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Influence of Friction Pressure and Friction Time Interaction on the Joint Strength of Friction Welded ST 41 Steel

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Abstract. The influence of heating stage parameters in RFW (rotary friction welding) of ST 41 steel is studied in this work. A Series of experiments on ST 41 steel were conducted in a lathe machine equipped with a hydraulic power pack system. Full factorial design of experiments is employed to investigate the influence of the parameters, *i.e.,* friction pressure and friction time on the joint strength of the samples. A replication experiment is carried out to study if the factors' interaction affects joint strength. Cross-weld tensile tests were performed using tensile specimens that ensure failure at the joint. The results indicated a significant influence of friction pressure, friction time, and their interaction on the joint strength.

INTRODUCTION

Rotary friction welding (RFW) is one of friction welding methods that is used to weld cylindrical metal. Unlike fusion welding process, this method requires no external heat to melt the metals. During the process, one material is hold in the fixed chuck, whereas the other material is hold by rotating chuck. Axial pressure is applied to make a contact between the surface. The heat in RFW is obtained from the friction yielded by a relative motion between two materials surfaces. The generated heat softens the materials. At this condition, axial pressure is applied to produce joint of the metals. Joining automotive components, mechanical components, cutting tools are the area of RFW applications RFW.

RFW is employed to join similar or dissimilar metals. The welded materials are ranging from carbon steel [1-3], stainless steel [4-7] and non-ferrous metals [8, 9]. Heat generation is the first stage of RFW process. In this stage, besides the materials, controlling parameters in this stage are rotation speed of the specimen, applied axial pressure to produce friction (friction pressure), and the duration of the pressure application (friction time). Applying second axial pressure (*i.e.,* upset pressure) at a certain duration creates an upsetting process that produces the joint. Therefore, upset pressure and upset time are two parameters that influence the joint. Parametric study of RFW focused on parameters of heating or joining stage. Influence of friction pressure and friction time were studied in joining carbon steel. It was observed that increasing pressure or its time increasing the joint strength [1, 3].

In this research, joining of ST 41 steel is carried out. A full factorial design of experiment is designed to investigate the influence of friction time and friction pressure and their interaction on the joint strength. Plain tensile test cannot be used to evaluate the welding joint when the joint is stronger than the base metal [10], therefore cross weld tensile test was performed to obtain real joint strength. In this work, the idea was adopted. Tensile specimen to enable fracture right at the welding joint was employed to perform cross weld tensile test.

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EXPERIMENTAL PROCEDURE

Material

The material used for the experiment is ST 41 which is equivalent to AISI 1018 steel supplied in bar with 16 mm diameter. Composition of the material is given in Table 1. The material was cut in 125 mm length for the RFW experiments.

TABLE 1. Chemical compositions of ST 41 steel

%C	%Si	%Mn	%P	Fe
0.18	0.35	0.7	0.05	balance

Equipment

Experiments of RFW process is carried out in lathe machine which is equipped with hydraulic powerpack system. Control mechanism was built to enable adjusting the applied pressure and its duration. Setting of the equipment is shown in Fig. 1.

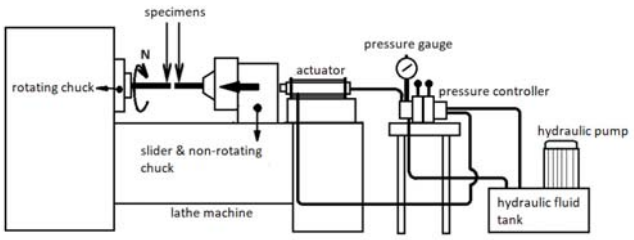

FIGURE 1. Lathe machine equipped with hydraulic powerpack system for RFW experiments

Methodology

Pre-experiment

The experiment starts by pre-determining factors and their level. Influencing factors in rotary friction welding involves friction pressure, friction time, spindle speed, forging pressure, and forging time [11, 12]. The main idea in this paper is to consider the influence of heating stage parameters *i.e*., friction pressure and friction time on the joint strength, while other factors are fixed. These two factors still give different result for some types of materials [13] and need to be further investigated by involving their interaction. This consideration also refers to the work by [14] which set the friction pressure and time at certain value independently, while the forging pressure, forging time, and spindle speed remain constant. By applying one factor at a time, Sahin [14] did not investigate their interaction, he focused on individual influence at certain range of factors. In other way, Vairis and Petousis [11] showed potential interaction between these factors in joining different material.

This research emphasizes on how friction time, friction pressure, and their interaction affect the tensile strength of friction welded joint. Techniques of design and experiment (DoE), as commonly proposed by Montgomery [15], leads the research methodology to accommodate its principles in conducting experiment. Next step, as the factors involved in this research has been determined, the selection of their levels also plays important parts with some consideration to previous research. Refer to Sahin [14] and Mousavi and Kelishami [16] that studied friction welding of mild steel, friction pressure within 10 to 100 bar ensured that both material would be perfectly joined and all parts of joining point were well covered without any brittles particles. Meanwhile, friction time ranges between 3 to 13 seconds, this range logically accepted in Belkahla *et al.*, [13] and Sahin [14] with consideration to well joined materials. Based on those consideration, factors and their level of this research are determined. Summary of the factors and their level of this research is shown in Table 2.

TABLE 2. Factor and level determination

Factors	level 1	level 2	level 3	Level 4
Friction pressure (bar)	16	20	35	50
Friction time (seconds)	5	7	9	
Forging pressure (bar)	fixed at 70			
Forging time (seconds)	fixed at 3			
Rotation speed (RPM)	fixed at 910			
Experiment response (MPa)	Joint tensile strength			

Design of Experiment

A pre-DoE experimental completes and strengthens the level value determination in Table 2, it is shown that the minimum friction pressure is about more than 15 bar and friction time is not less than 5 seconds. Outside those ranges will result in insufficient joint and it is not convenient for DoE experiments. A full factorial DoE experiments accommodates factors in Table 2 excluding fixed ones. There are 4 x 3 = 12 treatments in this experiment with two replications, thus total number of randomized experiments is 24 runs.

