Outline of the NUGELP Curriculum

NUGELP offers all its courses in English within a comprehensive and interdisciplinary curriculum. Master's program students are required to obtain a minimum of 30 credits mainly from the courses listed below as well as to defend their Master's thesis.

Target: Basic Knowledge and Skills as a Leader

- **Sustainability and Environmental Studies (Lecture, 2 credits) by Hiroki TANIKAWA, Miho IRYO and Anatoly Zinchenko**
  The objective of the course is to provide students with several definitions, views, interpretations, and analyses on the notion of sustainability. The lectures are to be given by several lecturers that may include external guest speakers. Sustainability covers broad areas. It is therefore inevitable that the course consists of various topics. The course tries to clarify the topics from three viewpoints, namely: 1) Society and/or social sciences, 2) Observation and analysis by natural sciences, and 3) Urban and spatial perspective. One common element that should be noted here is "safety".

- **English Communication in Environmental Issues (Lecture, 2 credits) by Miho IRYO and Sohyun CHUN**
  Develop ability to learn and think about environmental problems in English and apply the ability for presenting and discussing one's ideas in English. English communication ability is a fundamental requirement for engineers and scientists working in the field of environmental problems, since environmental problems are not unique to any one country. In this course students will be assigned specific subjects concerning environmental problems and will be required to study the assigned subjects deeply, and then present and discuss the studied subjects in class in English.

- **Frontier in Civil Engineering (Lecture, 2 credits) by Associated Faculty**
  The aim of the lecture is to comprehensively examine the framework of civil engineering through the introductions of various research topics, projects and so on which the staff of civil engineering have investigated in recent years.
  [Course topics] 1. Guidance 2. Frontier of structural engineering 3. Frontier of material engineering 4. Frontier of coastal engineering 5. Frontier of river engineering 6. Frontier of geotechnical engineering 7. Frontier of urban and transportation planning.

- **Civil Engineering and Policies for Developing Countries I (Lecture, 2 credits) by Miho IRYO and Kiichiro HAYASHI**
  The objective of this course is to learn the basic knowledge related to sustainable development, environmental management, and international cooperation in developing countries for infrastructure development.
  [Course topics] 1. Development 2. Development and agriculture 3. Development and industrialization 4. Sustainable development 5. MDGs and SDGs 6. Environment and resource issues in developing countries 7. International environmental management (international treaty, international organization) 8. International cooperation.

- **Civil Engineering and Policies for Developing Countries II (Lecture, 2 credits) by Associated Faculty**
  The objectives of this course are 1) to study the fundamental knowledge on planning, design, construction and maintenance of infrastructure in Japan, as well as developing countries, 2) to survey various issues in civil engineering, including the environmental management and disaster risk reduction.
  [Course topics] 1. Introduction to disaster risk assessment 2. Water resources and river basin management 3. Coastal zone management 4. Infrastructure development under aid programs 5. Infrastructure projects in developing countries.

Target: Advanced Technologies and Knowledge

- **Environmental Systems Analysis and Planning (Lecture, 2 credits) by Hiroki TANIKAWA**
  The course objectives are to understand "environmental systems", i.e., the interaction of human activities and nature, to learn the scientific mechanisms of global environmental problems, such as climate change, to learn the basic principles and methods of analyzing environmental systems, e.g., environmental economics, mathematical models, life-cycle assessment, etc., and to learn the principle and methods of environmental management at local, national and global scales.
  [Course Topics] 1. About Environmental System Analysis 2. Carrying Capacity, Water, Energy, Material Flow/Stock 3. Simple Global Warming modeling 4. Industrial Symbiosis modeling 5. The basis on Input and Output Analysis 6. Urban Climate Modeling.

- **Spatial Development and Environment (Lecture, 2 credits) by Takashi TOMITA**
  This course helps students deepen basic knowledge of sustainability and safety and security in urban and territorial areas and understand methodologies for improving them in order to acquire the capability to address issues in urban and territorial development including disaster risk reduction and environmental conservation. Upon completion of this course, students will be able to: 1) understand importance in urban and territorial sustainability and safety and security, 2) clearly explain important matters in developing and improving sustainability and safety and security in urban and territorial areas, and 3) synthetically consider planning and development ways to make urban and territorial areas sustainable.

