. Chorlton, Text Book of Dynamics, (ELBS Edition), G. Van Nostrand and co.(1969.

Paper Code:2.6.	**Paper Title: Latex and Beamer**
Lab Teaching Hours: 2 Hrs / Week	**Marks: Lab – 35 + IA - 15**
Teaching Hours: 2Hrs	**Credits: 01**

Latex practicals:

1. Creating Article/document
2. Write and Display Mathematical Equations
3. Create a table in different forms
4. Import figures and graphs into latex document
5. Draw different figures using latex commands

Using Beamer

6. Create frames in different formats
7. Create frames containing mathematical expressions
8. Create frames containing tables and figures
9. Create Bibliography in frames

Paper Code:2.7. I Open Elective Course	**Paper Title: SET THEORY (Arts & Commerce Stream)**
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 3 Hrs	**Credits: 04**

Unit 1:

Logic, Proposition, Truth Values, Connectives, Truth table.

Unit 2:

Set, Subset, Cross-Product, Complement, Difference, intersection, union function, onto function, One-One function, Bijective functions, Relations, Equivalence Relations.

Unit 3:

Combinations, Properties, Binomial Theorem, Expansion using Binomial Theorem.

Unit 4:

Matrix, Determinant, Cramer's rule, Inverse, Cayley- Hamilton Theorem (Statement only) Eigen values. (Discussion & problems of 3X3 matrix only)

Unit 5:

Vectors' Representation of vectors, Properties , Scalar of Dot Product vectors, or Cross product, Scalar Triple Product, vector Triple product.

REFERENCES:

1. Courant.R, Robbins ,What is Mathematics. Oxford University Press.
2. Kalyan Sinha, Rajeeva Karandikar, C.Musili and others, Understanding Mathematics,University Press.
3. Proof and fundamental, Ethan , d Bloch, UTM springar.
4. How to think like a Mathematics, Kevinhouston Cambridge University.

Paper Code:2.7. II Open Elective Course	**Paper Title:** Integral Transforms (Science Stream)
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 3 Hrs	**Credits: 04**

Unit 1:

Integral Transforms, Fourier Integral Theorem, Fourier sine and cosine integrals Fourier complex integral.

Unit 2:

Fourier Transforms, Fourier sine and cosine transforms, Properties, convolution theorem, Parseval's Identity, Parseval's identity cosine transform, Parseval's identity sine transform Fourier transforms of Derivative of a function.

Unit 3:

Solution of Boundary value problems by using integral transform, Fourier transforms of partial derivative of a function, Finite Fourier transforms.

Unit 4:

Z- Transforms, Properties, Z- Transform Theorem, Change of Scale, Shifting property.

Unit 5:

Inverse Z- Transform, Solution of Difference equations.

REFERENCES :

1. B.S Grewal, Higher Engineering Mathematics 43rd Edition, Khanna Publication.
2. Lokenath Debnath, Dambaru Bhatta, Integral Transforms and Their Applications, CRC Press.
3. Gerald B. Foland, Fourier Analysis and its applications, AMS.
4. E.M. Stein and R. Shakarchi, Fourier Analysis: An instruction, Princenton University Press,Princenton – 2003.

SEMESTER – III

Paper Code: 3.1.	**Paper Title: Measure Theory & Lebesgue Integration**
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 3 Hrs	**Credits: 04**

Unit 1:

Length of sets, Lebesgue outer measure, properties, Lebesgue measurable sets and measurable functions, Non-measureable sets, Borel sets and their measurability.

Unit 2 :

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

Unit 3:

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

Unit 4:

Lebesgue General (Dominated) convergence theorem. Differential of an integral, L_p space. Completeness of L_p-space.

Unit 5:

Product Measure, Fubini theorems, Radon-Nikodym theorem.

REFERENCES:

1. H.L.Royden: Real Analysis (Chapter 1,3,4,5 and 6).3rd Edition,MacMillan,NewYork(1963)
2. Inder Kumar Rana, Measure Theory and Integration, Narosa.
3. C.Goffman : Real Functions,Holt,Rinehart and Winston Inc.New York (1953)
4. P.K.Jain and V.P.Gupta : Lebesgue Measure and Integration, Wiley Eastern Ltd.(1986)
5. P.Halmos, Measure Theory, Narosa Publishers.