Welded samples (Fig. 2) show that the experiments produced good joint. Due to the ductility of the low carbon steel, excessive flash might be formed at the joint. High friction pressure and time produce excessive flash and length reduction of the samples. The flash was removed by turning process to prepare the tensile specimen to perform the tensile test. During the preliminary study, tensile test of the welding joint showed fracture at the base metal. It was a good sign that the welding joint was stronger than the base metal. However, the tensile test did not give the strength of the welding joint. Yet, it gave the tensile strength of the parent metal. In term of the DoE, the tensile test failed to provide the real strength of the joint. To perform cross weld tensile testing and ensure that fracture occurs exactly at joint spot, tensile specimen was made with the smallest diameter at the joint [17]. As shown in Fig. 3, the smallest area of the specimen is made right at the joint of the welded material. This technique leads the tensile test to break the sample exactly at the welded joint. Thus, the measured data strongly represent the friction welding joint strength. Simple pre-testing was carried, and the result showed that the failure occurred exactly at the joint (see Fig. 4).

FIGURE 2. Samples of welded materials, illustration of welding flash that would be removed by turning process prior to tensile test

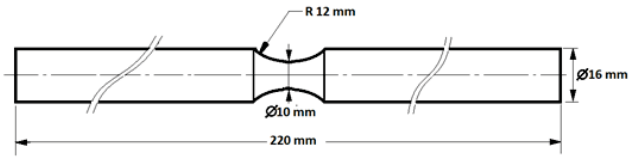

FIGURE 3. Tensile test specimen

FIGURE 4. Fracture occurs exactly at the joint during the cross weld tensile test, represents real joint strength

RESULTS AND DISCUSSION

For all combinations of friction pressure and friction time employed for the experiments, successful joints were obtained. This can be seen in Fig. 2 which shows some samples of the RFW results. Higher pressure and time produced excessive flash at the joint and length reduction of the sample. The high parameters yield high heat at the joint which also produce high deformation. Thus, more flash was created at the joint. This high flash is also due to high ductility that is commonly possessed by low carbon steel. Conversely, very little flash was found at the lower friction parameters.

Tensile strength for 24 run of experiments is shown in Table 3. Using standard analysis for factorial DoE design, an ANOVA analysis gives information about significance of factors and their interaction. Refer to the previous works, the initial hypothesis in this research involves significance influence of both factor and their interaction (see Belkahla *et al.*,[13]). To confirm these hypotheses, ANOVA analysis was performed to the data as shown in Table 4. Using significance level of 5% ANOVA result shows that both factors and their interaction influenced the response (see Fig. 5). When interaction between the two factors is significantly existed, then the interpretation of ANOVA result should involve both factors simultaneously [15]. Thus, in this experiment friction pressure and times influence the tensile strength at the same time and cannot be interpreted as individual factor.

TABLE 3. Tensile strength result at each treatment

Randomized runs	Factors		Fixed setting			Response
	P_friction (bar)	t_friction (seconds)	P_forging (bar)	t_forging (seconds)	Rotation speed (RPM)	Tensile strength (Mpa)
1	20	5				531.91
2	35	7				518.34
3	20	9				519.01
4	50	7				546.15
5	50	5				542.08
6	50	9				518.34
7	20	7				529.87
8	35	5				530.55
9	35	9				495.95
10	50	5				529.19
11	35	9				495.27
12	20	7	**70**	**3**	**910**	546.83
13	50	7				519.01
14	50	9				508.16
15	20	5				551.58
16	20	9				472.20
17	35	7				502.05
18	35	5				528.51
19	16	5				393.50
20	16	5				422.67
21	16	7				520.37
22	16	7				538.01
23	16	9				552.94
24	16	9				503.41

The range of tensile strength of the joint is 393.50 to 552.94 MPa. The maximum tensile strength is higher than the tensile strength of the raw material, that is 532.08 MPa. It gives the maximum welding efficiency is 103.92%. A clear trend of the joint strength with respect to friction parameters is not indicated from the experiments. However, the interaction plot shows anomaly and maximum tensile strength. The experiments result also reveal that higher heat at the joint do not continuously increase the joint strength. Excessive heat may reduce the strength of the joint.

TABLE 4. ANOVA for tensile strength

Analysis of Variance for tensile strength (re-DoE)

Source	DF	SS	MS	F	P	
pressure	3	5715	1904.9	5.89	0.010	Significant at 5%
time	2	2572	1286.0	3.98	0.047	
pressure*time	6	21212	3535.4	10.94	0.000	
Error	12	3879	323.2			
Total	23	33378				

Refer to Fig. 5, an anomaly occurs at the treatment combination of friction pressure 16 bar and friction time 5 seconds. Unlike the other treatments, this point shows lowest tensile strength and raises a strong hypothesis that it is the critical point for an ST41 steel friction welding. One should consider setting pressure and time above this point to have strong joint welded metal. Moreover, interaction between both factors leads to the necessity of careful setting of the combination to get a desired strength. Increasing pressure and time simultaneously does not always result to higher tensile strength, at certain point it will lead to reduced strength. Refer to this research, safe parameter setting for strong joint ST41 steel is at 20 bar and 5 second, this is the highest point that can be seen on interaction plot.

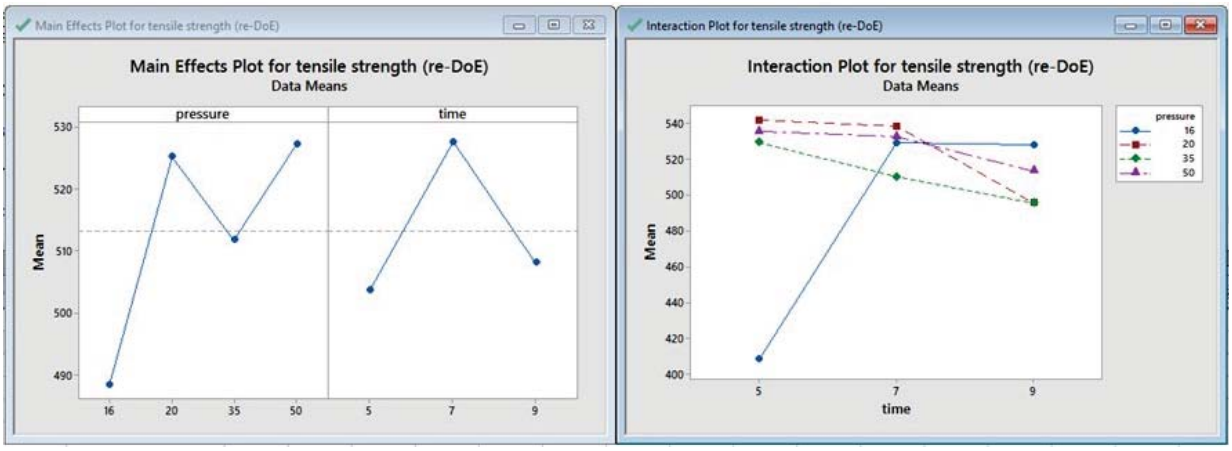

FIGURE 5. Main effect and interaction plot for friction pressure and friction time