- **Theory of Environmental Management in Urban Space (Lecture, 2 credits) by Hirokazu KATO**
  In the state of the aging and declining population, global environmental issues and catastrophic natural disasters, you explore desired urban spatial planning and management,as well as required economic and financial systems to support it.
  [Course Topics] 1. Directions of urban management strategies under environmental constraints 2. Relationship between the urban activities and the various issues 3. Effects of motorization and life style changes 4. Methods for measuring the environmental load from urban activities 5. Application of analytical methods of transport and urban systems to the environmental evaluation 6. Policy packages for transport and urban planning under environmental constraints 7. Final presentation: Report on a survey about sustainable region and city

- **Water and Waste Engineering (Lecture, 2 credits) by Nagahisa HIRAYAMA**
  Water pollution and solid waste are some of the major environmental problems facing our society today. In this class we will learn about various technologies and measures applied in drinking water supply, control of pollution of water bodies, and solid waste management. The objectives of this class are the followings: 1) To understand the outline of water supply engineering, wastewater engineering, waste management. 2) To grasp the cutting-edge research activities in the filed of emergency environmental engineering. 3) To study a solution for sustainable society.

- **Environmental Risk (Lecture, 2 credits) by Takaaki HARADA, Kengo TOMITA and Rumiko HAYASHI**
  "Environmental risk" is defined as the possibility that pollution and changes in the environment caused by human activities affect human health and ecosystems. What are the risks we have to think about the environment and safety? And how do we think about those risks? Thinking about recent environmental problems, accidents, and incidents, it is needless to say that the knowledge to deal with such risks related to the environment and safety is essential knowledge in the real world. In considering environmental risks, harmful factors such as chemical substances are often centered on, but in this lecture, we consider the environment in a broader sense, and discuss risks, accidents and incidents, environmental measures in universities, and global environmental problems.

- **Transportation Systems Analysis (Lecture, 2 credits) by Takayuki MORIKAWA**
  To plan and evaluate efficient and sustainable transportation systems analysis, the objectives of this lecture are to learn transportation surveys, travel demand analysis, and evaluation methods of the systems. It also aims to build capacities of using them in transportation research and practices.
  [Course Topics] 1. Transportation demand and travel survey 2. Aggregate demand model (trip generation, trip production/attraction, trip distribution & modal split) 3. Traffic assignment on network 4. Preview of disaggregate demand modeling 5. Disaggregate demand model (binary choice, multinomial choice, estimation and statistical test, aggregation and forecast, multi-dimensional choice, advanced discrete choice models).

- **Advanced Traffic Engineering and Management (Lecture, 2 credits) by Hideki NAKAMURA**
  There is no doubt that a considerable portion of pollution emissions is resulted from transportation related activities and vehicular movements in particular. Managing traffic safely and efficiently is one of the most effective solutions to relieve environmental issues worldwide. Training specialists who have the knowledge and skills of traffic engineering is highly demanded especially in developing countries where travel demand is rapidly increasing despite insufficient transportation infrastructure. In this

course, fundamentals and internationally forefront issues in traffic engineering are to be covered in theory and practice, so that students can effectively master the most important issues for practicing in highway planning and traffic operations.

- **Advanced Course in Lifecycle Design of Civil Structures (Lecture, 2 credits) by Hikaru NAKAMURA, Takeshi HANJI and Koji NISHIGUCHI**
  This course objective is to study design method and maintenance of bridge structures in the context of lifecycle management of civil structures. After completing this course, students will be able to list different types of structural design methods and explain their differences, explain typical design flow of bridge structures, and understand current conditions of existing bridges and describe maintenance systems of bridges in Japan.
  [Course Topics] 1. To study fundamental theory of reliability-based structural design and to understand structural reliability and different design methods such as the allowable stress method and the limit state design method 2. To understand a typical flow of structural design which includes structural planning, selection of structural systems, verification of required performances, lifecycle cost analysis, and maintenance plan, by studying design examples of steel and concrete structures 3. To understand current conditions of existing bridges in Japan and to study efficient maintenance systems of bridge structures.

