TOPICS AND SCHEDULE

BASICS

• 2/4: L1. Kinematics, strain and vorticity, Kinematic transport theorem, mass conservation, Forces in a fluid, stresses and Cauchy’s law

• 2/5: R1. Review of BASICS

• 2/6: L2 Momentum conservation and Navier-Stokes, Vorticity theorems for homogeneous and inhomogeneous fluids

• 2/9: L3 Scaling and approximations.

• 2/12: R2: Cartesian tensors.

SLOW FLOWS

• 2/11: L4. Lubrication approximation for a thin fluid layer

• 2/13: L5. A gravity current on an incline

• 2/16: Presidents’ Day

• 2/17: L6. Stokes flow past a sphere

• 2/17: R3. Rayleigh Problem - solid wall as a source of vorticity

• 2/18: L7. Oseen’s improvement

• 2/20: L8 Selective withdrawal from an isothermal stratified fluid

• 2/23: L9 Selective withdrawal from an isothermal stratified fluid
HIGH SPEED FLOWS AND BOUNDARY LAYERS

- 2/25: L10. Inviscid and irrotational flows, Bernoulli theorems
- 3/5: L15. Unsteady boundary layers
- 3/8: L16. Oscillatory boundary layers and induced streaming
- R5: Homework

- 3/10: L17. Impulsive boundary layers

TAKEHOME MIDTERM

TRANSPORT OF HEAT OR MASS

- 3/12: L17. Conservation of energy
- 3/15: L18. Approximations
- R5: Discussion of midterm.
- 3/19: L20. Buoyant plume from a steady source of heat
- 3/22-26 Spring vacation.
- 3/31: L22. Dispersion in steady shear flow
- 4/2: L23. Dispersion in an oscillatory shear flows
INTRODUCTION TO INSTABILITY

- 4/5: L23. Kelvin-Helmholtz instability - discontinuous profile
- 4/7: L24. Kelvin-Helmholtz instability - continuous stratification, Rayleigh-criterion for parallel flow instability
- 4/9: L25. Boundary layer instability and Orr-Sommerfeld equation
- 4/12: L26. Effects of viscosity
- 4/14: L27. Energy argument

FLOW AND TRANSPORT IN POROUS MEDIA

- 4/16: L28. Empirical and theoretical basis of Darcy’s law
- 4/19-20 Patriots’ Day
- 4/21: L29. Saffman -Taylor instability
- 4/23: L30. Equation for geothermal convection

COASTAL GEOPHYSICAL FLUID DYNAMICS (For 1.63J)

- 4/30: L34 Rotating coordinates and Coriolis force
- 5/3: L35. Taylor-Proudman theorem
- 5/5: L36. Ekman Boundary layer and Shallow-sea approximation
• 5/7: L37. Nonuniform wind forcing - Ekman pumping
• 5/10: L38. Transient long-shore wind
• 5/12 L39. Coastal upwelling
• R.9. Kelvin & Poincare waves
• R10. Homework
• 5/12: L36. Wind-forced coastal upwelling in a two-layered sea

TAKEHOME FINAL

CAPILLARY PHENOMENA (Lectures by Prof. John Bush)

• Laplace formula
• Effects of surface tension on Helmholtz instability.
• Waves on the surface a of a thin film– Kapitsa’s problem.
• Capillary instability of a liquid jet– low jet velocity
• Capillary instability of a liquid jet– high jet velocity
• Small oscillations of a gas bubble, inviscid and viscous theories.
• Marangoni stresses and instability.
• Moving contact lines

TAKEHOME FINAL