[A-3]COURSE SYLLABUS

1. Course Description (Approximately 100 words)

The recent advances in gravitation theory and cosmology, combined with breakthroughs in observational astronomy are transforming our understanding of space and time and our perspectives on the origin and future fate of the universe. This course will cover a large number of topics, ranging from the experimental and theoretical underpinnings of the special and general theories of relativity to the birth, history, and future evolution of the universe. All subject matter will be presented on a level accessible to anyone familiar with algebra and Freshman-level physics. This course will introduce the modern perspectives of space-time and geometry, and the foundations of general relativity. The first important objective is to derive the Einstein equation of the space-time structure, and the second objective is to apply the Einstein equation to derive the concepts of black holes, gravitational waves, and expanding universe.

2. Course Goals and Objectives (Approximately 100 words)

By the end of this unit, the student will have a good idea of the mathematical tools required for by special relativity and general relativity, including basics of tensor analysis and differential geometry and be able to compute and use the metric, connection and curvature of a Riemannian geometry. They will understand the physical content of general relativity, including the effect of matter on the geometry of spacetime and the effect of geometry on the motion of matter and show an understanding of the application of general relativity to the description of collapsed stars and cosmology, becoming familiar with the various experimental tests of general relativity. Finally they will use maple subroutines to compute geometric properties.

3. Textbook (Title, Author, Publisher, Year of Publication, etc.)

1. A First Course in General Relativity 2nd Edition by Bernard Schutz
2. A Short Course in General Relativity 3rd Edition by James Foster, J. David Nightingale
3. A Student's Manual for A First Course in General Relativity Paperback by Dr Robert B. Scott

4. Reference

[1] N. M. J. Woodhouse, “General relativity,” London, UK: Springer (2007) 219 p.
[2] L. P. Hughston K. P. Tod, “An Introduction to General relativity,” London Mathematical Society Student Texts, UK: CUP.
[3] J. M. Stewart, “Advanced general relativity,” Cambridge University Press, Cambridge, 1990.
[4] R. M. Wald, “General Relativity,” Chicago, Usa: Univ. Pr. (1984) 491p.
[5] P. K. Townsend, “Black holes: Lecture notes,” Available from http://arXiv.org/pdf/grqc/9707012.
[6] S. Weinberg, “Gravitation and Cosmology,”
[7] C. W. Misner, K. S. Thorne, J. A. Wheeler, “Gravitation,” San Francisco 1973, 1279p

5. Course Requirements and Grades

CAT =30%
ASSIGNMENT = 10%
EXAMINATION = 60%
TOTAL = 100%

6. Course Calendar

Week	Main Content
1	The physics of flat space-time
2	Tensor Calculus and Differential Geometry
3	Higher Valence Tensors
4	Covariant derivatives
5	Normal Coordinates and Local Inertial Frames
6	The Curvature of Space-time
7	CAT / ASSIGNMENT
8	The Einstein Field Equations
9	Recovering Newtonian gravity and Static solutions with spherical symmetry
10	Geodesics of massive particles
11	Null geodesics in Schwarzchild space-time
12	Black Holes
13	Symmetries of space-time geometries
14	EXAMINATION