Education	NATIONAL INSTITUTE OF TECHNOLOGY, ARUNACHAL PRADESH (ESTABLISHED BY MINISTRY OF HUMAN RESOURCE DEVELOPMENT, GOVT. OF INDIA)	Ethics
In GOD's own land, a fusion of scholastic students, innovative & motivated researchers & teachers and fast moving visionary leaders.	 **COURSE STRUCTURE & SYLLABUS** **FOR** **MATHEMATICAL RESEARCH IN ENGINEERING AND TECHNOLOGY**	Steeping Stone and Sky reaching ladder to success
Research	PO-Yupia, Dist. – Papum Pare, Arunachal Pradesh, Pin – 791 112 Ph No : 0360-2284801/2001582 Fax No : 0360-2284972 Email – nitarunachal@gmail.com	Service to Society

NATIONAL INSTITUTE OF TECHNOLOGY

(Established by Ministry of Human Resources Development, Govt. Of India)
Yupia, District Papum Pare, Arunachal Pradesh – 791112
Fax: 0360 – 2284972, E-mail: nitarunachal@gmail.com

PROPOSED COURSE STRUCTURE FOR MATHEMATICAL RESEARCH IN ENGINEERING AND TECHNOLOGY

FIRST SEMESTER							
Sl. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Hours/Week**	**Credit**
1	MER 911	Advanced Numerical Methods	3	0	2	5	4
2	MER 912	Advanced differential equation: ODE and PDE	3	1	0	4	4
3	MER 913	Special Function & Integral Transform	3	1	0	4	4
4	MER 914	Advanced Graph Theory	3	1	0	4	4
5	MER 915	Continuum Mechanics	3	1	0	4	4
6	CSE 904	Research Paper Communication	3	0	0	3	3
TOTAL			**18**	**4**	**2**	**24**	**23**
SECOND SEMESTER							
Sl. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Hours/Week**	**Credit**
1	MER 921	Applied Algebra	3	1	0	4	4
2	MER 922	Complex Analysis	3	1	0	4	4
3	MER 923	Nonlinear Dynamical System	3	1	0	4	4
4	MER 924	Applied Functional Analysis	3	1	0	4	4
5	MER 925	Wavelet Analysis	3	1	0	4	4
6	MER 926	Applied Topology	3	1	0	4	4
TOTAL			**18**	**6**	**0**	**24**	**24**
THIRD SEMESTER							
Sl. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Hours/Week**	**Credit**
1	MER 931	Teaching in UG (Specified Project Guide)				3-4	2
2	MER 932	Seminar/ Presentation	0	0	3	3	3
3	MER 933	Dissertation(Continue to 4^{th} Semester)				20	14
TOTAL			**0**	**0**	**3**	**26**	**19**
FOURTH SEMESTER							
Sl. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Hours/Week**	**Credit**
1	MER 941	Dissertation				40	24
TOTAL						**40**	**24**

Name of the Module: Advanced Numerical Methods
Module Code: MER 911
Semester: I
Credit Value: 4 [P=1, T=0, L=3]

Objectives:

The course is design to meet the following objectives:

1. Introducing the basic concepts of round-off error, truncation error, numerical Stability and condition, Taylor polynomial approximations; to derive and apply some fundamental algorithms for solving scientific and engineering problems: roots of nonlinear equations, numerical solution of ordinary differential equations.

2. Application of computer oriented numerical methods which has become an Integral part of the life of all the modern engineers and scientists. The advent of powerful small computers and workstation tremendously increased the speed, power and flexibility of numerical computing.

3. Injecting future scope and the research directions in the field of numerical methods.

Learning outcomes:

Upon completion of the subject:

1. Students will be skilled to do Numerical Analysis, which is the study of algorithms for solving problems of continuous mathematics.

2. Students will know numerical methods, algorithms and their implementation in Fortran/C++ for solving scientific problems.

3. Students will be substantially prepared to take up prospective research assignments.

Subject Matter:

Unit I

Definition and sources of errors, solutions of nonlinear equations, Bisection method, Newton's method, fixed point iterations, convergence analysis, Newton's method for non-linear systems.

Unit II

Solution of the system of Linear equations: Gauss elimination method, Matrix Inversion, Operations Count, LU Factorization Method (Crouts Method), Gauss-Jordan Method, Gauss-Jacobi and Gauss-Seidel Method.

Unit III

Initial value problems: Taylor series method, Euler and modified Euler methods, Runge-Kutta methods, Predictor-Corrector method, multistep methods and stability.

Unit IV

Finite difference schemes for partial differential equations: Explicit and Implicit schemes, Consistency, Stability and Convergence , Stability analysis by matrix method and Von Neumann method, Lax's equivalence theorem, Finite difference schemes for initial and boundary value problems - FTCS, backward Euler and Crank-Nicolson schemes, ADI methods.

List of Practical: (Minimum six experiments are required to be performed)

1. Assignments on Numerical solution of a system of Linear Equations: Gauss elimination, Gauss Jordan, Matrix Inversion, Jacobi, Gauss Seidel.
2. Assignments on Solution of Algebraic Equations: Bisection, Secant, Regula-Falsi, Newton- Raphson Methods.
3. Assignments on Ordinary Differential Equations: Taylor Series, Eulers Method, Runge-Kutta (4th Order).
4. Assignments on Partial Differential Equations: FTCS scheme, Crank-Nicolson Scheme, ADI scheme.

