Tsuyama College	Year	2021	Course Title	Applied Creative Engineering

Course Information

Course Code	0017	Course Category	Specialized / Elective
Class Format	Lecture	Credits	Academic Credit: 2
Department	Advanced Mechanical and Control System Engineering Course	Student Grade	Adv. 1st
Term	First Semester	Classes per Week	2
Textbook and/or Teaching Materials	Textbooks: Koichi TAGUCHI, Goji AKASHI "Precision Machining (Mechanical Textbook Series 16)" (Corona Publishing) Reference: Toyoji ITO "Essence of Ultra-Precision Machining" (Nikkan Kogyo Shimbun) explains from the perspective of know-how at production sites. "Principles of Production Processing" edited by the Japan Society of Mechanical Engineers (Nikkan Kogyo Shimbun) explains overall production processing from a comprehensive and principle perspective. For beginners to learn about machine manufactring in general, Hiromichi ONIKURA "Introduction to Machine Manufacturing" (Yokendo) is easy to read.		
Instructor	KONISHI Daijiro		

Course Objectives

Learning purposes :
To deepen the basic knowledge about ultra-precision machining by thinking about machine tools, cutting tools, machining processes and their technologies for high-precision machining.

Course Objectives :
1. Consider the fields of application of precision machining and ultra-precision machining and their social implications.
2. Understand the definition of ultra-precision machining and knowledge about precision machining, and consider measures for high-precision machining.
3. Reconfirm basic knowledge about machining and machine tools.
4. Understand the element design technology of machine tools and tool technology for ultra-precision machining.
5. Understand the metal cutting mechanism.
6. Understand the characteristics of cutting / grinding / polishing and understand the challenges for ultra-precision machining.
7. Understand the machining process of composite machining and gain knowledge about application examples to ultra-precision machining.

Rubric

	Excellent	Good	Acceptable	Unacceptable Level
Achievement 1	Describe the fields of application of precision machining and ultra-precision machining and their social implications.	Explain the fields of application of precision machining and ultra-precision machining and their added value.	The fields of application of precision machining and ultra-precision machining and their added value can be generally said.	Can not say the fields of application of precision machining and ultra-precision machining.
Achievement 2	Understand the definition of ultra-precision machining and knowledge about precision machining, and be able to evaluate and consider guidelines for precision machining.	Be able to understand and classify the difference between normal machining / ultra-precision machining / micromachining from the relationship between the machining unit and the size of the tool.	From the relationship between the machining unit and the size of the tool, the difference between normal machining / ultra-precision machining / micromachining can be roughly said.	From the relationship between the machining unit and the size of the tool, the difference between normal machining / ultra-precision machining / micromachining can not be said.
Achievement 3	Explain the characteristics of various machining methods by classifying them from the viewpoint of changes in the mass of the workpiece. Explain that the machine tools are designed based on displacement. Explain the relationship between machine tools, cutting tools, and workpieces.	Explain the characteristics of various machining methods by classifying them from the viewpoint of changes in the mass of the workpiece. Explain that the machine tools are designed based on displacement.	Explain the characteristics of various machining methods by classifying them from the viewpoint of changes in the mass of the workpiece.	Can not explain the characteristics of various machining methods by classifying them from the viewpoint of changes in the mass of the workpiece.
Achievement 4	Explain the element design technology of machine tools and cutting tool technology, phenomena and models of removal process, and evaluate and consider measures for precision machining.	Explain the element design technology of machine tools and cutting tool technology, phenomena and models of removal process.	Can be said the element design technology of machine tools and cutting tool technology, phenomena and models of removal process.	Can not be said the element design technology of machine tools and cutting tool technology, phenomena and models of removal process.
Achievement 5	Understand the characteristics of cutting / grinding / polishing from the processing principle, and evaluate and explain methods and issues for ultra-precision processing.	Explain the characteristics of cutting / grinding / polishing from the processing principle.	From the processing principle, the characteristics of cutting / grinding / polishing can be generally said.	From the processing principle, the characteristics of cutting / grinding / polishing can not be said.

