Special Subjects of the Department of Accelerator Science

Field	Course Code	Subject	Credit	Content of subject	Instructor
Beam physics	20DACa01**	Advanced Course for Nonlinear Dynamics	2	Particle motions in nonlinear fields created by magnets and beam are studied mainly by analytical methods. Nonlinear phenomena of beams such as hysteresis and catastrophe are also covered.	NISHIKAWA, Patrice
	20DACa07**	Perturbation theory based on realistic tracking codes	2	In this course we explain how a perturbation theory centred on and perfectly adapted to a tracking code is nearly totally independent of the models found in the code itself. This theory covers transverse dynamics with or without (stochastic) radiation, spin and periodically modulated magnets. All the known concepts of (non)linear perturbation theory are revisited. The theoretical framework is universal so that one does not have to learn something new to go from Courant–Snyder theory to spin functions. The Hamiltonian theory of Guignard–(Deprit–Hori) also falls out.	NISHIKAWA, Patrice
	20DACa02**	Analysis of Electromagnetic Field of Beams	2	In accelerators, a beam interacts electromagnetically with its surrounding structures such as accelerating cavities and produces electromagnetic fields called wake fields. The wake fields then act back on the beam behavior and may cause an unstable collective motion of the beam. In the present class, I will lecture on the basic of the wake field theory as well as its application, including the numerical computation method of wake fields in the existence of a beam.	
	20DACa03**	Theory of Collective Motion of Beams	2	Comprehensive study of theoretical analysis and measurements about beam–beam effects and beam instabilities.	
	20DACa04**	Generation of Synchrotron Radiation	2	Generation mechanism of synchrotron radiation will be explained based on the Maxwell's equation. Characteristics of radiation from various kind of sources will be introduced together with some interesting accelerator projects for synchrotron radiation.	NAKAMURA, Norio TSUCHIYA, Kimichika
Beam Development	20DACb01**	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.	TOBIYAMA, Makoto OBINA, Takashi
	20DACb02**	Beam measurement with photons	2	This course will cover the theory and techniques needed for the measurement of charged–particle beam properties using synchrotron radiation in both visible and x–ray regions. Theoretical topics covered include: characteristics of synchrotron radiation, geometrical optics, and wavefront propagation. Measurement techniques such as imaging and interferometry will be studied, as well as specific technologies required, such as gated cameras, streak cameras, x–ray detectors, etc.	
	20DACb03**	An introduction to development of beam performance	2	The goal of this lecture is to understand what methods have been effective to improve performance of the existing colliding accelerators and to deliberate effectiveness of those methods in the future machines. To this end, we start with the beam physics as a basis of the beam operation and move on to a quick look at methods of the beam operation such as beam diagnostics and luminosity tuning at KEKB. Based on those, we will discuss issues of the future colliders.	
	20DACb04**	Advanced Course for Beam Stability	2	This course introduces collective beam instabilities caused by electromagnetical interaction of the beam with surrounding structures in the beam pipe. We learn detail phenomena of the instabilities on the basis of the theory, and also method for the suppression of them will be introduced in this course.	KOBAYASHI, Tetsuya

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Beam Development	20DACb05**	Optics and its application for beam measurements	2	The beam measurements to observe the various parameters of the beam are extremely important to understand the state of the beam in the particle accelerator. In the beam measurement, we observe the electromagnetic signal naturally emitted from the beam or to observe a signal emitted as a result of some perturbation to a beam. In this lecture, we learn the optics and its application for beam measurements using the light which is one of electromagnetic signal in the accelerator. In the optical beam measurement, a wide variety of measurement such as the static and dynamical observation for transverse and longitudinal profile or size of the beam, and observation of the vibration of the beam such as optical BBQ are performed. In the first, the summary of the optical beam measurements in the accelerators are introduced. In the second, we learn an introduction to the geometrical optics and the wave optics. As application of geometrical and wav optics, we learn about the beam measurement by the imaging system. In the next, for the understanding to the beam measurement using the coherent property of the light, we learn about an introduction to the quantum optics and coherence of the light. After leaning these basic courses, we lean the physics of the synchrotron radiation begin with the d'Alembert equation. We also include some other possible light sources such as the transition radiation in here. Then, we proceed to learn about a beam measurement in the inverse space using the coherence of the light which is called interferometry. In the last, we learn about recent special topics in the optical beam measurement including the optical beam measurements in the future accelerators.	MITSUHASHI, Toshiyuki
Design of Accelerator Projects	20DACc01**	An introduction to designing accelerator	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.	ONISHI, Yukiyoshi
	20DACc02**	Advanced course for linear accelerator design	2	Lectures on linear accelerators (linac) with particular emphasis upon electron linacs using microwaves. They will cover not only underlying theories of linacs but various beam diagnostic methods comprising techniques of beam tuning and controls.	MATSUMOTO, Shuji
	20DACc03**	Design of Circular Accelerators	2	Lectures on design of circular accelerators, mainly design of beam optics based on single particle dynamics.	
	20DACc04**	Basic lecture on synchrotron radiation light sources	2	This lecture is aimed to obtain basic knowledge on a lattice design of synchrotron radiation sources.	HARADA, Kentaro
	20DACc05**	Advanced course for proton accelerators	2	Lectures on the beam optics of the high power proton accelerator J-PARC and related beam dynamics. They include designs and characteristics of J-PARC accelerator components.	HOTCHI, Hideaki
	20DACc06**	Collider Accelerators	2	The design characteristics of ring collider and linear collider are lectured. The main operational parameter, luminosity, is the highest priority in the collider accelerator. In order to achieve high luminosity, required beam technologies and countermeasure technologies against beam instabilities in the collider are lectured by supplying understanding of physical process of beam instabilities and by showing realistic examples.	