Paper Code: 3.2.	**Paper Title: NUMERICAL ANALYSIS**
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 3 Hrs	**Credits: 03**

Unit 1:

Criterion-Aitken's Δ 2-process-sturm sequence method to identify the number of real roots-Newton-Raphson's methods convergence criterion Ramanujan's Method- Birge-Vieta method, and Bairstow method

Unit 2:

Linear and Nonlinear system of Equations: Gauss Eliminations with Pivotal Strategy. LU -decomposition methods – Crout's, Cholesky method, Partition method –Jacobi and Gauss Seidel Itervative Methods with convergence criterion consistency and ill conditioned system of equations.

Unit 3:

Iterative methods for Nonlinear system of equations, Fixed point iteration method, Newton Raphson, Quasi Newton and Successive Over Relaxation methods for Nonlinear system of Equations. Tri-diagonal system of equations –Thomas Algorithm. Eigen values and eigenvector of symmetric matrix.

Unit 4:

Interpolation: Lagrange, Hermite, Cubic-spline's (Natural, Not a Knot and Clamped) - with uniqueness and error term, for polynomial interpolation. Bivariate interpolation.
Orthogonal polynomials Grams Schmidth Orthogoralization procedure and least square, Chebyshev and Rational function approximation.

Unit 5:

Numerical differentiation and Integration: Method based on interpolation, Gaussian quadrature, Gauss-Legendre, Gauss-Chebeshev formulas, Gauss Leguree, Gauss Hermite and Spline intergation– Integration over rectangular and general quadrilateral areas and multiple integration with variable limits.

REFERENCE BOOKS:

1. S.C.Chapra, and P.C. Raymond : Numerical Methods for Engineers, Tata Mc Graw Hill, New Delhi, 2000
2. R.L.Burden, and J.Douglas Faires : Numerical Analysis, P.W.S. Kent publishing Company, Boston ,1989 Fourth edition.
3. S.S. Sastry : Introductory methods of Numerical analysis, Prentice- Hall of India, New Delhi, 1998.
4. M. K. Jain, S. R. K.Iyengar and R.K.Jain : Numerical methods for scientific and engineering computation, Wiley Eastern Ltd. 1993, Third Edition.
5. C.F.Gerald, and P.O. Wheatley : Applied Numerical Methods, Low- priced edition, Pearson Education Asia 2002, Sixth Edition.
6. D.V. Griffiths and I.M. Smith, Numerical Methods for Engineers, Blackwell Scientific Publications (19991).

Paper Code: 3.3.	**Paper Title:** **DIFFERENTIAL GEOMETRY**
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 3 Hrs	**Credits: 04**

Unit 1.

Curves in Euclidean space; arc length; reparametrization; unit speedcurves; Tangent vectors; Principal normal and binomial vectors; Curvatureand torsion; Frenet-Serret equations; Isoperimetric Inequality; Thefour vertex theorem.

Unit 2.

Surfaces, Charts, Smooth functions; Tangent space;Normalsand orientability; the first fundamental form; Isometries of surfaces, the second fundamental form; The Gauss and Weingarten map.

Unit 3.

Normal curvature and geodesic curvatures; Parallel transport and covariantderivative; Gauss Equations; Gaussian, mean and principal curvatures;Surfaces of constant Gaussian and Mean curvature.

Unit 4.

Gaussian curvature of compact surfaces; Geodesics; Geodesic equations;Geodesics on surfaces of revolution; Geodesic coordinates.

Unit 5.

Exponential map, Gauss'sTheoremaEgregium; Gauss–Bonnet theorem, Riemannian metrics, upper half space model for hyperbolic geometry.

References:

[1] Manfredo P. doCarmo, Differential geometry of curves and surfaces, Prentice-Hall, 1976.

[2] S. Kumaresan, A course in differential geometry and lie groups, TRIM Series, HBA, 2002.

[3] Andrew Pressley, Elementry differential geometry, Springer, 2010.

[4] Anant R. Shastri, Elements of differential topology, CRC Press, 2012.

[5] J. A. Thorpe, Elementry topics in differential geometry, Springer-Verlag, 2015.

[6] Svetlana Katok, Fuchsian Groups, University of Chicago press, 1992.

Paper Code: 3.4.	**Paper Title: NUMBER THEORY AND CRYPTOGRAPHY**
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 3 Hrs	**Credits: 04**

Unit 1:

Divisibility and Euclidean algorithm, Congruences and their applications to factoring.