CONCLUSION

A full factorial experiment design has been employed to study the influence of friction pressure and friction time and their interaction on the RFW results of ST 41 steel. The study yields several findings as follow:

a. Maximum welding efficiency of 103% was achieved in the experiment of RFW of ST 41 steel.
b. Friction pressure and friction time significantly influenced the tensile strength simultaneously, in other word, interaction between both factors should be considered and individual influence of each factor only gives weaker interpretation.
c. As the friction pressure and friction time increase simultaneously, the tensile strength trend is unexpectedly downward, and the optimal balance point is involved within.
d. The lowest tensile strength is indicated at the combination of friction pressure and friction time at 16 bar and 5 seconds respectively, this could be the critical point for RFW of ST 41 steel. Setting above this combination for joining ST 41 using RFW is recommended.
e. Interaction plot of the experiments gives the highest tensile strength at the combination of 20 bar and 5 seconds friction pressure and friction time of respectively.

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The 4th International Conference on Engineering and Technology for Sustainable Development

"Advancement of Engineering and Technology for Sustainable Development"

PROGRAM BOOK

Monday, 13 December 2021

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The 4th International Conference on Engineering and Technology for Sustainable Development (4th ICET4SD 2021)

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PROGRAM BOOK

Yogyakarta, 13 December 2021

Organized by:

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Foreword

Assalamualaikum warahmatullah wabarakatuh

Greetings from Yogyakarta.

Along with the rapid development of technology, recent breakthroughs are necessary to preserve the sustainability of the implementation in society. Technology advancement especially in the engineering field could improve the efficiency and effectiveness of sustainable development by fostering research and eliciting innovation. The significant key in sustainable development encompasses environmental matters, climate issues, benefit in society, big data analysis, etc.

On 13th December 2021 the Faculty of Industrial Technology, Universitas Islam Indonesia organizes the 4th International Conference on Engineering and Technology for Sustainable Development (4th ICET4SD 2021) with the theme "Advancement of Engineering and Technology for Sustainable Development". This conference series has been conducted biennially since 2015 as an academic forum for the engineer, researchers, and scientists to present their knowledge of technological advances and research in the field of engineering specifically mechanical, chemical, informatics, industrial, and electrical engineering. Due to the current global Covid-19 pandemic condition, this year, the conference will be conducted virtually using the Zoom platform.

On behalf of the committee, I would greet all the participants and presenters. We have a total of about 114 papers submitted, and the acceptance rate was 78%, i.e., there were a total of 89 papers accepted. I would like to express our utmost gratitude to all committees and reviewers for contributing to the conference program and proceeding. We would like to express our appreciation to the reviewers and suggestions.

We would also like to express appreciation to our distinguished keynote speaker: Dr. Eng. Muhammad Aziz from The University of Tokyo, Prof. Zahari Taha from Malaysia (Fellow Asia Pacific Industrial Engineering and Management Society) , Sisdarmanto Adinandra, Ph.D. from Universitas Islam Indonesia.

In closing, I welcome all the participants and presenters. I hope this event will be a great experience and will further stimulate advanced research in engineering and technology.

Wa`alaykumsalam warahmatullah wabarakatuh.

Best regards,

Irfan Aditya Dharma, S.T., M.Eng., Ph.D.
Chairman of the 4th ICET4SD 2021

Welcoming Remarks

Distinguished guests and participants,

Assalamu'alaikum warahmatullahi wabarakatuh

Firstly, let us thank Allah Almighty, who has given us His blessings and mercies so we can gather today, in good health and spirits. On behalf of the Faculty of Industrial Technology, Universitas Islam Indonesia (UII), I welcome our distinguished speakers and participants.

The 4th International Conference on Engineering and Technology for Sustainable Development (4th ICET4SD 2021) is a biennial conference organized by the Faculty of Industrial Technology, Universitas Islam Indonesia. Due to the condition of current global Covid-19 pandemic, the conference will be conducted virtually by using the Zoom platform in this year. The theme of 4th ICET4SD 2021 is "Advancement of Engineering and Technology for Sustainable Development."

Technology has developed rapidly, which can encourage sustainable development for the welfare of society. Sustainable development is defined as a development that meets the needs of the present and considers the needs of future generations. Sustainable development with the principles of economic welfare, social and environmental preservation. Things that need to be considered are environmental conservation by making the good use of natural resources, making the best use of natural resources, multiplying natural resources that can improve and pay attention to the quality of human life.

The roles of engineering and technology are significant in managing sustainable development. Technological advances are expected to increase the efficiency and effectiveness of development. Within this framework, the efforts of increasing human and community productivity are important so that production can take place with the less use of natural resources. The development pattern must also consider the impact of natural resource management so as not to exceed the threshold.

This seminar was conducted by five departments, namely Industrial Engineering, Electrical Engineering, Mechanical Engineering, Chemical Engineering, and Informatics. The seminar is expected as a forum to provide information and can be used for stakeholders in policies related to sustainable development. In addition, the results of this seminar can be applied in the learning process at the Faculty of Industrial Technology and higher education in developing learning materials to support sustainable development.

To our distinguished speakers and all those who support the seminar, we thank you for your cooperation in participating this seminar. Finally, our congratulations on attending the semi-nar. Hopefully, what we achieve in this seminar will benefit our government and society as a whole.

Wassalamu'alaikum warahmatullahi wabarakatuh

Dean,
Faculty of Industrial Technology

Prof. Dr. Ir. Hari Purnomo, MT, IPU

Keynote Speaker 1

Renewable and Clean Energy Systems Toward Smart and Sustainable Community

Dr.Eng. Muhammad Aziz, B.Eng., M.Eng.
Institute of Industrial Science, The University of Tokyo

Abstract

Renewable and green energy sources play a pivotal role in the future energy system due to their environmentally-friendliness and sustainability. However, renewable energy sources have their peculiar characteristics, including high fluctuation, geographical and seasonal dependences, and low accessibility. In addition, the technologies to convert, storage/transport, and utilize these resources are also under development and relatively high cost. It is imperative to set up an appropriate scenario for each potential renewable and green energy resources; therefore, these resources can be utilized optimally, while maintaining the high quality of energy system. Furthermore, the designated energy system does not only cover the energy security, but also the energy equity, in which the new energy system should be able to facilitate a creation of new circular economy in the energy sector. The participation of all the stakeholders becomes crucial aspects to be accelerated to realize sustainability in the energy sector. Non-carbon-based secondary energy resources, including electricity, hydrogen, and ammonia, must be mutually utilized together to facilitate high sustainability and resilience in energy system.