Achievement 6	Understand the machining process of cutting / grinding / polishing, explain application examples to ultra-precision machining, and evaluate and consider issues of ultra-precision machining technology.	Understand the machining process of cutting / grinding / polishing, explain application examples to ultra-precision machining.	Understand the machining process of cutting / grinding / polishing, and can generally say about application examples to ultra-precision machining.	Can not understand the machining process of cutting / grinding / polishing, and can not say about application examples to ultra-precision machining.
Achievement 7	Understand the machining process of composite machining and explain the knowledge about application examples of ultra-precision machining.	Understand the machining process of composite machining and explain application examples of ultra-precision machining.	Explain the application example of composite machining to ultra-precision machining.	Can not explain the application example of composite machining to ultra-precision machining.

Assigned Department Objectives

Teaching Method

Outline	General or Specialized : Specialized Field of learning : Design and production / management Foundational academic disciplines : Engineering／Mechanical engineering／Production Engineering/Processing Studies Relationship with Educational Objectives : This class is equivalent to (2) Acquire knowledge in specialized technical fields such as materials and structure, motion and vibration, energy and flow, information and measurement / control, design and production / management, and machines and systems, and can be used for designing, manufacturing, and operating machines and systems. Relationship with JABEE programs The main : The main goals of learning / education in this class is (A), A－2 . Course outline : Precision and ultra-precision machining technologies play an important role in modern science and technology, and are evolving and developing complementarily with other peripheral technologies. In this lecture, we will give an overview of the features and mechanisms of precision and ultra-precision machining technologies, mainly for cutting and abrasive machining, and learn about their roles in advanced technologies.
Style	Course method : Classes will be conducted using a projector. We will proceed with the lessons while confirming the knowledge about machining and machine tools that we have acquired so far. In addition, in order to deepen understanding, exercises will be imposed at appropriate times while considering the progress of the lesson. Grade evaluation method : The results of the two regular exams are evaluated equally (70%). For each examination, textbooks are allowed. Students who score less than 60 points in each examination may have their scores changed if their understanding is confirmed through make-up exams and retests. However, the score after the change will not exceed 60 points. Evaluation is also based on exercises and reports (30%).
Notice	Precautions on the enrollment : Students must be completed (no more than 1/3 of the required numbers of class hours may be missed). This subject is a "subject that requires study outside of class hours". Classes are offered for 15 credit hours per credit, but 30 credit hours are required in addition to this. Follow the instructions of your instructor for these studies. Course advice : This is a subject that requires knowledge of machining and machine tools that have been learned so far. Therefore, as a preparatory study to be conducted in advance, it is recommended to look back on the knowledge about machining and machine tools learned in your department. Students from other than Mechanical Systems are required to review mechanics and self-learn what students gratuated from Mechanical Systems have learned in Manufacturing Technology, Mechanical Design, and Strength of Materials. Foundational subjects : Design of Mechanical Elements I, II (Mechanical 3rd, 4th year),Manufacturing Technology (Mechanical 2nd), Instrumentation Engineering (Mechanical 4th)), Material Processing (Mechanical 5th), etc. Related subjects : Experiments of Mechanical and Control Systems (Advanced Course 1st), Advanced Design Engineering (Advanced Course 1st), etc. Attendance advice : Based on the knowledge learned in this department, comprehensively consider the knowledge of element technology in machine tools, cutting tool technology, machining technology, control / measurement technology for improving machining accuracy. You can be late for up to 25 minutes, and if you exceed this, you will be considered absent.

