PROGRAM BOOK

ICVEE 2022

ICVEE 2022 The Fifth International Conference on Vocational Education and Electrical Engineering (ICVEE)

THE FUTURE OF ELECTRICAL ENGINEERING, INFORMATICS, AND EDUCATIONAL TECHNOLOGY THROUGH THE FREEDOM OF STUDY IN THE POST-PANDEMIC ERA

September

10-11, 2022

UNESA

IEEE ComSoc
IEEE Communications Society

Welcome Message from the General Chair

ICVEE 2022 is the fifth International Conference on Vocational Education and Electrical Engineering organized by the Faculty of Engineering, Universitas Negeri Surabaya. This year, the theme of this conference is "THE FUTURE OF ELECTRICAL ENGINEERING, INFORMATICS, AND EDUCATIONAL TECHNOLOGY THROUGH THE FREEDOM OF STUDY IN THE POST-PANDEMIC". Following the theme, this conference aims to bridge the scientists, education experts and practitioners, and students in the scientific forum through sharing ideas and issues about theoretical and practical knowledge in electrical engineering, informatics engineering, engineering education and vocational education.

ICVEE 2022 is attended by presenters from overseas, such as the Brazil, Marocco, Germany, and Indonesia. Hopefully, we can have a productive conference with exciting and encouraging discussions, knowledge exchanges, and networking.

This conference will not be possible without tremendous supports and help from those who give their all-out efforts and hardworking. I am very grateful to all the organizing committee and scientific committee members for their outstanding work to support this conference. Through this conference, we wish to increase our knowledge and work together to advance technology for the humanities.

Sincerely yours,

Dr. Hapsari Peni Agustin T., S.Si., M.T.
Conference Chair
e-mail: hapsaripeni@unesa.ac.id

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ICVEE in a Glance

The International Conference on Vocational Education and Electrical Engineering (ICVEE) is an international conference hosted by Universitas Negeri Surabaya's Electrical Engineering Department.

The International Conference on Vocational Education and Electrical Engineering (ICVEE) began in 2005 with the introduction of the Seminar Teknik Elektro (STE). STE was born and later evolved into ICVEE as the era progressed. The first ICVEE was held in 2015. ICVEE 2020 and 2021 proceedings were published in IEEE eXplore in the last two years.

While the implementation in 2022 will be the fifth, 2022 The Fifth The conference will be held in Surabaya, Indonesia, inviting academics, researchers, and practitioners to submit case studies of practice, theoretical papers, empirical studies, and other papers that address any topic within the broad areas of Vocational Education, Electrical Engineering and Informatics. On this occasion, the conference's theme is "The future of electrical engineering, informatics, and educational technology through the freedom of study in the post-pandemic era". IEEE Indonesia Section through IEEE ComSoc Indonesia Chapter will support ICVEE. Accepted papers will be submitted for inclusion into IEEE Xplore subject to meeting IEEE Xplore's scope and quality requirements.

Short Biography

Prof. Auzuir Ripardo de Alexandria

Affiliation

Instituto Federal de Educação Ciência e Tecnologia do Ceará: Fortaleza, CE, Brazil

Biography

Auzuir R. Alexandria has a degree in Electrical Engineering (1993) and a Bachelor's Degree in Computer Science (1994) from the Federal University of Campina Grande, a master's degree (2005), and a doctorate (2011) in Teleinformatics Engineering from the Federal University of Ceará. He is a professor at the Federal Institute of Education, Science, and Technology of Ceará – IFCE, Fortaleza campus, Industry department, since 2003. As a researcher, he works in the fields of Computer Vision, Mobile Robotics, Biomedical Engineering, Artificial Neural Networks, and Industrial Automation, coordinating and guiding several projects. He is the leader of the Computer Simulation research group at IFCE.

Areas of Expertise

Major Area: Engineering / Area: Electrical Engineering.
Major Area: Engineering / Area: Electrical Engineering / Subarea: Industrial Electronics, Electronic Systems and Controls / Specialty: Electronic Automation of Electrical and Industrial Processes.
Major Area: Engineering / Area: Electrical Engineering / Subarea: Computer Vision.
Major Area: Engineering / Area: Electrical Engineering / Subarea: Industrial Electronics, Electronic Systems and Controls / Specialty: Electronic Process Control,Feedback.
Major Area: Engineering / Area: Electrical Engineering / Subarea: Embedded Automation Systems.

Dr. Sven Schulte

Affiliation
TVET School
School administration of the city of Dortmund
Germany

Areas of Expertise:

Learning, Pedagogics, Teaching and Learning, Academic Writing, Pedagogy, Assessment, E-Learning, Educational Evaluation, Technology Enhanced Learning, Blended Learning

Prof. Dr. I Gusti Putu Asto Buditjahjanto, S.T., M.T.

