上海交通大学研究生课程开设申请表

New Graduate Course Application Form, SJTU

<table>
<tr><th colspan="6">课程基本信息 Basic Information</th></tr>
<tr><td rowspan="2">*课程名称
Course Name</td><td colspan="5">（中文 Chinese） 核工程材料</td></tr>
<tr><td colspan="5">（英文 English） Nuclear Engineering Materials</td></tr>
<tr><td>*学分
Credits</td><td>2</td><td>*学时
Teaching Hours</td><td colspan="3">32 （1 学分≥16 课时）</td></tr>
<tr><td>*开课学期
Semester</td><td>秋季
Fall</td><td>*时否跨学期
Cross-semester?</td><td>否</td><td colspan="2">跨 Spanning over 个 学期 Semesters。</td></tr>
<tr><td>*课程性质
Course Category</td><td>专业课
Major Course</td><td>*课程分类
Course Type</td><td colspan="3">全日制
Full-time</td></tr>
<tr><td>*授课语言
Instruction Language</td><td colspan="5">中文 Chinese</td></tr>
<tr><td>*成绩类型
Grade</td><td colspan="5">等级制 Letter Grade</td></tr>
<tr><td>*开课院系
School</td><td colspan="5">(050)材料科学与工程学院
School of Materials Science & Engineering</td></tr>
<tr><td>所属学科
Subject</td><td colspan="5"></td></tr>
<tr><td rowspan="2">负责教师
Person in charge</td><td>姓名 Name</td><td>工号 ID</td><td>单位 School</td><td colspan="2">联系方式 E-mail</td></tr>
<tr><td>沈朝</td><td></td><td></td><td colspan="2">952911809@qq.com</td></tr>
<tr><th colspan="6">课程扩展信息 Extended Information</th></tr>
<tr><td>*课程简介
(中文)
Course Description</td><td colspan="5">课程定位：本课程为重要的材料科学与工程专业选修课，课程以课堂授课为主，以学生研讨为辅，使学生了解主要核反应堆型材料的成分、晶体结构、微观组织结构与材料性能的关系，以及与核安全相关的选材原则。

教学目标：分类讲解核工程材料的种类以及其在严苛服役环境下的失效行为及机理，掌握预测结构材料服役寿命、改善反应堆运行条件以及开发新型核工程材料的基础知识。学生大作业及研讨内容包括先进燃料、事故容错燃料材料、先进核反应堆安全相关关键材料技术的发展趋势及研究方法，使学生学会从现象分析问题的本质，抓住问题背后的科学问题，将所学到的核工程材料学知识运用到核工业实践过程。

主要内容：课堂重点介绍先进压水堆主要设备所用的材料及其性能特点，掌握有机、无机氧化物、金属等工程材料在γ射线和快中子辐照条件下的辐照损伤机理、金属材料在高温高压水环境下的腐蚀机理，了解核燃料、包壳材料、堆内构件、反应堆压力容器、主冷却剂管道、蒸汽发生器传热管等核电厂主要设备及部件的选材原则、失效机理、防范措施等知识。

先修课程：《材料科学基础》</td></tr>
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*课程简介
（English）
Course Description

Course Positioning: This course is an important elective in the field of materials science and engineering, primarily lecture-based with supplemental student seminars. It aims to familiarize students with the composition, crystal structure, microstructure, and the relationship between these aspects and the material properties of main nuclear reactor types, as well as the material selection principles related to nuclear safety.

Educational Objectives: The course categorically explains the types of nuclear engineering materials and their failure behaviors and mechanisms under harsh service conditions. It provides foundational knowledge for predicting the service life of structural materials, improving reactor operating conditions, and developing new nuclear engineering materials. The major student projects and seminar topics include advanced fuels, accident-tolerant fuel materials, and the trends and research methods in critical material technologies related to advanced nuclear reactor safety. This enables students to analyze the essence of phenomena, grasp the underlying scientific issues, and apply the knowledge of nuclear engineering materials learned to the practical processes of the nuclear industry.

