Week 1:

Overview of Astrophysics: The size, mass, distance, and timescales involved, what do we want to know in astrophysics

Basics of observations: Key properties of telescopes, spectroscopy (continuous, line, and absorption spectra), atmospheric seeing, multi-wavelength astronomy, need for space telescopes.

Reading: Maoz: Chapter 1, 2.1, 2.2.3

Week 2:

Astronomical quantities: luminosity, flux, magnitude, color, stars as blackbody radiator, Planck function, Wien's displacement law.

Mass measurement in Astronomy: Mass measurements from binary stars, extrasolar planets, transit (temperature and size of binary companion), planetary atmosphere.

Reading: Maoz: 2.2.4

Scientific method keynote: Are we really detecting planets? Compare transit and Doppler periods.

Week 3:

Stellar spectra: Boltzmann and Saha Equation, HR diagram

Reading: Maoz: 2.2.2

Possible Student teaching assignment: Statistical mechanics of Saha Equation **--- ?**

Scientific method keynote: Can we really tell stellar chemical composition from its observed spectra? No one believed Cecilia Payne.

Stellar structure:

a) Equation of hydrostatic equilibrium

Reading: Maoz: 3.1 (up to eqn 3.19)

b) Equation of energy transport (radiative transfer, convection, eqn. of state, radiation pressure)

Reading: Maoz: 3.3-3.8, 3.12

Scientific method keynote: Is our Sun really at hydrostatic equilibrium? Gone with the (solar) wind.

Week 4:

Stellar nucleosynthesis: Failure of chemical and thermal fuelling, success of nuclear fuelling, p-p chain

Reading: Maoz: 3.9, 3.10

Possible Student teaching assignment: Quantum mechanics (tunnelling) of stellar nuclear fusion

Scientific method keynote: Is our understanding of stellar nucleosynthesis correct? stellar lifetimes, Solar neutrino problem (50 years of finding pins in haystacks and being right all along).

Cosmology:

Existing observations of our Universe: Galaxy power spectrum, cosmic microwave background.

Reading: Ryden Chapter 1, 2

Week 5:

Virial theorem and its application
Reading: Maoz: 3.1 (after eqn 3.19)
Possible Student teaching assignment: Derivation of Virial theorem and demonstration of some application (Flashback of Lagrangian Mechanics)
Scientific method keynote: Why is Virial theorem so powerful? (And who is this "Virial" anyway? Hint: It's a trick question!)

Cosmology:
Standard theoretical model of Cosmology that explains the existing observations.
Robertson-Walker matric, Friedmann equation
Reading: Ryden Chapter 3, 4

Week 6:
Fluid eqn. and Jeans instability
Star formation: theory and observation, interstellar medium
Reading: Maoz: 5.1 (up to the end of 5.1.3), 5.3
Possible Student teaching assignment: Derivation of Jeans instability (direct application of fluid mechanics) **--- ?**
Scientific method keynote: Does our prediction about star formation match with observations? P-Cygni profile, emission and reflection nebulae, star formation rate of other galaxies, … in other words … yes!

Cosmology:
Radiation and matter dominated universe.
Reading: Ryden Chapter 5, 6

Week 7:
Stellar evolution
Reading: Maoz: 4.1
Scientific method keynote: How can we test this elaborate story about stellar evolution? HR diagram, Hertzsprung gap, population <---> evolution, isochrones, spectroscopic parallax. We can … and we have.

Cosmology:
Distances in Cosmology, Horizons and look-back time.
Reading: Ryden Chapter 7

Week 8:
Pulsars
Reading: Maoz: 4.4 (omit 4.4.3)
Possible Student teaching assignment: Derivation of radiation from a magnetic dipole **--- ?**
Scientific method keynote: Is our theory of pulsars right? Pulsars and their parent supernova remnants, black widow pulsars, millisecond pulsars (Most neutron stars spin once every 10 sec around its axis, … some do it once every ms!).

Cosmology:
The physics of Cosmic Microwave Background.
Reading: Ryden Chapter 9

Week 9:
Close binary system: Lagrange points, tidal force, accretion disk
Reading: Maoz: 4.6
Possible Student teaching assignment: Memories of the physics of non-inertial reference frame, restricted 3-body problem **--- ?**
Scientific method keynote: Do black holes exist? (Hawking loses ... and yet wins)

Cosmology:
The early Universe.
Reading: Chapter 11

Week 10:
Stellar death: Degeneracy pressure (White dwarf, Neutron star), supernova
Reading: Maoz: 4.2 (omit 4.2.3.3), 4.3
Possible Student teaching assignment: Statistical mechanics of degeneracy pressure **--- ?**
Scientific method keynote: Is the above theory right? Chandrasekhar mass. Is our theory of supernovae right? Evidence from Supernova 1987A (Yes, a star exploded 168,029 years ago in a nearby galaxy, we saw it in 1987 and tested our theory of exotic nuclear reactions and explosions using those observations. No big deal).

Cosmology:
Formation of structure.
Reading: Ryden Chapter 12

Week 11:
Galaxies: classification, Milky Way, rotation, spiral arms, rotation curve, dark matter, singular isothermal sphere
Reading: Maoz: 6 (up to the end of 6.1.2), 6.2
Scientific method keynote: Is dark matter real? Bullet cluster.

Week 12:
Galaxy clusters: Largest gravitationally bound systems, X-ray gas

Cosmology:
Current status of the standard model of cosmology, dark energy, λCDM.

Week 13:
AGN: As a singular exotic object, as part of galaxy evolution
Reading: Maoz: 6.3-6.4
Scientific method keynote: Unification of various classes of AGN.