Unit 2:

Finite Fields, Legendre symbol, quadratic reciprocity, Jacobi symbol.

Unit 3:

Cryptosystems, Digraph Transformations and enciphering matrices, RSA cryptosystem.

Unit 4:

Primality and factoring, Pseudoprimes, Carmichael numbers, Primality tests, Strong Pseudoprimes, Montecarlo method, Fermat factorization, Factor base, implication for RSA, continued fraction method.

Unit 5:

Elliptic curves, Basic facts, elliptic curves over R,Q,C and finite fields, Hasse Theorem, Weil Conjectures (without proof), elliptic curve cryptosystem.

REFERENCES:

1. N.Koblitz, A course in Number theory and Cryptology, GTM Springer 1987.
2. Rosen.M, Ireland K, A Classical introduction to Number Theory, Spinger.
3. David.Bressoud, Facorization and Primality testing, UTM,Springer1989
4. David. M. Borton, Elementay Number Theory.

Paper Code: 3.5. a)ELECTIVE	**Paper Title: Algebraic Topology - I**
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 3 Hrs	**Credits: 04**

Unit 1:

Topological groups; Orbit space; Quotient Topology; Construction of cylinder, Cone, Möbiusband, torus. Suspension of a space; Join of two spaces; Wedge Sum; Smash Product; Mapping cylinder; Mapping cone.

Unit 2:

Homotopy and Homotopy Type; the Fundamental Group; Induced Homomorphisms; Deformation Retraction.

Unit 3:

Simplicial and CW complexes; Covering Spaces; Lifting Properties; Relation with the Fundamental Group.

Unit 4:

Classification of Covering Spaces; Deck Transformations and Group Actions; Universal coverings; Brouwer fixed point theorem; Borsuk-UlamTheorem.

Unit 5:

Free Products of Groups; Van Kampens Theorem; Applications to Cell Complexes; Computation of fundamental groups.

Reference:

[1]O. Ya. Viroet. al., Elementary topology problem textbook, A.M.S, 2008.

[2]Allen Hatcher, Algebraic topology, Cambridge University Press, 2002.

[3]James R. Munkres,Topology, Pearson, 2000.

[4]Anant R. Shastri,Basic algebraic topology, CRC Press, 2014.

Paper Code: 3.5. b)ELECTIVE	**Paper Title: FOURIER ANALYSIS**
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 3 Hrs	**Credits: 04**

Unit 1:

Basic Properties of Fourier Series: Uniqueness of Fourier Series, Convolutions, Cesaro and Abel Sumability, Fejer's theorem, Poisson Kernel and Dirichlet problem in the unit disc. Mean square Convergence, Example of Continuous functions with divergent Fourier series.

Unit 2:

Distributions and Fourier Transforms: Calculus of Distributions, Schwartz class of rapidly decreasing functions, Fourier transforms of rapidly decreasing functions, Riemann Lebesgue lemma, Fourier Inversion Theorem, Fourier transforms of Gaussians.

Unit 3:

Tempered Distributions: Fourier transforms of tempered distributions, Convolutions, Applications to PDEs (Laplace, Heat and Wave Equations), Schrodinger-Equation and Uncertainty principle.

Unit 4:

Paley-Wienner Theorems, Poisson Summation Formula,

Unit 5:

Radial Fourier transforms and Bessel's functions. Hermite functions. Wavelets and X-ray tomography. Applications to Number Theory.

REFERENCES:

1. R. Strichartz, A Guide to Distributions and Fourier Transforms, CRC Press.
2. E.M. Stein and R. Shakarchi, Fourier Analysis: An Introduction, Princeton University Press, Princeton 2003.
3. Richards and H. Youn, Theory of Distributions and Non-technical Approach, Cambridge University Press, Cambridge, 1990.

Paper Code: 3.5. c)ELECTIVE	**Paper Title: FLUID MECHANICS**
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 3 Hrs	**Credits: 04**

Unit 1:

Kinematics of fluids in motion; Velocity of a fluid at a point,Stream lines. Path lines and Streak lines. Velocity potential. Vorticity vector, local and particle rate of change, equation of Continuity. Motion of inviscid fluids ; Euler's Equations of motion. Bernoulli's equation. Equation of motion by flux method.