Teaching/Learning/Practice Pattern:

Teaching: 40%
Learning: 10%
Practice: 50%

Examination Pattern:

1. Theoretical Examination and open book examination.

Reading List:

A. Books:

1. D. Kincaid and W. Cheney, Numerical Analysis: Mathematics of Scientific Computing, 3rd Ed., AMS, 2002.
2. K. E. Atkinson, An Introduction to Numerical Analysis, Wiley, 1989.
3. S. D. Conte and C. de Boor, Elementary Numerical Analysis - An Algorithmic Approach, McGraw-Hill, 1981.
4. John H. Mathews, Numerical Methods for Mathematics Sciences and Engineering 2nd ed. Prentice Hall of India, New Delhi 2003.
5. M.K.Jain, S.R.K. Iyengar and R.K. Jain, Numerical method for Scientific and Engineering Computation, New Age International Pvt. Ltd. 3rd edition, 1993.
6. G. D. Smith, Numerical Solutions to Partial Differential Equations, Oxford University Press, 3rd Edn., 1986.
7. J. C. Strikwerda, Finite Difference Schemes and Partial Differential Equations, SIAM, 2004.
8. L. Lapidus and G. F. Pinder, Numerical Solution of Partial Differential Equations in Science and Engineering, John Wiley, 1982.
9. K. W. Morton and D. F. Mayers, Numerical Solution of Partial Differential Equations, Cambridge University Press, 2nd Edn., 2005.

B. Magazines:

1. Current Science (Indian Academy of Science).

2. The Mathematics Student (Math Student) (Indian Mathematical Society).
3. Mathematical Spectrum (The University of Sheffield).
4. Mathematics Magazines (Mathematical Association of America).
5. +Plus Magazines (University of Cambridge).
6. Ganithavahini (Ramanujam Mathematical Society).

C. Journals:

1. Numerische Mathematik, Springer Link.
2. Acta Numerica, Cambridge University Press.
3. SIAM Review, University of Bristol, UK.
4. Journal of Computational Physics, Elsevier.
5. SIAM Journal on Numerical Analysis, University of Bristol, UK.
6. SIAM Journal on Scientific Computing, University of Bristol, UK.
7. IMA Journal of Numerical Analysis, Oxford Journals.
8. Mathematics of Computation, American Mathematical Society.
9. Foundations of Computational Mathematics, Springer Link.

Name of the Module: Advanced Differential Equations: ODE and PDE
Module Code: MER 912
Semester: I
Credit Value: 4 [P=0, T=1, L=3]

Objectives:

The course is design to meet the following objectives:

1. To give the basic ideas about the existence and uniqueness of solution of an ODE's.
2. To give the basic concepts about the series solution of ODE's, and Legendre's, Bessel's and Hermite's polynomial solutions of ODE's.
3. To give the basic ideas about parabolic, hyperbolic and elliptic PDE's and their solution by method of separation of variables and integral transform.

Learning outcomes:

Upon completion of the subject:

1. Students can able to find the solution of the systems of linear ODE's.
2. Students can able to find series solution of differential equations.
3. Student can able to classify the characteristic of a PDE's.
4. Student can able to find the solution of a ODE's or PDE's by integral transform(Laplace and Fourier).

Subject Matter:

Unit I

Introduction, Existence and Uniqueness of solution, Lipschitz Condition, Existence theorems, Picards theorem, Homogeneous and non-homogeneous systems of linear ODEs, Stability of linear systems.

Unit II

Power series solutions, Frobenius Method, Singularity of ODEs, Legendre's equation, Bessel's equation, Hermite's equation, Hypergeometric's equation.

Unit III
Linear and quasi-linear partial differential equations (PDEs), Canonical form, Cauchy problem, Classification of second order PDEs, characteristics, Well-posed problems, Solutions of hyperbolic, parabolic and elliptic equations, Dirichlet and Neumann problems, Maximum principles, Green's functions in ODEs & PDEs.

Unit IV
Non-line ODEs and PDEs.

Teaching/Learning/Practice Pattern:
Teaching: 70%
Learning: 30%
Practice: 0%
Examination Pattern:

1. Theoretical Examination and open book examination.

Reading List:

A. Books:

1. E. A. Coddington and N. Levinson, Theory of Ordinary Differential Equations, Tata McGraw Hill, 1990.
2. S. L. Ross, Differential Equations, 3rd Edn., Wiley India, 1984.
3. I. N. Sneddon, Elements of Partial Differential Equations, Dover Publications, 2006.
4. F. John, Partial Differential Equations, Springer, 1982.
5. S. J. Farlow, Partial Differential Equations for Scientists and Engineers, Dover Publications, 1993.
6. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.
7. K. Sankara Rao, Introduction to Partial Differential Equations, PHI, New Delhi, 2010.
8. A. Chakraborty, Elements of Ordinary Differential Equations and Special Function, New Age International(P) Limited, 2002

B. Magazines:
1. Current Science (Indian Academy of Science).
2. The Mathematics Student (Math Student) (Indian Mathematical Society).
3. Mathematical Spectrum (The University of Sheffield).
4. Mathematics Magazines (Mathematical Association of America).
5. +Plus Magazines (University of Cambridge).
6. Ganithavahini (Ramanujam Mathematical Society).

C. Journals:
1. Differential Equations, Springer.

2. Journal of Differential Equations, Elsevier.
3. International Journal of Differential Equations, Hindawi.
4. Journal of Hyperbolic Differential Equations, World Scientific.
5. International Journal of Dynamical Systems and Differential Equations, Inderscience Publishers

Name of the Module: Special Functions and Integral Transforms
Module Code: MER 913
Semester: I
Credit Value: 4 [P=0, T=1, L=3]

Objectives:

The course is design to meet the following objectives:

1. To investigate the properties of special functions and integral transforms.

2. To introduce from the point of view of applications to differential and integral equations.

Learning outcomes:

Upon completion of the subject:

1. Students can able to understand the properties of Integral Transforms and Special functions.

2. Student can able to demonstrate a firm understanding of the solution techniques for ordinary and partial differential equations.
3. Student can able to understand the mathematical framework that supports engineering, science, and mathematics.

