Research Areas: Subsurface Flow & Transport

(modified after *Springer*; YZ's expertise/interest marked by "**X**")

Classification	Description	
A	**Fundamental of Transport in Porous Media**	
A1	Phenomenological theory	
A2	Thermodynamics of porous media	
A3	Hydrodynamics in porous media	
A4	Pore Scale Modeling (flow, solute transport and heat transport)	
B	**Analytical and Numerical Solution Methods**	
B1	Analytical solution methods	
B2	Numerical solution methods	
B3	Asymptotic methods	
B4	Self similar methods.	
B5	Finite differences	
B6	Finite elements, Galerkin method	
B7	Volume elements	
B8	Numerical technique in Lagrangian variables.	
B9	Euler-lagrangian methods.	
B10	Godunov's methods	
B11	High-order schemes	
B12	Numerical dispersion	
B13	Numerical stability	
B14	Lattice gas techniques	
C	**Applications in Various disciplines**	
C1	Flow and other Transport in Phenomena in Aquifers	**X**
C2	Flow and other Transport in Phenomena in the vadose zone.	**X**
C3	Applications in Soil mechanics/geotechnical engineering.	
C4	Constitutive relations	
C5	Consolidation. Land subsidence	
C6	Mechanics of saturated and unsaturated materials under drying	

C7	Consolidation and subsidence	
C8	Effective stress	
C9	Applications in Petroleum Reservoirs Engineering	X
C10	Natural Drive	
C11	Chemical flooding	
C12	Fluid Displacement	
C13	Secondary Recovery	
C14	Enhancing Oil Recovery	
C15	Foam flow	
C16	Chemical flooding	
C17	Flow in the vicinity of wells, hydraulics of wells	
C18	Well testing (petroleum), NMR techniques	
C19	Pumping tests (groundwater)	
C20	Horizontal wells	
C21	Well testing in groundwater	
C22	Gas-liquid flow with phase transitions	
C23	Compositional Modelling	X
C24	VT-modelling	
C25	Applications in Chemical Engineering	
C26	Drying processes in industry.	
C27	Applications in Agricultural Engineering	
C28	Applications in Bio-medical Engineering, and sciences.	
C29	Applications in Civil and Environmental Engineering	
C30	Applications in Geochemistry	
C31	Remediation in contaminated subsurface	
C32	Pump-and-treat	
C33	Soil vapour extraction	
C34	Permeable reactive barriers	
C35	Nuclear and chemical waste storage	
C36	CO2- sequestration	X
D	**Coupling Non-Isothermal flow and Transport Phenomena**	
D1	Coupled processes	

D2	Coupled fluxes. Soret, Duffor effects	
D3	Modeling flow couples processes	
D4	Instability in coupled processes	
E	**Uncertainty**	
E1	Kriging. Geostatistics.	**X**
E2	Stochastic modeling	
F	**Waves in Porous Media**	
F1	Travelling waves.	
F2	Shock waves.	
F3	**Miscellaneous Phenomena of Transport in Porous media**	
F4	Thermodynamics of Irreversible Processes	
F5	Electro-osmosis	
F6	Electrolytic phenomena in porous media	
F7	Membranes	
F8	Magneto-hydrodynamics in porous media	
F9	Effective medium theory. Transport coefficients inheterogeneous media	
F10	Migration of fines	
F11	Filtration	
G	**Laboratory and field experimental and measurement techniques**	
H	**Porous Medium Physical Characteristics**	
H1	Description of Pore Structe	
H2	Experimental techniques (NMR, mercury injection porosimetry)	
H3	The use of NMR	
H4	Fractured domains. Fractured porous medium domains	
H5	Solid matrix properties	
H6	Porous medium properties: Porosity/permeability/dispersivity/tortuosity	
H7	Core analysis in reservoir engineering	
H8	Anisotropy, tortuosity	
H9	Models of porous medium structure	
H10	Fractal,self-similar and self-affine descriptions	
H11	Swelling and shrinkage phenomena in porous media, swelling soils	
H12	Clay minerals. Swelling of clay soils	