Keynote Speaker 2

AI and Sustainable Manufacturing

Prof. Dr. Zahari Taha, CEng, MIED, FASc, Fellow APIEMS
Fellow Asia Pacific Industrial Engineering and Management Society

There are many definitions of artificial intelligence. John McCarthy in his 2004 paper defines it as " the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable." Artificial intelligence combines computer science and big data to solve problems. The sub-fields of machine learning and deep learning are often associated with artificial intelligence to make predictions or classifications based on input data.

Sustainable manufacturing focuses on both how a product is made as well as the product's attributes. This includes the inputs, the manufacturing processes, and the product's design. Factors that are considered include things such as making products using less energy and materials, producing less waste, and using fewer hazardous materials as well as products that have greener attributes such as recyclability or lower energy use. The implementation of sustainable manufacturing can range from very simple process improvements to large investments in new technologies and product redesign.

AI can be implemented at the various stages of the implementation of sustainable manufacturing which includes housekeeping, process optimization, raw material substitution, new technologies and new product design. In housekeeping AI can be used for better monitoring and scheduling of the production process and predictive maintenance. Process optimization involves minimizing waste, conserving raw materials, and capturing and reusing waste materials. Deep Learning in AI can be applied in detecting defects which will help to reduce waste. Utilizing new technologies involves incorporating more environmentally responsible technologies and equipment production processes including equipment that uses less energy or materials or alternative energy production. Machine learning in AI can be used to identify the best conditions for equipment to use less energy.

Finally AI can be used to design products to be greener from the ground up including the selection of suitable recycled materials or renewable materials, designing for easy disassembly, for recycling, or for remanufacturing and using less packaging and more recycled or recyclable packaging.

Case Studies of AI deployment in predictive maintenance and defect detection will be presented

Keynote Speaker 3

Predictive Control and IoT: A Challenge

Sisdarmanto Adinandra, Ph.D.
Department of Electrical Engineering, Faculty of Industrial Technology
Universitas Islam Indonesia

Model predictive control becomes more exciting to be explored with the emerging cheap computation power. Despite interesting stability proof, the practicability of model predictive control attracts wider range of people. Among main parts of predictive control, the availability of an accurate model and a fast optimization technique that comply with the model are compulsory.

The exponentially growth of IoT applications opens more possibilities to create data driven model that suitable to predictive control. Data collected from the sensor network combine with AI can give us a better dan more accurate model. Yet, it is not a straightforward process from AI result to usable predictive model.

In this talk challenges and results to bring AI results to usable predictive model is going to be presented. Examples on wind farming and robotics application will be presented. Issues on size, scalability and the consequences on the optimization step will be discussed.

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Hasyim Asyari	Universitas Jenderal Soedirman
Henry Palit	Universitas Kristen Petra
Heri Kusuma	Universitas Pembangunan Nasional "Veteran" Yogyakarta
I Made Ronyastra	Universitas Surabaya
Ifa Puspasari	Universitas Islam Indonesia
Ilham Bakri	Hasanuddin University
Ilyas Masudin	University of Muhammadiyah Malang
Ira Setyaningsih	Universitas Islam Indonesia
Irfan Aditya Dharma	Universitas Islam Indonesia
Irving Paputungan	Universitas Islam Indonesia
Irwan Setiawan Muthalib	Universitas Hasanuddin
Ishardita Pambudi Tama	Universitas Brawijaya
Islamudin Ahmad	Mulawarman University
Iswandaru Widyatmoko	Universitas Pertamina
Iveline Anne Marie	Universitas Trisakti
Iwan Sukarno	Universitas Pertamina
Iwan Vanany	Institut Teknologi Sepuluh Nopember
Joniarto Parung	University of Surabaya
Kasmad Ariansyah	Centre for Research and Development on Resources
Khamdan Cahyari	Universitas Islam Indonesia
Kristiana Asih Damayanti	Universitas Katolik Parahyangan

Latifa Seniorita	Kyoto University
Leo Willyanto Santoso	Universitas Kristen Petra
Leony Lidya	Universitas Pasundan
M Mujiburohman	Universitas Muhammadiyah Surakarta
Markus Hartono	University of Surabaya
muchamad sugarindra	Universitas Islam Indonesia
Muflih Arisa Adnan	Universitas Islam Indonesia
Muhammad Khafidh	Universitas Islam Indonesia
Muhammad Niswar	Universitas Hasanuddin
Muhammad Ridwan Andi P.	Universitas Islam Indonesia
Nasmi Herlina Sari	Mataram University
Nia Budi Puspitasari	Universitas Diponegoro
Panji Darma	Chiba University
Parwadi Moengin	Trisakti University
Prima Sentia	Universitas Syiah Kuala
Purnawan Adi Wicaksono	Universitas Diponegoro
Rhiza S. Sadjad	Universitas Hasanuddin
Rindra YUSIANTO	Universitas Dian Nuswantoro
Rizki Firmansyah Setya Budi	BATAN
Rosmalina Hanafi	Universitas Hasanuddin
Ryan Anugrah Putra	Gadjah Mada University
Sani Susanto	Universitas Katolik Parahyangan
Sari Widya Sihwi	Universitas Negeri Sebelas Maret
Sholeh Ma'mun	Universitas Islam Indonesia
Sisdarmanto Adinandra	Universitas Islam Indonesia
Suci Miranda	Universitas Islam Indonesia
Syarifuddin Mabe Parenreg	Hasanuddin University
Thedy Yogasara	Universitas Katolik Parahyangan
Uky Yudatama, S.Si., M.Kom	Universitas Muhammadiyah Magelang
Vembri Helila	Universitas Islam Indonesia
Wahyu Oktri Widyarto	Universitas Serang Raya
Wijaya Yudha Atmaja	Universitas Gadjah Mada
Wildanul Isnaini	Universitas PGRI Madiun
Wilson Kosasih	Universitas Tarumanegara
Yandra Rahadian Perdana	UIN Sunan Kalijaga Yogyakarta
Yasser Abd Djawad	Universitas Negeri Makassar
Yosephus Ardean Kurnianto P.	Chiba University
Yusuf Sulistyo Nugroho	Universitas Muhammadiyah Surakarta
Zaki Saldi	Universitas Prasetia Mulya