- **Advanced Infrastructure Planning (Lecture, 2 credits) by Takayuki MORIKAWA and Toshiyuki YAMAMOTO**
  The course objective is to understand the meanings and objectives of infrastructure and learn the infrastructure planning methods. The goals of the class are to be able to explain the public economy, and solve the problems to derive the appropriate results by applying the evaluation methods and decision methods considering the uncertainty.
  [Course Topics] 1. Public economics (Social welfare and Pareto optimum, Consumer's behavior and demand curve, Producer's behavior and market equilibrium, Market failure, Externality, Public goods) 2. Introduction to decision making in infrastructure planning 3. Evaluation and decision making (Cost-benefit analysis and value of non-market goods, Evaluation methods of non-market goods and utility function, Value of travel time saving and project evaluation, Social welfare function and analytic hierarchy process) 4. Decision making under uncertainty (Expected utility theory, Bayesian decision making and value of information, Game theory and dilemma problem).

- **Advanced Fluvial and Coastal Hydrodynamics (Lecture, 2 credits) by Tomoaki NAKAMURA and Ryota TSUBAKI**
  The aim of this course is to understand physical processes in rivers and oceans. This class will provide advanced theories and technologies applied in the management of rivers and coasts.
  [Course Topics] 1. Outline of the course 2. Governing equations for incompressible viscous fluid flow 3. Shallow water equations 4. Flow resistances in open-channel flow 5. Long wave theory 6. Shallow water wave theory 7. Wave-averaged conservation equations.

- **Advanced Geotechnical Engineering (Lecture, 2 credits) by Toshihiro NODA and Kentaro NAKAI**
  This lecture aims to learn how the basic knowledge learned in soil mechanics and geomechanics are applying to actual geoengineering, and to understand its theoretical background. Specifically, the purpose is to learn about settlement and failure (bearing capacity) problems in soft ground, as well as how to deal with uncertainties in the actual field of geoengineering such as the safety factor method and reliability design.
  [Course Topics] 1. Introduction to geotechnical engineering 2. Multi-dimensional consolidation analysis 3. Observational method for predicting consolidation settlement (Asaoka method) 4. Mean effective stress and bearing capacity 5. Undrained bearing capacity (φ_u=0 circular slip surface analysis).

- **Advanced Numerical Analysis (Lecture, 2 credits) by Tomio MIWA and Kentaro NAKAI, Tomoaki NAKAMURA and Koji NISHIGUCHI**
  This lecture provides basic theories of numerical analyzing techniques which are often used in the civil engineering field. The goal is to understand and apply numerical optimization method, finite element method, approximate analysis of ordinary differential equation and finite difference method for computational fluid dynamics simulation through the lecture and practical work.
  [Course Topics] 1. Finite element method 2. Optimization problem 3. Finite difference method 4. Approximate analysis of ordinary differential equation.

- **Advanced Steel Structures (Lecture, 2 credits) by Kazuo TATEISHI**
  Deterioration and its prediction method for steel structures are lectured. The goal of this course is to understand the following issues: Importance of maintenance of infrastructures, Deterioration in steel structures, Calculation method for remaining life of steel members based on fracture mechanics, Fatigue and corrosion in steel members, Inspection method for steel structures.
  [Course Topics] 1. Importance of maintenance and difficulties 2. Experiences of damage in steel structures and repair/retrofitting methods 3. Fatigue and preventing method 4. Linear fracture mechanics and its application 5. Corrosion and preventing method 6. Inspection method for steel structures.

