

報 告

Educational Activities in the Academic Year 2017

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1. Introduction

UTR-KINKI had stopped its operation for three years since February 2014 to undergo safety reviews based on the new regulatory standard for research reactors established after the Fukushima nuclear power plant accident. On March 17, 2017, completing all the reviews and inspections, UTR-KINKI became the first research reactor that was allowed to resume operation under the new regulatory standard in Japan. On April 12, 2017, the first workshop after the restart was held for selected Kindai University's students, in which they experienced reactor operation and rod worth measurement. Following the first workshop, all the educational activities previously planned were fully conducted in the academic year 2017 (from April 2017 to March 2018).



Atomic Energy Research Institute completed all the reviews and inspections for UTR-KINKI under the new regulation standard for research reactors on March 17, 2017.



UTR-KINKI resumed operation for the first time in three years on April 12, 2017.

2. Higher Education

2. 1 Kindai University's Curriculum

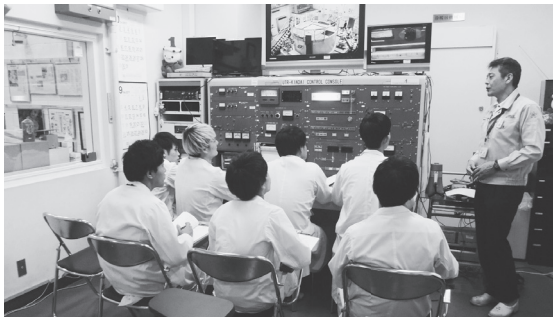
UTR-KINKI was used for one of the compulsory subjects, "Energy and Environment Experiment", in the curriculum of Energy and Environment Course, Department of Electric and Electronic Engineering, Faculty of Science and Engineering. The subject included a lecture on nuclear reactor basics, facility tour of UTR-KINKI, reactor operation and neutron radiography. The course is offered in the second semester of the third year, and 95 students participated in the course in the academic year 2017.

In addition to the above laboratory experiment, fifteen undergraduate fourth year students from Department of Electric and Electronic Engineering and Department of Life Science, Faculty of Science and Engineering and six graduate students from Graduate School of Science and Engineering Research used UTR-KINKI in their researches for thesis. Students

who use UTR-KINKI for their researches are encouraged to obtain a qualification of co-operator, with which students can operate the reactor by themselves under the supervision of a qualified reactor operator. In the academic year 2017, eighteen students completed a prescribed training course and qualified as a co-operator of UTR-KINKI.

In summer holidays, a special one-day workshop was held for the members of Energy Research Club (an extra-curricular activity organized by the students of Faculty of Science and Engineering) , in which fifteen students experienced reactor operation and neutron radiography.

2. 2 Training Workshop for Undergraduate and Graduate Students



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

Twelve training workshops were held for graduate and undergraduate students in the academic year 2017, in which 169 students including six teaching assistants from twelve 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 universities.

- 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. source jerk method
- M. inverse kinetics analysis
- N. reactor noise analysis
- O. others

The training workshops held in the academic year 2017 are summarized in Table. 1.

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

No.	University	Date	Students	Contents
1	Kindai University	April 12	8	A B C D E
2*	Kindai University Kyoto University Osaka University	June 12-13	9	A B C D E F H I
3*	Nagoya University	June 26-27	14 (2)	A B C D E F G I
4	Osaka University	September 1	10	A B D K
5	Tokyo Metropolitan University	September 11-12	14	A B C F I
6	Fukui Institute of Technology	September 13-15	33	A B C D
7*	Kyushu University	September 19-20	15 (2)	A B C D E F G H I
8*	University of Fukui Kindai University	September 27-28	9	A B C D E I K
9*	Kindai University Nagoya University University of Fukui Kyung Hee University	November 7-10	11	A B K L M N
10*	Tokyo City University	December 9-10	15 (2)	A B C E I J
11	Tokai University	December 12-16	20	A B C D E F H I J
12**	Osaka Prefectural University	January 30	5	A I O***
Total			163 (6)	

The number in the parenthesis shows the number of teaching assistants.

