INSTITUTO DE FÍSICA
FACULTAD DE FÍSICA

COURSE	:	**RELATIVITY AND GRAVITATION**
TRANSLATION	:	RELATIVIDAD Y GRAVITACIÓN
NUMBER	:	FIM4545
CREDITS	:	15 UC / 9 SCT
MODULES	:	3
REQUISITE	:	FIZ0311, FIZ0314
CONECTOR	:	OR
RESTRICTIONS	:	030401, 030501
CHARACTER	:	OPTATIVE
FORMAT	:	THEORICAL LECTURES
QUALIFICATION	:	STANDARD
FORMATIVE LEVEL	:	DOCTORATE
DISCIPLINE	:	PHYSICS AND ASTRONOMY

I.COURSE DESCRIPTION

A modern and geometric view of Einstein's theory of gravitation will be presented. The basic principles will be developed, including the necessary elements of differential geometry (within the context of physical applications to Special and General Relativity), and emphasis will be placed on astrophysical applications such as gravitational waves, compact stars, black holes and cosmology.

II.LEARNING OUTCOMES

- Develop a geometric-physical intuition about what curved spacetime is
- Understand and appreciate the beauty and importance of Einstein's General Theory of Relativity
- Solidly handle the basic mathematical objects on which this theory is based, in particular tensors
- To be able to solve problems related to gravitation, applying this theory, for example, to calculate the structure of a compact star or a black hole, the deflection of light, the precession of the orbit of Mercury and the evolution of the expansion of the Universe
- To be able to start a research project in which the previous elements are used

III.CONTENT

1) Special Relativity, Minkowski spacetime
2) Vectors in Minkowski space
3) Tensors in Minkowski space
4) Perfect Fluids in Special Relativity
5) Vectors and tensors in curvilinear coordinates
6) Curved spaces, geodesics, Riemann tensor
7) Physics in curved spacetime, geodesics, conservation laws
8) Einstein field equations
9) Gravitational waves
10) Relativistic stars
11) Schwarzschild geometry and black holes
12) Cosmology

IV.METHODOLOGICAL STRATEGIES

Theoretical lectures

V.EVALUATIVES STRATEGIES

- Homework
- Interrogations or partial checks
- Final exam

VI.BIBLIOGRAPHY

Required:
Bernard Schutz, A first course in general relativity, 2a edición, Cambridge U. Press 2009.
Robert B. Scott, A student's manual for A first course in general relativity, Cambridge U. Press, 2016.

Optional:
Sean M. Carroll, Spacetime and Geometry, Addison Wesley, 2004.
James B. Hartle, Gravity, Addison Wesley, 2003.
Charles W. Misner, Kip S. Thorne y John A. Wheeler, Gravitation, Princeton U. Press, 1973.
Alan P. Lightman, William H. Press, Richard H. Price & Saul A. Teukolsky, Problem Book in Relativity and Gravitation, Princeton U. Press, 2017.
Wolfgang Rindler, Relativity, Oxford Univ. Press, 2001.
Steven Weinberg, Gravitation and Cosmology, Wiley, 1972.
Robert M. Wald, General Relativity, U. of Chicago Press, 1984.
Ta-Pei Cheng, Relativity, Gravitation, and Cosmology. A basic introduction, Oxford U. Press, 2005.
Kip S. Thorne & Roger D. Blandford, Modern Classical Physics: Optics, Fluids, Plasmas, Elasticity, Relativity, and Statistical Physics, Princeton U. Press, 2017.
Kip S. Thorne, Black Holes and Time Warps, Norton, 1994.
Abraham Pais, Subtle is the Lord, Oxford Univ. Press, 1982.
Hernán Quintana, Espacio, Tiempo y Universo, 2ª ed., Alfgaomega, Ediciones Universidad Católica de Chile, 2002.
Clifford Will, Theory and experiment in gravitational physics, Cambridge Univ. Press, 1981.
Stuart L. Shapiro & Saul A. Teukolsky, Black Holes, White Dwarfs, and Neutron Stars, John Wiley & Sons, 1983.
Nelson Christensen & Thomas Moore, Teaching general relativity to undergraduates, Physics Today, vol. 65, núm. 6 (junio 2012), pág. 41.
Información sobre el experimento LIGO y sus recientes detecciones de ondas gravitacionales: https://www.ligo.caltech.edu/
Papers de LIGO: https://www.lsc-group.phys.uwm.edu/ppcomm/Papers.html