ENCH 630: Transport Phenomena, Spring 2002

COURSE OUTLINE

Lecture	Topic
1.	Review of Appendix: vector operations, differential operators Index notation (class notes)
2.	Continuum Hypothesis General conservation equation (integral, differential form)
3.	Student talks on papers Mass conservation
4.	Momentum conservation (integral, differential form) Stress tensor, pressure, viscous stress
5.	Constitutive equation for viscous stress for Newtonian fluids Tensor operations (Appendix) Dynamic pressure Example: fully-developed flow between two parallel plates
6.	Energy conservation (integral, differential form) Kinetic energy conservation Thermal energy conservation
7.	Conservation of chemical species (integral, differential form) Similarities between thermal and mass conservation Example: 1D steady conduction/diffusion in rectangular, cylindrical and spherical coordinates.
8.	Boundary Conditions at interfaces: general case Simplifications: plane of symmetry, axisymmetry (cylindrical, spherical) BC's at interfaces: mass, velocity, heat, chemical species Additional BC's for heat/temperature
9.	2D "diffusion" problems: Finite Fourier Transform Example: steady conduction in a square rod
10.	FFT: basic functions for different BC's Additional examples/cases
11.	Review of Perturbation Analysis FFT and Perturbation Analysis (class notes)
12.	Dimensionless conservation equations (mass, momentum, energy, chemical species) Similarities between momentum, energy and chemical species equations Time scales for convective and diffusive transport
13.	Test #1
14.	Review of Test #1 Review of Fluid Dynamics Momentum conservation (integral, differential form) Stress tensor, pressure, viscous stress
15.	Displacement, strain/deformation, vorticity Rigid-body rotation flow Plain strain flow

16. Fluid Mechanics at interfaces
    Review of surface tension and curvature
    Streamfunction and streamlines
    Example: 2D pure extensional flow

17. Dimensionless analysis for steady and unsteady Navier-Stokes
    Viscous stress for Newtonian and non-Newtonian fluids

18. Exact solutions of Navier-Stokes
    Example 6.2-4: Liquid film on inclined plane
    Example: Couette flow

19. Similarity method: solid plate moving with constant velocity
    Example: Flow over an oscillatory plate
    Lubrication Theory

20. Lubrication Theory
    Case I: shearing
    Case II: applied pressure gradient
    Lubrication forces

21. Low-Re Flows
    Examples: rotation and swimming in Stokes flow
    Streamfunction solution: flow around a sphere

22. Streamfunction solution: flow around a sphere (cont.)
    Assumption of negligible inertia
    Fluid Dynamics: VIDEO

23. Test #2

24. Review of Test #2
    Inviscid flows
    Properties, Potential function
    Example: Flow past a cylinder

25. Boundary Layer Theory
    Blasius problem

26. Further discussion on BL: entry length for flow in tube or channel
    Energy Conservation: equation and BCs

27. Dimensionless analysis for Energy Conservation
    Thermal and Concentration Boundary Layers

28. Blasius problem with thermal boundary layer

29. Natural convection: Boussinesg approximation
    Thermal BL near a vertical wall

30. Final Test