机械与动力工程学院博士生资格考试笔试大纲

Syllabus of Ph.D. Qualification Examination (SJTU-ME)

<table>
<tr><td rowspan="2">*笔试主题
Exam Topic</td><td>（中文）固体力学</td></tr>
<tr><td>（English）solids Mechanics</td></tr>
<tr><td>*考核形式
Exam Format</td><td>闭卷考试，1 小时
Closed-book exam, 1 hour</td></tr>
<tr><td>*考核目标
Exam Target</td><td>固体力学是是机械结构强度分析、机械设计、机械加工制造等领域的重要基础，相关方向博士生应具备基本的固体力学常识和基础分析方法。
考试主要考察学生对与机械工程相关固体力学基础知识的掌握程度，包括学生对固体受力、变形、失效等行为及机制的理解，和利用力学方法解决机械领域简单问题的能力。为博士生资格评价提供参考。
Solid mechanics is an important foundation in the fields of mechanical strength analysis, mechanical design, machining and manufacturing, etc. Doctoral candidates in related fields should have the fundamental knowledge of solid mechanics and the basic analysis methods.
The examination mainly focuses on the students' mastery of the basic knowledge of solid mechanics, especially the one related to mechanical engineering, including:
Understanding of the solid behaviors and mechanisms of loading, deformation and failure.
, Ability to use solid-mechanics methods and theories to solve simple problems in the mechanical engineering field.
The exam is expected to provide reference for the doctoral qualification evaluation.</td></tr>
<tr><td>*考核内容
Exam Contents</td><td>1、应力应变基础知识
• 掌握应力应变的定义、计算和初步分析；
• 掌握主应力/应变、正八面体应力/应变、最大剪应力/应变、任意截面正应力与切应力的定义和计算；
2、弹塑性基础知识：
• 掌握线性弹性力学本构、平衡、几何等弹性力学基本方程，能够运用位移法或应力法求解简单具有边界条件的弹性力学平面问题；
• 掌握 Tresca、Mises 屈服准则，了解其与最大切应力、正八面体应力的联系，能够判断某种应力状态下是否失效；了解刚塑性、理想弹塑性、幂指数硬化等硬化规律；
3、断裂力学基础知识：
• 了解韧性断裂、脆性断裂、疲劳断裂基本知识及原理；
• 掌握线弹性断裂力学基本知识，能够计算不同情况下的应力强度因子，掌握安全因子、最大裂纹长度、最大许用应力等的计算方法；掌握压力容器“先漏后裂”LBB 准则及计算方法，了解塑性影响区的概念，并能够根据给定公式判断线弹性断裂理论的可应用性。
• 掌握疲劳断裂 SN 曲线，掌握疲劳安全因子的计算，能够估</td></tr>
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	算平均应力变化下的疲劳寿命，掌握疲劳切口因子与应力集中系数，能够根据给定公式估算给定切口下的疲劳寿命、最大许用应力等； 4、粘弹性力学基础知识： • 了解应力松弛与蠕变的基本概念 • 能够利用 Maxwell 模型和 Kelvin 模型的结合描述简单力学单元的线性粘弹性力学行为； 5、*损伤力学基础知识： • *了解损伤失效的过程，了解连续体损伤模型和细观损伤模型的基本原理； 6、多尺度力学模型基础知识： • 了解固体力学行为的多尺度本质； • *了解分子动力学仿真的基本原理； • 了解位错的基本概念及其与宏观变形行为的联系； • *了解晶体结构与滑移系的联系，了解晶体塑性力学的基本概念和方法。 1. Stress and strain • Definition, preliminary analysis of stress and strain; • Principal stress/strain, octahedral stress/strain, maximum shear stress/strain, normal stress and shear stress in any section. 2. Basic knowledge of elastoplasticity: • Basic equations of linear elasticity. • Using displacement or stress method to solve plane problems of elasticity with simple boundary conditions; • Principal stress/strain, octahedral stress/strain, maximum shear stress/strain, normal stress and shear stress in any section; • Tresca and Mises yield criteria and their relationship with the maximum shear stress and octahedral shear stress • Hardening laws of rigid plasticity, ideal elastoplasticity, power exponent hardening, etc. 3. Basic knowledge of fracture mechanics: • Fundamentals of ductile fracture, brittle fracture and fatigue; • Linear elastic fracture mechanics: Calculating the stress intensity factor, safety factor, maximum crack length, maximum allowable stress, etc. under different conditions; Using the Leak-Before-Broken criterion for pressure vessels design, plastic influence zone, etc. • S-N curve: Calculate the fatigue safety factor, estimate the fatigue life under different average stresses • Fatigue notch factor and stress concentration factor: estimate the fatigue life and maximum allowable stress under the given notch lengths according to the given formula. 4. Basic knowledge of viscoelastic mechanics:

	• The basic concepts of stress relaxation and creep. • The combination of Maxwell model and Kelvin model to describe the linear viscoelastic mechanical behavior of simple viscoelastic elements. 5. * basic knowledge of damage mechanics: • *Continuum damage and meso damage mechanics. 6. Basic knowledge of multi-scale mechanical model: • The multi-scale nature of solid mechanical behavior; • *fundamentals of molecular dynamics simulation; • *fundamentals of dislocations and their relationship with macroscopic deformation behavior; • crystal structure and slip systems. • Basic concepts of crystal plasticity.
*参考书目 References	材料学科中的固体力学，陈昌麒主编，北京航空航天大学出版社。 Mechanical Behavior of Materials: Engineering Methods for Deformation, Fracture, and Fatigue (2nd Edition), Pearson College Div, ISBN-13: 978-0139057205. 损伤力学，余寿文主编，清华大学出版社。 INTEGRATED COMPUTATIONAL MATERIALS ENGINEERING (ICME) FOR METALS: Using Multiscale Modeling to Invigorate Engineering Design with Science. Mark F.Horstemmeyer, John & Wiley & Sons, Inc.
备注 Notes	