Relativity and Gravitation (MTH720U/ASTM033) 2011

About the course

This course is an introduction to General Relativity and includes:

Explanation of the fundamental principles of GR.
The motion of particles in a given gravitational field.
The propagation of electromagnetic waves in a gravitational field.
The derivation of Einstein's field equations from the basic principles.
The derivation of the Schwarzschild solution.
Analysis of the Kerr solution.
A discussion of physical aspects of strong gravitational fields around black holes.
The generation, propagation and detection of gravitational waves.
The weak general relativistic effects in the Solar System and binary pulsars.
The experimental tests of General Relativity.

Assessment

Course-work 0%, exam 100%

Key Objectives

1**. Effects of General Relativity in the Solar System and in the Universe:** You should have a good understanding of the importance of general relativity in physics and astronomy.

2. Curvilinear Coordinates, Covariant Differentiation: You should be able to operate with concepts of differential geometry and understand the deep relationship between physics and geometry.

3. Motion of Particles in a Gravitational Field: You should understand the fundamental difference in the motion of particles in relativistic theory of gravitation and in Newtonian theory. You should be able to write down and solve in the simplest cases the geodesic equation.

4. The Curvature Tensor and the Einstein Equations: You should understand basic physical principle of the least action and have good qualitative understanding of the most important stages of the derivation of these equations.

5. Black Holes: You should understand what is event horizon and what is the limit of stationarity. You should be able to describe the main effects of strong gravitational field around black hole and have idea how the black holes could be discovered.

6. Gravitational Waves: You should be able to derive the wave equation for propagation of gravitational radiation, understand why gravitational waves are transverse and traceless, what is similarity and what is the difference with electromagnetic waves. You should also be able to produce order of magnitude estimations of amplitudes of gravitational waves from astrophysical sources of gravitational radiation.