NATIONAL TSING HUA UNIVERSITY

DEPARTMENT OF POWER MECHANICAL ENGINEERING

2013 Fall Semester

Course No.:	PME 510200
Course Title:	**Multiscale Transport (多尺度傳輸)**
	(Fluid, Molecule and Quantum Flows)
Hours/Week:	T6 T7 T8
Classroom:	エ一館 R 209
Teacher:	Prof. Che-Wun Hong (洪哲文教授)

Contents:

(1) Introduction to Multi-scale Transport

1.1 Development of Multi-scale Transport in Physics
1.2 Classical Physics and Modern Physics
1.3 Macroscopic and Microscopic Models
1.4 Micro Flow Examples
1.5 Macro Flow Development
1.6 Kinetic and Transport Properties of Fluids
1.7 General Boundary Conditions

(2) Macro Flow Models (The Navier-Stokes Equation)

2.1 Fundamental Equations
2.2 Conservation of Mass (Continuity Equations)
2.3 Conservation of Momentum (Navier-Stoke Equations)
2.4 Conservation of Energy (1st Law of Thermodynamics)
2.5 Summary of the Basic Equations
2.6 Examples of Boundary Conditions
2.7 Orthogonal Coordinate System
2.8 Mathematical Characters of the Basic Equations
2.9 Dimensional Analysis and Dynamic Similarity
2.10 Summary of the Basic Equations in CFD
2.11 Control Volume Formulations
2.12 Integral Form of the Generic Conservation Equation

(3) Analytical Solutions of the Continuum Flow

3.1 Classification of Solutions
3.2 Couette Flows
3.3 Poiseuille Flow through Ducts
3.4 The Circular Pipe: Hagen-Poiseuille Flow

7.6 Fluid and Solid Mechanics
7.7 Radial Distribution Function
7.8 General Monte Carlo Methods

(8) Quantum Flows (The Schrödinger Equation)

8.1 Development of Quantum Mechanics
8.2 The Born Interpretation
8.3 Classical Wave Equations
8.4 The 1-D Simple Harmonic Oscillator
8.5 Wavefunction for a Free Particle
8.6 Wavefunctions in the Presence of Potential Forces
8.7 Numerical Method for the Schrödinger Equation
8.8 The Particle in a Box
8.9 The Finite Square Well
8.10 The Square Potential Barrier
8.11 Electron, Photon and Phonon Statistics
8.12 Unified Quantum Fluid Dynamics and Quantum LBM

Lecture Notes: Supplement notes provided by PDF before each lecture

References: (1) "Viscous Fluid Flow"
F.M. White, 3rd Ed., McGraw-Hill, 2006 (N-S Eq)
(2) "Computational Methods for Fluid Dynamics", J.H. Ferziger, M. Peric, Springer, 2002. (CFD)
(3) "Molecular Gas Dynamics and the Direct Simulation of Gas Flows", G.A. Bird, Clarendon Press, 1994. (DSMC+MD)
(4) "Lattice-Gas Cellular Automata and Lattice Boltzmann Models- An Introduction", D. A. Wolf-Gladrow, Springer, 2005 (LBM)
(5) "Modern Physics", 3rd Ed., R.A. Serway, C.J. Moses, C.A. Moyer, Thomson, 2005 (Schrodinger Eq)
(6) "Simulating the Physical World: Hierarchical Modeling from Quantum Mechanics to Fluid Dynamics", 4th Ed., H.J.C. Berendsen, Cambridge Univ. Press, 2007

Grades: Exercises (20%)
Midterm Exam (40%), close book
Final Report and Presentation (40%)