One-year course on *Partial Differential Equations in Continuum Transport Processes I and II for the graduate students having strong background in mathematics and physics.*

Name of Lecturer/s: *Professors Boris Zaltzman and Golan Bel*

Pre-Requirements: *Ordinary Differential Equations, Advanced Analysis*

Grade: *3 Assignments (50%) + Final Examination (50%) 1-2-4061 (3 credits)*

Partial Differential Equations in Continuum Transport Processes II 1

1. Conservation Laws. First order Partial Differential Equations. Basic concepts: linear equations, quasi-linear equations, and nonlinear equations. Methods of characteristics for linear and nonlinear equations. Singularities in Cauchy problems (properties of discontinuities), Simple quasi-linear equation, Generalization of discontinuity. Physical Examples (Traffic Problem, Shocks in Sedimentation and Ion-Exchange Columns).

2. Basic equations of mathematical physics. Telegraph equation, heat conduction equation, wave equation and Laplace equation. Singularities and discontinuous solutions, elements of Variational Analysis, Dirichlet principal, Determination of minimalizator's class. Physical Examples (Burgers Equation, Nernst-Planck-Poisson equations in electrodiffusion of ions and semiconductor devices).

3. Generalized (weak) solution and elements of distribution theory. Basic distributiontions' Theory. Hilbert Spaces. Functional in Hilbert spaces, Riesz theory, Weak convergence. L2, Hp spaces. Generalized functions as functional in Hilbert space. Physical Applications: Stefan problem in phase transitions, modelling transport in porous media.

4. Elements of numerical analysis: finite differences and finite elements methods.

5. Operators in Hilbert space. Boundary operators. Self-adjoint operators. Eigen-Value problems in heat, mass and charge transfer.

6. Green's function and inverse operators. Degenerated kernels and Fredholm Theorem. Alternative representations for Green's functions. Theory of Potentials.

Bibliography:

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- *R. Courant and D. Hilbert, Methods of Mathematical Physics, New York: Wiley-Interscience, 1989*
- *S. L. Sobolev. Partial Differential Equations of Mathematical Physics: Pergamon Press, 1964*
- *C.R. Chester, Techniques in partial differential equations. McGraw Hill, 1971.*
- *A.N Tikhonov and A.A. Samarskii Equations of mathematical physics. Pergamon Press, 1963.*
- *Tveito, A., and R. Winther. Introduction to Partial Differential Equations: A Computational Approach. New York, NY: Springer, 1998.*
- *O. Dimon, Foundations of Potential Theory Berlin : Springer-Verlag, 1967*
- *R. S. Pathak, A Course in Distribution Theory And Applications: Alpha Science, 2001*