2025 年度シラバス

科目分類/Subject Categories				
学部等/Faculty	/工芸科学部 : /School of Science and	今年度開講/Availability	/有:/Available	
	Technology			
学域等/Field	/設計工学域 : /Academic Field of	年次/Year	/3年次:/3rd Year	
	Engineering Design			
課程等/Program	/機械工学課程・課程専門科目 :/Specialized	学期/Semester	/前学期:/First term	
	Subjects for Undergraduate Program of			
	Mechanical Engineering			
分類/Category	/:/	曜日時限/Day & Period	/金 2 : /Fri.2	

科目情報/Course Information					
時間割番号	12315201				
/Timetable Number					
科目番号	12360039				
/Course Number					
単位数/Credits	2				
授業形態	講義:Lecture				
/Course Type					
クラス/Class					
授業科目名	塑性力学:Engineering Pl	asticity			
/Course Title					
担当教員名	/飯塚 高志:IIZUKA Tak	ashi			
/ Instructor(s)					
その他/Other	インターンシップ実施科	国際科学技術	ドコース提供	PBL 実施科目 Project	DX 活用科目
	目 Internship	科目 IGP		Based Learning	ICT Usage in Learning
	実務経験のある教員によ				
	る科目				
	Practical Teacher				
科目ナンバリング	B_ME3420				
/Numbering Code					

授業の目的・概要 Objectives and Outline of the Course

- 日 塑性変形における力学的挙動を支配する応力,ひずみ,三軸応力状態,流動曲線,体積一定則,降伏条件および流れ則を理解するとともに,荷重-変位の関係,マルチプロセスの進行に伴うひずみ・応力経路および塑性仕事量などの工学的な塑性挙動の考え方を修得できるようにする。これらの知識は金属材料,および生産技術として広く用いられている塑性加工に関する理解のために重要である。設計開発はもちろん,特に生産技術の分野において必要な知識である。
- 英 Students are requested to understand the basic concepts and equations such as stress, strain, tri-axial stress state, flow curve, volume constancy, yield criteria and flow rule that are essential in understanding plastic deformation. Furthermore, students are also expected to understand the methodology for grasping load-stroke relationship, strain- and stress paths in multi-processes and plastic work.

学習の到達目標 Learning Objectives

- 日 応力、ひずみ、ひずみ増分、静水圧、体積ひずみ、体積ひずみ増分、偏差応力、偏差ひずみ、偏差ひずみ増分など塑性力学における応力、ひずみの考え方および求め方を理解する。
 - 体積一定則,加工硬化,流動曲線,降伏条件,流れ則など塑性力学における材料特性および力学的関係式について理解する. 三軸応力状態,変形と形,比例負荷,比例変形など塑性変形挙動や塑性加工プロセスの表現手法について理解する.
 - 単一のプロセス(比例変形)における荷重-変位の関係、最大荷重、相当ひずみ量および塑性仕事量などを導出し、単一プロセスの評価ができる。
 - マルチプロセスにおけるひずみ・応力経路,形状変化,必要荷重,塑性仕事量などを導出し,マルチプロセスの評価ができる.
- 英 To understand the way of thinking and acquiring for stress and strain parameters like stress, strain, strain increment, volume strain, volume strain increment, deviatoric stress, deviatoric strain, deviatoric strain increment etc. in fundamentals of plast

Understanding material properties and mechanical relationships like volume constancy, work hardening, flow curve, yield criteria, flow rule etc. in fundamentals of plasticity.

Understanding expressions for plastic deformation behaviors and plastic forming processes like tri-axial stress state, differences between deformation and shape, proportional loading, proportional deformation etc. .

Being able to evaluate an uni-process, in other words proportional deformation, through acquiring load-stroke relationship, maximum load, equivalent strain, amount of plastic work etc..

Being able to evaluate a multiple-process through acquiring strain- and stress- paths, change of shape, necessary load, amount of plastic work etc..

