報　告

Educational Activities in the Academic Year 2019

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1．Introduction

The use of UTR-KINKI in the academic year 2019（April 1, 2019 – March 31, 2020）started in May. The reactor and its facility had no trouble throughout the year and was fully utilized for the planned educational activities.

2．Higher Education

2．1　Kindai University

UTR-KINKI is used for one of the compulsory subjects, "Energy and Environment Experiment", in the curriculum of Energy and Environment Course, Department of Electric and Electronic Engineering, Faculty of Science and Engineering. The subject includes a lecture on nuclear reactor basics, facility tour of UTR-KINKI, reactor operation and neutron radiography. 92 students took the subject which was offered in the second semester of the academic year 2019.

Fifteen undergraduate forth year students from Department of Electric and Electronic Engineering and Department of Life Science, Faculty of Science and Engineering and four graduate students from Graduate School of Science and Engineering Research conducted their researches using UTR-KINKI for theses. These students were also encouraged to obtain a qualification of co-operator, with which one can operate the reactor under the supervision of a qualified reactor operator. In the academic year 2019, nineteen students completed a prescribed training course to be qualified as a co-operator of UTR-KINKI.

2．2　Training Workshop for Other Universities

Six training workshops were held for graduate and undergraduate students in the academic year 2019, in which 79 students from six universities participated. Part of the workshops were held under the International Nuclear Human Resource Development Initiative Program funded by the Ministry of Education, Culture, Sports, Science and Technology（MEXT）of Japan. The contents of the workshop were selected from the following subjects based on the request of the participating university.

Undergraduate and graduate students operated UTR-KINKI by themselves and conducted various experiments.

A. safety instruction
B. tour to UTR-KINKI
C. reactor operation
D. rod worth measurement
E. neutron and γ-ray dose rate monitoring
F. neutron flux measurement by activation
G. leakage γ-ray spectrometry
H. neutron flux mapping
I. neutron radiography
J. Aluminum foil activation and half-life measurement
K. approach to criticality
L. others

The training workshops held in the academic year 2019 are summarized in Table. 1.

2．3 MEXT International Nuclear Human Resource Development Initiative Program

Kindai University received a new funding for a three-year educational program (2019-2021) from International Nuclear Human Resource Development Program by MEXT. The title of the program is "The enhancement of training system for the effective use of educational nuclear reactors". The member universities of the program are Kindai University, Kyoto University, Kyushu University, Nagoya University, University of Fukui, Tokai University, Tokyo City University and Kyung Hee University (Korea).

The program offers two kinds of workshop, one is Basic Reactor Experiment Workshop provided by Kindai University and the other is International Reactor Experiment Workshop provided by Kyung Hee University in South Korea.

The program also includes the development of remote reactor experiment system for UTR-KINKI, which aims to provide students in remote university classrooms with practical reactor experiments. We developed Virtual Console using NI LabVIEW, which shows reactor operation parameters of UTR-KINKI on a PC such as rod positions and detector outputs from the nuclear instrumentation system by extracting and digitizing signals from the real reactor console. Real time views of Virtual Console and the reactor are sent from the reactor control room to remote classrooms via internet video conference system. We still believe that hands-on experiments are the most effective way to educate and train students, but the opportunities for students to participate in hands-on classes are becoming limited unfortunately, due to limited travel expenses and tightening nuclear regulations. The

Table 1. Training workshops held for graduate and undergraduate program.

No.	University	Date	Students	Contents
1	Nagoya University	July 16-17	9	A B C D E F G I
2	Osaka University	August 30	9	A B C D K
3	Fukui Institute of Technology	September 11-13	25	A B C D
4	Tokyo Metropolitan University	September 24-25	9	A B F L**
5	Tokai University*	December 4-6	17	A B C D E F H I J
6	Tokyo City University*	December 14-15	10	A B C E I J
	total		79	

* MEXT International Nuclear Human Resource Development Initiative Program (Kindai University, AY2019-2021)

** Neutron Measurement with a BF_3 counter

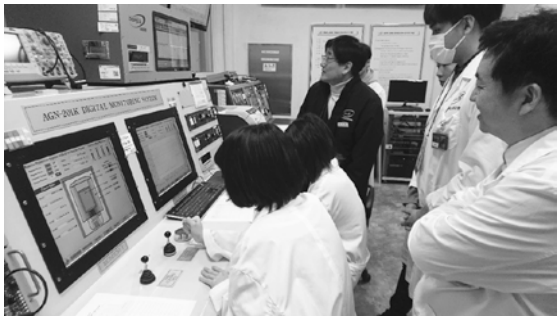
developed system will be a tool to expand the opportunities to provide students with practical reactor experiments.

