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Module	***Plasma Physics: Applications***
Code	71064
Instruction language	English
ECTS credits	4
Credit hours	4
Duration	1 semester
Cycle	Each summer semester
Coordinator	Dean of Physics Studies
Lecturer	Dr. Thomas Eich, Dr. Tim Happel
Allocation to study programs	Physics M.Sc., elective module, 1st or 2nd semester Wirtschaftsphysik M.Sc., elective module, 1st - 3rd semester
Formal prerequisites	None
Recommended prerequisites	Basics in Experimental Physics, Electro dynamic of advantage, Plasma I not necessary though beneficial
Learning objectives	Nuclear fusion is one of the promising options for generating large amounts of carbon-free energy in the future. Fusion is the process that heats the Sun and all other stars, where atomic nuclei collide together and release energy. Fusion scientists and engineers are developing the technology to use this process in tomorrow's power stations. This course gives an introduction to the basics of nuclear fusion in general with particular focus on modern magnetic confinement experiments such as ASDEX Upgrade in Garching and Wendelstein-7X in Greifswald. During the course actual problems and challenges for the development of today’s experiment to large scale machines like ITER and commercially viable reactors (DEMO) will be discussed. Basics of turbulent transport in magnetically confined plasmas with particular focus on power exhaust physics. Basic description of plasmas in general and its existence in nature. **Learning Outcomes** Basics of Nuclear Fusion processes in nature (stars) and as envisaged in magnetic confinement experiments. Van-Allen-Radiation Belt as an example of a natural magnetic cage. Basics of plasma motion for high temperature fusion plasmas in magnetic cages. Requirement of the magnetic confinement proper-ties to reach breakeven in fusion reactors. Detailed description of the physical goals of the European fusion program (‘Roadmap to fusion’) and physical goal of the international thermonuclear experimental reactor ITER.
Syllabus	• Magnetic confinement • Tokamaks, stellarators • Fusion plasma basics • Motion of charges particles in magnetic fields, fluid description of plasmas, drifts in electro-magnetic fields • Plasma heating • Plasma boundary physics • Basics of turbulent transport in the edge plasma • Power balance of fusion reactors

	• Requirement for commercial power plants, necessity for CO_2 free base load, socio-economic aspects of nuclear fusion, actual topics for fusion research • Special devices: ASDEX Upgrade, JET, ITER, Wendelstein-7X • Exercises to get more familiar with the content.
Literature	• Lecture Notes by F. Jenko and E. Poli • T.J.M. Boyd J.J. Sanderson, The Physics of Plasmas, CUP, 2003 • R.J. Goldston P.H. Rutherford, Plasmaphysik, Vieweg, 1998 • F.F. Chen, Plasma Physics, Springer, 1984 • R. Kippenhahn C. Möllenhoff, Elementare Plasmaphysik, BI, 1975 • P.M. Bellan, Fundamentals of Plasma Physics, CUP, 2008 • J. Freidberg, Plasma Physics and Fusion Energy, CUP, 2007 • R.M. Kulsrud, Plasma Physics for Astrophysics, PUP, 2004 • A. Yoshizawa S.-I. Itoh K. Itoh, Plasma and Fluid Turbulence, IoP Publishing, 2003 • P.H. Diamond S.-I. Itoh K. Itoh, Modern Plasma Physics, CUP, 2010 • I.H. Hutchinson, Principles of Plasma Diagnostics, CUP 2005 • C.K. Birdsall A.B. Langdon, Plasma Physics via Computer Simulation, IoP Publishing, 2004 • S. Jardin, Computational Methods in Plasma Physics, CRC Press, 2010
Teaching and learning methods	Lecture (3 hours per week)
Workload	40 hours lecture (attendance time) 80 hours self-study and exam preparation Total: 120 hours
Assessment	Oral examination. A prerequisite for the participation in the examination is an ungraded course achievement. Form and scope of the examination and of the course achievement are determined and notified by the lecturer at the beginning of the course.
Examination	12081 Plasma Physics: Applications
Grading procedure	The module grade is the examination grade.
Basis for	Research in the field of Plasma Physics