* MEXT International Nuclear Human Resource Development Initiative Program (Kindai University, AY2016-2018)

** MEXT International Nuclear Human Resource Development Initiative Program (Osaka Prefectural University, AY2015-2017)

*** Neutron imaging with a cooled CCD camera

2. 3 MEXT International Nuclear Human Resource Development Initiative Program

Kindai University received a funding for a three years educational program (AY2016-2018) from International Nuclear Human Resource Development Program by MEXT. The title of the program is "International Workshop Utilizing Educational Nuclear Reactors in Japan and Korea". The program consists of three kinds of workshop, in which participating students are able to experience experiments on reactor physics and radiation measurement from basic to advanced levels using two education-oriented research reactors in Japan and Korea. The member universities of this program are Kindai University, Kyoto University, Kyushu University,

Nagoya University, University of Fukui, Tokyo City University and Kyung Hee University (Korea).

(1) Nuclear Energy Training Workshop (Basic)

This workshop aimed to evoke participating students' interest and encourage them to pursue careers in nuclear science and technology. Therefore, the program mainly consisted of basic level experiments on reactor physics and radiation measurement using UTR-KINKI. Five workshops were held under this program, in which 68 students including six teaching assistants from seven universities participated as shown in Table 1 in the previous section. All the lectures and experiments were given in Japanese.

(2) Nuclear Energy Training Workshop
(Advanced)



Students conducted reactor physics experiments in the advanced nuclear energy workshop.

This international workshop was a four days program which consisted of rather professional reactor physics experiments. The workshop also aimed to develop communication skills in English and included English presentation seminar in which participating students learned useful skills for academic presentation in English as well as frequently used expressions and technical terms in nuclear science and technology. As is shown in Table 1 (No. 9) in the previous section, the

workshop was held from November 7 to 10, in which eleven students from four universities participated. All the lectures and experiments were given in English. The schedule of the workshop is shown in Table 2.

The travel expenses for participants from Korea were supported by the donated fund from Chiyoda Technol Corporation, because the MEXT budget only covers the fee for students who reside and study in Japan.

(3) Reactor Experiment Program at Kyung Hee University



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

Table 2. The schedule of Nuclear Energy Training Workshop (Advanced)

day	time		contents
	14:00		Opening Ceremony & Introduction (15 min)
	14:15	LEC	Safety Instruction (30 min) Break (10 min)
1	14:55	LEC	Tour to UTR-KINKI Break (10 min)
	16:00	LEC	English Presentation Seminar (90 min)
	17:30		Check-in to Guest House
	18:00		Welcome Reception
	9:30	EXP	Critical Approach and Subcriticality Measurement (210 min)
2	13:00		Lunch
	14:00		Data Analysis and Preparation of Presentation (180 min)
	17:00		Free time
	9:30	EXP	Rod Worth Measurement and Reactor Noise Analysis (210 min)
3	13:00		Lunch
	14:00		Data Analysis and Preparation of Presentation (180 min)
	17:00		Free time
4	9:30		Presentation and Discussion, English Presentation Seminar (120 min)
	11:30		Closing Ceremony (30 min)

This workshop was held from July 18 to 21 at the Reactor Research and Education Center (RREC) of Kyung Hee University, Korea. The workshop was a four days 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 3. Thirteen students including one teaching assistant from five 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.

Table 3. 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 Gold wire loading and irradiation for AGN-201K EXP2
	18:00	Welcome Reception
2	9:00	EXP1 Reactor Operation Practice (search for critical rod position)
	12:00	Lunch
	13:00	EXP2 Thermal Flux Measurement (Neutron Activation Analysis)
	16:00	Preparation of Presentation
3	9:00	Presentation and Discussion for EXP1&2
	10:30	EXP3 Critical Mass Approach (1/M Experiment)
	13:00	Lunch
	14:00	EXP4 Temperature Feedback and Reflector Effect Measurement
	17:00	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 2017, five training workshops were held in summer, in which 68 teachers participated. The summary of the workshops is shown in Table 4.

Table 4. Summary of training workshop for teachers held in the academic year 2017.

No	workshop	date	participants
1	Training workshop for science teachers (co-hosted by KAC)	July 24-25	15
2	Training workshop for science teachers (co-hosted by JAIF)	July 28-29	8
3	Training workshop for science teachers (co-hosted by KAC)	July 31-August 1	11
4	Workshop for teaching license renewal	August 5-6	19
5	Training workshop for science teachers (co-hosted by JAIF)	August 21-22	15
total			68

- (1) Training Workshop for Science Teachers (co-hosted by the Japan Atomic Industrial Forum) which participants are recruited from all over the country. The schedule of the workshop is shown in Table 5.
- Two workshops were held in cooperation with the Japan Atomic Industrial Forum (JAIF), to

Table 5. 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)

- (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), to which participants were recruited 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 6.

