Appendix-F

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: **MATHEMATICS DEPARTMENT**

1. Subject code: **MA-901** Course Title: **ANALYSIS**
2. Contact Hours: **L: 3 T: 0 P: 0**
3. Examination Duration (Hrs): **Theory:** 3 **Practical:** 0
4. Relative Weightage: **CWS:** 25 **PRS:** 00 **MTE:** 25 **ETE:** 50 **PRE:** 0
5. Credits: 3 6. Semester: **Autumn/Spring** 7. Subject Area: **PEC**
8. Pre-requisite: **Nil**
9. Objective: To impart the knowledge of some advanced topics in Analysis.
10. Details of Course:

S. No.	Contents	Contact Hours
1.	**Abstract Integration:** The concept of measurability, simple functions, Properties of measure, Integration of positive functions and complex functions, Sets of measure zero.	7
2.	**Positive Borel Measures:** Vector spaces, Review of topological preliminaries leading to locally compact Hausdorff spaces, Riesz representation theorem, Regularity properties of Borel measures, Lebesgue measures, Continuity property of measureable functions.	7
3.	**L^p spaces:** Convex functions and inequalities, L^p spaces, Approximation by continuous functions.	5
4.	**Banach Space Techniques:** Banach spaces, Consequences of Baire's theorem, Fourier coefficients of L^1 functions, Hahn Banach theorem.	6
5.	**Integration on product spaces:** Measurability on Cartesian products, Product measure and its completion, Fubini's theorem, Convolution, Distribution functions.	6
6.	**Harmonic Functions:** Laplacian of a harmonic function, Poisson integral of L^1 functions, Mean value property, Boundary behavior of Poisson Integrals, Representation theorems.	6
7.	**Analytic Continuation:** Regular and Singular Points, Continuation along curves natural boundaries, Monodromy theorem.	5
Total		**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	W. Rudin, Real and Complex Analysis, Tata McGraw Hill, Third edition	1987
2.	H.L. Royden, Real Analysis, Collier Macmillan	1988
3.	P.R. Halmos, Measure theory, Graduate Text in Mathematics, Springer Verlag, New York	1974
4.	M. Thamban Nair, Functional Analysis, Prentice Hall, India	2003
5.	E. Kreyszig, Introductory Functional Analysis with Applications, John Wiley and Sons	1989
6.	L.V. Ahlfors, Complex Analysis, McGraw Hill	1988
7.	J.B. Conway, Functions of one complex Variables I, Narosa Publishing House	2000
8.	S. Lang, Complex Analysis, Springer - Verlag.	2003

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: **MATHEMATICS DEPARTMENT**

2. Subject code: **MA-902** Course Title: **ADVANCED NUMERICAL ANALYSIS**

2. Contact Hours: **L: 3 T: 0 P: 0**

3. Examination Duration (Hrs): **Theory:** 3 **Practical:** 0

6. Relative Weightage: **CWS:** 25 **PRS:** 00 **MTE:** 25 **ETE:** 50 **PRE:** 0

7. Credits: 3 6. Semester: **Autumn/Spring** 7. Subject Area: **PEC**

8. Pre-requisite: **Nil**

9. Objective: To impart the knowledge of some advanced topics in Numerical Analysis.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	LU and QR decomposition methods for solving a system of linear equations, Conjugate Gradient iterative method and its convergence. Norms of a matrix. III-conditioned system.	6
2.	Jacobi, Given and Householder method for finding eigenvalues of a symmetric matrix. LR and QR methods for finding eigenvalues of non-symmetric matrices.	8
3.	Elliptic PDE- Finite difference analysis to solve Poisson's equation in Cartesian and Cylindrical Coordinates in axial symmetry; Hockney Method or similar method for solving resulting block tri-diagonal systems.	6
4.	Parabolic PDE - Explicit and implicit finite difference schemes for heat conduction equation. Stability, consistency and convergence of finite difference schemes; ADI methods to solve tow dimension heat conduction equation.	6
5.	Hyperbolic PDE: Propagation of errors in finite difference methods for hyperbolic equations. Method of Characteristics for Hyperbolic Equation.	6
6.	Different weighted residual methods - Galerkin, Least Square and Collocation methods; Ritz method to solve a boundary value problem. Solving BVP by taking linear elements.	10
Total		**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	G.D. Smith, Numerical Solution of Partial Differential Equations: Finite Difference Methods 3rd Edition, Clarendon Press; 3 edition.	1985
2.	M.K. Jain, Numerical Solution of Differential Equations, Wiley Eastern Ltd.	2006
3.	L. Collatz, Numerical Treatment of Differential Equations, Springer	1962
4.	M K Jain, S. R. K. Iyengar, and R K Jain, Numerical Methods for Scientific and Engineering Computation, New Age International Publisher	2006
5.	R S Gupta, Elements of Numerical Analysis, Mcmillan Indian Ltd.	2009

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: **MATHEMATICS DEPARTMENT**

