Ph.D. Level courses

MA857 Integral transform and Distribution Theory 4 0 0 4

Unit1: Countably multi normed spaces, Countable Union spaces and their duals

Unit 2**:** Distributions and generalized functions

Unit3**:** Two sided Lapalce Transformation

Text Book:

1. Amen Zemanian, Generalized Integral Transormations, Inderscience Publications, New York (1968). (Chpater 1,2,3)
   (Chapter 6, 7, 8, 9)
2. R.S. Pathak, Integral transforms of generalized functions, Taylor and Francis 1997
3. Ram P Kanwal, Generalized Functions Theory and applications, Springer Science, Newyork, 2004.

MA856 Mathematical Foundations of Blood Flow and Drug Delivery 4 0 0 4

Commented [L1]: Already exists in Ph.D Syllabus.

Objective

To enable the students to get an overview of the mathematical description of blood flow and drug delivery in the human circulatory system. To identify the underlying hemodynamic mechanisms and drug delivery strategies in the normal and in various pathological conditions.

Unit 1

Review of preliminary concepts in fluid dynamics, governing equations – conservation of mass, conservation of momentum, Fourier series, Bessel Equations and Mathieu functions. Cardiovascular system, coronary, systemic and pulmonary circulations, modeling of pressure gradient using Burton's model and McDonald's model, other existing models in literature-advantages and disadvantages, root mean square error, steady state oscillation.

Unit 2

Hemodynamic wall parameters and their significance, wall shear stress, oscillatory shear index, relative residence time, Lumen wall interface conditions – no slip and various slip conditions. viscoelastic property of blood, hematocrit, drag force - Schiller-Naumann model, magnetophoretic force, fluidic force, magnetic force, particle-particle interaction, inertia force, Saffman lift force, permeability of the microvessel and carrier particle.

Unit 3

Single phase model, two-phase model and particle fluid suspension model- mathematical formulation, uniform cross section, circular tube, elliptic tube; constant, oscillatory and pulsatile pressure gradient; constant blood viscosity, radially varying blood viscosity; rigid wall, rigid and permeable wall, wall elasticity.

Unit 4

Fundamentals of targeted drug delivery, History of targeted drug delivery, Levels of targeting, Types of drug delivery system- controlled and targeted drug delivery, Different kinds of targeted drug delivery: active and passive targeting, organ specific targeting, Disease, organ and cell based targeting, Physiochemical approaches for targeting, multifunctional approach in targeted drug delivery, Transdermal, Gastroretentive, Nasopulmonary drug delivery system – Introduction, advantages and disadvantages.

Unit 5

Principle of magnetic drug targeting, Advantages of localization of drugs, Classification of magnetic drug delivery systems, Magnetic bioprobes – loading/release of specific drug, Approaches to magnetic drug targeting, Magnetic fields and forces acting upon a particle, magnetic particles, magnetic force dominated behavior, Fluid particle dynamic model, ferrofluid dynamics

– basic idea, magnetization, magnetic susceptibility of the particle, magnetic flux density, advection-diffusion equation, comparison of hemodynamic forces with magnetic forces.

Review of mathematical methods, recent developments, future prospect and identifying the open problem addressed in the literature in the field of blood flow and targeted drug delivery.

Text Books / Reference Books

1. Clement Kleinstreuer and Zelin Xu, Computational microfluidics applied to drug delivery in pulmonary and arterial systems, Microfluidics: Fundamentals, Devices and Applications, First Edition, Wiley-VCH Verlag GmbH & Co., 2018.
2. Sachin Shaw, Mathematical model on magnetic drug targeting in the micro vessel, Magnetism and Magnetic Materials, 2018. DOI: 10.5772/intechopen.68579.
3. Sid M Becker and Andrey V Kuznetsov, Heat transfer and fluid flow in biological processes, Academic Press, Elsevier, USA, 2015.
4. Wilmer W Nichols, Michael O'Rourke, McDonald's Blood Flow in Arteries, Theoretical, Experimental and Clinical Principles, Oxford University Press, New York, 2005.
5. Aleksandar Nelson Nacev, Magnetic Drug Targeting: Developing the basics, Thesis, Department of Bioengineering, University of Maryland, College Park, 2013.
6. Mohammad K D, Manashadi, Mahsa Saadat, Mehdi Mohammadi, Milad Shamsi, Morteza Dejam, Reza kamali and Amir Sanati-Nezhad, Delivery of magnetic micro/nanoparticles and magnetic-based drug/cargo into arterial flow for targeted therapy, Drug Delivery, Vol.25, No.1, 1963-1973, 2018.