- **Advanced Concrete Structures (Lecture, 2 credits) by Hikaru NAKAMURA and Taito MIURA**
  The objective of this course is to learn advanced knowledge of the design, construction and maintenance of concrete structures, to acquire applied skills that make use of the knowledge in practice. After completing this class, students will be able to: Confirm basic knowledge of RC structures, Understand nonlinear analysis of concrete, Understand time dependent behavior of concrete, Understand construction for quality control.
  [Course Topics] 1. Basic knowledge of design of concrete structures 2. Outline of nonlinear structural analysis for concrete structures 3. Outline of diffusion analysis for concrete structures 4. Volume change and cracking of concrete. 5. Quality control of concrete 6. Proposal of design and construction concepts for quality control.

- **Advanced Mechanics of Geomaterials (Lecture, 2 credits) by Masaki NAKANO**
  The aim of this course is to acquire the basics and applications of geomaterials mechanics for safely constructing and maintaining various geotechnical structures. Concretely, this course introduces the mechanical behavior of remolded clay and natural deposited clay, and the difference between the two. Then, the course also introduces the basics of plastic mechanics, an elasto-plastic constitutive model, and the mechanical behavior of remolded clay and naturally deposited clay based on the constitutive model. In addition, the object is expanded to sand, problematic soil, and improved soil, and their mechanical behavior is also explained based on elasto-plastic mechanics. In addition, in the design of the geotechnical structure, the advantages and disadvantages of each are compared by comparing the current design method and the approach using the elasto-plastic constitutive model.

- **Advanced Urban Planning (Lecture, 2 credits) by Hirokazu KATO**
  In the state of the aging and declining population, global environmental issues and catastrophic natural disasters, you explore desired urban planning and required economic and financial systems to support it. The goals by learning this lecture is as follows: 1) To learn and explain the necessity of urban planning and its basic items and requirements, 2) To understand and explain the contents, problems and reasons for Japanese spatial planning, 3) To understand and explain the direction of spatial planning in Japan and developing countries in the future.

- **Advanced Continuum Mechanics (Lecture, 2 credits) by Masaki NAKANO and Toshihiro NODA**
  The aims of this course are to review the concept of vector/tensor and to understand the basics of continuum mechanics such as kinematics (geometry of motion), equilibrium rules, and objectivity. Students will be able to 1) Understand and explain the basis of Vector and Tensor Analysis, 2) Explain material and spatial descriptions of the physical value of body, material/spatial time derivatives and expression of deformation of body using tensor, 3) Understand and explain properties of Cauchy's stress tensor, 4) Understand and explain law of mechanics and Cauchy's first/second law of motion, and apply them to the interpretation and representation of the mechanical behavior of continuum body.

- **Advanced Structural Mechanics (Lecture, 2 credits) by Junji KATO**
  The objective of this course is to learn the basic knowledge of nonlinear computational mechanics and topology optimization for advanced and numerical structural design.
  [Course Topics] 1. Nonlinear computational mechanics based on the finite element method (Newton-Raphson method, Geometric nonlinear structural analysis, Basis of numerical instability problem) 2. Topology optimization (Foundation of mathematics of optimization, Formulation of sensitivity analysis).

- **Advanced Coastal and Offshore Engineering (Lecture, 2 credits) by Norimi MIZUTANI, Tomoaki NAKAMURA, and Yonghwan CHO**
  The aim of this course is to understand wave dynamics in a coastal zone and wave-structure interactions. Students will be able to 1) understand and explain hydraulic phenomena related to the radiation stress, 2) understand and explain diffraction problems, 3) understand and explain wave dynamics including evanescent waves, 4) understand and explain the dynamic behavior of floating bodies.
  [Course Topics] 1. Radiation stress and wave dynamics in a shallow water 2. Diffraction wave theory (vertical cylinder, axisymmetric structure) 3. Dynamic behaviour of floating bodies 4. Potential and the boundary element method 5. Green function and numerical methods.

