DEPARTMENT OF AUTOMOTIVE ENGINEERING

**Department Introduction**

**■ History**

Department of automotive engineering was established in 2016 and now graduates of the department will contribute to the development of local and national industries.

**■ Introduction**

The automobile industry embraces cutting-edge technologies in machinery, electronics, IT communications, materials, and design together. Nowadays, automotive engineering is therefore one area of the total engineering. To understand the functions of automobile components and the organic relations between these elements, students learn about general mechanical engineering, electric & electronic engineering, and material science, especially including next-generation eco-friendly automobile (fuel cell vehicle, electric vehicle). In addition, students also deal with various computational software (CAD, CAM, CAE) related with each subject to stay in touch with the development trends of the automobile industry.

The education program blends intense technical study and creation of strong engineering-based skills with an emphasis on leadership and other business acumen needed to thrive in a global economy. The hands-on, holistic approach ensures that graduates move seamlessly into employment within the automotive industry or academia.

**List of Faculty Members**

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| --- | --- | --- | --- | --- |
| **Position** | **Name** | **Last School Graduated** | **Degree** | **Major** |
| Professor | Sah, Jong Youb | KAIST (1989) | Ph.D. | Computational Fluid Mechanics and Convective Heat Transfer |
| Associate Professor | Kang, Seok-Won | Texas A&M University, College Station (2012) | Ph.D. | Heat and Mass Transfer, MEMS, Energy Storage Devices |
| Associate Professor | You, Yong Min | Hanyang University (2013) | Ph.D. | Electric Machine, e-Powertrain, Optimum Design |
| Assistant Professor | Baek, Jong Dae | Nanyang Technological University (2015) | Ph.D. | Hydrogen fuel cell, Thin film mechanics, Nano-fabrication process. |
| Assistant Professor | Park, Jihyuk | KAIST (2018) | Ph.D. | Mechatronics, Robot control |
| Assistant Professor | Kim, Dongwook | KAIST (2019) | Ph.D. | Electric/Electronics |
| Collaboration  Professor | Kim, Dae Eop | Pusan National University (1986) | M.S. | CAE |
| Foreign Professor | Rudraraju, Vijayalakshmi | Sri Venkateswara University | Ph.D. | Optical Materials |
| Foreign Professor | Yadav, Anuja Arun | Shivaji University (2018) | Ph.D. | Thin Film, Supercapacitor, Photocatalysis, Water Splitting |
| Foreign Professor | Liu, Yanheng | Yeungnam University (2020) | Ph.D. | Kinematics and Control, Mobile Robot Design |

**Course Description**

**■ Basic Major Courses**

**ADVANCED NUMERICAL ANALYSIS (3 credit)**

Basic concept of approximate numerical method and solution of linear system equation, numerical integration and differentiation, optimization problem, interpolation method, approximation of function, approximation of nonlinear equation, numerical solution of simultaneous linear equation, matrix eigenvalue problem, partial differential equation Boundary value problems, and numerical analysis of partial differential equations.

**ADVANCED APPLIED ENGINEERING MATHEMATICS (3 credit)**

This course focuses on mathematical equations, partial derivatives, vector, tensor and matrix, and Fourier transform, which are not dealt with engineering mathematics in depth.

**■ Major Courses**

**AUTOMOTIVE BODY STRUCTURAL DESIGN (3 credit)**

Emphasis is on body concept for design using first order modeling, finite element method, approximation, and numerical methods. Review of a practical application is extensively considered to design automotive bodies for global bending, torsion, vibration, topology, material selection, manufacturing constraints, and processes enabling part assembly.

**SPECIAL TOPICS IN VEHICLE CHASSIS DESIGN (3 credit)**

This course deals with practical design-based lectures and literature review on mechanical design, elastic mechanism design, dynamical design, strength and endurance design of vehicle chassis systems. Also, the lecture will be conducted in such a way that students find, present and discuss related papers.

**ADVANCED MECHANICS OF MATERIALS (3 credit)**

Stress and strain, suitability of deformation, elasticity, strain energy, yield and failure theory, minimum principle, plane strain and plane stress, beam bending and torsion are extensively considered.

