Accelerator Science

Course Code	Course	Credit	Content of Subject
40COM001**	High Energy Accelerator Science Seminar 1	2	Active fields of accelerator related science, such as elementary particles, nuclear physics, materials science and life science etc., will be presented by front-line researchers.
40COM002**	High Energy Accelerator Science Seminar 2	2	Active fields of accelerator related science, such as elementary particles, nuclear physics, materials science and life science etc., will be presented by front-line researchers.
40ACS001**	Introduction to Accelerators 1	2	General introduction to accelerators in omnibus-style classes for specific fields by the experts and given in Japanese.
40ACS002**	Introduction to Accelerators 2	2	General introduction to accelerators in omnibus-style classes for specific fields by the experts and given in English.
40ACS003**	Seminar on Introduction to Accelerators 1	2	General introduction to accelerators in omnibus-style seminars and practicals for specific fields by the experts and given in Japanese.
40ACS004**	Seminar on Introduction to Accelerators 2	2	General introduction to accelerators in omnibus-style seminars and practicals for specific fields by the experts and given in English.
40ACS005**	Radiation Physics	2	This class is on the basic topics about generation of radiation ray and interaction of radiation and matter. 1. Structure of atom and ionization 2. Structure of nucleus 3. Decay of radioactive nucleus 4. Nuclear interaction 5. Interaction of x ran and gamma ray 6. Interaction of beta ray 7. Interaction of proton ray and alpha ray 8. Interaction of neutron 9. Transfer of energy to material 10. Quantity and unit of radiation ray.
40ACS006**	Fundamentals of electromagnetism for particle accelerators	2	Lectures on basics of electromagnetism necessary to understand accelerators will be given. Contents: Vector Analysis /Static electromagnetic field /Maxwell equations /Transmission of electromagnetic field /Waveguides and resonant cavities/Radiation from charged particles /Interaction between charged particles and material (electromagnetic field).
40ACS007**	Analytical Dynamics	2	In this lecture, single-particle dynamics in phase space wil be discussed for understanding linear and nonlinear beam-phenomena in an accelerator.
40ACS008**	Foundations of Data Science	1	This course introduces the statistical processing for Big Data, Multivariate analysis, Machine Learning, in particular, the principles of Deep Learning and its application with exercise.

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40ACS009**	Control of distributed devices for large systems	1	EPICS (Experimental Physics and Industrial Control System) is a toolkit to monitor and control many devices, which are distributed over a wide area. At the beginning, EPICS was developed and used in an accelerator community. For example, KEK introduced EPICS into SuperKEKB and J-PARC accelerators. In addition, EPICS has been introduced in non-accelerator fields: telescopes, laser interferometers for gravitational-wave detections, and nuclear fusion facilities. Nowadays developments and maintenances of EPICS have been continued under a world-wide collaboration. In the class, introduction of EPICS will be given, followed by hands-on lessons with a tiny computer (Raspberry Pi). Students, who are expected to have knowledge of basic Linux commands, will study basic functions of EPICS by implementing EPICS and controlling remote I/O signals.
40ACS010**	Practicum for accelerator science using the education-oriented electron linear accelerator	1	In this lecture, a practice and an exercise are performed based on the small-scale linear electron accelerator as the KEK Education and Training Accelerator (KETA).
40ACS011**	Machine Design	2	This course provides an introduction to mechanical design, material strength and machine components used in mechanical engineering for the design of accelerator devices.
40ACS012**	Introduction to Robotics	1	This course covers from sensors, actuators and other elements used in experimental equipment to the fundamentals of robotics.
40ACS013**	Beam Physics	2	Lectures and exercises will be given on the fundamentals of beam physics. The goal is to understand multipole expansion of electromagnetic field, equation of motion, transfer matrix, Twiss parameters, betatron oscillation, synchrotron oscillation, Courant-Snyder invariant, and beam injection.
40ACS014**	Particle Accelerator Design	2	Introductory lectures on the beam dynamics and primary knowledge for designing accelerators and the basic components for generation, acceleration, transportation, storage, collision, extraction, diagnostic, and control of their beams.

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40ACS015**	Accelerator magnets and power supplies	2	In addition to the lecture on magnetic circuits, which are the basis of the magnet, their accelerator applications, and fabrication techniques, this course gives the lecture on power electronics circuits for magnet power supplies, which are the source of magnetic field generation. Finally, through practical training to learn the magnet system, this course aims at the acquisition of magnetic field measurement techniques to evaluate magnet performance, as well as alignment techniques.
40ACS016**	Introduction to Computational Science	2	The course aims to encourage learners to understand the fundamental concept of computer architecture and network communication. Learners will also study programming principles through the computational simulation/calculation program, which is required particularly for high-energy/nuclear physics. Two or more lecturers help learners with hands-on lessons throughout the course.
40ACS017**	Introduction to Radiation Detection and Measurement	2	Characteristics of various types of radiation (charged particles, photons, neutrons) and their interactions with matter. An introductory treatment of detection and measurement for radiation generating in accelerators which, nevertheless, extends to a detailed account of detector types, properties and functions.
40ACS018**	Introduction to Surface Analysis	2	Basic concepts, instruments, and characteristics of surface analysis techniques using electromagnetic waves and/or charged particles will be presented with their materials applications.
40ACS019**	Beam instrumentation basics	2	This course covers the principles of beam instrumentation, mainly using electrical method ranging from DC to the RF region. In the beginning, we emphasize signal processing techniques to be able to handle the beam signal in both time domain and frequency domain. Next, we study microwave engineering essentials which will be needed to understand real beam monitors. After studying the theory of the techniques, the principles of beam instrumentation widely used in circular accelerators will be reviewed by showing real beam monitors in accelerators at KEK.

