GRG-II: Course Contents

1. **Resumé of General Relativity & Gravitation Part I**

   Foundations of GR; properties of manifolds; transformation laws for tensors; the metric tensor; covariant differentiation, parallel transport and geodesics; the energy-momentum tensor; the Riemann-Christoffel and Ricci tensors; conservation of energy and momentum; Einstein's field equations.

2. **Static Models with Spherical Symmery**

   Orthogonal metrics; spherically symmetric metrics in curved spacetime; evaluation of the Christoffel symbols and components of the Ricci tensor; derivation of the Schwarzschild metric.

3. **The Schwarzschild Metric and Classical Tests of General Relativity**

   Geodesics for the Schwarzschild metric; identification with planetary orbits; classical tests of General Relativity: advance of pericentre, gravitational light deflection – applications to gravitational lensing and binary pulsars.

4. **Einstein's Equations for Static Spherically Symmetric Stars**

   Derivation of the Oppenheimer-Volkhoff equation; outline of a general numerical solution and derivation of the exact solution for constant density.

5. **Gravitational Waves**

   Linearisation of Einstein's Equations for a weak gravitational field; establishment of the wave equation for gravitational radiation; example of plane gravitational radiation – its quadrupole nature and forms of polarisation; example of a binary star system.

6. **Black Holes**

   The infall of particles and photons towards the Schwarzschild horizon; behaviour of the coordinate time and radial coordinate inside and outside this horizon; new form of the metric and interpretation of the spacetime diagram; rotating Black Holes and Frame Dragging; Hawking radiation.

7. **GR and Cosmology**

   The cosmological principle and derivation of the Robertson-Walker metric; Einstein's cosmological constant.