**VEHICLE NOISE AND VIBRATION CONTROL (3 credit)**

This course deals with multi-degree-of-freedom vibration, energy method, rotating vibration, irregular vibration, mode analysis and experimentation method, frequency analysis method, FEM applied vibration analysis method, In addition, an objective, and subjective assessment of the effects of noise and vibration on humans will be discussed. Other passive or active mitigation methods for noise and vibration characteristics will be also discussed.

**ADVANCED VEHICLE DYNAMICS (3 credit)**

Fundamental concepts in the dynamic behavior of vehicles are discussed. The application of dynamic systems modeling and analysis are stressed to bring understanding to ride performance, handling and straight-line running, as well as practical considerations in vehicle design.

**ADVANCED INTERNAL COMBUSTION ENGINES (3 credit)**

Lecture on the thermochemical properties of a mixer, combustion modeling, gas exchange process, fuel metering system, gas flow and combustion including basic theory of internal combustion engine.

**ADVANCED HYDROGEN-FUEL CELL (3 credit)**

Lecture on fuel cell theory using hydrogen as a fuel including new and renewable energy based on thermodynamics and electrochemistry. Also, theory, practice and development status of new energy vehicles will be lectured.

**ADVANCED ENERGY STORAGE SYSTEMS (3 credit)**

Introduction to battery and supercapacitor and review on typical characteristics, modeling process of battery and supercapacitor, consideration of state of charge prediction technology and battery management system

**ADVANCED FINITE ELEMENT METHOD IN AUTOMOTIVE ENGINEERING (3 credit)**

Practical training on the basic theory of the finite element method which is essential in the design process of the automobile system, as well as the practical application of the FEM analysis technique in the body design, vehicle dynamics, control system design and engine design.

**AUTOMOTIVE CONTROL ENGINEERING (3 credit)**

Introduction to basic theory necessary for automobile control. Lecture on state equations, closed loop system performance, system stability determination, frequency response, controller design, etc.

**MOTOR CONTROL ENGINEERING (3 credit)**

Introduces the basic theory for controlling motors that are a major part of a car. Understanding vector control for controlling permanent magnet synchronous motors, current control and speed controller design method, motor dynamic simulation

**LIGHTWEIGHT MATERIALS FORMING ANALYSIS (3 credit)**

Lecture on design and analysis of lightweight body using lightweight new material such as high tensile steel, aluminum, magnesium, and composite materials.

**AUTONOMOUS DRIVING RECOGNITION AND DECISION (3 credit)**

Learning how to solve the problem of recognition and recognition of autonomous driving by using artificial intelligence technology. We introduce the latest technology cases that perceive the surrounding environment and judge the danger situation by using sensor data such as camera and lidar, and practice through deep learning-based algorithm

**AUTOMOTIVE ENGINEERING SEMINAR (3 credit)**

Learn about the latest research trends related with ground vehicles and future technologies and discuss them. Held seminars by inviting external experts as needed.

**OPTIMIZATION TECHNIQUE (3 credit)**

In engineering design problems where there are several design variables, we study how to get the best design by selecting these variable values ​​appropriately. First, you will learn how to construct a given design problem as an optimization problem, and how to solve it mathematically or numerically by applying the appropriate solution technique according to the type of problem

**ADVANCED MECHANICAL SYSTEM DESIGN I (3 credit)**

Project team composition, project goal / specification definition and analysis, creative idea idea technique (brainstorming, TRIZ, mind map), project schedule creation, basic design, primary design and design review

**ADVANCED MECHANICAL SYSTEM DESIGN II (3 credit)**

Concurrent Design with consideration of 2nd stage design (optimization), implementation (production) process reflecting 1st stage prototype measurement / evaluation, modular design with high usability, design review (presentation), risk analysis and prediction, To improve performance through prototype building / implementation, prototype performance evaluation and analysis, prototype tuning (debugging), and optimization.

**ADVANCED MACHINE DESIGN (3 credit)**

Mechanical Element and System Design, Precision Mechanical Design Theory and Practice, Design Project will be processed.