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40ACS020**	Introduction to accelerator control system	2	Introduction to the accelerator and beam control is provided. Design policies and actual implementations are explained with examples for accelerator control components such as computer system, control software, network system, input/output interface, timing system, machine-protection system, and personnel-protection system. A technique to improve the beam stabilities through the control system is also discussed.
40ACS021**	Superconducting technology and cryogenics engineering	2	Introduction to the accelerator and beam control is provided. Design policies and actual implementations are explained with examples for accelerator control components such as computer system, control software, network system, input/output interface, timing system, machine-protection system, and personnel-protection system. A technique to improve the beam stabilities through the control system is also discussed.
40ACS022**	Beam acceleration and RF systems	2	Experts in electron and proton acceleration give this lecture for a comprehensive understanding of normal-conducting radio frequency (RF) acceleration. Students will learn the impedance concept peculiar to RF waves, network-analyzing method using equivalent circuits, and RF acceleration systems used in recent beam accelerators. The system composed of a high-power source, three-dimensional transmission circuits with special waveguide elements and cavity resonators generating high electric fields is a treasure trove of various ideas and technologies. In addition to the theory and technical explanation, beam physics related to the RF acceleration such as beam-loading compensation, beam instability due to wake fields, its suppressing methods and improvement of beam dynamics by harmonic superposition will be developed.
40ACS023**	Vacuum science and technology for particle accelerators	2	Surface phenomena in accelerators, such as secondary electron emission, photodesorption and electrical breakdown in vacuum are described. Further, vacuum system design and pressure distribution calculation are to be studied.
40ACS024**	Particle Sources	2	Design of electron beam sources (electron guns) and related new developments, such as photocathode guns and rf guns.

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40ACS025**	Advanced Course for Superconducting Cavities	2	Design principles, fabrication technology and operational aspect of superconducting cavities for light sources, colliding accelerators and other accelerators.
40ACS026**	Data Acquisition and Analysis Methods	2	This course covers the methodologies on on-line data acquisition and analysis techniques in High Energy Physics.
40ACS027**	High Performance Computing	2	The course covers the hardware/software techniques and applications for computers with high performance as compared to a general-purpose computer.
40ACS028**	Advanced Course for Radiation Shielding	2	Shielding methods and materials for various types of radiation in matter, shield design for radiation facilities. Radiation transport simulation.
40ACS029**	Advanced Course for Radiation Protection	2	Introduction of radiation effect on human health. Characteristics of radiation fields, mechanism of induced radioactivity and dose estimation for radiation protection at accelerator facilities.
40ACS030**	Advanced Computational Radiation physics	2	Students learn the basic techniques, and methods to provide numerical quantities of radiation simulation by Monte Carlo code.
40ACS031**	Practicum of Radiation Simulation by Monte Carlo Code	2	Students will install favorite Monte Carlo codes (EGS5, PHITS, or GEANT4) into their Laptop, learn the input and usage, run the code, and check the results for some theme.
40ACS032**	Advanced Course for superconducting magnets	2	Lectures on fundamentals, design and manufacturing of superconducting magnets for accelerators. Includes introduction to recent developments in magnetic technologies for compact accelerators and high field-strength magnets for energy-frontier machines.
40ACS033**	Computer Architecture	2	This course covers wide field of software engineering such as software development methodologies, computer languages and database.
40ACS034**	Computer Programming（C++ or Python）	2	This course covers techniques for programming and data analysis using C++ and Python.
40ACS035**	Computer Programming Laboratory	2	Learn about programming and data analysis using C++ and Python through hands-on exercises.
80ACS001**	Qualifying Research in High Energy Accelerator Science ⅡA	2	Students are required to perform a research on an advanced subject in accelerator science.

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Course Code	Course	Credit	Content of Subject
80ACS002**	Qualifying Research in High Energy Accelerator Science ⅡB	2	Students are required to perform a research on an advanced subject in accelerator science.
80ACS003**	Special Exercise for Accelerator Science ⅠA	2	Exercise on accelerator science.
80ACS004**	Special Exercise for Accelerator Science ⅠB	2	Exercise on accelerator science.
80ACS005**	Special Exercise for Accelerator Science ⅡA	2	Exercise on accelerator science.
80ACS006**	Special Exercise for Accelerator Science ⅡB	2	Exercise on accelerator science.