Affiliation
Electrical Engineering Department of State University of Surabaya (Universitas Negeri Surabaya- UNESA), Indonesia

Biography
I.G.P.A Buditjahjanto has a degree in Electrical Engineering in Telecommunication (1998) from Institut Teknologi Sepuluh Nopember (ITS), a master degree (2003) in Industrial Engineering from ITS and a doctoral (2011) in Game Technology from ITS. He is a profesor at UNESA, Electrical Engineering department, since 2021. As a researcher, he works in the fiels of Computational Intelligent, Decision Support System, Education Engineering. He is a member of MCDM Society.
Areas of Expertise
Major Area: Electrical / Area: Electrical Engineering/ Sub Area: Computational Intelligent, Artificial Intelligent, MCDM, intelligent System/ Specialty: Optimization, DSS, Decision Making.

TIMETABLE

10th September 2022

MC: *Paramitha Nerisafitra*, S.ST., M.Kom

Roswina Dianawati, S.Pd., M.Ed

Zoom Link: http://unesa.me/ICVEE2022

Or

Zoom Link:

https://us06web.zoom.us/j/83315901773?pwd=ekl1ZnJiZnFEMXU0bHl4a1kyYnVZZz09

Meeting ID: 833 1590 1773

Passcode: 839188

Time (GMT+7)	Activity
07.00 – 08.00	Online Registration
08.00 – 08.05	Opening and Rule Guidance
08.05 – 08.10	Listening Indonesia National Anthem
	Listening Mars of Universitas Negeri Surabaya
08.10 – 08.15	Conference report by ICVEE chair
08.15 – 08.25	Welcome Speech from Rector of Universitas Negeri Surabaya Prof. Dr. Nur Hasan.M. Kes
08.25 – 08.35	. IEEE Comsoc Indonesia Chapter Chair Opening speech: Dr. Bambang Setia Nugroho
08.35 – 08.45	Advisory Board Committee Representative Speech: Prof. Nobuo Funabiki Okayama University
08.45-08.55	Photo session
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09.00 – 09.50	**Keynote speaker 1** Prof. Auzuir Ripardo de Alexandria Instituto Federal de Educação Ciência e Tecnologia do Ceará: Fortaleza, CE (Brazil) Moderator : Pradini Puspitaningayu, S.T., M.T
09.50 – 10.40	**Keynote speaker 2** Prof. Dr. I Gusti Putu Asto B., S.T., M.T. Dept. of Electrical Engineering State University of Surabaya (Indonesia) Moderator : Dr. Yeni Anistyasari
10.40-10.45	Awarding Token of Appreciation I
11.00 – 12.00	**PARALLEL SESSION I** (5 breakout rooms) Room 1 – 5
12.00 – 12.30	BREAK
PLENARY SESSION II	
12.30 – 13.20	**Keynote speaker 3** Dr. Sven Schulte Scientific Researcher and Lecturer TU Dortmund University (Germany) Moderator : Dr. Lilik Anifah, M.T
13.20 – 13.25	Awarding Token of Appreciation II
13.25 – 13.45	Break
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Room 1

Moderator : Dr. Lilik Anifah

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2	2238	11.15-11.30	Evianita Dewi Fajrianti, Sritrusta Sukaridhoto, Nobuo Funabiki, Muhammad Udin Harun Al Rasyid, Rizqi Putri Nourma Budiarti and Yohanes Yohanie Fridelin Panduman	Design and Implementation of Indoor Navigation for PENS Visitors Using Augmented Intelligence
3	3145	11.30-11.45	Raymond Sunardi Oetama, Ford Lumban Gaol, Benfano Soewito and Harco Leslie Hendric Spits Warnars	When Candlesticks are different among Forex Brokers, can Traders still win?
4	4765	11.45-12.00	Lilik Anifah, Puput Wanarti Rusimamto, Haryanto Haryanto, I Made Arsana, Subuh Isnur Haryudo and Meini Sondang Sumbawati	Dentawyanjana Character Segmentation Using K-Means Clustering CLAHE Adaptive Thresholding Based
5	5178	13.45-14.00	Hapsari Peni Agustin Tjahyaningtijas, Laras Suciningtyas, Naim Rochmawati, Lusia Rakhmawati, Cucun Very Angkoso and Andi Kurniawan Nugroho	Brain Tumor Classification Using Deep Neural Network Based on MRI Images
6	5527	14.00-14.15	Rommel Traya, Raisa Mel Verona, Lady Ann Malatbalat, Lyra Nuevas, Dindo Obediencia, Ma.	Android Mobile Application: Tsunami Alert System with an Escape Route for