Unit 2:

Motion of inviscid fluids:- Steady motion under conservative body forces, Potential theorems, - Kelvin's theorem – Impulsive motion - Dimensional analysis – Non-dimensional numbers.

Unit 3:

Two dimensional flows of inviscid fluids:- Meaning of two-dimensional flow - Stream function – Complex potential - Line sources and sinks - Line doublets and vortices - Images - Milne-Thomson circle theorem and applications - Blasius theorem and applications.

Unit 4:

Motion of Viscous fluids:- Stress tensor – Navier-Stokes equation - Energy equation - Simple exact solutions of Navier-Stokes equation: (i) Plane Poiseuille and Hagen-Poiseuille flows (ii) Generalized plane Couette flow (iii) Steady flow between two rotating concentric circular cylinders (iv) Stokes's first and second problems (vi) Slow and steady flow past a rigid sphere and cylinder. Diffusion of vorticity - Energy dissipation due to viscosity.

Unit 5:

Boundary layer concept –Derivation of Prandtl boundary layer equations – Boundary layer along flat plate, Blasius solution , Boundary layer on a surface with pressure gradient, Momentum Integral theorem.

REFERENCES:

1. F. Chorlton : Text book of Fluid Dynamics, Van Nostrand, 1967

1. 2. Z. U. A.Warsi : Fluid Dynamics, CRC Press (2nd edition), 1999.

3. J. L. Bansal, Viscous Fluid Dynamics.

4. S. W. Yuan : Foundations of Fluid Mechanics, Prentice Hall, 1976.

5. G. K Bachelor -.An Introduction to Fluid dynamics.

Paper Code: 3.5. d)ELECTIVE	**Paper Title: Combinatorial Network Theory**
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 3 Hrs	**Credits: 04**

Unit 1:

Graphs and Interconnection Networks: Interconnection networks, graph isomorphism, trees, embedding and planar graphs.

Unit 2:

Transmission delay and diameter: diameter of graph, average distance of graph and routing in networks. Fault tolerance and connectivity: Menger's theorem, connectivity in graphs and fault tolerance of networks. Basic principles of networks and design:

Unit 3:

Design Methodology of Interconnection network: Line graphical method, Calyley method, Cartesian Product Method, Basic Problems in optimal design.

Unit 4:

Topological Structures of Interconnection Networks: Hypercube network, De Bruijin network, Kautz network, Double loop network, Mesh network and grid network, Pyaramid network, Butterfly network, Benes network, Omega network, Shuffling exchange network.

Unit 5:

Fault Tolerance analysis of Interconnection networks: Routing in interconnection networks, Fault-Tolerent diameter, Menger type problems in parallel system, Wide diameter of network, (l,w)-independence and dominating number, Ritricted fault tolerance of networks.

References:

1. Junming Xu, Topological Structures and Analysis of Interconnection Networks, Kluwer Academic Publisher, (2001).
2. Frank Harary, Graph Theory, Addison Wisley (1976).
3. Nurshing Deo, Graph Theory
4. Bondy and Muthy, Graph Theory, Springer-Berlin.

Paper Code: 3.6.	**Paper Title: Practical: Scila**
Teaching Hours: 2 Hrs / Week	**Marks: Lab - 35 + IA - 15**
Teaching Hours: 2 Hrs	**Credits: 01**

Scilab practicals:

Programs for finding the root of the function using

1. Fixed-point iterative method
2. Newton-Raphson method
3. Newton-Raphson method for multiple roots
4. Ramanujan method 5

Programs for the solution of system of equations using

5. Gauss-elimination method with pivoting
6. LU Decomposition method
7. Gauss-Seidel iterative method
8. Jacobi iterative method

Programs on interpolation using

9. Lagrange interpolation method
10. Cubic Spline interpolation method

Programs for solution of ordinary differential equation using

11. Euler's method and modified Euler's method.
12. Adam's Predictor-corrector method
13. Finite difference methods
14. Shooting methods

Paper Code: 3.7.I Open Elective Course	**Paper Title: STATISTICS (Arts and Commerce Stream)**
Teaching Hours: 4 **Hrs / Week**	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 4 Hrs	**Credits: 04**

Unit 1:

Frequency Distribution, Measure of Central Tendency A.M.G.M., H.M Median, Mode Standard deviation.

