

# G6004 Lecture schedule

Fall 2006

(subject to change, last updated September 4, 2006)

## week 1

Sept 5: Introduction to course [DP 1]

1. Course dynamics (goals, outline, hours, grading, etc.)
2. Overview of observations: HR diagram, ML relation
3. Overview of important physics used and their timescales.

Sept 7: overview cont'd [DP 2.1, 2.2, 2.3]

1. Overview of equations to be used:
  - A. Hydro equations plus gravity (static case)
  - B. Equations of State
  - C. Radiative Transfer
  - D. Heat transport: radiative, conductive, convective
  - E. Nucleosynthesis
2. Overview of stellar evolution

## week 2

Sept 12: Hydro equations (momentum and energy) [GC 2.1][DP 2.1, 2.2, 2.3]

1. origin (MHD, gravity)
2. spherical symmetry (assumption)
3. time-independent
4. applications: dynamical time, thermal (KH) time, sound crossing

Sept 14: EOS: statistical physics I [GC 1.1] [DP 3]

1. Intro to statistical physics (microstates and macrostates)
2. Partition function
3. Things derived from partition function
4. The connection with kinetic theory

## week 3

Sept 19: statistical physics II [GC 1.1, 1.3] [DP 3]

1. simple examples
2. ideal gas

Sept 21: statistical physics III [GC 1.3] [DP 3]

1. degenerate gas
2. radiation

## week 4

Sept 26: Nuclear processes I [GC 3.3] [DP 4.1-4.5]

1. binding energies
2. nuclear cross-sections
3. Major reactions: pp, CNO, triple-alpha

Sept 28: Nuclear processes II [GC 3.3][DP 4.6-4.10]

1. CO burning
2. nuclear statistical equilibrium
3. s- and r-process
4. pair production

**week 5**

Oct 3: Radiative transfer (introduction) [DP 3.7, Appendix 1][GC 4.1, 4.2]

1. intro to radiative transfer
2. opacities
3. radiative equilibrium
4. radiative flux

Oct 5: (away?)

**week 6**

Oct 10: Heat transport [DP 3.7, 6.5] [GC 4.2, 4.3, 4.4, 4.5]

1. Radiative
2. Conductive
3. Convective

Oct 12: Equilibrium stellar configurations: simple models I [DP 5] [GC 2]

1. Summary of equations
2. Constant density
3. Polytropic models
4. Eddington's model

**week 7**

Oct 17: Equilibrium stellar configurations: simple models II [DP 5] [GC 2]

1. Point source model
2. Homology
3. Review

Oct 19: midterm exam

**week 8**

Oct 24: Stellar stability [DP 6]

1. Thermal stability
2. Dynamical stability

Oct 26: Evolution of stars: a schematic picture I [DP 7]

1. Characterization of T-rho plane
2. Evolution of central point of star
3. Theory of the main sequence

**week 9**

Oct 31: Evolution of stars: a schematic picture II [DP 7]

1. Outline of the structure of stars in late states
2. shortcomings of simple picture
3. Numerical methods for full solution
4. Boundary conditions

Nov 2: Evolution of stars: a detailed picture I [DP 8]

1. Hayashi zone
2. The main sequence
3. Red giant phase
4. Helium burning
5. Thermal pulses and the AGB
6. Superwind and PN phase
7. Evolution of massive stars

**week 10**

Nov 7: election day (no class)

Nov 9: Structure of white dwarfs [DP 8.8, 9.4] [GC 6.3]

1. WD structure
2. cooling
3. neutron stars

**week 11**

Nov 14: Supernovae [DP 9.1]

1. SN mechanism
2. nucleosynthesis during SN
3. BH accretion (X-ray binaries)

Nov 16: Stellar pulsation, helioseismology [GC 8.1, 8.2]

1. linear adiabatic radial oscillations
2. linear non-adiabatic radial oscillations
3. other kinds of oscillations
4. Connection to observed variable stars

**week 12**

Nov 21: Stellar atmospheres I [GC 9]

1. Equation of radiative transfer
2. Source function
3. Moments of radiation field and RT equations

Nov 23: Thanksgiving (no class)

**week 13**

Nov 28: Stellar atmospheres II [GC 10]

1. Classic solution
2. Gray atmosphere
3. More sophisticated approaches
4. mean opacities

Nov 30: Exotic single stars and Binary stars (student presentations)

**week 14:**

Dec 5: Star formation, IMF (student presentations)

Dec 7: Summary (last class)

Notes:

DP refers to *Stellar Structure and Evolution* by Dina Prialnik

GC refers to *Fundamentals of Stellar Astrophysics* by George Collins

All references to book chapters are rough guidelines only