Rundown Program – Monday, 13 December 2021
The 4th International Conference on Engineering and Technology for Sustainable Development (4th ICET4SD 2021)

Time (WIB/GMT+7)	Activities
07.45-08.00	Participants enter the Zoom room
	Zoom meeting link: https://bit.ly/icet4sd Meeting ID = 925 6681 9538 Passcode = fit.uii
08.00-08.05	Opening by Master of Ceremony
08.05-08.15	National Anthem&Universitas Islam Indonesia Hymne
08.15-08.25	Al-Qur`an Recitation
08.25-08.40	Welcoming speech (Chairman)
08.40-08.50	Welcoming speech (Dean of Faculty of Industrial Technology)
08.50-08.55	Opening Show Performance
08.55-09.00	Photo Session
09.00-09.45	Keynote Session
	1st keynote: Dr.Eng. Muhammad Aziz (The University of Tokyo)
	Moderator: Sholeh Ma'mun, S.T., M.T., Ph.D.
09.45-09.50	Transition
09.50-10.35	Keynote Session
	2nd keynote: Prof. Dr. Zahari Taha, CEng, MIED, FASc, Fellow APIEMS (Fellow Asia Pacific Industrial Engineering and Management Society)
	Moderator: Ir. Ira Promasanti Rachmadewi, M.Eng.
10.35-10.40	Transition
10.40-11.10	Keynote Session
	3rd keynote: Sisdarmanto Adinandra, S.T., M.Sc., Ph.D. (Universitas Islam Indonesia)
	Moderator: Dr. Muhammad Khafidh, S.T., M.T.
11.10-11.15	Transition
11.15-12.30	Break
12.30-15.15 (@15 minutes)	Parallel Session
15.15-15.20	Transition
15.20-16.00	Announcement (Best paper award) and closing

ICET4SD 2021 Presentation Guidelines

We provide the following brief guidelines for all presenters to follow:

- The official language is English.
- Each presenter is given 15 minutes of presentation time including discussion, question, and answer.
- The platform for the virtual presentation is ZOOM.
- Each presenter must use the given ICET4SD virtual background during the presentation. (Download link : https://drive.google.com/file/d/1VI0FOFu0hCaSUAmaL7O72K4xHg_v3D4S/view?usp=sharing)
- Each presenter is required to join the virtual room at least 20 minutes before the session start.
- The presenter must fill in the attendance form. The link will be shared at the end of each session.
- When entering the ZOOM, please mute the microphone.
- All participants must rename their ZOOM display name with the following format: PaperID_RoomNo_Name. Example: 20000_01_Irfan Aditya Dharma

PARALLEL SESSION SCHEDULES

Room 1 Session Chair: Ir. Ira Promasanti Rachmadewi, M.Eng.
Track/Area: Industrial Engineering

Zoom meeting link: https://bit.ly/icet4sd
Meeting ID = 925 6681 9538
Passcode = fit.uii

Time	Paper ID	Title and Authors
12.30-12.45 PM	20948	Applying Adaptive Genetic Algorithm for Heterogeneous Vehicle Routing Problem with Asymmetric Distance and Fuzzy Demand (HVRPADFD) Zakka Ugih Rizqi, Dzyqi Ugih Qinthara, Adinda Khairunisa, Vembri Noor Helia
12.45-13.00 PM	21257	Autofill Valve as a Solution for Automatic Drinking Water Needs Based on Arduino in Laying Hen Coop Suryo Wisnuhadi, Alya Fauziah Kusuma Wardhani, Husna Indika Putri, Andita Rizky Fadilah, Muh. Luqman Khakim, Ali Parkhan
13.00-13.15 PM	21384	Feasibility Study of Production Machinery Replacement Investments in CV TU: Management and Finance Aspect A. Dicasani, I D Widodo, Ali Parkhan
13.15-13.30 PM	21486	Crowdfunding in Indonesia: The Use of Data Mining to Predict Success and Failure (A Case Study) Harwati, Annisa Luthfi Nur Afifah
13.30-13.45 PM	21227	Risk Management System Design in Frozen Shrimp Processing Industry's Cold Chain Muhammad Naufal Noor Farras Dharosca, Ari Yanuar Ridwan, Nia Novitasari
13.45-14.00 PM	21915	Key Performance Indicator Selection For Procurement Process Elisa Kusrini, Elanjati Worldailmi, Alma Fitria Milania, Putri Shafira Carolina
14.00-14.15 PM	21379	An Analysis of Social Vulnerability Clustering to Natural Disaters (Case Studies in All Distric/Cities in Indonesia in 2019) Sufyan Aziz Prabaswara, Yuliagnis Transver Wijaya, Suci Miranda
14.15-14.30 PM	21716	Cognitive Workload Evaluation in Visual-Auditory Navigation System Through EEG Measurement Driving Performance Using Driving Simulator Andrie Pasca Hendradewa, Tiara Lusiana Della

Room 2 Session Chair: Winda Nur Cahyo, S.T., M.T., Ph.D. Track/Area: Industrial Engineering		
Zoom meeting link: https://bit.ly/icet4sd Meeting ID = 925 6681 9538 Passcode = fit.uii		
Time	**Paper ID**	**Title and Authors**
12.30-12.45 PM	21385	Design Of Mechanical Quality Of Yarn As A Result Of Dyeing Process Using Vikor Method Ali Parkhan, D. Widodo
12.45-13.00 PM	21640	SWOT Analysis In Determining The Development Strategy Of Crude Palm Oil (CPO) Using QSPM Method In PT. Xyz Palm Oil Atyanti Dyah Prabaswari, Dwi Putra Sandika
13.00-13.15 PM	21707	Indonesia's Energy Policy: A SWOT Analysis And Effectiveness Measure J Sulistio, B Wirjodirdjo, PD Karningsihi
13.15-13.30 PM	21333	The Design Of Yarn Quality With TOPSIS Method Ali Parkhan, Muchamad Sugarindra
13.30-13.45 PM	20821	User Preferences For Video Conferencing Using The Analytical Hierarchial Process (AHP) Hasan Mastrisiswadi, Berty Dwi Rahmawati, Astrid Wahyu Adventri Wibowo
13.45-14.00 PM	21293	Employee Performance Improvement of PT. XYZ with Clustering Method Mohammad Arsyad Fathurrohman, Khairunnisa Nurul Istiqomah, Rizha Syukrillah, Annisa Uswatun Khasanah
14.00-14.15 PM	21327	The Vendor Selection In Multisite Project - Multi Location-Based Vendor Using Analytical Hierarchy Process (AHP) Method In Repair Center Project W. Tripiawan, W. M. Frestikawati
14.15-14.30 PM	21641	Human Resources Analysis using NASA-TLX Methods, Full Time Equivalent (FTE), and SWOT Analysis with Case Study in The production Section of PT. Kon Kuwat Indonesia Atyanti Dyah Prabaswari, Muhammad Ilham Mahfudhi

Room 3 Session Chair: Nur Aini Masruroh, ST., M.Sc., Ph.D.