Main Content: The course emphasizes the materials and their performance characteristics used in major equipment of advanced pressurized water reactors, mastering the mechanisms of radiation damage under gamma rays and fast neutron irradiation conditions for organic, inorganic oxides, and metals. It also covers the corrosion mechanisms of metal materials under high-temperature and high-pressure water environments. Additionally, it addresses the material selection principles, failure mechanisms, and preventive measures for main nuclear power plant equipment and components such as nuclear fuel, cladding materials, in-core components, reactor pressure vessels, primary coolant pipes, and steam generator heat transfer tubes.

Prerequisite Course: "Fundamentals of Materials Science"

*教学大纲
(中文)
Syllabus

章节	主要内容	课时数	教学方式	章节是否有课程思政内容。如有，请详述
1. 绪论	核电站材料问题及挑战	2	课堂教学	结合我国核电技术从落后到完全自主研发大型先进压水堆“华龙一号”的发展历程，鼓励学生向早期的国内核电领军人才去学习，要学会志存高远的同时去脚踏实地的解决国家当前面临的卡脖子问题。
2. 材料的性质	材料的机械、物理、化学性质	2	课堂教学	
3. 核燃料材料	分类和特征、UO2 燃料的堆内行为、耐事故燃料	2	课堂教学	
4. 燃料包壳材料	锆合金及合金化原理、包壳堆内性能、耐事故包壳	6	课堂教学	
5. 压力容器材料	主要部件、性能要求、异种材料焊接	2	课堂教学	
6. 堆内构件和蒸发器材料	选材标准、失效行为	2	课堂教学	
7. 控制材料	冷却剂、慢化剂、反射层材料	2	课堂教学	
8. 材料的	辐照损伤机理、	6	课堂教学	

	辐照损伤	微观结构、性能变化			
	9. 材料的腐蚀与防护机理	均匀腐蚀、点蚀、晶间腐蚀、应力腐蚀、流动加速腐蚀、氢脆、磨蚀、腐蚀防护机理	8	课堂教学	

*教学大纲 (English) Syllabus

Chapter	Main Contents	Hours	Teaching Style	Whether there is ideological and political content
1. Introduction	Material Issues and Challenges in Nuclear Power Plants	2	Classroom teaching	Combining the development history of our country's nuclear power technology from lagging behind to the completely independent development of the large advanced pressurized water reactor 'Hualong One', students are encouraged to learn from the early domestic nuclear power leaders. They should aim high while also addressing the pressing 'bottleneck' issues that the nation currently faces.
2. Properties of Materials	Mechanical, Physical, and Chemical Properties of Materials	2	Classroom teaching	
3. Nuclear Fuel Materials	Classification and Characteristics, In-core Behavior of UO2 Fuel, Accident Tolerant Fuel	2	Classroom teaching	
4. Fuel Cladding Materials	Zirconium Alloys and Alloying Principles, In-core Performance of Cladding, Accident Tolerant Cladding	6	Classroom teaching	
5. Pressure Vessel Materials	Main Components, Performance Requirements, Dissimilar Material Welding	2	Classroom teaching	
6. In-core Components and Evaporator	Material Selection Criteria, Failure	2	Classroom teaching	

	Materials	Behavior			
	7. Control Materials	Coolant, Moderator, and Reflector Materials	2	Classroom teaching	
	8. Irradiation Damage of Materials	Mechanisms of Irradiation Damage, Microstructure, Performance Changes	2	Classroom teaching	
	9. Mechanisms of Material Corrosion and Protection	Uniform Corrosion, Pitting Corrosion, Intergranular Corrosion, Stress Corrosion, Flow-Accelerated Corrosion, Hydrogen Embrittlement, Erosion, Corrosion Protection Mechanisms	8	Classroom teaching	
*课程要求（中文）Requirements	本课程主要从出勤率和论文两个维度来考察学生对本课程的掌握程度，学生如果平时出勤率低于 80%以及期末论文不合格均被视为未通过本课程的学习。				
*课程要求（English）Requirements	The students are examined in two dimensions of attendance and thesis, if the usual attendance rate is less than 80% and the final paper is not passed, students are considered to have failed the course.				
课程资源（中文）Resources	《核反应堆材料》，主编：周邦新				
课程资源（English）Resources	“Nuclear Engineering Materials”, edited by Bangxin Zhou				
备注 Note					