**STRUCTURAL VIBRATION (3 credit)**

Free vibration, Harmonic vibration, Forced vibration, Vibration analysis and Vibration analysis program

**FRACTURE MECHANICS (3 credit)**

The analysis of elastic stress around cracks, the concept of stress intensity factor, the energy release rate, the concept of J integral, the concept of fracture toughness, the analysis of fatigue crack propagation characteristics, stress corrosion cracking Experimental methods, analysis of numerical and numerical fracture mechanics parameters, and lectures on practical application to mechanical structure design.

**LUBRICATION ENGINEERING (3 credit)**

Study the lubrication phenomena of relative motion of machine. Friction and wear phenomena, induction of Reynolds' equation, pressure distribution by numerical analysis, and study on the bearing specificity on stability of rotor - bearing system.

**SMART MATERIALS AND STRUCTURES (3 credit)**

Develop a mechanical model for smart materials and structures, study the electrical and energy aspects of these models, model and understand a series of nonlinear features generated by smart materials, design smart materials for actuators, sensors, and control system designs. Finally, smart materials are applied to actual engineering systems.

**LOW-CARBON ENERGY SYSTEM (3 credit)**

As a countermeasure against global warming, low-carbon energy system is one of the top ten technologies that will lead the future. This lecture deals with low-carbon energy system for prevention of global warming. The main contents of the lecture first to explain the causes of global warming and the global countermeasures, and to lecture on various technologies and policies to prevent them.

**DIGITAL SIGNAL PROCESSING (3 credit)**

This course introduces the characteristics and processing methods of digital signals, and covers Fourier transforms, design and implementation of digital filters, and spectrum analysis.

**ADVANCED ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING (3 credit)**

Learn about basic concepts and algorithms of machine learning techniques that outline artificial intelligence and learn from data themselves. It covers various machine learning and deep learning models such as artificial neural network, support vector machine, decision tree, ensemble technique, clustering, convolution and cyclic neural network, and various issues related to algorithm and machine learning system development.

**ADVANCED DEEP LEARNING AND IT CONVERGENCE (3 credit)**

The course covers the latest research and application examples on various topics related to deep learning and IT convergence. It covers the latest technologies of deep learning and topics on IT convergence in automotive applications, intelligent automobiles and autonomous vehicles.

**POWERTRAIN SYSTEM DYNAMICS (3 credit)**

Lecture on dynamic behavior characteristics design of vehicle power source and power transmission device such as engine and transmission.

**HMI-BASED AUTONOMOUS DRIVING (3 credit)**

This lecture introduces the human factors in autonomous driving vehicles at various levels such as control switching and examines the latest research trends. In addition, by carrying out an autonomous HMI-related term project for each team, practical use of experimental techniques is improved.

**AUTOMOTIVE POWER ELECTRONICS (3 credit)**

Lecture on design and analysis of overall power conversion circuit and implementation of complex application circuit. Also, by using semiconductor switching device controlled by PWM method, it is possible to realize the practical power conversion system application ability applying electronic circuit and computer application technology.

**SPECIAL TOPICS IN VEHICLE BODY DESIGN (3 credit)**

This course covers practical design-based lectures and literature reviews on strength, vibration, durability, and aerodynamic design of bodywork. Also, the lecture will be conducted in such a way that students find, present and discuss related papers.

**SPECIAL TOPICS IN ENVIRONMENTAL-FRIENDLY VEHICLES (3 credit)**

Learn about the latest research trends and future technologies in the field of environmental-friendly automobiles. Also, the lecture will be conducted in such a way that students find, present and discuss related papers.

**HIGH-PRECISION BEARING SYSTEM DESIGN (3 credit)**

The purpose of this lecture is to develop the ability to design and utilize high-precision bearing systems by understanding the fundamental design theory from an engineering perspective. The subject details and lecture structure are as follows:

- Introduction to high-precision bearing systems

- Theories for high-precision bearing system design and hands-on practices

- Term-project for design of high-precision bearing systems

**INDEPENDENT STUDY (1)**

**INDEPENDENT STUDY (2)**

**NON-THESIS PROJECT**