学習目標の達成度の評価基準 / Fulfillment of Course Goals (JABEE 関連科目のみ)

日 塑性力学における基礎的事項および塑性変形挙動や塑性加工プロセスの表現手法について十分に理解し、一工程および多工程の 塑性加工プロセスを十分に評価できる.

塑性力学における基礎的事項および塑性変形挙動や塑性加工プロセスの表現手法について理解し、一工程および多工程の塑性加工プロセスの評価の一部ができる.

塑性力学における基礎的事項および塑性変形挙動や塑性加工プロセスの表現手法について一部を理解できているが、プロセスの評価ができない.

塑性力学における基礎的事項および塑性変形挙動や塑性加工プロセスの表現手法について理解できていない。

英 Able to comprehend fundamentals of plasticity and expressions for plastic deformation behaviors and for plastic forming processes enough, and to evaluate plastic forming processes enough.

Comprehending fundamentals of plasticity and expressions for plastic deformation behaviors and for plastic forming processes, and able to evaluate parts of plastic forming processes.

Comprehending parts of fundamentals of plasticity and expressions for plastic deformation behaviors and for process for plastic works, but unable to evaluate plastic forming processes enough.

Unable to comprehend fundamentals of plasticity and expressions for plastic deformation behaviors and process for plastic works.

授業	授業計画項目 Course Plan		
No.		項目 Topics	内容 Content
1	日	塑性力学の概要	講義のオリエンテーションと塑性力学の基礎理論の体系に関する概略の説明を行う.
	英	Review on fundamental theory	Orientation about this lecture and review on fundamental theory of plasticity will be
		of plasticity	conducted.
2	日	金属材料の変形, 弾性と塑性	金属材料の一軸引張りにおける応力とひずみの関係の説明から始めて原子レベルの金
			属の構造と弾性変形および塑性変形の素過程について解説する.
	英	Deformation of metals,	At first, stress-strain relationship in uni-axial tension of metals will be reviewed. And
		elasticity and plasticity	metallic structure in atomic scale, elementary processes to bring about plasticity and
			elasticity of metals will be explained.
3	日	応力-ひずみ曲線と体積一定の	金属材料の一軸引張試験について応力とひずみ線図の求め方および変形挙動との関係
		関係	について説明する.また,対数ひずみの特徴についてまとめ,体積一定の関係について
			説明する.
	英	Stress-strain curves and	In relation to uni-axial tensile test of metals, some methods to obtain stress-strain
		volume constancy law	curves, and variations of deformation behavior in the test will be instructed.
			Furthermore, features of the logarithmic strain will be summarized.
4	日	流れ曲線と塑性不安定	流れ曲線について説明し,荷重‐変位の関係と塑性不安定点を導出する.これまでに学
			習した内容に関する課題1を提示する.
	英	Flow curve and plastic	Meaning of the flow curve will be explained. The point where plastic instability is
		instability	occurred will be calculated using a stress-strain curve. Finally, the first report will be
			imposed in order to deepen comprehension on contents learned through lectures $\boldsymbol{1}$
5	日	まとめ1	これまでに学習した内容に関して出題された課題1について,考え方を解説する.
	英	Summary 1	Summary 1
6	日	モールの応力円と主応力	二次元もしくは主応力面内の方向による応力成分の変化について,モールの応力円を用
			いて特徴を理解する.また,方向余弦と行列表記を用いることで考え方を三次元に拡張
			する.主応力,主せん断応力,応力不変量など塑性力学の基礎になる事項について解説
			する.