1 Subject code: **MA-903** Course Title: **THEORY OF DIFFERENTIAL EQUATIONS**

2. Contact Hours: **L: 3 T: 1 P: 0**

3. Examination Duration (Hrs): **Theory:** 3 **Practical:** 0

8. Relative Weightage: **CWS:** 25 **PRS:** 00 **MTE:** 25 **ETE:** 50 **PRE:** 0

9. Credits: 4 6. Semester: **Autumn/Spring** 7. Subject Area: **PEC**

8. Pre-requisite: **Nil**

9. Objective: To impart the knowledge of some advanced topics in Differential Equations.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	System of differential equations: System of first order equations, existence and uniqueness of solution, Gronwall's inequality, continuous dependence on initial conditions and parameters.	3
2.	Linear systems: Autonomous systems, Transition matrix, Phase-space of two dimensional systems, time varying systems, fundamental matrix and its properties, linear systems with periodic coefficients.	4
3.	Stability of differential systems; Stability of linear systems, almost linear systems, stability of periodic solutions, Lyapunov stability theorems for nonlinear system, limit cycles, Poincare-Bendixon theorem, Lienard Syatems, Construction of Lyapunov function, Bifurcations (Transcritical, Saddle-node, Pitchfork, Hopf, Sotomayor theorem)	8
4.	Review of first order PDE: classification, solution method for quasi-linear and nonlinear pde, discontinuous solutions, conservation laws and shocks	3
5.	Four important linear PDE's (transport, Lapace, heat and wave equations): fundamental solution, meanvalue formulae, properties of harmonic functions, Green's function and energy method.	6
6.	Sobolev spaces: Definition, approximations, sobolev inequalities, extensions, traces, compactness, dual spaces	8
7.	Elliptic Equations: Definitions, Existence Of Weak Solutions, Regularity, Maximum principles, Eignevalues and eigen-function. Linear evolution equations: Parabolic equations, hyperbolic equations, semigroup theory	10
Total		**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	G.F. Simmons, Differential Equations with Applications and Historical Notes, 2nd Ed., McGraw-Hill.	1991
2.	R.P. Agarwal, D.O'Regan, An Introduction to Ordinary Differential Equations, Springer.	2008
3.	K.S. Bhamra, Ordinary Differential Equations, Narosa Publications.	2015
4.	I.N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill.	1957
5.	L.C. Evans, Partial Differential Equations, 2nd Ed., American Mathematical Society.	2015
6.	M. Renardy, R.C. Rogers, An Introduction to Partial Differential Equations, 2nd Ed., Springer.	2010
7.	S. Kesavan, Topics In Functional Analysis And Its Applications, New Age International(P) Ltd.	2012

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPTT/CENTRE: **MATHEMATICS DEPARTMENT**

3. Subject code: **MA-904** Course Title: **ALGEBRA**

2. Contact Hours: **L: 3 T: 0 P: 0**

3. Examination Duration (Hrs): **Theory:** 3 **Practical:** 0

4 Relative Weightage: **CWS:** 25 **PRS:** 00 **MTE:** 25 **ETE:** 50 **PRE:** 0

5. Credits: 3 6. Semester: **Autumn/Spring** 7. Subject Area: **PEC**

8. Pre-requisite: **Nil**

9. Objective: To impart the knowledge of some advanced topics in Algebra.

10. Details of Course:

S. No.	Contents	Contact Hours
1.	Review of group actions and Sylow's theorems. Free groups and relations, normal series, nilpotent and solvable groups.	8
2.	Review of rings and ideals, PID, Euclidean domains, and UFD. Modules, direct sums of modules, free modules, exact sequences, finitely generated modules over a PID, structure of finitely generated abelian groups, rational and Jordan canonical forms.	10
3.	Review of algebraic extensions of fields, algebraic closure and splitting fields. Normal extensions and separable extensions, finite fields, Galois theory - The Fundamental Theorem of Galois Theory, roots of unity, cyclotomic extensions, cyclic extensions, Galois group of a polynomial, solvable and radical extensions, insolvability of the quintic.	11
4.	Artinian and Noetherian modules and rings, modules of finite lengths, simple and semisimple modules and rings. Wedderburn-Artin theorem, nil radical and Jacobson radical, radical of an Artinian ring.	10
5.	Commutative rings: Primary decompositions of ideals and modules.	3
	Total	**42**

11. Suggested Books:

S. No.	Name of Books / Authors/ Publishers	Year of Publication/ Reprint
1.	Dummit D.S. and Foote R.M., "Abstract Algebra", John Wiley & Sons (3rd Edition)	2003
2.	Hungerford T.W., "Algebra", Springer	1980
3.	Bhattacharya P.B., Jain S.K. and Nagpaul S.R., "Basic Abstract Algebra", Cambridge University Press (2nd Edition)	1995
4.	Lang S., "Algebra", Springer (3rd Edition)	2005
5.	Jacobson N., "Basic Algebra Vol. I & Vol. II" Dover Publications (2nd Edition)	2009
6.	Musuli C., "Introduction to Rings and Modules", Narosa Publishing House (2nd Edition)	1997