			Windie Velarde and Raymond Daylo	Evacuation in Municipal Disaster Risk Reduction and Management Office
7	6340	14.15-14.30	Surjandy Surjandy and Cadelina Cassandra	The Influence of Information Quality, Trust, and Risk Factors of The Digital Advertising on Buying Decision
8	7011	14.30-14.45	Yuni Yamasari, Anita Qoiriah, Naim Rochmawati, I.M. Suartana, Oddy Virgantara Putra and Andi Iwan Nurhidayat	Exploring the Kernel on SVM to Enhance the Classification Performance of Students' Academic Performance
9	9057	14.45-15.00	Yeni Kustiyahningsih, Eza Rahmanita, Devie Rosa Anamisa and Jaka Purnama	An integrated approach to determine mapping of SMEs during Covid-19 pandemic
10	9414	15.00-15.15	Evi Pane, Diah Risqiwati, Adhi Dharma Wibawa and Mauridhi Hery Purnomo	Gender Difference in EEG Emotion Recognition with Overlapping Shifting Window
11	9654	15.15-15.30	Cucun Very Angkoso, Ari Kusumaningsih, Hapsari Peni Agustin Tjahyaningtijas and Andi Kurniawan Nugroho	Multiclass Deep Transfer Learning for Covid 19 Classification

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2	2181	11.15-11.30	Yohanes Yohanie Fridelin Panduman, Nobuo Funabiki, Pradini Puspitaningayu, Masaki Sakagami and Sritrusta Sukaridhoto	Implementations of Integration Functions in IoT Application Server Platform
3	3087	11.30-11.45	Beatriz Silva Brasil, Auzuir Ripardo de Alexandria and Glendo de Freitas Guimarães	Artificial Intelligence applied to the classification of retinal diseases in Optical Coherence Tomography images
4	3229	11.45-12.00	Abdul Rahman Patta, Nobuo Funabiki, Yan Watequlis Syaifudin and Wen Chung Kao	An Implementation of Solving Activity Monitoring Function in Android Programming Learning Assistance System
5	6606	13.45-14.00	Pradini Puspitaningayu, Nobuo Funabiki, Yuanzhi Huo, Yohanes Panduman, Xinyu Wu, Minoru Kuribayashi and Wen-Chung Kao	Accuracy Investigations of Fingerprint-based Indoor Localization System Using IEEE 802.15.4 in Two-Floor Environment
6	7160	14.00-14.15	Naim Rochmawati, Hanik Badriyah Hidayati, Wiyli Yustanti, Yuni Yamasari, Hapsari Peni Agustin Tjahyaningtijas,	Brain Tumor Classification Using Transfer Learning

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8	7992	14.30-14.45	Irin Tri Anggraini, Nobuo Funabiki, Pradini Puspitaningayu, Shih-Wei Shen, Wan-Chia Huang and Chih-Peng Fan	Implementation and Evaluation of Exercise and Performance Learning Assistant System Platform for Yoga Pose Practices Using Node.js
9	8015	14.45-15.00	Shintami Hidayati, Nafa Zulfa, Pima Safitri and Yeni Anistyasari	Exploring the Potential of Adopting Computer-graphics Animation to the Switch to a Plant-Based Diet
10	8979	15.00-15.15	Glenn Gumba and Jessie Paragas	PREDICTION ANALYSIS OF STUDENT ADMISSION TO INFORMATION TECHNOLOGY EDUCATION (ITE) PROGRAMS USING CLASSIFICATION ALGORITHM
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2	409	11.15-11.30	Rifqi Firmansyah	Power Sharing Control and Voltage Restoration in DC Microgrid Using PI Fuzzy
3	3634	11.30-11.45	Widi Aribowo, Reza Rahmadian, Ayusta Wardani, Mahendra Widyartono, Bambang Suprianto and Aditya Chandra Hermawan	Marine Predators Algorithm For Tuning DC Motor
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5	6910	13.45-14.00	Yanuar Zulardiansyah Arief, Hendri Masdi, Nur Izziani Roslan, Mohd Hafiez Izzwan Saad, Hamzah Eteruddin and Rosyid Ridlo Al Hakim	Investigation on Various Faults of 500 kV Transmission Line Design in Sarawak, Malaysia Using Power Systems Computer Aided Design
6	7243	14.00-14.15	Unit Three Kartini, Hariyati Hariyati, Widi Aribowo and Ayusta Lukita Wardani	Development Hybrid Model Deep Learning Neural Network (DL-NN) For Probabilistic Forecasting Solar Irradiance on Solar Cells To Improve Economics Value Added

7	7547	14.15-14.30	Ilham A.E. Zaeni, Wahyu Primadi, Dessy Rif'A Anzani and Anik Nur Handayani	Detection of the Imbalance Step Length using the Decision Tree
8	8559	14.30-14.45	Yanuar Zulardiansyah Arief, Hendri Masdi, Kelvin Juing Anak Tinggom, Aulia, Irza Sukmana and Rosyid Ridlo Al Hakim	Simulation of Water Tree Defect on Different Type of XLPE Underground Power Cable Using Finite Element Analysis
9	9022	14.45-15.00	Widi Aribowo, Reza Rahmadian, Mahendra Widyartono, Aditya Chandra Hermawan, Ayusta Lukita Wardani and Unit Three Kartini	Tasmanian Devil Optimization For Economic Load Dispatch
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11	9806	15.15-15.30	Jamiu Omotayo Oladigbolu, Mustafa M.A. Seedahmed, Rifqi Firmansyah Muktiadji and Amir A. Imam	Optimal Design and Viability Assessment of a Stand-alone Hybrid Power System for the Electrification of a Grid-unconnected Location in Saudi Arabia

