Introduction to General Relativity II

Curvature and Einstein equations: Sources of gravity: the energy momentum tensor. Fluids and conservation laws, sound waves, gravitational perturbations and Jeans-instability, the basics of gravitational collapse. Relativistic fluids and covariant conservation of the energy momentum tensor. Geometry: curvature, Bianchi identities and Einstein equations, the Newtonian limit. The Einstein-Hilbert action.

Basics of stellar evolution. Relativistic stars: White dwarfs (a prelude). Relativistic Hydrostatic equilibrium and the Tolman-Oppenheimer-Volkov equations. Compact stars: neutron stars and pulsars. Supernovae, type II and Ia, standard candles. Bounds on maximum masses. Black Holes as end points of stellar evolution. Rotations and frame dragging (Thirring effect) . Astrophysical Black-Holes, accretion disks and jets. Quasars and X-ray sources.

Black holes: Schwarschild black holes, event horizon and innermost circular orbits. Gravitational collapse to a B.H. Kruskal and other coordinate systems. Hawking radiation. Spinning black holes: the Kerr metric, ergospheres, Penrose processes, charged b.h.

Linearized gravity with and without sources. Gravitational waves: the quadrupole formula, experiments and observations. The Taylor-Hulse pulsar and gravitational radiation. Ligo and gravitational waves from collapsing compact stars.

Cosmology: Friedmann-Robertson-Walker cosmologies, Matter and Radiation: equations of state and cosmological evolution. Inflation and the Cosmological constant: deSitter space-time. A (very) brief excursion into quantum field theory and inflation. The Big Bang: age and size of the Universe, particle horizons. A (very) brief history of the Universe: connection with particle physics. The growth of gravitational perturbations in expanding cosmologies. The origin of galaxy formation. Cosmic microwave background radiation, horizon problem and solution.