Unit I

Legendres polynomial, Associated Legendres functions, Bessels functions, Recurrence relations, orthogonal properties, Hermite and Laguerre polynomials, their generating functions and general integral properties, Hyper-Geometric functions.

Unit-II

Laplace transform, Inverse of Laplace transform, Definition and properties, Laplace transform of derivatives and integrals, Convolution theorem, Complex inversion formula, Theorems of Laplace transform.

Unit-III

Fourier integral theorem, Fourier transform and inverse Fourier transform, Fourier sine and cosine transform, convolution theorem, Fourier transform of derivatives, Hankel Transform,

definition and elementary properties, inversion theorem, Hankel transform of derivatives, Parsevals theorem.

Unit-IV
Application of Laplace transform to the solution of ordinary differential equations with constant coefficients and with variable coefficients, simultaneous ordinary differential equations,
application of Fourier transform to the solution of boundary value problems, partial differential equations.

Teaching/Learning/Practice Pattern:
Teaching: 70%
Learning: 30%
Practice: 0%

Examination Pattern:

Theoretical Examination and open book examination.

Reading List:

A. Books:
1. E. D. Rainville, Special Function, Macmillan, New York.
2. I. N. Sneddon, The Use of Integral Transform, Tata McGraw Hill.
3. M. R. Spigel, Theory and Problems of Laplace transform.
4. Sharma and Vasistha, Integral Transforms, Krishna Prakashan, Meerut.

B. Magazines:
1. Current Science (Indian Academy of Science).
2. The Mathematics Student (Math Student) (Indian Mathematical Society).
3. Mathematical Spectrum (The University of She_eld).
4. Mathematics Magazines (Mathematical Association of America).

5. +Plus Magazines (University of Cambridge).

6. Ganithavahini (Ramanujam Mathematical Society).

C. Journals:
1. Ganita Sandesh.
2. Journal of Rajasthan Academy of Physical Sciences.
3. Bulletin of Calcutta Mathematical Society.
4. Integral Transforms and Special Functions.
5. Journal of Integral Equations and Applications.

Name of the Module: Advanced Graph Theory
Module Code: MER 914
Semester: I

Credit Value: 4 [P=0, T=1, L=3]

Objectives:

The course is design to meet with the objectives of:

1. Imparting theoretical and practical application to the students in the area of Graph theory.
2. Injecting future scope and the research directions in the field of theory.
3. Making students competent to analyze and design of real world problem.

Learning outcomes:

Upon Completion of the subjects:

1. Students will be adequately trained to model problems of real world.
2. Students will be skilled both theoretical and practical application to other branch of engineering.
3. Students will be substantially prepared to take up prospective research assignments.

Subject Matter:

Unit I:

Basic concepts, degree, incidence, isomorphism, subgraph, walk, path, cycle, operations on graphs, degree sequences, connectivity, cut vertices and cut edges, Eulerian and Hamiltonian graphs, Trees, Spanning trees, Cayley formula.

Unit II:

Covering numbers and matching, perfect matching, colour of a graph, edge colouring,Vizing Theorem, Independent sets, vertex colouring, chromatic polynomial,planer and non-planer graphs, Euler's formula, Kuratowski'stheorem,five colour theorem, history of four colour theorem.

Unit III:

Directed graphs.

Unit IV:

Introduction to algebraic graph theory.

Unit V:

Introduction to random graph.

Teaching/Learning/Practice Pattern:

Teaching: 70%
Learning: 30%
Practice: 0%

Examination Pattern:

Theoretical Examination and open book examination.

Reading list:

1. Berge, Claude. Hypergraphs: Combinatorics of Finite Sets Amsterdam: North-Holland, 1989.
2. Berge, Claude. Graphs, New York, NY: Elsevier Science, 1985. Second Revised Edition.
3. Biggs, Norman L. Algebraic Graph Theory New York, NY: Cambridge University Press, 1974.
4. Bollobas, Bela. Graph Theory: An Introductory Course New York, NY: Springer-Verlag, 1979.
5. Chartrand, Gary and Lesniak, Linda. Graphs Digraphs, Belmont, CA: Wadsworth, 1986. Second Edition.
6. Gibbons, Alan. Algorithmic Graph Theory New York, NY: Cambridge University Press, 1985.
7. Harary, Frank. Graph Theory Reading, MA: Addison-Wesley, 1969. Narosa (1988).
8. J. A. Bondy and U. S. R. Murty. Graph Theory with Applications. North-Holland, 1976.
9. J. M. Aldous. Graphs and Applications. Springer, LPE, 2007.
10. D. B. West, Introduction to Graph Theory, Prentice-Hall (Indian Edition 1999).
11. Bollobas, Bela. Random Graph, Academic Press, 1985

Journals

1. Combinatorica
2. Discrete Applied Mathematics
3. Discrete Mathematics
4. European Journal of Combinatorics
5. Graphs and Combinatorics
6. Journal of Combinatorial Theory, Series A
7. Journal of Combinatorial Theory, Series B
8. Journal of Graph Theory
9. SIAM Journal on Computing
10. SIAM Journal on Discrete Mathematics
11. Theoretical Computer Science

Magazines:

1. Current Science (Indian Academy of Science)
2. The Mathematics Student (Math Student) (Indian Mathematical Society)
3. Mathematical Spectrum(The University of Sheffield)
4. Mathematics Magazine (Mathematical Association of America)
5. +Plus magazine (University of Cambridge)
6. Ganithavahini (Ramanujan Mathematical Society)

Name of the Module: Continuum Mechanics
Module Code: MER 915
Semester: I
Credit Value: 4 [P=0, T=1, L=3]

Objectives:

The course is design to meet the following objectives:
1. The purpose of this course is to introduce the main ideas of fluid.
2. Student will get basic idea about the mass conservation equation, momentum conservation equation and energy conservation equation.
3. Student gets the ideas to analyze the different problem associate in fluid motion.