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4	5716	11.45-12.00	Arda Editya, Neny Kurniati and Angga Lisdiyanto	Optimalization Jaro Winkler Algorithm Using Fuzzy Logic to Evaluate Essay Questions in E-Learning System Based Microserver
5	5985	13.45-14.00	Mohammad Idhom, Munoto Munoto, I Gusti Putu Asto Buditjahjanto and Muchlas Samani	Performance Evaluation of Automated Essay Scoring Online System for Competency Assessment of Community Academy
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10	9816	15.00-15.15	Sunarti Sunarti and Irawan Dwiwahyono	Optimizing the Certainty Factor on K-Nearest Neighbor to Determine the Learning Model during the Pandemic

Investigation on Various Faults of 500 kV Transmission Line Design in Sarawak, Malaysia Using Power Systems Computer Aided Design

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***Abstract*—This paper deals with simulation investigation on 500 kV transmission line design in Sarawak, Malaysia using Power Systems Computer Aided Design (PSCAD). Currently transmission system in Sarawak mainly supplied by 275 kV system which covering whole Sarawak state, starting from Miri district up to Kuching city - so called Sarawak Power Grid Backbone. Due to rapidly growth of industries and population in this state within last ten years, it is necessary to improve the transmission system become 500 kV. Therefore the investigation on transient overvoltage and overcurrent in a new 500 kV transmission line system when faults occurs due to various faults on the line as well as lightning strike, will be important in order to evaluate the system reliability. It was found that the lightning and three-phase faults cause the highest transient current surge on the line up to 9.06 and 9.27, respectively while the highest lightning transient overvoltage was observed at the receiving end of the line where it is near to Tada substation.**

Keywords—500 kV transmission line, single-line to ground fault, double-line to ground fault, line to line fault, three-phase fault, line energizing, lightning surge, PSCAD simulation, substation.

I. INTRODUCTION

Transmission system is an important part in electrical power since this part for transmitting the electricity from power plant to consumer's load. The power losses of the transmission line are rapidly changing from year to year at the rate of 3.85% in the year of 2013 to 5.792% in 2014 [1]. Losses in transmission system are most likely from power quality problems such as transients. Transients are the high unexpected increment in voltages or currents magnitudes. The transients might be caused by faults in the line such as single-line to ground fault, lightning strikes as well as line energization. The damage of power lines insulators and supply interruption could be happened due to the oscillatory and impulsive transient waveforms [2-3]. Transient phenomena become one major power quality problems which make power transmission interruption and breakdown. The surges due to transients can vitally cause power system failure and breakdown of electrical equipment especially at the substations.

Many researches have been performed on transient overvoltage and overcurrent surge due to various faults including lightning strikes in power transmission lines [4-8]. Malaysia has a high record of isokeraunic level nearly 200 thunderstorm days per year. The high number of lightning strike is responsible for 50% of the total number of system failures in *Tenaga Nasional Berhad* (TNB) system; a national power company, and caused multiple trip-outs on the EHV transmission lines every year [9]. The keraunic number is a system to describe lightning activity by using thunder audible detection in a specific area. It is about 30 kA to 120 kA lightning current may occur during lightning strikes. Meanwhile, lightning current is typically more than 20 kA in Malaysia [10]. That will cost fatal death and breakdown of electrical equipment.

The main objective of this research work is to investigate the performance of Sarawak 500 kV transmission line design due to various faults, namely single-line to ground, double-line to ground, line to line, three-phase faults, lightning surges as well as line energization by employing Power System Computer Aided Design (PSCAD) software. The model of faults and their transients' waveforms profiles will be

conducted systematically in this study. The result hopefully could give a better understanding in study of transient phenomena in high voltage transmission line.

II. METHOD

A. PSCAD Software

In this research work, Power Systems Computer Aided Design (PSCAD) software was employed to simulate the transient overvoltage and overcurrent due to various faults in 500 kV transmission line like three-phase fault, lightning strike as well as line energized. We used PSCAD version 4.6 for completing this simulation works. PSCAD is one of main software in electrical power system which can simulate electrical as well as electronic components from simple passive elements and control functions to electric machines and other complex devices. This software widely uses to study on power quality particularly on power system transient investigation study. PSCAD developed by Manitoba Hydro International Ltd, Canada [11-12].

B. Procedure of Simulation

Flowchart of simulation study for 500 kV transmission line design in Sarawa, Malaysia due to various faults is depected in Fig. 1. Firstly, we define the necessary parameters for transmission line simulation in PSCAD, such as transmission line configuration and power outputs off of power plants in the Sarawak Power Grid System. All the date were fed into the simulation model and then PSCAD runs the simulation analysis. The simulation results will be compared with different type of faults and the graph were plot using Microsoft Excel. While, Fig. 2 shows the structue of Sarawak Power Grid System which used in this investigation. Note that, the current main transmission line system is 275 kV which cover from Tudan to Sejingkat district. The design of 500 kV transmission system also shown in the figure indicated by dash line.