(1) Basic Reactor Experiment Workshop

This workshop aimed to evoke participating students' interest and encourage them to pursue careers in nuclear science and technology. Therefore, the program mainly consists of basic level experiments on reactor physics and radiation measurement using UTR-KINKI. Two workshops were held under this program, in which 27 students from two universities participated as shown in Table 1 in the previous section. All the lectures and experiments were given in Japanese.

(2) International Reactor Experiment Workshop

This workshop was held from January 6 to 9 at the Reactor Research and Education Center (RREC) of Kyung Hee University. The workshop was a four-day program in which students experience basic reactor physics experiment using the education-oriented research reactor, AGN-201K (rated thermal power: 10 W). The schedule of the workshop is shown in Table 2. Seven students from three universities participated in the workshop. All the lectures and experiments were given in English, and the students developed their international communication skills through working with Korean professors and students.



Seven students from Japan participated in the reactor experiment program held at Kyung Hee University, Korea.

Table 2. The schedule of reactor experiment program at Kyung Hee University

day	time		contents
1	AM		From Japan to Incheon International Airport (flight)
	13:00		From Incheon International Airport to Kyung Hee University (bus)
	15:30	LEC	Opening Ceremony & Introduction to RREC
	16:00	LEC	Safety Instruction & Introduction to AGN-201K / Gold wire loading and irradiation for EXP2
	18:00		Welcome Reception
2	9:00	EXP1	Reactor Operation Practice (search for critical rod position)
	12:00		Lunch
	13:00	EXP2	Critical Mass Approach (1/M Experiment)
	16:00		Preparation of Presentation
3	9:00		Presentation and Discussion for EXP1&2
	10:30	EXP3	Thermal Flux Measurement (Neutron Activation Analysis)
	13:00		Lunch
	14:00	EXP4	Temperature Feedback and Reflector Effect Measurement
	17:00		Tour to Hwaseong, Preparation of Presentation
4	9:00		Presentation and Discussion for EXP3&4
	10:00		Wrap-up Session
	11:00		Campus Tour and Lunch
	15:00		From Kyung Hee University to Incheon International Airport (bus)
	17:00		From Incheon International Airport to Japan (flight)

3. Secondary Education

3. 1 Training Workshop for Teachers

Science teachers learned how a nuclear reactor works by operating UTR-KINKI by themselves.

Training workshop for teachers began in 1987 and has been continued for more than thirty years. The aim of the workshop is to provide teachers with scientifically correct knowledge on nuclear science and technology through experiencing experiments on a real nuclear reactor and radiation measurements. In the academic year 2019, five training workshops were held in summer, in which 67 teachers participated. The summary of the workshops is shown in Table 3.

(1) Training Workshop for Science Teachers (co-hosted by the Japan Atomic Industrial Forum)

Two workshops were held in cooperation with the Japan Atomic Industrial Forum (JAIF), in which teachers participated from all over the country. The schedule of the workshop is shown in Table 4.

(2) Training Workshop for Science Teachers (co-hosted by the Kansai Atomic Conference)

Two workshops were held in cooperation with the Kansai Atomic Conference (KAC), in which teachers participated from the Kinki region (includes the prefectures of Osaka, Kyoto, Hyogo, Wakayama, Shiga, Nara, Mie) and Fukui Prefecture. The schedule of the workshop is shown in Table 5.

(3) Workshop for Teaching License Renewal

This workshop is annually held as one of the teaching license renewal programs offered by Kindai University. Though the workshop targeted secondary school science teachers, other teachers who are interested in nuclear science and technology were also accepted upon request. Twenty teachers participated in the workshop. The schedule of the workshop is shown in Table 6.

Table 3. Summary of training workshop for teachers held in the academic year 2019.

No.	workshop	date	participants
1	Training workshop for science teachers (co-hosted by KAC)	July 29-30	15
2	Training workshop for science teachers (co-hosted by JAIF)	August 5-6	13
3	Training workshop for science teachers (co-hosted by KAC)	August 7-8	6
4	Workshop for teaching license renewal	August 22-23	20
5	Training workshop for science teachers (co-hosted by JAIF)	August 28-29	13
	total		67

Table 4. The schedule of training workshop for science teachers (co-hosted by JAIF).

day	time		contents
1	12:00		Opening Ceremony (15 min)
	12:15	LEC	Safety Instruction (30 min) + Break (10 min)
	12:55	LEC	Tour to UTR-KINKI (45 min) + Break (10 min)
	13:50	LEC	Nuclear Reactor Basics (60 min) +Break (10 min)
	15:00	EXP	Reactor Operation (90 min)
	16:30	EXP	Neutron Radiography (60 min)
	17:30		Free Discussion (60 min)
2	9:30	LEC	Radiation Basics (60 min) + Break (10 min)
	10:40	EXP	Environmental Radiation Measurement (90 min)
	12:10		Lunch
	13:00	EXP	Radiation Properties (90 min) + Break (10 min) (radiation shielding, inverse square law)
	14:40	LEC	Radiation Applications (60 min) + Break (10 min)
	15:50	LEC	Health Effect of Radiation (60 min)
	16:50		Closing Ceremony (30 min)