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Design of Accelerator Projects	20DACc08**	Next-Generation Accelerating Structure Developments for Energy-Frontier Experiments	2	This lecture focuses on high-gradient accelerating structure developmens for future energy-frontier experiments, including: 1. Fundamentals of RF acceleration and cavity 2. Fundamentals of RF high-power sources 3. Developments of normal-conducting high-gradient accelerating tubes – Materials and machining – Surface finishing and cleaning technologies – Bonding and assembly technologies 4. Physics of vacuum breakdown which determines breakdown rates 5. RF conditioning process 6. Application to next-generation advanced accelerators and perspectives	
Accelerator Technology	20DACd01**	An Introduction to Electronics	2	A series of this lecture provides a comprehensive introduction to the basic theory of electrical circuits for students in the accelerator sciences. The methods of circuit analysis are clearly explained and illustrated with the aid of numerous worked examples. Applications of the theory relevant to the fields of accelerator technologies and researches are treated throughout. The lecture contents covered in the 1st semester (half a year) are that electric-circuit basic, transmission-line circuits, electrical transient response, feedback circuits, electronic-circuit basic, signal detection techniques, etc.	SUWADA, Tsuyoshi
	20DACd02**	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.	FURUKAWA, Kazuro KAMIKUBOTA, Norihiko SATOH, Masanori YAMADA, Shuei
	20DACd03**	Introduction to superconducting technology and cryogenics engineering	2	Basics and applications of superconducting technology and cryogenic engineering: Basics of the superconducting technology and cryogenics engineering for accelerator science will be lectured. Application of superconducting magnets and superconducting RF cavities will be introduced.	OGITSU, Toru NAKANISHI, Kota
	20DACd04**	Cryogenics Engineering with a seminar	2	It aims to study on the basic knowledge of the low temperature technology through the design method of the cryostat indispensable to design the superconducting equipment. The example of the cryostat for the superconducting equipment that has been produced is taken up in the lecture, and structure and thermal insulation technique, etc. that are the design points are examined in detail. A small cryostat is designed as a seminar.	
	20DACd05**	Advanced Course for Refrigeration Techniques	2	Fundamentals of helium liquefier/refrigerator for superconducting devices in accelerators, and an introduction to superfluid helium refrigeration systems.	NAKAI, Hirotaka
	20DACd06**	Introduction to Electron Beam Sources	2	Design of electron beam sources (electron guns) and related new developments, such as photocathode guns and rf guns.	YOSHIDA, Mitsuhiro