Table 1 shows the data of voltage sources for all power stations in Sarawak Power Grid System for this simulation study. Models of various faults are described in Figures 3, 4, 5, respectively, namely three-phase, single line to ground, double line to ground, line to line faults, lightning surge as well as line energizing.

TABLE I. VOLTAGE SOURCE INPUT PARAMETER IN PSCAD SIMULATION [13]

Power station	Type	Output Power	Voltage	Resistance
Sejingkat	Coal	210MW	132kV	82.97
Tun Abdul Rahman	Thermal Diesel = 46MW Gas = 68MW	114MW	132kV	152.84
Batang Ai	Hydro	108MW	275kV	700.23
Pujut	Geothermal	79MW	275kV	957.28
Bintulu	Geothermal	514MW	275kV	146.56
Bakun	Hydro	2400MW	275kV	31.51
Murum	Hydro	944MW	275kV	80.11
Mukah	Coal	270MW	132kV	64.53
Balingian	Coal	600MW	275kV	126.04

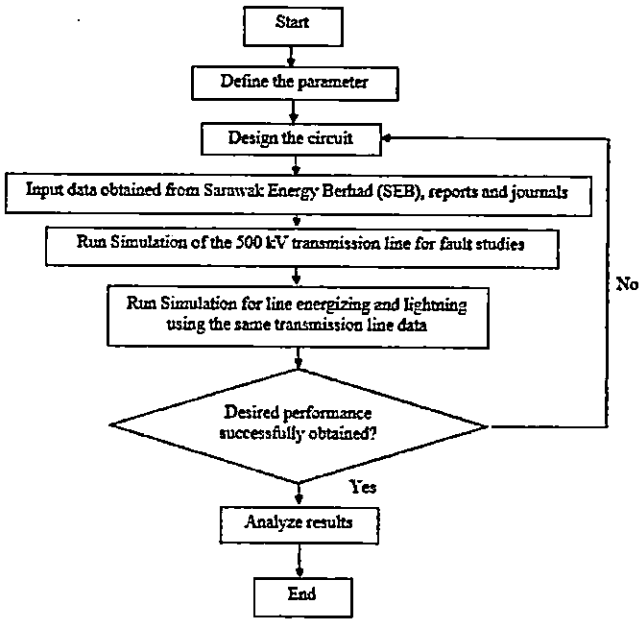


Fig. 1. Flowchart of simulation for 500 kV transient various faults.

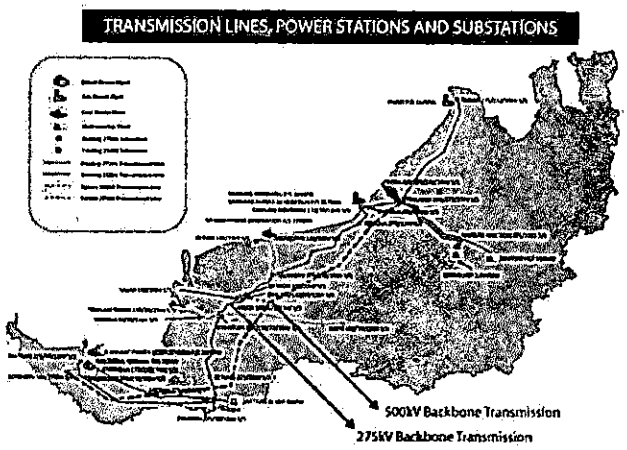


Fig. 2. The existing 275 kV transmission system and design of 500 kV system in Sarawak, Malaysia Power Grid System [13].

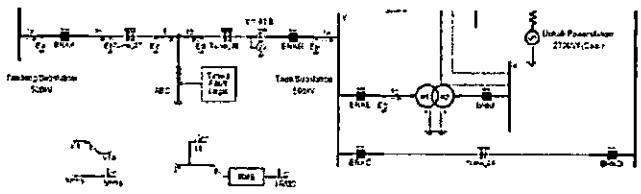


Fig. 3. Model of fault in PSCAD for the simulation work in this study.

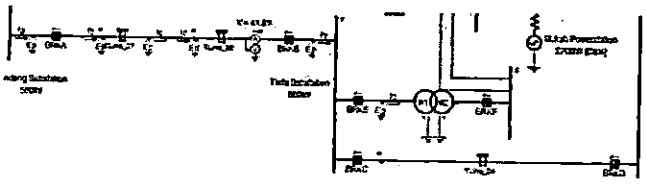


Fig. 4. Model of line energizing in PSCAD for the simulation work in this study.