Learning outcomes:

Upon completion of the subject:

1. Students can able to visualize the different flow problem.
2. Student can able to draw the stream line, path line, vortex line associate different flow problem.
3. Students can able to derive the boundary layer solution of boundary layer equation.

Subject Matter:

Unit I

Introduction: Basic concept of fluid, Unit of Measurement, solid, Liquids and Gases, Continuum Hypothesis, Transport Phenomena, surface Tension, Inviscid Incompressible fluid: Lagrangian and Eulerian specifications, Streamline, Path line and Streak line, Irrotational flow. Vorticity and circulation, Conservation of Mass, Euler Equation of motion, Bernoullis equations and its applications. Two-dimensional motion. Stream function, complex potential, comlpex velocity, sources, sinks. Doublets, Image system, Circle theorem, Blasius theorem.

Unit-II

Vortex motion, vortex lines and filaments, strength of a vortex, system of vortices, rectilinear vortices, vortex pair and doublets. A single infinite row of vortices, Karmans vortex sheet. Viscous incompressible fluid: Basic equation of conservation of mass, momentum and energy. Law of similarity, Reynolds numbers.

Unit-III

Navier-Strokes equations and Exact solutions: Flow through parallel walls, flow through circular pipe, Strokes first and second problems. Prandtls concept of boundary layer. Boundary layer approximation. Derivation of boundary- layer equations for two-dimensional flow, different measures of boundary layer on a plate Blasius solution.

Unit-IV

Ideal gas, Reversible and irreversible process, First and second laws of thermodynamics, Integral equation for quasi one dimensional flow, Isentropic relation, Normal shock relation, Hugoniot equation, Supersonic flow over wedges and cone, Interaction of shocks of opposite and same families, Linearized velocity potential equation, Linearized pressure coefficient, Linearized subsonic flow, Improve compressible corrections, Linearized subsonic flow, critical mach number.

Teaching/Learning/Practice Pattern:

Teaching: 70%
Learning: 30%
Practice: 0%

Examination Pattern:

Theoretical Examination and open book examination.

Reading List:

A. Books:

1. H. Schlichting, Boundary-Layer theory, McGraw-Hill,Inc
2. S.W Yuen, Foundation of fluid Mechanics
3. L.M Milne-thomson, theoretical hydrodynamics. The Macmilan Co. 1960
4. L.D Landau and E.M Lifshitz, uid mechanics. Course of Theoretical Physics, Vol.6 Pergamon Press, 1959
5. H. Lamb, Hydrodynamics. Cambridge Mathematical Library. Cambridge University Press, 1993
6. W.H. Besant and A.S. Ramsey, A treatise of Hydro-mechanics, Part II, ELBS .
7. H. W. Liepmann & A. Roshko, Elements of Gas Dynamics, John Wiley & Sons Inc. (1957), Dover Publications (2002).
8. Anderson, J.D., *"Modern Compressible Flow With Historical Perspective*, Mc Graw Hill, 2nd edition, 2003.
9. V. Babu, Fundamentals of Gas Dynamics, Ane Book Pvt. Ltd. 2009.
10. Ascher H. Shapiro, The Dynamics And Thermodynamics Of Compressible Fluid Flow, John Wiley & Sons Inc.

B. Magazines:

1. Current Science (Indian Academy of Science).
2. The Mathematics Student (Math Student) (Indian Mathematical Society).
3. Mathematical Spectrum (The University of Sheffield).
4. Mathematics Magazines (Mathematical Association of America).
5. +Plus Magazines (University of Cambridge).
6. Ganithavahini (Ramanujam Mathematical Society).

C. Journals:

1. Journal of Fluid Mechanics, Oxford University Press.
2. Physics of Fluids, American Institute of Physics.
3. International Journal of Non-Linear Mechanics, Elsevier.
4. International journal of Heat and Mass Transfer, Elsevier.

Name of the Module: Research Paper Communication
Module Code: Semester: CSE 904
Semester: I
Credit Value: 3 [P=0, T=0, L=3]

Objectives:

The course is design to meet the objectives of:

1. Steps in Research, Motivation, Types, good research techniques.
2. Methods of Data collection, Processing, Analysis techniques of raw data's.
3. Hypothesis, Technical writing techniques etc.

Learning outcomes:

Upon Completion of the subjects:

1. Writing techniques of research paper.
2. Collecting raw data, processing data using mathematics computation, transformation, and other else.
3. Hypothesis techniques, testing techniques of Hypothesis etc.

Subject Matter:

Unit I:

Research Methodology

Definition, Objective, Motivation, Types of Research, Significance, Criteria of Good Research

Defining the Research Problem

Definition of Research Problem, Selection of Problem, Necessity of defining the Problems, Techniques involves in defining the problem.

Research Design

Meaning of Research Design, Need for research Design, Features of a Good Design, Different Design Approach

Sampling Design

Census And Sample Survey, Implications Of A Sample Design, Steps In Sample Design, Criteria of Selecting A Sampling Procedure, Different Types of Sample Designs, How to Select A Random Sample? Random Sample From An Infinite Universe, Complex Random Sampling Designs.