Unit 2:

Moments, Moments generation function, Skewness, Correlation

Unit 3:

Karls Pearson's Co- efficient of Corrdation, Rank correlation co efficient Regression, line of regression, Equations to the lines of regression, Error of prediction.

Unit 4:

Probability, Definitions, Addition Law of Probability, Multiplication of law of Probability Baye's theorem.

Unit 5:

Binomial Distribution, Mean of binomial distribution, Poisson distribution, mean of Poisson distribution, Normal distribution, mean of normal distribution.

REFERENCES:

1. Das.M.J, Statistical Methods, Das and Co Publishers Kolkata.
2. Miller,J.E.Freud, Mathaematical Statistics with applications,Pearson, New Delhi.
3. Gupta and Gupta, Business Statistics, Sultann Chad Publishers.
4. Chandan.J, Statistics for Business Economics, Vikas Publishers.

Paper Code: 3.7.IIOpen Elective Course	**Paper Title: COMPUTATIONAL METHODS (Science Stream)**
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 4 Hrs	**Credits: 04**

Unit 1:

Solution of algebraic and transcendental equations ; Fixed point iterative method, Bisection method, Regula –Falsi method, Secant method and Newton-Raphson method

Unit 2:

Linear algebraic system of Equations: Direct method; Gauss Eliminations and Gauss-Jordan methods. Iterative methods ; Jacobi iteration method and Gauss Seidel iteration Method.

Unit 3:

Interpolation: Newton forward and backward interpolation, Lagranges interpolation. Least square approximation (linear, quadratic and cubic).

Unit 4:

Numerical Integration: Trapezoidal Rule, Simpsons 1/3 and 3/8th rule. Numerical solution of derivatives ; Taylor' series method, Euler method and Euler modified method and Runge-kutta 2 and 4th order methods.

Unit 5:

Permutations and Combinations: Introduction, Rules of Sum and Product, Permutations, Combinations, Generation of Permutations and Combinations.

REFERENCES :

1. S.S. Sastry : Introductory methods of Numerical analysis, Prentice- Hall of India, New Delhi (1998).
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain : Numerical methods for scientific and Engineering computation, Wiley Eastern (1993)
3. B.K Kolman, R.C Busby and S. Ross, Discrete Mathematical Structure, PHI.
4. K.D Joshi, Foundations of Discrete Mathematics, Wiley Estern.

SEMESTER – IV

Paper Code: 4.1.	**Paper Title:** FUNCTIONAL ANALYSIS
Teaching Hours: 4 **Hrs / Week**	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 4 Hrs	**Credits: 04**

Unit 1:

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(X,Y) for Banach spaces , X,Y'.

Unit 2:

Dual space of normed linear space , Equivalence of norms, Dual space of C[a,b], Isometric isomorphism.

Unit 3:

Hahn-Banach theorem and its applications, Seperable normed linear space

Unit 4:

Canonical embedding of X into X**. Reflexive spaces, Open mapping theorem , Closed graph theorem, Principle of Uniform boundedness(Banach-Steinhauss Theorem), Projection on Banach spaces. Hilbert spaces, Definition and examples, Orthogonal complements, Orthonormal basis, Gram-Schimdt process of orthonormalisation, Besel's inequality, Riesz Fisher Theorem.

Unit 5:

Adjoint of an operator, Self adjoint, normal, unitary and projection operators.

REFERENCES:

1. G.F.Simmons: Introduction to T opology and Modern Analysis, McGraw Hill Book company Inc (1962)
2. C.Goffman and G.Pedrick: First Course in Functional Analysis, Prentice Hall of India Pvt
3. Ltd N.Delhi(1974)
4. B.V.Limaye: Functional Analysis 2nd Edition, New Age International (P) Ltd
5. Publication 1997.
6. D.Somasundaram, Functional Analysis, S.Vishwanathan Printers and Publishers Pvt, Limited (1994)
7. Ponnuswamy, Foundations of Functional analysis, Narosa.
8. K.Chandrashekara Rao,Functional Analysis, Narosa

Paper Code: 4.2.	**Paper Title: MATHEMATICAL METHODS**
Teaching Hours: 4 **Hrs / Week**	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 4 Hrs	**Credits: 04**

Unit 1:

Integral Transforms**:**. Applications of Laplace transforms, Laplace transforms to solve ODEs and PDEs - typical examples. Integral Equations: General definition of Integral transforms, Kernels, etc. Definition, Volterra and Fredholm integral equations. Solution by separable kernel, Neumann's series,

Unit 2:

Resolvant kernel and transform methods, Convergence for Fredholm and Volterra types. Reduction of IVPs, BVPs and eigen value problems to integral equations. Hilbert Schmidt theorem, Raleigh Ritz and Galerkin methods. Asymptotic Methods: Asymptotic expansion of functions, power series as asymptotic series, Asymptotic forms for large and small variables. Uniqueness properties and Operations.