### principal stresses, principal shear stressesses (circle. ### principal stressesses (circle.) ### principal stressesses (circle.) ### principal stressesses (circle.) ### principal stresses (circle.) ### principal stressesses (circle.) ### principal stresses (circle.) ### principal stressesses (circle.) ### principal stresses (circle.) ### principal stress (circle.)		英	Mohr's stress circle and	Understanding for features and variation depending on direction in 2D stresses or in
Shear stresses		^		
日				
大説明する。	7	н		
### Fundamental parameters for theory of plasticity like infinitesimal strain increment infinitesimal strain increment will be explained. ### T 学的微小ですみと モールの	,	П		
Infinitesimal strain increment And strain increment will be explained.		苗	Infinitesimal strain and	
日 工学的微小ひずみと モールの		大		
グザみ円 関係(フックの法則)から応力と弾性がすみの対応および弾性定数間の関係を説明す 大変 Engineering infinitesimal strain and Mohr's strain circle is derived from coordinate transformation of engineer infinitesimal strain and Mohr's strain circle is derived from coordinate transformation of relationships during elastic moduli are explained. 9 日 ひずみ増分と座標変換、有限 ひずみ (対数のずみ) ひずみ増分テンソルの性質を確認し、その座標変換について説明する。また、偏差のみを導入し、偏差成分のフックの法則を導く、主応力空間における偏差応力の意味にして考える。 英 Coordinate transformation of strain increment and finite strain increment and finite strain increment and finite strain 10 日 降伏条件と 相当応力・相当 ひずみ でははないまないではいまないでは、活動画線の意味について考える。でする。 Yield criteria and equivalent strain stress, equivalent strain increment stress, equivalent strain increment and meaning of deviatoric strain in principal stress space are explained. In relation to the Mises' criterion, the equivalent stress and the equivalent strain be calculated and defined. 11 日 流れ則と塑性仕事量 現象論的考察からレービー・ミーゼスの関係を導き、その性質について考える。 活動線と塑性仕事量の関係について影ける。 流動曲線の滑を導き、その性質について考える。 活動線と塑性上乗車の関係について影ける。 流動曲線の滑をできる。 で学習した内容に関する。 流動曲線の滑をでする、 で学習した内容に関する。 流動曲線の潜みに関する、 流動曲線の潜みに関する。 でで学習した内容に関する場合は、 11、will be outlined. 12 日 まとめ2 これまでに学習した内容に関して出環された課題とについて、考え方を解説する。 それまでに学習した内容に関する。 表面が表面を含めら考察から、 流動曲線や潜伏条件の持つ性質について考える。 後藤隆代園 現底からの考察から、 流動曲線や潜伏条件の持つ性質について考える。 後藤隆代園 現底のいて解説する。 大力経路の場合に、 11、will be outlined. 13 日 関連流れ則と硬化則 レービー・ミーゼスの関係は、 降代関数を用いた関連流れ則に一般化される。 接続階段 関連流がりまる。 11、will be outlined. 13 日 関連流れ則と硬化則 レービー・ミーゼスの関係に、 12、変数ののでは、 13、変数ののでは、 13、変数ののでは、 13、変数ののでは、 14、変数ののでは、 14、変数ののでは、 14、変数ののでは、 14、変数ののでは、 14、変数ののでは、 1	Q			·
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日			Strain and Moni 3 Strain Circle	
### Propropersistance	a		7. ずみ増分と広煙亦換 右限	
下で考える。	3	н		
英Coordinate transformation of strain increment and finite strain increment and finite strain increment and finite strainFeature of strain increment tensor is confirmed, and coordinate transformation or is discussed. Deviatoric strain is introduced, and Hook's law for deviator components and meaning of deviatoric strain in principal stress space are explain.10日降伏条件と 相当応力・相当ひ すみ所伏条件および相当応力、相当ひずみについて説明する。流動曲線の意味について考える。できないできる。支Yield criteria and equivalent stress, equivalent strain be calculated and defined.The yield criterion proposed by Tresca and by Mises will be explained, respective in relation to the Mises' criterion, the equivalent stress and the equivalent strain be calculated and defined.11日流机則と塑性仕事量現象論的考察からレービー・ミーゼスの関係を導き、その性質について考える。流動線と塑性仕事量の関係について説明する。深題2を提示する。英Flow rule and plastic workThe flow rule proposed by Levy and Mises will be explained, and relationship between the plastic work and the flow curve is considered. Furthermore, features of the flow curve is considered. Furthermore, features of the flow curve is considered. Furthermore, features of the flow curve is also considered. Finally, the second report will be imposed in order to dee curve is also considered. Finally, the second report will be imposed in order to dee curve is also considered. Finally, the second report will be imposed in order to dee curve is also considered. Finally, the second report will be imposed in order to dee curve is also considered. Finally, the second report will be imposed in order to dee curve is also considered. Finally, the second report will be imposed in order to dee curve is also considered. Finally, the second report will be imposed in order to dee curve is also considered. Finally, the second report will be imposed in order to dee curve is also considered.13日財産流列を開発していて考える。			0 9 ° / (x) x (0 9 ° /)	
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おける応力およびひずみ経路の導出について考える.これまでに学習した内容に関す	14	日	応力経路と ひずみ経路	応力経路とひずみ経路について、深絞り加工を例に説明する. 比例負荷と比例ひずみ経
理題3を提示する				おける応力およびひずみ経路の導出について考える.これまでに学習した内容に関する
·····				課題 3 を提示する.
		英		The proportional loading paths and the proportional strain paths will be explained
			forming process	relating to the multiple processes for metal forming. Furthermore, the forming limit
diagram which is used mainly in the field of cheet metal forming will be also eval				diagram, which is used mainly in the field of sheet metal forming, will be also explain
	15	日	まとめ3	これまでに学習した内容に関して出題された課題 3 について,考え方を解説する.
15 日 まとめ 3 これまでに学習した内容に関して出題された課題 3 について、考え方を解説する.		英	Summary 3	Points to solve the last report, which is related to contents learned in the whole
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理題3を提示する				おける応力およびひずみ経路の導出について考える.これまでに学習した内容に関する
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履修条件 Prerequisite(s)