Unit II:

Measuring and Scaling Techniques

Measurement in Research, Measurement Scales, Sources of Error In Measurement, Tests of Sound Measurement, Technique of Developing Measurement Tools, Scaling, Scale Classification Bases.

Methods of Data Collection

Collection of Primary Data, Observation Method, Interview Method, Collection of Data, Collection of Secondary Data.

Processing and Analysis of Data

Processing Operations, Some Problems In Processing, Elements/Types Of Analysis, Statistics In Research, Measures Of Central Tendency, Measures Of Dispersion, Measures Of Relationship, Regression Analysis.

Unit III:

Sampling Fundamentals

Need For Sampling, Important Sampling Distributions, Central Limit Theorem, Sampling Theory, Concept Of Standard Error, Estimation, Estimating The Population Mean (M),Estimating Population Proportion, Sample Size And Its Determination

Testing of Hypothesis

What Is A Hypothesis? Basic Concepts Concerning Testing Of Hypotheses, Procedure For Hypothesis Testing, Measuring The Power Of A Hypothesis Test, Tests Of Hypotheses

Unit IV:

Analysis of Variance and Co-varience

Analysis of Variance (Anova), The Basic Principle of Anova, Anova Technique, Setting up Analysis of Variance Table, Coding Method,

Interpretation and Report Writing

Meaning of Interpretation, Technique of Interpretation, Precautions in Interpretation, Different Steps in Writing Report, Types of Reports, Precautions for Writing Research Reports

Teaching/ Learning/ Practice Pattern:

Teaching: 60%
Learning: 40%
Practice: 0%

Examination Pattern: Theoretical Examination, Open book and on line.

Reading List:

A. Books

1. C R Kothari, "Research Methodology- Methods and Techniques", New Age International Publications.
2. Ranjit Kumar, "Research Methodology", SAGE Publications.
3. James Arthur, Michael Waring, Robert Coe, Larry V Hedges, "Research Methods & Methodologies in Education", SAGE Publications.
4. Donald Howard Menzel , "Writing a technical paper", McGraw-Hill
5. R. Panneerselvam, "Research Methodology" PHI Publication

6. V.V Khanzone"Research Methodology- Techniques and Tools", APH Publisher
7. Raj Mohan Joshi, "Writing Skills for Technical Purpose", Isha Books

B. Magazines:

C. Journals:

1. Journal of Research Methods and Methodological Issues, ISSN 2150-8143.

Name of the Module: Applied Algebra
Module Code: MER 921
Semester: II
Credit Value: 4 [P=0, T=1, L=3]

Objectives:

The course is design to meet the following objectives:

1. This course aims to provide a first approach to the subject of algebra, which is one of the basic pillars of modern mathematics.
2. The focus of the course will be the study of certain structures called groups, rings, fields and some related structures.
3. Abstract algebra gives to student a good mathematical maturity and enables to build mathematical thinking and skill.

Learning outcomes:

Upon completion of the subject:

1. The student will be able to define the concepts of group, ring, field, and will be able to readily give examples of each of these kinds of algebraic structures.
2. The student will be able to define the concepts of coset and normal subgroup and to prove elementary propositions involving these concepts.
3. The student will be able to define the concept of subgroup and will be able to determine (prove or disprove), in specific examples, whether a given subset of a group is a subgroup of the group.
4. The student will be able to define and work with the concepts of homomorphism and isomorphism.

Subject Matter:

Unit I

Review of groups, Subgroups, Normal subgroups, Quotient group, Group Homomorphism.

Unit II

Permutation groups, Cayley theorem, Cyclic group, Direct product of groups, Finite Abelian groups, Cauchy theorem and Sylow theorem.

Unit III

Ring, Zero divisor, Integral domain, Ideals, Quotient ring, Isomorphism theorems, Polynomial ring, Euclidean ring, Prime & Irreducible elements & their properties, UFD, PID and Euclidean Domain.

Unit IV

Field, Finite Fields, Field Extensions, Galois theory.

Teaching/Learning/Practice Pattern:

Teaching: 70%
Learning: 30%
Practice: 0%
Examination Pattern:

Theoretical Examination and open book examination.

Reading List:

A. Books:

1. N. Herstein, Topics in Algebra, Wiley Eastern Ltd, 2008
2. S. Lang, Algebra, Addison Wesley
3. J. B. Fraleigh, A First Course in Abstract Algebra
4. C. Musili, Introduction of Rings and Modules, Narosa Publishing House.
5. M. Artin, Algebra, PHI.
6. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra, Cambridge University Press, 1995.
7. J. Fraleigh, A First Course in Abstract Algebra, Pearson, 2003.
8. D. Dummit and R. Foote, Abstract Algebra, Wiley, 2004.

B. Magazine:

1. Current Science (Indian Academy of Science).
2. The Mathematics Student (Math Student) (Indian Mathematical Society)
3. Mathematical Spectrum (The University of Sheffield)
4. Mathematics Magazine (Mathematical Association of America)
5. +Plus magazine (University of Cambridge)
6. Ganithavahini (Ramanujam Mathematical Society)

C. Journals:

1. Ganita Sandesh.
2. Journal of Rajasthan Academy of Physical Sciences.
3. Bulletin of Calcutta Mathematical Society.

Name of the Module: Complex Analysis
Module Code: MER 922
Semester: II
Credit Value: 4 [P=0, T=1, L=3]

Objectives:

The course is design to meet the following objectives:

1. The purpose of this course is to introduce the main ideas of complex analysis.
2. Student gets the ideas to performing basic arithmetic and algebraic operations (including powers and roots) with complex numbers.
3. The emphasis will be on gaining a geometric understanding of complex analytic functions.
4. Developing computational skills in employing the powerful tools of complex analysis in particular residue calculus.
5. Appreciate how mathematics is used in design (e.g. conformal mapping).