Unit 3:

Asymptotic expansions of integrals; Method of integration by parts (include examples where the method fails), Laplaces method and Watson's lemma, method of stationary phase and steepest descent.

Unit 4:

Regular and singular perturbation methods: Parameter and co-ordinate perturbations. Regular perturbation solution of first and second order differential equations involving constant and variable coefficients. Include Duffings equation, Vanderpol oscillator, small Reynolds number flow.

Unit -5

Singular perturbation problems, Matched asymptotic expansions, simple examples. Linear equation with variable coefficients and nonlinear BVP's. Problems involving Boundary layers. Poincare – Lindstedt method for periodic solution. WKB method.

REFERENCE BOOKS

1. I.N. Sneddon – The use of Integral Transforms, Tata Mc Graw Hill, Publishing Company Ltd, New Delhi, 1974
2. R.P. Kanwal: Linear integral equations theory and techniques, Academic Press, New York, 1971
3. C.M. Bender and S.A. Orszag – Advanced mathematical methods for scientists and engineers, Mc Graw Hill, New York, 1978
4. H.T. Davis – Introduction to nonlinear differential and integral equations, Dover Publications, 1962.

Paper Code: 4.3.	**Paper Title: ADVANCED GRAPH THEORY**
Teaching Hours: 4 Hrs / Week	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 4 Hrs	**Credits: 04**

Unit 1:

Coverings, Vertex covering, Edge covering, Independence number, Matching and Matching polynomials, Factorization of graphs: Factorization-1 factorization, 2-factorization, and decomposition of Graphs. Colorings, Chromatic numbers and chromatic polynomials,

Unit 2:

Distance in Graphs: The center of a graph, distant vertices. Distance Based Topological Indices: Wiener index, Hyper- Wiener index and Harary index, related bounds.

Unit 3:

Spectra of Graphs, Characteristic polynomial, Eigenvalues, Eigenvectors, Energy of graphs: Energy of all standard class of graphs, Bounds for energy of a graph.

Unit 4:

Groups and Graphs, Automorphism group of Graph. Operations on Permutation graphs, The Group of composite graphs, Domination: Dominating sets, Domination numbers, Domatic number and its bounds, independent domination of a number of a Graph, Other domination parameters.

Unit 5:

Directed graphs, directed paths, directed cycles, a job sequencing problem, designing an efficient computer drum, making a road system one-way, ranking the participants in the tournament.

REFERENCES:

1. G.Charatrand and Ping Zhang: Introduction to graph theory.
2. R.B.Bapat, Graphs and matrices.
3. I. Gutaman and Xi Li, Graph Energy.
4. I. Gutman and O.Polansky, Mathematical Concepts in organic Chemistry.
5. J.A.Bondy ans V.S.R.Murthy, Graph Theory with applications McMillan, London.
6. F. Buckley and F.Harary: Distance in Graphs, Addison Wesley, 1990.
7. Diestel: Graph Theory, Springer Verlag, Berlin
8. R J. Gould: Graph Theory, Benjamin Cummins Publication Company Inc, Calif 1998.
9. F. Harary Graph theory, Addision Wesley, Reading Mass 1969.
10. D. Cvetkovic, M.Doob and H.Sachs, Spectra in Graphs, Academic Press, 1980.
11. R. Balakrishnan and K. Ranganathan, A text book on graph theory, Springer-Berlin.

Paper Code: 4.4.	**Paper Title: Advanced Numerical Methods**
Teaching Hours: 4 **Hrs / Week**	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 4 Hrs	**Credits: 04**

Unit 1:

Numerical solution of ordinary differential equations: Initial value problems - Picard's and Taylor series methods – Euler's Method- Higher order Taylor methods- Modified Euler's method- Runge Kutta methods of second and fourth order.