Characteristics of Class / Division in Learning

☐ Active Learning	☐ Aided by ICT	☑ Applicable to Remote Class	☐ Instructor Professionally Experienced

Elective subjects

Course Plan

			Theme	Goals

1st Semester	1st Quarter	1st	Guidance, Products to which the ultra-precision machining method is applied Learning contents outside class hours [Items] (Instructions): ○ Precision and accuracy, three elements of accuracy, functional compatibility, dimensional tolerance and fits, geometrical tolerance, surface texture (for those who are not from Mechanical Systems)	Describe the fields of application of ultra-precision machining and micromachining and their social implications.
		2nd	Background of ultra-precision machining 1 [What is ultra-precision machining?] Learning contents outside class hours [Items] (Instructions): ・ Technical trends of machine tools from the viewpoint of function / machining accuracy (for all students), ○ Outline of removal process, shape of workpiece and tool motion relationships, cutting mechanisms and processes, machinability, cutting tools and machine tools	Understand how to cut machine materials and the basics of machine tools.
		3rd	Background of ultra-precision machining 2 [Types of ultra-precision machining] Learning contents outside class hours [Items] (Instructions): ・ Ultra-precision machining technology from the viewpoint of transferability and resolution of machining, ○ Machining principle, abrasive machining, fixed abrasive machining and free abrasive machining, self-sharpening, grinding, grinding wheel / grinding fluid	Explain the characteristics of various machining methods by viewing and classifying them from the viewpoint of changes in the mass of the workpiece. Explain the characteristics of cutting / grinding / polishing from the viewpoint of transferability and resolution. Understand and classify the difference between normal machining / ultra-precision machining / micromachining.
		4th	Background of ultra-precision machining 3 [Basic technology of ultra-precision machining system] Learning contents outside class hours [Items] (Instructions): ・ Reproducibility and basic technology of ultra-precision machining machine, ○ Hooke's law, rigidity, residual stress, coefficient of thermal expansion of cast iron / steel (linear expansion coefficient), self-excited vibration, vibration isolation and vibration control, numerical control (NC), feedback	Understand the elemental technologies of machine tools / cutting tools technologies / machining technologies and consider measures for precision machining.
		5th	Ultra-precision machine tools 1 [Structure of machine tools, roles of components, structural elements] Learning contents outside class hours [Items] (Instructions): ・ Basic components of machine tools and shape-creating motion, ・ Relationship between mechanical properties and rigidity of structural materials, ○ Line of force, flexural rigidity, torsional rigidity, equation of motion of 1 degree of freedom lumped constant system model, material characteristic value and structural material	Explain the structure of the machine tool body. Explain the principles and ideas necessary to realize high-precision machining. Understand the elemental technologies of machine tools / cutting tools technologies / machining technologies and consider measures for precision machining.
		6th	Ultra-precision machine tools 2 [Machine tool components and technical ingenuity-spindle] Learning contents outside class hours [Items] (Instructions): ・ Rigidity of spindle (bearing structure) and rotation accuracy, rigidity of guidway and motion accuracy, technical ingenuity for speedup, ○ Rolling bearing / hydrodynamic bearing (dynamic pressure) / hydrostatic bearing (static pressure), Newton's law of viscosity, pressure flow and shear flow,equation of continuity	Explain the structure of machine tools and the drive system of the spindle. Explain the principles and ideas necessary to realize precision machining. Understand the elemental technologies of machine tools / cutting tools technologies / machining technologies and consider measures for precision machining. Explain the principle of fluid lubrication of plain bearings and journal bearings. Explain the difference between hydrostatic bearings and dynamic pressure bearings and the principle of hydrostatic bearings.
		7th	Ultra-precision machine tools 3 [Machine tool components and technical ingenuity-linear motion mechanism] Learning contents outside class hours [Items] (Instructions): ・ Rigidity and motion accuracy of linear motion mechanism ・ technical ingenuity for speedup, ○ Servo system elements: servomotor, coupling, ball screw / nut, encoder, linear scale	Explain the structure of machine tools and the drive system for guidway. Explain the principles and ideas necessary to realize precision machining. Understand the elemental technologies of machine tools / cutting tools technologies / machining technologies and consider measures for precision machining.
		8th	1st semester mid-term exam	
	2nd Quarter	9th	Return and commentary of exam answers. Tools for ultra-precision cutting [ultra-precision cutting tools and tool holders] Learning contents outside class hours [Items] (Instructions): ・ Items required for cutting tools, ○ Chuck, machine vise, collet chuck, single point tool, ceramics / cemented carbide / high-speed tool steel, hardness / toughness, wear	Understand the elemental technologies of machine tools / cutting tools technologies / machining technologies and consider measures for precision machining. Acquire basic knowledge about machine tools / cutting tools / machining processes, and be able to consider ultra-precision machining techniques and issues. Explain the properties that cutting tools should have and the conditions and types of cutting tool materials. Explain the phenomenon caused by the wear of the cutting tool edge and the cutting tool life.