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Science of Magnetics	20DACe01**	Introduction to magnets	2	Lectures on magnetization of ferromagnetic substances and magnetic flux circuits.	MASUZAWA, Mika
	20DACe02**	Advanced course on magnets design and measurements	2	Lectures on fundamental design of magnets, and detailed computer-based designing. Precision measurement of magnetic fields is also covered.	MASUZAWA, Mika, HARADA, Kentaro
	20DACe03**	Introduction to magnet power supplies	2	Introduction to accelerator magnet power supplies. Lectures cover high power, high current pulsed power supplies and DC power supplies, as well as resonant networks for high-repetition-rate magnets.	MIMASHI, Toshihiro OKI, Toshiyuki NAKAMURA, Shu
	20DACe04**	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.	NAKAMOTO, Tatsushi
Science of Radio-Frequency Acceleration	20DACf01**	Advanced Course for Beam Acceleration Science	2	Basic concepts of the wake field, impedance and beam-loading and technologies to cure them by acceleration cavity design and control technique.	MORITA, Yoshiyuki
	20DACf02**	Advanced Course for Superconducting Cavities	2	Design principles, fabrication technology and operational aspect of superconducting cavities for light sources, colliding accelerators and other accelerators.	UMEMORI, Kensei SAKAI, Hiroshi SAEKI, Takayuki
	20DACf03**	Advanced Course for High Power Microwave Engineering	2	Basic technologies for generation, transmission and control of high power rf systems.	MICHIZONO, Shinichiro
Vacuum Science and Technologies	20DACg01**	Basic concepts of vacuum science and technology	2	Outline of gas molecule dynamics, molecular flow, gas-surface interactions are introduced. Methods of vacuum pressure measurement and characteristic properties of the materials for use as vacuum components are also presented.	SUETSUGU, Yusuke
	20DACg02**	Vacuum science and technologies applied to 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.	SUETSUGU, Yusuke SHIBATA, Kyo TANIMOTO, Yasunori YAMAMOTO, Masahiro ISHIBASHI, Takuya
Computer Science	20DACh01**	Introduction to Computer 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.	ICHII, Shingo IWAI, Go NAKAMURA, Tomoaki YONAMINE, Ryo
	20DACh02**	Software Engineering	2	This course covers wide field of software engineering such as software development methodologies, computer languages and database.	SASAKI, Takashi MATSUNAGA, Hiroyuki
	20DACh04**	Data acquisition and analysis methods in High Energy Physics	2	This course covers the methodologies on on-line data acquisition and analysis techniques in High Energy Physics.	MANABE, Atsushi SUZUKI, Soh SUZUKI, Jiro
	20DACh05**	High Performance Computing	2	The course covers the hardware/software techniques and applicationsfor computers with a high level of performance as compared to a general-purpose computer.	MATSUFURU, Hideo SHIBATA, Akihiro

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Radiation Science	20DACi01**	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.	IWASE, Hiroshi SAKAKI, Yasuhito
	20DACi02**	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.	SANAMI, Toshiya SAITO, Kiwamu KISHIMOTO, Yuji
	20DACi03**	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.	BESSHO, Kotaro TAKECHI, Hideaki
	20DACi04**	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.	MATSUMURA, Hiroshi YOSHIDA, Go
	20DACi05**	Lecture of Radiation Simulation by Monte Carlo Code	2	Students learn the basic techniques, and methods to provide numerical quantities of radiation simulation by Monte Carlo code.	IWASE, Hiroshi MURAKAMI, Koichi
	20DACi06**	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.	IWASE, Hiroshi OKADA, Shogo
Mechanical Engineering for Accelerator Development	20DACj01**	Introduction to Mechanical 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.	YAMANAKA, Masashi
	20DACj02**	Fundamentals of Mechanical Machining	2	This course provides an introduction to ultra-precision machining, precision measurement and machining/grinding of the primary parts of accelerator cavities and structures.	YAMANAKA, Masashi
	20DACj03**	Fundamentals of Surface Engineering	2	Surface treatment, bonding technology and welding technology for manufacturing accelerator structures and cavities; the physics of surface cleanness, diffusion physics, solid bonding and welding are covered from the viewpoints of both mechanical engineering and the evaluation of the structure or cavity.	
	20DACj04**	Fundamentals of Material Science	2	Metallic materials, metallic material crystallography, and elastoplasticity based on structure performance are covered from the viewpoints of both mechanical engineering and the evaluation of the structure or cavity.	YAMANAKA, Masashi
Common cources	20DACk01**	Special Exercise for Accelerator Science ⅠA	2	Exercise on accelerator science.	All Faculty Members
	20DACk02**	Special Exercise for Accelerator Science ⅠB	2		
	20DACk03**	Special Exercise for Accelerator Science ⅡA	2		
	20DACk04**	Special Exercise for Accelerator Science ⅡB	2		
	20DACk05**	Special Exercise for Accelerator Science ⅢA	2		
	20DACk06**	Special Exercise for Accelerator Science ⅢB	2		
	20DACk07**	Special Research for Accelerator Science ⅣA	2	Exercise on accelerator science.	All Faculty Members
	20DACk08**	Special Research for Accelerator Science ⅣB	2		
	20DACk09**	Special Research for Accelerator Science ⅤA	2		
	20DACk10**	Special Research for Accelerator Science ⅤB	2		

A two-digit number or letter will be entered to ** according to the semester or the lecturer in charge.