Unit 2:

Multistep method- The Adams-Bashforth method, Adams - Moulton method- stability- (Convergence and Truncation error for the above methods). Boundary- Value problems – Second order finite difference method, cubic spline method and shooting method.

Unit 3:

Numerical solution of Partial differential equations- Finite difference methods for Parabolic equations in one-dimension – methods of Schmidt, Laarsonen, Crank-Nicolson and Dufort. Frankel. Stability and convergence analysis for Schmidt and Crank-Nicolson methods and iterative methods.

Unit 4:

A.D.I. method for two - dimensional parabolic equation. Finite difference methods for hyperbolic equations in one-dimension explicit and implicit finite difference schemes. Stability and convergence analysis for hyperbolic equations.

Unit 5:

Finite Difference methods for Elliptic partial differential equations – Difference schemes for Laplace and Poisson's equations. Iterative methods of solution by Jacobi and Gauss-Seidel methods – solution techniques for rectangular and quadrilateral regions.

REFERENCE BOOKS:

1. M.K. Jain: Numerical solution of differential equations, Wiley Eastern (1979), Second Edition.
2. C.F. Gerald and P.O. Wheatley : Applied Numerical Methods, Low- priced edition, Pearson Education Asia (2002), Sixth Edition.
3. D.V. Griffiths and I.M. Smith, Numerical Methods for Engineers, Blackwell Scientific Publications (1991).
4. S.C. Chapra, and P.C. Raymond : Numerical Methods for Engineers, Tata Mc Graw Hill, New Delhi (2000)
5. R.L. Burden, and J. Douglas Faires : Numerical Analysis, P.W.S. Kent Publishing Company, Boston (1989), Fourth edition.
6. S.S. Sastry : Introductory methods of Numerical analysis, Prentice- Hall of India, New Delhi (1998).
7. M.K. Jain, S.R.K. Iyengar and R.K. Jain : Numerical methods for scientific and Engineering computation, Wiley Eastern (1993)
5. G.D.Smith: Numerical Solutions of partial differential equations 2nd edition London, Oxford University Press (1978)

Paruiz Moin: Fundamentals of Engineering Numerical analysis, Cambridge University Press (2006)

Paper Code: 4.5.(a) Elective	**Paper Title: Algebraic Topology II**
Teaching Hours: 4 **Hrs / Week**	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 4 Hrs	**Credits: 04**

Unit 1:

Singular Homology; Reduced Homology groups; Homotopy invariance; Exacts equences and Excision; Relative Homology group; Brouwer fixed point theorem for $n \geq 1$.

Unit 2:

Cellular Homology; Equivalence of singular and cellular homology; Euler Characteristic; Split Exact sequence; Homology of groups.

Unit 3:

Mayer-Vietoris sequences; Homology with coefficients; Relation between Homology and Fundamental groups

Unit 4:

Some classical applications including Jordan Brouwer separation theorem; Brouwers invariance of domain; Alexander Horned sphere; Borsuk-UlamTheorem for $n \geq 1$

Unit 5:

Simplicial Approximation Theorem; The Lefschetz Fixed Point Theorem.

Reference:

[1]O. Ya. Viroet. al., Elementary topology problem textbook, A.M.S, 2008.

[2]Allen Hatcher, Algebraic topology, Cambridge University Press, 2002.

[3]James R. Munkres,Topology, Pearson, 2000.

[4]Anant R. Shastri,Basic algebraic topology, CRC Press, 2014.

Paper Code: 4.5.(b) Elective	**Paper Title: Banach algebra**
Teaching Hours: 4 **Hrs / Week**	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 4 Hrs	**Credits: 04**

Unit 1:

Preliminaries, Banach spaces, Weak topologies on Banach spaces, Banach valued functions and their derivatives, Holomorphic functions, Banach space values measures and Integration.

Unit 2:

Definition of Banach Algebra, Homomorphisms, Spectrum, Basic properties of Spectra, Gelfand- Mazur Theorem, Spectral Mapping Theorem, group of invertible elements.

Unit 3:

Ideals, Maximal Ideals and Homomorphisms, Semisimple Banach Algerbras

Unit 4:

Gelfand Topology, Gelfand Transform, Involutions, Banach-C-*Algebras, Gelfand Naimark Theorem, Applications to Non-Commutative Banach Algebras, Positive functions.