Track/Area: Industrial Engineering

Zoom meeting link: https://bit.ly/icet4sd
Meeting ID = 925 6681 9538
Passcode = fit.uii

Time	Paper ID	Title and Authors
12.30-12.45 PM	21329	Application of System Dynamics Simulation in Food Supply Chain Putri Amelia, Budisantoso Wirjodirdjo, Ratna Sari Dewi
12.45-13.00 PM	21225	Reducing the Rejected Parts Using DFSS, TRIZ and DFFS for Supply Chain Procedure Kinley Aritonang, Hanky Fransiscus, Neneng Meiliana
13.00-13.15 PM	21330	Risk Assessment in the Supply Chain to Reduce Risk Cost Fariza Halidatsani Azhra and Elisa Kusrini
13.15-13.30 PM	21338	Risk Control in Supply Chain Using House of Risk and System Dynamic Method Elisa Kusrini, Fariza Halidatsani Azhra
13.30-13.45 PM	20647	Barriers Model of Social Sustainability in the Supply Chain: A Case in Palm Oil Industry from Emerging Economy Rangga Primadasa, Dina Tauhida, Elisa Kusrini
13.45-14.00 PM	21482	Risk Management of The Halal Supply Chain: A Literature Review Intan Putri, Elisa Kusrini
14.00-14.15 PM	21705	Risk Analysis on Water Distribution Using Failure Mode and Effect Analysis (FMEA) Approach and Fishbone Diagram Rofi Brianpratama Windarto, Roaida Yanti, Qurtubi, Muchamad Sugarindra

Room 4 Session Chair: Suci Miranda, S.T., M.Sc.

Track/Area: Industrial Engineering

Zoom meeting link: https://bit.ly/icet4sd
Meeting ID = 925 6681 9538
Passcode = fit.uii

Time	Paper ID	Title and Authors
12.30-12.45 PM	21669	Ergonomic and Innovative Infusion Monitoring System Design to Increase Usability Hartomo Hartomo, Rezki Amelia A.P., Muhammad Surya Jaya
12.45-13.00 PM	21254	The Influence of Audio Intervention Based on Situational Awareness Drivers Hari Purnomo, Anindya Agripina Hadyanawati
13.00-13.15 PM	21714	The Utilization of Ocular Indicators in Detecting Fatigue in Freight Train Drivers Sevty Auliani, Iksan Adiasa, Hardianto Iridiastadi
13.15-13.30 PM	21311	Analysis of Work Posture and Proposed Design of Slondok Printing Machines at Slondok MSMEs in Yogyakarta Elanjati Worldailmi, Agus Mansur, Syafa Thania Prawibowo, Almuzani Almuzani
13.30-13.45 PM	21262	Analysis of the Influence of ERP Information Systems on Net Benefit using PLS-SEM in Higher Education Institutions Danang Setiawan, Muhamad Gamal Ramadan
13.45-14.00 PM	21685	Discomfort Level of Online Taxi Car Drivers Rela Adi Himarosa, Nurvita Risdiana
14.00-14.15 PM	21605	Production Process Analysis Using Six Sigma Approach and Failure Mode Effect Analysis to Reduce Sheet Break on Core Board Paper Products PT. Indonesian Papertech, Subang Apsari Dita Indah Rahayu, Abdullah 'Azzam, Rizky Alditama and Fahrul Triyulianto Rusli
14.15-14.30 PM	20627	Performance Measurement Of Pt Xyz Using The Balanced Scorecard Method Elanjati Worldailmi, Putri Shafira Carolina, and Alma Fitria Milania

Room 5 Session Chair: Bambang Suratno, S.T., M.T.

Track/Area: Industrial Engineering

Zoom meeting link: https://bit.ly/icet4sd
Meeting ID = 925 6681 9538
Passcode = fit.uii

Time	Paper ID	Title and Authors
12.30-12.45 PM	20935	Development of Communication Tools for Deaf and Mute People Using Design Thinking Method Khairunnisa Nurul Istiqomah, Rizky Alditama, Salma Salsabila, Abdullah 'Azzam
12.45-13.00 PM	20889	Analysis of Potential Hazards in Slondok MSMEs Using the Hazard Identification, Risk Assessment and Risk Control (HIRARC) Method Elanjati Worldailmi, Agus Mansur, Sinta Wulandari, Ahmad Zaidan
13.00-13.15 PM	21112	Analysis of Service Quality Improvements on Zoom Cloud Meetings Application Based on End User Reviews using Text Mining and Fishbone Diagram Annisa Uswatun Khasanah, Muhammad Agung Pratama
13.15-13.30 PM	21276	A Self-Assessment Model for Measuring the Fitness Level of Industrial Engineering Graduates Competence to a Quality Control Job Position Evy Herowatil, Joniarto Parung, Sharon Limantara, Rahman Dwi Wahyudi, I Made Ronyastra
13.30-13.45 PM	20921	Life Cycle Cost of Mobility Electrification with Renewable Energy in Off-grid Rural Area: The Karya Jadi Village case in Indonesia Andante Hadi Pandyaswargo, Alan Dwi Wibowo, Meilinda Fitriani Nur Maghfiroh, Hiroshi Onoda
13.45-14.00 PM	21706	Maintenance Scheduling for Compressors Considering Asset Performance and Cost Muhammad Bayu Prasetyo Aji, Winda Nur Cahyo
14.00-14.15 PM	21533	Influence of UI/UX on Online Purchase Decisions in E-Commerce Ahmad Sawal
14.15-14.30 PM	20923	Redesign of Production Table for Boiling And Removing Chiken Feathers Using NBM (Nordic Body Map) and Reverse Engineering to Reduce Musculoskeletal Disorder Complaints at XYZ Chicken Slaughterhouse Retno Dyah Purwaningrum, Syafa Thania Prawibowo, Muria Shandy Majid