Table 5. The schedule of training workshop for science teachers (co-hosted by KAC).

day	time		contents
1	10:00		Opening Ceremony (15 min)
	10:15	LEC	Radiation Basics (60 min) + Break (10 min)
	11:25	LEC	Safety Instruction (30 min)
	11:55		Lunch
	12:45	LEC	Tour to UTR-KINKI (60 min) + Break (10 min)
	13:55	LEC	Nuclear Reactor Basics (60 min) + Break (10 min)
	15:05	EXP	Reactor Operation (90 min) + Break (10 min)
	16:45	EXP	Neutron Radiography (60 min)
	17:45		Free Discussion (45 min)
2	9:30	LEC	Radiation Applications (60 min) + Break (10 min)
	10:40	EXP	Environmental Radiation Measurement (90 min)
	12:10		Lunch
	13:00	EXP	Radiation Properties (90 min) + Break (10 min) (radiation shielding, inverse square law)
	14:40	LEC	Health Effect of Radiation (60 min) + Break (10 min)
	15:50		Discussion on Radiation Education (Presentation of practical examples by participating teachers) (60 min)
	16:50		Closing Ceremony (30 min)

Table 6. The schedule of workshop for teaching license renewal.

day	time		contents
1	9:20		Opening Ceremony (10 min)
	9:30	LEC	Nuclear Reactor Basics (60 min)
	10:30	LEC	Safety Instruction and Tour to UTR-KINKI (60 min)
	11:30		Lunch
	12:40	EXP	Reactor Operation (120 min)
	14:40		Break (15 min)
	14:50	EXP	Neutron Radiography (120 min)
2	9:30	LEC	Radiation Properties and Radiation Applications (60 min)
	10:30	EXP	Radiation Measurement (120 min)
	12:30		Lunch
	13:40	EXP	Cloud Chamber (60 min)
	14:40		Break (10 min)
	14:50	LEC	Health Effect of Radiation (60 min)
	15:50		Break (10 min)
	16:00		Examination (60 min)
	17:00		Closing Ceremony (15 min)

3．2 Workshop for High School Students

Two workshops were held for high school students to encourage young generation to pursue careers in nuclear science and technology. The both workshops included reactor operation where high school students operated the reactor by themselves under the supervision of university staff. The summary of the workshop and contents is shown in Table 7.

Table 7. The summary of the workshops held for high school students.

No.	High School	Date	Students	Contents
1	Kainan Senior High School	October 29-30	36	Safety instruction Tour to UTR-KINKI Reactor operation Neutron radiography Aluminum foil activation and half-life measurement
2	Otemae Senior High School	December 11	20	Safety instruction Tour to UTR-KINKI Reactor operation Lecture “Future of nuclear energy”

4．Other Educational Activities

4．1 Training for New Employees of Chiyoda Technol Corporation

A two-day workshop was held for the training of new employees of Chiyoda Technol Corporation from April 13 to 14. The workshop aimed to give all around knowledge on nuclear reactor and radiation from principles to applications through lectures and experiments. 22 trainees participated in the workshop. The schedule of the workshop is shown in Table 8.

Table 8. The schedule of the workshop for new employee training of Chiyoda Technol Corp.

day	Time		contents	
1	13:00		Opening Ceremony	
	13:15	LEC	Basic Reactor Physics	
	14:15	LEC	Safety Instruction	
	14:45	LEC	Tour to UTR-KINKI	
	15:30	EXP	(Group A) Reactor Operation	(Group B) Neutron Radiography
	18:00		Workshop Reception	
2	9:30	LEC	Radiation Basics	
	10:20	EXP	(Group A) Neutron Radiography	(Group B) Reactor Operation
	12:20		Lunch	
	13:20	EXP	Environmental Radiation Measurement	
	14:40	EXP	Radiation Properties (radiation shielding, inverse square law)	
	16:00	LEC	Health Effect of Radiation	
	17:00		Closing Ceremony	

4．2 Training for HTTR Operators

A training workshop for the operators of High Temperature engineering Test Reactor (HTTR) was held for three days from June 24. HTTR is a 30 MW gas-cooled research reactor operated by Japan Atomic Energy Agency (JAEA). The reactor had been operated since 1998, but it stopped operation in 2011 due to the impact of Great East Japan Earthquake. Since then, the reactor has been shut down to have safety reviews under the new regulatory standards established after the Fukushima Daiichi nuclear power plant accident. The workshop was planned and held to provide HTTR operators who has no experience in reactor operation after 2011 with opportunities to experience reactor physics experiments with a real nuclear reactor. The schedule of the workshop is shown in Table 9.