		10th	Metal cutting mechanism 1 [Cutting model and chips] Learning contents outside class hours [Items] (Instructions): ・ Phenomenon of cutting, ○ Decomposition and composition of force, equilibrium of forces / moments, ductile fracture and brittle fracture, stress and strain, normal stress and shear stress, elasticity and plasticity, work hardening	Explain the mechanism of cutting, the form of chips, the generation of heat due to cutting, and the build up edge. After understanding the phenomenon of removal processing, the model can be explained.
		11th	Metal cutting mechanism 2 [Cutting resistance and machining with a single shear plane model] Learning contents outside class hours [Items] (Instructions): ・ Cutting resistance and single shear plane model, ○ Friction angle, material defects (point defects, line defects (dislocations), surface defects (grain boundaries)), crystal slip (yield)	Acquire basic knowledge about machine tools / cutting tools / machining processes, and be able to consider ultra-precision machining techniques and issues. Explain the mechanism of cutting, the form of chips, the generation of heat due to cutting, and the build up edge. After understanding the phenomenological theory of removal processing, the model can be explained.
		12th	Metal cutting mechanism 3 [Roughness of finished surface, method of obtaining high quality finished surface roughness by cutting and ultra-precision cutting mechanism] ・ Abrasive machining [Model for grinding, problems of grinding, conventional grinding and Its features] Learning contents outside class hours [Items] (Instructions): ・ Relationship between cutting conditions / tool conditions and surface roughness, ○ Real contact, adhesion, heat treatment (annealing, recovery and recrystallization), austenite, ○ Probability density function, (cumulative) distribution function, upward / downward cutting	It is possible to describe the precision cutting technology and its social implications. Explain how to devise cutting tools to improve machining accuracy and productivity.
		13th	Ultra-precision grinding [ultra-precision grinding] Learning content outside class hours [Items] (Instructions): ・ Characteristics of abrasive machining and technical ingenuity for higher accuracy	Explain the 3 elements and 5 factors of the grind wheel, and explain how to select the grind wheel from the relationship between these and the grinding performance. Explain the similarities and differences between grinding and polishing. Abrasive machining can be classified into machining using fixed abrasive grain tools and free abrasive grain tools. Explain the mechanism and features of grinding It is possible to describe the high precision grinding technology and its social implications.
		14th	Ultra-precision polishing [conventional polishing method and ultra-precision polishing] Learning contents outside class hours [Items] (Instructions): ・ Characteristics of processing with fixed and free abrasive grains, ・ Processing mechanism for super smooth surface creation	Polishing can be classified according to how the abrasive grains are fixed. It is possible to describe the high-precision polishing technology and its social implications.
		15th	(1st semester final exam)	
		16th	Return and commentary of exam answers.	

Evaluation Method and Weight (%)

	Examination	Presentation	Mutual Evaluations between students	Behavior	Portfolio	Work / report	Total
Subtotal	70	0	0	0	0	30	100
Basic Proficiency	0	0	0	0	0	0	0
Specialized Proficiency	70	0	0	0	0	30	100
Cross Area Proficiency	0	0	0	0	0	0	0