- **Advanced Theory of River Basin Management (Lecture, 2 credits) by Yuji TODA**
  This course aims to obtain the comprehensive understanding of the theoretical background and the recent technologies for river and river basin management. The attainment target is to get the fundamental knowledge of river basin managements and to acquire the understanding of new technologies of river engineering and fluvial hydraulics.
  [Course Topics] 1. Outline of river and river basin management 2. Sediment transport 3. Fluvial Hydraulics 4. Eco-Hydraulics

- **Advanced Soil Dynamics (Lecture, 2 credits) by Toshihiro NODA and Kentaro NAKAI**
  In this lecture, students will know the seismic damage example such as liquefaction during the actual earthquake and will learn the basic matters and advanced contents related to the ground dynamics, such as the cyclic response of the ground during the earthquake. By learning this lecture, the goal is to be able to: 1) Understand seismic damage caused by recent earthquakes 2) Understand the concept of seismic design 3) Understand the vibration mechanism of the mass / mass system 4) Understand the double reflection theory 5) Understand how to understand dynamic problems of water-soil two-phase system based on mixture theory.

Target: Interdisciplinary Topics

- **Environmental Industry Systems (Lecture, 2 credits) by Hiroki TANIKAWA, Takayuki MORIKAWA and Miho IRYO**
  The student will learn the practical skills as a leader in developing infrastructure by learning examples of how to apply the expertise and engineering techniques related to environmental conservation activities and technologies to the real world. Lecturers are invited from companies mainly in the Chubu region, which has an advantage in environmental conservation activities and environmental technologies, for lectures on the latest environmental initiatives in business. 1) Lectures by companies and discussions: Listen to lectures on application examples of environmental conservation activities and environmental technologies from companies and discuss their contents. 2) Group presentations: Based on the contents of the lectures and the contents learned in other subjects, a group discussion will be held on the connection between theory and practice, and the results will be presented.

- **Sustainable City Studies (Lecture, 2 credits) by Hiroki TANIKAWA**
  Students will learn policies, plans, technological and institutional measures to realize Sustainable Society with the idea of sound material cycle society and decarbonization cities, with a view to integrating climatic change mitigation in urban development.
  [Course Topics] 1. Global climatic system 2. Mechanisms of global warming 3. Climatic change and human history 4. Economy, energy and environment and IPCC AR 5. Industrial Ecology and Circular Economy 6. Human activities and energy in cities 7. Urban forms, land use and energy 8. Material and Energy metabolism in cities 9. Material and Energy metabolism of buildings and districts 10. Sound Material Cycle Society and Circular Economy 11. Metal resource and sustainability 12. Stock-type Society and sustainability

- **Climate Change and Infrastructure (Lecture, 2 credits) by Miho IRYO**
  This lecture aims to acquire the knowledge about the current status and risks of climate change and international initiatives, and to develop the capacity to consider mitigation and adaptation measures from the perspective of sustainable infrastructure development. The objective of this lecture is to acquire the following knowledge and skills.
  [Course Topics] 1. Scientific basis of climate change and its impact on social system (Learn about climate change and its impact on social systems based on IPCC reports.) 2. Climate change mitigation

and adaptation (Through group work, learn how to analyze the potential regional risks of climate change and propose mitigation and adaptation measures.) 3. International efforts to mitigate and adapt to climate change (Learn the historical background of international climate change measures under the Framework Convention on Climate Change, and deepen your understanding of the international decision-making process.)

- **Environmental Urban Systems (Lecture, 2 credits) by Miho IRYO**
  The aim is to deepen the understanding of the technical and institutional systems required to build an environmental city, mainly from the perspective of city planning and transportation planning.
  [Course Topics] 1. Components of urban environment and their issues 2. Historical review of city structures and location theory 3. Observation and assessment of environmental impact 4. Urban / transportation plan for environmental improvement 5. Consensus building and community development 8. Case studies and presentations of environmental improvement in various cities

Target: Research-oriented internship

- **Global Research Internship (Research training, 2 credits) by Associated Faculty**
  As part of the Global Environmental Leaders Program, this course aims at providing research and survey opportunities at universities, research institutions, companies, governments in Japan and overseas to acquire the ability to conduct practical and applied research. Internship should be conducted based on close communication with Academic Advisor(s). Students are expected to acquire practical research know-how through On-site Research Training (ORT). Details of the internship such as period and terms of implementation should be decided through consultation with Academic Advisor(s) and experts at host institutions.