BABASAHEB BHIMRAO AMBEDKAR UNIVERSITY, LUCKNOW-226025
SCHOOL OF PHYSICAL & DECISION SCIENCES

DEPARTMENT OF MATHEMATICS

Syllabus for Ph.D. in Mathematics

Academic Session: 2019-20 Onwards

Every student admitted in Mathematics for Ph.D. programme will be required to pass the Departmental level course work of minimum 16 credits. The division of this 16 credits course is as follows:

DPH-101: **Research Methodology** **Credits : 04**

This paper is compulsory and based on 50% theory (research methodology) and 50% practical (softwares), required to carry out the research work.

Course contents:

Theory: Qualitative research, Quantitative research, Concept of measurement, causality, generalization, replication, Merging the two approaches.

Paper writing layout of a research paper, Journals in Mathematical Sciences, Impact factors of Journals, Ethical issues related to publishing, Plagiarism and Self Plagiarism.

Practical: LaTex: - Producing input and output files, Greek letters, standard functions, mathematical expressions, matrices, tables, derivatives, integrations, matrix array, tables, ordinary and partial differential equations.

MATHEMATICA/MATLAB: Variable and functions, trigonometric functions, matrices, integration, differentiation, solution of system of linear equations, solution of ordinary and partial differential equations.

References:

1. Research Methodology by C.R. Kothari.
2. George Gratzer, First steps in LATEX: A short Course, Birkhauser, Boston and Springer Verlag, New York 1999.
3. A.H. Register, A guide to MATALB object-oriented programming, Boca Raton, FL: CRC Press, 2007.
4. Eugene Don, Schaum's Outline of Mathematica, 2ed (Schaum's Outline Series).
5. Frank Garvan, The maple book.

DPH-102: **Optional Paper** (Select any one of the following) **Credits: 04**
Students are required to choose any one of the following courses

1. Convection in Fluid and Porous Media
2. Advanced Mathematical Modelling

1. Convection in Fluid and Porous Media

Fundamentals of hydrodynamic stability. Thermal instability. Various types of thermal instabilities; Rayleigh-Benard convection, double diffusive convection, cross diffusion convection, magnetoconvection, rotational instability.

Concepts of porous medium, Darcy's law, Brinkman equation, equations for conservation of mass, momentum and energy in fluid and porous medium. Boussinesq and Oberbeck approximations. Boundary conditions, normal modes, cell patterns, heat and mass transfer in fluid and porous medium. Nonlinear stability.

References:

1. D.A. Nield, A. Bejan, Convection in porous medium, Springer, 2006.
2. P.G. Drazin, W.H. Reid, Hydrodynamic stability, Cambridge Uni. Press, 1982.
3. S. Chandrasekhar, Hydrodynamic and Hydrmagnetic stability, Oxford Univ. Press, 1981.

2. Advanced Mathematical Modeling

Modeling biological phenomena from several areas of biology and medicine, Ordinary differential equations and biological populations, Stability and linearization methods for system of ordinary differential equations, Dynamics of continuous time models of species interactions: Competition models, Lotka-Volterra system, Mutualism models, Functional and numerical response, Prey dependent and predator dependent functional responses, Predator-prey model with harvesting, Predator-prey model with refuge, Dynamics of predator–prey reaction–diffusion models, Bifurcations of population models with time delay**.** Discrete time models of interacting populations and their stability.

Models of advanced and current problems in ecology and environment such as the conservation and depletion of resource biomass, water pollution and global warming. Mathematical Models for spread of infectious diseases; compartmental models, Modeling the role of carrier and bacteria in spread of infectious diseases, Models involving control measures; vaccination models.

References:

1. J.N. Kapur, Mathematical Models in Biology and Medicine, East-West Press Pvt. Ltd.,1992
2. J.D. Murray, Mathematical Biology: I An Introduction , Third Edition, Springer,2010.
3. Sven Erik Jorgensen, G. Bendoricchio, Fundamentals of Ecological Modelling, Gulf Professional Publishing.
4. Mark Kot, Elements of Mathematical Ecology, Cambridge University Press, 2001.
5. Fred Brauer and Carlos Castillo-Chavez, Mathematical Models in Population Biology and Epidemiology, Springer, 2001.
6. R.S. Bhopal, Concepts of Epidemiology: An integrated introduction to the ideas, theories, principles and methods of epidemiology, Oxford University Press, 2002.

ADVANCED PAPERS:

DPH-103: **Advanced Numerical Techniques** **Credits: 04**

Introduction, Weighted residual methods: Galerkin, Least square, Subdomain, collocation and moment methods for homogeneous and non-homogeneous boundary conditions. Examples.
Variational method: Euler equation, Construction of Functional, Rayleigh-Ritz method, Equivalence of Galerkin and Rayleigh-Ritz methods. Examples.
Finite element methods: Shape functions-straight lines, triangular, rectangular. Natural coordinates in one, two and three dimensions. Shape functions using Lagrange's polynomials for one, two and three dimensions.
Solution of ODEs FEM, weighted-residue methods and parabolic, hyperbolic and elliptic equations using FEM.

References:

1. MK Jain, S.R.K. Iyengar, R.K. Jain; Numerical methods Problems and Solutions, New Age International (P) ltd,2007.
2. Radhey S. Gupta, Elements of Numerical Analysis, Macmillan India Ltd. New Delhi (2009).
3. Schaum series; Partial differential equations, 1986.
4. Chandraputla and Belagundu O.C. Zienkiewic, The finite element method in structural and continuum mechanics, 2005.

DPH-104: **Numerical Solution of Partial Differential Equations** **Credits: 04**

Numerical solutions of parabolic PDE in one space: two and three levels explicit and implicit difference schemes. Convergence and stability analysis.
Numerical solution of parabolic PDE of second order in two space dimension: implicit methods, alternating direction implicit (ADI) methods. Non linear initial BVP.
Numerical solution of hyperbolic PDE in one and two space dimension: explicit and implicit schemes. ADI methods. Difference schemes for first order equations.
Numerical solutions of elliptic equations.

References:

1. M.K. Jain, S. R. K. Iyengar and R.K. Jain, Computational Methods for Partial Differential Equations, Wiley Eastern, 1994.
2. S.S. Sastry, Introductory Methods of Numerical Analysis, Prentice-Hall of India, 2002.
3. D.V. Griffiths and I. M. Smith, Numerical Methods of Engineers, Oxford University Press, 1993.
4. C.F. Gerard and P. O. Wheatley Applied Numerical Analysis, Addison- Wesley, 1998.