H13	Electrical resistance		
H14	Heterogeneity		
I	**The Continuum Approach to Transport in Porous Media**		
I1	Principles		
I2	Volume averaging/REV		
I3	Homogenization techniques		
I4	Stochastic approaches		
I5	Heterogeneity. Scale effects. Up-scaling	X	
I6	Effective medium	X	
I7	Field scale considerations	X	
I8	Percolation theory; percolation techniques		
I9	Network models		
I10	Continuum approach to fractured domains		
I11	Double/multiple continua models		
J	**Motion equations - saturated flow**		
J1	Darcy's law		
J2	Averaging Navier-Stokes equations		
J3	Motion equation--Newtonian and non-Newtonian Fluids		
J4	Non-Darcian Laws : Brinkman equation / Forchheimer equation C Molecular flow		
J5	Inertial and turbulence effects.		
J6	Flow in fractures		
K	**Modeling saturated flow**		
K1	Mathematical modeling	X	
K2	Double/Dual porosity models		
K3	Modeling flows in aquifers	X	
K4	Boundary conditions		
K5	Free surface. Phreactiv surface, fluid-fluid interface		
K6	Instability of free surface		
K7	Interface between bulk fluid and a porous medium		
K8	Deformable porous media. Swelling soils		
K9	Analytical solutions		
K10	Saturated flow in fractured domains		

K11	Hydraulic fracturing		
K12	Variable density flow		
K13	Instability in variable density flow		
K14	Flow models with sharp interfaces		
K15	Stochastic modeling		
L	**Modeling multiphase flow. Flow in the Vadose Zone**		
L1	Surface phenomena		
L2	Capillary pressure. Retention Curves.		
L3	Triple point.		
L4	Wetting. Spreading. Hysteresis		
L5	Motion equations	X	
L6	Effective/relative permeability	X	
L7	Mass balance equations		
L8	Boundary conditions		
L9	Analytical solutions		
L10	Three-Phase flow models		
L11	Sorptivity / imbibition. Capillary trapping.		
L12	Multiphase flow in porous medium domains.		
L13	Multiphase flow in fractured domains		
L14	Preferential flow		
L15	Double/Dual porosity models		
L16	Instability: three-phase, viscous, gravitational.		
L17	Fingering		
L18	Petroleum Engineering/reservoir engineering	X	
L19	Unsaturated flow in fractured domains		
M	**Modeling Non-Isothermal Flow**		
M1	Thermodynamics in porous media.		
M2	Heat/energy fluxes in multiphase flow		
M3	Modeling heat and mass transport in single and multiphase domains		
M4	Energy balance equations		
M5	Boundary conditions		
M6	Flow stability		

M7	Convection	
M8	Natural Convection	
M9	Forced Convection	
M10	Mixed Convection	
M11	Magneto-hydrodynamics (MHD) in Porous Media	
M12	Convection due to Electric fields	
M13	Thermo-Vibrational Convection	
M14	Convection due to Rotation	
M15	Thermo-Solutal Convection	
M16	Bio-Convection	
M17	Drying processes in industry	
M18	Modeling transport processes during drying	
M19	Chemical transport (with deposition, dissolution, mineralization)	
M20	Double/Dual porosity models	
M21	Heat Transfer at micro and nano scales	
M22	Conduction in Porous Media	
N	**Modeling Solute Transport**	
N1	Fluxes. Advection. Diffusion. Dispersion. Dispersivity.	**X**
N2	Boundary conditions	
N3	NAPL dissolution. DNAPL. LNAPL	
N4	Analytical solutions	
N5	Tracers	
N6	Solubility	
N7	Solute Transport. Reactive Transport	
N8	Sources: Volatillization. Phase change. Adsorption. Ion Exchange. Phase transfer. Radioactive decay. Dissolution. Hydrolysis	
N9	Solute Transport. Chemical reactions. Chemical kinetics	
N10	Chemical compositional simulations/models	
N11	Solute Transport. Biological Activities in Porous Media. Bio-transformations.	
N12	Double/Dual porosity models.	
N13	Matrix diffusion. Diffusion in porous media	
N14	Solute Transport. Colloids and particle transport	
N15	Remediation techniques	

N16	Stochastic modeling	
O	**Inverse problem. Parameter Estimation**	
O1	Methodology of solving the inverse problem	**X**
O2	Model structure identification	**X**
O3	History matching	**X**