Room 6 Session Chair: Dr. Muhammad Khafidh, S.T., M.T

Track/Area: Mechanical Engineering

Zoom meeting link: https://bit.ly/icet4sd
Meeting ID = 925 6681 9538
Passcode = fit.uii

Time	Paper ID	Title and Authors
12.30-12.45 PM	20920	The Characterization Of Coal Waste By Paiton Power Plant Nurul Fitria Apriliani, Dadang Sanjaya Atmaja, Wahyu Tamtomo Adi, Ilham Satrio Utomo
12.45-13.00 PM	21499	CFD Simulation Analysis Of Thermal Comfort With Variations In The Number Of Cooling Inlets Catur Harsito, Ariyo Nurachman Satiya Permata, Ilham Wahyu Kuncoro, Miftah Hijriawan
13.00-13.15 PM	21269	Modeling Of 2d Fluid Flows In Geothermal Areas By Using Finite Element Methods S Bahri, F F Safii, M A Sofyan
13.15-13.30 PM	21676	Improving The Greenhouse Microclimate In Tropical Country Using Shading And Natural Ventilation Technique Dewanto Harjunowibowo, Yesiana Arimurti, Yudi Rinanto
13.30-13.45 PM	21700	Performance Of Solar Panels As Electricity Supply Tools To Burn Rice Powder Through Glow Plug In Biomass Gasification Process Suliono, Dedi Suwandi, Muhammad Luthfi, Felix Dionisius, Dori Yuvenda
13.45-14.00 PM	21491	Simulated Comparison For Different Roof's Construction Materials On Energy Consumption For Residential Buildings Saad F. Al-Nuaimi1, Wasan Maki Muhammed
14.00-14.15 PM	21216	Influence of Friction Pressure and Friction Time Interaction on the Joint Strength of Friction Welded ST 41 Steel Hudiyo Firmanto, Susila Candra, and M. Arbi Hadiyat
14.15-14.30 PM	21017	Effect of Friction Welding Parameters to Weld Joint Performance of Cylindrical Stainless Steel Hakam Muzakki, Sabarudin Akhmad, Setya Mujaini

Room 7 Session Chair: Finny Pratama Putera, S.T., M.Eng.

Track/Area: Mechanical Engineering

Zoom meeting link: https://bit.ly/icet4sd
Meeting ID = 925 6681 9538
Passcode = fit.uii

Time	Paper ID	Title and Authors
12.30-12.45 PM	21779	Introducing New CNC Machining Strategy for Thin-Walled Structure (Case study on Acrylic Machining for Butterfly Jewellery Frame Master) Paryana Puspaputra, Risdiyono, and Rahmat Riza
12.45-13.00 PM	21697	Laterite Nickel Hydrometallurgical Residues Characterization and Potential Utilization of Valuable Elements Nur Ikhwani, Sri Harjanto, Adji Kawigraha, Yurian Ariandi Andromeda, Nur Vita Permatasari
13.00-13.15 PM	21780	The Analysis of the Acrylic, CNC and SLA 3Dprint Results as the Basis of the Jewelry Master Production Paryana Puspaputra, Risdiyono, Rahmat Riza
13.15-13.30 PM	21405	Selected Basic properties of concrete with Polypropylene Plastic Granular Aggregates Muhammad Sofyan, Ade Okvianti Irlan, Abdul Rokhman, Muhammad Akbar Caronge
13.30-13.45 PM	21698	Implementation of Lean Tools as Waste Assessment Method in a Coil Spring Manufacturing Rabiatul Syuhada Binti Hasan, Muhammed Nafis Bin Osman Zahid
13.45-14.00 PM	21375	The effect of loading type, anchoring type, and material selection on a MEMS switch design Abdelhaleem Obeid and Musaab Zarog
14.00-14.15 PM	21369	Utilization of Low Density Polyethylene (LDPE) Powder and Rice Husk Ash (RHA) on Compressive Strength and Initial Setting Time of Alkaline Activated Mortar Muhammad Sofyan, Ade Okvianti Irlan, Irma Wirantina Kustanrika, Sajiharjo Marto Suro
14.15-14.30 PM	21695	Laboratory Study Using LDPE Plastic Waste and Zeolite Stone on the Characteristics of AC-BC Mixtures Indah Handayasari, Arief Suardi Nur Chairat, Dyah Pratiwi Kusumastuti, Vierra Wahyuni

Room 8 Session Chair: Sholeh Ma'mun, S.T., M.T., Ph.D.

Track/Area: Chemical Engineering

Zoom meeting link: https://bit.ly/icet4sd
Meeting ID = 925 6681 9538
Passcode = fit.uii

Time	Paper ID	Title and Authors
12.30-12.45 PM	21224	Process Simulation of Fixed Bed Downdraft Gasifier for Rice Husks and Sawdust Resky Ervaldi Saputra, Hafif Dafiqurrohman, Yuswan Muharam, Adi Surjosatyo
12.45-13.00 PM	21678	Extraction of Bioactive Compound from Mangosteen Peel (Garcinia mangostana L.) Using Ternary System Solvent Nurhayati Rahayu, Setiyo Gunawan, and Hakun Wirawasista Aparamarta
13.00-13.15 PM	21381	Utilization of Mangosteen Pericarp Extract (Garcinia mangostana L.) as Herbal Medicine Using Microwave-Assisted Extraction (MAE) Method Surya Iryana Ihsanpuro, Hakun Wirawasista Aparamarta, Setiyo Gunawan, Arief Widjaja, Tri Widjaja, Dwi Santoso, Abdul Malik Al Mulki
13.15-13.30 PM	21403	Alkyl Polyglucoside from Tapioca Starch as Emulsifier for an OW Emulsion Putri Ramadhany, Judy Retti Witono, Gadmon Gadmon
13.30-13.45 PM	21693	Cashew Nut Shell Liquid (CSNL) As A Renewable Adhesive Eni Budiyati, Edi Santoso, and Putri Maharani Budi
13.45-14.00 PM	21319	Utilization of Styrofoam Type Waste into Fuel Oil by Pyrolysis Method T K Dhaniswara, Y T Rahkadima, M A Fitri, Z Azizah, D Oktawila
14.00-14.15 PM	21703	Synthesis and Characterization of Poly-lactic Acid (PLA) Biocomposites Reinforced with Rice Husk and Clay Samira Kayla Biyanti1, Dela Ramadhini Hertiana, and Tika Paramitha
14.15-14.30 PM	21360	Modified nanocellulose by Trivalent Cationic Ions as an Antimicrobial for Paper Based Food Packaging Anggraini Wulansari, Wida Banar Kusumaningrum, Deni Zulfiana and Nanang Masruchin
14.30-14.45 PM	22164	Active and Intelligent Packaging Films based on Cassava Starch and Anthocyanins from Red Cabbage Extract with the Addition of Lemongrass Essential Oil Syifa Ayu Alsadilla Qothrunnada, Hikmah Muji Rahayu, Istiqomah Nur Al Amsah, Rifky Murdiansyah, Ifa Puspasari, Lilis Kistriyani