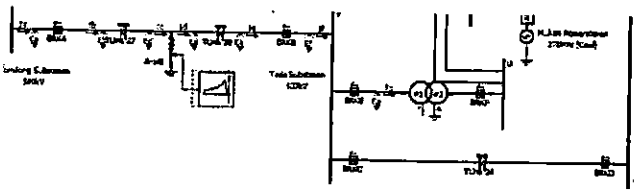
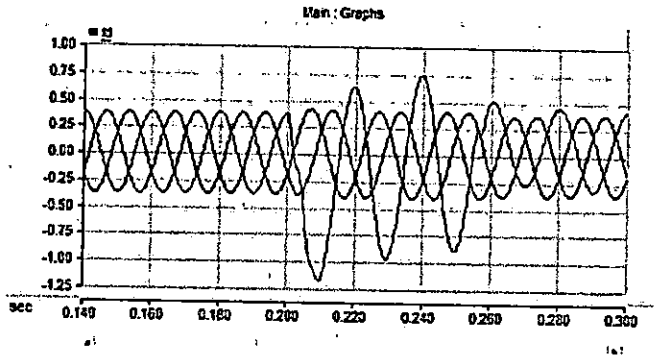


Fig. 5. Model of lightning surge in PSCAD for the simulation work in this study.

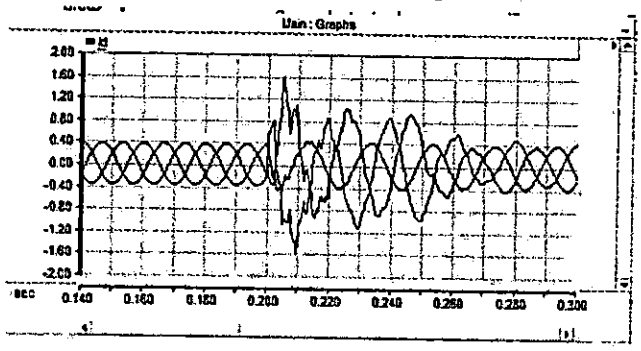
III. Result and Discussion

Fig. 6 shows the typical waveform profile of current transient in 500 kV transmission system which obtained from the PSCAD simulation results for fault duration of 0.05s. As can be seen from the figure, the current magnitude increases higher than its nominal rate. It was observed that, the transient magnitude for each faults are 4.6, 4.9, 5.2, 5.3 p.u., respectively. The all transient magnitudes of faults are summarized in Fig. 7. The graph shows the highest peak current between all four types of fault on 500 kV Sarawak transmission line design system. The reading is taken at two different point of location which are receiving end and middle line which is the fault location. The highest current which is the most severe faults is three-phase fault measured at the receiving end with 5.25 p.u. followed by three-phase fault measured at the fault location with the value of 5.11 p.u. Then, transient magnitude of current profile for longer fault duration, namely 1.0s was also performed in this study. The maximum current magnitudes which observed at receiving and middle line are summarized in Fig. 8. As can bee seen from the graph, three-phase fault at the receiving end of transmission line has the highest magnitude compared to the single-line to ground fault, namely 9.27 p.u. This is because of the occurred fault might to keep increase as high current travel in longer distance with longer of fault duration.

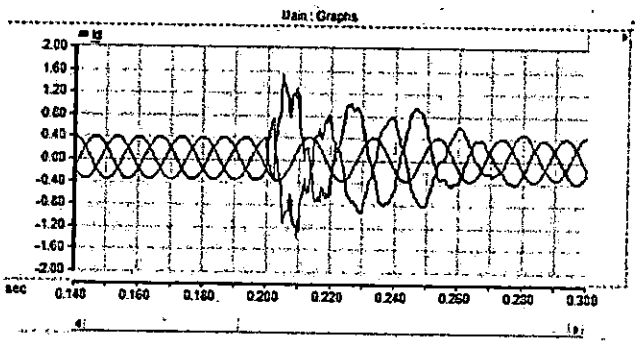
Fig. 9 and 10 show simulation results for line energizing which observed at Tada and Tondong substation of 500 kV transmission line. The sending end refer to transmission line near Tondong substation of Kuching division. The receiving end voltage showed that the voltage before energizing at the sending end to be higher than after energizing. This is because the receiving end carry power from Bakun and Murum Hydropower station which is large power station in Sarawak. Bakun running capacity was 2400 MW per day made it to be the largest hydro power station in Sarawak.



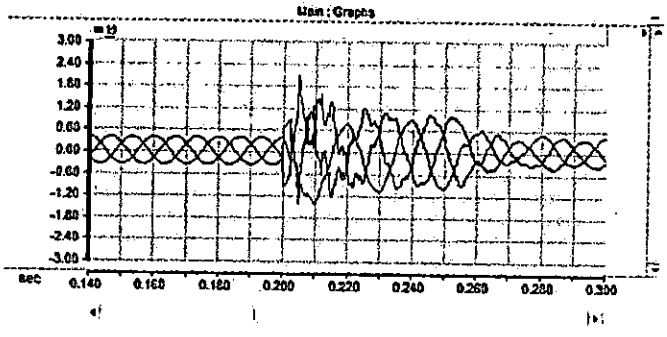
(a) Current waveform of single-line to ground fault.



