Strength of Materials 3

Syllabus Number 1E301
Special Subjects
Elective 2 credit

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1. Course Description

In this course, the following topics are taught;
(1) Stress and strain tensors
(2) Basis of finite elements method; Basis of linear elastic fracture mechanics
(3) Physical meaning and mathematical expression of plastic deformation
(4) Simple problems for elastic-plastic body
(5) Yield criterion; Basis of constitutive equation for elastic-plastic body

2. Course Objectives

The objective of the course is to provide students with a basic understanding of mechanics for elastic-plastic solids.

3. Grading Policy

Your overall grade in the class will be decided based on followings:
- Term-end examination (60%)
- Report (20%)
- Mini tests in the lessons (20%)

Retest will not be arranged except the case of absence of Term-end exam due to reasonable reason.
We will give feedback by returning the previous exercise question and comment on the answer during class.

4. Textbook and Reference

Textbook
Yoshida Soshito Foundations of Elasticity and Plasticity
Kyoritsu Shuppan (1997) ISBN 4-320-8114-5
Reference
Seiichiro Seike Strength of Materials Kyoritsu Publishing (1997) ISBN 978-4-320-08117-8
Goichi Nabe et al. Standard Mechanics of Materials Nikkan Kogyo Shimbun (2001) ISBN 4-526-047-19-8

5. Requirements(Assignments)

Students should carefully review the contents learned in "Strength of Materials 1" and "Strength of Materials 2" during the second year. If you do not take these course or equivalent ones, learning the fundamentals of the courses by yourself is required.
Please read the relevant pages of the textbook before each lesson and confirm the relationship between the one and the contents of the last lesson. (1 hour)
As a review, you can solve the problem explained during the lesson and you can answer the task in the handouts and the analogy of the text. (2 hours)
As the preparation learning for first lesson, review the stress-strain curves of metal materials and definition formula of stress and strain. Please summarize the difference between elastic deformation and plastic deformation and write it down into one A4 size paper. (See the text of "Material Dynamics 1" (see p.1-9 of "Strength of Materials" written by Masaichiro Seike, Kyoritsu Shuppan (1997)))
Detailed preparation will be instructed in the class.

6. Note

We will do problem exercises during the class, so be sure to bring a scientific calculator. Please learn how to calculate exponent, logarithm, trigonometric function values using a calculator beforehand. A calculator is also required for the Term-end examination.

7. Schedule

[1] What is elastic-plastic mechanics of materials?: Elasticity and plasticity, Elastic-plastic mechanics of materials, Application of plasticity
[2] Tensile test and elastic-plastic mechanics of materials: True stress and true strain, Stress-strain curve, Strain hardening law
[3] Stress and strain 1: Stress tensor, Cauchy's Relation
[4] Stress and strain 2: Coordinate transformation of stress
[5] Stress and strain 3: Principal stress, Invariant of stress, Strain tensor
[6] Introduction to finite element method 1: What is finite element method?, Element and node, Stifness equation, Boundary condition
[7] Introduction to finite element method 2: Stress and strain analysis, Example of finite element analysis
[8] Plastic Deformation and Plastic Dynamics: Physical meanings of plastic deformation, Mechanical behavior of plastic deformation
[9] Elastic-plastic problem in tension/compression: Loading/unloading and reloading, Residual stress, Bauschinger's effect
[10] Simple elastic-plastic problem 1: Bending of elastic-plastic beam, Springback
[11] Simple elastic-plastic problem 2: Torsion of elastic-plastic rod
[12] Yield criteria 1: Deviatric stress, Yield criteria of Mises, Yield criteria of Tresca

[13] Yield criteria 2: Yield surface, Equivalent stress, Comparison between yield criteria and experiment results

[14] Elastic-Plastic Constitutive Equations: Elastic-Plastic Stress-Strain Relations, Strain Increment Theory, Total Strain Theory, Expression of Work Hardening

[15] Overall summary and exam