MA858 **Fundamentals of Semigroup Theory** **4 0 0 4**

Unit I: - Basic Definitions- Monogenic Semigroups- Ordered Sets, Semi lattices and lattices- Binary relations; equivalences- Congruences- Free semigroups- Ideals and Rees Congruences.(Chapter I Section 1.1-1.7)

Unit II: - Greens Relations- Structure of D- classes- regular D- classes- regular semigroups-The sandwich Sets (Chapter II Section 2.1 – 2.5)

Unit III: - Simple and 0-simple semigroups- principal factors, Rees Theorem- Completely simple semigroups- Isomorphism and normalization (Chapter III Section 3.1 – 3.4)

Unit IV: -Completely Regular Semigroups- Clifford Decomposition- Clifford semigroups- Bands- Free Bands- Varieties of Bands(Chapter IV Section 4.1- 4.6)

Unit V: -Inverse semigroups- Preliminaries- The Natural partial order relation on an inverse semigroup- Congruences on Inverse semigroups- -The Munn Semigroup(Chapter V Section 5.1 – 5.4)

Text Books / Reference Books:

1. Fundamentals of Semigroup theory, J. M. Howie, Clarendon Press, Oxford ISBN0- 19-851194-9
2. The Algebraic Theory of Semigroups- A. H. Clifford and G. B. Preston, American Mathematical Society 1961
3. Semigroups: An Introduction to the Structure Theory- P. A. Grillet, Marcel Decker INC. 1995
4. Techniques of Semigroup Theory- Peter M. Higgins, Clarendon press

MA859 **Algebraic Graph Theory** **4 0 0 4**

Syllabus:
Adjacency matrix of a graph and its eigenvalues, Spectral radius of graphs, Regular graphs and Line graphs, Strongly regular graphs, Cycles and Cuts, Laplacian matrix of a graph, Algebraic connectivity, Laplacian spectral radius of graphs, Distance matrix of a graph, General properties of graph automorphisms, Transitive and Arc-tranisitve graphs, Symmetric graphs.
Text Books / Reference Books:

1. N. Biggs, "Algebraic Graph Theory", Cambridge University Press, 1993.
2. C. Godsil, G. Royle, "Algebraic Graph Theory", Graduate Texts in Mathematics 207, Springer-Verlag, 2001.
3. R. B. Bapat, "Graphs and Matrices", Universitext, Springer, Hindustan Book Agency, New Delhi, 2010.

MA860 **Algorithmic Graph Theory** **4 0 0 4**

Objectives: The main objective of the course is for students to learn some classical theorems and algorithms in the field. It is expected that students will be able to demonstrate their knowledge of algorithms by solving concrete problems. In addition, students will learn some proofs of the discussed theorems and prove simple facts about graphs and graph algorithms

Typical topics include:

- Computational complexity. Definitions of the complexity classes P, NP, and NP-hard. polynomial reductions, 2-SAT problem, 3-SAT problem.
- Tree search in graphs and digraphs. Breadth-first search and depth-first search
- Introduction to graphs: undirected graphs, directed graphs, weighted graphs, graph representation and special classes of graphs (trees, planar graphs etc.).

- Algorithmic problems on graphs: minimum spanning trees, shortest path problems, matching problems.
- Planar graphs and their properties. Eular's formula, planar separateor theorem and their algorithmic applications.
- Optimization problems on graphs including graph colouring and graph questions in distributed systems. Matching and maximal matching algorithms. Approximation algorithm for vertex cover problem. Approximation algorithms for the metric traveling salesman problem.
- Discussing practical applications of graphs and efficient algorithms for such practical problems. Approximation algorithms and heuristic algorithms. Applications to searching in massive graphs (e.g. page ranking); use of structural properties and algebraic properties.
- Further examples of tractable problems. Polynomial time algorithm for the maximum cut problem in planar graphs. Polynomial time algorithm for the 3-coloring problem on

graphs with small dominating sets. The independent set problem: Matching techniques. Method of augmenting graphs. Decomposition by clique separators. Modular decomposition. Bounded tree-width, bounded clique-width. Applications of these methods, both individually and combined.

Text / Reference books:

1.Algorithmic Graph Theory, Alan Gibbons.

2.Introduction to Algorithms, Cormen, Leiserson, Rivest.

3. M. C. Golumbic. Algorithmic Graph Theory and Perfect Graphs, Volume 57 in the series Annals of Discrete Mathematics. North Holland, second edition, 2004.

4. M. R. Garey, D. S. Johnson, Computers and Intractability: A guide to the theory of NP-Completeness, 1979.

5. Introduction to Graph Theory, Douglas B. West, 2nd Ed.