Table 6. The schedule of training workshop for science teachers (co-hosted by KAC).

day	time		contents
	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
1	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)
	9:30	LEC	Radiation Applications (60 min) + Break (10 min)
	10:40	EXP	Environmental Radiation Measurement (90 min)
	12:10		Lunch
2	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)

(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.

Nineteen teachers participated in the workshop.

The schedule of the workshop is shown in Table 7.

Table 7. The schedule of workshop for teaching license renewal.

day	time		contents
	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)
1	11:30		Lunch
	12:45	EXP	Reactor Operation (120 min)
	14:45		Break (15 min)
	15:00	EXP	Neutron Radiography (120 min)
	9:30	LEC	Radiation Properties and Radiation Applications (60 min)
	10:30	EXP	Radiation Measurement (120 min)
	12:30		Lunch
2	13:45	EXP	Cloud Chamber (60 min)
	14:45		Break (10 min)
	14:55	LEC	Health Effect of Radiation (60 min)
	15:55		Break (5 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 contents of the workshop included reactor

operation, radiation measurements and lectures on recent topics on nuclear energy. The summary of workshop for high school students is shown in Table 8.

Table 8. The summary of the workshops held for high school students.

No.	High School	Date	Students	Contents
1	Kainan Senior High School	July 26-27	43	Safety instruction Tour to UTR-KINKI Reactor operation Neutron radiography Aluminum foil activation and half-life measurement
2	Otemae Senior High School	December 7	20	Safety instruction Tour to UTR-KINKI Reactor operation Lecture "Future of nuclear energy"

4. Other Educational Activities

4. 1 New Employee Training

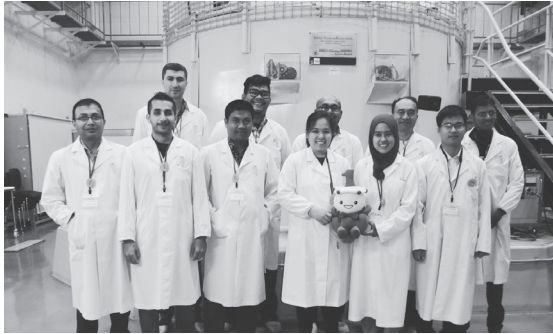
A two-day workshop was held for the training of new employees of Chiyoda Technol Corporation from April 13 to 14. The workshop aimed to give all around knowledge on nuclear reactor

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 9.

Table 9. The schedule of the workshop for new employee training of Chiyoda Technol Corp.

day	time	contents		
1	13:00	Opening Ceremony (10 min)		
	13:15	LEC	Basic Reactor Physics (60 min)	
	14:15	LEC	Safety Instruction (30 min)	
	14:45	LEC	Tour to UTR-KINKI (45 min)	
	15:30	EXP	(Group A) Reactor Operation (120 min)	(Group B) Neutron Radiography (120 min)
	17:30	Workshop Reception		
	2	9:00	LEC	Radiation Basics (60 min)
10:00		EXP	(Group A) Neutron Radiography (120 min)	(Group B) Reactor Operation (120 min)
12:00		Lunch		
13:00		EXP	Environmental Radiation Measurement (90 min)	
14:30		EXP	Radiation Properties (radiation shielding, inverse square law) (90 min)	
16:00		LEC	Health Effect of Radiation (60 min)	
17:00		Closing Ceremony (15 min)		

4. 2 International Seminar



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

A two-days international seminar was held at Kindai University as part of Instructor Training Program of Nuclear Human Resource Development Center, Japan Atomic Energy Agency (JAEA). Ten trainees from Asian countries 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.

4. 3 Special Workshop for Alumni

Students who graduated from Kindai University during the temporary shutdown of UTR-KINKI had no opportunity to experience reactor operation, though many of them looked forward to conducting experiments with a real nuclear reactor. On November 11, the 56th anniversary of the first criticality of UTR-KINKI, Atomic Energy Research Institute held a special one-day workshop for the alumni who were not able to operate the reactor while in university and provided them with an opportunity to operate UTR-KINKI. Five alumni participated in this special workshop.

5. Conclusion

UTR-KINKI resumed operation for the first time in three years and fully conducted educational activities in the academic year 2017, in which 481 people participated in total. As many research reactors in Japan are still in the state of temporary shutdown due to the new regulatory standard, 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 maintain UTR-KINKI as long as possible and utilize it in various educational activities.