Room 9 Session Chair: Ahmad M. Raf'ie Pratama, S.T., M.I.T., Ph.D.

Track/Area: Informatics

Zoom meeting link: https://bit.ly/icet4sd
Meeting ID = 925 6681 9538
Passcode = fit.uii

Time	Paper ID	Title and Authors
12.30-12.45 PM	20917	A proposed prototype of TRIZ mobile application in Business and Management Kholid Haryono, Ikhwan Alfath Nurul Fathony, Reza Cahya Nugraha
12.45-13.00 PM	21397	Portrait vs Landscape: A User Experience Analysis in Education based Mobile Learning Sunardi, GG Faniru Desak, Rudi Bachtiar, Christianna Wulan Sari
13.00-13.15 PM	21183	Survey on Top Rank Android Applications for Traveling Septia Rani, Irving V Paputungan, Dhomas H Fudholi, Sheila N Huda, Zainudin Zukhri
13.15-13.30 PM	21277	Usability Evaluation on Pre-Worker eLearning Websites Sunardi, GG Faniru Pakuning Desak, Immanuel Revelino, Jusman Sitohang
13.30-13.45 PM	21261	Accuracy Rate of Relevance Vector Machine with Modified Algorithm: A Meta-Analysis Syaharuddin, Fatmawati, Herry Suprajitno
13.45-14.00 PM	21717	Implementation of Support Vector Machine (SVM) Based on Particle Swarm Optimization (PSO) with Synthetic Minority Over-Sampling Technique (SMOTE) on Tweet Data Dina Tri Utari, Yunanda Mustofa Putri

Room 9 Session Chair: Dhomas Hatta Fudholi, S.T., M.Eng., Ph.D.

Track/Area: Informatics

Zoom meeting link: https://bit.ly/icet4sd
Meeting ID = 925 6681 9538
Passcode = fit.uii

Time	Paper ID	Title and Authors
12.30-12.45 PM	21666	Online Attendance System Implementation in Pandemic Era Using ITIL CSI Imanuel Revelino Murmanto, Faniru Pakuning Desak, Sunardi Sunardi
12.45-13.00 PM	21684	State Transition Diagrams for Business Process Flows Testing Luthfi Anggy Kurniawan, Hanson Prihantoro Putro
13.00-13.15 PM	21708	Design and Implementation of Honeypot Indicator of Compromise (IoC) Profiling using Information Sharing Platform (MISP) Muhammad Arfan Salamun, Fadhlan Zaky Muttaqin, Nur Rohman Rosyid
13.15-13.30 PM	21710	DNS Query Log Data Enrichment Based on Cyber Threat Intelligence Hilya Qothrun Najahah, Muhammad Arfan Salamun, Fadhlan Zaky Muttaqin, Nur Rohman Rosyid
13.30-13.45 PM	21591	Virtual University Tour Using 360-Degree Technology and Interactive Virtual Tours to Present Academic Atmosphere Tanti Octavia, Andreas Handojo
13.45-14.00 PM	20896	Virtual Reality in Tourism: Content or System? Evidence From New Zealand Tourism Destination Dwi Suhartanto, David Dean, Lusianus Kusdibyo, Yackob Astor, Aditia Sobarna

Room 10 Session Chair: Sisdarmanto Adinandra, S.T., M.Sc., Ph.D. Track/Area: Electrical Engineering		
Zoom meeting link: https://bit.ly/icet4sd Meeting ID = 925 6681 9538 Passcode = fit.uii		
Time	**Paper ID**	**Title and Authors**
12.30-12.45 PM	**21300**	Photoplethysmograph-Based Real-time Emotion Recognition Using Logistic Regression with Heart Rate Changes Parameter Alvin Sahroni, Pramudya Rakhmadyansyah Sofyan, Nur Widiasmara, Isnatin Miladiyah
12.45-13.00 PM	**21318**	Industrial Internet of Things for Condition-based Maintenance of an Induction Motor Handy Wicaksono, Roche Alimin, Handry Khoswanto, Jonathan Aditya Wijaya, and Wendy Wibisono
13.00-13.15 PM	**21493**	Performance of Built Microclimate System Control Arduino-Based Fitri Juwita Inayati, Yesiana Arimurti, Yudi Rinanto, Dewanto Harjunowibowo
13.15-13.30 PM	**21688**	Design of Recirculating Aquaculture Monitoring system Based on Internet of Thing and Machine Learning Algorithms Mohammad Nur Shodiq, Dedy hidayat Kusuma, Alif Akbar Fitrawan, Nuraini Lusi
13.30-13.45 PM	**21715**	Monitoring Systems Design and Data Acquisition on Powerhouse and Utility using MES Interface based on Programmable Logic Controller Syahril Ardi and M Ghani Saputra
13.45-14.00 PM	**21275**	A Flight Control System in VTOL Plane for Waypoint Tracking Using LQR Method Akhmad Jayadi, Jaka Persada Sembiring, Novia Utami, Faisal Dharma Adhinata

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4th ICET4SD 2021

The 4th International Conference on Engineering and Technology for Sustainable Development

"Advancement of Engineering and Technology for Sustainable Development"

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As Presenter

The 4th International Conference on Engineering and Technology for Sustainable Development (4thICET4SD 2021)

"Advancement of Engineering and Technology for Sustainable Development"

Held by Faculty Industrial Technology, Universitas Islam Indonesia at Yogyakarta, December 13th, 2021

CONFERENCE CHAIR

4th ICET4SD 2021 International Conference

Irfan Aditya Dharma, ST., M.Eng, Ph.D