Learning outcomes:

Upon completion of the subject:

1. Students can able to identify analytic functions and singularities.
2. Students can able to prove simple propositions concerning functions of a complex variable, for example using the Cauchy-Riemann equations.
3. Students can able to evaluate certain classes of integrals.
4. Student can able to compute Taylor and Laurent series expansions.

Subject Matter:

Unit I

Complex numbers and their basic geometry; Stereographic projection: $C \cup \{\infty\} \equiv S$; Complex analysis from the point of view of advanced calculus ; Complex derivatives; Conformal and quasiconformal mappings ; Green's formula and applications.

Unit-II

Definitions and basic properties; Polynomial and rational functions; Power series; radius of convergence, Abel's theorem; Exponential and trigonometric functions; Introduction to Riemann surfaces; Conformal mapping by elementary functions; Mobius transformations; classification; model examples, action in C, quotient spaces; extension to 3D; cross ratio;

symmetry; Introduction to hyperbolic geometry ; Covering surfaces and the Riemann-Hurwitz formula.

Unit-III

Cauchy's Theorem and Integral Formula Line integrals; Local Cauchy theorem; exceptional points; Convex Cauchy integral theorem; Winding number; General Cauchy theorem and Cauchy integral theorem; Removable singularities and their classification; Taylor's theorem with remainder; Zeros and poles; finite factorization; Essential singularities; The local mapping

Unit-IV

Morara's theorem; Liouville's theorem; Maximum principle; Schwarz lemma; Schwarz-Pick lemma; Argument principle; Rouche's theorem; the local inverse; Residues:The residue theorem; Various explicit examples.

Teaching/Learning/Practice Pattern:

Teaching: 70%
Learning: 30%
Practice: 0%

Examination Pattern:

Theoretical Examination

Reading List:

A.Books:

1. Ahlfors, Complex Analysis (3rd ed)
2. Rudin, Real and Complex Analysis (2nd ed)|a classic text combining treating real and complex analysis together;
3. Palka, An Intro to Complex Function Theory (closely parallels Ahlfors but more expansive);
4. R. Remmert, Classical Topics in Complex Function Theory;
5. R. Narasimhan and V. Nievergelt, Complex Analysis in One Variable (from point of view of several complex variables).
6. E.B. Sa and A.D.Snider, Fundamentals of Complex Analysis with Appl.
7. J.B.Conway, Functions of One Complex Variable (simpler treatment).
8. E. T. Copson, Introduction to the Theory of Functions of a Complex Variable, Oxford At the Clarendon Press, 1970.

B. Magazines:

1. Current Science (Indian Academy of Science).
2. The Mathematics Student (Math Student) (Indian Mathematical Society)
3. Mathematical Spectrum (The University of Sheffield)
4. Mathematics Magazine (Mathematical Association of America)

5. +Plus magazine (University of Cambridge)
6. Ganithavahini (Ramanujam Mathematical Society)
7. Mathematics Today, London Metropolitan University.

C. Journals:

1. Proceedings of the American Mathematical Society, American Mathematical Society.
2. Proceedings of the London Mathematical Society, London Mathematical Society.
3. Annals of Mathematics, Princeton University & Institute for Advanced Study.

Name of the Module: Nonlinear Dynamical System

Module Code: MER 923

Semester:

Credit Value: 4 **[**P=0, T=1, L=3]

Objectives:

The course is design to meet with the objectives of:

1. Basics of nonlinear differential equations that are encountered when dealing with practical dynamical systems in the context of their control.
2. This course provides an introduction to applied dynamical systems and the qualitative study of differential equations.

Learning Outcomes:

Upon completion of the subject student would/should have:

1. learned and used various tools for the analysis and control of nonlinear systems.
2. got a feeling and gained insight into the complexity of nonlinear systems.
3. known and played around with a wide variety of interesting, inherently nonlinear examples.

Subject Matter:

Unit-I

Solutions of nonlinear dynamical systems:

Preliminary concepts, solutions of initial value problems, existence and uniqueness of solutions, continuous dependence on initial conditions and parameters, flows, classical examples, the bowing of a violin string, Euler's buckling beam and the celtic stone.

Unit-II

Linearization methods for nonlinear dynamical systems:

Linearization, invariant manifolds, stable, unstable and center manifolds, Hartman-Grobman theorem Lyapunov stability theory for nonlinear dynamical systems Lyapunov functions, Lie derivative, stability and instability theorems, LaSalle Invariance Principle, exponential stability.

Unit-III

Bifurcation theory for nonlinear dynamical systems:
Bifurcations of vector fields, saddle-node, transcritical, pitchfork and Hopf bifurcations, Global bifurcations; and Poincaré maps.

Unit-IV
Lyapunov stability theory for nonlinear dynamical systems:
Lyapunov functions, Lie derivative, stability and instability theorems, LaSalle Invariance Principle, exponential stability.

