Especialidad: Astrofísica, Cosmología y Gravitación

Nombre del curso	**TOPICOS ESPECIALES EN ASTROFÍSICA, COSMOLOGÍA Y GRAVITACIÓN I ó II: BLACK HOLE PHYSICS** Código USM: FIS487/FIS488 Código PUCV: FIS901/FIS902
Descripción del curso	In this course the graduate student will assimilate the basic knowledge on physics of black hole solutions in General Relativity and be able to apply it to different models. Through this course, the student will also be exposed to important ideas of timely research on the subject.
	Asignatura de Tópicos Especiales – Astrofísica, Cosmología y Gravitación PREREQUISITOS: Relatividad General I Créditos USM: 5 Créditos PUCV: 7 Horas Semanales Cátedra: 4 Horas Semanales Ayudantía: - Horas Semanales Laboratorio: -
Objetivos	The student will receive modern overview of most important features of black holes. The course will start with the Schwarzschild black hole and its properties, stability and quasi-normal modes. Then the student will learn about electrically charged black hole and the rotating one, and about general aspects of black hole thermodynamics and its phase transitions. He will also understand methods of gravitational collapse that produce black holes, and a number of applications that cover non-standard black holes, their conserved charges and holographic duality.
Contenidos	1. Review of basic tools of General Relativity • General covariance • Uniformly accelerated reference frame • Curvature tensor, parallel transport of a vector • Symmetries and Killing vectors 2. The Schwarzschild black hole • Birkhoff's theorem • Eddington-Finkelstein coordinates • Kruskal coordinates • Causal structure and Penrose diagrams • Vaidya metric, horizons (event, apparent, killing) • Axial and polar perturbations • Stability • Quasi-normal modes

	3. Charged black hole • Reissner-Nordström solution • Cauchy horizon 4. Rotating black hole • Newman-Janis algorithm, Kerr solution • Ergosphere and the Penrose process • Uniqueness theorems 5. Gravitational collapse • Tolman-Bondi-Lemaître spacetime • Cosmic censorship conjecture, Hoop conjecture • Critical phenomena 6. Black hole thermodynamics • Surface gravity • The laws of black hole mechanics • Variational principle and Gibbons-Hawking boundary term • Euclidean section • Free energy and conserved charges • Phase transitions 7. Astrophysical black holes • Evidence for black holes • Classes of astrophysical black holes • Stellar evolution, Chandrasekhar limit • Disk accretion • Primordial black holes 8. Beyond standard black holes • Scalar fields with arbitrary potentials, no-go theorems • Hairy black holes • Higher-dimensional black holes • Gregory-Laflamme instability • Wormholes 9. Selected advanced topics • Cosmological horizons • AdS/CFT duality • Kerr/CFT correspondence • Black hole microscopics and attractor mechanism ▪ Wald formalism
Modalidad de evaluación	The student will have homework assignments and a final presentation
Bibliografía	**Básica:** ▪ V. P. Frolov and A. Zelnikov, "Introduction to black hole physics" (Oxford University press, 2011)

	▪ L. Landau and E. Lifshitz, "The classical theory of fields" (Elsevier, 4rd edition, first published 1987)
	Recomendada: ▪ A. Fabbri and J. Navarro-Salas, "Modeling black hole evaporation" ▪ P. Joshi, "Gravitational collapse and spacetime singularities" ▪ S. Chandrasekhar, "The mathematical theory of black holes" ▪ E. Poisson, "A relativist's toolkit: the mathematics of black hole mechanics" ▪ http://jila.colorado.edu/~ajsh/insidebh/intro.html