(b) Current waveform of double-line to ground fault.



(c) Current waveform of line to line fault.



(d) Current waveform of three-phase fault.

Fig.6. Simulation results of various faults which obtained from PSCAD.

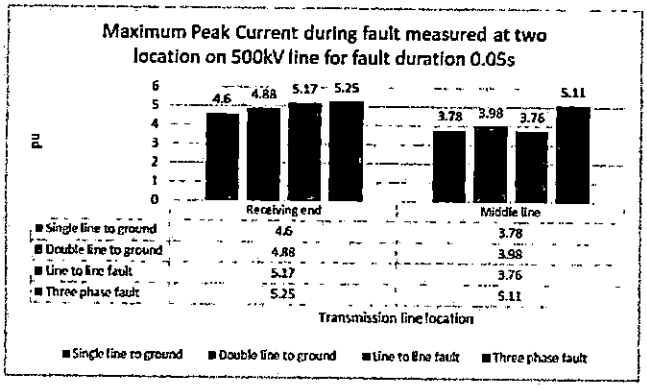


Fig. 7. Current magnitudes during fault measured at two locations for 0.05s.

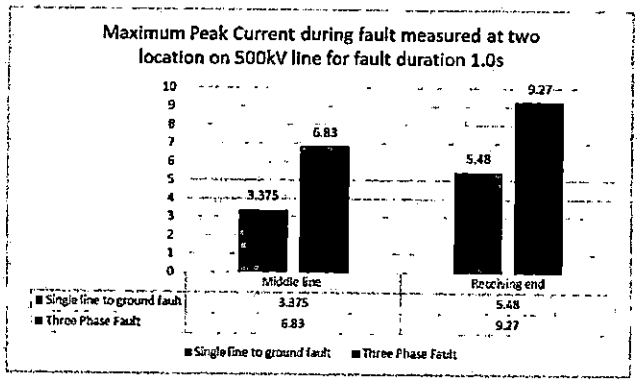


Fig. 8. Current magnitudes during fault measured at two locations for 1.0 s.

During the energization, voltage waveform seems to have disturbances before return to its nominal value. The voltage waveform reached nominal value after line energization is due to the power is being distribute evenly through Tondong substation. Summary of maximum values for line energizing simulation are summarized in Fig. 11. The highest current amplitude of 3.89 p.u. occurred at same time for both Tondong and Tada substation, whereas highest voltage amplitude of 2.42 p.u. occurred at receiving end of Tondong substation.

Lastly, we investigated effect of lightning strike at 500 kV Sarawak transmission line design with low and high magnitude, namely 30 and 120 kA, respectively [14-16]. The lightning waveform is 1.2/50 μs according to IEC standard lightning waveform. Fig. 12 and 13 show the transient current profile in the middle line during 30 and 120 kA lightning strike at the middle line of 500 kV transmission line. The maximum values of transient current due to the lightning strike at middle and receiving ends are summarized in Fig. 14. It was found that there is not much different of current magnitude increment of 30 kA lightning than that of 120 kA lightning strike. Moreover, the highest current magnitude was observed at receiving end of transmission line when lightning strike at the receiving end as well. While, the lowest current magnitude occurred at receiving and of transmission when lightning strike in the middle of the line.

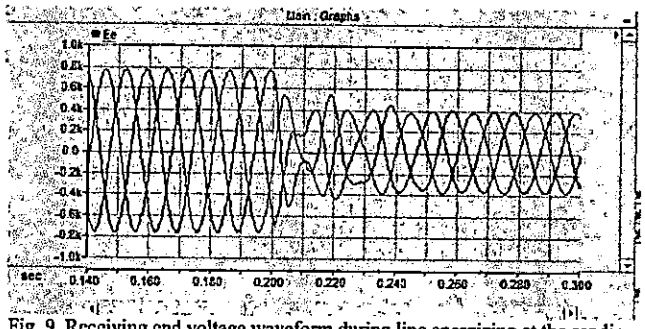


Fig. 9. Receiving end voltage waveform during line energizing at the sending end which observed at Tondong substation.

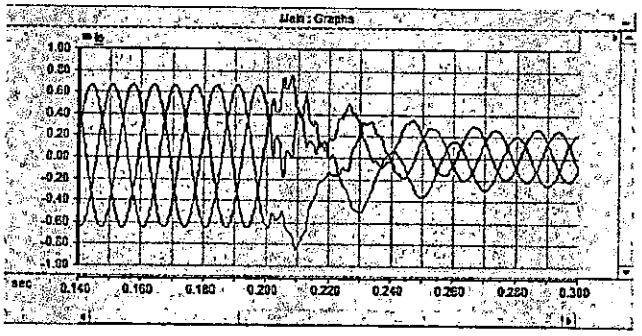


Fig. 10. Receiving end current waveform during line energizing at the sending end which observed at Tondong substation.