Teaching/Learning/Practice Pattern:

Teaching: 70%
Learning: 30%
Practice: 0%

Examination Pattern:
Theoretical Examination

Reading List:
A. Books:

1. S. Sastry, Nonlinear Systems: Analysis, Stability, and Control, Springer 1999.
2. H. Khalil, Nonlinear Systems, Prentice Hall, 2002.
3. L. Perko. Differential Equations and Dynamical Systems, volume 7 of Texts in Applied Mathematics. Springer Verlag, New York, 3rd edition, 2000.
4. M. Vidyasagar, Nonlinear Systems Analysis, Prentice Hall, 2nd Edition 1992.
5. H. Khalil, Nonlinear Systems, Macmillan, 1992.
6. J.M.T. Thompson and H.B. Stewart, Nonlinear dynamics and chaos, John Wiley and Sons, New York, 1986.
7. S.H. Strogatz, Nonlinear Dynamics and Chaos with Applications to Physics, Biology, Chemistry and Engineering, Perseus Books Publishing, 2000.
8. S. Wiggins. Introduction to Applied Nonlinear Dynamic Systems and Chaos. Texts in Applied Mathematics. Springer Verlag, New York, 2nd edition, 2003.
9. H. Nijmeijer and A. van der Schaft, Nonlinear Dynamical Control Systems, Springer Verlag, 1990.

B. Magazines:

1. Current Science (Indian Academy of Science).
2. The Mathematics Student (Math Student) (Indian Mathematical Society)
3. Mathematical Spectrum (The University of Sheffield)
4. Mathematics Magazine (Mathematical Association of America)
5. +Plus magazine (University of Cambridge)
6. Ganithavahini (Ramanujam Mathematical Society)
7. Dynamical Systems Today

C. Journals:

1. International Journal of Nonlinear Dynamics and Control.
2. Journal of Nonlinear Systems and Applications.
3. International Journal of Nonlinear Dynamics in Engineering and Sciences.

4. Mathematical and Computer Modelling of Dynamical Systems.
5. SIAM Journal on Applied Dynamical Systems.
6. International Journal of Bifurcation and Chaos.

Name of the Module: Applied Functional Analysis
Module Code: MER 924
Semester: II
Credit Value: 3 [P=0, T=0, L=3]

Objectives:

The course is design to meet the following objectives:

1. This course aims to provide introduction to the basic concepts.
2. Principles and methods of functional analysis and its applications.

Learning outcomes:

Upon completion of the subject:

1. The student will be able to define the concepts of Linear spaces, Hilbert spaces, Banach spaces, Dual spaces, Linear operators and adjoints and spectral theory.
2. The student will be able to articulate the fundamental theorems forLinear spaces, Hilbert spaces, Banach spaces, Dual spaces, Linear operators and adjoints and spectral theory
3. The students will be able to apply the above topics to problems in real and functional analysis.

Subject Matter:

Unit I

Linear spaces: Hilbert spaces, Banach spaces, topological vector spaces.

Unit II

Hilbert spaces: geometry, projections, Riesz Representation Theorem, bilinear and quadraticforms, orthonormal sets and Fourier series.

Unit III

Banach spaces: continuity of linear mappings, Hahn-Banach Theorem, uniform boundedness, open-mapping theorem. Closed operators, closed graph theorem.

Unit IV

Dual spaces: weak and weak-star topologies (Banach-Alaoglu Theorem), reflexivity. Space of bounded continuous functions and its dual, dual ofL^P, dual of$L^{\propto}$.

Unit V

Linear operators and adjoints: basic properties, null spaces and ranges. Compact operators.Sequences of bounded linear operators: weak, strong and uniform convergence.

Unit VI

Introduction to spectral theory: Notions of spectrum and resolvent set of bounded operators, spectral theory of compact operators

Teaching/Learning/Practice Pattern:

Teaching: 70%
Learning: 30%
Practice: 0%

Examination Pattern:

Theoretical Examination and open book examination.

Reading List:

A. Books:

1. N. Dunford and J. T. Schwartz, Linear Operators. Part I: General Theory, Wiley Interscience,1958.
2. T. Kato, Perturbation Theory for Linear Operators, Springer-Verlag, 1980.
3. H. Brezis, Analysefonctionnelle, Theorieet applications, Masson, 1983.
4. P. Lax, Functional Analysis, Wiley Interscience, 2002.
5. W. Rudin, Functional Analysis, McGraw-Hill, 1973.
6. A. Friedman, Foundations of Modern Analysis, Dover, 1982.
7. K. Yosida, Functional analysis. Grundlehren der MathematischenWissenschaften,Springer-Verlag, 1980.
8. Functional Analysis with Applications by A.H. Siddiqi, Tala Mc. Graw Hill Publishing Company.
9. Functional Analysis by K. Chandra SekharRao, Narosa 2002.
10. M. Reed and B. Simon, Methods of Mathematical Physics I: Functional Analysis (2nd edition),Academic Press, 1980.

B. Magazine:

1. Current Science (Indian Academy of Science).
2. The Mathematics Student (Math Student) (Indian Mathematical Society)
3. Mathematical Spectrum (The University of Sheffield)
4. Mathematics Magazine (Mathematical Association of America)
5. +Plus magazine (University of Cambridge)
6. Ganithavahini (Ramanujam Mathematical Society)

C. Journals:

1. Journal of Functional Analysis
2. International Journal of Functional Analysis, Operator Theory
3. Annals of Functional Analysis
4. Functional Analysis and Its Applications
5. Journal of Nonlinear Functional Analysis
6. Journalof Applied Functional Analysis

Name of the Module: Wavelet Analysis
Module Code: MER 925
Semester: II
Credit Value: 3 [P=0, T=0, L=3]

Objectives:

The course is design to meet the following objectives:

1. Understand the definition and properties of multiresotion analysis.

2. Understand orthonormality of scaling functions and Fourier transform criteria.

3. Understand the smoothness of scaling function and wavelets.

Outcomes:

Upon completion of the subject:

1. Students will be able to use wavelets to implement the image compression thresholding and denoising.

2. Students will effectively communicate, expression integrity, leadership management, team cooperation division of labor and moderate integration of ability.