Unit 5:

Operators on Hilbert Spaces, Commutativity theorem, Resolution of the identity spectral theorem, A Charecterization of Banach C*-Algebras

REFERENCES:

1. Rudin.W, Functional Analysis.
2. Bachman and Narice L, Functional Analysis , Academic Press.
3. B.V.Limaye, Functional Analysis, New Age International Limited
4. S.K.Berbenon, Lectures in Functional Analysis and Operator Theory, Narosa, 1979.
5. K.B.Athreya, B.K.Lahiri, Measure Theory and Probability Theory, Hindustan BookAgency, TRIM Series.

Paper Code: 4.5.(c) Elective	**Paper Title: Mathematical modeling**
Teaching Hours: 4 **Hrs / Week**	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 4 Hrs	**Credits: 04**

Unit 1:

Some basic topics in Nonlinear Waves: Shock waves and hydraulic jumps. Description and various physical set ups where they occur: traffic flow, shallow water.

Unit 2:

Fundamental concepts in continuous applied mathematics. Continuum limit. Conservation laws, quasi-equillibrium. Kinematic waves. _ Traffic flow (TF). Continuum hypothesis. Conservation and derivation of the mathematical model.

Unit 3:

Integral and differential forms. Other examples of systems where conservation is used to derive the model equations (in nonlinear elasticity, fluids, etc.), Linearization of equations of TF and solution. Meaning and interpretation. Solution of the fully nonlinear TF problem.

Unit 4:

Method of characteristics, graphical interpretation of the solution, wave breaking. Weak discontinuities, shock waves and rarefaction fans. Envelope of characteristics. Irreversibility in the model.

Unit 5:

Quasilinear First Order PDE's, Shock structure, diffusivity. Burger's equation. The Cole-Hopf transformation. The heat equation: derivation, solution, and application to the Burger's equation. Inviscid limit and Laplace's method.

REFERENCES:

1. R. Haberman, Mathematical Models, Mechanical Vibrations, Population Dynamics and Traffic flow, SIAM.
2. C. C. Lin and L. Segal, Mathematics Applied to Deterministic Problems in the Natural Sciences, SIAM.
3. F. Y. M. Wan, Mathematical Models and their Analysis, Harper and Row.
4. J. D. Logan, An Introduction to Nonlinear Partial Differential Equations, J. Wiley.
5. R. D. Richtmyer and K. W. Morton Difference Methods for Initial-Value Problems, Inter science, Wiley, Krieger.
6. C. Fowler, Mathematical Models in the Applied Sciences, Cambridge U. Press.
7. J. J. Stoker, Nonlinear Vibrations in Mechanical and Electrical Systems , J. Wiley.
8. G. B. Whitham, Linear and Nonlinear Waves, J. Wiley.
9. R. Haberman, Applied Partial Differential Equations With Fourier Series and Boundary Value Problems, Prentice Hall.

Paper Code: 4.5.(d) Elective	**Paper Title: Galois Theory**
Teaching Hours: 4 **Hrs / Week**	**Marks: Theory – 80 + IA - 20**
Teaching Hours: 4 Hrs	**Credits: 04**

Unit 1:
Algebraically closed fields, existence of algebraic closure, group of monomorphisms,group of automorphism of field extension, Galois group of extension.

Unit 2:
Separable extension, normal extension, Galois extension, primitive element theorem, fundamental theorem of finite extensions.

Unit 3:
Artin's theorem, fundamental theorem of Galois theory, examples of Galois groups, cyclotomic polynomial, cyclotomic and Abelian extension over Q.

Unit 4:
Galois group of polynomials, normal basis theorem, norm and trace, Hilbert theorem 90.

Unit 5:
Ruler and compass constructions, Solvable and radical extension, insolvablity of the Quintic, abelian and cyclic Galois groups, transcendental extension, inseperable extension, infinite Galois group.

References:

1. J. J. Rotman, Galois Theory, UniversitextSpringer 1990.
2. Ian Stewart, Galois Theory, Chapman Hall/CRC Math 2003.
3. Dummit and Foote,Abstract Algebra, Wiley India 2003.
4. Patrick Morandi, Field and Galois Theory, GTM Springer 2011.
5. Serg Lang, Algebra, GTM Springer 2005.

4.6 PROJECT

The candidate shall submit a dissertation carrying 80 marks and appear for viva-voce carrying 20 marks.