Table 9. The schedule of the workshop for HTTR operators

day	Time		contents
June 24	13:30	13:40	Opening Ceremony
	13:40	14:30	Safety Instruction
	14:30	15:50	Tour to UTR-KINKI
	15:50	16:00	Break
	16:00	18:00	Lecture on Rod Worth Measurement (rod drop method, positive period method, inverse kinetics method)
June 25	10:00	12:00	Reactor Operation
	12:00	13:00	Lunch
	13:00	14:20	Reactor Operation
	14:20	16:20	Rod Drop Method
	16:20	18:00	Data Analysis
June 26	10:00	12:00	Positive Period Method
	12:00	13:00	Lunch
	13:00	14:20	Data Analysis
	14:20	15:00	Report and Presentation
	15:00	15:30	Closing Ceremony

4．3 International Seminar

International seminar was held at Kindai University as part of Instructor Training Program of Nuclear Human Resource Development Center, Japan Atomic Energy Agency (JAEA) on October 8. Eleven trainees from eight Asian countries (Indonesia, Bangladesh, Kazakhstan, Malaysia, Mongolia, Thailand, Turkey and Vietnam) participated in the seminar and experienced reactor operation, rod worth measurement and neutron radiography with related lectures. All the lectures and experiments were given in English. The schedule and contents of the seminar are shown in Table 10.

Participants from Asian countries conducted various experiments with UTR-KINKI in the international seminar.

Table 10. The schedule of International Seminar

Time		contents
9:00	9:10	Opening Address
9:10	9:40	Safety Instruction
9:40	9:50	Break
9:50	10:30	Tour to UTR-KINKI
10:30	13:00	Reactor Operation and Reactivity Measurement
13:00	14:00	Lunch
14:00	16:00	Neutron Radiography
16:00	16:30	Closing Session

Participants of IAEA Regional Research Reactor School conducted various experiments with UTR-KINKI.

4．4 IAEA Regional Research Reactor School

Regional Research Reactor School in Japan was held for the first time in association with International Atomic Energy Agency (IAEA) at Kindai University. The school was held for two weeks and co-hosted by Kyoto University and Wakasa-wan Energy Research Center. The target of the school was young professionals with technical degree in nuclear engineering, nuclear science and related fields, and the aim was to develop technical skills and provide basic backgrounds to carry out activities related to the safe operation of research reactors. Ten participants from seven countries (Australia, Indonesia, Russia, South Africa, Thailand, Vietnam and Zambia) participated in the school and experienced hands-on classes including reactor operation, neutron flux measurement and neutron radiography using UTR-KINKI as well as theoretical classes. The schedule and contents of the school at Kindai University are shown in Table. 11

Table 11. The schedule and contents of IAEA Regional Research Reactor School at Kindai University (July 24-26)

day	Time		contents
June 24	9:30	9:45	Opening Session
	9:45	10:30	Safety Instruction
	10:30	10:45	Coffee Break
	10:45	11:30	Technical Tour of UTR-KINKI
	11:30	13:00	Lunch
	13:00	14:00	Lecture on Reactor Operation
	14:00	14:15	Coffee Break
	14:15	16:00	Experiment 1: Reactor Operation
	16:00	16:30	Discussion Session
	16:30	17:00	Coffee Break
	17:00	19:00	Reception
June 25	9:30	10:30	Lecture on Neutron Flux Measurement
	10:30	10:45	Coffee Break
	10:45	11:30	Experiment 2-1: Sample Preparation
	11:30	13:00	Lunch and Experiment 2-2: Sample Irradiation
	13:00	16:00	Experiment 2-3: Measurement and Data Analysis
	16:00	16:30	Discussion Session
June 26	9:30	10:30	Lecture on Neutron Radiography
	10:30	10:45	Coffee
	10:45	12:00	Experiment 3: Neutron Radiography
	12:00	13:30	Lunch
	13:30	15:00	Presentation of Experimental Results and Closing Session

5. Conclusion

UTR-KINKI was fully utilized throughout the academic year 2019 for educational activities, in which 363 people participated in total. As many research reactors in Japan are still in the state of temporary shutdown for continued safety reviews under the new regulatory standard established after the Fukushima Daiichi nuclear power plant accident, the role of UTR-KINKI as an educational resource in nuclear science and technology in Japan has become more important than ever. Atomic Energy Research Institute will operate UTR-KINKI as long as possible and utilize it in various educational activities.