Subject Matter:

Unit I

Fourier transform on L1(R) and L2(R) and basic properties and examples, Windowed Fourier Transform : Motivation and definition of Windowed Fourier Transform and examples, Time frequency localization, the reconstruction formula

Unit-II

Continuous Wavelet Transform Introduction, Continuous-time wavelets, Definition of the CWT, the VWT as a Correlation, Constant-Factor Filtering Interpretation and Time-Frequency Resolution, the VWT as an Operator, Inverse CWT, Problems.

Introduction to Discrete Wavelet Transform And Orthogonal Wavelet Decomposition: Introduction, Approximation of Vectors in Nested Linear Vector Subspaces.

Unit III

Multiresolution Analysis : Definition of MRA and examples, Properties of scaling functions and orthonormal wavelets basis, Construction of orthonormal wavelets, Interpreting Orthonormal MRAs for Discrete-Time signals, Scaling Functions and wavelets from Filter Coefficient, Problems.

Unit IV

Wavelet Transform And Data Compression: Introduction, Transform Coding, DTWT for Image Compression, Audio Compression, Video Coding Using Multiresolution Techniques.

Teaching/Learning/Practice Pattern:
Teaching: 70%
Learning: 30%
Practice: 0%
Examination Pattern:

1. Theoretical Examination and open book examination.

Reading List:

A. Books:

1. L. Debnath, Wavelet Transformation and Their Applications, Birkhauser Pub.
2. E. Mallat, A wavelet Tour of Signal Processing, Elsevier.
3. Yves Mayer, Wavelets and Operators, Cambridge University Press.
4. G. Kaiser, A Friendly Guide to Wavelets, Birkhauser Pub.
5. G. Bachman, L. Narici & E. Beckensterin, Fourier and Wavelet Analysis, Springer-Verlage, 2000.
6. C. K. Chui, An Introduction to Wavelets, Academic Press, 1992.

B. Magazines:

1. Current Science (Indian Academy of Science).
2. The Mathematics Student (Math Student) (Indian Mathematical Society).
3. Mathematical Spectrum (The University of Sheffield).
4. Mathematics Magazines (Mathematical Association of America).

5. +Plus Magazines (University of Cambridge).
6. Ganithavahini (Ramanujam Mathematical Society).

C. Journals:

1. Wavelet-Based Algorithm for Signal Analysis, Springer.
2. International Journal of Wavelets, Multiresolution and Information Processing, World Scientific.
3. Applied and Computational Harmonic Analysis, Elsevier.

Name of the Module: Applied Topology
Module Code: MER 926
Semester: II
Credit Value: 4 [P=0, T=1, L=3]

Objectives:

The course is design to meet the following objectives:

1. To explain how to distinguish spaces by means of simple topological invariants.

2. To explain how to construct spaces by gluing and to prove that in certain cases that the result is homeomorphic to a standard space;.

3. To construct simple examples of spaces with given properties (eg compact but not connected or connected but not path connected).

Outcomes:

Upon completing this course students should be able to:

1. Prove elementary theorems involving sets and functions.
2. Determine whether a topological space has any of various topological properties.
3. The course forms a basis for all further studies in analysis, geometry and topology as well as courses building on these topics.

Subject Matter:

Unit I
Topological Spaces, Basic for a topology, Limit points, Open and closed sets, basis, closure, interior and boundary. Subspace topology, Hausdorff spaces.

Unit II
Continuous maps, pasting lemma. Homeomorphisms. Subspace topology , Product topology and Quotient topology.

Unit III
Connected, path connected and locally connected spaces. Lindelof and compact spaces, locally compact spaces and one point compactification. Tychonoff's theorem. Countability and separation axioms.

Unit IV
Urysohn's lemma, Tietze's extension theorem and applications. Convergence, nets and filters. Urysohn's embedding lemma and metrization theorem for second countable space. Stone-Cech compactification. Paracompactness.

Teaching/Learning/Practice Pattern:
Teaching: 70%
Learning: 30%
Practice: 0%

Examination Pattern:

1. Theoretical Examination and open book examination.

Reading List:

A. Books:

1. J. R. Munkres, *Topology: A first course*. Prentice-Hall, Inc., 1975.
2. J. Dugundji, *Topology*. Allyn and Bacon Series in Advanced Mathematics. Allyn and Bacon, Inc., 1978.
3. W. S. Massey, *A basic course in algebraic topology*. Graduate Texts in Mathematics, 127. Springer-Verlag, 1991.
4. M. Singer and J. A. Thorpe, *Lecture notes on elementary topology and geometry*. Undergraduate Texts in Mathematics. Springer-Verlag, 1976.
5. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill, 1963.
6. Stephan Willard, General Topology, Dover, 2004.
7. Klaus Janich, Topology, Springer, UTM, 1984.

B. Magazines:

1. Current Science (Indian Academy of Science).
2. The Mathematics Student (Math Student) (Indian Mathematical Society).

3. Mathematical Spectrum (The University of Sheffield).
4. Mathematics Magazines (Mathematical Association of America).
5. +Plus Magazines (University of Cambridge).
6. Ganithavahini (Ramanujam Mathematical Society).

C. Journals:

1. Topology, Elsevier.
2. Journal of Topology, Oxford Journals.
3. Journal of Topology and Analysis, World Scientific.
4. Journal of Topology, London Mathematical Society.