日 「材料力学 | 及び演習」,「材料力学 || 及び演習」,「工業材料学」,「材料強度学」および「機械構造解析学」を履修していることが望ましい.

You are required to have knowledge on mechanics of materials. So, it's desirable that you have already taken the course of "Strength of Materials", "Engineering Materials", "Fracture and Strength of Materials" and "Theory of Structural Analysis of Machine".

授業時間外学習(予習・復習等)

Required study time, Preparation and review

- 日 講義は、基礎から応用へと進展する内容となっているため、継続的な講義の聴講が重要である。本講義に対しては、少なくとも 67.5 時間の予復習に充てる自己学習時間が必要である。したがって、予習および復習を強く励行し、そのための補足資料および 補足課題を用意する。
- Because this course goes from fundamentals to applications, it is important for you to attend the class continuously. In addition, total 67.5 hours of preparation and reviewing time are at least necessary for your comprehending the contents of this course.

教科書/参考書 Textbooks/Reference Books

- 日 特定の教科書は使用しない. その代わりに, 講義資料とその補足資料,および補足課題を用意するので, 利用して欲しい. 参考書「改訂工業塑性力学」(益田森治, 室田忠雄共著, 養賢堂).
- 英 No specific textbooks are used. In stead of that, some materials and supplementary materials, supplementary issues are prepared and provided through the moodle system.
 - "Kogyo Sosei Rikigaku", which was written by M. Masuda and T. Murota and published fr

成績評価の方法及び基準 Grading Policy

- 日 講義内容ごとの理解の程度を確認するために、複数回(通常3回)のレポートを課す。また、最終的な理解度を確認するために 学期末に筆記試験を行う。配点比率はレポート(30%)、筆記試験(70%)である。合計100点中で60点以上を合格とする。た だし、補足課題に関する取り組みに応じて積極性を評価し、積極性の高い学生には補点を与える。
- 英 In order to grasp the extent of comprehension for each lecture, multiple reports, which are usually four times, will be imposed. Furthermore, a term-end exam will be also conducted to evaluate the final understanding on theory of plasticity. Weight in the

留意事項等 Point to consider

- 日 講義は原則として対面形式で実施する。資料の配布等に Moodle を利用することがある。
 - 学習・教育目標 B(3)(a)に対応する科目であり、達成度評価の対象である。
- 英 This course is ordinary opened in lecture room only. Moodle system is often used for distributing materials related to lectures and so on.
 - Study and education target B(3)(a).