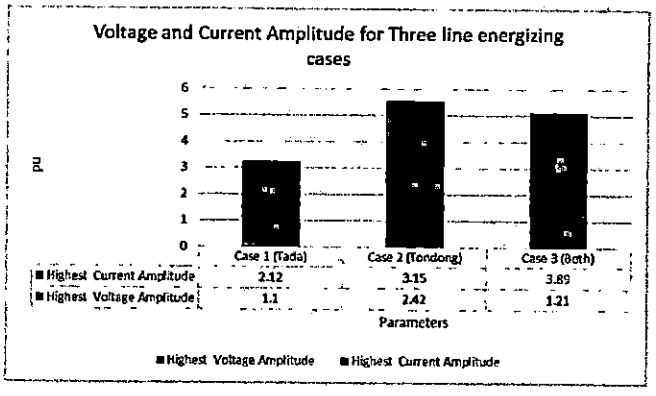


Fig. 11. Summary of maximum values for line energizing faults which obtained from simulation results in PSCAD.

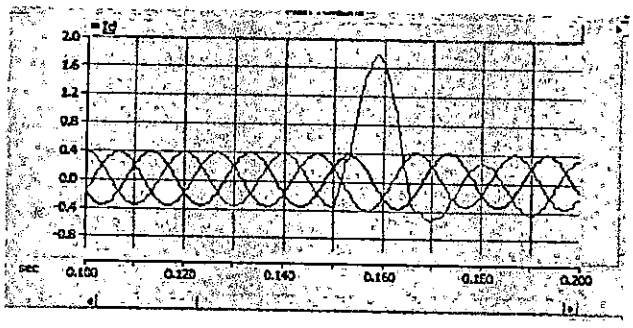


Fig. 12. Transient current profile in the middle line during 30 kA lightning strike at the middle line of 500 kV transmission line.

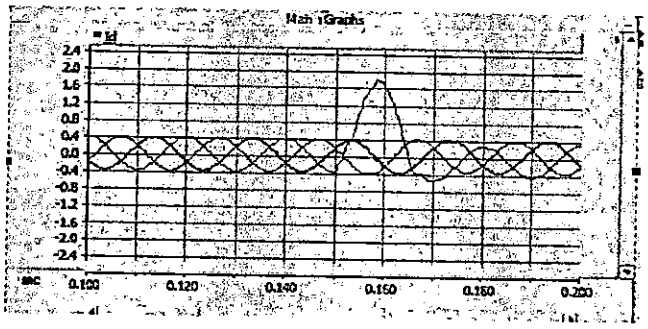


Fig. 13. Transient current profile in the middle line during 120 kA lightning strike at the middle of the line.

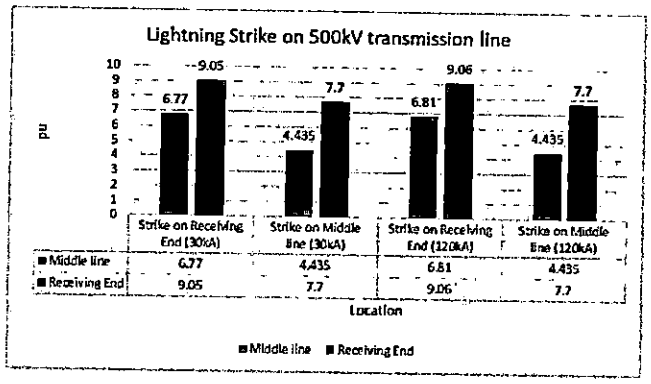


Fig. 14. Simulation results in PSCAD for lightning strike occurred at Sarawak 500 kV transmission line design.

IV. CONCLUSION

Investigation of various faults on design of 500 kV transmission line in Sarawak, Malaysia using power Systems Computer Aided Design (PSCAD) has been completed successfully in this study. The main results obtained from this study are summarized as followings.

- The three-phase fault caused the high current magnitude rise compared to other faults which is 5.25 p.u. for 0.05s fault duration, meanwhile 9.27 p.u. for 1.0s fault duration, respectively. This is due to the current of three lines are overlapping during faults and reach the ground. This phenomenon was unlikely to occur but still have to put into consideration upon designing a high voltage transmission line especially for the protection system of the line.

- For the line energization of transmission line, the highest current magnitude recorded at both ends of transmission line having current of 3.89 p.u. compared to the nominal current value. Line energizing is a normal activity but since the starting of high voltage transmission line causes a high current at initial state, the line energizing has to be simulated to study its effect against the transmission line. By knowing the maximum value which might be occurred, the transmission line can be designed properly for electrical protection system. The line energization somehow can cause fault up to certain point.

- For lightning surge fault, a lightning magnitude of 120 kA causes largest current to increment up to 9.06 p.u. compared to the nominal current magnitude followed by 30 kA of lighting magnitude. The lightning strike on the transmission line usually because the lightning current tends to travel to ground using fastest route. Moreover, the material of that transmission line is usually conductor which have high conductivity increasing the probability for lightning to occur in that transmission line.

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